Ocean Water Desalination

Program Master Plan (PMP)

Volume I

January 2013

Signature Page

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

Executive Summary

January 2013

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Acronyms

AACE	American Association of Cost Engineering
ACOE	U.S. Army Corps of Engineers
ADP	Alternative Project Delivery
AFY	Acre Feet per Year
BIP	Base Interruptible Program
CC	Combined Cycle
CCC	California Coastal Commission
CDP	Coastal Development Permit
CEC	California Energy Commission
CEQA	California Environmental Quality Act
CPUC	California Public Utilities Commission
CSDPR	Conceptual System Design and Program Requirements
DB	Design-Build
DBB	Design-Bid-Build
DBO	Design-Build-Operate
DBOOT	Design-Build-Own-Operate-Transfer
EIR	Environmental Impact Report
EIS	Environmental Impact Statement
ERP	Environmental Review Plan
ESGS	El Segundo Generating Station
ESP	Energy Service Provider
FERC	Federal Energy Regulatory Commission
HDD	Horizontal Directional Drilling
IPP	Independent Power Producer
kV	Kilovolt
kWh	Kilowatt-Hour
LCOE	Levelized Cost of Energy
MCC	Motor Control Center
MGD	Million Gallons per Day
MW	Megawatt
MWD	Metropolitan Water District of Southern California

NEPA	National Environmental Policy Act
NERC	North American Electric Reliability Corporation
O&M	Operations and Maintenance
OMP	Operations & Maintenance Plan
OWDDF	Ocean Water Desalination Demonstration Facility
OWDPMP	Ocean Water Desalination Program Master Plan
PDP	Project Delivery Plan
PEAP	Project Entitlements and Acquisition Plan
PFD	Process Flow Diagram
PFP	Project Costs & Funding Plan
PMP	Program Master Plan
PPP	Project Permitting Plan
PPP	Public Private Partnerships
PSP	Power Supply Plan
PV	Photovoltaic
QTCB	Qualified Tax Credit Bond
RBGS	Redondo Beach Generating Station
RFP	Request for Proposal
RO	Reverse Osmosis
SCAQMD	South Coast Air Quality Management District
SCE	Southern California Edison
SDP	Seawater Desalination Program
SOQ	Statement of Qualifications
SWRO	Seawater Reverse Osmosis
TOU	Time of Use
TM	Technical Memoranda
UWMP	Urban Water Management Plan
WBMWD	West Basin Municipal Water District
WIFIA	Water Infrastructure Finance and Innovation Authority

1. Introduction

1.1. Background

The West Basin Municipal Water District (West Basin) is one of 26 member agencies of the Metropolitan Water District of Southern California (MWD) and provides wholesale water service to approximately 1 million people on the coastal plain of the Los Angeles area. West Basin also provides regional management of the area's water resources through production and distribution of recycled water, extensive public education, and customer water conservation programs. These activities combined have significantly reduced West Basin's dependency on imported water. To further that reduced dependency, West Basin is integrating desalinated ocean water as a portion of their local water supply portfolio through a "stepwise approach" which has included extensive pilot testing, demonstration testing of full-scale processes, conducting numerous technical studies, and development of a comprehensive program master plan.

Piloting: Over an eight year period, West Basin conducted ocean water desalination pilot testing at the El Segundo Power Generating Station in El Segundo, California and assessed the feasibility of turning ocean water into drinking water. Various water treatment technologies (i.e., High rate pre-screening, microfiltration/ultrafiltration, reverse osmosis, etc.) were piloted and extensive water quality monitoring of the raw ocean source water, discharge concentrate, and product water quality was performed. As a result of this testing, West Basin concluded that ocean water desalination could be a viable alternative water supply and additional research was needed to further develop it as a future water supply resource.

Demonstration Project: West Basin is currently conducting larger scale testing at their Ocean Water Desalination Demonstration Facility (OWDDF) at the SEA Lab in Redondo Beach, California. The OWDDF was completed in 2010 and has been operating continuously. The OWDDF is providing West Basin with the opportunity to build on the operational protocols and challenges from piloting to establish environmentally-effective and sustainable intake technologies, determine an approach to energy usage and optimization/minimization, develop process optimization protocols, determine operational requirements, establish target water quality goals, and evaluate concentrate discharge management options. The OWDDF includes an evaluation of passive screening and subsurface intake systems, energy consumption and optimization analysis and an intensive brine discharge study. The results of the two to three year demonstration project will be used as the foundation for development of a full-scale design, permitting, and operations approach.

Comprehensive Planning: West Basin continues developing ocean water desalination as a reliable and local water supply source and is defining and assessing the critical components of a full-scale ocean water desalination program. The assessment results and desalination program requirements are documented in this Ocean Water Desalination Program Master Plan (PMP).

1.2. Project Objectives and Purpose

The purpose of West Basin's Ocean Water Desalination Program Master Plan (PMP) is to define the overall desalination program scope and the key project components. These critical components consist of supply availability, water demands, siting alternatives, intake and discharge facilities, treatment process engineering and technological requirements, conveyance and distribution requirements, system integration and treated water quality requirements, environmental and permitting requirements, power supply development, capital and O&M costs, project delivery, and operational requirements.

1.3. Report Organization

The PMP document is comprised of a number of technical memoranda (TM), which address each of the critical program components providing detailed narrative, analysis, calculations, exhibits, drawings, and conclusions. The PMP document is divided by TM such that each component can be referenced by section. This report division (and an objective of the PMP) is intended to be used as a technical study for the California Environmental Quality Act (CEQA)/Environmental Impact Report (EIR) process and in support of the basis of design development for the full-scale project. The PMP includes the following sections:

- **TM 1: Conceptual System Design and Program Requirements (CSDPR) –** This section defines alternatives for all key project components; assesses and prioritizes these alternatives; and provides recommendations for narrowing the selection of key project components (intake, pretreatment, reverse osmosis desalination system, post-treatment and product delivery).

- **TM 2: Power Supply Development (PSP) –** This section provides an estimate for the electrical power consumption for the desalination plant and evaluates several power supply alternatives (conventional onsite generation, renewable onsite generation, and direct purchase from Southern California Edison [SCE]).

- **TM 3: Project Entitlements and Acquisition (PEAP) –** This section indentifies the significant key project entitlements, such as land purchase or lease agreements, needed for program implementation and provides a plan and schedule for their acquisition.

- **TM 4: Environmental Review Plan (ERP) –** This section defines and scopes the environmental impact investigation requirements, including data obtained through technical studies related to facilities and equipment. The ERP is intended to provide a "roadmap" for the environmental review process and outline the critical issues and decision points within that process.

- **TM 5: Project Permitting Plan (PPP) –** This section lists the major regulatory permits that may be required by West Basin in order to complete the desalination project. Critical issues for each permit are identified, along with additional data and studies needed in order to prepare the permit. Content for permit applications and suggestions for negotiations of permit provisions and conditions are also discussed. Finally, this plan defines the scope and budget for the implementation of the engineering support studies needed for project permitting.

- **TM 6: Facility Operations & Maintenance Plan (OMP) –** This section identifies 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.

- **TM 7: Project Costs & Funding Plan (PFP) –** This section provides an overview of complete project costs for all plant sizes and capacity buildout scenarios. It also outlines potential sources of project funding (internal, federal, state, regional, public private partnerships), assesses the viability of funding structures, and discusses the sequence and schedule of borrowings.

- **TM 8: Project Delivery (PDP) –** This section provides an overview of Alternative Project Delivery options (Design-Bid-Build, Design-Build, Design-Build Operate, Construction Manager at Risk, Design Build Own Operate Transfer, Alliance) and highlights the advantages and disadvantages of each. It also provides a more detailed comparison of Design-Bid-Build, Design-Build, and Design-Build-Operate, including an analysis of cost and schedule impacts and contractor procurement requirements for project delivery.

2. Project Components

2.1. Conceptual System Design

Demand & Supply

West Basin's 2010 Urban Water Management Plan (2010 UWMP) provides the most current review of water demands for its service area through 2035. The 2010 UWMP discusses a projected increase in water demands as the economy improves. However, planned conservation activities and conserved supply are estimated to offset this demand, resulting in a fairly static overall demand of less than 200,000 AFY from 2015 through 2035. West Basin's Water Reliability 2020 Program (WR 2020) targets reducing the District's dependence on imported water from 66 percent down to approximately 33 percent by the year 2020. To achieve this, WR 2020 focuses on maximizing recycled water production, expanding conversation efforts, and producing new sources of local potable water, including ocean water desalination.

Base demands were evaluated for both local and regional scale projects. The local project focuses on MWD service connections along the West Coast and West Basin Feeders west of the Sepulveda Feeder, which services the majority of West Basin's service area. The local demand supports up to a 20-MGD plant. Although the regional MWD conveyance system is capable of taking upwards of 60-MGD, the regional plant demand based on existing MWD operational constraints is 25-MGD. West Basin continues to work with MWD to evaluate regional supply approach options and approaches to limit operational constraints. Although it has not yet been determined if a larger facility is necessary, a regional plant size of 60-MGD has been selected for conceptual development within this study. Both the El Segundo and Redondo Beach sites can support up to a 60-MGD ocean water desalination plant. A total of five scenarios were considered for cost development in Section 2 of the PFP:

(1) Fully built-out 10-MGD facility

(2) Fully built-out 20-MGD facility

(3A) 10-MGD facility with 40-MGD backbone for expansion

(3B) Fully built-out 40-MGD facility

(4) Fully built-out 60-MGD facility

Conceptual development in the CSDPR was performed only for the fully built-out 20-MGD and 60-MGD facility options.

Siting Evaluation

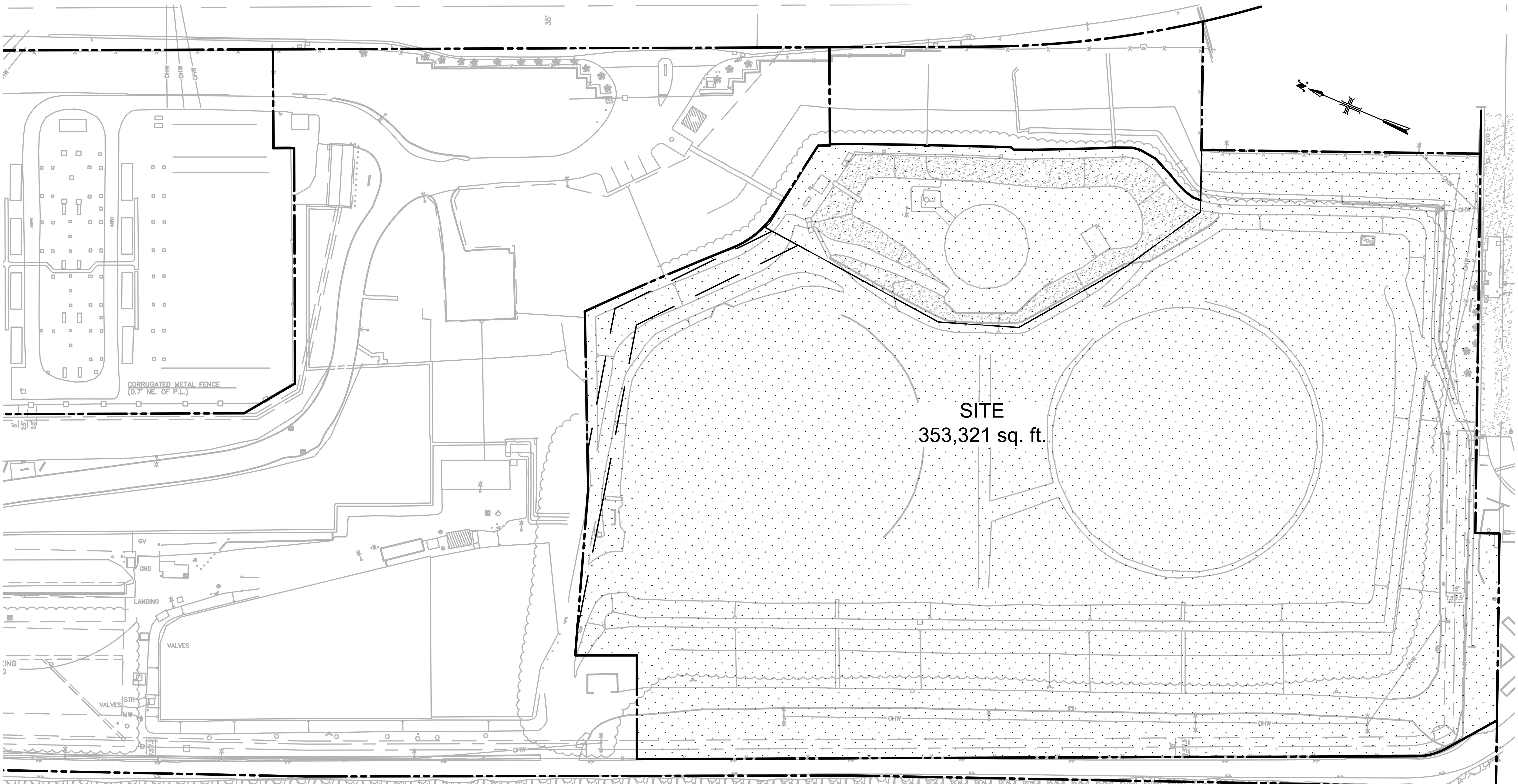
Two candidate desalination plant sites (El Segundo Generating Station [NRG] and Redondo Beach Generating Station [AES]) were reviewed for addressing both Local and Regional scenarios. See **Figures 2-1 and 2-2** for site boundary maps. West Basin previously looked at two additional sites, LADWP's Scattergood Generating Station and Chevron's El Segundo Refinery. Based on project considerations, the NRG and AES sites were selected by West Basin for this study. The NRG and AES sites were assessed and ranked using a standardized approach that considered several key performance factors grouped into categories as follows:

- Technical Performance
- Economic Performance
- Environmental Performance
- Social Performance

Each category was assigned a weighting factor. Criteria under each category was ranked and summed for each site. Category subtotals were then weighted and combined to derive a total score. Notable differences in the rankings can be attributed mainly to differences in space availability at each site. Overall, the performance rating assessment revealed similar results for both of these candidate sites. **Table 2-1** presents the results based on the initial weighting factors. A sensitivity analysis, which varied the distribution of weighting factors, showed a near equivalent rank. The sensitivity analysis can be found in Section 3 of the CSDPR.

Table 2-1: Standard Performance Rating Form

	Description	Percentage	Score	
			Site 1	Site 2
Technical Performance	Treatment Technology and Operational Complexity	40%	25	26
Economic Performance	Sound Financial and Resource Management	20%	12	11
Environmental Performance	Environmental Stewardship	20%	11	12
Social performance	Stakeholder Acceptance and Customer Service	20%	14	13
Overall Performance		100%	64	65



NOTES:

1. PARCEL BOUNDARIES PER PSOMAS ALTA/ACSM LAND TITLE SURVEY, DATED 7/21/11.

40 0 40 80
SCALE: 1" = 80'

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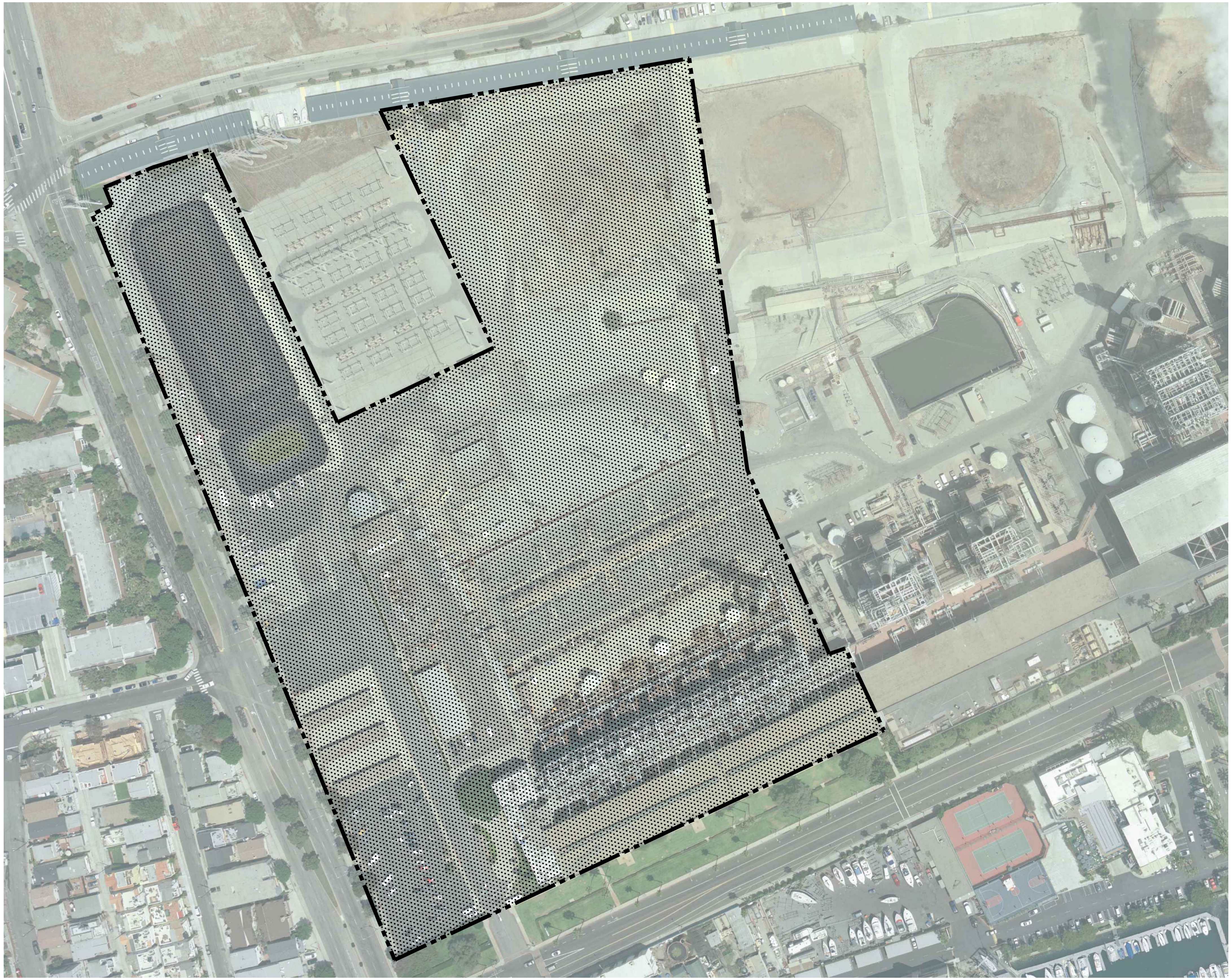
PROGRAM MASTER PLAN (PMP)

NRG ENERGY, INC. – 301 VISTA DEL MAR, EL SEGUNDO, CA. 90245
SITE BOUNDARY MAP
SCALE: AS NOTED

JANUARY 2013

FIGURE 2–1



N.

75 0 75 150
SCALE: 1" = 150'

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PROGRAM MASTER PLAN (PMP)

AES CORPORATION – 1100 N. HARBOR DR., REDONDO BEACH, CA. 90277

SITE BOUNDARY MAP

SCALE: AS NOTED

JANUARY 2013

FIGURE 2–2

Intake & Discharge

Both candidate project sites have existing ocean water intake and discharge tunnels that are being considered for desalination plant intake and discharge. The large diameter (12-ft at El Segundo and 10-ft at Redondo Beach) tunnels were originally designed for the generating station cooling systems at each site. Both subsurface and open surface intake and discharge alternatives were assessed, including advantages and disadvantages, description of the technology, and an analysis of how the technologies relate to the potential sites.

Five alternative subsurface intake technologies were considered for each of the two possible desalination plant sites, including:

(1) Infiltration Galleries and Seabed Filtration Systems

(2) Horizontal Collector Wells

(3) Horizontal Directional Drilled Wells

(4) Slant Wells

(5) Conventional Vertical Wells

Table 2-2 summarizes the various subsurface intake alternatives, and shows the measures of merit assigned to each to quantify their relative feasibility according to the selected screening criteria. The alternative with the lowest total score is considered the most feasible alternative. As shown in the table, subsurface intake alternatives would be relatively challenging to implement at the project sites. Results need to be compared with the open surface alternatives provided in **Table 2-3.**

Table 2-2: Screening of Subsurface Alternatives

Subsurface	Environmental Impact	Hazardous Waste	Contamination	Wave & Tsunami	Seismic	Public	Infrastructure Reuse	Integrity of Existing	Additional Studies	O&M	Constructability	Relative Cost	Overall
Infiltration Galleries & SF	10	7	10	10	10	10	0	0	10	7	10	8.5	**92.5**
Horizontal Collector Wells	10	7	10	10	10	10	0	0	10	7	10	8.5	**92.5**
HDD Wells	5.5	10	10	10	10	5.5	0	0	10	7	8.5	7	**83.5**
Slant Wells	5.5	10	10	10	10	10	0	0	10	7	8.5	5.5	**86.5**
Convential Vertical Wells	10	7	10	10	5.5	10	0	0	10	7	8.5	5.5	**83.5**

Severe	10.0
Very High	8.5
High	7.0
Fair	5.5
Acceptable	4.0
Good	2.5
Best	1.0
N/A	0.0

Open surface intake and discharge alternatives considered include the following:

(1) Existing Tunnels for Intake and Discharge

(2) Existing Tunnels as Casings for new Intake and Discharge Pipes (pipe inside pipe)

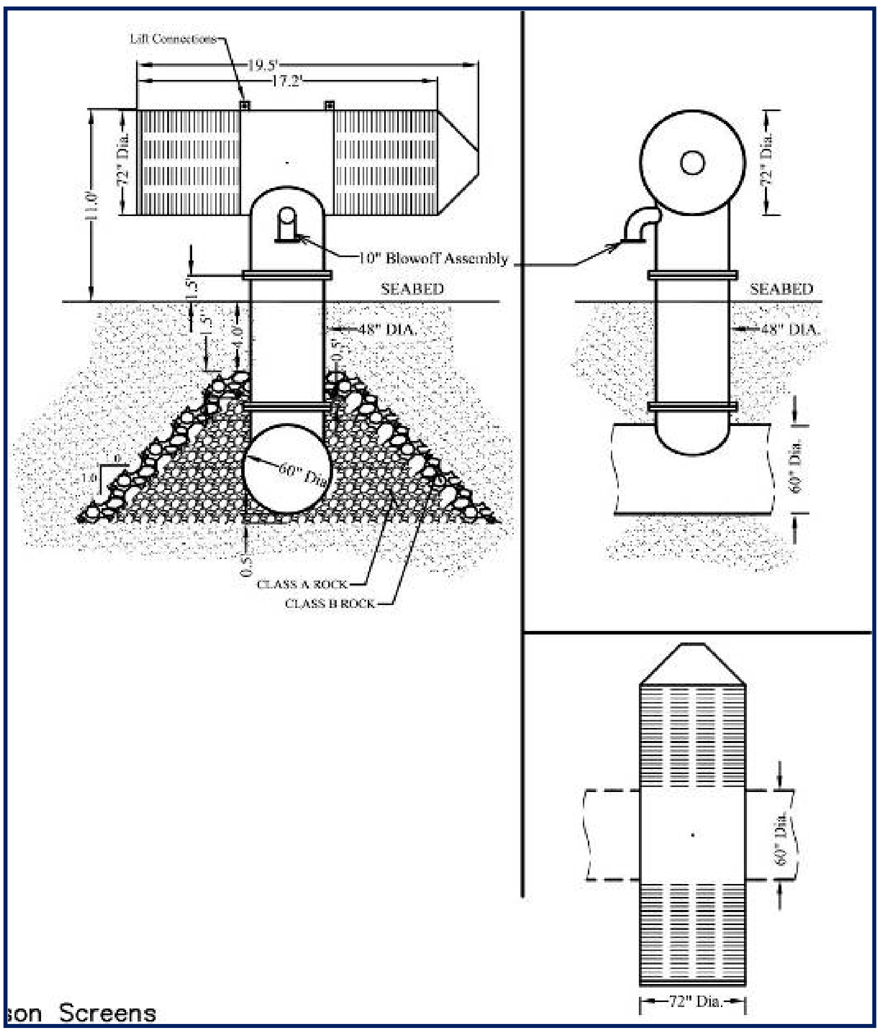
(3) Discharge into the nearby Hyperion Outfall

(4) Combined Intake and Discharge Tunnel

(5) Two Horizontal Directional Drilling (HDD) Pipelines for New Intake and Discharge

Intake and discharge appurtenances include intake screens and discharge diffusers. A passive wedge wire screen (**Figure 2-3**) has conceptually been assumed for the intake. When properly designed, this type of intake screen was shown to minimize the possible levels of entrainment and eliminate impingement of aquatic life.

Figure 2-3: Example Open Intake with Wedge Wire Screen (60-MGD)



Since the brine plume is denser than seawater and tends to concentrate on the bottom, it is necessary to enhance mixing. This can be accomplished using multi-port diffusers. Preliminary single and double diffuser designs were evaluated and both designs were found to meet the water quality requirements for the discharge.

Table 2-3 summarizes the various open surface intake and discharge alternatives, and shows the measures of merit assigned to each to quantify their relative feasibility according to the selected screening criteria. The alternative with the lowest total score is considered the most feasible alternative. When compared to the subsurface intake alternatives listed in **Table 2-2**, the open surface alternatives appear more advantageous.

Table 2-3: Screening of Open Surface Alternatives

	Environmental Impact	Hazardous Waste	Contamination	Wave & Tsunami	Seismic	Public	Infrastructure Reuse	Integrity of Existing	Additional Studies	O&M	Constructability	Relative Cost	Overall	Rank
Screened Surface (ESGS)														
Existing Tunnels	2.5	2.5	2.5	4	7	4	1	1	5.5	7	1	1	**39**	**1**
Hyperion Outfall	8.5	7	4	7	7	5.5	4	2.5	5.5	5.5	8.5	7	**72**	**5**
Existing Tunnels as Casings	2.5	2.5	2.5	7	7	2.5	7	2.5	7	2.5	7	4	**54**	**2**
Combined I/D Tunnel	4	7	2.5	4	4	2.5	10	10	7	2.5	4	10	**67.5**	**3**
Two HDD Pipelines	4	5.5	1	4	7	2.5	10	10	8.5	2.5	7	8.5	**70.5**	**4**
Screened Surface (RBGS)														
Existing Tunnels	4	2.5	2.5	4	7	4	1	4	7	5.5	1	1	**43.5**	**1**
Hyperion Outfall	5.5	7	4	7	7	5.5	4	2.5	5.5	2.5	8.5	5.5	**64.5**	**2**
Existing Tunnels as Casings	4	4	2.5	7	7	2.5	7	7	8.5	2.5	8.5	4	**64.5**	**2**
Combined I/D Tunnel	4	7	2.5	4	4	2.5	10	10	7	2.5	4	10	**67.5**	**3**
Two HDD Pipelines	4	5.5	1	4	7	2.5	10	10	8.5	2.5	7	8.5	**70.5**	**4**

Severe	10.0
Very High	8.5
High	7.0
Fair	5.5
Acceptable	4.0
Good	2.5
Best	1.0
N/A	0.0

Some of the discharge alternatives considered in **Table 2-3** could be used in combination with either subsurface or open surface intake options. However, since subsurface intake was found to be relatively challenging, discharge alternatives are evaluated only in combination with the open surface option.

General design criteria and considerations were developed for intake and discharge design based on these analyses. Based on the assessment of the alternatives, the preferred intake configuration is the installation of smaller diameter pipes inside the existing tunnels. The preferred discharge configuration is a diffuser design with discharge ports to meet site specific conditions.

Treatment Process

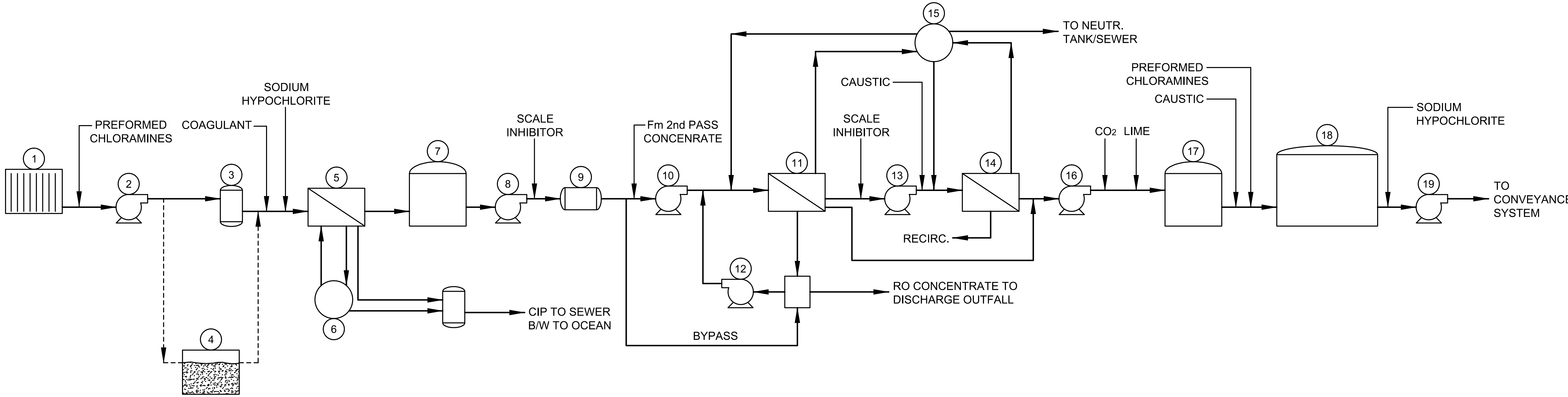
Treatment process designs consider raw water and product water quality. Raw water quality is based on using the preferred intake alternative for supplying raw ocean water to the treatment plant. Product water quality goals are discussed below.

The currently proposed process train is predicated on several important factors, including: 1) the use of reverse osmosis (RO) for desalination; 2) the use of an open intake; 3) source water quality and local environmental conditions in the vicinity of the intake, as identified in previous and ongoing studies conducted by West Basin; and 4) regulatory requirements. Based on these factors, the ocean water desalination plant will most likely include the following component processes:

- 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

Based on the assessments included in this PMP, a similar approach to that selected for the demonstration testing is considered for this planning phase. The approach during this planning phase was to identify the treatment trains using the evaluations and performance results derived from the demonstration testing facility, as well as to identify potential alternatives that may be considered in the future based on the availability of recent data.

The anticipated treatment train for both site locations is presented in **Figure 2-4**.



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.

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OCEAN WATER DESALINATION PLANT
PROCESS FLOW DIAGRAM (PFD)
SCALE: NONE

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FIGURE 2–4

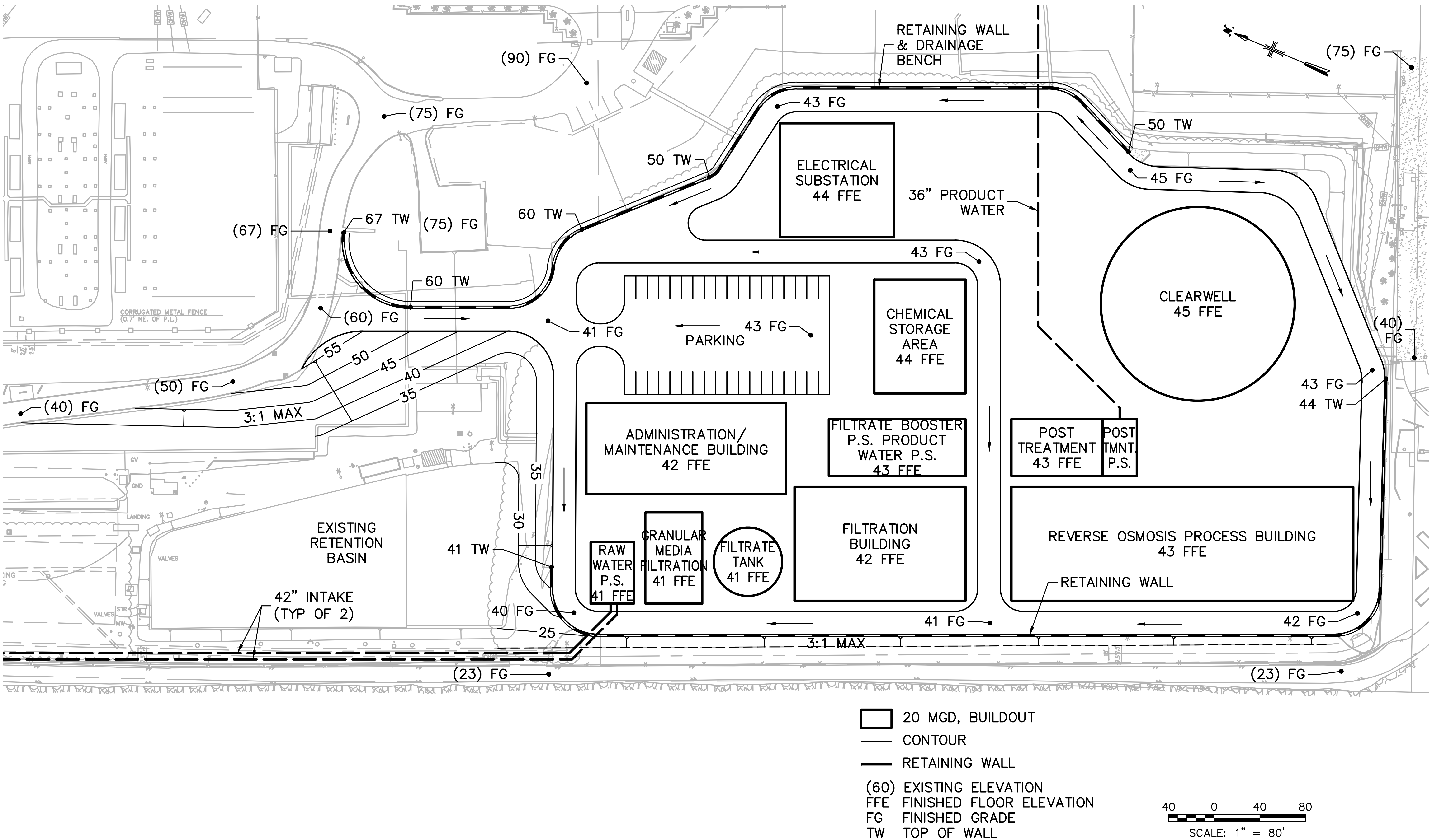
Facilities

The processes described previously can be associated with specific facilities to be located at both of the siting alternatives, some of which will include buildings, canopies, and/or containment areas. Most facilities at this plant will be related to the seawater desalination reverse osmosis (SWRO) treatment process, including associated pre- and post-treatment.

Footprint consideration is also required for peripheral, or appurtenant, facilities:

- Raw Water Pumping
- Chemical Storage and Handling
- Product Water Storage/ Clearwell
- Product Water Pumping
- Administrative Area/Control Room
- Education Center
- Electrical/MCC Buildings
- Maintenance Areas
- Power Sub-Stations
- Residuals Handling

Process and equipment footprints, elevations, and layouts, which consider site constraints and proposed grading plans, have been developed for each site. Preliminary site layouts, grading and utility plans for the 20-MGD and 60-MGD scenarios for both sites are shown in **Figures 2-5 through 2-8**. Additional details can be found in Section 7 of the CSDPR.



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PRELIMINARY GRADING & UTILITY PLAN – 20 MGD
SCALE: AS NOTED

JANUARY 2013
FIGURE 2–5

XREFS: B-BORDER.dwg I:\ACAD\PROJ\66005052 WEST BASIN DESAL PMP PROP\Figures\WestBasinBaseFile.dwg IMAGES: None
User: arivas Spec: PIRNIE STANDARD File: I:\ACAD\PROJ\05052016 West Basin MWD\Figures\NRG 10–20 MGD SITE PLAN – REV 1.DWG Scale: 1:1 Date: 09/20/2011 Time: 13:05 Layout: NRG-10-20

20 MGD, BUILDOUT

(60) EXISTING ELEVATION
FFE FINISHED FLOOR ELEVATION
FG FINISHED GRADE

75 0 75 150
SCALE: 1" = 150'

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PRELIMINARY GRADING & UTILITY PLAN – 20 MGD

SCALE: AS NOTED

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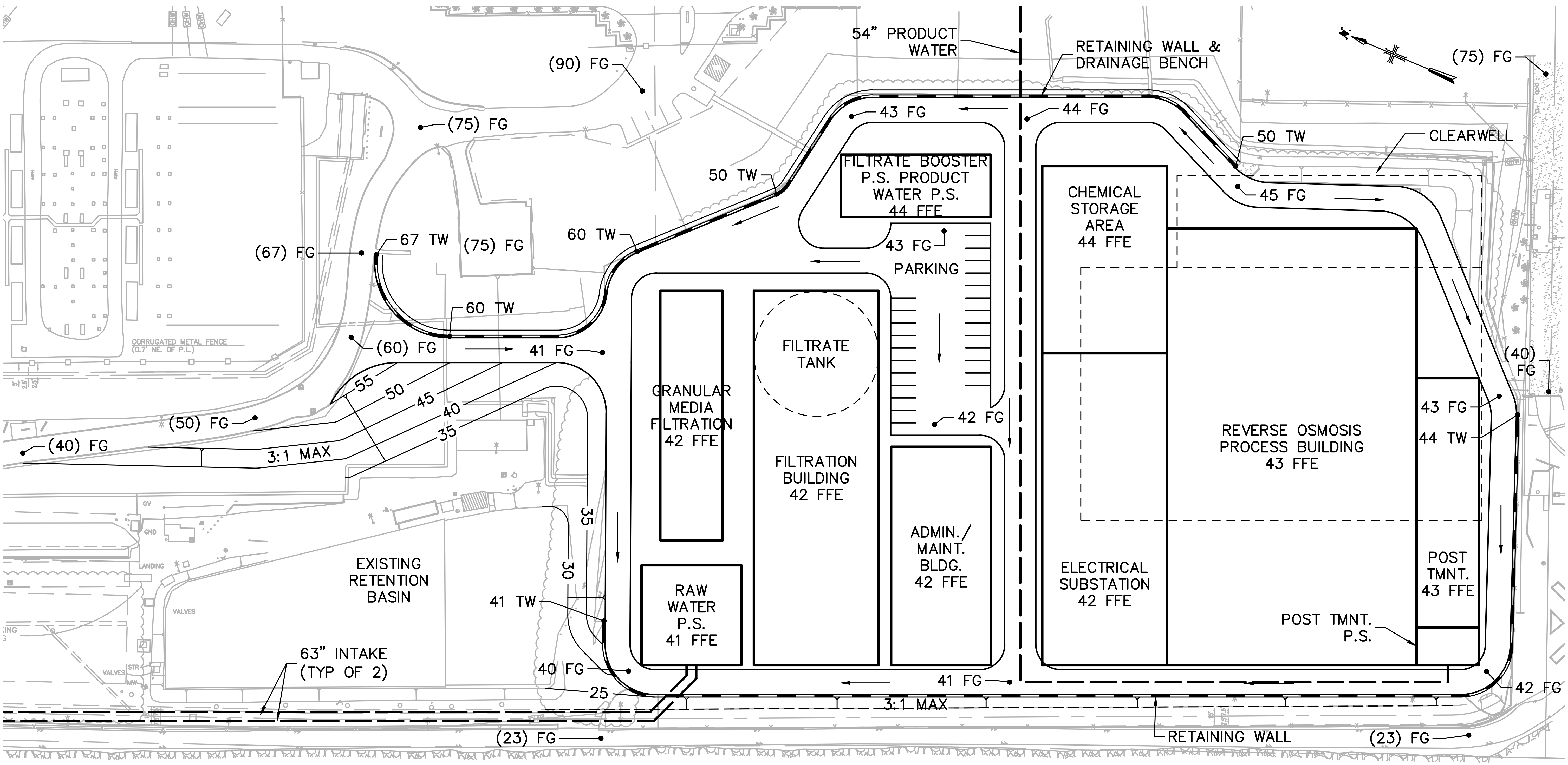
FIGURE 2–6



60 MGD, BUILDOUT
CONTOUR
RETAINING WALL

(60) EXISTING ELEVATION
FFE FINISHED FLOOR ELEVATION
FG FINISHED GRADE
TW TOP OF WALL

40 0 40 80
SCALE: 1" = 80'

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PRELIMINARY GRADING & UTILITY PLAN – 60 MGD
SCALE: AS NOTED

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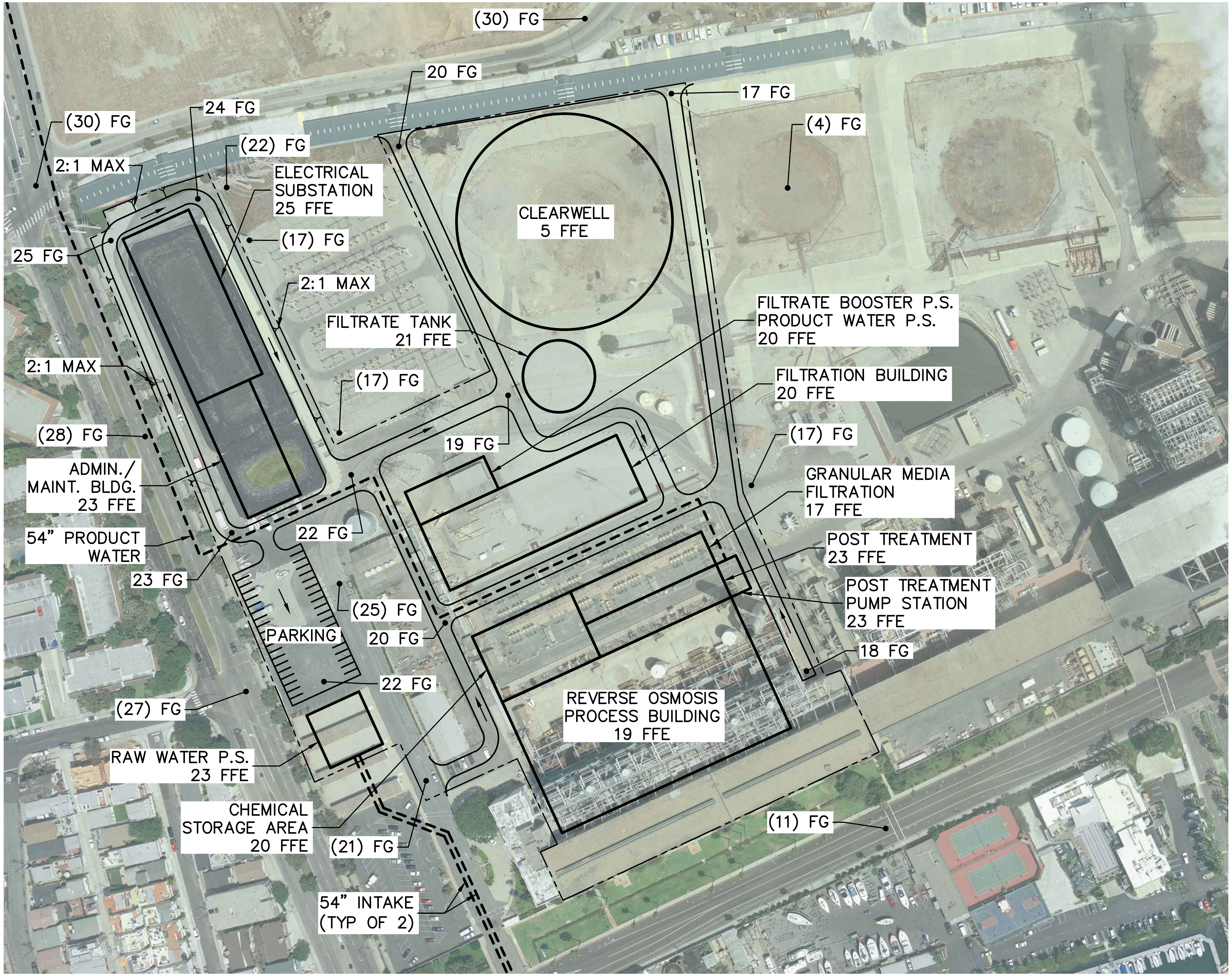
FIGURE 2-7



20 MGD, BUILDOUT

(60) EXISTING ELEVATION
FFE FINISHED FLOOR ELEVATION
FG FINISHED GRADE

75 0 75 150
SCALE: 1" = 150'

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OCEAN WATER DESALINATION
PROGRAM MASTER PLAN (PMP)

AES CORPORATION – 1100 N. HARBOR DR., REDONDO BEACH, CA. 90277

PRELIMINARY GRADING & UTILITY PLAN – 60 MGD

SCALE: AS NOTED

JANUARY 2013

FIGURE 2–8

Product Water Quality

Target water quality specifications were developed based on key literature reviews, full scale experience and demonstration plant operations, focusing on those in which desalinated water is specifically compared with water from MWD. Because the water that will be produced will ultimately be added to an existing distribution system, permeate conditioning will be required to mitigate any potential compatibility issues with the existing supply, particularly potential corrosion impacts.

Treatment options for permeate conditioning would likely include (1) lime with carbon dioxide for pH adjustment, or (2) calcite filters. Both would need to be assessed during design and implementation to ensure proper dosage selection and operational control for the West Basin facility. A target pH of 8.5 requires the least chemical doses and treatment cost. A target pH of 8.2 without sulfate adjustment requires moderate chemical doses and treatment cost. If sulfate adjustments to match MWD water quality are desired, significant doses of sulfuric acid and caustic soda may be needed in addition to lime and carbon dioxide, resulting in doubled treatment cost compared to no sulfate adjustment. Bench- or pilot-scale testing may be needed to identify the optimal effective chemical doses and operating conditions for the variety of pipe materials in the West Basin service areas.

A summary of how each water quality specification was selected is included in **Table 2-4**. The table also compares target water quality for a proposed West Basin desalination plant with the MWD Jensen plant water.

Table 2-4: Product Water Quality Specifications

Parameter	West Basin Target Range	Metropolitan Jensen Range (and Average)	Comments
pH	8.2 to 8.5	7.4 to 8.4 (average 8.2)	Higher pH allows lower alkalinity and calcium targets.
Alkalinity (mg/L as $CaCO_3$)	45 to 100	80 to 99 (average 87)	Sufficient alkalinity (together with Ca and pH) will be targeted to provide positive LSI and CCPP. A lower pH must be balanced by a higher alkalinity.
Calcium (mg/L as $CaCO_3$)	40 to 100	55 to 93 (average 68)	Sufficient calcium (together with alkalinity and pH) will be targeted to provide positive LSI and CCPP.
Langelier Saturation Index (LSI)	> 0	Not reported	Positive LSI has been shown to correlate with a decrease in corrosion outcomes for numerous distribution system materials[1].
Calcium Carbonate Precipitation Potential (CCPP, mg/L)	0 < CCPP < 10	Not reported	Positive CCPP has been shown to correlate with a decrease in corrosion outcomes for numerous distribution system materials[1].
Chloride (mg/L)	≤ 100	40 to 96 (average 68)	Chloride levels greater than the suggested target may impact agricultural crops [2].
Sulfate (mg/L)	No target	39 to 102 (average 59)	Targeting of a specific chloride-to-sulfate ratio is not expected to be necessary based on previous testing[1].
Bromide (mg/L)	0.3*	0.11 to 0.2 (average 0.18)	An initial target of 0.3 mg/L bromide is recommended based on studies of chloramine stability and reported targets for other desalination plants. ***Additional study is recommended to assess a chloramine stabilization approach rather than focusing on achieving a specific bromide level.**
Boron (mg/L)	0.5	0.15 to 0.37 (average 0.21)	Boron levels greater than the suggested target may impact agricultural crops[2].

Conveyance & Product Water Pumping

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. New conveyance infrastructure is required to carry flows from the desalination plant site to the existing distribution system. Several conveyance alternatives for each plant site were evaluated including:

(1) 10-MGD Facility: Tie-in to WB turnouts. No expansion capabilities.

(2) 20-MGD Facility: Tie-in to WB Feeder and WC Turnouts, Connect Downstream of Turnouts. No expansion capabilities.

(3A) 10/40-MGD Facility: Tie-in to WB and WC Feeders. 40-MGD backbone for expansion.

(3B) 40-MGD Facility: Tie-in to WB and WC Feeders. No expansion capabilities.

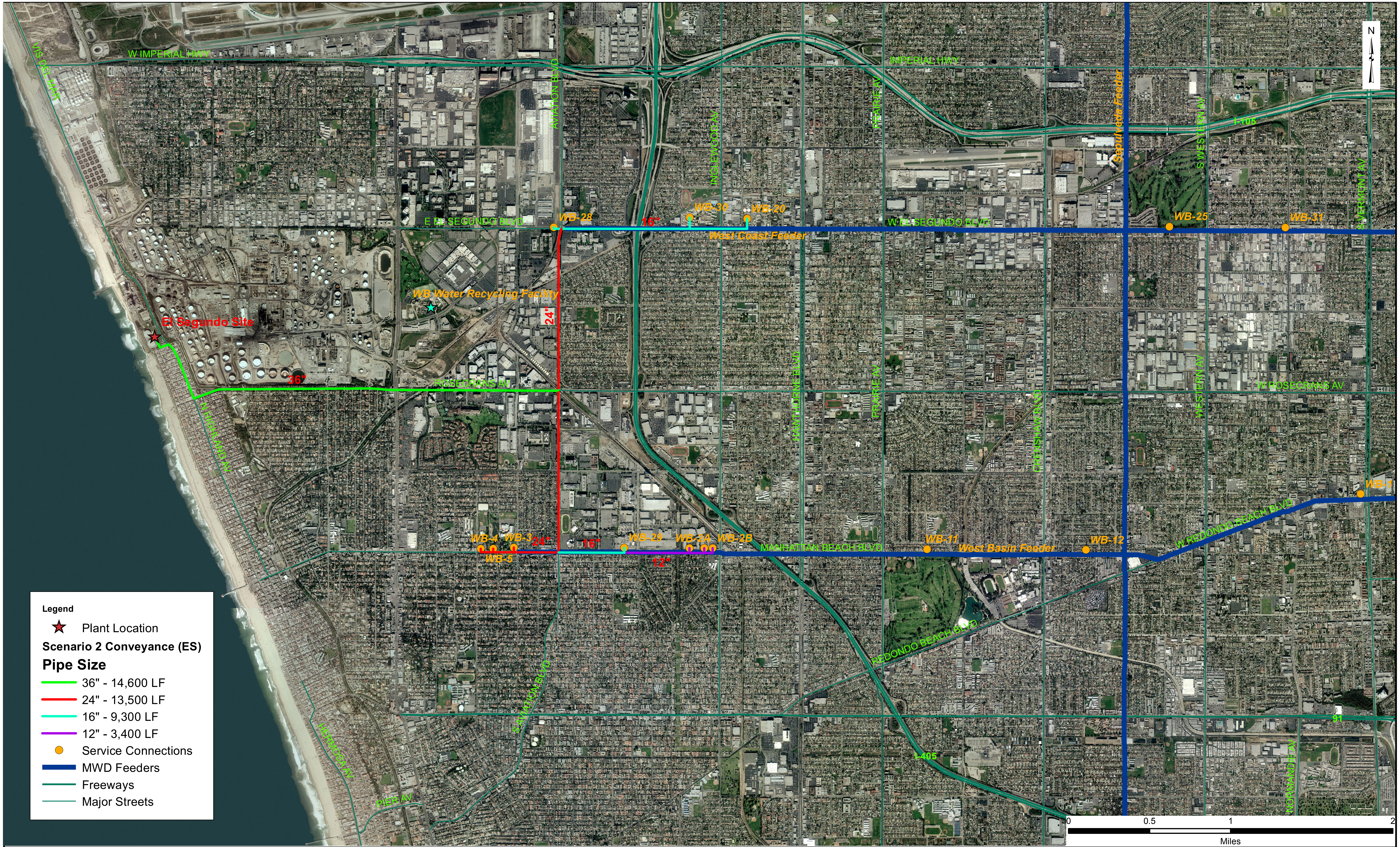
(4) 60-MGD Facility: Tie-in to Sepulveda Feeder. No expansion capabilities.

Evaluation factors include preliminary pipeline alignments, sizes, lengths and hydraulic requirements. The pipe and pump sizes are estimated based on typical criteria and assumptions which are defined in the report, including flow velocity, head loss, materials of construction, connection pressures, flow ranges, hydrostatic grade elevation, pump type, redundancy, and onsite storage for diurnal variation.

Preliminary pipeline alignments, pipe and pump sizing, and connections were developed for the conveyance alternatives and are presented in this PMP along with cost opinions. As an example, conveyance piping for the 20-MGD scenario at the El Segundo site is shown in **Figure 2-9**. Conveyance piping for other scenarios can be found in Section 2 of the PFP.

Cost Opinions

The cost opinions provided in this Program Master Plan for the two alternative site locations are based on the conceptual criteria provided in Section 1 of the CSDPR. The cost opinions provided herein most closely resemble the AACE criteria for Class 4. Estimates are based on January 2012 costs. The Engineering News Record (ENR) City Cost Index (CCI) for January 2012 in Los Angeles is 10091.80. See **Tables 2-9 and 2-10** for capital and O&M cost summaries and overall program costs, respectively.



MALCOLM PIRNIE | ARCADIS
The Water Division of ARCADIS

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OCEAN WATER DESALINATION PMP
CONTRACT NO. 05052016.0000

EL SEGUNDO SITE - LOCAL CONNECTIONS
CONVEYANCE PIPING
SCENARIO 2: 20-MGD FACILITY

PIRNIE/ARCADIS U.S.
JANUARY 2013
FIGURE 2-9

2.2. Power Supply

Power Demand

The power demand is estimated at approximately 0.6-0.8 MW/MGD. However, with additional efficiency improvements, this can potentially be reduced to 0.5 -0.7 MW/MGD.

Using the above factors, the total power requirement for the local supply option (20 MGD) is estimated at approximately 14 MW, while the total power requirement for the regional supply option (60 MGD) is estimated at approximately 46 MW.

A detailed breakdown of the electrical load for the desalination plant is provided in Conceptual System Design and Program Requirements Report.

Power Supply Options

Various power supply options were evaluated from both a legal and technical perspective. West Basin conducted a review of the legal aspects of four options for the proposed power demand scenario, including:

(1) Electric service provided directly by SCE

(2) Service from an Energy Service Provider ("ESP") under California's Direct Access program

(3) Direct purchase from NRG (El Segundo) or AES (Redondo Beach) under Public Utilities Code Section 218

(4) Self-generation, joint venture, or other arrangement with a third-party independent power producer ("IPP"), pursuant to Water Code Section 71663.5

Under the state and federal regulatory provisions, of the four supplier options, it appears that only two - SCE service and self-generation - are viable options for West Basin at this time.

Technical analysis of the following power supply options was provided:

(1) Onsite power generation with conventional means

(2) Onsite power generation by renewable resources

(3) Power supply directly purchased from SCE

Technical analysis of the power supply options includes a discussion of capacity, reliability, incentives and credits, footprint, layout, constructability concerns, permitting, and cost.

A more in depth analysis is provided for the SCE supply option to discuss the rate structure for large users (TOU-8), including energy, transmission, demand and maintenance charges, added facilities, and available credits for participation in the Time-of-Use Base Interruptible Program (TOU-BIP). The TOU-BIP allows customers to receive monthly credits for reducing their power consumption during peak demand events.

Onsite Power Generation (Conventional)

One option considered for onsite generation is a small combined cycle (CC) plant with gas turbine and steam turbine generator in a combined cycle mode. The gas turbine is fired with pipeline natural gas already available at both NRG and AES sites. The hot exhaust from the gas turbine is directed to a heat recovery steam generator where high pressure steam is generated. The high pressure steam is run through a steam turbine generator to generate additional power.

These gas turbines are available in ~ 1 MW range to 180+MW. For the proposed desalination facility, the power required will be in the range of 15 MW to 40 MW range, based on desalination plant capacity. A power plant in the size > 50 MW will require a detailed review and evaluation by California Energy Commission (CEC). This is an exhaustive process, subject to public hearing and review. Only standard combined cycle configurations offered by vendors in the range of 2.5 MW to 24 MW were reviewed. Other power generation options are available, such as gas reciprocating engines, and may be feasible depending on size and power supply framework utilized.

Onsite Power Generation (Renewable)

Under renewable power generation, wind, solar, qualifying biomass, geothermal, and small hydro are eligible for self generation incentives from SCE. However, biomass, geothermal, and small hydro are not feasible at the two proposed sites, so only feasibility of wind and solar is examined. Fuel cells were also evaluated. Under California Public Utilities Commission (CPUC) rules, on site fuel cell installation is eligible for incentive from SCE. Due to limited space and wind resources, wind generation potential at either candidate site is not considered a viable alternative. Also due to limited space and solar resources, solar generation on a large scale at either candidate site is not considered a viable alternative. However, rooftop PV panels for administration and process buildings are feasible.

Power Supply Development

Federal Energy Regulatory Commission (FERC) has established North American Electric Reliability Corporation (NERC) and developed rules for reliability of electric supply throughout North America. SCE as provider of the electricity in the region is required to follow these rules and meet the reliability standards set by NERC. These federal enforceable standards require utilities and transmission operators to provide dependable and clean power (set frequency and voltage to protect customer installation) 24/7 with very high reliability. FERC has enforceable power to require utilities and transmission operators to upgrade their system and procedures to maintain these reliability standards.

Generating stations at both candidate sites have existing 66 kV transmission line services and substations capable of supporting the required load for the desalination plant capacities considered. For either site, if West Basin decides to utilize SCE transmission and substation facilities, SCE will have to conduct a power flow analysis based on desalination plant size and power requirement to determine adequacy of the current installed system and if any upgrades are required.

Power Supply Cost Analysis

A cost analysis is provided for onsite and offsite generation and SCE supply. A budgetary cost estimate for onsite generation using combined cycle generation is provided in the report and compares various gas turbine models, including capital and O&M cost components. Total estimated costs range from $0.07/kWh to $0.22/kWh. A budgetary cost estimate for onsite generation using solar photovoltaic (PV) panels is also provided in the report. For analysis purposes a 12,000 square foot roof top area (or 100 kW PV system) is assumed to be available on an individual building. The 100 kW DC PV system has an estimate Levelized Cost of Energy (LCOE) of $0.124/kWh. The 100 kW DC system outlined is for illustrative purposes, but can be scaled up or down based on available roof area. Onsite generation will also require SCE back-up power during forced and planned outages and is therefore subject to SCE standby charges. Based on the current configuration of the desalination plant, standby charges are estimated at $0.015/kWh to $0.025/kWh. An estimate of SCE rates based on TOU-8 service is shown in **Table 2-5**. These rates do not include any monthly charges for additional facilities and applicable taxes. There are also several options for SCE power supply facilities setup and maintenance, which include varying levels of SCE involvement and cost. **Table 2-6** provides a cost summary for the power supply options evaluated.

Table 2-5 SCE Costs Under TOU-8 Rate

Plant Size (Peak Load) / Voltage	Total Cost (c/kWh)	Demand (c/kWh)	Energy (c/kWh)
15 MW at Less than 50kV	9.56	2.76	6.80
15 MW at Greater than 50kV	7.46	1.60	5.85
33 MW at Less than 50kV	9.56	2.76	6.80
33 MW at Greater than 50kV	7.45	1.60	5.84

2012 rates
>50 kV is for 66 kV line.

Table 2-6 Power Supply Options Cost Summary

Power Supply Option	COE (c/kWh)	Standby (c/kWh)	Total Cost (c/kWh)	Comments
Onsite power generation with conventional means (CC)	7 - 22	1.5 - 2.5	8.5 - 24.5	Based on CC. Varies due to model/output selected
Power supply directly purchased from SCE	7.45 - 9.56	N/A	7.45 - 9.56	Additional fees for SCE power supply facilities setup and maintenance

2012 rates

Summary of Power Supply Options

The power supply options analyzed in this report are summarized in **Table 2-7**.

Table 2-7 Summary of Power Supply Options

Power Supply Option	Advantages	Disadvantages	Conclusions
Onsite power generation with conventional means	Lower cost. Local control of power source and agreement terms.	Will require permitting and regulatory approval. Potential SCE standby charges. No renewable credits.	Obtaining emissions offsets and permitting is major hurdle. Economics marginal. WB has no experience in operating power plant but joint option could make feasible.
Onsite power generation by renewable resources	Attractive – green power.	Not very good wind or solar resources at site, not practical. Highest cost, with SCE supplying remaining power.	If implemented, on site renewable will generate <5% of power need of the desalination plant.
Power supply directly purchased from SCE	System reliability, defined contract terms and most accurate cost estimate. Will have 20-33% renewable component.	Current cost are well defined, but future escalation is subject to PUC process, and can have negative impact for large user to subsidize residential customers.	SCE >50 kV supply rates are competitive. SCE will work with WB within PUC guideline for best rates.

2.3. Environmental Review

Technical Studies and Data Needs

Various data and technical studies are required to be used in preparation of the full-scale desalination plant EIR and are available from a variety of sources, including information collected as part of the existing Demonstration Project, this PMP, as well as technical studies that are in progress and ongoing. A summary of the technical studies that will be available and/or needed for preparation of the EIR is provided in Section 2 of the ERP, including a list of issues and scopes for the corresponding studies ranging from Aesthetics and Cultural Resources to Air/Water Quality and Biological Resources. For instance, one key set of studies under Biological Resources are related to Impingement and Entrainment, which will characterize the effects to marine life from a screened intake. Another ongoing study related to Salinity Tolerance assesses the acute and chronic toxicity levels of brine discharge on local and site specific marine organisms. These studies and others will be completed prior to or during EIR development and will support preparation of the EIR, while other studies are specifically required to be included as part of the EIR process.

Environmental Review Plan

One of the most important tasks in the overall environmental process is to adequately define the project. The EIR Project Description must contain sufficient detail in order for the environmental analyses to be conducted, but should also provide flexibility to allow for consideration of variances in project design and for selection of different design options. Key considerations include: Project Purpose and Objectives, Intake and Discharge Options, Power and Supply Options, Alternative Site Selection, Conveyance Facilities, Construction Methods/ Schedule/ Sequence, and Operational Characteristics.

CEQA Lead Agency

The CEQA lead agency is the agency responsible for proposing, carrying out, and approving the project. Usually this is the agency that owns the site or facility and that will be responsible for seeking funding and permitting actions necessary to complete the project. Under Section 15064.7 of the CEQA Guideline, the lead agency has the discretion to establish or adopt significant thresholds that apply to the project, provided the decision is supported by substantial evidence. Several options for determining significant thresholds are described in the report. It is anticipated that West Basin will be the CEQA lead agency for the full scale ocean water desalination facility.

Federal Agency

After choosing the CEQA lead agency and reviewing the Project Description, it is important to determine if there is a federal action being proposed that would require preparation of a NEPA document. In this case, if marine construction is involved, the most likely federal agency to be involved would be the U.S. Army Corps of Engineers (ACOE). If a federal action is proposed, it is best to identify the action and the agency early in the process and discuss with the federal agency the type of environmental document to be prepared.

Stakeholders

Since stakeholders will likely have some amount of influence over the proposed project, it is valuable to identify the key stakeholders early on in the process. It may be worthwhile to develop a public outreach plan to educate, inform, and gather input about the proposed project along the way so that the project proposal put forward for consideration by the agency decision-makers has credibility with the community and agency stakeholders.

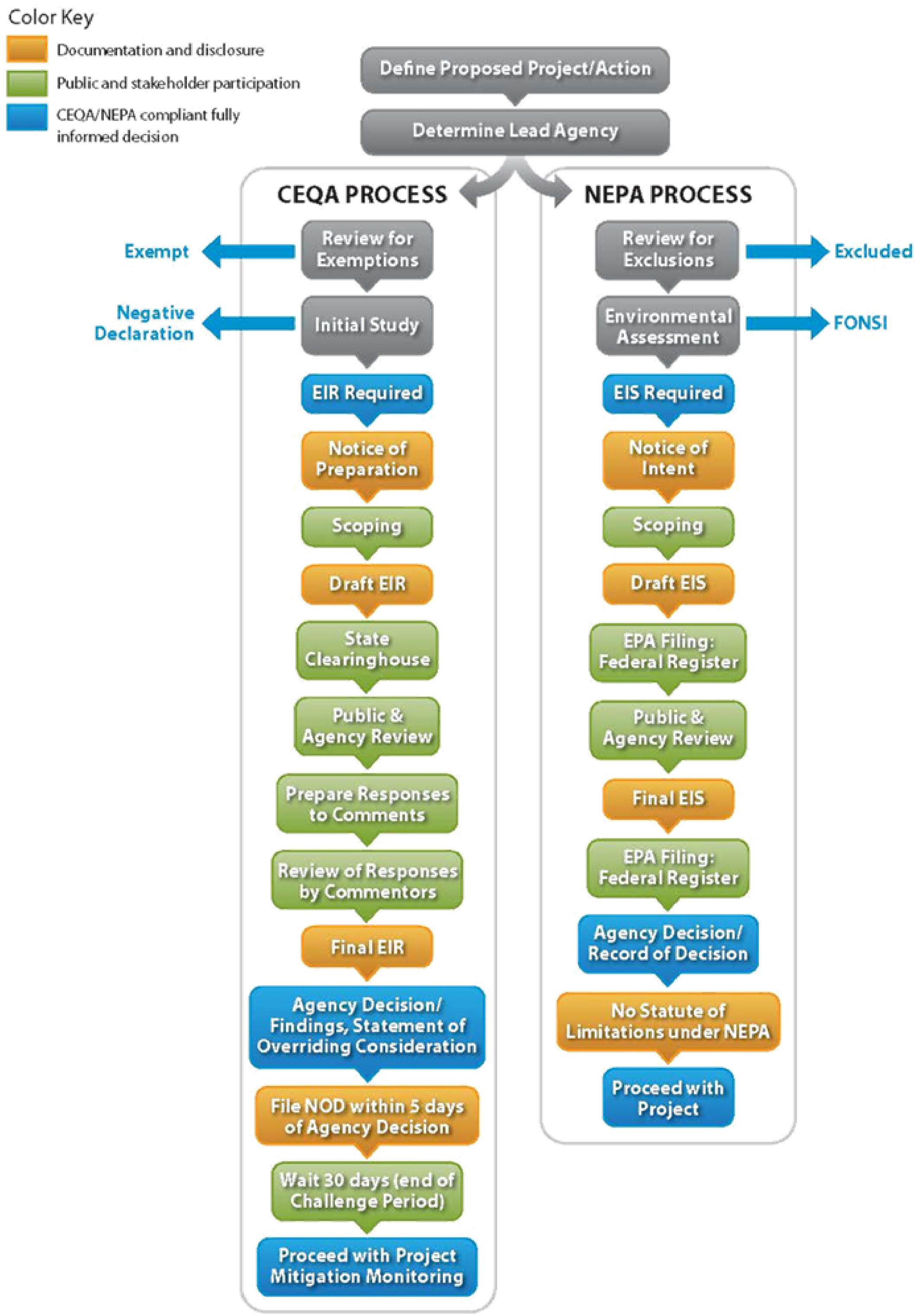
Preliminary Engineering and Design

The preliminary engineering and design is critical to the environmental process. The reports, plans, and preliminary alternatives that come out of this effort are citable documents used in the initial preparation of the environmental documentation.

CEQA requires the analysis of a reasonable range of feasible alternatives. The development of alternatives to be considered in the environmental document is driven by the need to reduce environmental impacts of the proposed project. The alternatives developed during the preliminary engineering and design phase may not represent a sufficient range of alternatives from an environmental point of view. It is important to consider and quantify West Basin's efforts to manage demand and to maximize reuse, recycling, and conservation as part of an integrated strategy to address water supply reliability. If the project will require a joint CEQA/NEPA document, it is critical to seek federal lead agency input on the least environmentally damaging practicable alternative because this will become the only alternative that the federal lead agency can permit.

Once the preliminary engineering, constraints and investigational reports have been completed, and a preferred alternative has been identified, the environmental analysis can proceed. **Figure 2-10** shows the typical steps in the process.

Figure 2-10: Steps in the EIR/EIS Process



A table is provided in the report that presents the key environmental issues that likely will need to be addressed in the EIR or EIS and will not be screened out in the Initial Study. The table is meant to serve as a guide for the anticipated scope of environmental work.

Risk to Schedule, Document Defensibility, and Budget Considerations

There are various risks during the environmental process including but not limited to: potential litigation, insufficient stakeholder involvement, improperly or poorly prepared CEQA/NEPA documentation, and unanticipated delays. A critical first step to avoiding these risks is ensuring that the scoping of the work effort is done in a comprehensive manner, and that the project team selected to execute the work has familiarity and experience in dealing with the unique environmental and regulatory issues associated with seawater desalination.

2.4. Permitting

Both West Basin and the regulatory community have a common goal: To develop a long-term, sustainable, and reliable water supply through a project that is technologically and economically feasible, environmentally sound, and socially acceptable. Despite this shared vision, the permitting process can be daunting. In addition to the sheer number of coordination points, a complicating factor is that some agencies may wait for other agencies to review before they will review or approve the permit, as in the case of the Coastal Development Permit (CDP) from the California Coastal Commission (CCC). In order to increase the potential for dialogue and productivity, initial scoping meetings with the various agencies should be considered, along with continued dialogue to provide updates on studies and milestones. **Table 2-8** lists the various agencies that will likely be consulted, anticipated permits and activities, approximate timeframe needed for consultation/ permit approval, and a rough budget for the assumed set of activities. A detailed breakdown of specific requirements for each agency and permit are provided in the report. Some permits may not be required depending on which alternative is selected.

Table 2-8 Anticipated Permits, Timeline, and Estimated Cost

Regulatory Agency	Regulatory Permit, Authorization or Approval	Timeline	Estimated Cost
Federal Agencies			
U.S. Fish and Wildlife Service (USFWS), Ecological Services Branch	Incidental Take Statement and coordination under Section 7 Endangered Species Act of 1973, as amended (ESA)	12-18 months	\$100,000 - \$500,000 or up[1]
	Incidental Take Permit (ITP) under the Migratory Bird Treaty Act (MBTA) (16 USC 703–711)		
	Consultation under the Fish and Wildlife Coordination Act (16 U.S.C. 661-667c)		

Regulatory Agency	Regulatory Permit, Authorization or Approval	Timeline	Estimated Cost
Federal Agencies (Continued)			
NOAA National Marine Fisheries Service (NMFS)	Consultation and biological opinion in accordance with Section 7 ESA	12-18 months	$100,000 - $500,000 or up[1]
	ITP per Section 104, Marine Mammal Protection Act of 1972 (MMPA) (16 U.S.C. § 1374)		
	Consultation under Section 305(b), Magnuson-Stevens Fishery Conservation and Management Act (16 U.S.C. § 1855(b))		
U.S. Army Corps of Engineers (USACE)	Individual Permit inaccordance with Section404 Clean Water Act(33 U.S.C. §1344)	6-18 months	$100,000
	Individual Permit under Section 10 Rivers and Harbors Appropriation Act (33 U.S.C. §403)		$50,000
State Agencies			
Regional Water Quality Control Board (RWQCB)	National Pollutant Discharge Elimination System (NPDES) General Permit For Storm Water Discharges Associated With Construction Activity (WQO No. 99-08-DWQ)	12-24 months	$100,000
	NPDES Permit in accordance with Clean Water Act Section 402 (33 U.S.C. § 1342)		$100,000
	Waste Discharge Requirements (WDR) per Porter-Cologne Water Quality Control Act (Water Code § 13000 et seq.)		$50,000
	Water Quality Certification in accordance with Section 401 Clean Water Act (33 U.S.C. § 1341)		$75,000
California State Lands Commission	Land Use Lease (Right-of-Way Permit) (Pub. Res.Code § 6000 et seq.; 14 Cal. Code Regs. § 1900 et seq.)	12-24 months	$50,000
California Department of Fish andGame (CDFG)	Incidental Take Permit in accordance with theCalifornia EndangeredSpecies Act (CESA)(Fish & Game Code § 2081)	6-12 months	$100,000 - $300,000 or up[1]
	Lake/Streambed Alteration Agreement (Fish & Game Code §1602)	6-12 months	$50,000
California Coastal Commission (CCC)	Coastal Development Permit in accordance with the California Coastal Act (Pub. Res. Code § 30000 et seq.)	24-36 months	$500,000
California Dept. of Public Health(CDPH)	Permit to Operate a Public Water System (Health & Safety Code § 116525)	24-36 months	$1,100,000
California Dept. of Parks & Recreation Office of Historic Preservation	Coordination underSection 106 of the National Historic Preservation Act (NHPA) (16 USC 470 et seq.)	6-12 months	$20,000
California Dept. of Transportation (Caltrans)	Encroachment Permit (Streets & Highway Code § 660 et seq.)	12-24 months	$50,000

Regulatory Agency	Regulatory Permit, Authorization or Approval	Timeline	Estimated Cost
Regional			
South Coast Air Quality Management District (SCAQMD)	Permit to Construct	6-12 months	\$100,000 - \$250,000[2]
	Permit to Operate	6-12 months	\$100,000 - \$250,000[2]
Metropolitan Water District of Southern California (MWDOC)	Encroachment permit for work within Metropolitan Right-of-Way	12-24 months	\$50,000
Local			
City of Redondo Beach	Encroachment Permit	3-6 months	\$20,000
City of El Segundo	Encroachment Permit	3-6 months	\$20,000
City of Manhattan Beach	Encroachment Permit	3-6 months	\$20,000
City of Hermosa Beach	Encroachment Permit	3-6 months	\$20,000
City of Lawndale	Encroachment Permit	3-6 months	\$20,000
City of Hawthorne	Encroachment Permit	3-6 months	\$20,000
City of Gardena	Encroachment Permit	3-6 months	\$20,000
City of Torrance	Encroachment Permit	3-6 months	\$20,000

1. Highly variable. Dependant on the number of species associated with the site.
2. Variable dependant on the number of pieces of equipment that require permitting.

Scoping studies, as well as, application forms, instructions, and additional guidance needed for permits are provided in an Appendix to the PMP.

2.5. Operations & Maintenance

An assessment of operations and maintenance requirements was included in the PMP to develop a high level understanding of requirements associated with this facility. This review is intended to serve as the basis for future staffing planning, environmental analysis, and potentially for the framework for contract operations procurement.

Operation Parameters

Numerous factors, including the treatment capacity, raw water quality, effluent requirements, brine discharge limitations, and preliminary plant design will have an impact on operation requirements for a seawater desalination facility. Some of these factors will differ between the two candidate sites. A review of key parameters and global operational considerations are provided in the OMP.

Operational oversight is required for a number of key parameters at the desalination facility, including monitoring influent and effluent water quality and process variables and maintenance, replacement, and calibration of equipment and instrumentation. Compliance and optimization goals are presented for these parameters to ensure that the treatment system operates as efficiently as possible.

Required Labor and Staffing

Appropriate personnel will be required in order to ensure that seawater desalination facilities are properly operated and maintained. Staffing considerations for the West Basin plant are described in the report. A labor/staffing plan is provided, which describes typical staff required, staff types, relevant certifications and recommended quantities for seawater desalination systems such as those proposed. A "lean" operation has been assumed, taking into account that certain staff members may take on additional roles as required to ensure successful plant operation. Various levels of automation and outsourcing are also discussed. Example baseline work schedules are provided for the 20-MGD and 60-MGD plant sizes.

Conveyance System Requirements

New conveyance infrastructure is required to carry flows from the desalination plant site to the existing distribution system. Operational resources, support, and other facilities for the conveyance system will be minimal compared to what is required to operate the desalination plant. This is because the conveyance system will consist of simpler assets (pipeline, valves, and appurtenances) than the desalination facility will utilize. Laboratories, contractors, and other resources that will provide materials and services integral to the efficient operation of the conveyance system are outlined in the report. Many of these resources will consist of on-demand labor and equipment for repairs.

Operations Options

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. Section 5 of the OMP discuss these alternatives as they relate to West Basin.

Required Support Facilities

Support facilities that should be considered for the desalination plant may include: Laboratory, Maintenance Shop, Control Room, Lunch Room, Vehicle Storage Garage, Spare Parts Storage Rooms, Locker Rooms, Rest Rooms, Records Storage, Janitor Closet, Conference Room, Administrative Offices, Meetings Area, Research and Development Area, and Tour Facilities. Some of the facilities will be shared with the conveyance system. The footprint for each of these facilities will depend on this size of the desalination and conveyance systems. A preliminary estimation of the footprint requirements for many these facilities can be found in Section 6 of the OMP.

Environmental Compliance Requirements

A regular monitoring schedule of key processes throughout the treatment system must be maintained in order to assure process efficiency and that environmental targets (such as temperature, pH, TOC, select major and minor cations and anions, bacteria, TDS, metals, etc.) are being met. Section 7 of the OMP outlines typical reporting requirements and the facilities needed to appropriately monitor water quality, including an example regulatory monitoring schedule similar to what may be required by the California Department of Public Health (CDPH) for a seawater reverse osmosis desalination facility.

Operations and Maintenance Budget

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. Example operation costs that may be incurred, as a function of treatment capacity and considering prior staffing assumptions, are provided in the report.

2.6. Costs & Funding

The cost opinions provided for the two alternative site locations (ES – El Segundo and RB – Redondo Beach) and five plant size scenarios are based on the conceptual criteria provided in the CSDPR. Capital cost opinions are divided into distinct process areas, or work areas, to assess and present the capital costs. These divisions are broken down into the following work areas: Intake and Raw Water Conveyance, Pretreatment, Reverse Osmosis, Post-Treatment, Product Water Pumping & Storage, Residuals Handling & Concentrate Discharge, Power Supply, Electrical Building, Administrative/ Education Center Building. Annual O&M costs are divided among the following categories: Power, Chemicals, Maintenance & Materials, Labor, and Replacement. To account for a range of values associated with the various indirect project costing assumptions used in this estimate, and to assess the sensitivity of the estimate to this potential variability, three costing categories were selected: High, Base, and Medium, corresponding to varying levels of conservatism. **Table 2-9** presents an overall comparison of capital and O&M costs among the scenarios. It also shows annualized costs for each scenario that includes both capital and O&M. Capital cost breakdown by work area and annual O&M cost breakdown by category are provided in the report. Itemized estimates are provided in the report.

Table 2-9: Capital and O&M Summary and Annualized Cost Comparison

	Scenario 1		Scenario 2		Scenario 3A				Scenario 3B		Scenario 4	
	10 MGD		20 MGD		10/40-MGD Phase 1[1]		10/40-MGD Phase 2[2]		40 MGD		60 MGD	
	ES	RB	ES	RB	ES	RB	ES	RB	ES	RB	ES	RB
Total Capital Cost PW ($/1000)												
Low	$142,488	$138,121	$261,767	$265,833	$165,734	$169,642	$262,264	$258,981	$393,789	$394,843	$635,003	$641,168
Base	$158,535	$153,677	$291,248	$295,772	$184,399	$188,748	$291,801	$288,148	$438,140	$439,312	$706,520	$713,379
High	$177,345	$171,910	$325,803	$330,864	$206,277	$211,142	$326,422	$322,335	$490,122	$491,434	$790,344	$798,017
Total Annual O&M Cost ($/1000)	$9,944	$9,925	$17,669	$17,656	$10,391	$10,403	$23,305	$23,219	$33,696	$33,621	$49,554	$49,631
O&M PW ($/1000)	$131,628	$131,373	$233,882	$233,703	$137,545	$137,691	$266,517	$265,526	$446,016	$445,026	$655,911	$656,932
Total PW (CAP AND O&M) ($/1000)												
Low	$274,120	$269,490	$495,650	$499,540	$303,280	$307,330	$528,780	$524,510	$839,800	$839,870	$1,290,910	$1,298,100
Base	$290,160	$285,050	$525,130	$529,480	$321,940	$326,440	$558,320	$553,670	$884,160	$884,340	$1,362,430	$1,370,310
High	$308,970	$303,280	$559,680	$564,570	$343,820	$348,830	$592,940	$587,860	$936,140	$936,460	$1,446,260	$1,454,950
Annualized Cost ($/1000)												
Low	$20,710	$20,360	$37,450	$37,740	$22,910	$23,220	$39,950	$39,630	$63,450	$63,450	$97,530	$98,070
Base	$21,920	$21,540	$39,670	$40,000	$24,320	$24,660	$42,180	$41,830	$66,800	$66,810	$102,930	$103,530
High	$23,340	$22,910	$42,280	$42,650	$25,980	$26,350	$44,800	$44,410	$70,730	$70,750	$109,260	$109,920
Annualized Cost Per 1,000 gal												
Low	$5.67	$5.58	$5.13	$5.17	$6.28	$6.36	$3.65	$3.62	$4.35	$4.35	$4.45	$4.48
Base	$6.01	$5.90	$5.43	$5.48	$6.66	$6.76	$3.85	$3.82	$4.58	$4.58	$4.70	$4.73
High	$6.39	$6.28	$5.79	$5.84	$7.12	$7.22	$4.09	$4.06	$4.84	$4.85	$4.99	$5.02
Annualized Cost Per AF												
Low	$1,849	$1,818	$1,672	$1,685	$2,045	$2,073	$1,189	$1,179	$1,416	$1,416	$1,451	$1,459
Base	$1,957	$1,923	$1,771	$1,785	$2,171	$2,202	$1,255	$1,245	$1,491	$1,491	$1,531	$1,540
High	$2,084	$2,045	$1,887	$1,904	$2,319	$2,352	$1,333	$1,322	$1,579	$1,579	$1,626	$1,636

1. Scenario 3A, Phase 1 is the initial 10-MGD plant with a 40-MGD backbone for expansion.
2. Scenario 3A, Phase 2 is the 30-MGD expansion of the initial 10-MGD plant to the full 40-MGD capacity.

Table 2-10 presents an overall comparison of program costs, from the planning phase through construction/start-up and operation of the full scale facilities.

Table 2-10: Program Development Costs Comparison

Major Activity	Program Development Costs, $K[1]				
	Scenario				
	1	2	3A[2]	3B[3]	4
	10-MGD	20-MGD	10/40-MGD	40-MGD	60-MGD
Retaining Owner's Representative	4,500	8,500	13,000	11,500	18,000
Continuing Studies	2,500	2,500	2,500	2,500	2,500
Environmental Documentation	2,000	2,000	2,000	2,000	2,000
Permitting and Approvals	2,000	2,500	3,000	3,000	3,500
Design/Construction (Present Worth)	155,000	295,000	475,000	440,000	710,000
Retaining Operations Team	700	800	900	900	1,000
Total	**166,700**	**311,300**	**496,400**	**459,900**	**737,000**

1. Values shown are in 1,000s of dollars, using the base costing category, averaged among site locations, and rounded to nearest $5M for comparative illustration purposes.
2. Values shown for Scenario 3A are for the phased plant at full build-out capacity of 40-MGD.
3. Values shown for Scenario 3B are for the 40-MGD plant built all at once (not phased).

Project Funding Options

The following funding sources and mechanisms are reviewed in the report, including both existing and future programs. Consideration is given to power ownership, delivery method, and West Basin's current financial structure.

(1) Internal Funding

(2) Federal Funding

- U.S. Bureau of Reclamation
- U.S. Army Corp of Engineers (ACOE)
- Water Infrastructure Finance and Innovation Authority (WIFIA)

(3) State Funding

- Proposition 84
- Safe, Clean and Reliable Drinking Water Supply Act of 2012

(4) Regional Funding

- Seawater Desalination Program (SDP)

(5) Public Private Partnerships (PPP)

- Investment Funds
- Qualified Tax Credit Bond (QTCB)

The recent economic recession has created significant uncertainty regarding the availability of funding from various sources that may have historically been accessed to fund the desalination facility. As noted above, sources such as earmarks from the U.S. Congress have temporarily been suspended and a planned State bond measure to fund water infrastructure has been postponed. Further, West Basin continues to develop its analysis of the potential financial impacts of internally funding the range of desalination facility sizes. Because of this uncertainty, it would premature to recommend particular funding options until the availability and impact of the various sources becomes clearer.

Cost of Water Analysis

The cost of water parameters in this PMP will feed into West Basin's financial impact analysis.

Funding Schedule/Sequencing

Funding needs and scheduling (i.e., the timing of borrowings) could be significantly different across the five capital scenarios and four broad-based funding options. Based on a 2018 on-line date for several of the capital scenarios West Basin may have limited flexibility in terms of the timing of borrowings via the funding scenarios. Subsequent expansions/phases might provide great opportunity for varying the timing of borrowings in light of the anticipated rate impact.

In general it would be critical to look at the segments of the project (design and the discrete elements of construction, as well as future expansions) in terms of scheduling borrowings and structuring the repayment provisions (e.g., traditional principal and interest payments versus interest-only payments for a defined, initial period).

An important consideration regarding the timing of borrowings is the impact on rates both during the period of design and construction as well as after the on-line date when incremental project-related O&M expenses would begin. This impact will likely be significantly influenced by the borrowing terms and specifically by the debt service coverage requirements as well as potential reserve requirements, e.g., debt service, operating and rate stabilization.

As a potential "off-set" to the rate impact (i.e. the rate increases needed to fund this project) the Metropolitan SDP incentive of up to $250 per acre foot should be considered in the financial planning element of the project funding and scheduling.

2.7. Project Delivery

The Alternative Project Delivery (APD) options, and associated advantages and disadvantages, presented in this Technical Memo include:

(1) Design-Bid-Build (DBB)

(2) Design-Build (DB)

(3) Design-Build Operate (DBO)

(4) Construction Manager (CM) at Risk

(5) Design Build Own Operate Transfer (DBOOT)

In addition, while not currently legal in the United States, Alliance Contracting is discussed.

As the various APD methods allocate risk differently between the Owner and the Private Sector, it is necessary to examine the implications to the Owner, and that this varying risk be considered by the Project Sponsors. The comparison of DBB, DB, and DBO options for the Ocean Water Desalination Program Master Plan (OWDPMP) included a look at Project Schedules for all short-listed alternatives. Cash flow analyses are included in the Project Financial Plan (PFP). The notable differences included the following:

- Retaining Owners Representatives: This activity is associated with the DB and DBO approaches. For the DB and DBO approaches, this activity reflects a significant duration, including the following sub-activities and durations.

RFP/ Retain Project Team	6 months
Project Description	6 months
Construction Impacts Report	6 months
Preliminary Engineering and DB Bid Package	9 months
Preliminary Opinion of Project Cost	2 months

For the DBB approach, some of the associated sub-activities (i.e., Project Description, Construction Impacts Report, Preliminary Design, and Preliminary Cost Estimate) roll up under the Designer/Engineering responsibilities, and therefore, do not reflect a significant difference in the Project Schedules.

- DB/DBO Team Procurement: For a two step DB/DBO approach, which includes prequalification and sort listing of teams prior to the RFP, this activity reflects a significant duration, including the following sub-activities and durations.

Prepare RFQ/ SOQ Submittal	4 months
Short List DB/DBO Teams	2 months
Prepare RFP/ Basis of Design	4 months
DB/DBO Response	6 months
Review/Select/Approval	2 months

With the DBB approach, these activities are replaced with Design Engineer Procurement, reflecting a shorter duration of approximately six months. However, the DBB approach also typically involves a longer design period, a longer contractor bidding and selection period, and a longer construction period (i.e., as a result of more involved submittal process).

- For the DB and DBO approaches, cost is typically determined earlier than the DBB approach with the activities associated with Retaining an Owner's Representative and the DB/DBO Procurement process. However, the additional activities required in the DBB approach, combined with the additional level of effort associated with the design and contractor bidding phases typically make a DB or DBO approach less costly. There are trade-offs however, and those trade-offs are discussed below in more detail.

These differences were considered for the OWDPMP together with the key factors that typically drive the selection process for an APD:

- Project Entitlement
- Project Risks
- Design
- Permitting
- Regulatory Approvals
- Capital Cost/Price Escalations
- Operations (Maintenance/Cost/Capability)
- Schedule Constraints/Timing
- Construction Experience/Approach
- Financing/Financial Strength
- Complexity of the Project/Opportunities for Innovation

West Basin has identified the following drivers for delivery method selection:

- Based on multiple years of project development and site specific understanding gained, West Basin is likely in a more knowledgeable position on the preferred treatment system performance than industry. As such, West Basin would likely consider providing the definition on the technical/treatment components (i.e. prescriptive approach).
- Technically qualified and experienced staff in alternative delivery

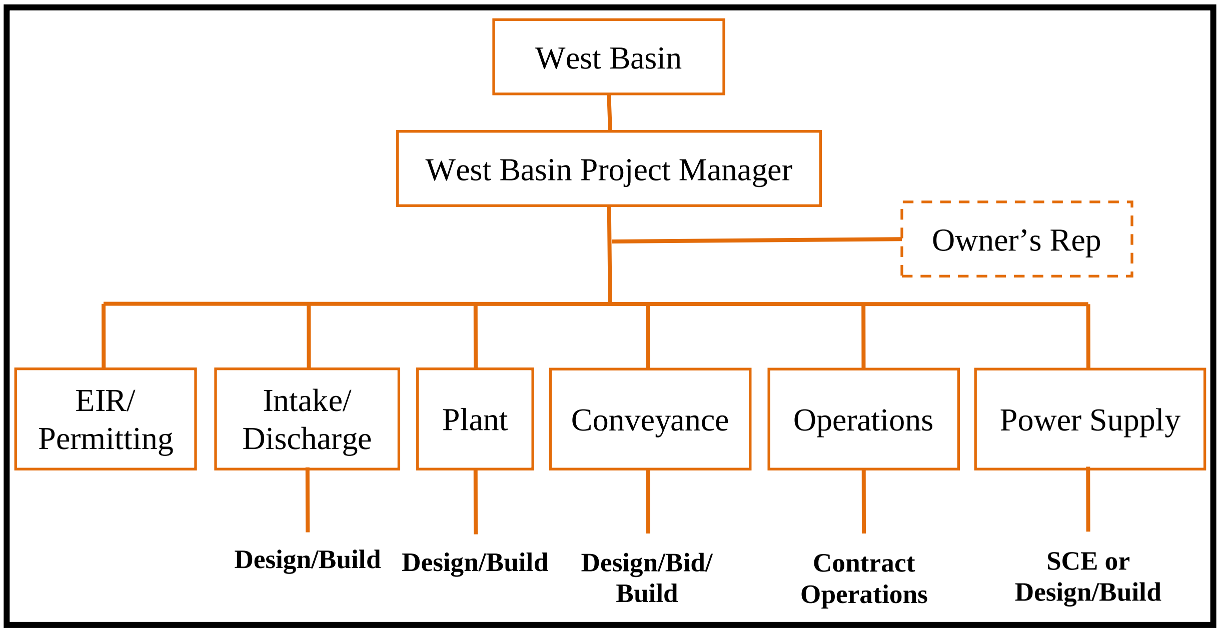
- Flexibility in contractor selection – ability to select based on best value
- Cost impacts
- Schedule (no regulatory constraints for expedited schedule)

By comparing the advantages/disadvantages identified above with the initial preferences/concerns provided by West Basin during the project delivery workshop, the CM@Risk, DBOOT and Alliance methods fall out of consideration. DBOOT and Alliance methods rely on private financing which is typically cost prohibitive and relinquishes some control of the project to the private sector. For a municipality that has not already adopted CM@Risk as an acceptable alternative, implementation would be challenging since the method has not been established in CA. There is also currently no legal precedent for the Alliance contracting method in the U.S.

The OWDPMP project can be broken down into three distinct components: the Intake/Discharge Structure, the Desalination Plant, and the Conveyance System. Among these components, the Desalination Plant and the Conveyance System components can be clearly defined by West Basin and a descriptive method of procurement may be warranted. For these two components, a traditional DBB, or descriptive specified DB method, could be appropriate. The Conveyance System requirements would need to be closely specified from the outset in order to satisfactorily integrate into the local distribution system. With more risk associated to the intake/discharge structures, and the industry proprietary solutions associated with this component, a procurement method with performance based requirements may be considered. DBO should also be included in the preferred delivery options as it presents the unique advantage of incorporating long term operational considerations into design and construction.

The use of multiple contracts would however bring its own risks associated with the overlapping and interconnecting components. Careful consideration to the management of such a hybrid delivery model will need to be undertaken, developed and implemented. Based on the assessment provided within TM 8, the hybrid organization might look like the Program Delivery Model shown below in **Figure 2-11**.

Figure 2-11: Example Program Delivery Model

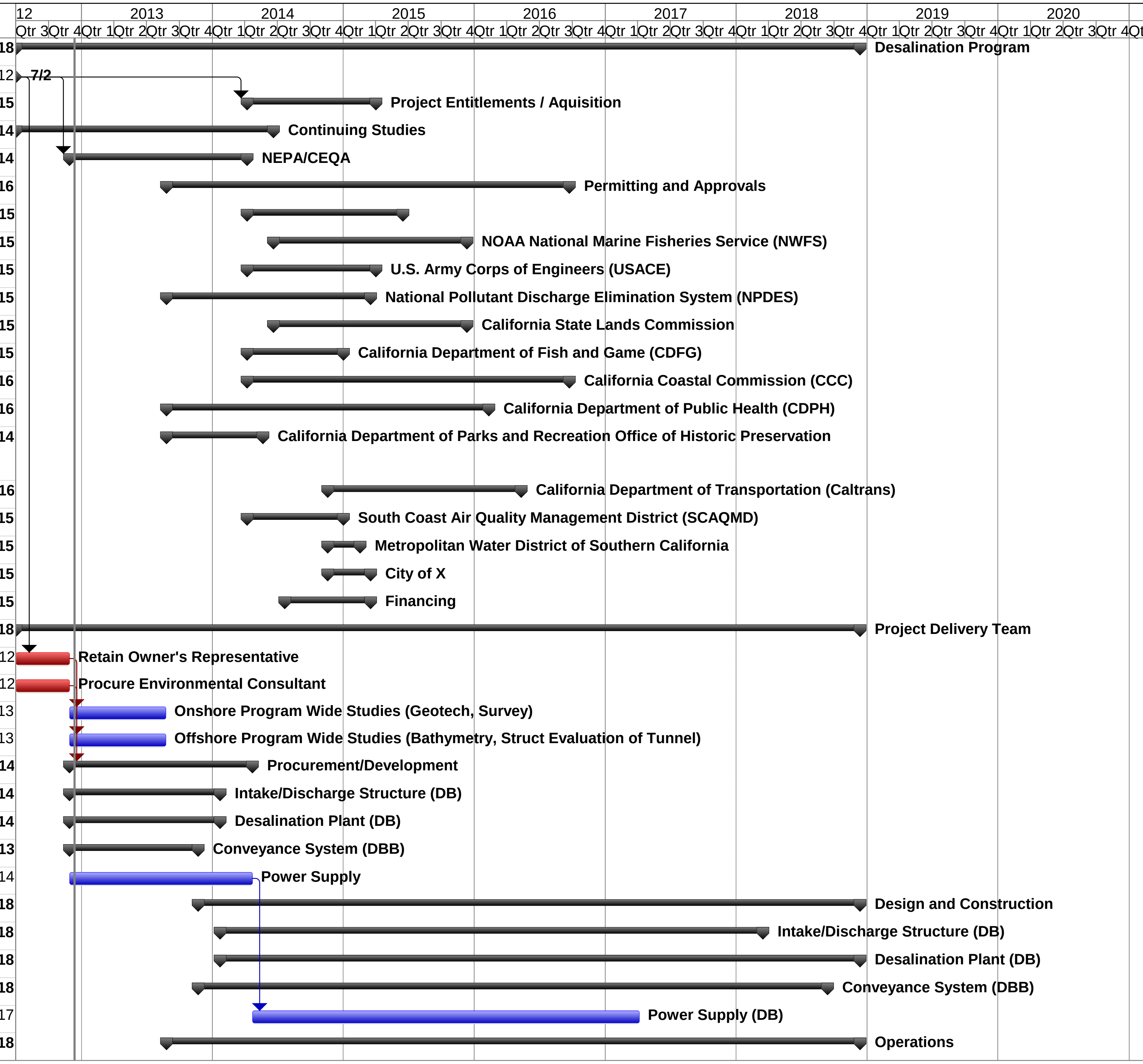


Within this type of Program Delivery Model that includes a hybrid set of delivery methods and contracts, additional development and coordination is often recommended and provided by an Owner's Representative. In general, this support can help to define and drive the program, in addition to providing significant coordination between the major components.

Overall Schedule

Figure 2-12 presents an overall schedule for the Program Master Plan that takes into account use of the hybrid delivery model described above. A more detailed version of this schedule is provided in the Appendix.

ID		Task Name	Duration	Start	Finish
1		**Desalination Program**	**2355 days**	**Mon 7/2/12**	**Wed 12/12/18**
2		Notice to Proceed	0 days	Mon 7/2/12	Mon 7/2/12
3		**Project Entitlements / Aquisition**	**360 days**	**Mon 4/7/14**	**Wed 4/1/15**
6		**Continuing Studies**	**720 days**	**Mon 7/2/12**	**Fri 6/20/14**
11		**NEPA/CEQA**	**495 days**	**Wed 11/28/12**	**Mon 4/7/14**
19		**Permitting and Approvals**	**1125 days**	**Mon 8/26/13**	**Thu 9/22/16**
20		**U.S. Fish and Wildlife Service (USFWS)**	**435 days**	**Mon 4/7/14**	**Tue 6/16/15**
23		**NOAA National Marine Fisheries Service (NWFS)**	**540 days**	**Fri 6/20/14**	**Fri 12/11/15**
25		**U.S. Army Corps of Engineers (USACE)**	**360 days**	**Mon 4/7/14**	**Wed 4/1/15**
28		**National Pollutant Discharge Elimination System (NPDES)**	**570 days**	**Mon 8/26/13**	**Wed 3/18/15**
45		**California State Lands Commission**	**540 days**	**Fri 6/20/14**	**Fri 12/11/15**
47		**California Department of Fish and Game (CDFG)**	**270 days**	**Mon 4/7/14**	**Thu 1/1/15**
50		**California Coastal Commission (CCC)**	**900 days**	**Mon 4/7/14**	**Thu 9/22/16**
56		**California Department of Public Health (CDPH)**	**900 days**	**Mon 8/26/13**	**Wed 2/10/16**
65		**California Department of Parks and Recreation Office of Historic Preservation**	**270 days**	**Mon 8/26/13**	**Wed 5/21/14**
67		**California Department of Transportation (Caltrans)**	**540 days**	**Tue 11/18/14**	**Wed 5/11/16**
69		**South Coast Air Quality Management District (SCAQMD)**	**270 days**	**Mon 4/7/14**	**Thu 1/1/15**
72		**Metropolitan Water District of Southern California**	**90 days**	**Tue 11/18/14**	**Mon 2/16/15**
74		**City of X**	**120 days**	**Tue 11/18/14**	**Wed 3/18/15**
76		**Financing**	**240 days**	**Mon 7/21/14**	**Wed 3/18/15**
79		**Project Delivery Team**	**2355 days**	**Mon 7/2/12**	**Wed 12/12/18**
80		Retain Owner's Representative	150 days	Mon 7/2/12	Wed 11/28/12
81		Procure Environmental Consultant	150 days	Mon 7/2/12	Wed 11/28/12
82		Onshore Program Wide Studies (Geotech, Survey)	270 days	Wed 11/28/12	Fri 8/23/13
83		Offshore Program Wide Studies (Bathymetry, Struct Evaluation of Tunnel)	270 days	Wed 11/28/12	Fri 8/23/13
84		**Procurement/Development**	**510 days**	**Wed 11/28/12**	**Tue 4/22/14**
85		**Intake/Discharge Structure (DB)**	**420 days**	**Wed 11/28/12**	**Wed 1/22/14**
92		**Desalination Plant (DB)**	**420 days**	**Wed 11/28/12**	**Wed 1/22/14**
99		**Conveyance System (DBB)**	**360 days**	**Wed 11/28/12**	**Fri 11/22/13**
105		Power Supply	510 days	Wed 11/28/12	Tue 4/22/14
106		**Design and Construction**	**1845 days**	**Fri 11/22/13**	**Wed 12/12/18**
107		**Intake/Discharge Structure (DB)**	**1515 days**	**Wed 1/22/14**	**Fri 3/16/18**
110		**Desalination Plant (DB)**	**1785 days**	**Wed 1/22/14**	**Wed 12/12/18**
113		**Conveyance System (DBB)**	**1755 days**	**Fri 11/22/13**	**Wed 9/12/18**
117		Power Supply (DB)	1080 days	Tue 4/22/14	Wed 4/5/17
118		**Operations**	**1935 days**	**Mon 8/26/13**	**Wed 12/12/18**



Project: West Basin OWDPMP
Date: January 2013
Figure: 2-12

Task | Split | Milestone | Summary | Project Summary | External Tasks | External Milestone | Inactive Task | Inactive Milestone | Inactive Summary | Manual Task | Duration-only | Manual Summary Rollup | Manual Summary | Start-only | Finish-only | Critical | Critical Split | Progress | Deadline

3. Conclusions

The major conclusions presented in this report include:

- The addition of a SWRO desalination facility will help to diversify West Basin's current water supply portfolio and reduce dependence on imported water.
- Pilot and demonstration scale testing have determined that SWRO, as part of a complete treatment train described herein, is an acceptable technology for meeting product water quality targets, given the historical source water quality at the candidate sites. The piloting and demonstration testing performed by West Basis has evaluated, and is continuing to assess, the performance of the selected treatment train, including a two-pass RO configuration. Identification of optimization opportunities for this treatment train and RO configuration is ongoing and final process selection will be based on final demonstration scale testing results and site specific requirements.
- Estimated local demands support up to a 20-MGD plant at either of the two candidate plant sites. Regional plant demand based on the existing MWD operational constraints would be 25-MGD. Although the necessity of a larger plant has not been determined, plant sizes up to 60-MGD are feasible.
- Both candidate sites (El Segundo and Redondo Beach) are found to be viable for SWRO desalination plants up to 60-MGD and rank similarly based on selected performance criteria that includes technical, economic, environmental, and social considerations.
- It was determined that the use of the existing tunnels as a conduit for intake and discharge pipes with open surface wedge wire intake screens and diffuser discharge is the best suited configuration for achieving the project objectives.
- Conveyance of product water into either local distribution systems or MWD local and regional feeders is viable from both candidate sites. Product water conditioning requirements and piping material compatibility concerns must be studied in further detail.
- West Basin has several options available for power supply. Additional investigations and negotiations with SCE and site owners (NRG and AES) should be pursued.

- For the Desalination Plant and Conveyance System, traditional DBB or DB methods are appropriate. As more risk is associated with the intake/discharge structures, and industry proprietary solutions are associated with this component, a less prescriptive procurement method may be considered, such as performance based requirements.
- Due to the recent economic recession, there is significant uncertainty in the availability of funds that have historically been accessible for funding major capital expenditures. Because of this uncertainty, it would be premature to recommend particular funding options until the availability and impact of the various sources becomes clearer.
- WHITE PAPER: Hydrodynamic Analysis of Intake and Dilution Issues for the West Basin Municipal Water District Sea Water Desalination Project by Scott Jenkins, Ph.D. Marine Physical Laboratory, Scripps Institution of Oceanography was completed at the end of this study. Intake and outfall concepts need to be iterated to incorporate minor suggested improvements.

4. Next Steps

Siting Evaluation

Subsequent analyses should be considered for both candidate sites. Terms and conditions in negotiations for each site have not been factored into this assessment, and they should be factored into future assessments and part of the decision process moving forward.

Additional studies that will be needed to support and further develop the alternatives include:

- Investigating the structural integrity of the existing tunnels at El Segundo to determine if they can be used as casing for pipes to be placed within the tunnels.
- Investigating whether the Redondo Beach discharge tunnel can be used under pressure conditions.
- Assess sediment transport at the sites to evaluate the potential effect of waves in eroding the seafloor and determine potential amounts of sediment in suspension.
- Bench- or pilot-scale testing is needed to identify effective chemical doses and operating conditions for the variety of pipe materials in West Basin service areas.
- Compatibility testing of stabilized product water with local groundwater and MWD system is also recommended to capture potential issues that may arise from blending, such as impacts of water quality on existing pipe corrosion products particularly in systems using groundwater of variable quality.

Power Supply

West Basin will have to evaluate the following going forward: on site self-generation and direct purchase from SCE. Both options will require further detailed analysis of terms and conditions to determine the best alternative. Further negotiation will be required with SCE on standby charges and added facilities charges. For the self-generation option, West Basin may have to secure emission off-sets. Although emission offsets have been available, there is no regulated market for the SCAQMD area. Individual entities deal with project developers and work out a price for selling or acquiring the off-sets. Since these trades are few and commercial terms are not published, cost of acquiring the offsets, specifically for NOx, CO and particulates (PM_{10} and $PM_{2.5}$), are not available.

Environmental Review

The next step for the program is initiation of environmental documentation consisting of an environmental impact report (EIR) phase. Alternatives of each key project component (intake, conveyance, and power supply) will be subjected to a more detailed environmental review during the EIR phase of the project. Land use, lease agreements, lease modifications, and easements will also need to be further identified. Procurement of environmental and engineering support for this process will be necessary. The following will be required moving forward into the EIR phase:

- Address technical studies and data needs.
- Prepare draft EIR/EIS and related NEPA/CEQA documentation.

Permitting

- A comprehensive plan to acquire all required permits should be instituted early on to ensure efficient acquisition.
- Early and on-going consultation with permitting agencies.
- Conduct initial scoping meetings.

Operations & Maintenance

Once a preferred delivery method is chosen, an analysis will be conducted to consider the tradeoffs that must be addressed in order to optimize an operations plan for the West Basin facility. This plan may include the use of West Basin personnel or provide for contract operations with a private entity.

West Basin Municipal Water District
17140 South Avalon Blvd. – Carson, CA 90746

Ocean Water Desalination Program Master Plan (PMP)

Conceptual System Design and Program Requirements Report (CSDPR)

January 2013

Report Prepared By:

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1. Introduction

1.1. Objectives

The Conceptual System Design and Program Requirements (CSDPR) is an important part of the Ocean Water Desalination Program Master Plan (PMP). It defines alternatives of all key project components, assesses and prioritizes these alternatives, and provides recommendations for selecting two to three most viable alternatives of each key project component (intake, pretreatment, reverse osmosis desalination system, post-treatment and product delivery). These alternatives will be subjected to a more detailed environmental review during the Environmental Impact Report (EIR) phase of the project.

1.2. Report Organization

The CSDPR is the result of numerous workshops and Technical Memoranda in which key ideas were vetted among the project team. Each section of this report addresses a key project component and is presented as follows:

- **Section 1: Introduction –** This section provides the background for the project, project objectives and purpose, and identifies the two sites selected for further review in this report.
- **Section 2: Demand and Supply Requirements –** This section focuses on the local demand analysis and informs the determination of the minimum feasible size for a desalination plant to meet the future water needs of the West Basin customers. (Primary author: Malcolm Pirnie/ARCADIS)
- **Section 3: Plant Siting Alternatives and Assessment –** This section assesses the two potential desalination plant sites (El Segundo and Redondo Beach) based on environmental, socioeconomic, and surface and subsurface site conditions and considerations. (Primary author: Malcolm Pirnie/ARCADIS)
- **Section 4: Ocean Water Intake and Desalination Plant Discharge –** This section describes the evaluation of subsurface and surface intake options, compatible discharge alternatives, identification of the preferred alternative for project implementation, and provides a conceptual design and cost estimate of the preferred alternative. (Primary author: Halcrow)
- **Section 5: Product Water Delivery –** This section discusses the development of product water quality specifications and distribution system alternatives for delivering the finished water. (Primary author: Malcolm Pirnie/ARCADIS)
- **Section 6: Power Supply –** This section discusses the power demands and introduces various power supply option concepts. A further detailed discussion of

Power Supply will be included in the overall Master Plan. (Primary author: Nexant)

- **Section 7: Conceptual Plant Design –** This section defines the conceptual criteria at both of the site alternatives, including process treatment trains, layouts, and costs. (Primary author: Malcolm Pirnie/ARCADIS; Contributing Authors: SKM, Veolia)
- **Section 8: Additional Studies –** This section discusses additional studies needed to further develop the alternatives.

Although additional studies needed to further support and develop the alternatives are discussed within specific sections, they are also summarized in Section 8 to provide a consolidated roadmap forward for next steps.

2. Demand and Supply Requirements

A key component of the Program Master Plan is an evaluation of potential sites within West Basin's service area that could accommodate a full-scale facility. An important element of this evaluation is the location of local and/or regional drinking water distribution systems relative to the two plant sites (El Segundo and Redondo Beach) that are under consideration.

This section focuses on the local demand analysis and informs the determination of the minimum feasible size for a desalination plant to meet the future water needs of the West Basin customers. The primary assumptions used for the analysis were:

- The project will help increase local supplies and reduce the reliance on imported water supplies to meet expected future demands,
- Imported water demands during the lowest demand month of February were appropriate for determining the "low-end" of the range for potential plant capacity size,
- The 80% exceedance level of the historical February demands over a representative demand period (CY2000-2011) and a 95% operating factor per year represent a conservative basis for selecting the low end of the range for plant size, and
- Conveyance facilities sizing is based on diurnal analysis results

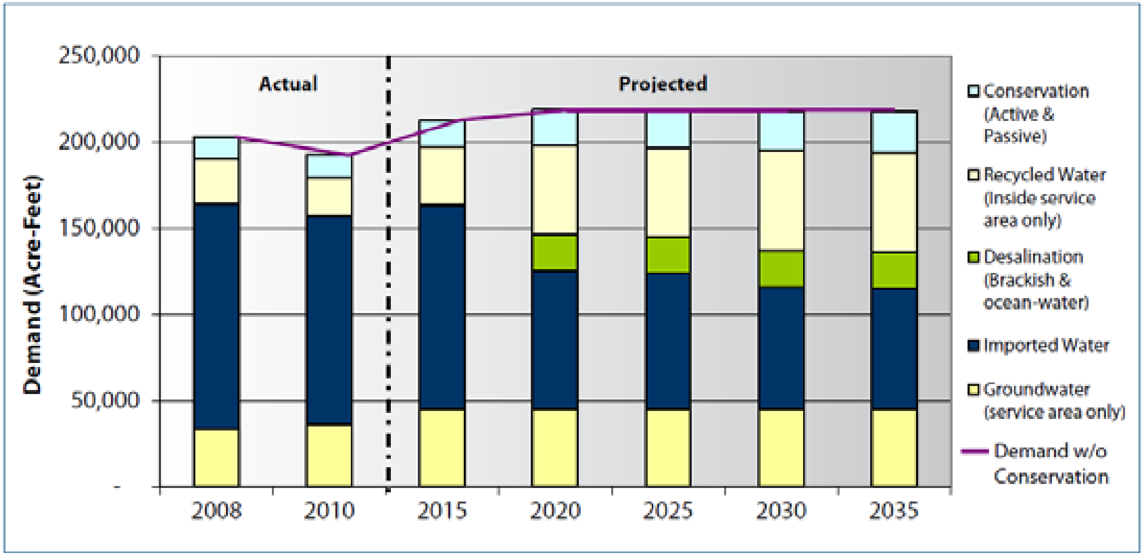
2.1. Local Project

2.1.1. Current and Future Demands Assessment

West Basin's 2010 Urban Water Management Plan (2010 UWMP) includes the most recent projections of future water demands for its service area through the year 2035. The projections were completed using West Basin's Water Demand Forecasting Model, which produces a range of forecasts depending on the level of anticipated conservation activities , change in the cost of water, economic recovery and hydrology.

Figure 2-1 below provides an overview of the anticipated demands as well as the supply sources (including conservation) identified to meet forecasted demands. This figure reflects the recent decrease in demands since 2008 and the anticipated future increase in demands as the economy improves. However, given planned conservation activities, conserved supply will actually offset this demand, maintaining a static level of overall demand of less than 200,000 AFY from 2015 through 2035.

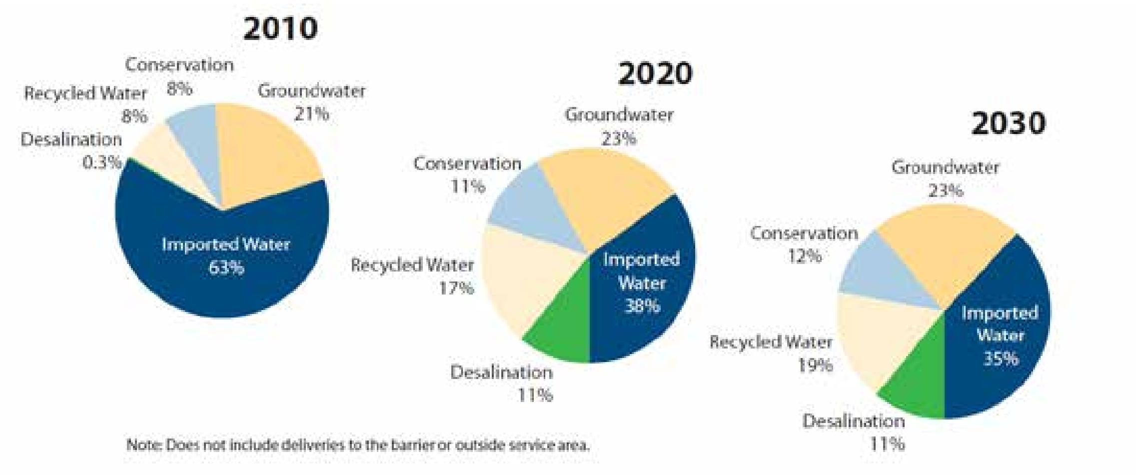
Figure 2-1: West Basin's Current and Projected Future Demands
Source: West Basin 2010 UWMP



The various supply sources identified above reflect West Basin's efforts to diversify its water resources portfolio to increase the district's reliability in the future. These reliability goals are embodied in West Basin's Water Reliability 2020 Program (WR 2020), which is projected to reduce the district's dependence on imported water from 66 percent down to approximately 33 percent by the year 2020.

To achieve this and other goals, WR 2020 focuses on producing new sources of local potable water, including expanding its recycled water customer base, broadening its water use efficiency programs and outreach and taking its brackish groundwater and ocean water desalination program to a full-scale level. West Basin's changing supply portfolio mix over the next decade is shown in **Figure 2-2** below.

Figure 2-2: Projected Changes in West Basin Water Supply Portfolio
Source: West Basin 2010 UWMP



As noted in the 2010 UWMP, West Basin intends to increase its combined brackish groundwater and ocean water desalinated supplies from the current 500 acre-feet (AF) per year to 21,500 AF by 2030. This would increase the desalinated share of total water supplies from less than 1 percent currently to approximately 11%.

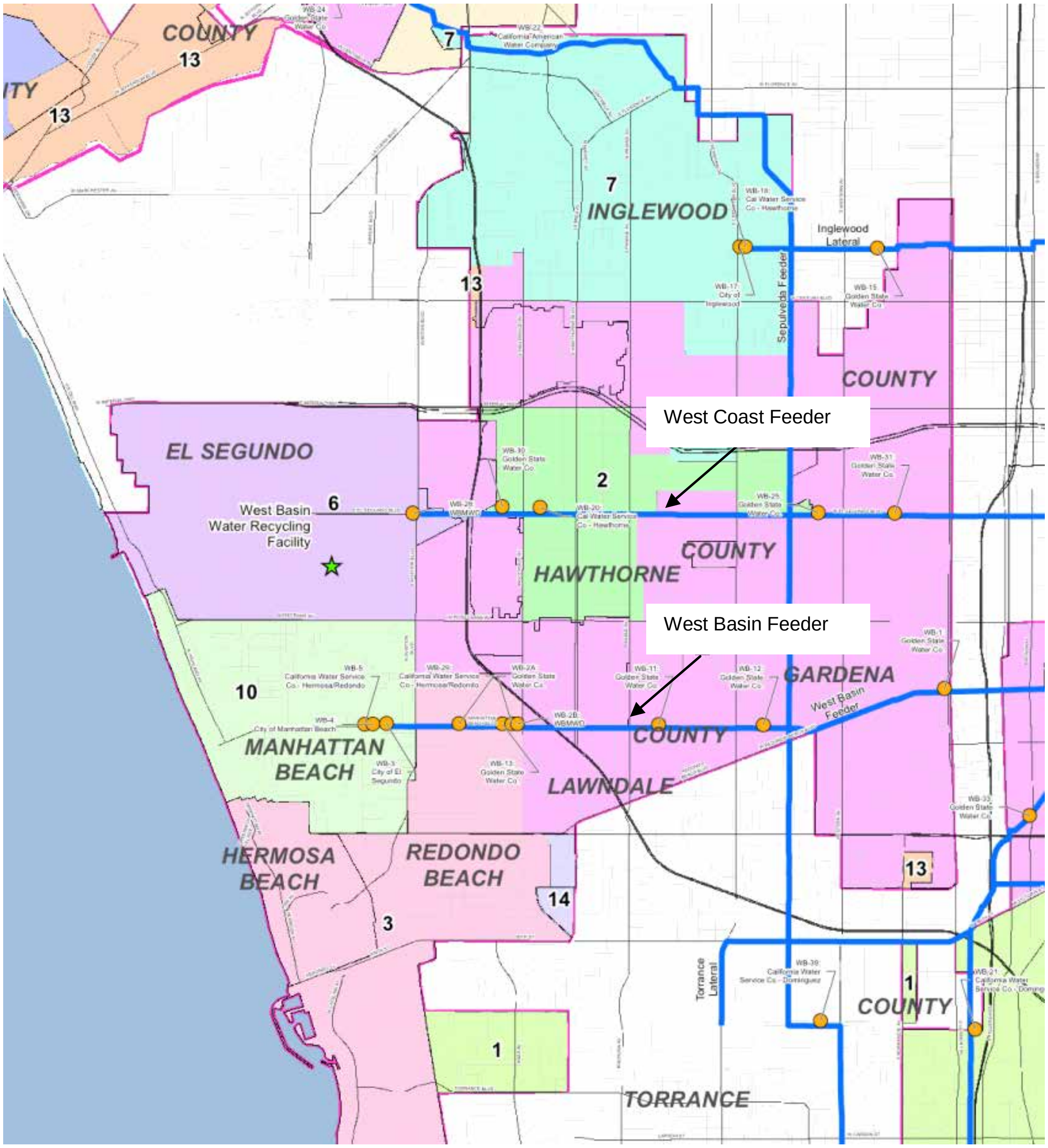
2.1.2. Available Supply Options

Based on a review of existing West Basin and MWD facilities, the proposed plant locations, and the analysis developed by MWD staff, two potential delivery scenarios were developed in order to assess local base demands. The two delivery scenarios focus on MWD service connections along the West Coast and West Basin Feeders east of the Sepulveda Feeder, which serves the majority of West Basin's service area. Those MWD service connections identified for further analysis were:

- West Basin - WB-5, WB-4, WB-3, WB-29, WB-13, WB-2A, WB-2B, WB-11 WB-12
- West Coast – WB-28, WB-30, WB-20

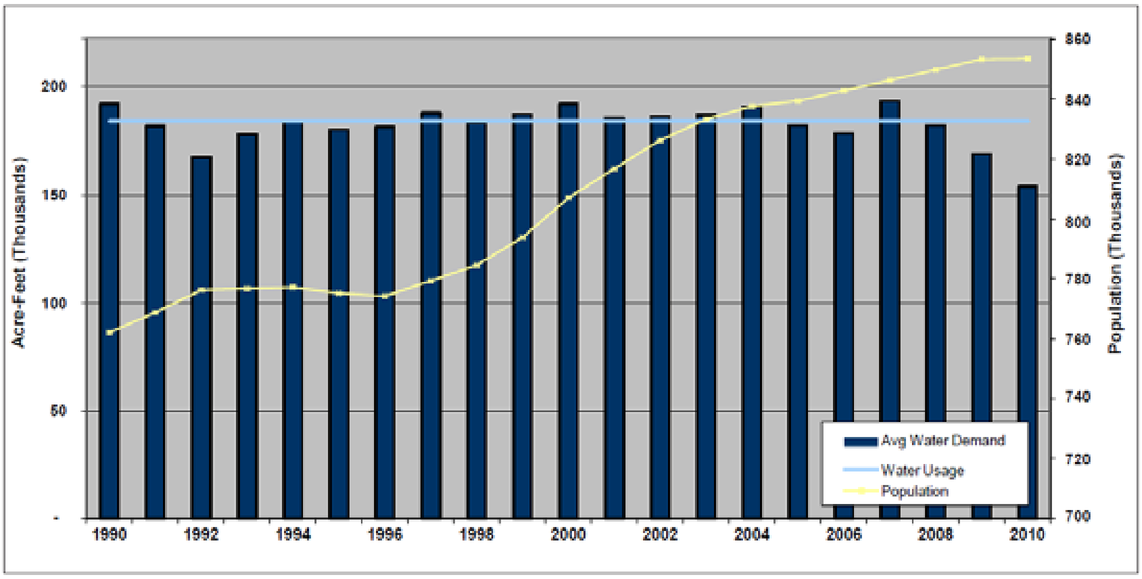
Figure 2-3 shows the two potential plant locations as well as the West Coast and West Basin Feeders.

Figure 2-3: Potential Plant Locations and West Coast and West Basin Feeders



The analysis focused on water deliveries through the specified connections from FY2001 through FY2010. As shown in **Figure 2-4**, this period is a representative range of West Basin's water demands since 1990 and includes the recent decrease in demands attributable to aggressive conservation in response to drought conditions, the economic downturn, and the subsequent wet seasons.

Figure 2-4: Historical West Basin Water Demands
Source: West Basin 2010 UWMP



A review of MWD meter readings from the identified service connections for the study period showed that demands for imported supplies were the lowest during the month of February. Absent any foreseeable, significant changes in demands, using historical data from this month would represent an appropriate base to estimate future low demands for imported supplies.

2.1.2.1. Analysis of Historical Demands

As noted above, the analysis was based on two delivery scenarios developed based on potential deliveries using current MWD connections along the two main feeders that serve imported supplies to West Basin retailers. The associated historical demands were analyzed separately and then combined to estimate potential future local demands.

The daily average flow readings (demands) for each group of service connections were then summed and ranked from lowest to highest. The rankings were then incorporated into a probability of exceedance curve that serves as a record of the probability that a given level of demand would be met or exceeded based on historical data for the period under review. The exceedance curves serve as a forecast of the likelihood that different levels of demand will be met or exceeded in the month of February.

For the purpose of estimating the minimum plant sizing, the 80% exceedance level was selected. Under this assumption, (1) demands associated with identified service connections would exceed the plant's minimum capacity 80% of the time in the month of February (approximately 23 out of the 29 days), and (2) operational actions (maintenance) or additional storage facilities may be necessary to manage or reduce excess flows. Based on the historical data and the assumption that this pattern would continue (with February showing the lowest level of demands historically), it was assumed that demands on an annual basis would exceed the minimum plant capacity approximately 95% of the time.

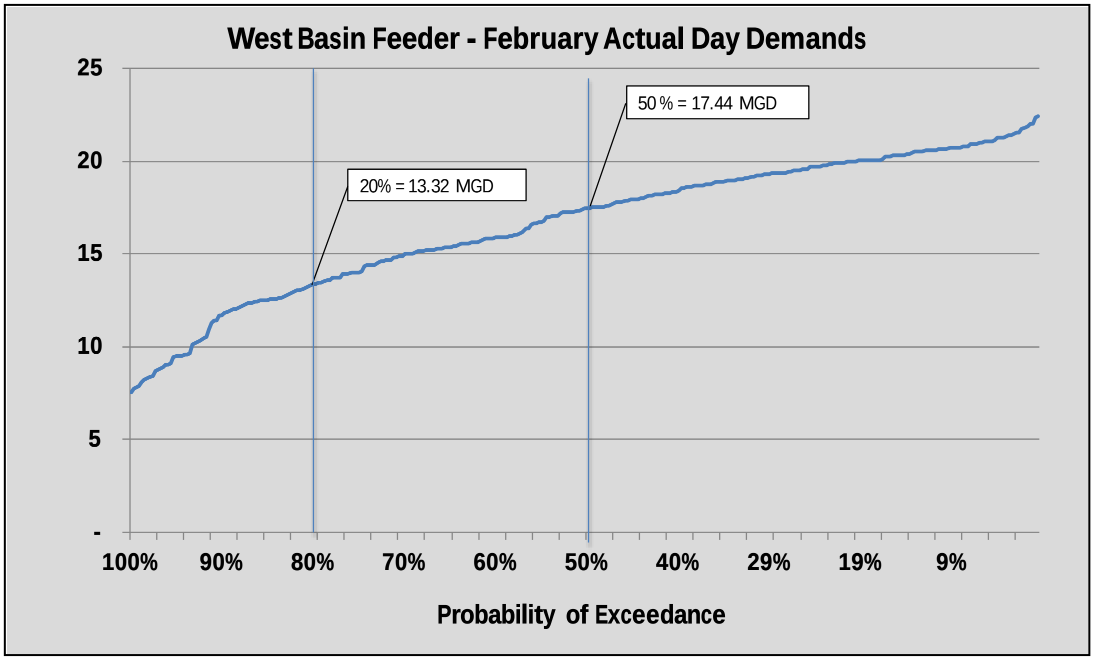
2.1.2.2. West Basin Feeder

The West Basin Feeder is a 6.9 mile, 45" diameter facility installed in 1950 that currently serves the Cities of Manhattan Beach, El Segundo, Hermosa Beach and Redondo Beach via service provided by California Water Service Company and Golden State Water Company. There are nine MWD service connections along the West Basin Feeder (WB-5, WB-4, WB-3, WB-29, WB-13, WB-2A, WB-2B, WB-11, WB-12), as shown in the **Figure 2-5** below.

Figure 2-5: MWD Service Connections along West Basin Feeder

The daily average flow readings (demands) for each feeder was separated and analyzed, focusing on the low months using the 20% and 50% exceedance curve. Each group of service connections was then summed and ranked from highest to lowest based on data for the month of February. Individual meter flow can be found in **Appendix 1:H**. For the 9 connections along the West Basin Feeder, the demand level associated with the 80% exceedance level was 13.32 million gallons per day (MGD), while demand level at the 50% exceedance level was 17.44 MGD. This compares with demand levels in the peak month of August of 17.43 MGD at the 80% exceedance level and 19.66 MGD at the 50% exceedance level. Exceedance levels are a common basis for selecting a conservative basis for a planning assumptions. Examples include the 90% exceedance level for increases in the State Water Project allocation and the 70% exceedance level for MWD's assumed water demands in a given year. These 80% and 50% amounts are highlighted below along the exceedance curve shown in **Figure 2-6**.

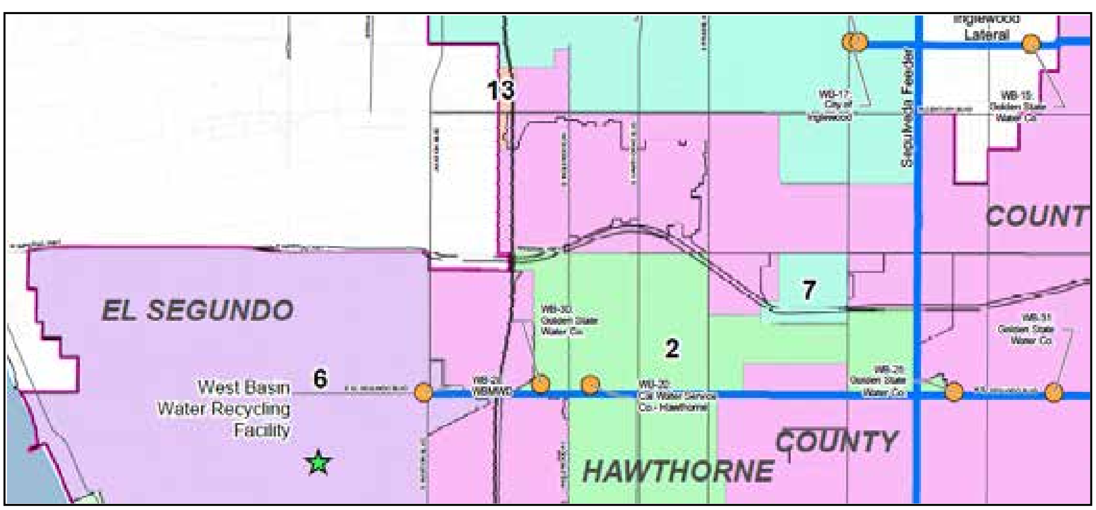
Figure 2-6: Historical West Basin Feeder Demands



2.1.2.3. West Coast Feeder

The West Coast Feeder is a14.6 mile facility with a diameter that ranges from 60”-66” that was installed in 1960. There are only 3 MWD service connections along the West Coast Feeder (WB-28, WB-30, WB-20) as shown in the **Figure 2-7** below. These connections serve the Golden State Water Company, West Basin and the City of Hawthorne via service provided by California Water Service Company.

Figure 2-7: MWD Service Connections along West Coast Feeder

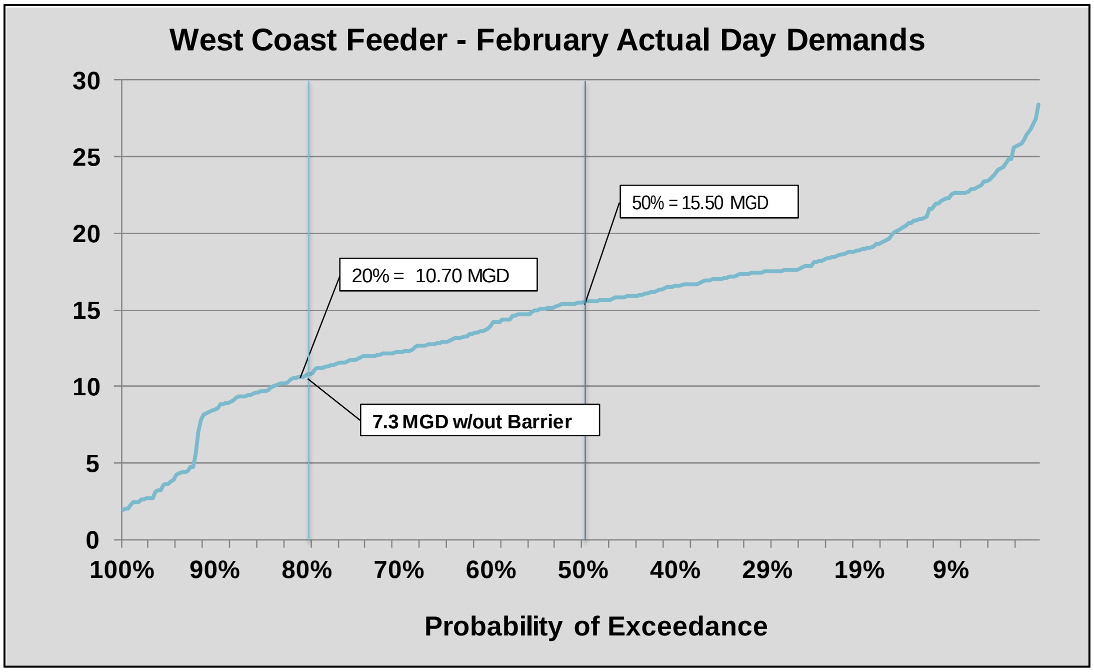


A review of the meter readings for the three service connections shows that demands along the West Coast Feeder during the month of February were 10.70 MGD at the 80% exceedance level, and 15.50 MGD at the 50% exceedance level after accounting for the seawater barrier deliveries. However, during a review of the initial analysis, it was noted that some of the deliveries of potable supplies to service connection WB-28 were used to meet demands for "seawater barrier water," which does not require potable supplies. Under West Basin's planned expansion of its recycled water program, deliveries of potable supplies from WB-28 will be replaced with recycled water supplies in the future. As a result, the analysis captures this change by subtracting out historical barrier water deliveries through WB-28 from the data to estimate future demands for desalinated supplies.

Additionally, deliveries of potable supplies to the barrier have increased during the years analyzed. These increasing deliveries include demands during the month of February. A review of the historical barrier deliveries through WB-28 from 2005 to 2011 during February showed barrier deliveries fluctuating because of operational and hydrologic factors, though 2005 stood out as having a significantly lower level of demand through WB-28. This is consistent with the initial findings, which showed that 2005 made up the vast majority of the high end of the exceedance curve (i.e., lowest daily average flow readings that make up the exceedance curve.. This means the lowest levels of overall demand were on the West Coast Feeder.

Without a complete set of daily flow readings for deliveries to the barrier for CY2000-2004-, the analysis looked at non-barrier water demands on WB-28 for the 11 daily flow readings on or near (actual observation plus 5 above and 5 below) the 80% exceedance level. The review showed that the daily flow readings were primarily from the years 2006 through 2008, which were included in the partial data available (i.e., 2005-2011). Next, the relevant non-barrier delivery data was then substituted in place of original data to determine the revised estimated potable demands on WB-28 at the 80% exceedance level. With the revised data, the average flows for the service connections on the West Coast Feeder dropped from 10.7 MGD to 7.3 MGD.

Figure 2-8: Historical West Coast Feeder Demands



2.1.3. Supply Recommendations

The estimated minimum demands for the combined West Coast Feeder and West Basin Feeder at the 80% exceedance level is 20.6 MGD. As a result, the estimated local demands (i.e., displaced MWD demands) support up to a 20 MGD plant at either of the possible plant sites. The Redondo Beach site has the potential for additional demand from Cal Water's Palos Verdes system as well as connection WB-16. The Redondo Beach site also has the potential to back-feed the West Basin feeder from Cal Water lateral WB-5.

Table 2-1: Combined Local Demands for West Basin and West Coast Feeders

	El Segundo Site (MGD)	**Redondo Beach Site** (MGD)
West Basin Feeder	7.3	7.3
West Coast Feeder	13.3	13.3
Combined	20.6	20.6

2.1.4. Meetings with West Basin Retailers

In order to develop the necessary information for the local demand analysis, in-person meetings were conducted with management and staff from six of West Basin's seven retailers during the months of June and July 2011. The retailers were selected based on their close proximity to MWD's West Coast and West Basin Feeders, which would make them the most viable recipients of desalinated supplies delivered through these facilities. The objectives for the meetings were the following:

1. Provide the retailers with an overview of the desalination master plan process
2. Gain an understanding of facility and operational capabilities of each retailer to receive and utilize desalinated supplies, and
3. Collect background materials from each agency including UWMPs, Master Plans, and other relevant documents.

The schedule and participants for each of the meetings are shown in **Table 2-2**.

Table 2-2: Meeting Schedule

Agency	Attendees	Date
City of El Segundo	ES: James Turner, Stephanie Katsouleas, Marion WB: Phil Lauri MP: Tom Visosky, Michael Hurley	06/23/2011
City of Manhattan Beach	MB: Raul Saenz, Jim Arndt WB: Phil Lauri MP: Tom Visosky, Michael Hurley	06/23/2011
California American Water	C-A: Gary Hofer, Mark Reifer WB: Phil Lauri MP: Tom Visosky, Michael Hurley	06/27/2011
City of Inglewood	City: Boyrese Osias WB: Phil Lauri MP: Michael Hurley	06/28/2011
California Water Service Company	CW: John Foth, Terry Tamble, Henry Wind WB: Phil Lauri, Fernando Paludi MP: Tom Visosky, Michael Hurley	06/28/2011
Golden State Water Company	GS: Paul Rowley and Shad Rezai WB: Fernando Paludi MP: Tom Visosky	07/29/2011

During these meetings, representatives of the retailers all expressed support for reliable local supplies, including a potential desalination project. They also believe that solutions should be cost competitive. None of the Agencies expressed a preference for site location. Those with storage facilities indicated a willingness to discuss further the potential use/integration of these facilities as part of a potential desalinated water supply program.

2.2. Metropolitan Regional Project

In consideration of a regional supply approach, West Basin has requested planning and engineering support from the Metropolitan Water District of Southern California (MWD) to evaluate the regional supply approach options. MWD provided in-house planning and engineering support services at the request of West Basin to assist with the regional demand analysis, conveyance, distribution, storage, and water quality aspects of this Program Master Plan development. MWD work products are provided by reference in the Appendices and are referenced throughout this document.

2.2.1. MWD Demand Analysis Summary

MWD provided the West Basin team a summary of its demand analysis on June 8, 2011. The summary included an overview of the forecasted demands and operational constraints on the MWD system in the vicinity of the potential desalination plants. The major demand assumptions included:

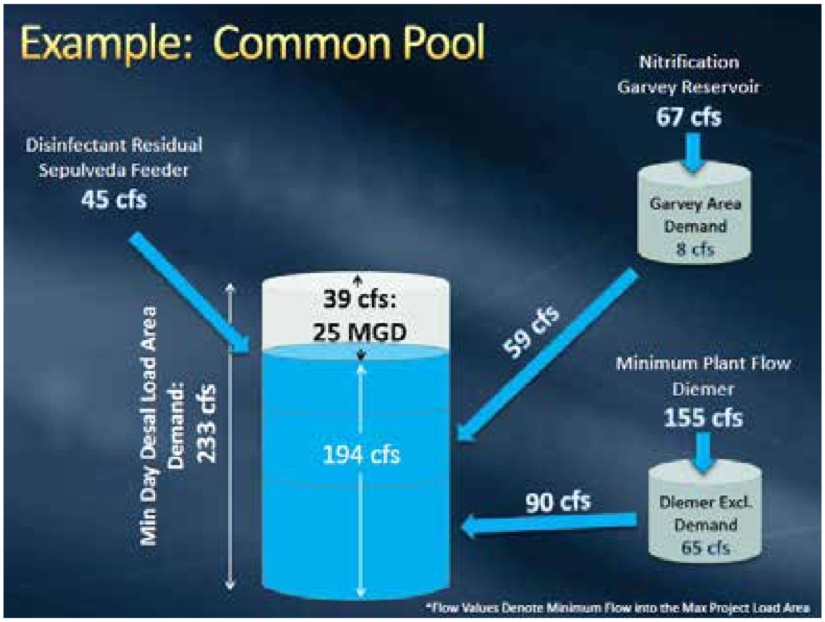
- Demand/ Sales Model forecasts for future years 2010 – 2050
- Demand adjustments for 20% conservation by 2020
- Minimum month and day analysis

This demand approach estimated a total minimum day firm demand for the region at 233 cfs or approximately 150 MGD. MWD existing surface water treatment and conveyance system, however, include existing operational constraints that would limit the ability of the region to be solely served by a new desalination facility. These current constraints are shown in **Figure 2-9** and include

- Minimum flow through each regional treatment plant
- Minimum flow out of Garvey Reservoir to avoid nitrification
- Minimum flow in Sepulveda feeder to maintain adequate chlorine residual

The analysis did not consider any modifications to MWD's existing system that could potentially expand the area served by a plant at either of the two sites.

Figure 2-9: MWD Operational Constraint Impact on Desalination Plant Size



2.2.2. MWD Regional Project Size

Although the regional MWD conveyance system is capable of taking upwards of 60 MGD, MWD's regional plant demand based on the existing operational constraints would be 25 MGD.

2.3. Plant Sizing for Conceptual Planning

2.3.1. Small Scale Desalination Plant - Local/Regional Project

The plant size of West Basin's local project (20 MGD) and MWD's regional project (25 MGD) are similar; therefore, for planning purpose the small scale desalination project will be planned for 20 MGD.

2.3.2. Large Scale Desalination Plant – Local/Regional Project

West Basin continues to work with MWD to evaluate regional supply approach options. While discussions regarding a larger scale project are ongoing. Although it has not yet been determined if a larger facility is necessary, a 60 MGD desalination plant is being analyzed by West Basin for conceptual development within this study. Both the El Segundo site and the Redondo Beach site have adequate size capacity to support up to a 60 MGD desalination plant.

2.4. Desalination Supply Alternatives

2.4.1. Summary of Previous Investigations

2.4.1.1. West Basin

West Basin has been removing salt from groundwater with high mineral content and desalting municipal wastewater for irrigation and industrial use since 1993. West Basin currently uses the same technologies necessary for ocean-water desalination that are used in groundwater and recycled water treatment. Since 1993, West Basin has been operating the C. Marvin Brewer Desalter Facility which treats brackish groundwater from the inland side of the West Coast Seawater Barrier, along with various recycling water treatment facilities since 1995.

Beginning in 2001, West Basin started a multi-phase program to explore the development of a full scale ocean-water desalination facility. In 2002, a 20 gpm ocean-water desalination pilot facility at El Segundo Power Plant. The facility used microfiltration and reverse osmosis membrane technologies for extensive research and water quality testing purposes. The goal of the project was to identify feasible performance levels and to evaluate the water quality characteristics. The facility was in operation for over seven years and after tens of thousands of water quality tests, it was found that the quality of the desalinated ocean-water met or surpassed the current state and federal drinking water standards. The water that was produced at the facility had a total dissolved solids level of approximately 300 ppm, which is lower than the typical tap water in southern California.

In 2003, West Basin worked together with several national water agencies to raise attention towards desalination efforts by forming the U.S. Desalination Coalition. The formed Coalition helps encourage federal support and provides funding for ocean-water desalination projects all over the country.

In response to Southern California’s increasing demands and decreasing water supply, West Basin has initiated its WR 2020 in order to help reduce the area’s dependence on imported water from today’s 66 percent to 33 percent by 2020 and ocean-water desalination is a major part of that program. Although ocean-water desalination has been around for quite some time, technological advancements have made it less energy intensive as well as more affordable to desalt ocean water.

At the tail end of the pilot project, West Basin’s evaluated critical components of the ocean-water desalination process through a larger demonstration project. In early 2009, West Basin obtained all the necessary permits to proceed with the construction. West Basin completed its ocean-water desalination demonstration facility and water education center by late 2010. Located at the SEA Lab in Redondo Beach (**Figure 2-10**) the facility allows the evaluation and demonstration of ocean protection, energy recovery and cost reduction technologies. The data acquired from the pilot project were used in the planning and development of the demonstration facility that currently produces 50,000 gallons per day of product water. This facility has been developed to make sure a full scale ocean water desalination facility will be done in a cost and energy efficient manner and with the main goal of protecting the ocean.

Figure 2-10: West Basin's Desalination Demonstration Facility
Source: West Basin 2010 UWMP

2.4.1.2. MWD

MWD supports local resources development such as seawater desalination to meet its supply reliability and water quality objectives in a cost effective manner. Desalination of brackish groundwater and other local supplies helps supply reliability by maximizing local groundwater sources as well as the development of seawater desalination projects. Seawater desalination is a significant opportunity to diversify the region's water resource mix with a new, controlled, and drought-resistant potable supply. MWD supports its member agencies that are actively pursuing research that would minimize environmental issues and reduce the cost of ocean water desalination.

MWD has been exploring seawater desalination as a potential water supply since the 1950s. Early efforts included the purchase of a site for offshore desalination near Huntington Beach and procurement of coastal property at Ormond Beach in Ventura County. An integration study evaluated potential sites for an MWD facility that would have been located along coastal power plants but due to the cost of seawater it was not competitive with other resources at the time. In 1994, MWD completed a system integration study that considered 12 seawater desalination facilities with capacities ranging from 20 MGD to 100 MGD. The study showed that smaller projects located near water demand centers may integrate effectively into existing local distribution systems while minimizing distribution costs while larger regional projects or projects that were located farther away from demand centers may require conveyance to a regional pipeline, new coastal feeders, or additional distribution infrastructure to bring the supplies to the demand center.

MWD created the Seawater Desalination Program (SDP) in 2001 with the stated primary objective of “supporting the development of cost-effective seawater desalination projects consistent with Metropolitan’s overall water supply reliability needs”. The SDP offers member and local agencies up to $250 per AF of production. Currently MWD has entered into four SDP agreements for the Carlsbad Seawater Desalination project, Long Beach Seawater Desalination Project, South Orange Coastal Ocean Desalination Project, and the West Basin Seawater Desalination Project.

To promote the development of these local projects, MWD provides support for its member agencies in the permitting process during hearings and other proceedings, as well as coordinating responses to potential legislation and regulations, and working with agencies to resolve any issues that could impact the seawater desalination projects. Along with this support, MWD has formed a Board Committee to find ways to promote potential projects and explore opportunities for the development of regional seawater desalination supplies

2.5. Non Desalination Supply Alternatives

2.5.1. Summary of Previous Investigations

2.5.1.1. West Basin

Recycled water is an important part of West Basin’s efforts to increase local supplies and reduce the dependence on imported water. An increase in population and restrictions on imported supplies have challenged West Basin to diversify its supply portfolio to meet new demands through the expansion of recycled water production and distribution along with an increased conservation program.

West Basin has a long history of recycled water and reputation as a world-class leader in water reuse. West Basin has been producing recycled water 30 MGD from its Edward C.

Little Water Recycling Facility (ECLWRF) since 1995. The facility supplies the unique needs of municipal, commercial and industrial customers by conserving about 7 percent of the region's drinking water supply. West Basin's recycled water source is treated wastewater that connected nearly 2 miles from the City of Los Angeles's Hyperion Wastewater Treatment Plant which is located adjacent to West Basin service area, and is then treated by West Basin to an array of high quality water standards..

The majority of West Basin's recycled water is treated to meet Title 22 tertiary standards and about 2,000 tests are performed every month at the ECLWRF to make sure the water quality meets or exceeds all State and Federal requirements. ECLWRF was recognized by the National Water Research Institute as one of the six National Centers for Water Treatment Technologies in the country in 2002. West Basin produces five different water products including Tertiary, Nitrified, Reverse Osmosis, Pure Reverse Osmosis, and Ultra-Pure Reverse Osmosis water. The reverse osmosis water produced is purchased and blended with potable water to be injected into the West Coast Basin Seawater Barrier which has dual benefits of not only preventing seawater intrusion in the aquifers but also provides replenishment water that is extracted by drinking water wells.

To date, West Basin's recycled water efforts have avoided using over 100 billion gallons of potable water that would have been used for non-potable uses due to its recycled water efforts. All recycled water is originally treated at the ECLWRF and is then distributed to either end-use sites or one of the several satellite facilities for further treatment as shown in **Figure 2-11**.

Figure 2-11: West Basin's Water Recycling Facilities
Source: West Basin 2010 UWMP

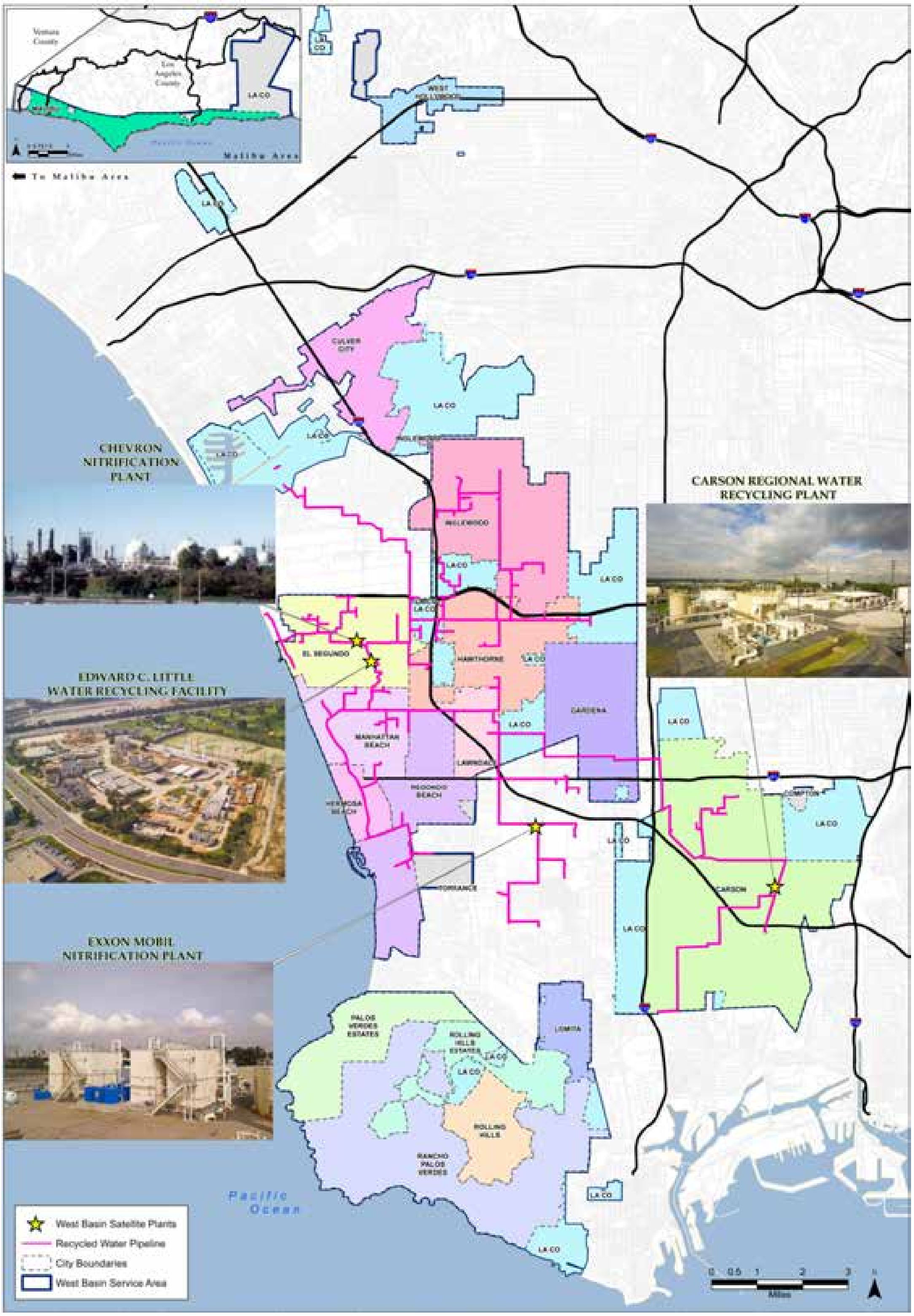
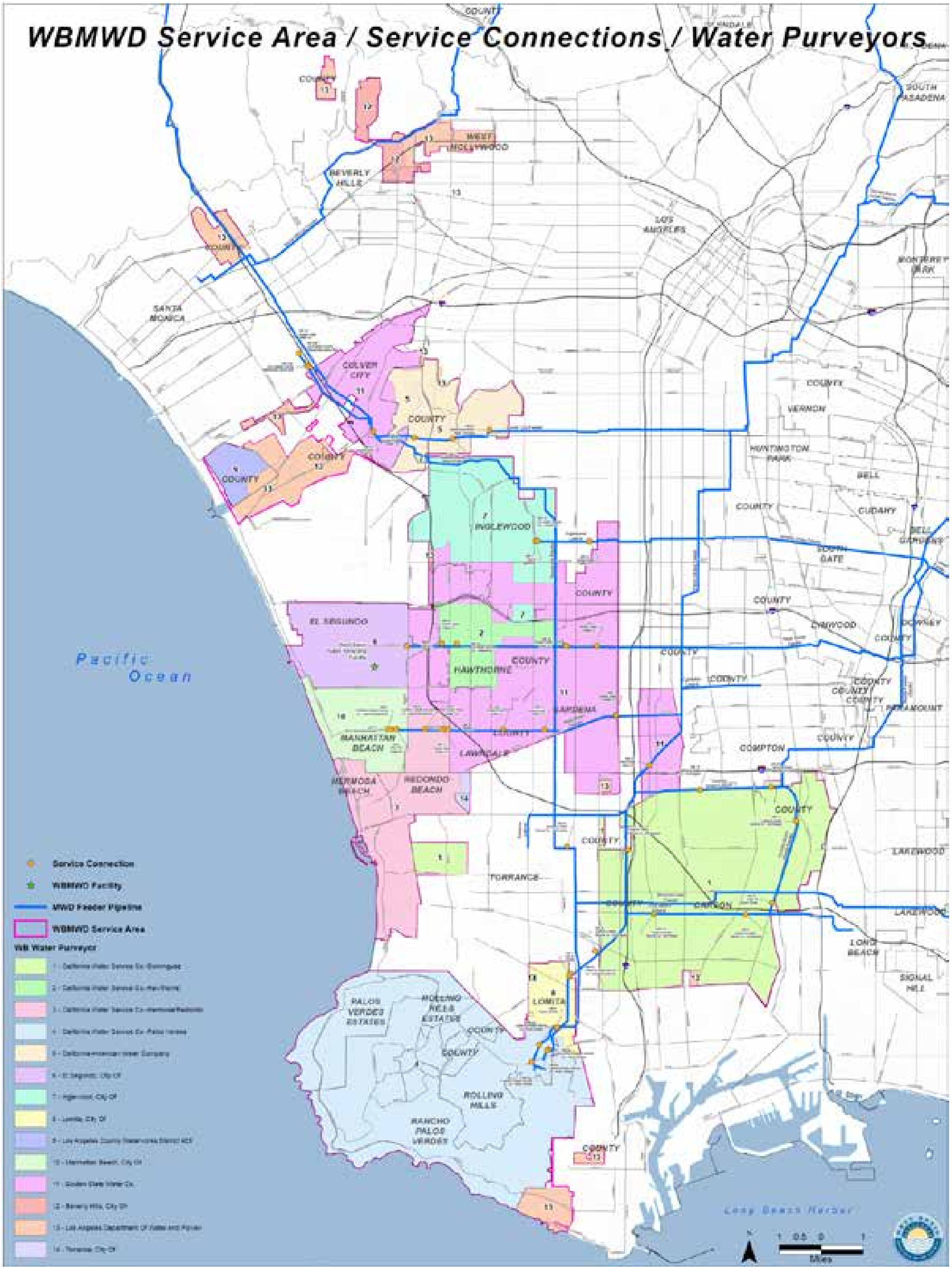


Figure 2-12: West Basin's Service Area



2.5.1.2. MWD

Water recycling has proven to be a reliable source of supply and also helps local agencies to comply with environmental regulations. More than half of the current recycled water in the state of California happens in MWD’s service area and a portion of that is used for groundwater replenishment and seawater intrusion barrier purposes.

In the 1990s, the US Bureau of Reclamation along with MWD, Department of Water Resources (DWR), and six other southern California agencies studied the feasibility of regional water reclamation projects in southern California. The study identified 34 potential projects in MWD’s service area back then and today along with its member agencies MWD continues to explore projects and develop updated plans on a regular basis.

MWD has been actively involved with other agencies and organizations to support the research and further expansion of recycled water use as well as working with the WateReuse Association on legislative and regulatory issues to streamline the permitting process to provide the necessary funding and support for the use of recycled water.

In 1991, MWD initiated its Groundwater Recovery Program to encourage agencies to treat and use degraded groundwater for municipal purposes which provides up to $250 per AF for the construction and operation of facilities that are used to recover degraded groundwater and help decrease the amount of imported purchased water from MWD.

MWD’s Integrated Resources Plan (IRP) Preferred Resource Mix provides MWD with a strategy to meet supply reliability needs and develop locally owned water recycling, groundwater recovery to allow MWD to reduce its capital improvements and its operating and maintenance costs for water importation, treatment, and distribution. Since 1982, MWD has been implementing programs to provide financial assistance to its member agencies for developing local water supplies by the use of incentive programs that are based on a pay-for-performance principle. Since the program began, MWD has invested and partnered with member agencies on 62 recycling projects and 22 groundwater recovery projects.

Groundwater is a significant source of drinking water in Southern California and its effective use has been a significant component of the regional water supply plan. While MWD does not own or control the groundwater basins, it has played an important role as the region’s supplemental water supplier providing water for replenishment of the groundwater basins and developing tailored local groundwater storage programs. In 2007, MWD prepared the Groundwater Assessment Study in coordination with its member agencies which evaluated the potential for groundwater storage and identified the challenges in developing additional storage programs. MWD then began a series of workshops to develop recommendations for addressing the challenges. Its groundwater replenishment program is currently under revision to better align incentives and regional value.

In 2009, MWD entered into a partnership with the Los Angeles County Sanitation Districts (LACSD) to study the potential for a regional indirect potable reuse program to purify treated wastewater at LACSD's Joint Water Pollution Control Plant (JWPCP) located in Carson. The JWPCP is the largest of LACSD's ten wastewater treatment plant and provides primary and secondary treatment to 290 MGD of wastewater before it is discharged through outfall tunnels to the Pacific Ocean. By 2050, the JWPCP is projected to treat approximately 400 MGD.

Under the program being studied, treated wastewater from the JWPCP would be diverted to new advanced water treatment facilities to purify the water to near-distilled quality. The purified water would then be put into groundwater aquifers in Los Angeles County, where it would be stored for sufficient time to allow additional natural treatment processes and mixing to occur. The water would later be withdrawn and further purified for potable use. Preliminary findings from the study indicate that (1) a large project of 150 MGD or greater is technically feasible, but would require phased implementation, and (2) operational constraints associated with MWD's facilities can be addressed. The findings also note that open reservoir storage has limitations and there are limited sites for the storage capacity required. Additionally, changed conditions since the study began, including MWD's current reservoirs being at or near capacity and projected lower long-term demands on MWD described in MWD's 2010 Update of its Integrated Resources Plan, will be included in a technical memoranda scheduled to be completed in late 2011.

MWD's policies on regional water supply reliability have evolved with regional and statewide conditions and requirements. In order to plan for supply uncertainty, MWD will continue to employ foundational actions that support their core water resources strategy and develop a supply buffer that helps manage supply uncertainty.

3. Plant Siting Alternatives and Assessment

The objective of this Section is to assess the feasibility of the two candidate desalination plant sites, at the NRG El Segundo Generating Station and AES Redondo Beach Generating Station. West Basin previously looked at two additional sites, at LADWP's Scattergood Generating Station and Chevron's El Segundo Refinery. Based on project considerations, the NRG and AES sites were selected by West Basin for this study. The NRG and AES siting alternatives are reviewed with consideration for addressing both the Local and Regional cases. In developing a complete, holistic approach to this assessment, factors based on environmental, socioeconomic, and surface and subsurface site conditions are considered.

3.1. Site Evaluation

The location of the ocean water desalination facility may have a significant impact on the feasibility and cost of developing a new ocean water supply. Site selection needs to consider several key factors, including the following:

- Available land for process, storage, operations & administrative facilities
- Site access
- Proximity to distribution system tie-in
- Existing onsite and offsite utility infrastructure
- Existing offshore (intake and outfall) infrastructure
- Overall permitability
- Local planning & zoning compatibility
- Known hazardous contamination remediation

3.1.1. Site Evaluation Criteria

To standardize the approach for assessing and ranking the siting alternatives, several performance factors will be evaluated for each siting alternative. These factors are grouped into the following categories and weighting factors as shown in **Table 3-1**:

Table 3-1: Site Evaluation Criteria

Category	Weighting Factor (%)
Technical Performance	40%
Economic Performance	20%
Environmental Performance	20%
Social Performance	20%

The weighting factors reflect the percentage of the total score that each category contributes. The initial weighting factors presented above are based on agreed values during the West Basin Water Resources Assessment for Local Supply Reliability project. The total score available for each category is based on this percentage. To assess the sensitivity of these weighting factors on the preferred alternative, three sensitivity analyses were performed using alternate weighting factors.

3.1.1.1. Technical Performance

Each siting alternative was assessed based on performance criteria that address items that are critical to the technical implementation of the facility and that meet the technical requirements of the project, including the following:

Space Availability: Each site has a delineated area that has been identified by property owners to potentially be made available for this project. Based on the range of plant production capacities defined by West Basin and preliminary site layouts, space availability at each site has been assessed. Space availability includes the following sub-categories:

- Space utilization
- Access into and around site
- Equipment access/Ergonomics
- Security

Use of Existing Intake/Outfall Infrastructure: Each site has existing tunnel structures that would be utilized for intake and outfall. These existing structures need to meet the design capacity requirements and be able to satisfy the project and site specific raw water supply and concentrate discharge requirements.

- Capacity
- Physical condition
- Impingement/Entrainment Mitigation Potential
- Leasing/Purchase Opportunities
- Sustainable operations
- Permitting
- Water Quality
- Short Circuiting

Water Quality: Ocean water quality supplying each site can drive process treatment, and associated costs. Product water quality requirements defined for this project must be met at each site. Concentrate quality, and offshore discharge conditions will affect outfall diffusion requirements and associated costs.

Conveyance Facilities: This criteria item concerns proximity to distribution system and interconnection requirements.

Hazardous Materials Remediation: As both sites are "brownfield" applications, existing hazardous conditions or contamination at the proposed construction site can affect project schedule, cost and even feasibility.

Constructability: Includes potential constructability issues at each site associated with implementing the proposed facilities.

Site Development Requirements: This criteria includes local site development requirements.

Permitting: Includes relative issues related to the ability to obtain permits at either site.

Power Supply: Issues associated with providing sufficient, sustainable power to each site, and effective partnership with the adjacent power plant facilities.

Reuse of Existing Facilities: Potential issues related to co-location and reuse of existing land based facilities.

Each of these criteria are assessed and rated as outlined in **Table 3-2**.

Table 3-2: Technical Performance Criteria – Ratings Table

Technical Performance Criteria	Scale
Space Availability	1-4
Use of Existing Intake/Outfall Infrastructure	1-4
Water Quality	1-4
Conveyance Facilities	1-4
Hazardous Materials Remediation	1-4
Constructability	1-4
Site Development Requirements	1-4
Permitting	1-4
Power Supply	1-4
Reuse of Existing Facilities	1-4
Technical Performance - Subtotal	**10-40**

Ratings Scale: 1 = Low Score/Most Uncertainties
4 = High Score/ Least Uncertainties

3.1.1.2. Economic Performance

This category includes several criteria associated with each site that affect project financing and resource management. These criteria include:

Capital Cost: Factors that affect the estimated capital cost for implementing the project at each site will be assessed. These factors will primarily be derived from the technical performance evaluation, but the cost component will be considered in this category.

Unit Annual Cost: Factors that affect the unit annual cost for implementing the project at each site will be assessed. These factors will primarily be derived from the technical performance evaluation, but the cost component will be considered in this category.

Real Estate Acquisition: This criteria will be based on the availability and cost of acquiring and using the necessary land at each site, including associated community costs.

Mitigation Costs: The relative differences in costs associated with the mitigation requirements at each site.

Each of these criteria are assessed and rated as outlined in **Table 3-3**.

Table 3-3: Economic Performance Criteria – Ratings Table

Economic Performance Criteria	Scale
Capital Cost	1-5
Unit Annual Cost	1-5
Real Estate Acquisition	1-5
Mitigation Costs	1-5
Economic Performance - Subtotal	**4-20**

Ratings Scale: 1 = Low Score/Most Uncertainties
4 = High Score/ Least Uncertainties

3.1.1.3. Environmental Performance

The more favorable alternatives under this category are those that provide a sustainable source of water while promoting environmental stewardship. The less favorable alternatives under this category are those that do not contribute towards environmental stewardship within the local service area.

Energy Utilization/Minimization: Relative differences at each siting alternative to optimize the performance of the facility with respect to energy requirements.

Habitat Protection: Siting related issues affecting the protection of offshore habitat, such as impingement/entrainment concerns and concentrate dispersion requirements.

Mitigation Measures: Environmental mitigations measures required as a direct result of locating a new ocean water desalination facility at each site, including air and noise pollution control, and impingement/entrainment mitigation measures.

"Brownfield" Redevelopment: Potential benefits to each site related to the implementation of this project and re-engineering at each site.

Each of these criteria are assessed and rated as outlined in **Table 3-4**.

Table 3-4: Environmental Performance Criteria – Ratings Table

Environmental Performance Criteria	Scale
Energy Utilization/Minimization	1-5
Habitat Protection	1-5
Mitigation Measures	1-5
"Brownfield" Redevelopment	1-5
Environmental Performance - Subtotal	**4-20**

Ratings Scale: 1 = Low Score/Most Uncertainties
5 = High Score/ Least Uncertainties

3.1.1.4. Social Performance

The more favorable alternatives under this category are those with the least amount of hurdles to overcome. The less favorable alternatives under this category are those with the most hurdles for implementation and have the potential for opposition outside of the local service area.

Public Acceptance: This criteria addresses public perception and general acceptance of siting location for a new ocean water desalination plant.

Community Benefits: Covers potential impacts of siting a new ocean water desalination facility to the community including financial, and environmental.

Partnership with Site Occupants: Addresses the readiness and willingness of the site occupants and/or owners to partner.

Stakeholder Acceptance: This criteria item factors in the opinions of the group of stakeholders associated with this project and locations.

Each of these criteria are assessed and rated as outlined in **Table 3-5**.

Table 3-5: Social Performance Criteria – Ratings Table

Social Performance Criteria	Scale
Public Acceptance	1-5
Community Benefits	1-5
Partnership with Site	1-5
Stakeholder Acceptance	1-5
Social Performance – Subtotal	**4-20**

Ratings Scale: 1 = Low Score/Most Uncertainties
5 = High Score/ Least Uncertainties

3.1.2. Criteria Ranking

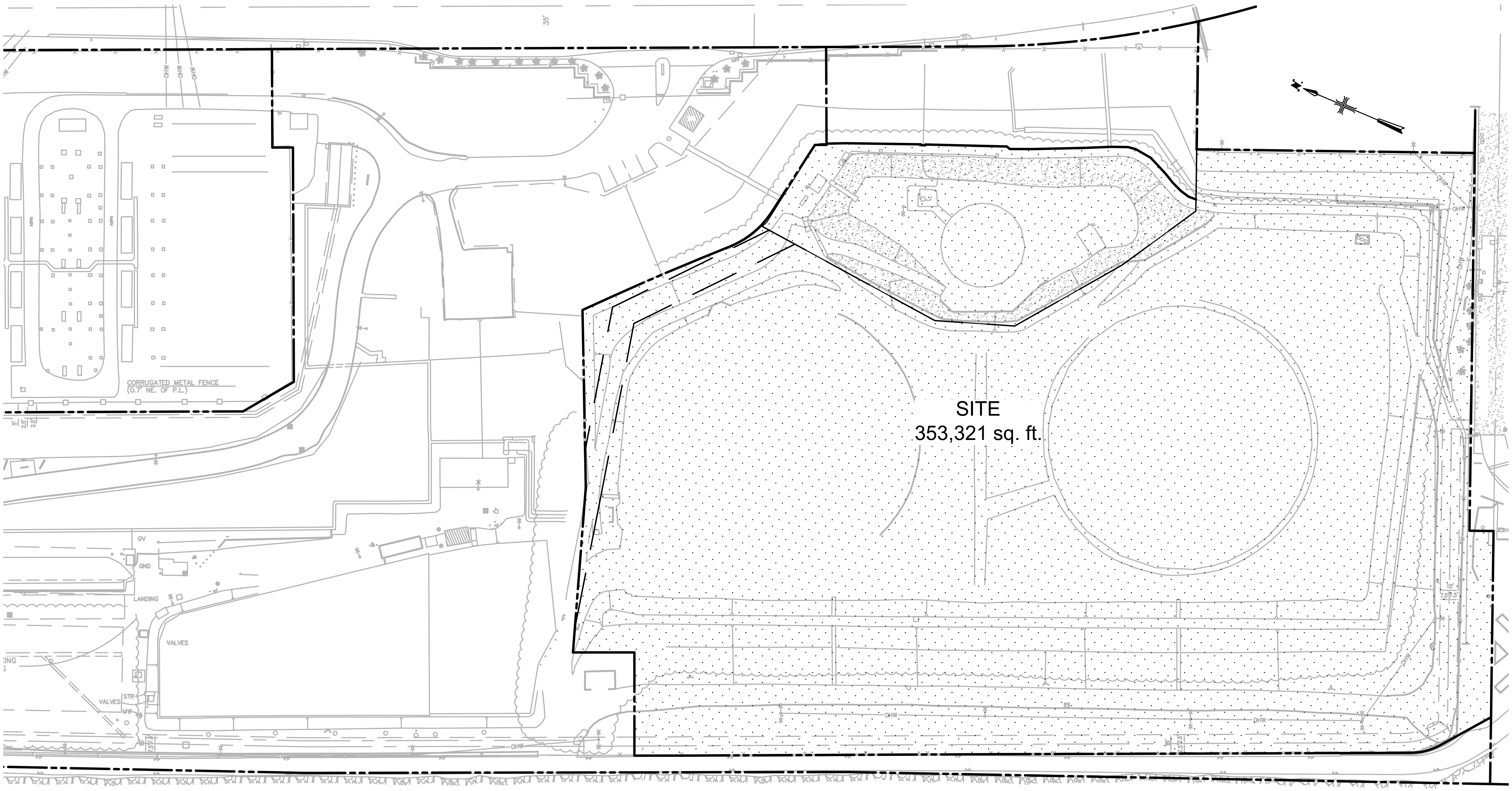
For each of the above sub-categories and criteria, a total score for each siting alternative can be attained. The standardized matrix reflecting these factors and the relative percentage of the categories is shown in **Table 3-6**. The relative percentages can be modified to place greater emphasis on selected performance categories. The scoring from each sub-category has been assigned to match the indicated weighting factors.

Table 3-6: Standard Performance Rating Form

	Description	Percentage	Score
Technical Performance	Treatment Technology and Operational Complexity	**40%**	10-40
Economic Performance	Sound Financial and Resource Management	**20%**	4-20
Environmental Performance	Environmental Stewardship	**20%**	4-20
Social performance	Stakeholder Acceptance and Customer Service	**20%**	4-20
Overall Performance		**100%**	22-100

3.1.3. Site Boundaries

The site land availability for the El Segundo site is approximately 7.8 Acres, while the Redondo Beach site is approximately 15 acres. The specific site boundaries for the project shown in **Figure 3-1 and Figure 3-2** reflect preliminary discussions with both property owners.



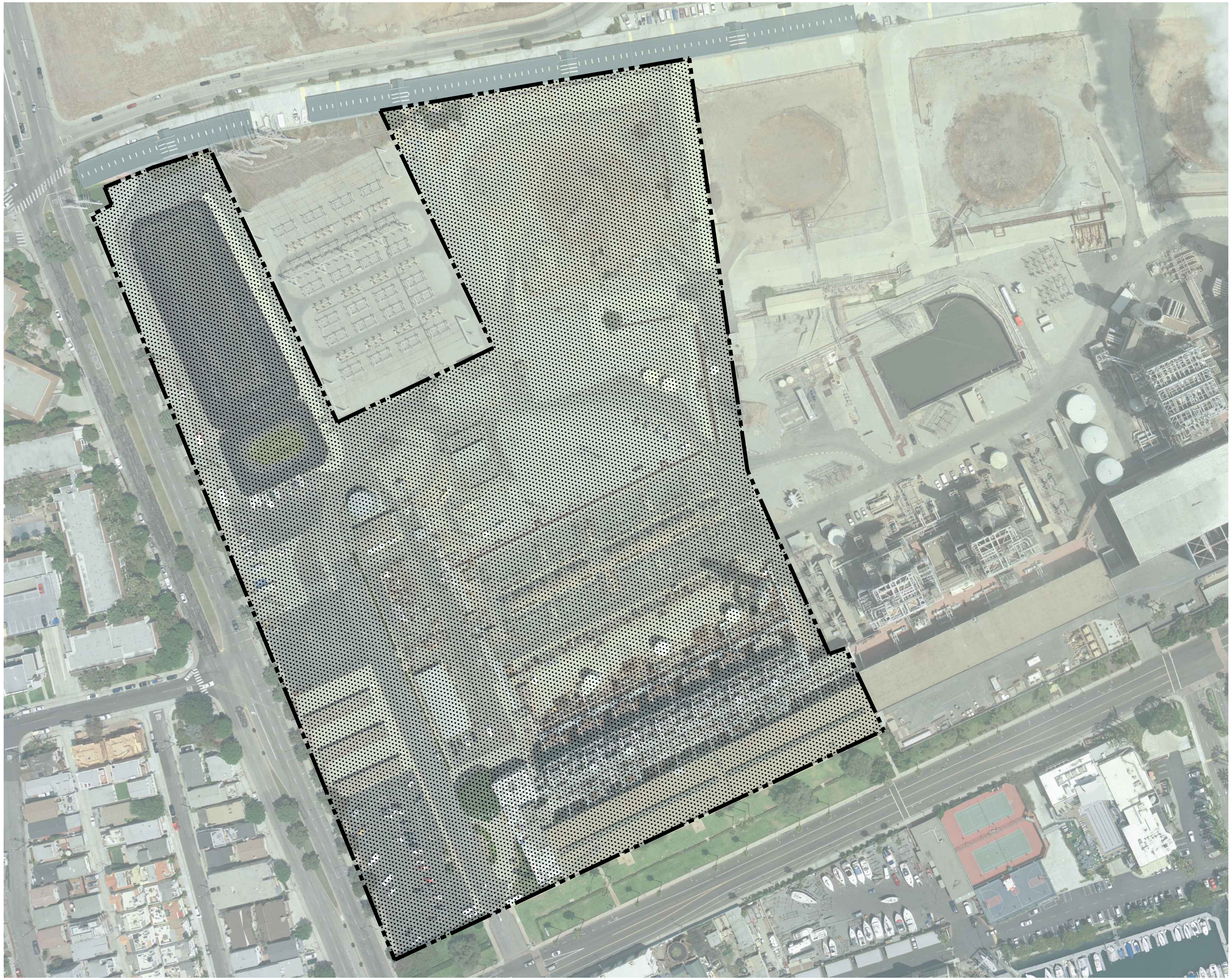
NOTES:

1. PARCEL BOUNDARIES PER PSOMAS ALTA/ACSM LAND TITLE SURVEY, DATED 7/21/11.

40 0 40 80

SCALE: 1" = 80'

MALCOLM PIRNIE / ARCADIS — The Water Division of ARCADIS	WEST BASIN MUNICIPAL WATER DISTRICT 17140 S. AVALON BLVD., SUITE 120, CARSON, CA 90746 OCEAN WATER DESALINATION PROGRAM MASTER PLAN (PMP)	NRG ENERGY, INC. – 301 VISTA DEL MAR, EL SEGUNDO, CA. 90245 SITE BOUNDARY MAP SCALE: AS NOTED	JANUARY 2013 FIGURE 3–1



WEST BASIN MUNICIPAL WATER DISTRICT
17140 S. AVALON BLVD., SUITE 120, CARSON, CA 90746

OCEAN WATER DESALINATION
PROGRAM MASTER PLAN (PMP)

AES CORPORATION – 1100 N. HARBOR DR., REDONDO BEACH, CA. 90277

SITE BOUNDARY MAP

SCALE: AS NOTED

JANUARY 2013

FIGURE 3–2

MALCOLM PIRNIE | ARCADIS
The Water Division of ARCADIS

3.1.4. Evaluation of Site Alternatives

The two identified sites were assessed against the technical, economic, environmental, and social performance criteria and scaling ranges as described above. **Table 3-7 through Table 3-10** show the results of the assessments for both sites for each of the identified categories. The sites are designated as follows:

- Site 1: El Segundo at the NRG Generating Station site.
- Site 2: Redondo Beach at the AES site.

Table 3-7: Technical Performance Criteria – Ratings Table

Technical Performance Criteria	Ratings[1]		Scale	Comments
	Site 1	Site 2		
Space Availability	**2**	**4**	1-4	At 60-MGD, NRG site limits require buried components, vertical construction & tighter access.
Use of Existing Intake/Outfall Infrastructure	**2**	**3**	1-4	AES site has deeper water, may require less modifications.
Water Quality	**3**	**2**	1-4	AES site more prone to algal blooms
Conveyance Facilities	**4**	**3**	1-4	NRG site has greater proximity to MWD feeders. AES potential reuse of Cal Water asset.
Hazardous Materials Remediation	**2**	**2**	1-4	Similar potential for soil remediation at both sites
Constructability	**1**	**3**	1-4	NRG site is confined with limited access – required vertical construction.
Site Development Requirements	**3**	**1**	1-4	Potential for tighter restrictions on AES site.
Permitting	**3**	**2**	1-4	Lease holder and lease end dates
Power Supply	**4**	**3**	1-4	Both sites have dual feeders available. NRG has higher potential for reliable on-site power.
Reuse of Existing Facilities	**2**	**3**	1-4	Greater potential for reusing facilities at AES.
Technical Performance - Subtotal	**25**	**26**	**10-40**	

Table 3-8: Economic Performance Criteria – Ratings Table

Economic Performance Criteria	Ratings[1]		Scale	Comments
	Site 1	Site 2		
Capital Cost	**3**	**2**	1-5	Constructability and space constraints at NRG drive cost differential.
Unit Annual Cost	**3**	**3**	1-5	Similar requirements for both sites.
Real Estate Acquisition	**3**	**3**	1-5	Land Availability
Mitigation Costs	**3**	**3**	1-5	Similar requirements for both sites.
Economic Performance - Subtotal	**12**	**11**	**4-20**	

Table 3-9: Environmental Performance Criteria – Ratings Table

Environmental Performance Criteria	Ratings[1]		Scale	Comments
	Site 1	Site 2		
Energy Utilization/Minimization	**3**	**3**	1-5	Similar requirements for both sites
Habitat Protection	**3**	**3**	1-5	Shallower intake at NRG
Mitigation Measures	**3**	**3**	1-5	Intake/Discharge modification requirement potential greater at NRG
"Brownfield" Redevelopment	**2**	**3**	1-5	Big push for redevelopment at AES site
Environmental Performance - Subtotal	**11**	**12**	**4-20**	

Table 3-10: Social Performance Criteria – Ratings Table

Social Performance Criteria	Ratings[1]		Scale	Comments
	Site 1	Site 2		
Public Acceptance	**3**	**2**	1-5	Similar estimated acceptance level. Less redevelopment potential at NRG
Community Benefits	**3**	**4**	1-5	Greater potential benefits to local customers
Partnership with Site	**4**	**3**	1-5	
Stakeholder Acceptance	**4**	**4**	1-5	Similar estimated support level
Social Performance – Subtotal	**14**	**13**	**4-20**	

3.1.4.1. Performance Ratings and Sensitivity Analysis

The ratings presented above were combined for each site to derive a total score. **Table 3-11** presents the results based on the initial weighting factors.

Table 3-11: Standard Performance Rating Form

	Description	Percentage	Score	
			Site 1	Site 2
Technical Performance	Treatment Technology and Operational Complexity	40%	25	26
Economic Performance	Sound Financial and Resource Management	20%	12	11
Environmental Performance	Environmental Stewardship	20%	11	12
Social performance	Stakeholder Acceptance and Customer Service	20%	14	13
Overall Performance		100%	64	65

Notable differences between each site are noted in each category. In the technical category, space availability for construction and operations of the new plant was a differentiator. This assessment was based on initial discussions on land availability with each site owner, and could vary with continuing negotiations. With the more restrictive site, site access and special construction considerations for the NRG site influence the overall capital cost differential between the two sites. The social performance criteria represent several relative differences. Although this category can be more subjective than the others, the ranking is influenced by current public actions, positions and directions taken towards support or opposition.

Since the values set for the weighting factors contribute to the end result, an assessment of the sensitivity of the results to variable weighting factors was assessed. **Table 3-12 through Table 3-14** present alternative results based on a different distribution of weighting factors to demonstrate their potential significance in the results.

Table 3-12: Performance Rating Form Sensitivity 1

	Description	Percentage	Score	
			Site 1	Site 2
Technical Performance	Treatment Technology and Operational Complexity	20%	13	13
Economic Performance	Sound Financial and Resource Management	40%	24	22
Environmental Performance	Environmental Stewardship	20%	11	12
Social performance	Stakeholder Acceptance and Customer Service	20%	14	13
Overall Performance		**100%**	62	60

Table 3-13: Performance Rating Form – Sensitivity 2

	Description	Percentage	Score	
			Site 1	Site 2
Technical Performance	Treatment Technology and Operational Complexity	20%	13	13
Economic Performance	Sound Financial and Resource Management	20%	12	11
Environmental Performance	Environmental Stewardship	40%	22	24
Social performance	Stakeholder Acceptance and Customer Service	20%	14	13
Overall Performance		**100%**	61	61

Table 3-14: Performance Rating Form – Sensitivity 3

	Description	Percentage	Score	
			Site 1	Site 2
Technical Performance	Treatment Technology and Operational Complexity	20%	14	13
Economic Performance	Sound Financial and Resource Management	20%	12	13
Environmental Performance	Environmental Stewardship	20%	9	11
Social performance	Stakeholder Acceptance and Customer Service	40%	30	27
Overall Performance		100%	65	64

As illustrated above, the performance rating assessment revealed similar results for both of the candidate sites. The sensitivity analysis, which varied the distribution of weighting factors, also showed a near equivalent ranking. Since a clear selection cannot be derived from the above assessment, it is recommended that further negotiations with both sites be pursued. As a result, subsequent analyses in this PMP should be considered for both sites. Terms and conditions in negotiations for each site have not been factored into this assessment, and they should be factored into future assessments and part of the decision process when moving forward.

4. Ocean Water Intake and Desalination Plant Discharge

This section describes the evaluation of subsurface and surface intake options, compatible discharge alternatives, identification of the preferred alternative for project implementation, and provides a conceptual design of the preferred alternative.

4.1. Proposed Project Sites

An overview of the two project sites is described below. A more thorough analysis of the identification and assessment of potential desalination plant sites relative to intake and discharge issues is given in **Appendix 1:A**.

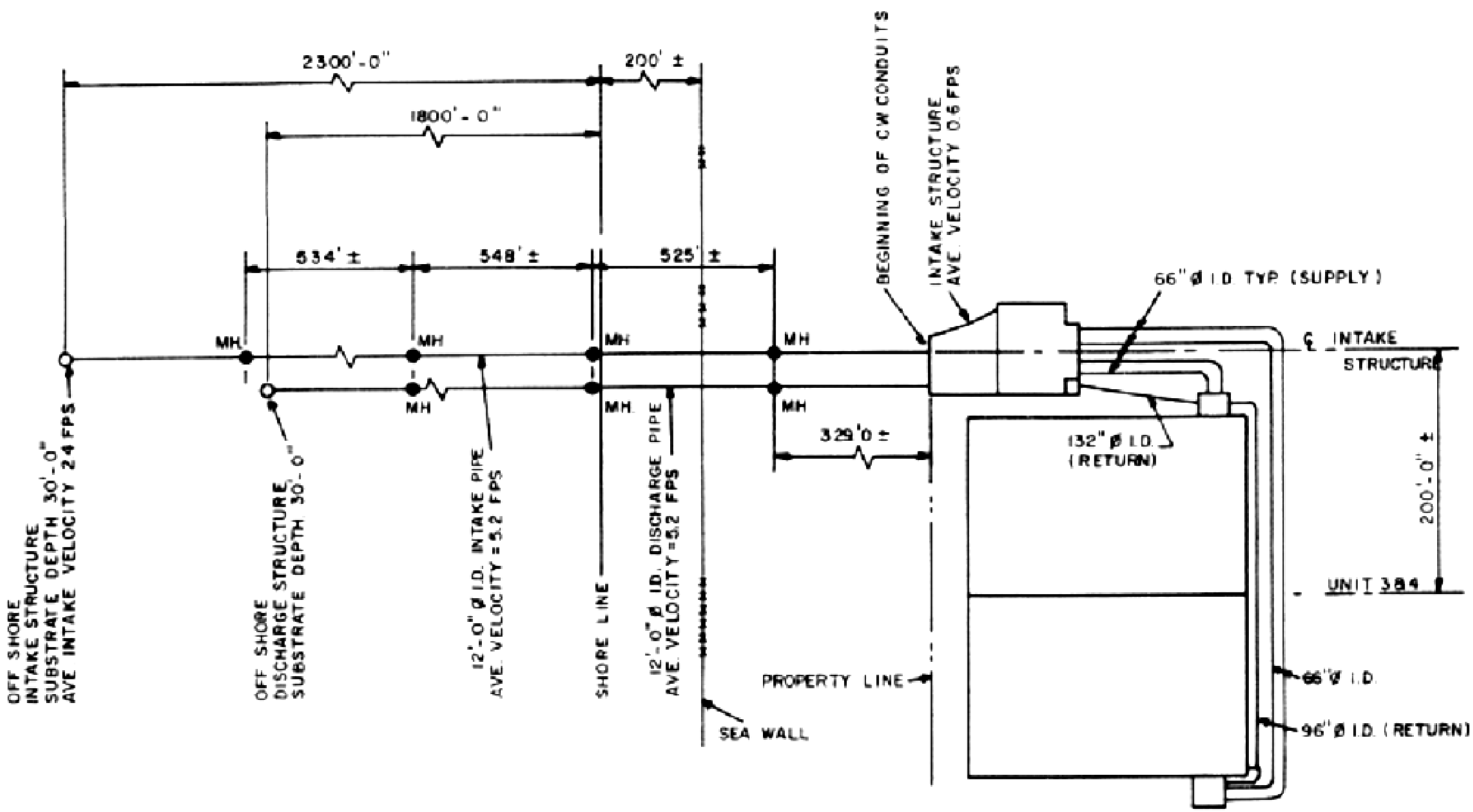
4.1.1. El Segundo

The El Segundo Generating Station is located on Santa Monica Bay within the City of El Segundo, California. At this location two pairs of tunnels exist, shown in **Figure 4-1**. The intake and discharge tunnels on the north side of the property, used for cooling water of units 1 and 2, have been decommissioned and are not be available for use. The intake and discharge tunnels on the south side of the property, used for cooling water of units 3 and 4, are currently operational. Per statements of NRG staff during the site visit on June 21 2011, it is expected that units 3 and 4 would be converted to air cooling in the near future and therefore its tunnels could be used for the desalination plant. Units 3 and 4 tunnels are 12-foot inside diameter, shore-perpendicular concrete pipes, buried approximately 5 feet under the seafloor in the offshore area, and at about 10 feet across the beach area. The offshore end of the intake tunnel, at approximately 2,300 feet from the shoreline at a water depth of approximately -35 feet Mean Lower Low Water (MLLW) level, features a vertical 16 x 21-foot internal cross section intake structure, with a velocity cap, which extends approximately 10 feet above the seafloor (SCE, 1982). The shorter discharge tunnel is approximately 1,800 feet from the shoreline at a water depth of approximately -29 feet MLLW. **Figure 4-2** shows a schematic of the circulating water system for this facility (SCE, 1982).

For the purposes of this assessment, it is assumed that the ocean currents are parallel to the shore in a northwestward direction on flood tide and southeastward on an ebb tide, with a net drift to the south induced by the dominant northwestern waves and wind. Therefore, the intake would be placed to the north of the discharge and would use the northern tunnel.

Figure 4-1: Segundo, Existing Intake and Discharge Layout
Source: MWH "El Segundo Generating Station Overview", 2006

Figure 4-2: Segundo, Units 3 and 4 Existing Intake and Discharge System
Source: SCE, El Segundo Generating Station 316(b) Demonstration, 1982



4.1.2. Redondo Beach

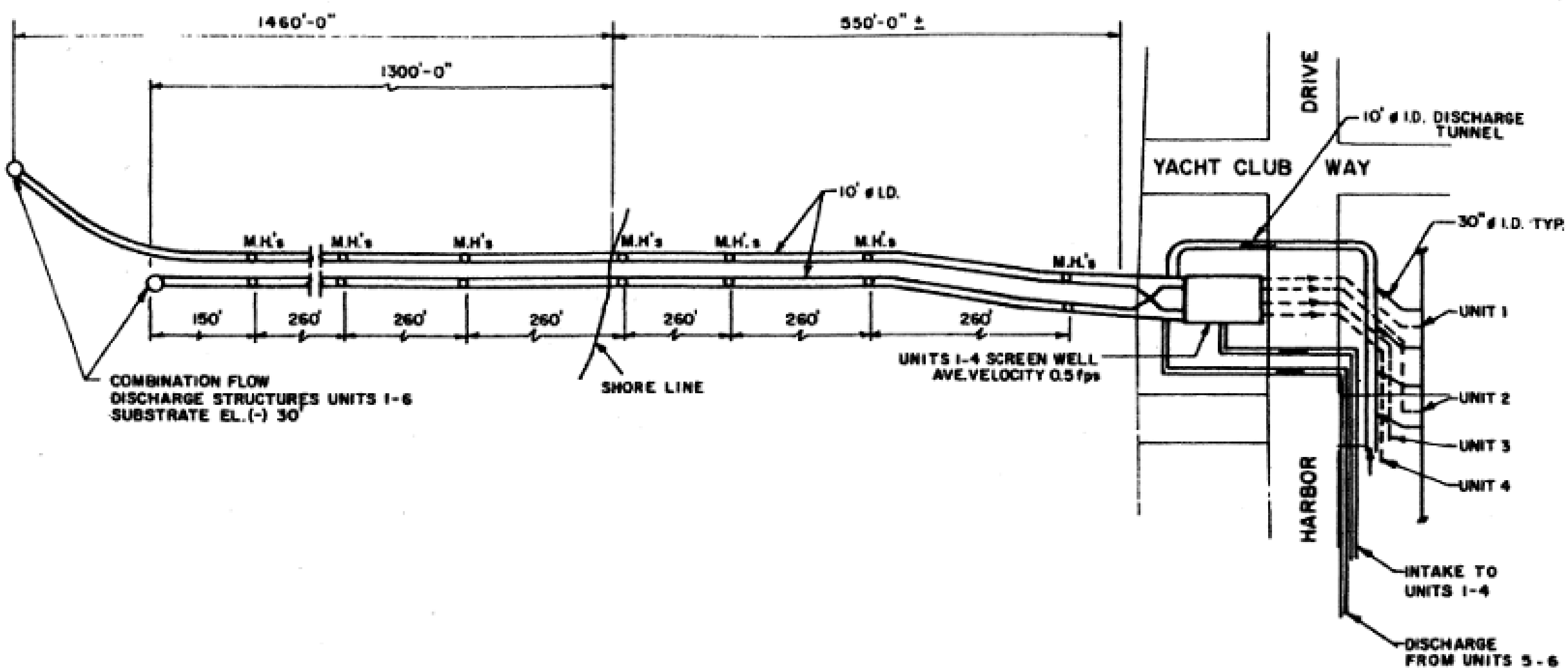
The Redondo Beach Generating Station, at the south end of Santa Monica Bay, features three pairs of tunnels that were designed for intake and discharge of the cooling system. The location of the tunnels is shown in **Figure 4-3**. The pair of tunnels located to the north of the King Harbor breakwater are considered for the desalination plant. These tunnels have been used alternatively as intake and discharge facilities. The longer tunnel extends offshore approximately 2,000 feet to a water depth of approximately -33 feet MLLW. The shorter tunnel extends offshore approximately 1,800 feet to a water depth of approximately - 30 feet MLLW. Both tunnels are 10-foot inside diameter, shore-perpendicular concrete pipes, buried approximately 4 feet under the seafloor. Both tunnels feature a vertical intake structure with a 14-foot internal diameter cross section. **Figure 4-4** presents a schematic of the existing intake and discharge system at Redondo Beach.

Similarly to El Segundo, currents in the vicinity of Redondo Beach run parallel to the coast. However, the presence of the King Harbor breakwater affects the direction of the current inducing eddies and flows with directions that are difficult to determine. However, given the conceptual nature of this study it has been assumed that current patterns are, in general, parallel to the coast and the breakwater, with currents flowing in the northwestward direction on flood tide, southeastward on an ebb tide, and with a net drift to the south induced by the dominant northwestern waves and wind. Therefore, the intake would be placed to the north of the discharge and would use the northern tunnel.

Figure 4-3: Redondo Beach, Existing Intake and Discharge Layout
Source: MWH "Redondo Beach Generating Station Overview", 2006.

Figure 4-4: Redondo Beach Existing Intake and Discharge System

Source: SCE Engineering, Physical and Hydraulic Descriptions of Southern California Edison Company Generating Station Circulating Water Systems, 1981



4.2. Subsurface Intake Alternatives

In the context of this section, "subsurface" refers to alternatives employing underground (in water-bearing strata) intake infrastructure for both offshore and onshore locations. This section discusses the advantages and disadvantages of subsurface technologies, describes the technologies, and relates the technologies to potential West Basin withdrawal sites at El Segundo and Redondo Beach.

4.2.1. Subsurface System Advantages

With regard to seawater supply for desalination, subsurface source water withdrawal has two main advantages. First, depending on the technology, the owner may be able to avoid marine construction. Second, since subsurface technologies leverage the natural filtration characteristics of porous aquifers, these technologies can produce high quality water that requires little or no pretreatment, saving on capital and O&M costs. Above-bottom seawater intakes require sea-to-land pipelines. Construction of these pipelines can be challenging and expensive compared to subsurface alternatives. Sea-to-land pipeline construction disturbs beaches, intertidal zones, and sea bottoms along pipe alignments, with consequent disruption of onshore economic and recreational activity as well as both onshore and offshore ecosystems. Depending on the prevailing weather (specifically during heavy seas), this type of construction also can be expensive and risky.

Natural filtration through porous sea bottoms or porous shallow aquifers removes a significant amount of contaminants that normally occur in open seawater. In addition to low oxygen content, the source water is normally characterized by its constant physical and chemical properties (Hassan, 1997). Unlike surface feed, a subsurface intake is unlikely to be affected by changes in weather or sea conditions. In addition, above-surface intake systems must contend with impingement and entrainment (I&E), the trapping and drawings in marine life at the point of intake, while subsurface systems avoid these ecological concerns. Nonetheless, as this section reveals, subsurface intakes also present challenges and uncertainties that tend to offset the advantages, particularly with regards to the potential sites available to West Basin.

4.2.2. Subsurface System Disadvantages

Disadvantages of subsurface technologies may include:

- Large Footprints: because these systems generally act like wells or slow sand filters, the sustainable withdrawal rate limits the overall yield, requiring long intake pipes or screens that are separated by enough distance to allow withdrawal at the design yield.
- Temporary and Long-Term Disruption: technologies that draw seawater from beach areas (e.g., multiple onshore wells) can disrupt and/or deny recreational and economic activity over a large area for the duration of the construction.

- Groundwater Contamination: if the subsurface aquifer contains contaminated water, the subsurface technology may forfeit any potential cost advantage.
- Vulnerability: subsurface withdrawal systems near high water levels may be vulnerable to beach erosion or littoral transport processes. They may also be vulnerable to tsunami action and clogging.
- Possible Public Opposition: the public may object for aesthetic, recreational, environmental, or economic reasons.
- Potential for Liquefaction: earthquakes can liquefy saturated porous soils, such as beach sands. Liquefaction at a subsurface intake site could severely damage or destroy equipment, not only requiring substantial repair and replacement costs, but more importantly, jeopardizing supply to the desalination plant.

4.2.3. Alternative Subsurface Intake Technologies

The team considered the following five alternative subsurface intake technologies for each of the two possible desalination plant sites:

(1) Infiltration Galleries and Seabed Filtration Systems

(2) Horizontal Collector Wells

(3) Horizontal Directional Drilled Wells

(4) Slant Wells

(5) Conventional Vertical Wells

Each alternative was evaluated relative to six criteria:

(1) Groundwater Contamination: the potential that a subsurface intake technology could draw contaminated water into the desalination plant. This is a particular concern at the El Segundo site.

(2) Sediment Transport: the potential for currents to carry sediment from the construction area. With respect to subsurface technologies, this applies to the seabed filtration technology, which entails seabed excavation. Erosion and sediment control for surface activities are considered in “environmental impacts” below.

(3) Ocean Floor Erosion and Scour: constraints on minimum cover for subsurface systems.

(4) Beachfront Infrastructure: constraints on construction methods, schedules and logistics.

(5) Environmental Impacts: the temporary or long-term consequences of construction and/or operation on the air, soil, and marine environments.

(6) Seismic Risk: potential damage to intake systems due to earth movement, liquefaction (buoyancy), and tsunami scouring.

As shown in **Table 4-1**, several technologies are not feasible, too risky, and/or too maintenance intensive for the two intake locations considered in this study. These alternatives are listed as “not recommended.” Technologies that would be problematic due to groundwater contamination concerns were not evaluated, and are listed as “n/a” in **Table 4-1**.

Table 4-1: Summary of Alternatives Subsurface intake Technologies

	Groundwater Contamination		Sediment Transport, Erosion, and Scour in Nearshore Zone		Beachfront Infrastructure Pipeline and Caissons	Environmental impact	Seismic Risk
Option	**El Segundo**	**Redondo Beach**	**El Segundo**	**Redondo Beach**	**El Segundo** **Redondo Beach**	**El Segundo** **Redondo Beach**	**El Segundo** **Redondo Beach**
Infiltration Galleries	Not Recommended	Not Recommended	n/a	n/a	n/a	n/a	n/a
Seabed Filtration Systems	Possibly Feasible	Possibly Feasible	Possibly Feasible, high risk	Not Recommended	Multiple collector well extensive shoreline	Extensive due to dredging, disposal, shoreline and nearshore pipeline installation	Tsunami risk of scour at Gallery, tsunami and liquefaction risk for beach from wells and piping
Horizontal Collector Wells (Ranney)	Not Recommended	Not Recommended	n/a	n/a	n/a	n/a	n/a
Horizontal Directional Drilled Wells	Possible feasible if well can be sealed through upper contaminated zones	Possible feasible if well can be sealed through upper contaminated zones	n/a	n/a	Single Caisson and limited piping	Minimal if drilled from upland area	Minimal risk if drilled from upland above tsunami run-up elevation and installed below liquefiable soil
Slant Wells	Not Recommended	Possible feasible if well can be sealed through upper contaminated zones	n/a	n/a	Single Caisson and limited piping	Visual and access impacts if drilled at beach level	n/a
Conventional Vertical Wells	Not Recommended	Not Recommended	n/a	n/a	n/a	n/a	n/a

4.2.3.1. Infiltration Galleries Seabed Filtration Systems

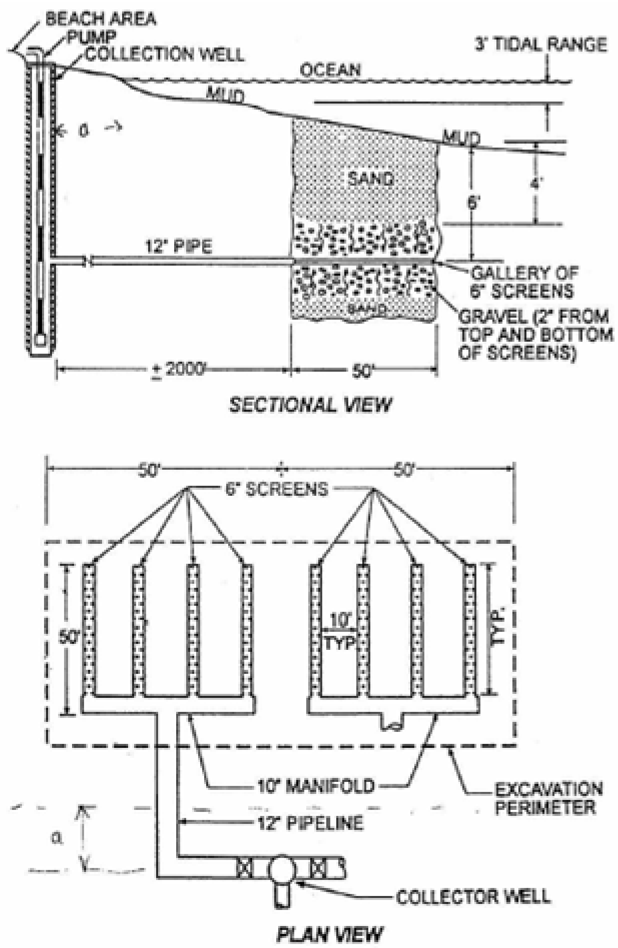
Embedded in beaches or in the near-shore ocean floor, infiltration galleries and seabed filtration systems essentially function as slow sand filters. A typical system would consist of a set of buried collector pipes manifolded to an onshore pumping station. The advantages of these systems include:

(1) draw essentially pure, undiluted seawater of relatively consistent quality directly from the sea,

(2) the seabed, beach sand, or engineered fill surrounding the infiltration pipes act to filter out particulates, and

There are few examples of actual seawater infiltration galleries or seabed filtration systems. The largest existing seawater desalination facility with a seabed filtration system is the 13.2 MGD Fukuoka District RO facility in Japan (Water Science and Technology Board, 2006), shown in **Figure 4-5**. The system covers 312,000 square feet (7.1 acres).

Figure 4-5: Seabed Infiltration System (Water Science and Technology Board, 2006)
Source: Water Science and Technology Board, 2006



Seabed filtration systems should be located in clean, sandy seafloors. This is mainly to take advantage of the permeability and filtration ability of natural sands. However, these systems may also be built by excavating unsuitable seabed and backfilling with graded fill. The following criteria would apply to the siting and design of seabed filtration systems:

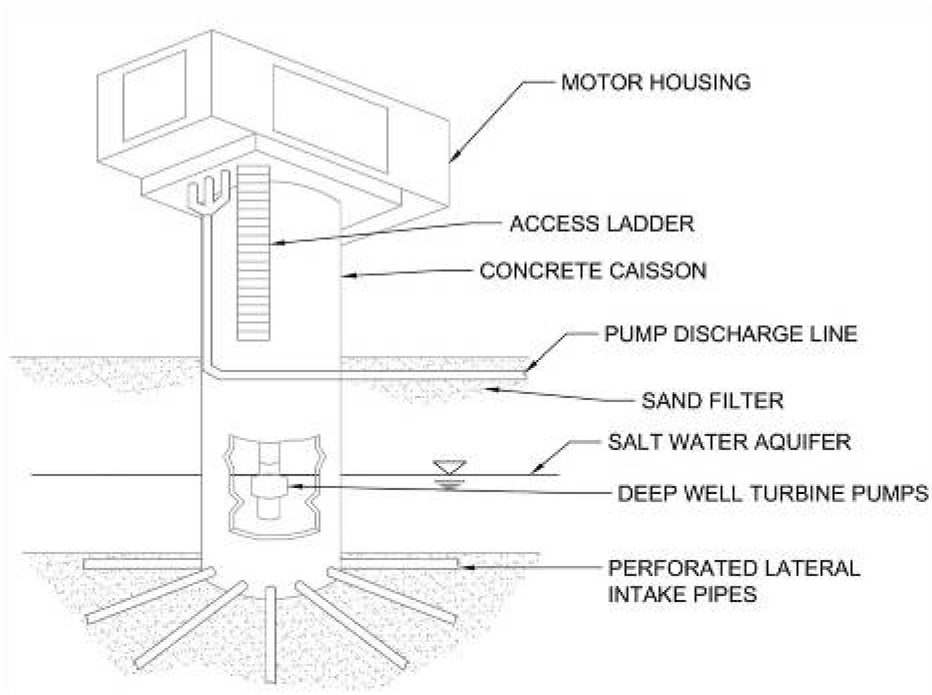
- Avoid siting seabed infiltration systems in areas susceptible to siltation or bottom growth, which can plug or lind granular beds that serve as a filter media.
- Locate the system below the deepest predicted depth of wave-induced scour and sediment transport.
- For feasibility analysis, consider using slow sand filter design criteria – typical surface loading rates between 0.05 and 0.10 gpm/ft^2.
- Wet side (working within ocean water): Trench or excavate the seabed to accept intake pipes or screens.
    - Note: Sandy sites should be tested for transmissivity before final design. Where suitable sands are not available, site conditions may require removing natural seabed and replacement with graded fill. Dredge spoils disposal becomes an additional cost and environmental consideration.
- Wet side: Install a grid of perforated collector pipes or screens.
- Wet side: Install manifold(s) to transmit seawater from the collector system to the pumping station.
- Wet side: Ensure that the filter pipes and manifold(s) have sufficient ballast to counteract wave-induced buoyancy.
- Dry side (working from on-shore): Install a pipe to convey filtered seawater to the pumping station.
    - Note: The preferred method is likely to be horizontal directional drilling (in lieu of open-trench, pulled-pipe, or barge-launch pipe placement techniques). This should help to minimize environmental impacts, avoid interference with beachfront infrastructure, avoid rough seas delays/costs.
- Maintenance: It may be necessary to remove approximately an inch of sand from the filter surface every six to twelve months to restore full filter capacity. After several years, it may be necessary to fill the filtration zone with new sand to restore the original grade. This may be challenging and costly in an ocean environment and it may pose environmental risks.

4.2.3.2. Horizontal Collector Wells (Ranney)

In the early 1920s petroleum engineer Leo Ranney introduced the concept of drilling horizontally to recover oil from saturated geological formations. In the 1930s, the concept was extended to water supplies. The first Ranney water collector well was installed in London, England in 1933 (Layne Christensen Company, 2002) Since then, hundreds of these wells have been built all over the world.

Ranney-type systems generally consist of radial wells that are drilled or jacked horizontally from a central sump. The wells and sump are placed below the piezometric surface of the aquifer (or low water level of the surface supply). The sump and submersible pumps should be sized to keep the sump water level in a range consistent with optimal aquifer yield. **Figure 4-6** presents an example of a Ranney-type radial well array. This is similar to the caisson/pumping station arrangement typical of Horizontal Directional Drilling (HDD) collector systems.

Figure 4-6: Typical Horizontal Collector Well in Radial Arrangement
Source: Halcrow



4.2.3.3. Horizontal Directional Drilled Wells

Horizontal Directional Drilling (HDD) can be used to place horizontal wells in porous strata onshore or under the seafloor as shown in **Figure 4-7**. Drilling can be accomplished by sonic, rotary, percussion, or jetting techniques. The advantages offered by HDD technology versus conventional open trench, pulled-pipe, or barge-launch placement techniques include:

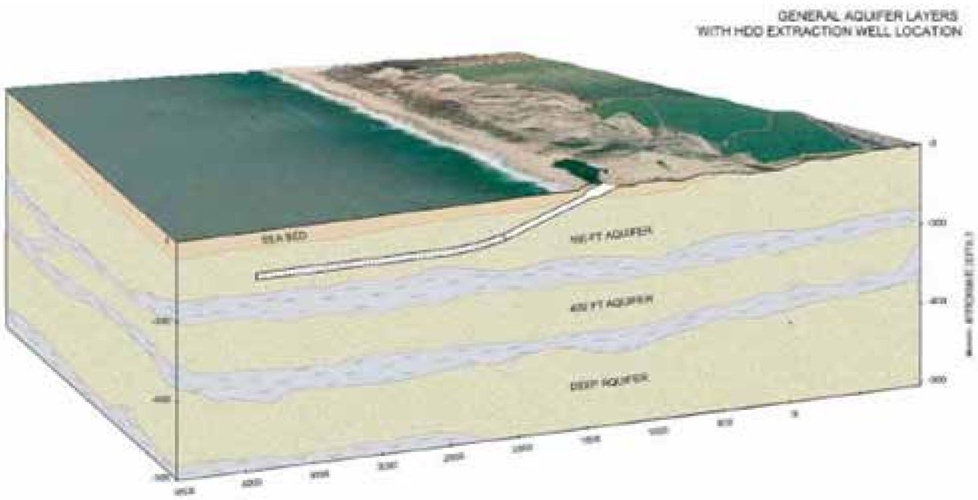
(1) minimized surface disturbance/impacts,

(2) reduced quantity of excavated material,

(3) precise conduit placement, and

(4) all-weather placement.

Figure 4-7: Horizontal Directional Drilling (HDD)
Source: MWH Temporary Ocean Water Desalination Demonstration Project TM-2 Process Requirements, 2007



The following criteria would apply to the siting and design of seabed filtration systems:

- Conduct marine (research barge or boat) exploration to confirm suitability of offshore strata:
  - Evaluate the potential for "frac-out" (leakage of drilling fluids into the marine environment) (ICF Jones & Stokes, 2008).
  - Estimate the yield of seabed filtration wells.
- Drilling lengths are limited to about 1,000 feet (ICF Jones & Stokes, 2008) to 2,000 feet (Peters, 2006). Thus the land-side caisson/pumping station must be located close to the beach.
- HDD horizontal wells require both entrance and exit holes as depicted in **Figure 4-8** thus eliminating dead ends (Peters, 2006). This should be recognized when considering construction impacts in the marine environment. The ends of these collectors should remain accessible for periodic maintenance.
- Well screen entrance velocity should not exceed aquifer transmissivity. Well production would vary accordingly, as shown in **Figure 4-9.**

Figure 4-8: Exit Holes are Essential to Completing the HDD Collector Installation

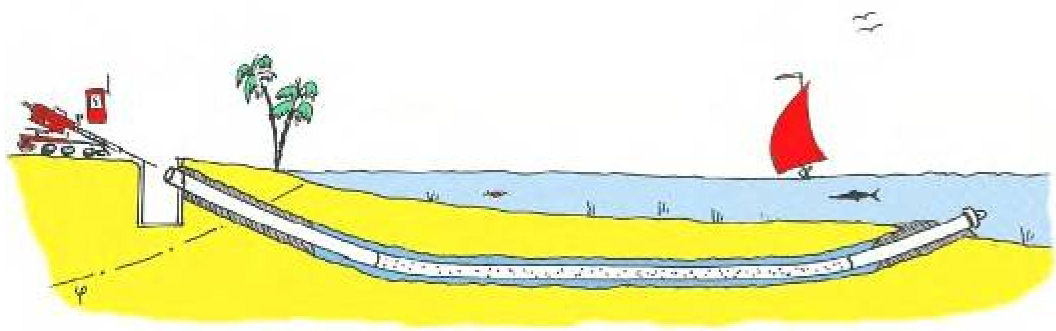
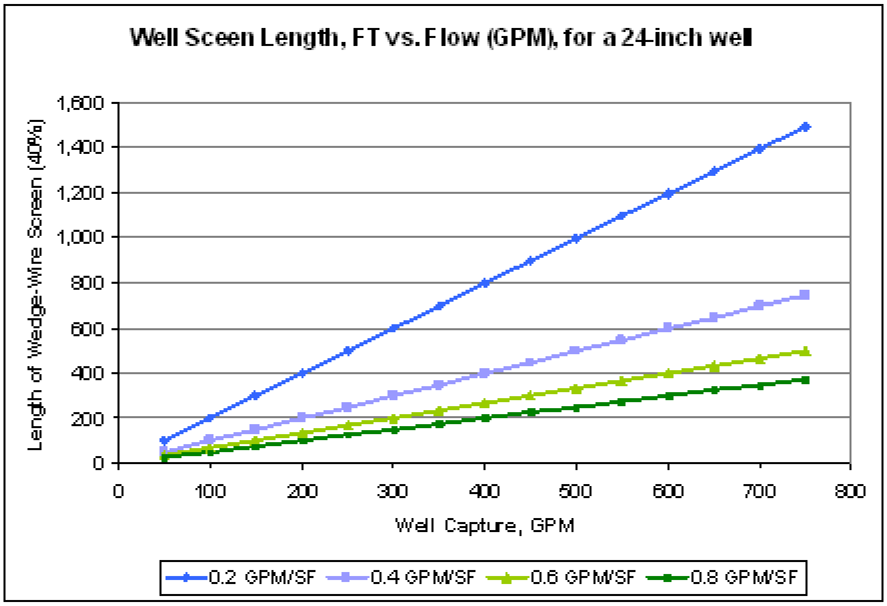
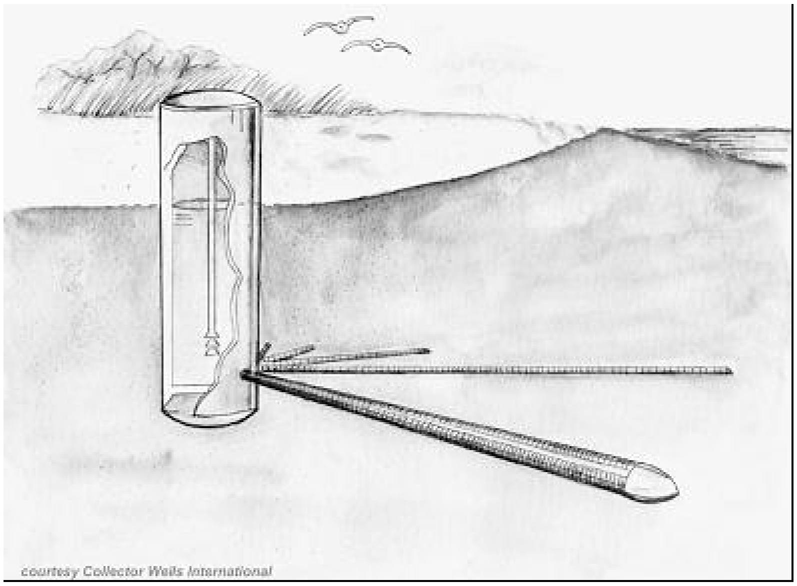


Figure 4-9: Possible Well Capture at Alternative Screen Loadings
Source: Halcrow



- Individual horizontal wells can be drilled or well screens can be jacked hydraulically from the bottom of the caisson using a direct-jack or pull-back process.
- Caissons may be 9-20 feet in diameter and 30-150 feet deep and radial arms are usually 8-12 inches in diameter but could be up to 24 inches in diameter. See **Figure 4-10**.

Figure 4-10: Typical Caisson Radial Well Configuration
Source: Collector Wells International

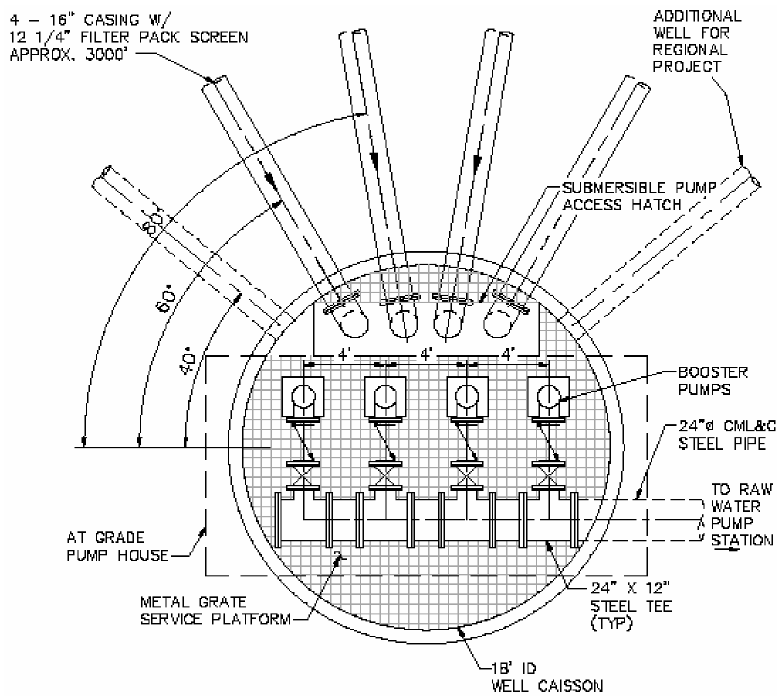


Place the onshore sump (caisson) and pumping station in a location central to the withdrawal zone, as shown in **Figure 4-11**.

Figure 4-11: Typical Collector Fan, Spacing is Essential to Optimizing Yield

Figure 4-12: Typical Collector or Sump Caisson

Source: MWH Temporary Ocean Water Desalination Demonstration Project TM-2 Process Requirements, 2007



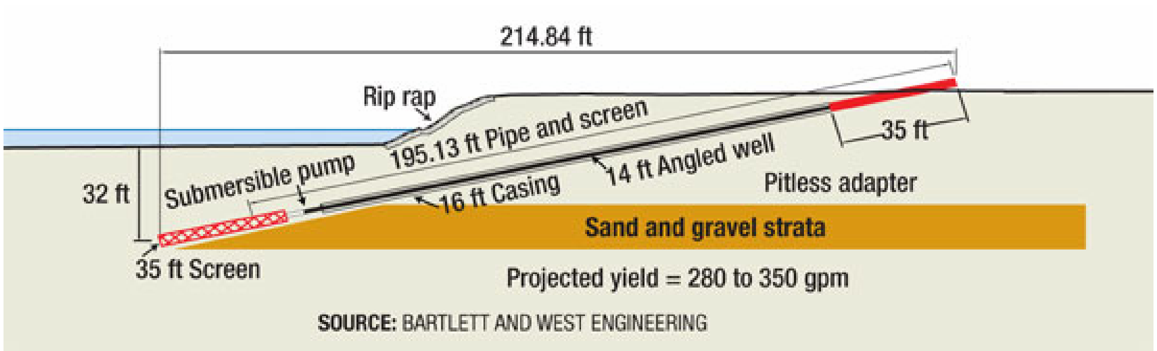
- A typical collection caisson (shaft) is provided in **Figure 4-12**.
- HDD systems can be designed to use porous polyethylene well pipe that serves as both the well screen and packing (Peters, 2006). Pre-packed well screens and filter mesh well screens that can be pulled over a slotted pipe are other options offered by several manufacturers.
- Onshore construction disturbance is relatively small; assume about 150 feet by 300 feet for the pit and materials/equipment storage area.

4.2.3.4. Slant Wells

Slant wells, as illustrated in **Figure 4-13**, are similar to HDD wells. In slant well construction, a shallow-entry drill rig is angled approximately 15-25 degrees from the horizontal; then the borehole is drilled straight, with a fixed drill head. This is different from HDD technology, where the drill operator can maneuver the drill head, gradually directing it to the desired stratum or location.

Figure 4-13: Slant Well with Submersible Pump

Source: MWH Temporary Ocean Water Desalination Demonstration Project TM-2 Process Requirements, 2007



Compared to conventional trench technology, slant wells offer several advantages:

(1) minimized surface disturbance/impacts,

(2) much smaller quantity of excavated material,

(3) accuracy of conduit placement, and

(4) no open trenches and no backfill and compaction.

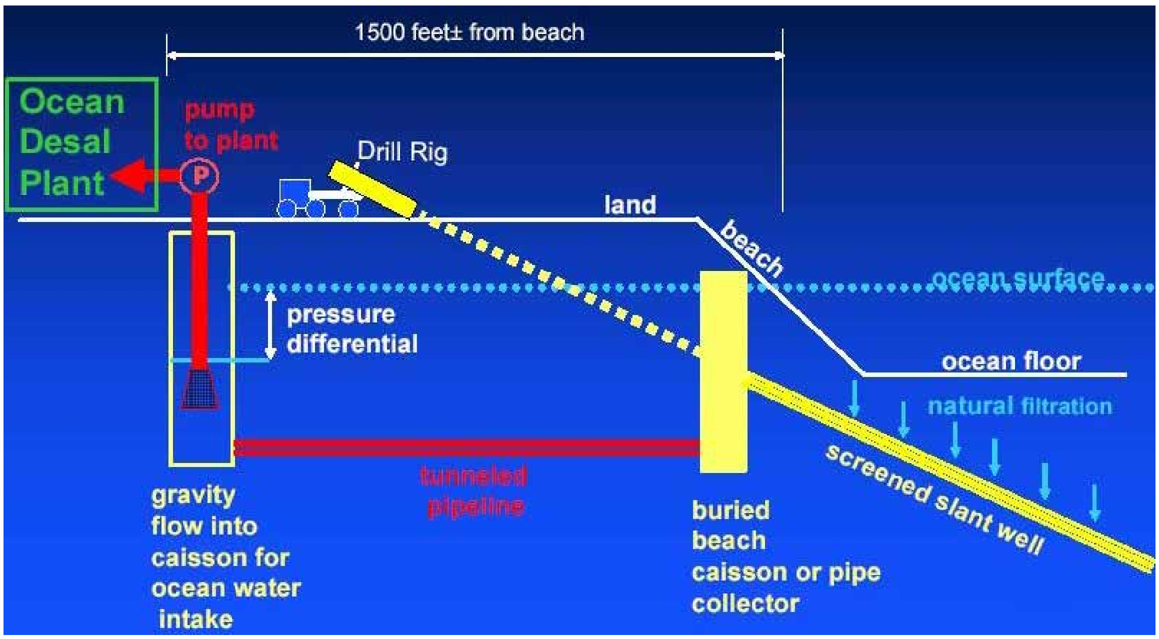
Slant wells can either be pumped using submersible pumps (**Figure 4-13** above) or be designed as gravity flow system as shown in **Figure 4-14**.

As with HDD wells, West Basin could construct slant wells with porous polyethylene well pipe that serves as both well screen and packing. This eliminates the need for external media packing. At the present time, these well screen and filter pack systems have a maximum diameter of 24 inches. As with other well systems, the designer must size the well screen and packing system so that the entrance velocity does not exceed the prescribed maximum flow velocity for the adjacent formation.

The Municipal Water District of Orange County (MWDOC) plans to construct a desalination plant in south Orange County. MWDOC has proposed to use slant wells at the mouth of San Juan Creek (MWDOC, 2006). To date, one 12-inch test well has been constructed in the spring of 2006 at Doheny Beach. It was drilled at an angle of 23 degrees below horizontal with a length of 350 feet. The well was tested at a rate of 1,680 gpm and produced groundwater with a total dissolved solids concentration of approximately 2,600 mg/l. MWDOC expects that future, deeper wells will produce between 2,000 to 3,000 gpm each.

A slant well intake system would have a production rate similar to a vertical well depending in part on the thickness and hydraulic conductivity of the aquifer surrounding the well screen. In order to determine yield of slant wells and the feasibility of this option, site-specific test drilling and production pump tests are needed to determine the hydraulic characteristics of the formation materials. As with HDD wells, multiple slant wells can be installed from the same origin within a caisson.

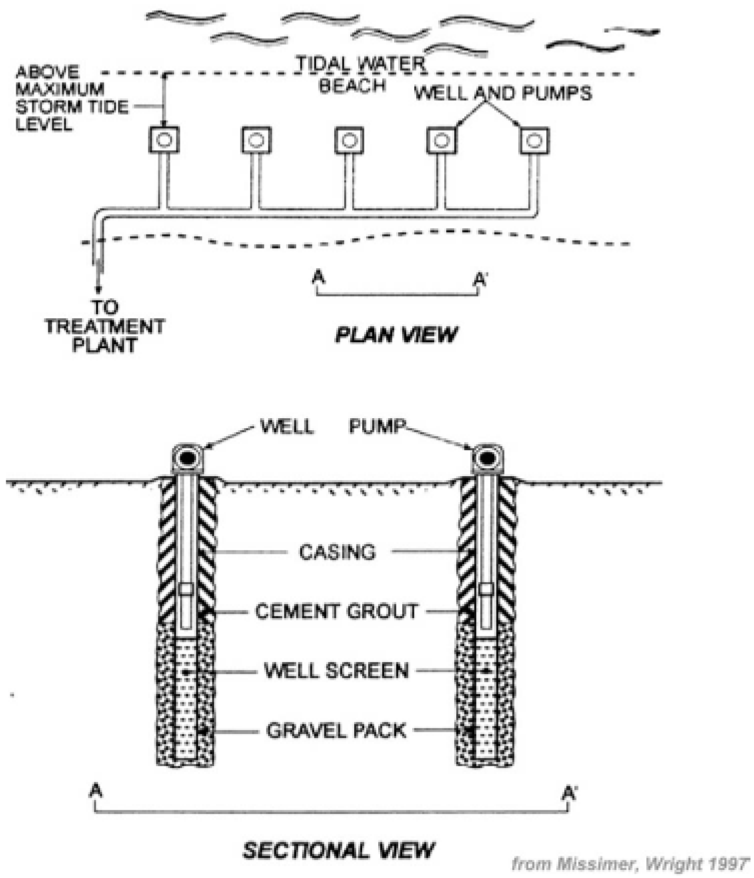
Figure 4-14: Slant Well with Gravity Flow
Source: MWH Temporary Ocean Water Desalination Demonstration Project TM-2 Process Requirements, 2007



4.2.3.5. Conventional Vertical Wells

Conventional vertical wells have been used in many locations around the world to extract seawater for desalination. The technology and design considerations are similar to those for slant wells. The essential difference is that vertical wells require multiple locations – as in a "well field" – to produce comparable source water flows. A typical configuration for an onshore well system is shown in **Figure 4-15**.

Figure 4-15: Typical Schematic Representation of an Onshore Well System
Source: MWH Temporary Ocean Water Desalination Demonstration Project TM-2 Process Requirements, 2007



4.2.3.6. Caisson, Tunnel and/or Micro tunnel Construction

Large diameter caissons may be used as wet wells for intake water collection for Ranney, HDD, and/or Slant Wells. In addition, tunnel boring machine (TBM) and/or microtunneling techniques may be appropriate to interconnect collector caissons to an onshore pumping station or to install new discharge pipelines offshore.

Caissons could be constructed as shored cylindrical shafts which are excavated within the dune sands using conventional earthwork equipment. Shoring would need to be water tight and be designed to resist at-rest soil and hydrostatic water pressures. A drilled secant-pile system with steel soldier piles could be an appropriate alternative. Either steel or reinforced concrete hoop wailers would be installed as excavation progresses to provide internal lateral support. A jet grout bottom plug may be required to prevent groundwater inflow from the caisson bottom. The entire caisson (walls and floor) must be built to resist soil, hydrostatic, and earthquake forces.

Tunnels could be constructed from within access caissons. In this case it may be necessary to jet grout the area outside the caisson to provide a high strength low permeability soil zone in which to launch tunneling equipment. As for HDD technology, tunneling will encounter saturated variable face soil conditions. Frequent and variable changes in soil conditions from sand to clays and silts should be expected along the alignment. Deeper alignments installed through the upper aquitards may encounter problematic excess hydrostatic pressures in the deeper aquifers.

4.3. Evaluation of Project Sites for Subsurface Systems

4.3.1. El Segundo

Groundwater contamination is a significant concern at the El Segundo site. Free petroleum products and volatile organic and inorganic compounds proliferate near the Southern California Edison and Chevron Refinery sites. Of particular concern at this location is the presence of contamination in the deeper Silverado and Gage (200-foot sand) aquifers, in addition to the shallow Old Dune Sand.

4.3.1.1. Onshore Infiltration Galleries, Ranney Collectors and Conventional Vertical Wells

Well yields must be determined from field studies. Assuming that one HDD well might produce as much as 3,000 gpm (4.3 MGD), then West Basin would need ten HDD wells to supply a 20 MGD desalination facility and 28 wells to supply a 60 MGD facility, excluding any allowance for loss of well capacity or maintenance. Allowing 20 percent standby capacity (to account for loss of well efficiency as well as maintenance downtime) the total number of wells would be 12 for the 20 MGD facility and 34 for the 60 MGD facility. This assumes that the Seawater Reverse Osmosis (SWRO) desalination plant has a recovery rate of 50%, therefore for every gallon of finished potable water, two gallons of seawater are required.

The maximum yield from individual conventional vertical wells could range from 0.1 to 1.0 MGD, depending on aquifer characteristics. Assuming 0.5 MGD per well, West Basin would need about forty 24-inch conventional vertical wells (with 300 feet of screens) along the beach for the 20 MGD desalination plant and about one hundred and twenty 24-inch conventional vertical wells for a 60 MGD plant, including 20% redundancy.

The presence of significant contamination in the Old Dune Sand makes subsurface onshore infiltration galleries, horizontal collector wells (Ranney collectors) and conventional vertical wells economically infeasible, requiring the intake water to be treated for contaminants prior to being treated for potable water use.

4.3.1.2. Slant Wells

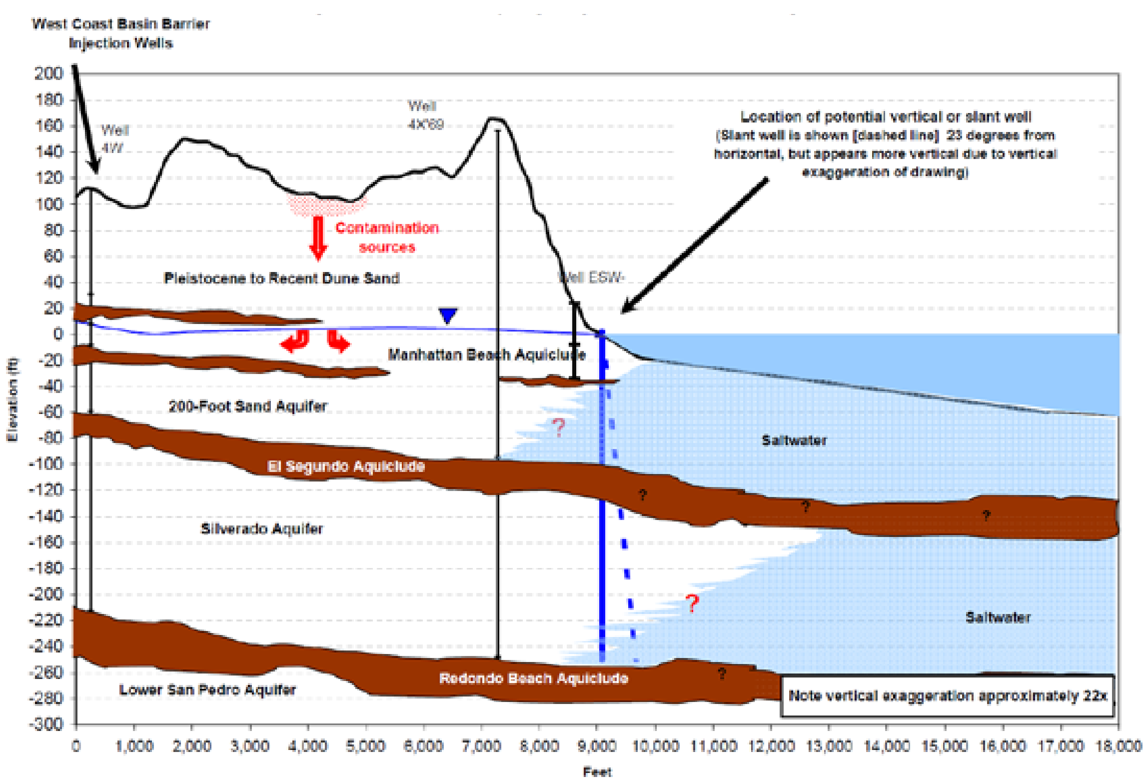
Figure 4-16 is a schematic hydrogeologic cross-section for the El Segundo site. This figure suggests that groundwater contamination in the shallow aquifer may not extend more than a few hundred feet offshore. Groundwater flow in the deeper zone is controlled by regional through-flow, increasing the possibility that the shallow aquifer discharge is further offshore. Similarly, contamination in the deeper aquifers may extend offshore.

Assuming that a single slant well can produce 1,500 gpm (2.17 MGD), then about 20 slant wells would be required to supply a 20 MGD desalination plant and 56 wells would be required for a 60 MGD plant. Allowing an additional 20 percent standby capacity, West Basin would need to construct 22 wells for the 20 MGD plant and 66 wells for the 60 MGD plant. Again, this assumes a 2:1 ratio of seawater to produced potable water.

Considering the inherent geometric and practical limits of slant well technology, slant wells probably cannot reach far enough offshore to bypass contaminated groundwater. Thus, slant wells would not be appropriate at the El Segundo site.

Figure 4-16: Schematic Hydrogeologic Cross Section at El Segundo

Source: MWH Temporary Ocean Water Desalination Demonstration Project TM-2 Process Requirements, 2007



4.3.1.3. HDD Wells

From a groundwater contamination standpoint, HDD wells and Seabed Filtration systems are potentially viable options. With HDD wells, West Basin may be able to position well screens at shallow depths. In this case, the wells would draw fresh seawater from the ocean above and the risk of communication with onshore contamination would be reduced. Since the wells would penetrate potentially contaminated groundwater en route to the withdrawal zone, however, it would be important to use solid casings and annular seals in the first several hundred feet of each horizontal well.

HDD wells would have several advantages at El Segundo. West Basin could:

(1) place the wells from uplands areas, above tsunami run-up elevations,

(2) place the wells under potentially liquefiable beach deposits,

(3) avoid interference with onshore development and infrastructure,

(4) terminate all the wells in a single, deep caisson, thereby reducing the footprint and the amount of piping, and

(5) avoid construction in the beach zone and surf zone.

4.3.1.4. Seabed Infiltration

Sediment transport, erosion and scour are important factors in determining the potential viability of a seabed filtration system. El Segundo's nearshore area is a high-energy, wave-dominated environment. In addition, sediment transport occurs on a seasonal basis, and longshore currents constantly move sediments along the beach. In this environment, a seabed infiltration system is likely to become fouled with sediment and to require extensive and ongoing maintenance. There is also a high risk that such a system could be damaged or destroyed as a result of storm or tsunami induced erosion.

For the West Basin desalination project, an infiltration gallery or seabed infiltration system (at a typical surface loading rates between 0.05 and 0.10 gpm/ft^2) would require 2 to 20 acres to supply a 20 MGD desalination plant and 6 to 60 acres to serve a 60 MGD plant. As shown in **Figure 4-5**, the screens are approximately six feet (6') below the lowest portion of the seabed.

If West Basin could achieve an intake rate similar to that at Fukuoka, a seabed infiltration system for a 20 MGD desalination plant would cover about 10.8 acres and a 60 MGD plant would require about 32.4 acres. Assuming that the screens in the gallery would be 100 feet wide, a seabed system would need to be about 0.9 miles long for a 20 MGD production and about 2.7 mile long for 60 MGD.

A seabed infiltration system at El Segundo would also require extensive dredging and spoils disposal to excavate the infiltration gallery pits. Depending on the loading rate (varying from 0.05 to 0.1 gpm/ft^2) an infiltration system sized for a 20 MGD desalination plant would cover between 3 and 19 acres of seafloor and generate 50,000 to 300,000 cubic yards of dredge spoils. An infiltration system sized to supply a 60 MGD plant would require 9 to 57 acres and generate 150,000 to 900,000 cubic yards of dredge spoils. The environmental mitigation that would be required to compensate for the dredging impacts of such a large area could be significant and would require extensive studies and, in particular, would require studies to identify disposal sites. A seabed infiltration system would require multiple offshore manifolds and pipelines, several collection sumps, and several miles of beachfront collector pipes. The onshore portions of the infiltration system would also be susceptible to tsunami run-up and liquefaction. On the basis of these considerations, a seabed infiltration system at El Segundo is not recommended.

4.3.2. Redondo Beach

Based on limited data, it appears that groundwater contamination at Redondo Beach is less extensive than at El Segundo. However, contamination has only been found in the shallow zone. Contaminants and contaminant concentrations in the deeper aquifers, if any, are not known. As shown on the schematic hydrogeologic cross section for this site, **Figure 4-17**, the Manhattan/El Segundo Aquitard may provide some level of protection against contamination of the deeper zones.

4.3.2.1. Onshore Infiltration Galleries, Ranney Collectors and Conventional Vertical Wells

Well yields must be determined from field studies. Assuming that one HDD well might produce 3,000 gpm (4.3 MGD), then 10 HDD wells would be needed to supply a 20 MGD desalination plant and 28 wells to supply a 60 MGD plant, excluding any allowance for loss of well capacity or maintenance. Allowing 20% standby capacity (to account for loss of well efficiency as well as maintenance downtime) the total number of wells would be 12 for the 20 MGD plant and 34 for the 60 MGD plant.

The maximum yield from individual conventional vertical wells could range from 0.1 to 1.0 MGD, depending on aquifer characteristics. Assuming 0.5 MGD per well, about eighty (80) 24-inch conventional vertical wells (with 300 feet of screens) would be needed along the beach for the 20 MGD desalination plant and about two hundred and forty (240) 24-inch conventional vertical wells for a 60 MGD plant, including 20% redundancy.

As with the El Segundo site, onshore infiltration galleries, Ranney collectors, and conventional vertical wells are not recommended at Redondo Beach due to contamination in the surficial aquifer which would require intake water to be treated for contaminants prior to being treated for potable water use.

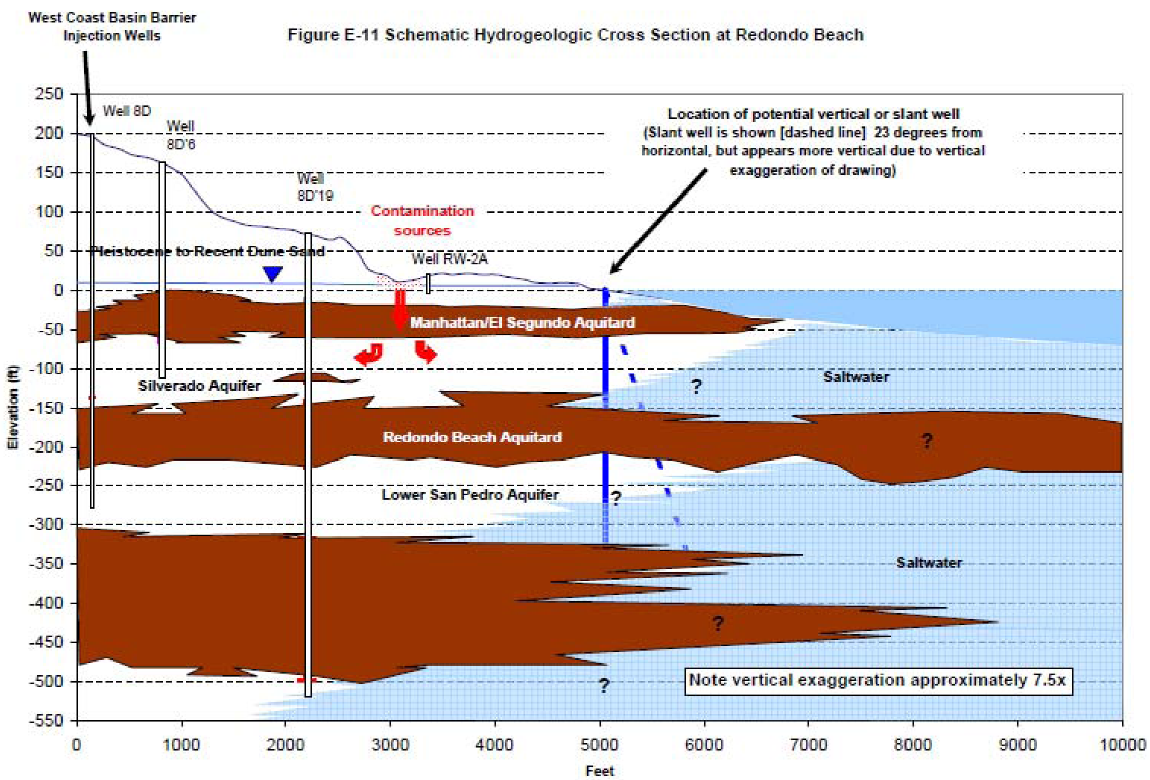
4.3.2.2. Slant Wells

Slant wells may be viable at the Redondo Beach site if future investigation confirms that the deeper Silverado and Lower San Pedro Aquifers are not contaminated.

Assuming that a single slant well can produce 1,500 gpm (2.17 MGD), about 20 slant wells would be required to supply a 20 MGD desalination plant and 56 wells would be required for a 60 MGD plant. Allowing for an additional 20% standby capacity, and a 2:1 ratio of seawater to potable water, 22 wells for the 20 MGD plant and 66 wells for the 60 MGD plant would be needed.

Figure 4-17: Schematic Hydrogeologic Cross Section at Redondo Beach

Source: MWH Temporary Ocean Water Desalination Demonstration Project TM-2 Process Requirements, 2007



4.3.2.3. HDD Wells

As discussed above for the El Segundo site, HDD wells may be viable from a groundwater contamination perspective. However, this alternative is not recommend because:

- A test well would have to be drilled to sample groundwater in the targeted withdrawal zone. Assuming positive results are obtained, test data would be used to establish design parameters for the HDD well system.

- Well drilling (particularly HDD drilling) would risk creating migration paths through the Manhattan-El Segundo Aquitard, increasing the possibility of contaminant transport into the Silverado Aquifer.
- Wells would have to extend to a depth of more than 60 feet to penetrate the Silverado Aquifer.
- Depending on piezeometric pressure in the Silverado Aquifer, the caisson/sump might also need to extend through the Manhattan-El Segundo Aquitard, presenting another opportunity for contaminant migration.
- If the Silverado Aquifer water quality is poor, then HDD would face the same limitations as those discussed for El Segundo.

In conclusion, the HDD alternative is not recommend for Redondo Beach.

4.3.2.4. Seabed Infiltration Systems

Seabed infiltration systems may be viable from a groundwater contamination perspective. However, a seabed infiltration system at Redondo Beach would have the same sediment transport issues as at El Segundo, except that these would likely be more accentuated at Redondo Beach due to the presence of the King Harbor breakwater which deflects the dominant southwesterly transport of sediment offshore. Therefore, a seabed infiltration at Redondo Beach is not recommended.

An infiltration gallery or seabed infiltration system (at a typical surface loading rates between 0.05 and 0.10 gpm/ft^2) would require 2 to 20 acres to supply a 20 MGD desalination plant and 6 to 60 acres to serve a 60 MGD plant.

If an intake rate similar to that at Fukuoka could be achieved, a seabed infiltration system for 20 MGD would cover about 10.8 acres and a 60 MGD production would require about 32.4 acres. Assuming that the screens in the gallery would be 100 feet long, a seabed infiltration system would need to be about 1.8 miles long for a 20 MGD plant and about 5.4 mile long for a 60 MGD plant.

4.3.3. Screening of Subsurface Intake Alternatives

Table 4-2 summarizes the various subsurface intake alternatives, and shows the measures of merit assigned to each to quantify their relative feasibility according to the following criteria:

- Potential Environmental Impact
- Hazardous Waste Concerns
- Contamination Concerns
- Wave and Tsunami Concerns

- Seismic Concerns
- Public Acceptance
- Reuse of Existing Infrastructure
- Requirements for Additional Studies
- Operations & Maintenance Requirements
- Constructability
- Relative Cost

The alternative with the lowest total score is considered the most feasible alternative. **Table 4-2** shows that subsurface intake alternatives would be relatively challenging to implement at the project sites. Results need to be compared with the open surface alternatives provided in **Table 4-7**.

Table 4-2: Screening of Subsurface Alternatives

Subsurface	Environmental Impact	Hazardous Waste	Contamination	Wave & Tsunami	Seismic	Public	Infrastructure Reuse	Integrity of Existing	Additional Studies	O&M	Constructability	Relative Cost	Overall
Infiltration Galleries & SF	10	7	10	10	10	10	0	0	10	7	10	8.5	**92.5**
Horizontal Collector Wells	10	7	10	10	10	10	0	0	10	7	10	8.5	**92.5**
HDD Wells	5.5	10	10	10	10	5.5	0	0	10	7	8.5	7	**83.5**
Slant Wells	5.5	10	10	10	10	10	0	0	10	7	8.5	5.5	**86.5**
Convential Vertical Wells	10	7	10	10	5.5	10	0	0	10	7	8.5	5.5	**83.5**

Severe	10.0
Very High	8.5
High	7.0
Fair	5.5
Acceptable	4.0
Good	2.5
Best	1.0
N/A	0.0

4.4. Open Surface Intake and Discharge Alternatives

In the context of this section, "open surface" refers to alternatives employing above the seabed intake and discharge infrastructure and returning the brine to the ocean. This section discusses the advantages and disadvantages of open surface alternatives, describes the technologies, and evaluates their feasibility at the El Segundo and Redondo Beach sites.

It is anticipated, that the proposed Seawater Reverse Osmosis (SWRO) desalination plant will have a recovery rate of 50%: for every one (1) gallon of potable water produced by the plant, the intake of two (2) gallons of saltwater are required, with the second gallon being returned to the ocean. Intake and discharge pipelines for a desalination facility may adversely affect marine life if not properly designed. Marine life can be harmed at an intake if they are pulled into the pipe and are unable to escape due to the relatively high water suction velocities (impingement and entrainment). Consideration needs to be made during design to ensure that marine life in the vicinity of the intake system is not adversely effected by the system. Section 4.4.5 provides the initially recommended welded wire screen system to be installed at the intake system to ensure the marine life are not infringed or entrained.

The brine discharged from a desalination plant can have a salt concentration of about 65,000 to 70,000 parts per million (ppm) compared to the natural seawater salt concentration of about 34,500 ppm. Organisms are adapted to the natural salt concentration and generally cannot handle a dramatic increase in concentration. In addition, organisms at different stages of their lives have different sensitivity to salt concentration. Therefore, finding a proper location for a discharge pipeline is crucial. Discharge should occur in areas where the aquatic population has a lower sensitivity to changes in salinity. A diffuser that allows the discharge to be spread over a large area can result in a more ecologically neutral diffusion of the brine into the seawater.

In addition, the seawater feed to a desalination plant requires very good water quality regarding suspended solids, seawater temperature, contamination by pollutants (particularly oil) and marine biological matter. These factors, individually and/or combined, present a significant challenge for the pre-treatment of the feed water for the SWRO process with regards to both performance and operational costs. Based on the lessons learned from several SWRO installations around the world, the pre-treatment is the most critical area of a SWRO desalination plant; long-term success in plant operation is greatly influenced by the combination of pre-treatment and intake method. A quality intake design not only protects downstream equipment and reduces environmental impact on aquatic life, but it also enhances process performance and reduces pre-treatment system capital and operating costs. The open surface intake and discharge alternatives considered in this study include utilizing:

(1) Existing Tunnels for Intake and Discharge
(2) Existing Tunnels as Casings for new Intake and Discharge Pipes (pipe inside pipe)
(3) Discharge into the nearby Hyperion Outfall
(4) Combined Intake and Discharge Tunnel
(5) Two HDD Pipelines for New Intake and Discharge Pipes

4.4.1. Existing Tunnels for Intake and Discharge

The objective of this section is to evaluate the possibility of using the existing tunnels for intake and discharge.

4.4.1.1. Alternative No. 1 – Use Existing Tunnels 'As-Is'

4.4.1.1.1 El Segundo

This alternative utilizes the existing 12-feet diameter tunnels from Units 3 and 4 as shown in **Figure 4-18 and Figure 4-19**. This alternative would use:

- the existing 12-foot diameter intake tunnel as intake.
- the existing 12-foot diameter discharge tunnel as discharge

Figure 4-18: Segundo Alternative 1, 20 MGD Scenario

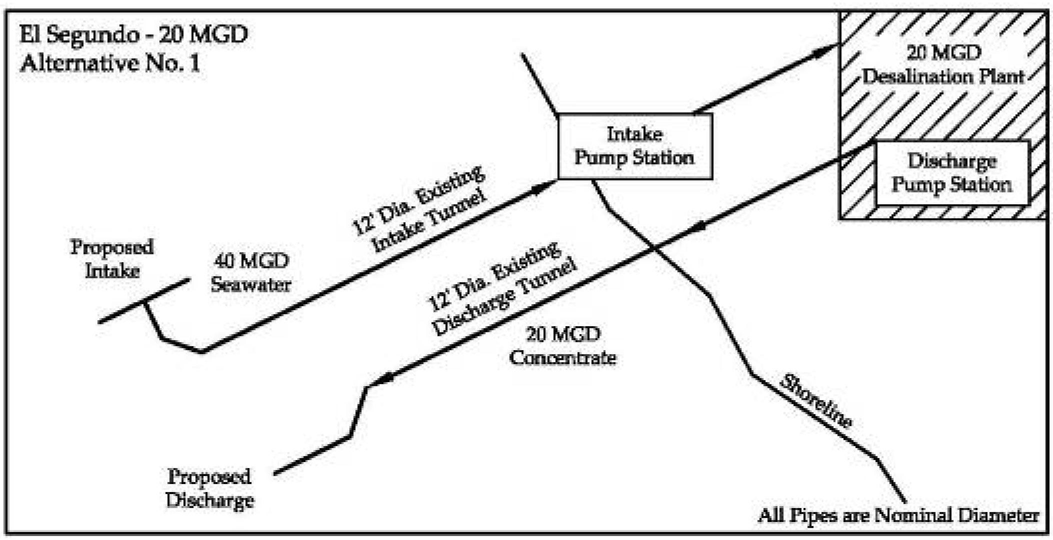
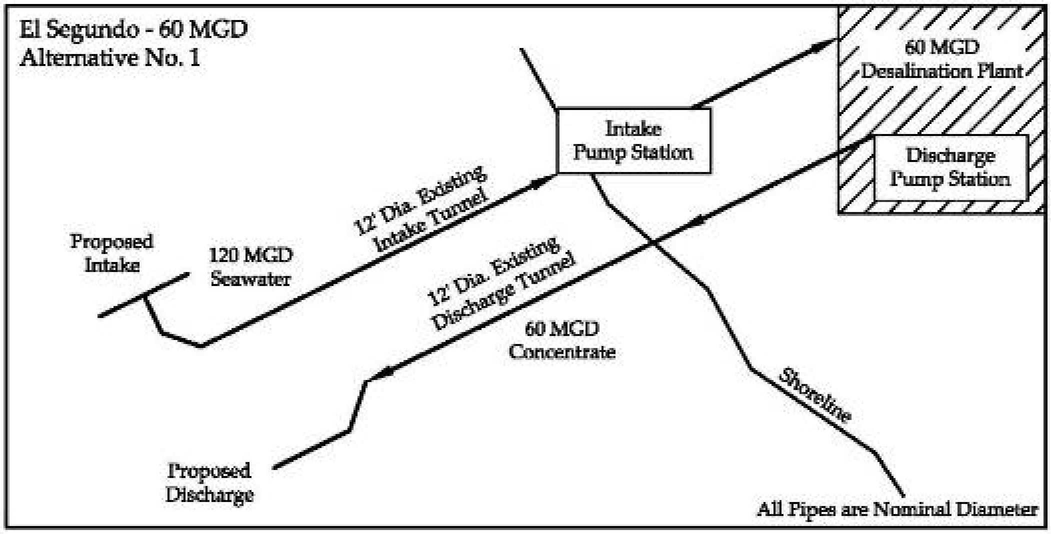


Figure 4-19: El Segundo Alternative 1, 60 MGD Scenario



In addition to modeling the system with the open-ended pipes, a modified intake option with wire-wedge screens and a modified discharge with multiple port diffusers were evaluated as shown in **Figure 4-20** and **Figure 4-21**. A schematic of the intake screen is shown in **Figure 4-41** and a discharge diffuser schematic is shown in **Figure 4-42.**

Figure 4-20: El Segundo Modified Intake and Discharge, 20 MGD Scenario

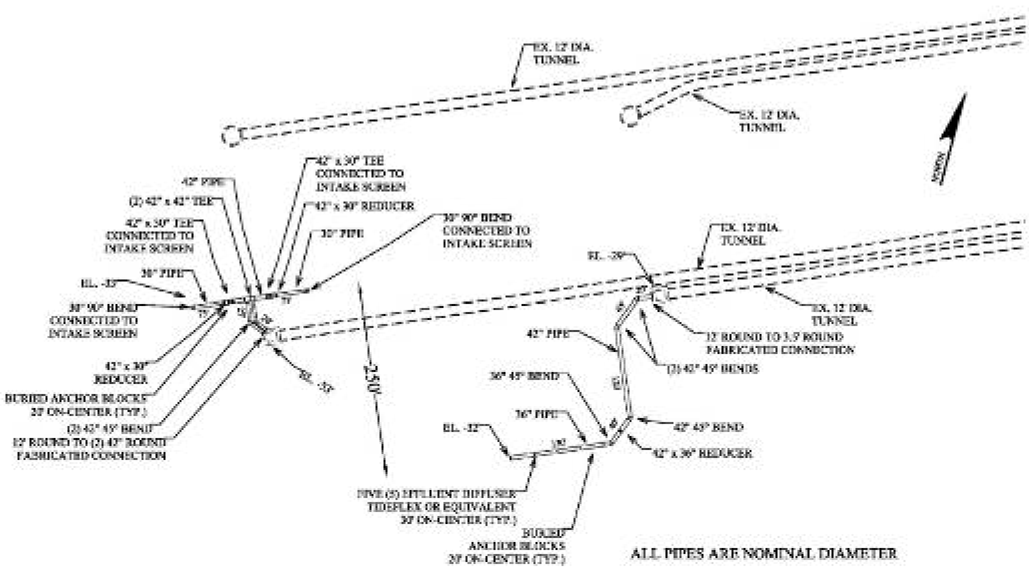
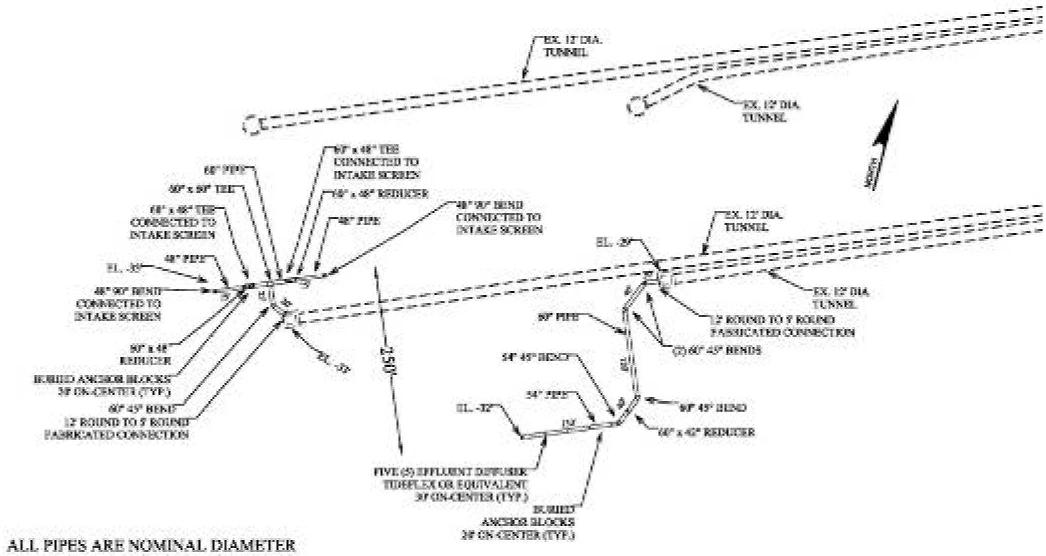


Figure 4-21: El Segundo Modified Intake and Discharge, 60 MGD Scenario



4.4.1.1.2 Redondo Beach

This alternative utilizes the existing 10-foot diameter tunnels on the north side of the King Harbor breakwater as shown in **Figure 4-22** and **Figure 4-23**. This alternative would use:

- the existing 10-foot diameter northern tunnel as intake.
- the existing 10-foot diameter southern tunnel as discharge.

Figure 4-22: Redondo Beach Alternative 1, 20 MGD Scenario

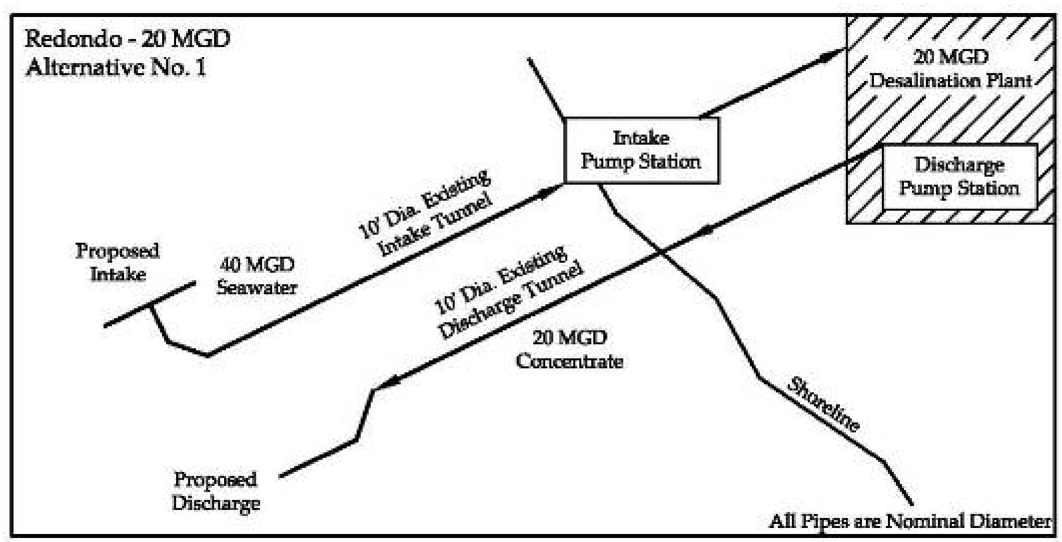
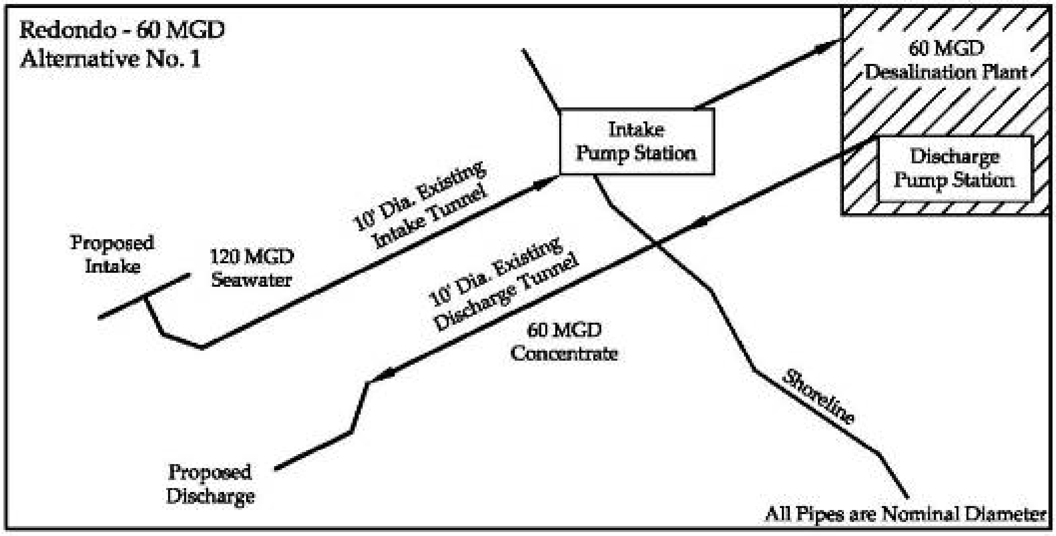


Figure 4-23: Redondo Beach Alternative 1, 60 MGD Scenario



In addition to modeling the system with the open-ended pipes, a modified intake option with wire-wedge screens and a modified discharge with multiple port diffusers were evaluated as shown in **Figure 4-24** and **Figure 4-25**. A schematic of the intake screen is shown in **Figure 4-41** and a discharge diffuser schematic is shown in **Figure 4-42.**

Figure 4-24: Redondo Beach Modified Intake and Discharge, 20 MGD Scenario

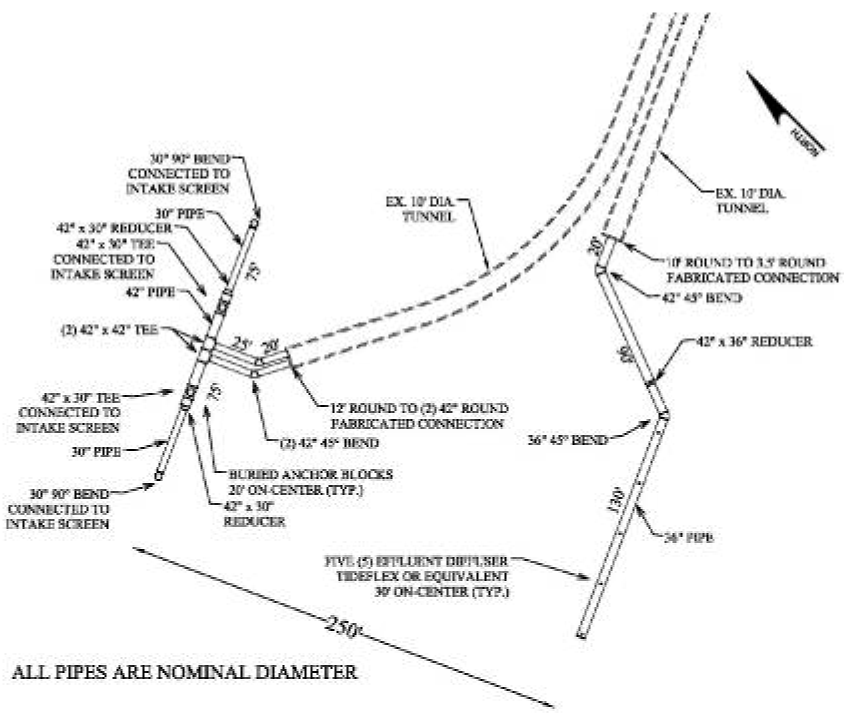
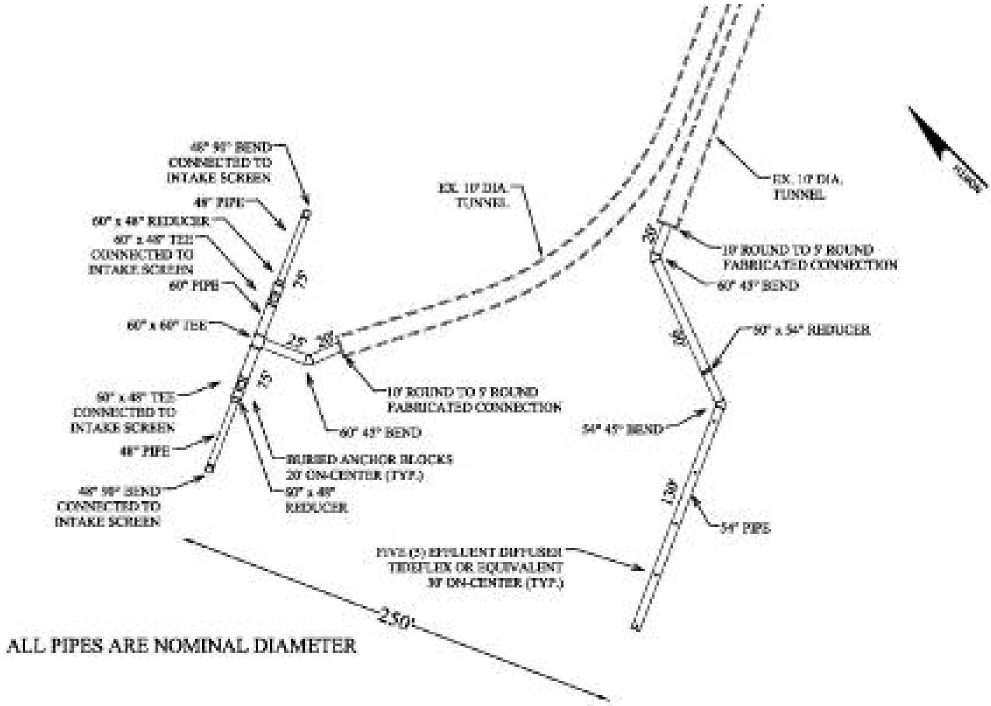


Figure 4-25: Redondo Beach Modified Intake and Discharge, 60 MGD Scenario



4.4.1.2. Alternative No. 2 – Intake Pipes with Existing Tunnel

4.4.1.2.1 El Segundo

This alternative consists of installing smaller diameter pipes within the existing tunnel for Units 3 and 4 as shown in **Figure 4-26** and **Figure 4-29.** Cross-section details of these alternatives are shown in **Figures 4-27, 4-28, 4-30**, **and 4-31**. This alternative consists of:

- Installing smaller diameter intake pipes inside the existing 12-foot diameter intake tunnel to be used as intake conduits. The purpose is to maintain a minimum 2 feet per second velocity in the intake conduits.
- Using the existing 12-foot diameter discharge tunnel as discharge tunnel.

Figure 4-26: Segundo Alternative 2, 20 MGD Scenario

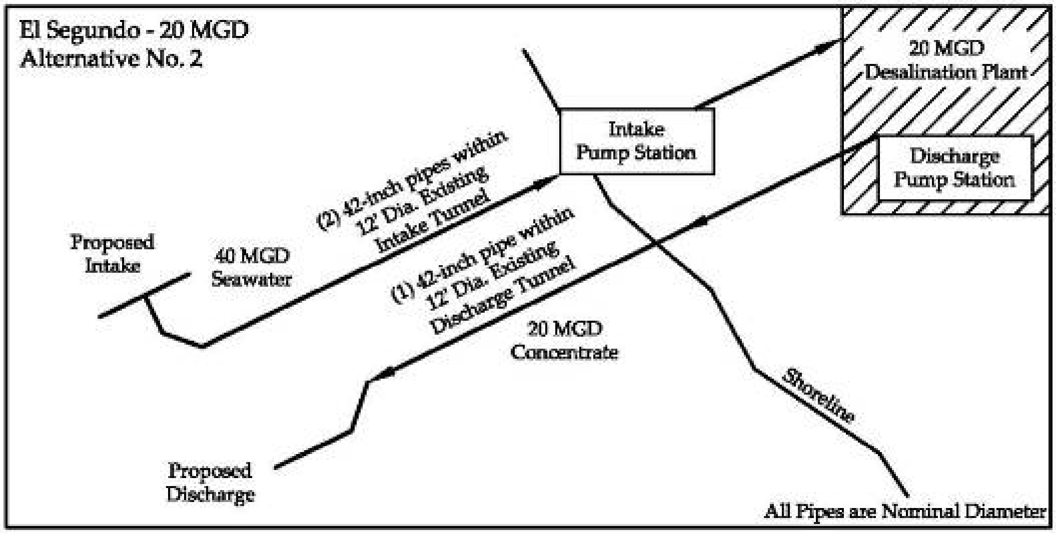


Figure 4-27: El Segundo Alternative 2 Intake Cross Section 20, MGD Scenario

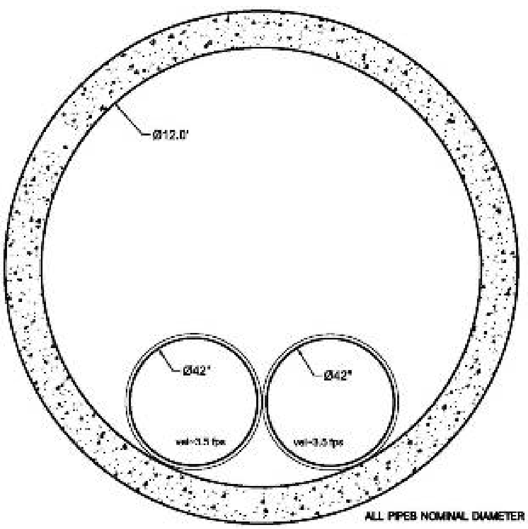


Figure 4-28: El Segundo Alternative 2 Discharge Cross Section, 20 MGD Scenario

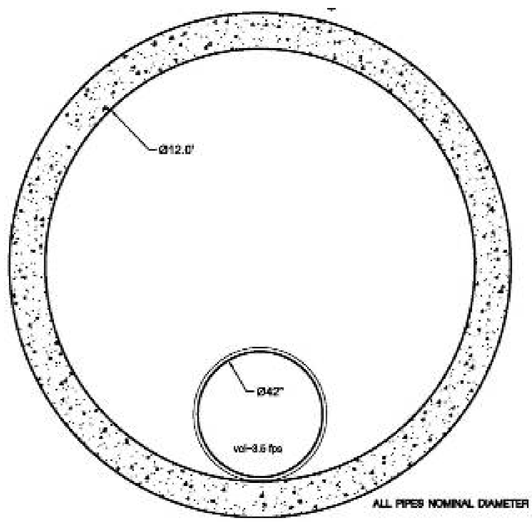


Figure 4-29: El Segundo Alternative 2, 60 MGD Scenario

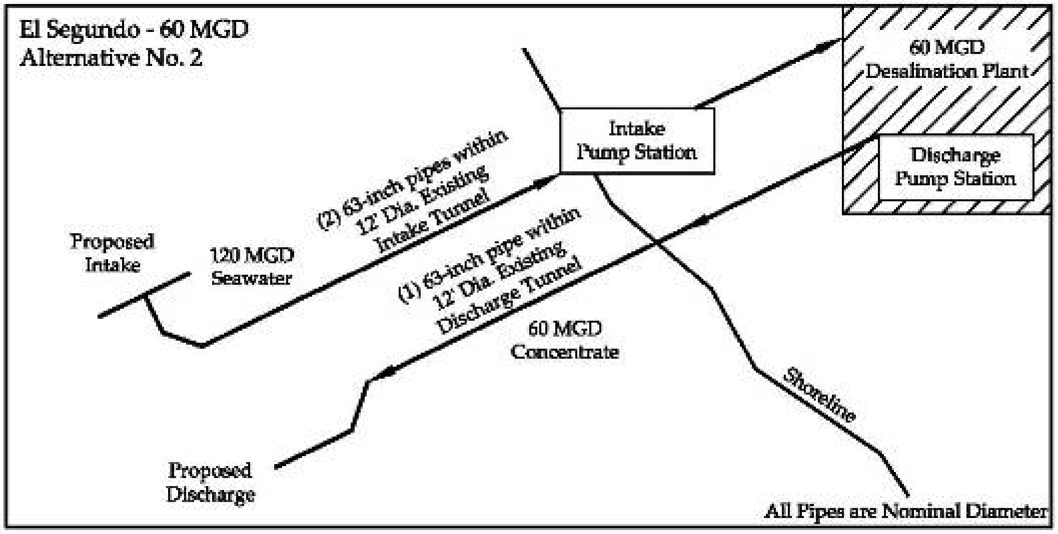


Figure 4-30: El Segundo Alternative 2 Intake Cross Section, 60 MGD Scenario

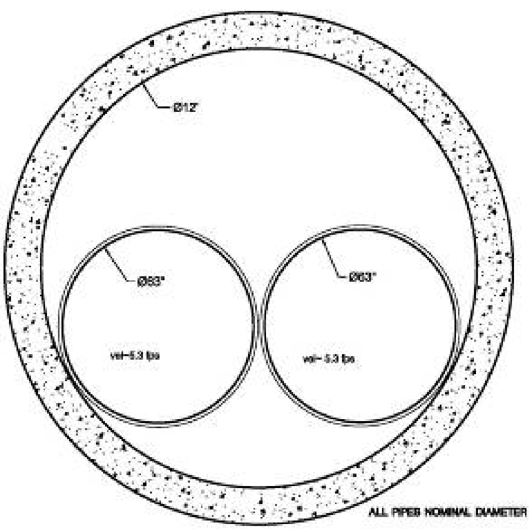
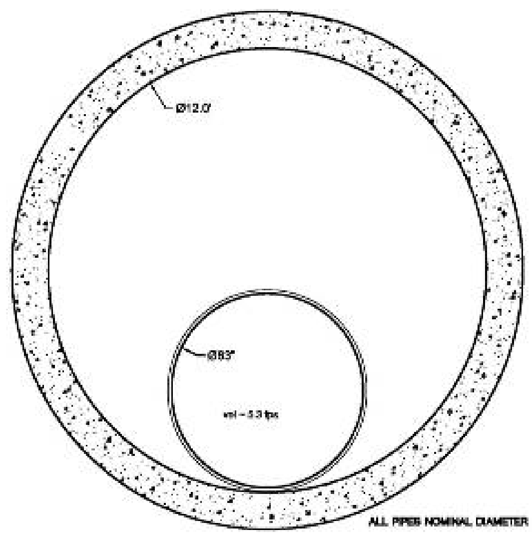


Figure 4-31: El Segundo Alternative 2 Discharge Cross Section, 60 MGD Scenario



4.4.1.2.2 Redondo Beach

This alternative consists of installing smaller diameter pipes within the existing tunnels to the north side of the King Harbor breakwater as shown in **Figure 4-32 and Figure 4-35**. Cross-section details of these alternatives are shown in **Figures 4-33, 4-34, 4-36**, **and 4-37**. This alternative consists of:

- installing smaller diameter intake pipe inside existing 10-foot diameter northern tunnel to be used as intake conduit. The purpose is to maintain a minimum 2 feet per second velocity in the intake conduits to prevent sedimentation.

- using the existing 10-foot diameter southern tunnel as discharge tunnel.

Figure 4-32: Redondo Beach Alternative 2, 20 MGD Scenario

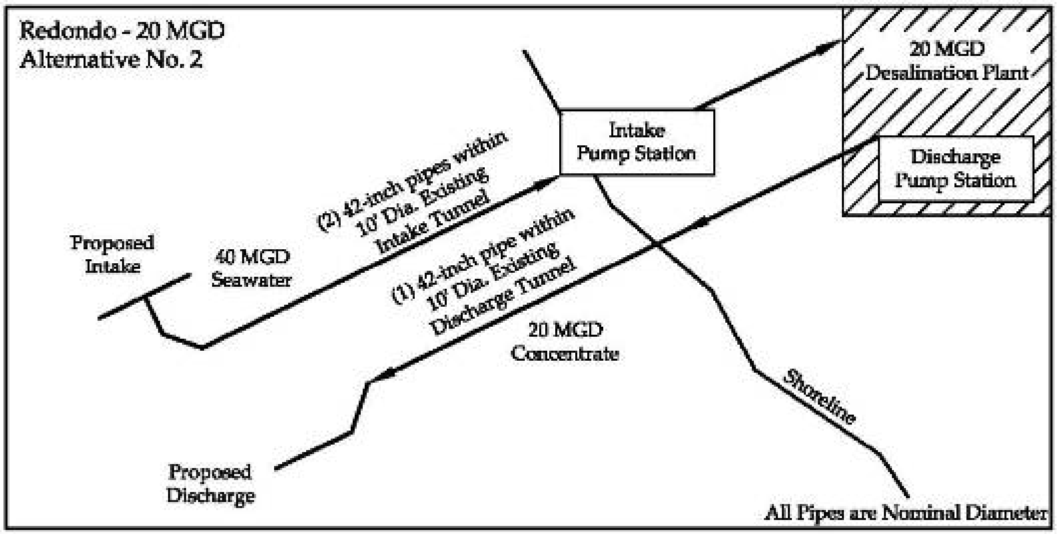


Figure 4-33: Redondo Beach Alternative 2 Intake Cross Section, 20 MGD Scenario

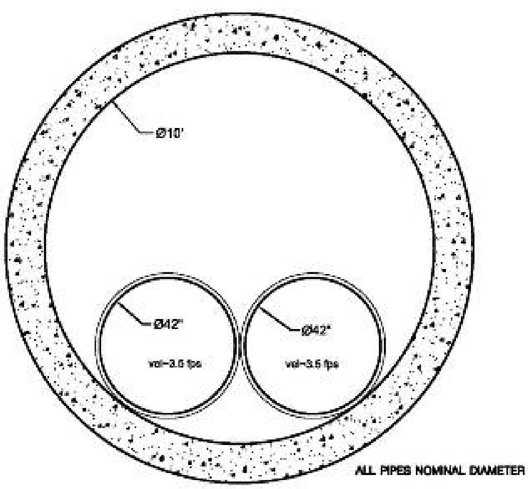


Figure 4-34: Redondo Beach Alternative 2 Discharge Cross Section, 20 MGD Scenario

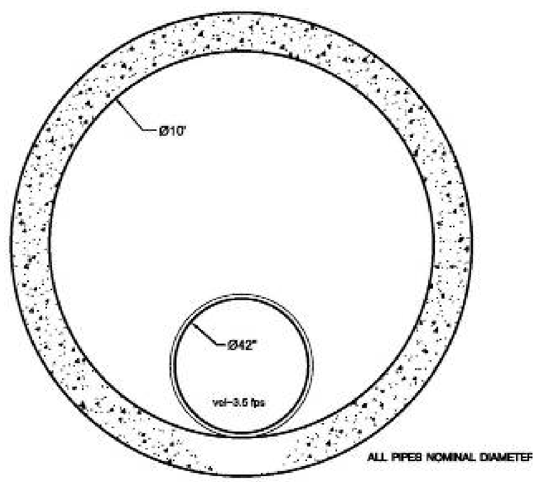


Figure 4-35: Redondo Beach Alternative 2, 60 MGD Scenario

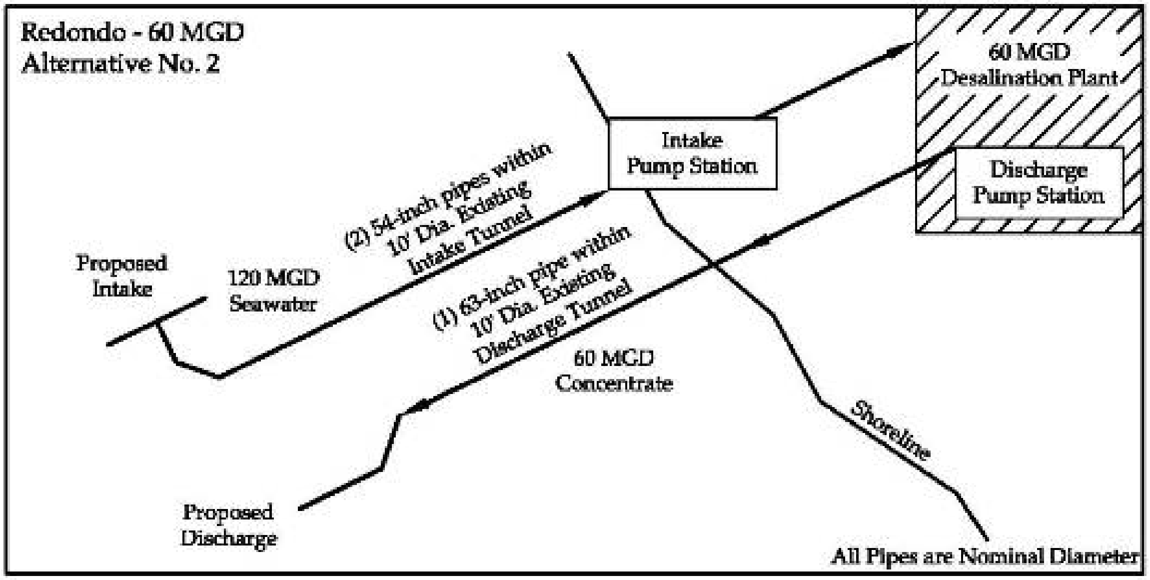


Figure 4-36: Redondo Beach Alternative 2 Intake Cross Section, 60 MGD Scenario

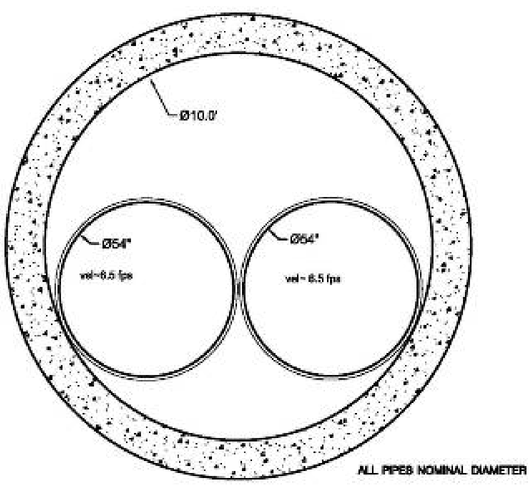
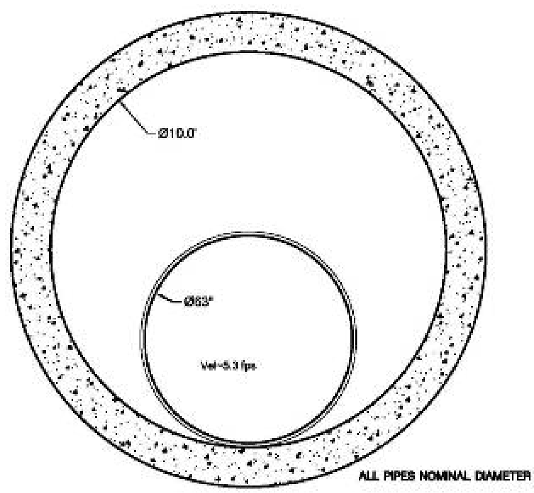


Figure 4-37: Redondo Beach Alternative 2 Discharge Cross Section, 60 MGD Scenario



4.4.2. Discharge the Hyperion Outfall

The Los Angeles Department of Public Works Hyperion Treatment Plant treats and disposes of approximately 350 MGD. The effluent disposal is done through the Hyperion Outfall, a five-mile tunnel extending into the Pacific Ocean across the Santa Monica submarine canyon. The outfall is +/-1.2 miles north of the El Segundo site and +/-5.2 miles north of the Redondo Beach site (see **Figure 4-38**).

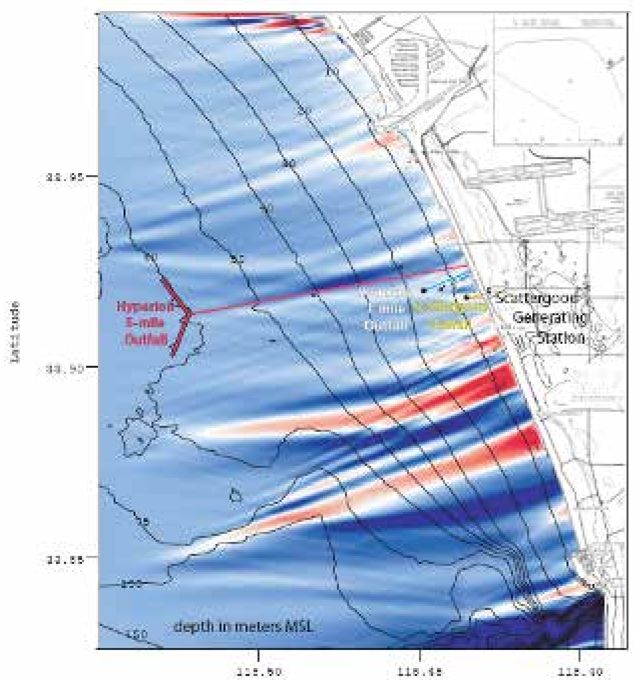
While this outfall has no consideration for water supply/intake, it may serve as a means of effectively discharging the brine without affecting the areas surrounding the outfall discharge point due to high salinity. **Table 4-3** summarizes the effluent salinity that would result from combining the desalination plant brine discharge with the Hyperion effluent. The resultant salinity is well below the ambient ocean salinity, typically around 33,500 ppm in the vicinity of the site.

Table 4-3: Resultant Salinity of Discharge into Hyperion Outfall

Plant Scenario	Hyperion WWTP		West Basin Desalination Plant		Combined Salinity
	Volume	Salinity	Volume	Salinity	
	MGD	ppm	MGD	ppm	ppm
20 MGD Plant	350	500	20	70,000	4,000
60 MGD Plant			60		10,000

The primary advantage of this alternative is, that the discharge effluent is handled through an existing outfall. However, infrastructure to transfer the discharge to the outfall is not in place and is likely cost prohibitive, particularly for the Redondo Beach site. In addition, the Hyperion Outfall is owned and operated by a separate agency, and therefore would require additional acquisitions or leases, and permits. Further, initial indications from the CLA BOS suggest that there are concerns with using the additional hydraulic capacity of this out fall for a non-CLA project.

Figure 4-38: Hyperion Outfall Location



4.4.3. Combined Intake and Discharge Tunnel

If the existing tunnels at El Segundo or Redondo Beach are not found adequate for this project, a single tunnel may be constructed housing both the intake and discharge pipes, as shown in **Figure 4-39** and **Figure 4-40** for the 20 MGD and 60 MGD plants, respectively. **Table 4-4** lists the tunnel diameters required to house the intake and discharge pipes for both plant cases.

Table 4-4: Pipe Sizes for Combined Intake/Discharge and HDD Tunnels

20 MGD Plant Scenario		
Conduit	**Flows**	**Pipe Diameter**
Horizontal Directional Drilling (HDD)	MGD	inches
Intake	40	63
Discharge	20	42
Combined Intake / Discharge Tunnel	40 + 20	144
60 MGD Plant Scenario		
Conduit	**Flows**	**Pipe Diameter**
Horizontal Directional Drilling (HDD)	MGD	inches
Intake	120	96
Discharge	60	63
Combined Intake / Discharge Tunnel	120 + 60	144

Figure 4-39: Combined Intake/Discharge Tunnel, 20 MGD Scenario

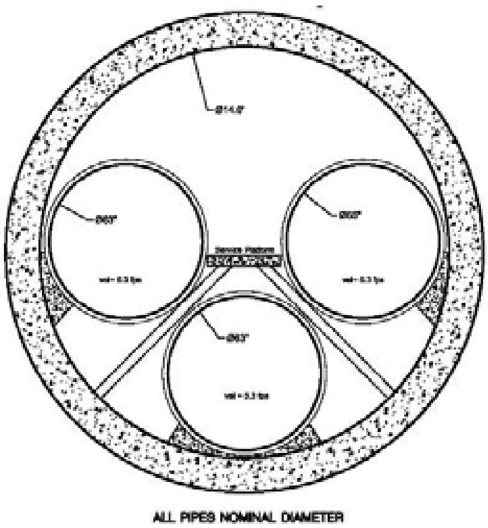
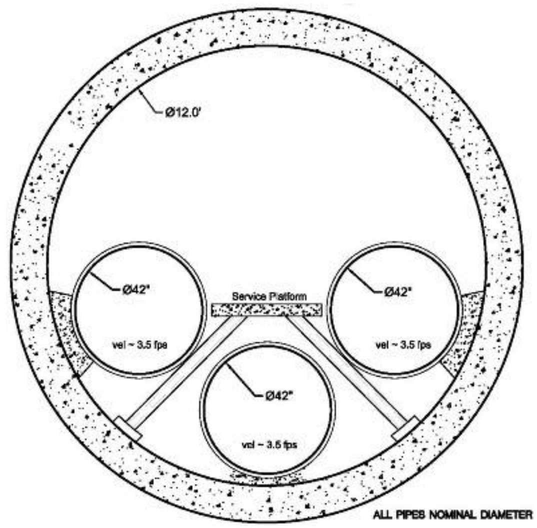


Figure 4-40: Combined Intake/Discharge Tunnel, 60 MGD Scenario



4.4.4. Two HDD Pipelines

If the existing tunnels at El Segundo or Redondo Beach are not found adequate for this project, two pipes may be drilled via Horizontal Directional Drilling (HDD), one for intake, one for discharge. A secondary alternative is to connect the discharge to the Hyperion Outfall. HDD would be done from the mainland under the seabed to be connected to an intake or discharge structure. **Table 4-4** provides the required pipe diameters for both plant scenarios. The 60 MGD scenario requires an intake diameter that pushes the limits of constructability.

4.4.5. Intake and Discharge Appurtenances

4.4.5.1. Offshore Pipeline

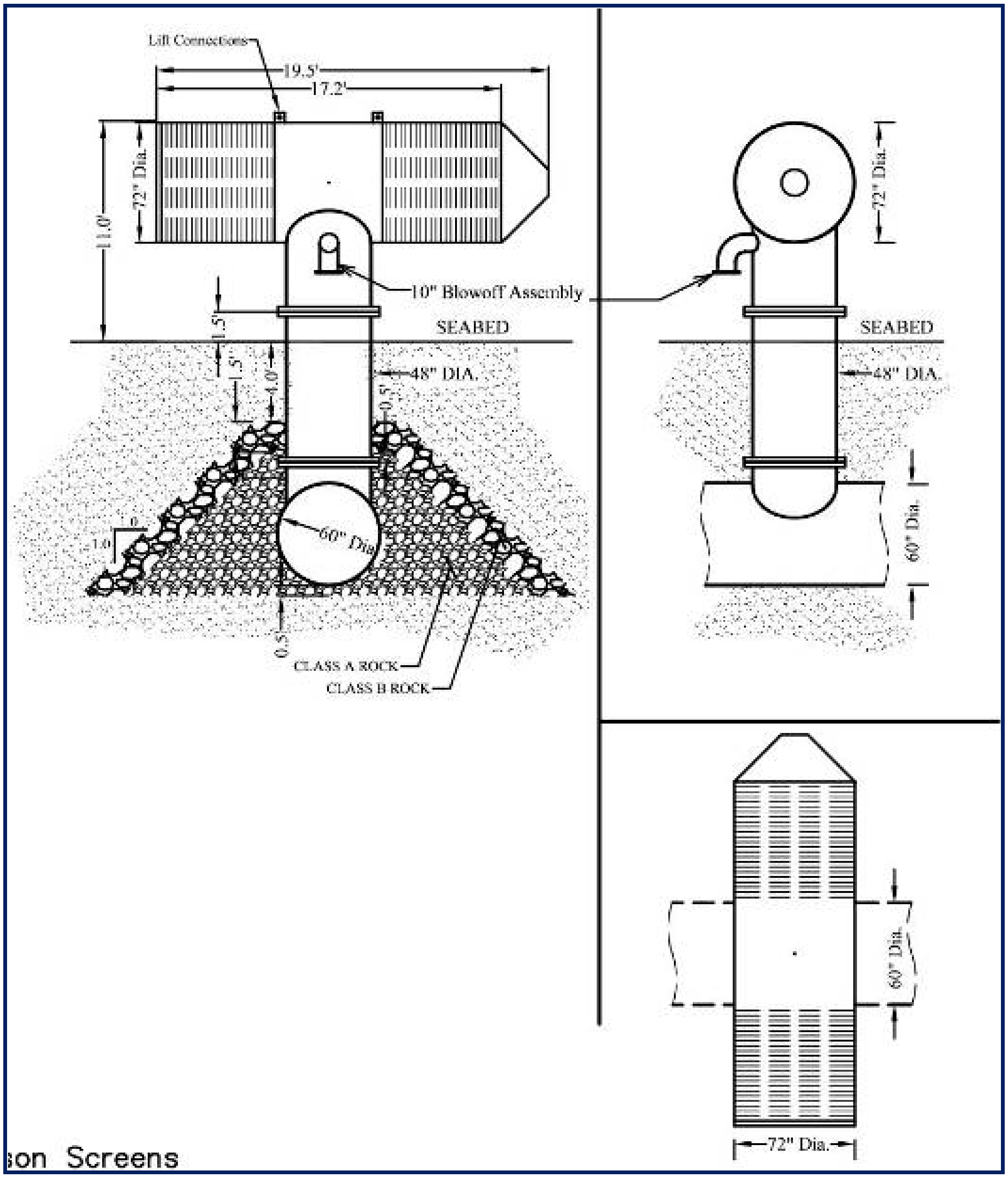
The pipeline design burial depths for the intake pipeline that goes from the end of the tunnel to the intake structure are typically in the range of 4 to 10 feet. For ductile iron pipe, which was assumed as the construction material in this conceptual design, concrete anchors are recommended. The anchor blocks are required to prevent flotation of the pipeline if local liquefaction of sand occurs. The anchors would also be designed to provide sliding resistance against drag forces should wave action temporarily expose the pipeline. This pipe and the associated anchor blocks would require that the pipe be laid in sections and a large trench be opened to allow for anchor placement.

In contrast, steel cylinder pipe would allow the pipeline to be dragged into a partially prepared trench on the bottom. An underwater trenching machine can then be used to bury the pipe, with the crown as deep as 8 to 10 feet, if necessary. The weight requirement for the flotation protection can be overcome by thickening the cement mortar coating on the pipe. This approach would not anchor the pipeline against sliding due to drag forces should wave action temporarily expose the pipeline. A schematic of the 60 MGD buried pipe cross section is shown in **Figure 4-42**. The 20 MGD cross section is a reduced scale version of this cross section.

4.4.5.2. Intake Screens

The objective of the intake screens is to minimize entrainment and impingement on fish and other aquatic organisms. The screen design must provide for uniform flow distribution over the surface of the screen, thereby minimizing the approach velocity (the water velocity vector component perpendicular to the screen face). The approach velocity should be measured approximately three inches in front of the screen surface and should not exceed 0.30 feet per second (fps). This design parameter is more conservative than the maximum approach velocity CWA 316(b) requirement of 0.5 fps. The screen material should provide a minimum of 30% open area and screen openings should not exceed 3/32 inches (2.4 mm). A passive wedge wire screen has conceptually been assumed for the intake. When properly designed, this type of intake screen was shown to minimize entrainment and eliminate impingement of aquatic life. A typical desalination plant wedge wire screen is shown on **Figure 4-41**. Other intake screens that could be used include a velocity cap or a similar intake arrangement that meet the design criteria.

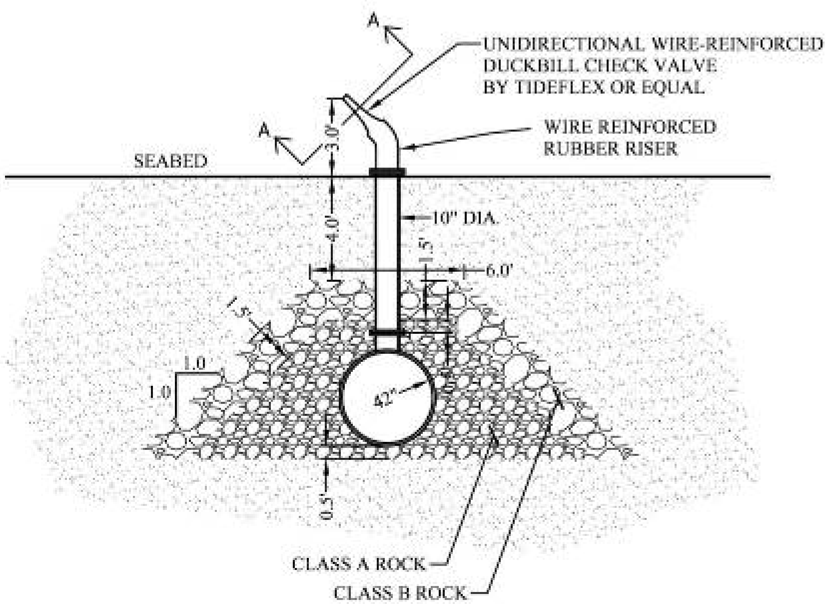
Figure 4-41: Intake Screen, 60 MGD Scenario

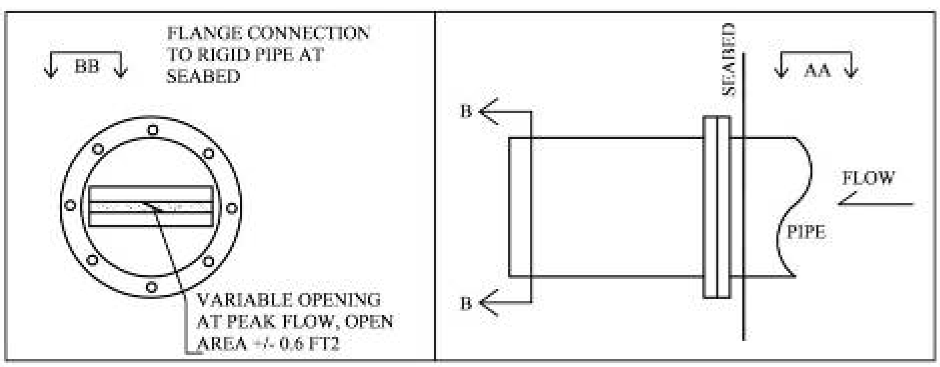


4.4.5.3. Discharge Diffuser

Diffusion involves conveying the concentrated brine through a pipe where it is discharged to the ocean through multiple outlets. Since the brine plume is denser than seawater and tends to concentrate on the bottom, it is necessary to enhance mixing. This can be accomplished using multi-port diffusers. The number of diffusers and spacing will be determined based on the dispersion modeling that is to be completed as part of Phase 2B of this project. A schematic of the diffuser port cross-section for the 60 MGD scenario is shown in **Figure 4-42**. The 20 MGD cross-section is a reduced scale version of this cross section. A plan view of the discharge piping with effluent diffusion ports is included in **Figure 4-25.**

Figure 4-42: Effluent Diffuser, 60 MGD Scenario





Note: The specific burial depth for this conceptual stage is assumed to range from 4 to 10 feet. The final design burial depths will be determined based on site-specific characteristics and anticipated wave forces

4.5. Evaluation of Project Sites for Open Surface Systems

4.5.1. Hydraulic Analysis of Open Surface Intake and Discharge Alternatives

A hydraulic model of the intake and discharge system was developed for El Segundo and Redondo Beach. The objective was to evaluate all alternatives in terms of conduit and pump station requirements. The 20 MGD and 60 MGD cases were evaluated for all alternatives. Conduit sizing is based on a 50% recovery rate for the RO system.

The following general conditions were applied in the hydraulic model:

- For the existing concrete tunnels a roughness coefficient (C-factor) of 110 was applied.
- Ductile iron is used for new conduits and a C-factor of 130 is applied.
- At El Segundo, the elevation at intake point was assumed to be -35 ft MLLW and the elevation at the discharge point was assumed to be -29 ft MLLW.
- At Redondo Beach, the elevation at intake and discharge points was assumed to be -37 ft MLLW.
- The intake pipe velocity to remain between 2 and 6 feet per second.
- The intake and discharge points were modeled as reservoirs that incorporate variations in head due to the tide.
- Variable speed pumps are used to maintain required flow at all times.

The hydraulic model was used to evaluate conduit velocities and pump capacity for Alternative 1 using the existing tunnels under the 20 MGD and 60 MGD scenarios. For Alternative 2, the model was then used to size two parallel pipes to be installed inside the intake tunnels that meets the velocity requirements.

4.5.1.1. El Segundo Flow Rates and Velocities

Intake and discharge flow rates and velocities for the two alternatives at El Segundo are presented in **Table 4-5**. The results for Alternative 1 show that minimum required velocity will not be met by using the existing 12-foot diameter intake tunnel for either the 20 MGD or 60 MGD scenarios. Sedimentation is likely to occur under these conditions. Alternative 2’s two smaller pipes within the existing pipe increase velocity inside the conduits.

Table 4-5: El Segundo Preliminary Conduit Flow Rates and Velocities

Alternative	Plant Production	Intake			Discharge		
		Flow Capacity	Nominal Diameter	Velocity	Flow Capacity	Nominal Diameter	Velocity
	MGD	MGD	inches	fps	MGD	inches	fps
No. 1 - Existing Intake and Discharge Tunnels	20	44	144	0.55	44	144	0.27
	60	132	144	1.64	132	144	0.82
No. 2 - New Pipe(s) within Existing Tunnels	20	40	2 x 42	3.5	20	42	3.5
	60	120	2 x 63	5.3	60	63	5.3

The recommended intake and discharge for El Segundo:

- 20 MGD – Alternative 2: Two (2) 42-inch diameter intake pipes placed inside the existing 12-foot diameter intake tunnel and one (1) 42-inch diameter discharge pipe placed inside the existing 12-foot diameter discharge tunnel.
- 60 MGD – Alternative 2: Two (2) 63-inch diameter intake pipes placed inside the existing 12-feet diameter intake tunnel and one (1) 63-inch diameter discharge pipe placed inside the existing 12-foot diameter discharge tunnel.

4.5.1.2. Redondo Beach Flow Rates and Velocities

Table 4-6 below shows conduit flow rates and velocities for the specified plant capacities (20 MGD and 60 MGD) at Redondo Beach. The results for Alternative 1 show that the minimum required velocity will not be met by using the existing 10-foot diameter intake tunnel if the plant capacity is 20 MGD. Sedimentation is likely to occur under these conditions. Two smaller parallel pipes appear to be a better option to increase velocity inside the conduits. For the 60 MGD scenario, using the existing tunnels is still viable while using two parallel smaller pipes would increase head losses to undesirable levels.

Table 4-6: Redondo Beach Preliminary Conduit Flow Rates and Velocities

Alternative	Plant Production	Intake			Discharge		
		Flow Capacity	Nominal Diameter	Velocity	Flow Capacity	Nominal Diameter	Velocity
	MGD	MGD	inches	fps	MGD	inches	fps
No. 1 - Existing Intake and Discharge Tunnels	20	40	120	0.79	20	120	0.39
	60	120	120	2.36	60	120	1.18
No. 2 - New Pipe(s) within Existing Tunnels	20	40	2 x 42	3.5	20	42	3.5
	60	120	2 x 54	6.5	60	63	5.3

The following alternatives are then recommended for intake and discharge at Redondo Beach:

- 20 MGD – Alternative 2: Two (2) 42-inch diameter intake pipes placed inside the existing 10-foot diameter northern tunnel and one (1) 42-inch diameter discharge pipe placed inside the existing 10-foot diameter southern tunnel.
- 60 MGD – Alternative 2: Two (2) 54-inch diameter intake pipes placed inside the existing 10-feet diameter northern tunnel and one (1) 63-inch diameter discharge pipe placed inside the existing 10-foot diameter southern tunnel.

4.5.2. Screening of Open Surface Intake and Discharge Alternatives

Table 4-7 summarizes the various open surface intake and discharge alternatives, and shows the measures of merit assigned to each to quantify their relative feasibility according to the following criteria

- Potential Environmental Impact
- Hazardous Waste Concerns
- Contamination Concerns
- Wave and Tsunami Concerns
- Seismic Concerns
- Public Acceptance
- Reuse of Existing Infrastructure
- Requirements for Additional Studies
- Operations & Maintenance Requirements

- Constructability
- Relative Cost

The alternative with the lowest total score is considered the most feasible alternative. When compared to the subsurface intake alternatives listed in **Table 4-2**, the open surface alternatives appear more advantageous.

Table 4-7: Screening of Open Surface Alternatives

	Environmental Impact	Hazardous Waste	Contamination	Wave & Tsunami	Seismic	Public	Infrastructure Reuse	Integrity of Existing	Additional Studies	O&M	Constructability	Relative Cost	Overall	Rank
Screened Surface (ESGS)														
Existing Tunnels	2.5	2.5	2.5	4	7	4	1	1	5.5	7	1	1	**39**	**1**
Hyperion Outfall	8.5	7	4	7	7	5.5	4	2.5	5.5	5.5	8.5	7	**72**	**5**
Existing Tunnels as Casings	2.5	2.5	2.5	7	7	2.5	7	2.5	7	2.5	7	4	**54**	**2**
Combined I/D Tunnel	4	7	2.5	4	4	2.5	10	10	7	2.5	4	10	**67.5**	**3**
Two HDD Pipelines	4	5.5	1	4	7	2.5	10	10	8.5	2.5	7	8.5	**70.5**	**4**
Screened Surface (RBGS)														
Existing Tunnels	4	2.5	2.5	4	7	4	1	4	7	5.5	1	1	**43.5**	**1**
Hyperion Outfall	5.5	7	4	7	7	5.5	4	2.5	5.5	2.5	8.5	5.5	**64.5**	**2**
Existing Tunnels as Casings	4	4	2.5	7	7	2.5	7	7	8.5	2.5	8.5	4	**64.5**	**2**
Combined I/D Tunnel	4	7	2.5	4	4	2.5	10	10	7	2.5	4	10	**67.5**	**3**
Two HDD Pipelines	4	5.5	1	4	7	2.5	10	10	8.5	2.5	7	8.5	**70.5**	**4**

Severe	10.0
Very High	8.5
High	7.0
Fair	5.5
Acceptable	4.0
Good	2.5
Best	1.0
N/A	0.0

In general, subsurface intake options are considered less feasible than most surface intake options. The main drawbacks of these alternatives include:

- Severe impact on the beach and near shore seabed for installation of wells
- Thousands of feet of subsurface collection wells covering several acres of land.
- Concerns about scouring potential, particularly in the vicinity of the El Segundo site.

When compared to most open surface options, it is apparent that the economical breakpoint of all subsurface intake alternatives is exceeded for seawater desalination plants with design capacities greater than 5 MGD.

Some of the discharge alternatives considered in **Table 4-7** could be used in combination with either subsurface or open surface intake options. However, since subsurface intake was found to be relatively challenging, discharge alternatives are evaluated only in combination with the open surface option.

4.5.2.1. Infrastructure Assessment

Subsurface intake options are not well suited for the plant capacity (20 to 60 MGD) due to:

- large land-area requirements
- concerns regarding groundwater contamination
- severe beach disturbance during construction

The preliminary evaluation shows that using the existing intakes and discharge infrastructure at both sites is acceptable and most cost effective solution for intake and discharge. Open surface intake and discharge alternatives screening is provided in **Table 4-7**. The existing structures will require certain modifications and improvements and additional investigations (including structural integrity of pipe and detailed surveys). Tunneling and HDD are considered less favorable than using the existing infrastructure due to their high costs and additional environmental short-term impacts during construction.

Open surface intake options using existing intake and discharge pipes can be retrofitted and upgraded with modified intake screens and a discharge diffuser. The extension and orientation of the intake screen and discharge diffuser must be determined based on hydrodynamic modeling results that show acceptable concentrate dispersion/diffusion.

4.5.2.1.1 Advantages of Existing Infrastructure

- Use of existing infrastructure
- Lower cost
- Lower environmental mitigation costs compared to infiltration galleries
- Shallow water location (approximately 30-foot water depth) of discharge beneficial due to enhance brine dispersion due to wave action.
- Possible good public acceptance

4.5.2.1.2 Disadvantages of Existing Infrastructure

- Need to modify the intake structure with extended intake and wedge wire screens.
- Need to modify discharge with extended diffuser about 1,000 ft from the discharge.
- Shallow water location (approximately 30-foot water depth) of intake disadvantageous due to relatively higher hydrodynamic wave loading and higher concentrations of suspended sediments.
- Short term environmental impact for installation of intake structure and discharge diffusers -- disturbance of seabed.

- Low velocity and possible sedimentation for the 10-foot intake tunnel at Redondo Beach at 20 MGD, but acceptable for 60 MGD.
- Need to mitigate possible sedimentation issues for the 20 MGD option.

From the hydraulic perspective, using the existing intake for a 60 MGD plant is more favorable than for a 20 MGD plant. The higher capacity ensures that intake pipe velocities are higher than 2 fps. In the lower water demand scenario, the intake velocities are significantly low and have the potential of sedimentation in the intake pipe.

4.5.2.2. Location Assessment

In general, the conditions for using the existing intake and discharge infrastructure at El Segundo seems to be less favorable than at Redondo Beach, due to the following reasons:

1. Less distance to the end of the tunnels at Redondo Beach compared to El Segundo.
2. The structural condition of the Redondo Beach tunnels has been assessed and determined to be adequate for the intended duty. No assessments have been made of the existing condition of the intake/discharge tunnels at El Segundo.
3. Less concern about wave loads and scouring at Redondo Beach.

Seismic concerns are considered about evenly weighted for either site.

4.6. Preliminary Diffuser Design

A preliminary evaluation of diffuser designs was performed using EPA's Visual Plumes model and Roberts (1997) simplified initial dilution model. The basis for design for this evaluation was the following:

- Predominant current north to south at 0.4 m/s or 1.3 fps
- The plant's recovery rate is 50%
- The background or ambient salinity is 33.5 ppt
- The brine salinity is 67.0 ppt
- The required dilution to get within 1 ppt of ambient salinity is 34:1. The target salinity is 34.5 ppt
- The required dilution to get within 10% of ambient salinity or 36.85 ppt is about 10:1
- The brine temperature is 20 deg. C
- The ambient temperature at surface is 18 deg. C and 16 deg C at 25 ft depth
- Port velocity between 12.5 to 18 fps (from previous experience)

Two diffuser designs were analyzed. First, a double diffuser design was evaluated, followed by a trial and error optimization that led to a single diffuser design.

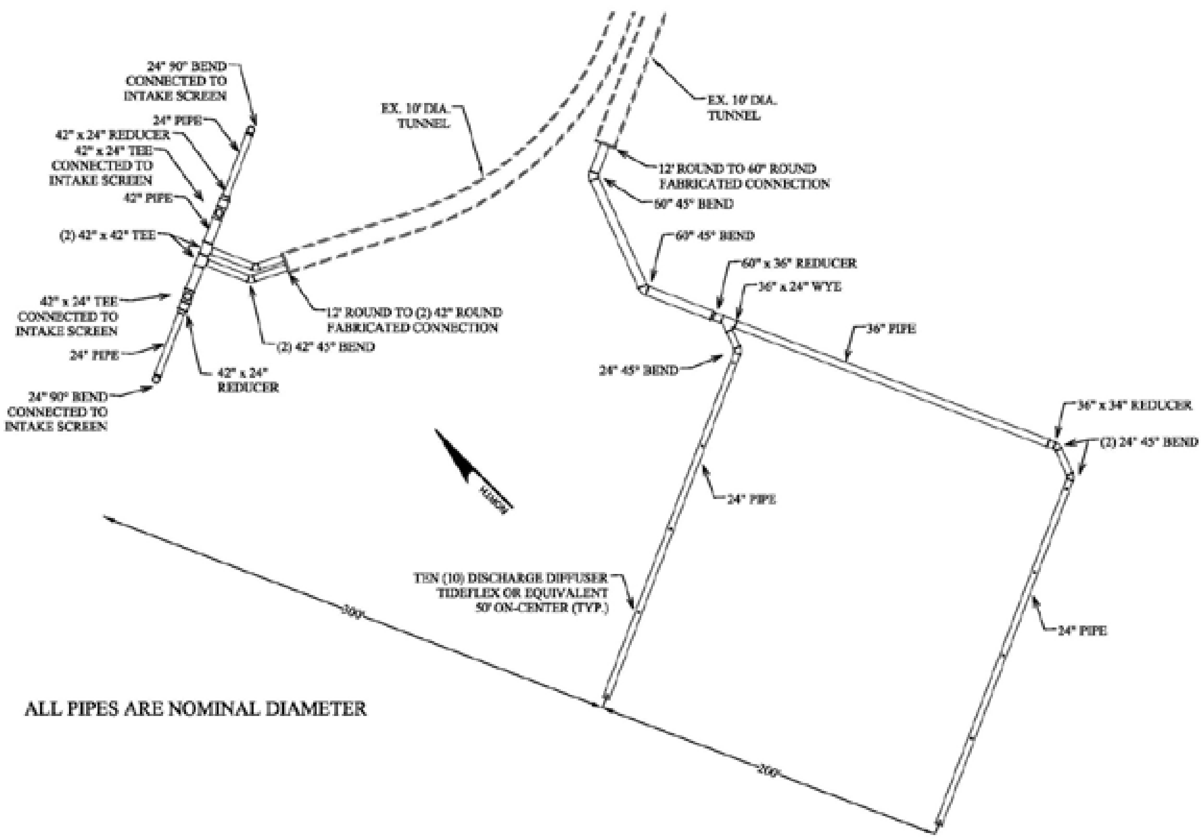
4.6.1. Double Diffuser Design

The preliminary double diffuser design consisted of:

- two diffusers
- five ports on each diffuser (6 -inch diameter for 20 MGD and 10-inch diameter for 60 MGD cases) spaced at 50 feet
- the diffusers were parallel to each other and separated laterally 200 feet, with the northern diffuser separated from the intake 300 feet

Figure 4-43 shows a layout of the double diffuser design for the Redondo Beach 20 MGD desalination plant. The discharge layouts for Redondo Beach and El Segundo are the same and because this preliminary evaluation did not account for local effects such as bathymetry, tidal, wind, and wave induced currents results are applicable to both locations. The detailed 3-dimensional hydrodynamic modeling performed accounted for these conditions at each site.

Figure 4-43: Double Diffuser Layout, Redondo Beach 20 MGD



- Initial dilution of 34:1 to match the 34.5 ppt or 1 ppt of ambient salinity
- Ambient salinity at 200 feet downstream from the diffuser.

The 1 ppt difference is obtained about 12.5 feet downstream from the diffuser. The intake location is 300 feet from the nearest diffuser. When tidal currents reverse the salinity at the intake will be at ambient levels or 33.5 ppt. The 10% ambient salinity level is obtained at about 2.2 ft from the discharge ports.

Table 4-8 and **Table 4-9** summarize the dilution and salinity of the discharge for the 20 MGD and 60 MGD designs, respectively. **Figure 4-44** and **Figure 4-45** show the dilution and salinity of the discharge versus distance from the discharge ports for the 20 MGD and 60 MGD designs, respectively.

Table 4-8: Double Diffuser Dilution and Salinity, 20 MGD

Case 1 - Halcrow Design Two Diffusers with (5) - 6" Ports Each @ 50'				
Distance from Port		Dilution of Concentrate	Concentrate Salinity	Background Salinity
meter	feet		psu	psu
0.0	0.0	1.0	67.0	33.5
0.2	0.7	5.3	39.9	33.5
0.3	1.0	6.6	38.6	33.5
0.7	2.3	11.8	36.4	33.5
3.8	12.3	32.6	34.6	33.5
5.8	19.1	41.4	34.3	33.5
6.0	19.6	42.2	34.3	33.5
10.7	35.0	73.4	34.0	33.5

Figure 4-44: Double Diffuser Dilution and Salinity Versus Distance from Port, 20 MGD
Source: Halcrow

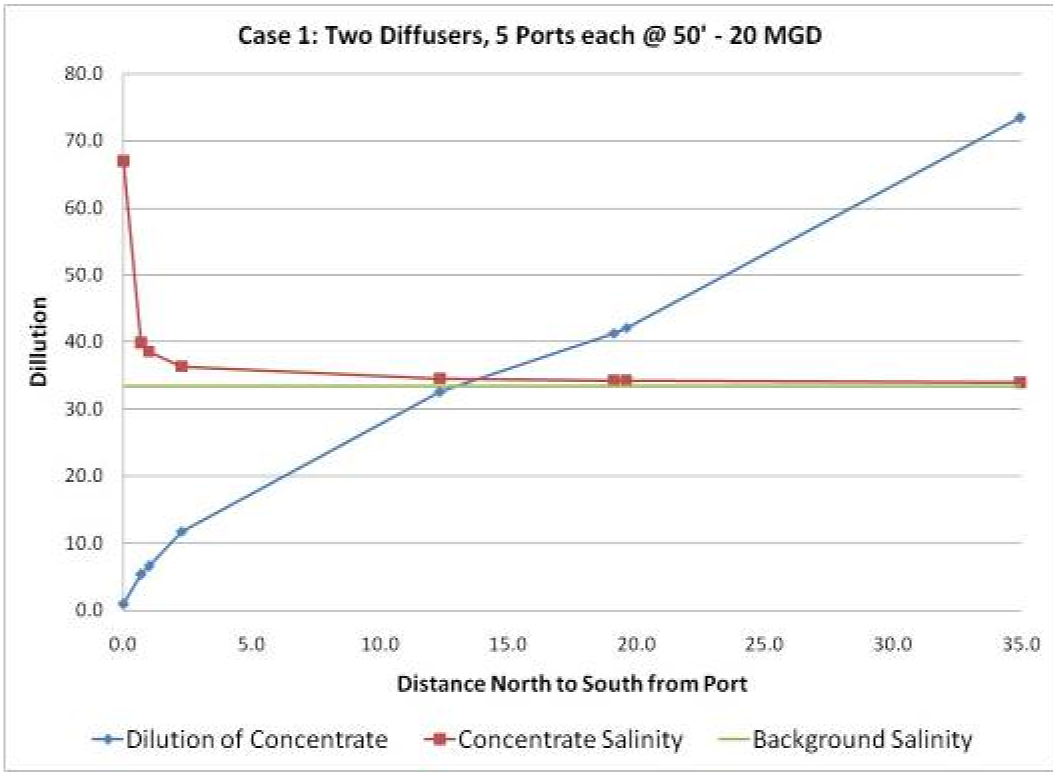
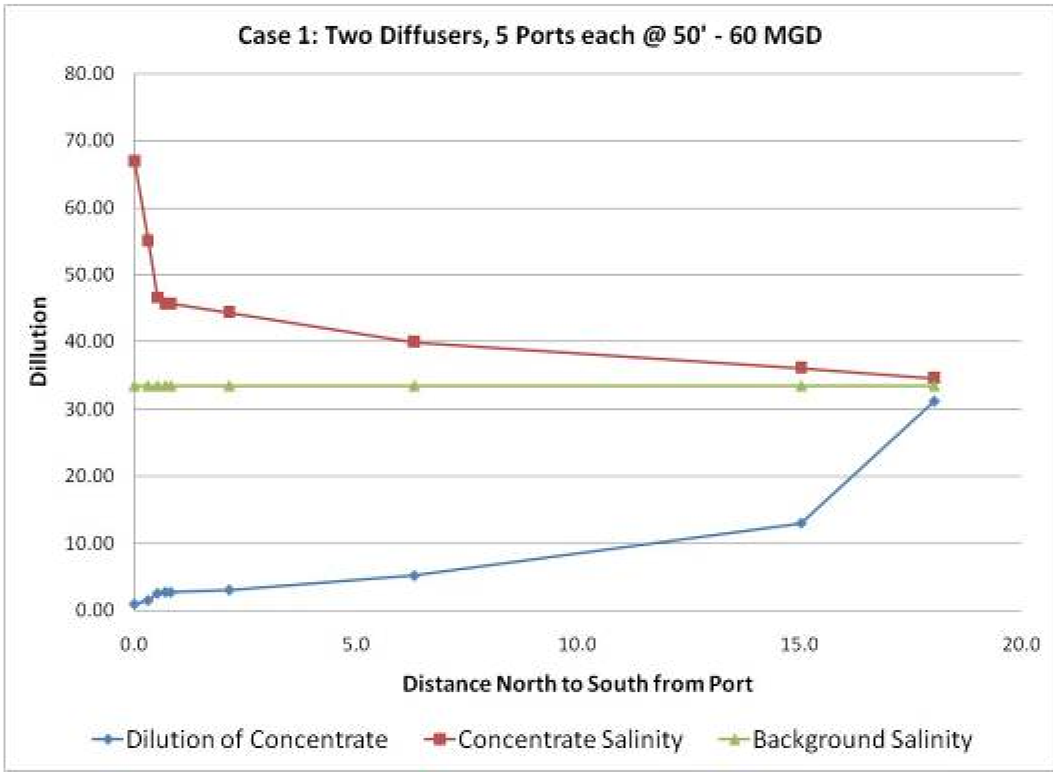


Table 4-9: Double Diffuser Dilution and Salinity, 60 MGD

Case 1 - Halcrow Design Two Diffusers with (5) - 10" Ports Each @ 50'				
Distance from Port		Dilution of Concentrate	Concentrate Salinity	Background Salinity
meter	feet		psu	psu
0.00	0.0	1.00	67.0	33.5
0.09	0.3	1.57	55.1	33.5
0.16	0.5	2.60	46.6	33.5
0.21	0.7	2.79	45.7	33.5
0.25	0.8	2.79	45.7	33.5
0.65	2.1	3.12	44.4	33.5
1.92	6.3	5.23	40.0	33.5
4.59	15.0	13.05	36.1	33.5
5.50	18.0	31.21	34.6	33.5

Figure 4-45: Double Dilution and Salinity Versus Distanve from Port, 60 MGD
Source: Halcrow



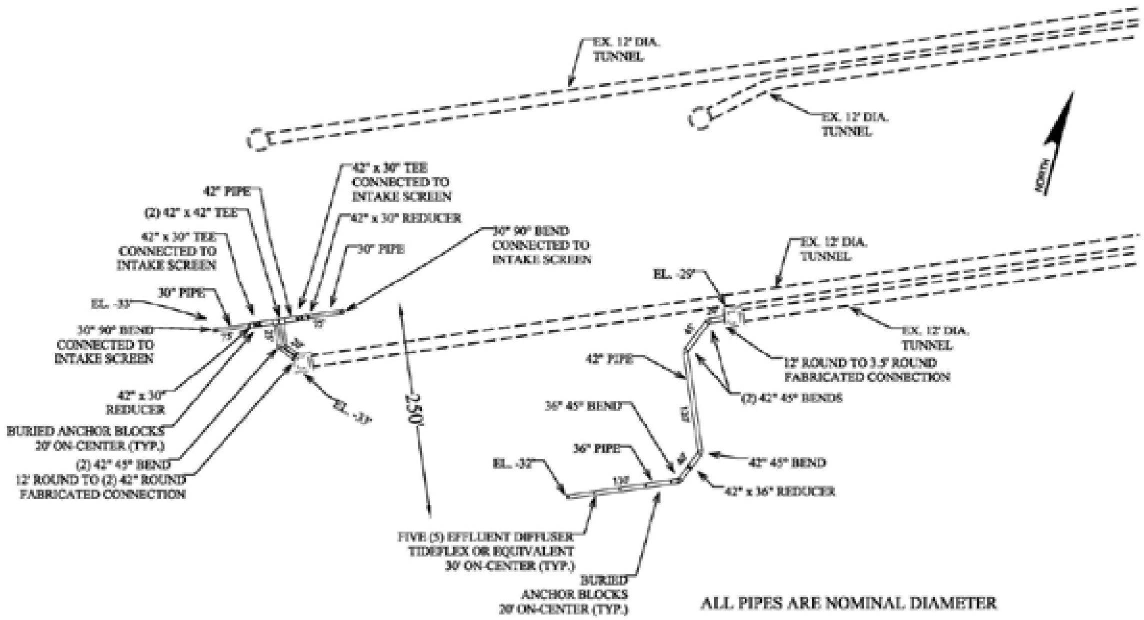
4.6.2. Single Diffuser Design

Upon review of the double diffuser design results, a simpler discharge and diffusion system was developed consisting of:

- one diffuser
- five ports each (8-inch diameter for 20 MGD and 16-inch diameter for 60 MGD cases) spaced at 30 feet
- the diffuser is separated laterally 250 feet from the intake.

Figure 4-46 shows a layout of the single diffuser design for the El Segundo 20 MGD desalination plant. Similar to the double diffuser design, the single diffuser design layouts for Redondo Beach and El Segundo are the same and because this preliminary evaluation did not account for local effects such as bathymetry, tidal, wind, and wave induced currents results are applicable to both locations. The detailed 3-dimensional hydrodynamic modeling performed accounted for these conditions at each site.

Figure 4-46: Single Diffuser Design Layout, El Segundo 20 MGD



The single diffuser design met all the design criteria, including:

- Initial dilution of 34:1 to match the 34.5 ppt or 1 ppt of ambient salinity
- Ambient salinity at 200 ft. downstream from the diffuser.

The 1 ppt difference is obtained about 17 feet downstream from the diffuser. The intake location can be placed at 250 feet north from the diffuser. Therefore when tidal currents reverse the salinity at the intake will be at ambient levels or 33.5 ppt. The lateral dispersion is about 25 feet in 200 feet. The 10% ambient salinity level is obtained at about 7.0 feet from the discharge ports.

Table 4-10 and **Table 4-11** summarize the dilution and salinity of the discharge for the 20 MGD and 60 MGD designs scenarios. **Figure 4-47** and **Figure 4-48** show the dilution and salinity of the discharge versus distance from the discharge ports for the 20 MGD and 60 MGD designs, respectively.

Table 4-10: Single Diffuser Dilution and Salinity, 20 MGD

Case 2 - Halcrow Design One Diffuser with (5) - 8" Ports Each @ 30'				
Distance from Port		Dilution of Concentrate	Concentrate Salinity	Background Salinity
meter	feet		psu	psu
0.0	0.0	1.0	67.0	33.5
0.1	0.3	1.9	50.9	33.5
0.2	0.5	3.2	44.1	33.5
0.4	1.2	5.5	39.7	33.5
0.4	1.3	5.7	39.5	33.5
0.5	1.7	6.0	39.2	33.5
3.4	11.3	26.2	34.8	33.5
4.6	15.2	37.5	34.4	33.5
5.4	17.6	44.8	34.3	33.5
17.0	55.7	190.1	33.7	33.5

Figure 4-47: Single Diffuser Dilution and Salinity Versus Distance from Port, 20 MGD
Source: Halcrow

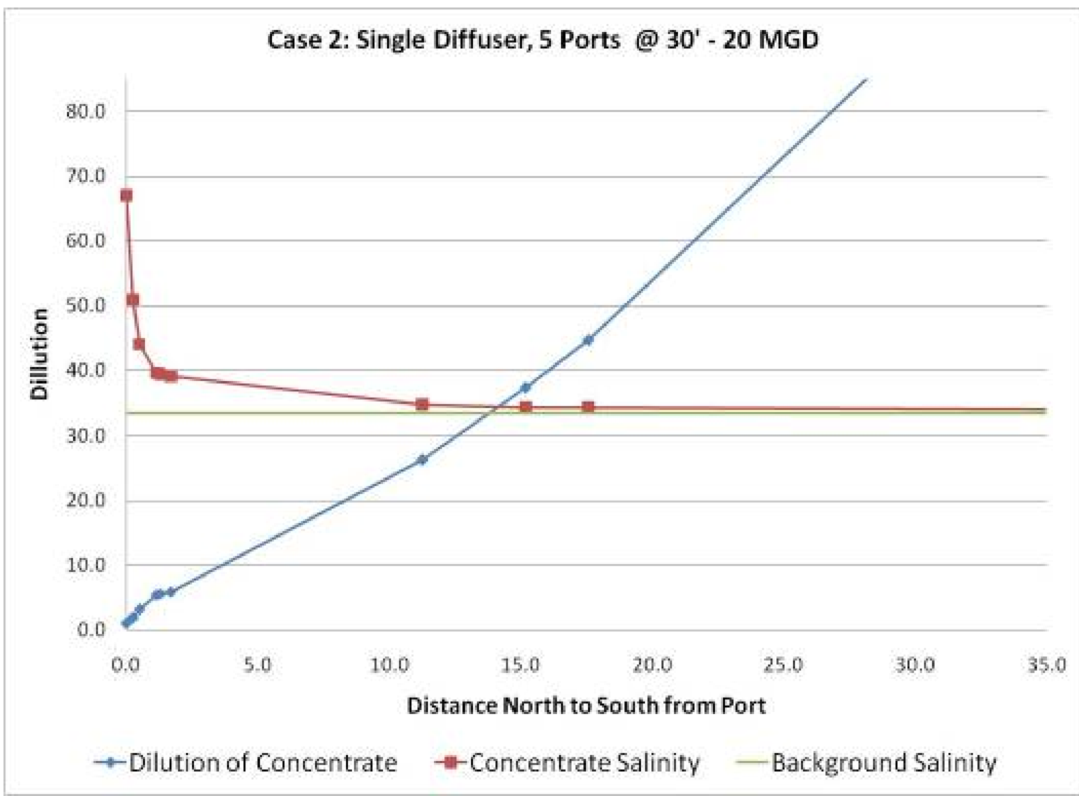
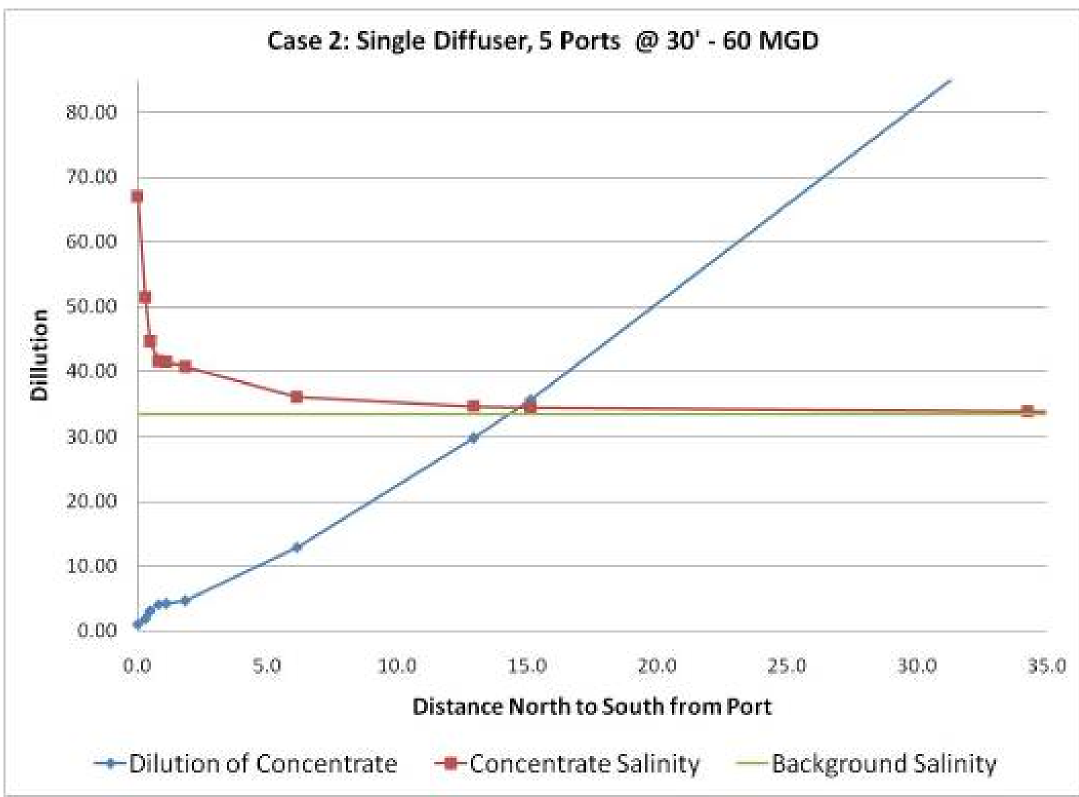


Table 4-11: Single Diffuser and Salinity, 60 MGD

Case 2 - Halcrow Design One Diffuser with (5) -16" Ports Each @ 30'				
Distance from Port		Dilution of Concentrate	Concentrate Salinity	Background Salinity
meter	feet		psu	psu
0.00	0.0	1.00	67.0	33.5
0.09	0.3	1.88	51.5	33.5
0.15	0.5	3.03	44.7	33.5
0.24	0.8	4.17	41.7	33.5
0.34	1.1	4.25	41.5	33.5
0.56	1.9	4.67	40.8	33.5
1.87	6.1	12.95	36.1	33.5
3.95	13.0	29.79	34.7	33.5
4.62	15.1	35.60	34.5	33.5
10.45	34.3	93.99	33.9	33.5
49.51	162.4	681.10	33.6	33.5
61.22	200.8	898.70	33.5	33.5
67.01	219.8	1012.00	33.5	33.5

Figure 4-48: Single Diffuser Dilution and Salinity Verses Distance from Port, 60 MGD
Source: Halcrow



On the basis of the preliminary evaluation presented above, both diffuser designs meet the water quality requirements for the discharge (i.e. 1 ppt above ambient salinity concentration at the chronic toxicity zone).

4.7. Conceptual Design of Preferred Alternative

4.7.1. General Design Criteria and Considerations

On the basis of the analyses presented in the previous sections the following criteria were developed for the design of the preferred alternative.

Intake Design Criteria

- Use existing tunnels as conduits for intake pipes
- The intake should be located to the north of the discharge structure based on the net drift of the longshore currents
- The intake should be located at least 250 feet from the discharge
- Corrosion resistant pipe material and fittings should be used
- Prevent/control marine growth
- Velocity of seawater through the pipes should be greater than 2 fps
- Intake wedge wire material should resist marine growth and minimize corrosion
- Intake maximum slot velocity should be 0.3 fps
- Slot opening should be 1.0 mm

A shock chlorination system may be considered to deter marine growth on the intake system. This technology has negative environmental consequences and may be of limited effectiveness. The use of appropriate material in design and construction and a proper maintenance schedule to ensure the intake is operating properly is recommended.

Discharge Design Criteria

- Use existing tunnels as conduits for discharge pipe
- Use a pressurized diffuser discharge
- Minimize footprint
- Prevent/control marine growth
- Discharge at 30 feet water depth
- Discharge velocity should exceed 12.5 fps
- Use of unidirectional check valves for diffuser
- Discharge outlet should be at 60^{o} angle with horizontal
- Use corrosion resistant materials

4.7.2. Preferred Intake and Discharge Configuration

The preferred intake and discharge configurations is the installation of smaller diameter pipes inside the existing tunnels with five (5) discharge ports. A final conceptual design and cost estimate will be presented as part of this study.

4.7.3. Marine Growth Prevention/Control

Marine growth is the undesirable accumulation of microorganisms, plants, algae and/or animals on structures submerged in the ocean. The proposed intake screens are exposed to marine growth and preventive measures should be in place to maintain the efficiency of these structures. The following measures are recommended:

- **Use of Z-Alloy for the intake screens**. Z-Alloy© includes copper which inhibits marine growth.
- **Cathodic protection.** Screens will be connected to an anodic alloy like steel or steel reinforced concrete and should be protected with galvanic cathodic protection, which prevents the copper dissolution and helps with marine growth control.
- **Chloramines application.** Chloramines can be applied to the intake structure to resist marine growth. For this purpose, a 2-inch or 3-inch pipe would have to be installed to carry the chloramines from the plant to the structures.
- **Inspection and cleaning**. Pilot research done at Redondo Beach showed that nothing more than regular cleaning should be required. It is expected that diving inspection and mechanical cleaning would be necessary twice a year. Once additional data is obtained; the cleaning frequency can be increased or decreased accordingly. Use of remote steam application should also be considered for cleaning.
- **Continuous monitoring.** It is recommended that monitoring cameras be installed at the intake and discharge structures. Using these cameras, operators should be able to see the condition of the structures and determine when maintenance or repair is required.

4.7.4. Intake Sediment Control

The raw water should be conditioned so that it does not damage the components of the desalination equipment. The pretreatment prior to the desalination process should include an intake sediment control system. The removal of sediments can be done either by using a gravity based settling system or by using a hydrodynamic vortex separator.

4.8. Biology and Modeling

Additional information on impacts to biology as well as models are currently in development. More information on these topics will be provided in the final report.

4.9. Conclusions and Recommendations

- Subsurface intake options are not well suited for the plant capacity (20 to 60 MGD) due to:
  (1) large area requirements,
  (2) groundwater contamination concerns, and
  (3) severe beach disturbance during construction.
- Open surface intake options using existing intake and discharge tunnels can be used, provided these are retrofitted and upgraded to accept intake screens and a discharge diffuser.
- The initial evaluation shows that using the existing intakes and discharge infrastructure at both sites is acceptable and is the most cost effective.
- Tunneling and HDD are considered less favorable than using the existing infrastructure due to high cost.
- The extension and orientation of the intake screens and discharge diffuser must be determined based on detailed hydrodynamic modeling.
- Using the existing infrastructure at Redondo Beach is slightly preferred over El Segundo, because:
  - There is less distance to the end of the tunnels
  - The structural condition of the Redondo Beach tunnels has been assessed and determined to be adequate for the intended duty.
  - There is less concern about wave loading and scouring.
- Additional investigations are needed to determine the adequacy of the existing tunnels, in particular:
  - Investigation of the structural integrity of the existing tunnels at El Segundo to determine if they can be used as casing for pipes to be placed within the tunnels.
  - Investigation on whether the Redondo Beach discharge tunnel can be used under pressure conditions.
- Assess sediment transport to evaluate the potential effect of waves in eroding the seafloor and to determine the potential amounts of sediment in suspension.

4.10. References

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ICF Jones & Stokes; Camp, Dresser, and McKee, Inc. (2008). Monterey Peninsula Water Management District: 95-10 Project Constraints Analysis.

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5. Product Water Delivery

This section discusses the development of product water quality specifications and distribution system alternatives for delivering the finished water.

5.1. Product Water Quality

The general water quality of desalinated water may be characterized as of high quality compared to typical surface water sources. Because the water that will be produced will ultimately be added to an existing distribution system, compatibility issues with the exiting supply must be considered. In particular, potential corrosion impacts of the desalinated water should be understood and mitigated.

5.1.1. Methodology for Developing Product Water Quality

Product water quality specifications were developed for this Program Master Plan based on literature-reported findings of conditions that minimize distribution system corrosion impacts for a variety of typical pipe and appurtenance materials. A brief overview of key literature on post-treatment stabilization is provided below.

5.1.1.1. Review of MWD Product Water Quality Targets

The premise behind selection of water quality targets for the stabilized desalinated water testing is consistency with MWD water. Memorandum 4[1] produced by MWD (see **Appendix 1:B**) was reviewed to assess the product water quality targets that are currently being considered by MWD and include the following parameters: alkalinity, pH, fluoride, and disinfectant residual. Exceptions for bromide, chloride, and boron were noted as necessary, since achieving MWD levels for these parameters may may not be merited and result in additional capital investment desalinated water without much higher expenditures. Preliminary goals of less than or equal to 0.3 mg/L for bromide, 100 mg/L for chloride, and 0.5 mg/L for boron were noted. Additional parameters of potential concern in Memorandum 4 included temperature (as it impacts pipeline integrity), high chloride-to-sulfate mass ratios, and DBP formation potential.

5.1.1.2. Overview of Key Literature and Full Scale Experience

Literature reports of tests comparing corrosion of distribution materials for post-treatment stabilized desalinated water with existing source water are fairly scarce. The information provided below highlights the seminal studies, including one at the City of Carlsbad and one at West Basin each comparing stabilized desalinated water with MWD water.

[1] Memorandum 4, Draft – Water Quality and Operational Considerations for Pumping Desalinated Water from the West Basin Municipal Water District into Metropolitan's Distribution System. 21 June 2011.

At the City of Carlsbad, California, a demonstration study comparing corrosion-related outcomes of post-treatment stabilized desalinated water quality with MWD water was performed for several types of distribution system materials[2]. Tested materials included cement mortar-lined pipe, copper pipe with lead solder, brass home water meters, and iron distribution system gate valves. Post-treatment stabilization of RO permeate was accomplished in this study using calcite (i.e., limestone) contactors to introduce calcium (40 mg/L as $CaCO_3$) and alkalinity (40 mg/L as $CaCO_3$) into the permeate and sodium hydroxide for pH adjustment (to pH 8.5). After an initial period in which the water did not meet target water quality objectives (i.e., positive Langelier Saturation Index, LSI, and Calcium Carbonate Precipitation Potential, CCPP) due to the need for modifications to the calcite filter, no negative water quality corrosion outcomes were observed despite "worst-case" scenarios tested in the study by recirculating water in pipe loops or newly applied lead solder to new copper pipes.

A smaller scale pilot test of RO permeate and Metropolitan water was also conducted at West Basin using several other pipe materials, including galvanized iron, brass faucets containing lead, and soft copper pipe[3]. RO permeate in this study was stabilized with a calcite filter, similar to the previously described study[1]. No negative impacts of introducing stabilized desalinated water into the pipes and appurtenances were observed.

Several literature reports of factors that can increase corrosivity of RO permeate include discussions of chloride-to-sulfate mass ratios (CSMR) [4,5,6]. These studies concluded that increases in lead leaching can occur with increases in the CSMR (e.g., an increase from 0.1 to 1.0) due to galvanic corrosion with lead pipe or lead solder to copper connections. However, these studies often do not focus on the overall stability of the water as reflected by LSI and CCPP; for example, one report[3] provided insufficient stabilization of the desalinated water, making it difficult to discern impacts of low LSI compared with CSMR. Demonstration-scale testing at Carlsbad, California of stabilized RO permeate with lead solder to copper pipe connections did not observe excess lead leaching, despite a CSMR in excess of 1 (i.e., often approximately 30 to 100). Metropolitan's Jensen water averages a CSMR of approximately 1, yet lead leaching is not a widespread issue in the

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[2] Blute, N.K., McGuire, M.J., Reich, K., West, N., Voutchkov, N., and MacLaggan, P. 2008. Integration of Desalinated Seawater into a Distribution System: A Corrosion Pilot Study. *Journal of the American Water Works Association*, v. 100 (9), p. 117-131.

[3] Loveland, J.P., Means, E.G., Amy, G.L., and Reiss, C.R. 2010. Seawater Desalination Implications for Drinking Water Quality. *American Water Works Association Research Foundation*, Denver CO.

[4] Nguyen, C.K., Stone, K.R., and Edwards, M.A. 2011. Chloride to sulfate mass ratio: Practical studies in galvanic corrosion of lead solder. *Journal of the American Water Works Association*, v.103(1), p.81-92.

[5] Taylor, J., Dietz, J., Randall, A. and Hong, S., 2005. Impact of RO desalted water on distribution water qualities. *Water Science and Technology*, v. 51(6-7), p. 285-291.

[6] Tang, Z., Hong, S., X, W, Seal, S. and Taylor, J., 2006. Effect of varying blends of finished RO, surface and ground waters on solid lead surfaces. *Corrosion Science*, v. 48, p. 3413-3427.

distribution system. Therefore, the necessity of purposefully adjusting the CSMR for corrosion control is not proven at this time.

At present, an established set of recommendations for desalinated product water quality for corrosion control does not exist[7, 8]. However, general criteria for stabilization of corrosive water include alkalinity above 40 mg/L as $CaCO_3$ (some sources recommend above 80 mg/L as $CaCO_3$), calcium above 40 mg/L as $CaCO_3$, and CCPP in the range of 0 – 10 mg/L as $CaCO_3$7'[1]. The World Health Organization recommends pH values in the range of 8.0 – 8.5 for lead and copper corrosion control [9].

Bromide concentrations in desalinated water often exceed native surface waters due to rejection rates by membranes. The presence of bromide can cause the preferential formation of bromamines over chloramines. In waters that contain a low concentration of natural organic matter such as RO permeate, the impact of bromide on chloramine stability can be significant. While bromamines are a stronger disinfectant than chloramines, bromamines are more reactive and less stable. Further, bromide can catalyze the decay of monochloramine. Vikesland et al (2001) modeled the effect of bromide on monochloramine decomposition based on the net reaction that bromide catalyzes monochloramine decay and generates nitrogen, chloride, and ammonia. The modeling results suggest that bromide levels below 0.1 mg/L have little effect on monochloramine decay; however, bromide at higher levels (e.g. 0.5 mg/L) could significantly accelerate the monochloramine decay rate[10].

5.1.2. Product Water Quality

A comparison of recommended target water quality specifications for the West Basin PMP, based on the literature review, and MWD Jensen plant water is provided in **Table 5-1**. A summary of how each water quality specification was selected is included in **Table 5-1** and discussed in more detail below.

In prior demonstration testing[1], key product water quality parameters found to impact corrosion included pH, alkalinity, and calcium. Together, these parameters can be viewed by considering Langelier Saturation Index (LSI) and Calcium Carbonate Precipitation Potential (CCPP) indices. Positive LSI and CCPP values corresponded to minimal corrosion in demonstration testing[1]. A balance of a higher pH with lower

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[7] Lahav, Q. and Birnhack, L., 2007. Quality criteria for desalinated water following post-treatment. *Desalination*, v. 207, p. 286-303.

[8] Lahav, Q., Salomons, E. and Ostfeld, A., 2009. Chemical stability of inline blends of desalinated, surface and ground waters: the need for higher alkalinity values in desalinated waters. *Desalination*, v. 239, p. 334-345.

[9] World Health Organization, Guidelines for Drinking-Water Quality, 3rd ed., Chap. 8. http://www.who.int/water_sanitation_health/dwq/GDW8rev1and2.pdf

[10] Vikesland, P.J., Ozekin, K. and Valentine, R.L., 2001. Monochloramine decay in model and distribution system waters. *Water Research*, v. 35(7), p.1766-1776.

calcium and alkalinity can achieve the same LSI and CCPP endpoint as lower pH with higher calcium and alkalinity. **Table 5-1** shows a range of potential pH, alkalinity, and calcium levels reflecting the potential windows that could be targeted, which will depend on external factors. For example, West Basin currently has a groundwater quality requirement to inject water with a pH less than or equal to 8.5. At the time of this analysis, West Basin would like to target 8.2 to provide sufficient buffer against exceeding the groundwater requirement. Should this groundwater requirement change in the future, West Basin could increase the pH target on stabilized desalinated water and concomitantly decrease the alkalinity and calcium.

Positive LSI and CCPP values can be achieved with a lower pH of 8.2 using an alkalinity of 100 mg/L as $CaCO_3$ and calcium of 40 mg/L as $CaCO_3$. Alternately, calcium levels could be increased and alkalinity decreased (e.g., 70 mg/L alkalinity as $CaCO_3$ and 60 mg/L calcium as $CaCO_3$) to achieve the target LSI and CCPP.

If a pH target of 8.5 is selected, the necessity of increasing the alkalinity and calcium to match the MWD supply beyond a positive LSI and CCPP is in question with respect to both corrosion outcomes and practicality. For example, achievement of MWD water quality ranges may necessitate downstream addition of caustic soda or soda ash to increase alkalinity, when the potential benefit of this addition has not been shown.

As discussed previously, the impact of chloride-to-sulfate ratio on corrosion is not certain, based on conflicting literature and demonstration testing findings. The need to add sulfate to RO permeate to increase a chloride-to-sulfate ratio for purposes of corrosion control is not supported at this time and requires additional study if specific sulfate levels or chloride-to-sulfate ratios are required. Similarly, the need to artificially increase total dissolved solids (TDS) is unclear with respect to corrosion.

Bromide requires a sensitivity analysis of tradeoffs in installing additional second pass capacity to achieve goals that do not necessarily need to be fixed. The purpose behind limiting bromide concentrations in RO permeate is to minimize the impacts of bromide on chloramine stability. However, other options to improve chloramine stability might be more cost-effective than reducing bromide levels and should be investigated prior to design. Several potential options include preformed chloramines, preammoniation, or superchlorination (i.e. adding a chlorine –to-ammonia ratio of greater than 5:1 to account for decay).

Boron levels below 0.5 mg/L have been discussed as protective of common Southern California landscape[11]. This value is included in this product water quality specification

[11] MWH. 2007. Technical Memorandum #2 – Process Requirements. Report to West Basin: Phase A – Preliminary Design Development.

at this time but should be reviewed in the future with respect to whether a slightly higher value (e.g., 0.7 mg/L) could be protective of the plants within the West Basin service area. Boron will likely be the parameter that dictates how much second pass will be needed, and the target values for chloride and bromide are expected to be achieved if a boron level of 0.5 mg/L is targeted.

Table 5-1: Product Water Quality Specifications

Parameter	West Basin Target Range	Metropolitan Jensen Range (and Average)	Comments
pH	8.2 to 8.5	> 8.0 (average 8.2)	Higher pH allows lower alkalinity and calcium targets.
Alkalinity (mg/L as $CaCO_3$)	45 to 100	80 to 99 (average 87)	Sufficient alkalinity (together with Ca and pH) will be targeted to provide positive LSI and CCPP. A lower pH must be balanced by a higher alkalinity.
Calcium (mg/L as $CaCO_3$)	40 to 100	55 to 93 (average 68)	Sufficient calcium (together with alkalinity and pH) will be targeted to provide positive LSI and CCPP.
Langelier Saturation Index (LSI)	> 0	> 0	Positive LSI has been shown to correlate with a decrease in corrosion outcomes for numerous distribution system materials[1].
Calcium Carbonate Precipitation Potential (CCPP, mg/L)	0 < CCPP < 10	Not reported	Positive CCPP has been shown to correlate with a decrease in corrosion outcomes for numerous distribution system materials[1].
Chloride (mg/L)	≤ 100	40 to 96 (average 68)	Chloride levels greater than the suggested target may impact agricultural crops [2].
Sulfate (mg/L)	No target	39 to 102 (average 59)	Targeting of a specific chloride-to-sulfate ratio is not expected to be necessary based on previous testing[1].
Bromide (mg/L)	0.3*	0.11 to 0.2 (average 0.18)	An initial target of 0.3 mg/L bromide is recommended based on studies of chloramine stability and reported targets for other desalination plants. *Additional study is recommended to assess a chloramine stabilization approach rather than focusing on achieving a specific bromide level.
Boron (mg/L)	0.5	0.15 to 0.37 (average 0.21)	Boron levels greater than the suggested target may impact agricultural crops[2].

5.1.2.1. Treatment Options for Product Water Stabilization

Two primary approaches to product water stabilization are commonly used to impart calcium and alkalinity into the water and adjust pH, including:

- Lime and carbon dioxide
- Calcite (i.e., limestone) filter followed by sodium hydroxide

Based on literature summarized in this TM, the need to match water quality targets shown in **Table 5-1** is not justified from a corrosion perspective. However, West Basin's need to target a pH of 8.2 (to stay below the groundwater injection requirement of 8.5) results in a water quality similar to MWD's in terms of pH and alkalinity. Should West Basin choose to target a higher pH of approximately 8.5 (and a lower calcium and alkalinity) in the future, additional treatment would be needed to increase the alkalinity to match the MWD supply if that is a requirement.

In addition, if MWD's CSMR must be achieved, sulfate addition would be needed.

5.1.2.2. Calculated Chemical Dosages for Product Water Stabilization – Target pH 8.2

Based on a combined desalinated (RO permeate) water pH of 10 currently achieved by the demonstration facilities, approximate chemical doses expected to achieve targets of pH 8.2 and positive LSI and CCPP are provided below.

Lime, carbon dioxide, and caustic soda: Approximately 50 mg/L lime, 84.5 mg/L carbon dioxide, and 19 mg/L caustic soda, resulting in a calcium level of 68 mg/L as $CaCO_3$ and positive LSI and CCPP values.

Calcite beds require a relatively low water pH (i.e. < 6) to dissolve sufficient calcium carbonate into the water. If calcite filters are selected to increase calcium and alkalinity in the combined RO permeate, acid pre-treatment would be needed to lower the pH prior. Considering the combined RO permeate has a pH of 10 and they are not commonly used, calcite filters were not modeled in this effort but might merit more close examination if combined with sulfuric acid for sulfate adjustment.

5.1.2.3. Calculated Chemical Dosages for Product Water Stabilization – Target pH 8.5

By comparison, much lower chemical doses would be necessary for stabilization if a target pH of 8.5, alkalinity of 68 mg/L as $CaCO_3$, and calcium of 59 mg/L as $CaCO_3$, as shown below:

Lime and carbon dioxide: Approximately 44 mg/L lime and 55.5 mg/L carbon dioxide.

5.1.2.4. Addition of Sulfate to Decrease the CSMR– Target pH 8.2

The addition of sulfate to mirror that of MWD water would require sulfuric acid or another chemical to add sulfate. This chemical addition, in turn, impacts the doses of the other chemicals as follows:

Lime, carbon dioxide, caustic soda, sulfuric acid and gypsum (calcium sulfate): Approximately 40 mg/L lime, 84.5 mg/L carbon dioxide, 70.5 mg/L caustic soda, and 50 mg/L sulfuric acid, resulting in a calcium level of 63 mg/L as $CaCO_3$ and positive LSI and CCPP values. The high caustic soda dose is needed to neutralize the sulfuric acid dose. Sulfuric acid commonly has a dose limitation established by NSF 60 certification of 50 mg/L, so the balance of sulfate addition was considered from gypsum in this case. If soda ash is used instead of caustic soda, a dose of 187 mg/L is needed to achieve a pH level of 8.2 (the resulting alkalinity level of 188 mg/L as $CaCO_3$).

5.1.2.5. Cost Estimates of Chemicals

The cost impact of the following scenarios (all lime addition cases) are provided below:

Scenario 1 – Lime, carbon dioxide, and caustic soda to achieve pH of 8.2 and alkalinity of 100 mg/L as $CaCO_3$.

Scenario 2 – Lime and carbon dioxide to achieve pH of 8.5, with alkalinity of 68 mg/L as $CaCO_3$.

Scenario 3 - Lime, carbon dioxide, caustic soda, and sulfuric acid to achieve pH of 8.2, alkalinity of 100 mg/L as $CaCO_3$, and sulfate of 59 mg/L.

Chemical costs (except for carbon dioxide) were provided by West Basin, which are based on the existing contracts with their chemical suppliers. Carbon dioxide cost is based on a unit cost for a demonstration scale study in City of Glendale, California during 2010 and 2011. Prices and the respective characteristics of the chemicals are listed **Table 5-2**.

Table 5-2: Approximate Chemical Costs and Characteristics

Chemical	Characteristics	Unit Price Quote ($/lb)
Lime (hydrated)	>90% hydrated lime; True density: Approx. 18.36 to 20 lb/gal	0.084[1]
Carbon Dioxide	Supplied as liquid in storage tanks, added to water as gas	0.07[1]
Caustic Soda	25% sodium hydroxide; Density: Approx. 12.72 lb/gal	0.245[1]
Sulfuric Acid, 66° Baume	93% grade; density: Density: 15.3 lb/gal	0.099[1]
Calcium Sulfate Dihydrate (Gypsum)	>95% gypsum, supplied as solid Density: Approx. 19.38 lb/gal	0.249[2]

[1] Unit Price quote is based on 48,000 lb truck load pricing from Brenntag

[2] Unit Price quote is based on average of bulk pricing from Pacific Coast Chemicals and Norman, Fox & Co.

Based on the estimated dosages and the prices in **Table 5-2**, **Table 5-3** shows the approximate chemical costs for the scenarios. Note that these costs reflect those of the chemicals only and not any additional O&M costs related to these additional operations.

Table 5-3: Additional Chemical Costs

	Scenario 1		Scenario 2		Scenario 3	
Chemical	**Dose**	**Cost**	**Dose**	**Cost**	**Dose**	**Cost**
Lime (hydrated)	50 mg/L	$13/AF	44 mg/L	$11/AF	40 mg/L	$10/AF
Carbon Dioxide	84.5 mg/L	$16/AF	55.5 mg/L	$11/AF	84.5 mg/L	$16/AF
Caustic soda as NaOH	19 mg/L	$13/AF	-	-	70.5 mg/L	$47/AF
Sulfuric Acid, as H_2SO_4	-	-	-	-	50 mg/L	$13/AF
Gypsum					17.5 mg/L	$12/AF
TOTAL		**$42/AF**		**$22/AF**		**$98/AF**

All chemical doses for product water stabilization are based on water temperature of 16 °C, which represents the average water temperature at the demonstration facility. At a higher water temperature, the same carbon dioxide and lime doses would result in a higher pH and CCPP value. For example, a carbon dioxide dose of 55.5 mg/L and a lime dose of 44 mg/L results in pH of 8.44 and CCPP of 0.59 mg/L as $CaCO_3$ at 16 °C. The same chemical doses result in a pH of 8.83 and CCPP of 5.99 mg/L as $CaCO_3$ at 25 °C.

To maintain the product water pH below 8.5, a slightly higher carbon dioxide dose (57 mg/L) would be needed at 25 °C, which will also reduce the CCPP value. For the typical water conditions, alkalinity and calcium concentrations are not affected by temperature, thus, lime, acid and caustic soda doses are not affected. In general, more carbon dioxide is needed at a higher water temperature. On the other side, a lower water temperature would require a slightly lower carbon dioxide dose to achieve the same water pH.

5.1.3. Product Water Quality Summary

Product water quality specifications for desalinated seawater stabilization of the West Basin RO permeate are based on literature-reported values of key parameters that have been protective of common distribution system piping materials in the Metropolitan system.

Treatment options for permeate conditioning would likely include (1) lime with carbon dioxide for pH adjustment, or (2) calcite filters. Both would need to be assessed during design and implementation to ensure proper dosage selection and operational control for the West Basin facility. A target pH of 8.5 requires the least chemical doses and treatment cost. A target pH of 8.2 without sulfate adjustment requires moderate chemical doses and treatment cost. If sulfate adjustment to match MWD water quality is desired, significant doses of sulfuric acid and caustic soda may be needed in addition to lime and carbon dioxide, resulting in doubled treatment cost compared with no sulfate adjustment. All chemical doses were estimated based on RTW modeling. Bench- or pilot-scale testing may be needed to identify the optimal effective chemical doses and operating conditions for the variety of pipe materials in the West Basin service areas. Additionally, compatibility testing of stabilized product water with local groundwater is also recommended to capture potential issues that may arise from blending, such as impacts of water quality on existing pipe corrosion products particularly in systems using groundwater of variable quality.

5.2. Conveyance

The majority of West Basin's service area is served 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 (WB-2A, 2B, 3, 4, 5, 11, 12, 13, and 29). The West Coast (WC) Feeder is aligned along El Segundo Boulevard with three local turnouts (WB-20, 28, and 30). Both feeders are fed by the MWD Sepulveda Feeder, which is aligned along Van Ness Avenue. **Figure 5-1** shows a map of existing MWD facilities.

New conveyance infrastructure is required to carry flows from the desalination plant site to the existing distribution system. For the local project, the flows will be split and distributed to both the WB and WC Feeder local service areas. For the regional project, the flows will be conveyed directly to the Sepulveda Feeder.

The conveyance requirement is primarily set forth by the flow demand. As described in Section 2, the local project flow demand is 20 MGD (based on 80% exceedance level) with observed diurnal peaking factors of 0.7 and 1.5. The resulting minimum and maximum flow demands are 14 and 30 MGD, respectively. The maximum flow demand for the regional project is 60 MGD. It is also estimated that 2.5 and 5 million gallon storage reservoirs will be required for local and regional projects, respectively, to accommodate additional demands due to diurnal flow variations.

Several conveyance alternatives from each plant site are evaluated in this section. Key factors in evaluation include preliminary pipe alignments, sizes, lengths and pump requirements.

Further analysis on the impacts on MWD's distribution system is needed, including possible deterioration of disinfection residuals, and impact on pipeline operations.

5.2.1. Key Criteria and Assumptions

The pipe and pump sizes are estimated based on the following key criteria and assumptions:

- 2 feet per second (fps) < flow velocity < 10 fps
- Total head loss < 150 feet
- Pipe size > 24" diameter: Steel – AWWA C200 CMLC
- Pipe size ≤ 24" diameter: Ductile Iron – AWWA C150/C151 CML or
- Steel – AWWA C200 CMLC
- 100 psi minimum at all local service connections
- Flow range: 14 to 30 MGD for Local Project
- 30 to 60 MGD for Regional Project
- Maximum hydrostatic grade elevation at MWD Feeder:

  415 feet – West Basin Feeder (low pressure)

  650 feet – West Coast Feeder (high pressure)

  660 feet – Sepulveda Feeder (high pressure)

  Pump type: vertical turbine pumps
- Pump number: duty + one (1) standby
- 25% of plant capacity needed for onsite storage for diurnal variation (performed by MWD, see **Appendix 1:C**) and disinfection

5.2.2. West Basin Conveyance Alternatives

The Preliminary Regional Conveyance & Pump Station Study (See **Appendix 1:D**) has already performed an extensive assessment of tie-in and alignment options for each plant site, NRG (El Segundo) and AES (Redondo Beach). The Draft MWD Integration Study focused on a single feeder connection in all of its alternatives, whereas this evaluation considers connections to both the West Basin and West Coast Feeders in its local project alternatives. Four of the more feasible and likely conveyance schemes from the Draft MWD Integration Study were modified and evaluated further in detail in this section; local service connections, connections to WB Feeder at west and east ends, and a regional connection.

Local Service Connections – Service connections to each turnout along WB and WC Feeders would be made at 100 psi minimum. This would minimize the required pipe and pump sizes due to lower hydraulic static heads at turnouts compared to other alternatives that would connect directly into a feeder, but result in longer pipe lengths.

For all local project options, a direct connection to the WC Feeder was not considered due to its high pressure system (HGL elevation of 650 feet), which would result in much larger pipe and pump size requirements.

West Basin Feeder Connection (West End) – A feeder connection to the WB Feeder would be made near the intersection of Manhattan Beach Boulevard and Aviation Boulevard (west end). The desalinated water could then blend with MWD water as it is distributed through the local service connections along the WC Feeder. Approximately 10 MGD of the 15 MGD flow will be diverted westwards from the connection point due to larger flow demands at the turnout cluster of WB-3, 4, and 5 at the west end of the feeder. The remaining 5 MGD flow will be diverted eastwards. The blending along the alignment would not be consistent and the impacts to water quality are discussed elsewhere in this report. This alternative would minimize the required pipe lengths, but result in larger pipe and pump sizes due to a higher hydraulic static head along the WB Feeder (HGL elevation of 415 feet) compared to the local service connections where the connection pressure need only be 100 psi. The maximum grade along either the WB or WC feeders is not much over 100 feet above sea level so the HGL at each connection only needs to be in the vicinity of 230 feet.

As previously mentioned, this alternative will provide direct connection to the service connections off the West Basin Feeder to avoid the high pressure impacts of that feeder.

West Basin Feeder Connection (East End) – A feeder connection to the WB Feeder would be made just east of the WB-12 turnout (east end) and local service connections would be made along the WC Feeder at each turnout. This alternative is similar to the previous alternative but provides a better blending opportunity since flow is carried to the west end from the point of connection. Larger pipe sizes and longer pipe lengths are required compared to the previous alternative. The connection to the West Coast turnouts remains unchanged.

Sepulveda Feeder (Regional) Connection – A regional feeder connection to the Sepulveda Feeder would be made at approximately Station 1918+50, upstream of the West Coast Feeder. This alternative assumes a larger treatment capacity of 60 MGD at the plant site.

Table 5-4 summarizes the conveyance schemes and corresponding alternatives.

Table 5-4: Summary of West Basin Preliminary Conveyance Schemes

<table>
<tr><th>Alternative</th><th>Plant Site</th><th>Conveyance Scheme</th></tr>
<tr><td>1</td><td>NRG</td><td rowspan="2">Local Service Connections – WB and WC Feeders</td></tr>
<tr><td>2</td><td>AES</td></tr>
<tr><td>3</td><td>NRG</td><td rowspan="2">Feeder Connection – WB Feeder West End
Local Service Connections – WC Feeder</td></tr>
<tr><td>4</td><td>AES</td></tr>
<tr><td>5</td><td>NRG</td><td rowspan="2">Feeder Connection – WB Feeder East End
Local Service Connections – WC Feeder</td></tr>
<tr><td>6</td><td>AES</td></tr>
<tr><td>7</td><td>NRG</td><td rowspan="2">Regional Feeder Connection – Sepulveda Feeder</td></tr>
<tr><td>8</td><td>AES</td></tr>
</table>

A typical MWD connection requires isolation and flow control valves in an underground concrete vault with sump, ventilation system, and access platforms, and the bypass line is encased in concrete. A similar requirement is assumed for local connections as well.

5.2.2.1. Preliminary Pipeline Alignments and Sizing

Preliminary alignments for each alternative, except for the Sepulveda Feeder connection, are based on the most direct routes on major roads. The preliminary alignments for the Sepulveda Feeder connection are based on the Draft MWD Integration Study. The preliminary alignments are classified into three categories:

Backbone Feeder Alignment includes new pipelines required from the plant site to the WB and WC Feeders.

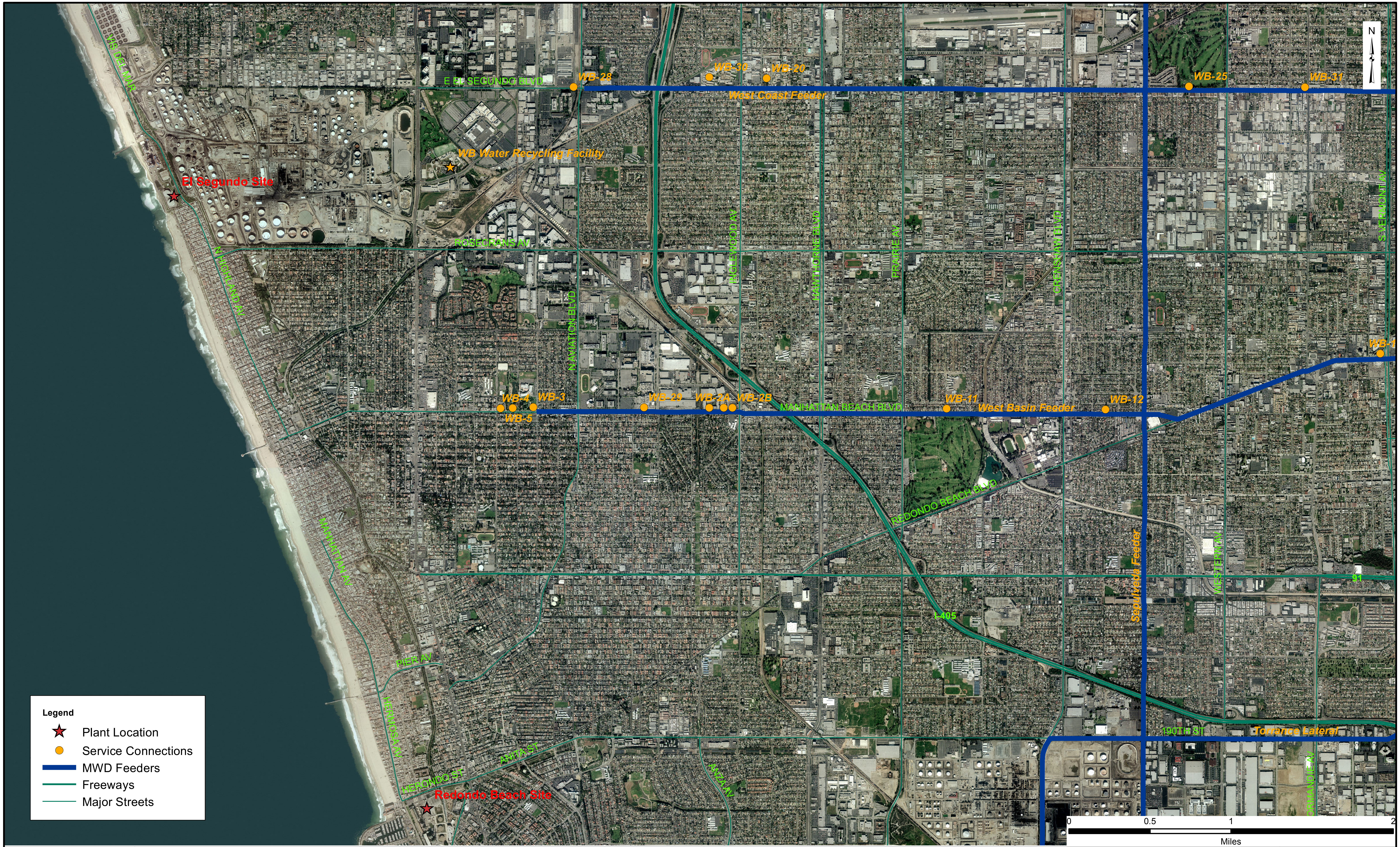
West Basin Feeder Alignment includes new pipelines required for connections along the MWD West Basin Feeder.

West Coast Feeder Alignment includes new pipelines required for connections along the MWD West Coast Feeder.

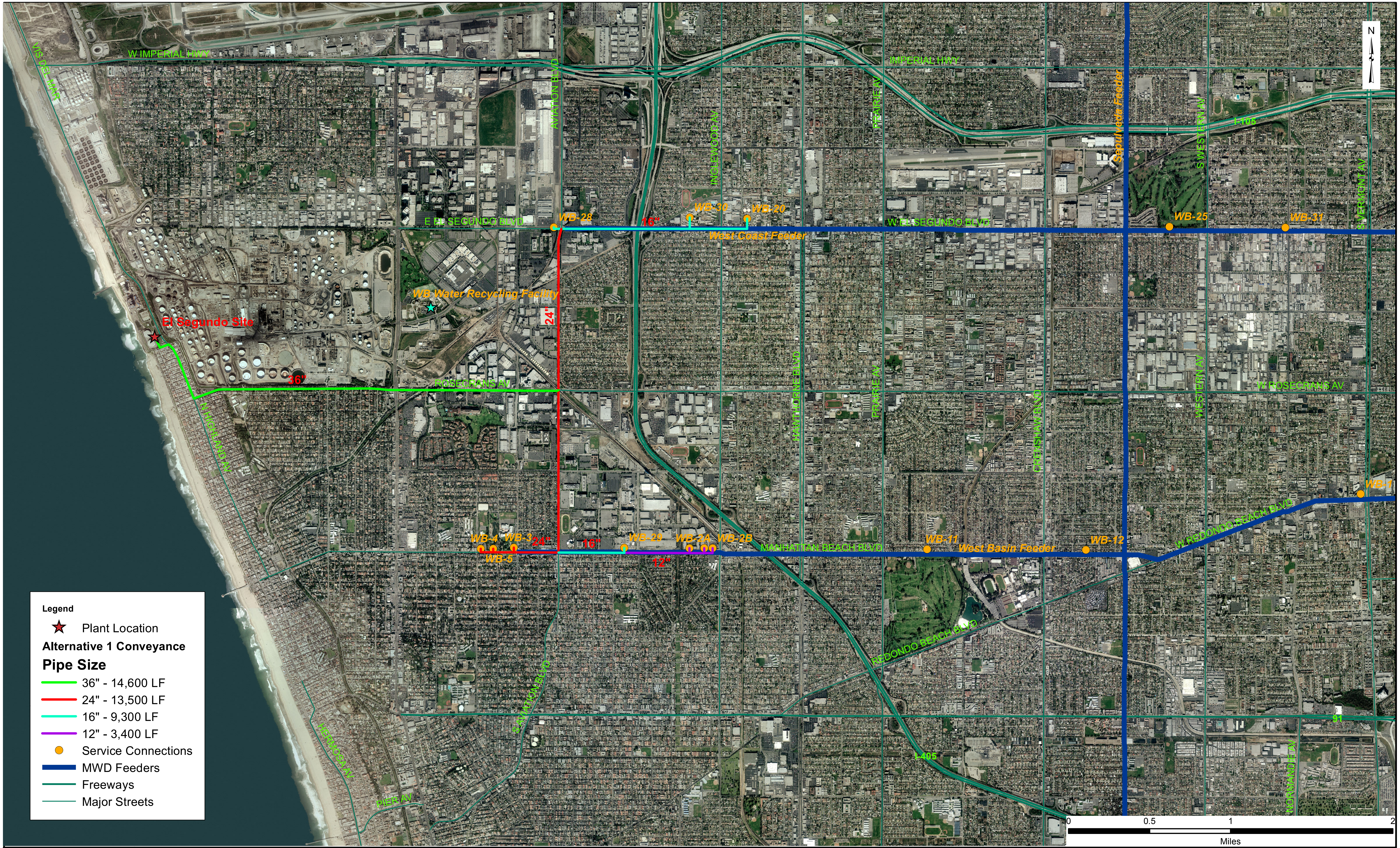
Figures 5-1 through 5-9 depict the preliminary pipeline alignments, sizing, and connections. **Table 5-5** summarizes pipe sizes and lengths for the preliminary alignments.

Table 5-5: Summary of Pipeline Sizes and Lengths

Alt.	Backbone Feeder Alignment	WB Feeder Alignment	WC Feeder Alignment
1	36" ~ 14,600 LF 24" ~ 10,600 LF	24" ~ 2,900 LF 16" ~ 2,300 LF 12" ~ 3,400 LF	16" ~ 7,000 LF
2	36" ~ 16,000 LF 30" ~ 10,600 LF	24" ~ 2,900 LF 16" ~ 2,300 LF 12" ~ 3,400 LF	18" ~ 7,000 LF
3	36" ~ 14,600 LF 24" ~ 10,600 LF	24" x 24" Tee Connection	18" ~ 7,000 LF
4	36" ~ 16,000 LF 24" ~ 10,600 LF	36" x 24" Cross Connection	18" ~ 7,000 LF
5	36" ~ 14,600 LF 24" ~ 10,600 LF	24" ~ 17,600 LF	18" ~ 7,000 LF
6	36" ~ 16,000 LF 30" ~ 10,600 LF	30" ~ 17,600 LF	18" ~ 7,000 LF
7	54" ~ 42,900 LF	-	-
8	54" ~ 47,100 LF	-	-



MALCOLM PIRNIE / ARCADIS — The Water Division of ARCADIS	WEST BASIN MUNICIPAL WATER DISTRICT 17140 S AVALON BLVD, STE 210, CARSON, CA 90746 OCEAN WATER DESALINATION PMP CONTRACT NO. 05052016.0000	MAP OF MWD FACILITIES	PIRNIE/ARCADIS U.S. JANUARY 2013 FIGURE 5-1



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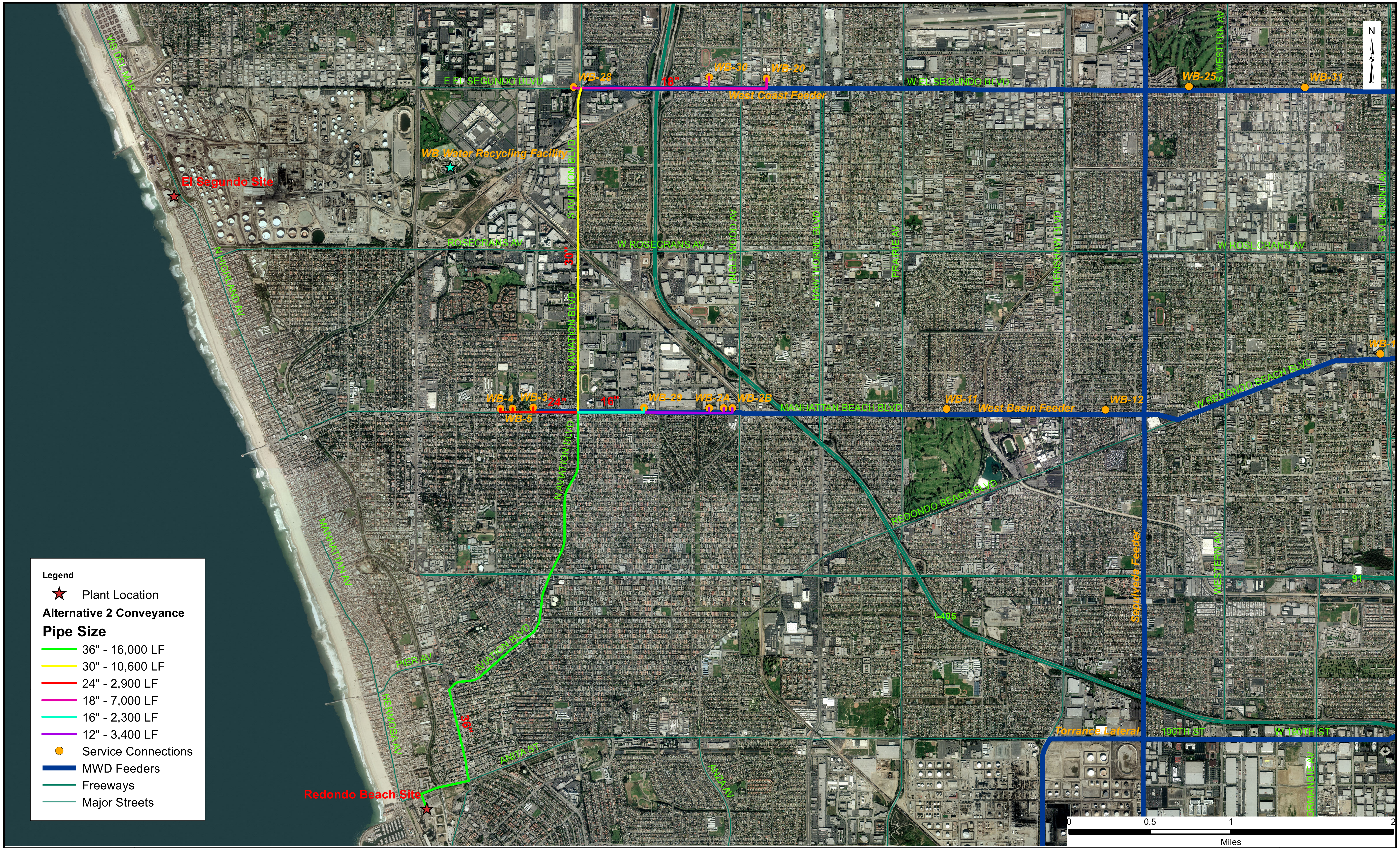
EL SEGUNDO SITE - LOCAL CONNECTIONS
CONVEYANCE ALTERNATIVE 1

PIRNIE/ARCADIS U.S.
JANUARY 2013
FIGURE 5-2



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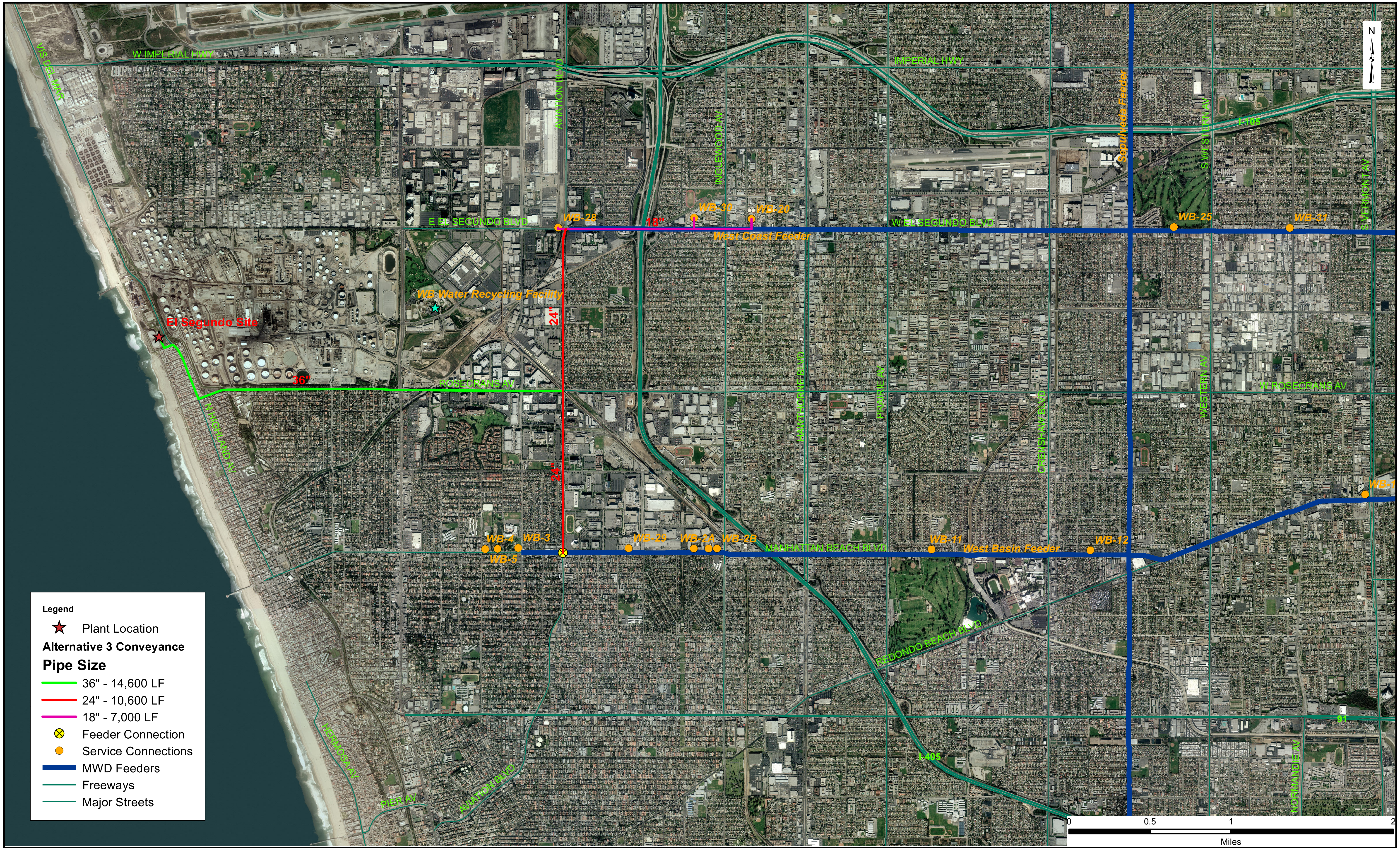
REDONDO BEACH SITE - LOCAL CONNECTIONS
CONVEYANCE ALTERNATIVE 2

PIRNIE/ARCADIS U.S.

JANUARY 2013

FIGURE 5-3



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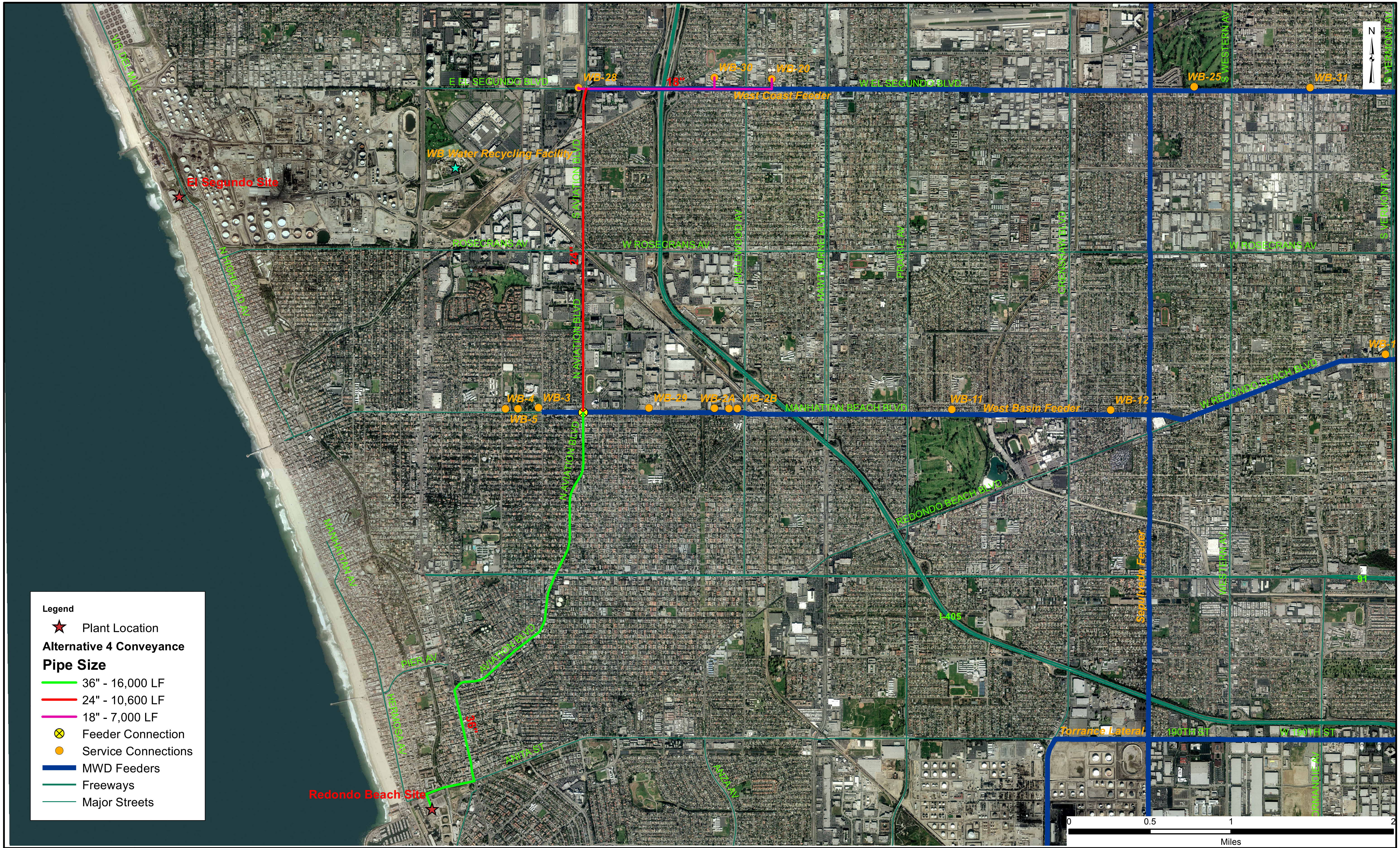
EL SEGUNDO SITE - CONNECTION TO WEST BASIN FEEDER
CONVEYANCE ALTERNATIVE 3

PIRNIE/ARCADIS U.S.
JANUARY 2013
FIGURE 5-4



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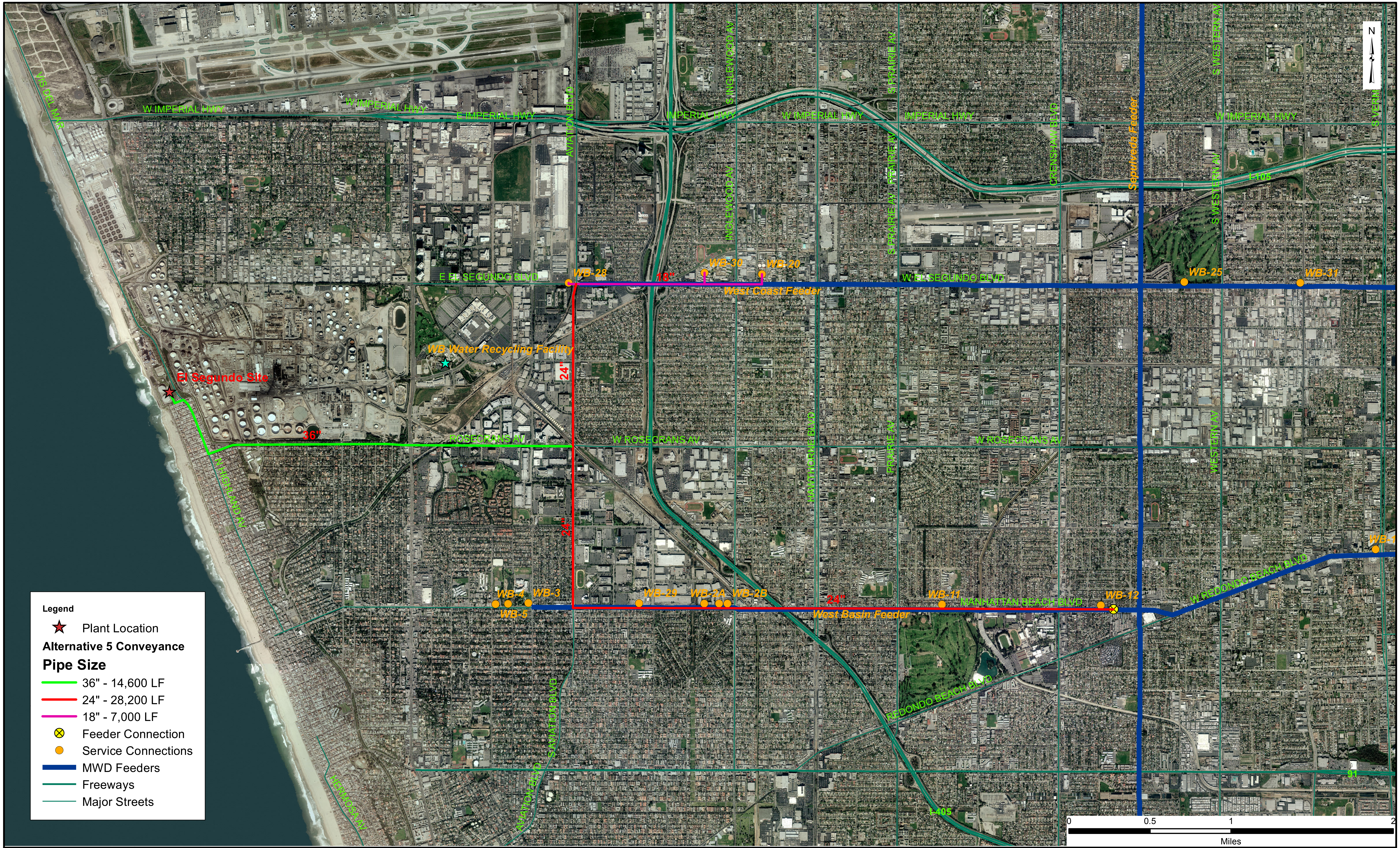
REDONDO BEACH SITE - CONNECTION TO WEST BASIN FEEDER
CONVEYANCE ALTERNATIVE 4

PIRNIE/ARCADIS U.S.
JANUARY 2013
FIGURE 5-5



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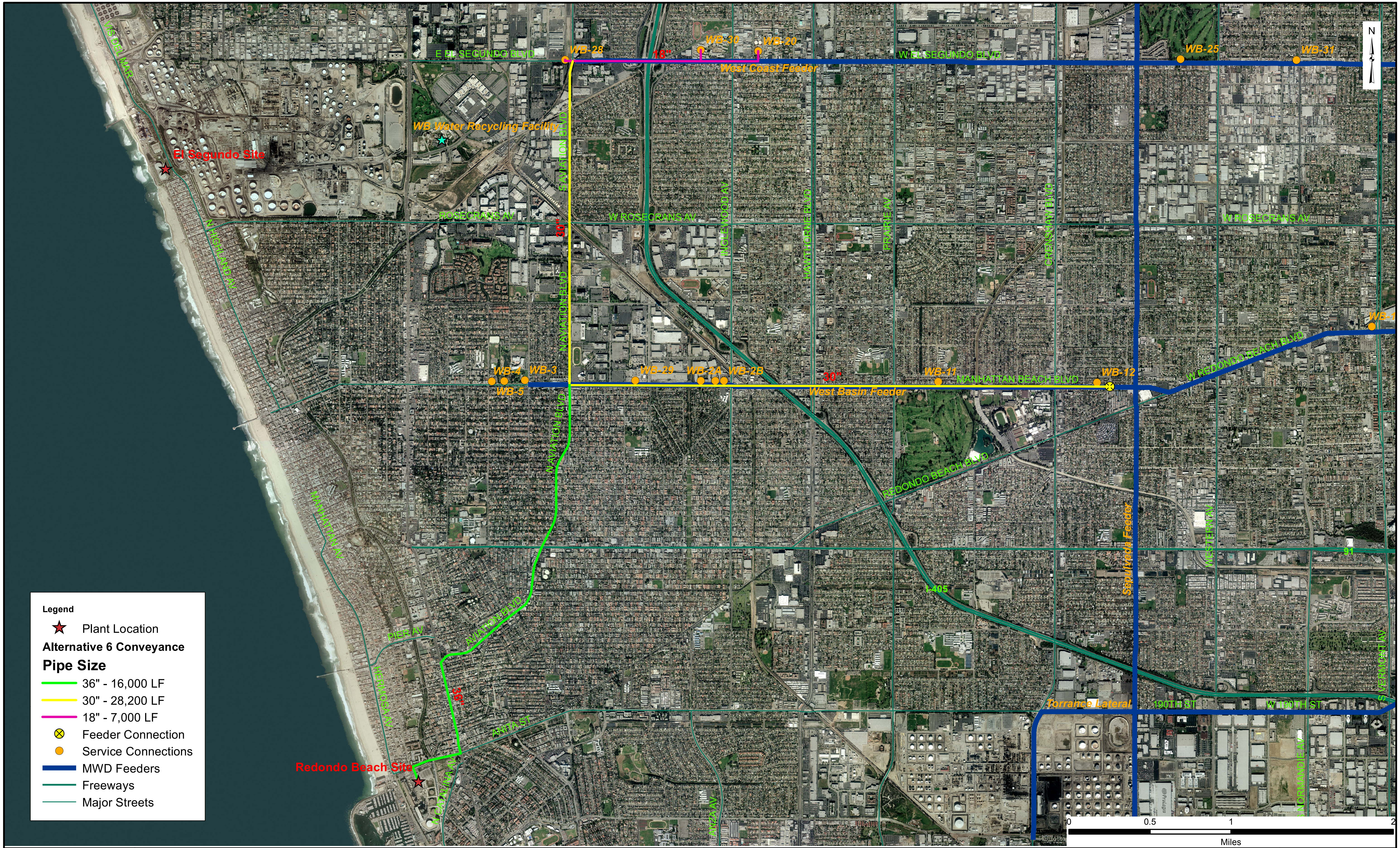
EL SEGUNDO SITE - CONNECTION TO WEST BASIN FEEDER EAST END
CONVEYANCE ALTERNATIVE 5

PIRNIE/ARCADIS U.S.
JANUARY 2013
FIGURE 5-6



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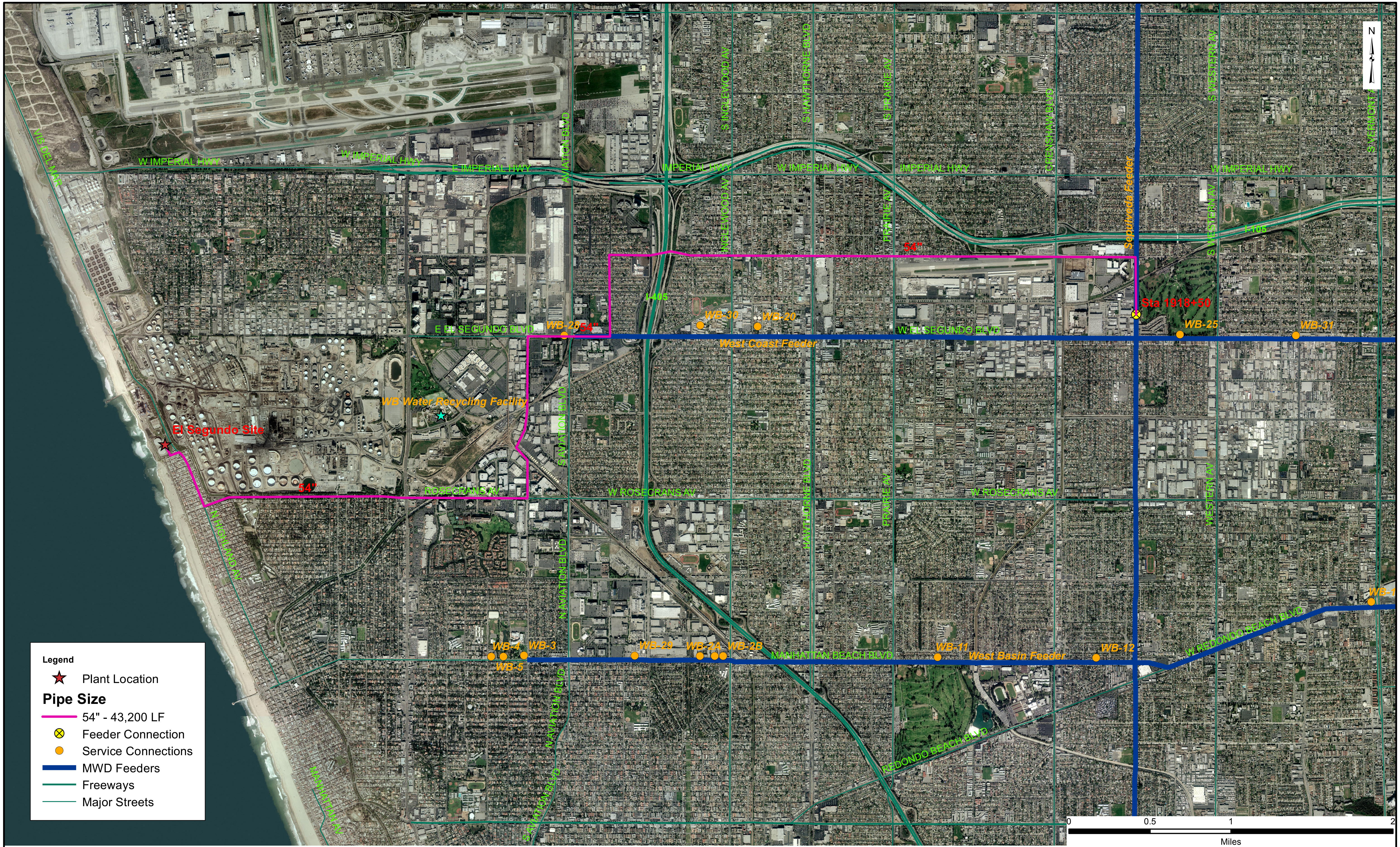
REDONDO BEACH SITE - CONNECTION TO WEST BASIN FEEDER EAST END
CONVEYANCE ALTERNATIVE 6

PIRNIE/ARCADIS U.S.
JANUARY 2013
FIGURE 5-7



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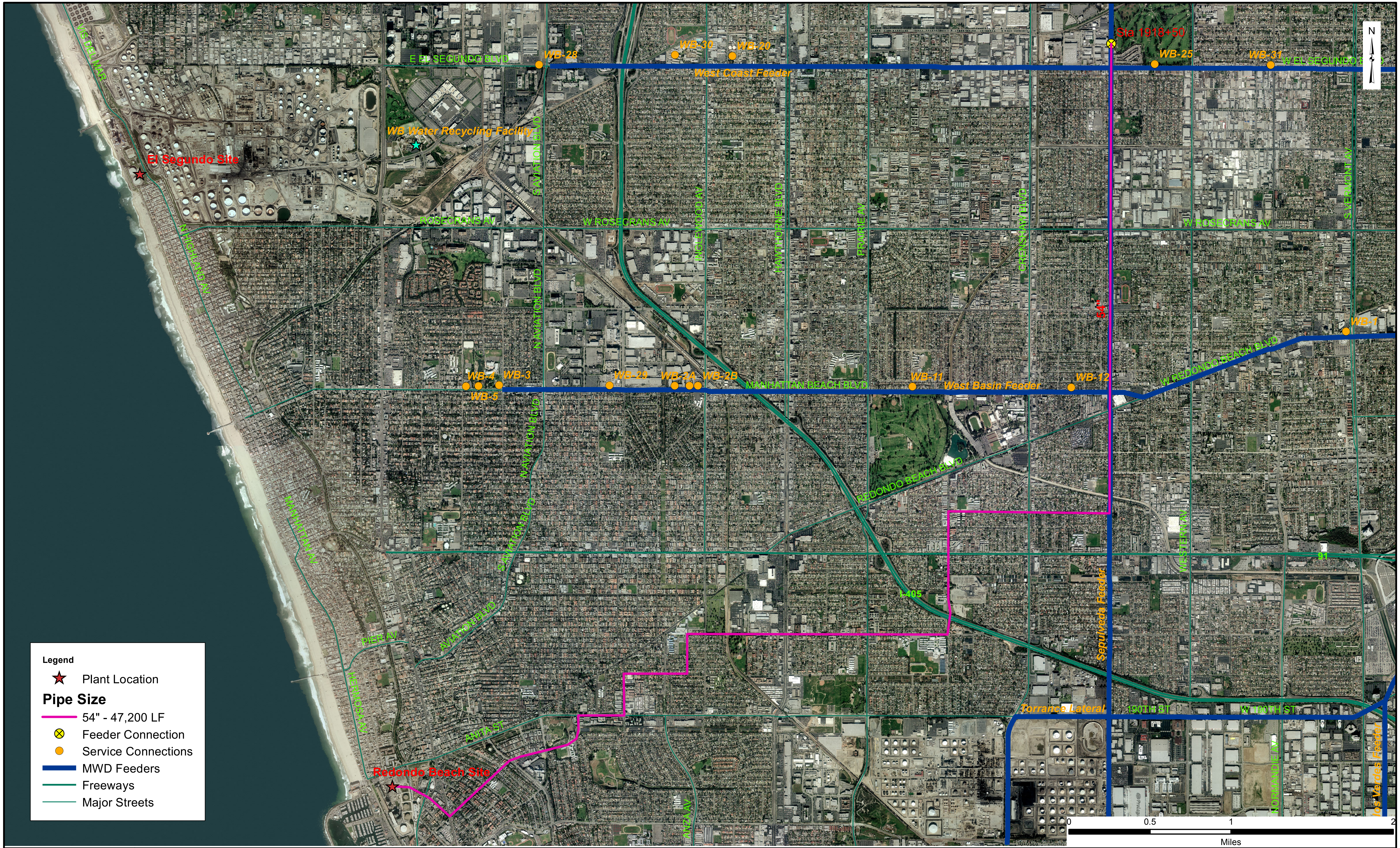
EL SEGUNDO SITE - CONNECTION TO SEPULVEDA FEEDER
CONVEYANCE ALTERNATIVE 7

PIRNIE/ARCADIS U.S.
JANUARY 2013
FIGURE 5-8



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REDONDO BEACH SITE - CONNECTION TO SEPULVEDA FEEDER

CONVEYANCE ALTERNATIVE 8

PIRNIE/ARCADIS U.S.

JANUARY 2013

FIGURE 5-9

5.2.2.2. Preliminary Pump Station Sizing and Layout

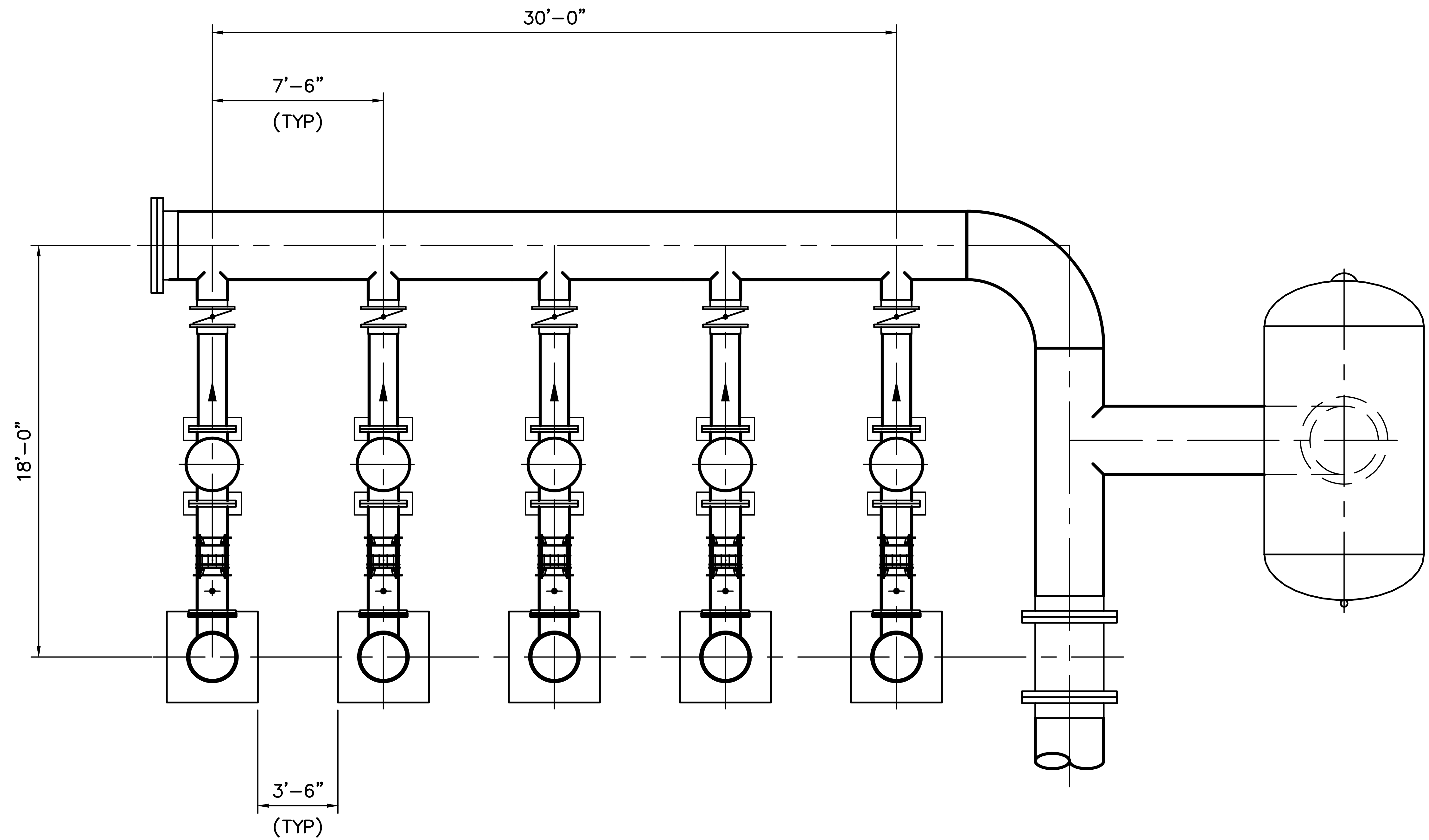
For the purposes of this study, a pump station also includes a surge tank and electrical equipments (VFDs and switchgears) required to operate the pumping system. A single-lift pump station located at the plant site was selected to minimize capital and operating costs for all alternatives. Less equipment will be required for a single pump station and electrical costs at the plant site will likely be less since power can be supplied directly from the adjacent power plant. A two-lift pump station design, comprised of a low-head pump station located at the plant site and a high-head pump station located near the feeder connection, would be more expensive to build and operate.

For the conveyance system, the power distribution and costs are mainly associated with the number and size of pumps. In general, a 480 volt (V) power supply is required for a 400 horsepower (Hp) or less pump, and a 4,160 V power supply is required for a pump greater than 400 Hp. **Table 5-6** summarizes the required pumps for all the conveyance alternatives.

Table 5-6: Summary of Preliminary Pump Requirements

Alt.	No. of Pumps	Description	Total Dynamic Head (feet)	Pump (Hp)
1	5	7.5 MGD Vertical Turbine Pumps	427	700
2	5	7.5 MGD Vertical Turbine Pumps	408	700
3	5	7.5 MGD Vertical Turbine Pumps	497	800
4	5	7.5 MGD Vertical Turbine Pumps	479	800
5	5	7.5 MGD Vertical Turbine Pumps	487	800
6	5	7.5 MGD Vertical Turbine Pumps	530	900
7	9	7.5 MGD Vertical Turbine Pumps	725	1500
8	9	7.5 MGD Vertical Turbine Pumps	737	1500

A typical pump station layout with pumps, piping, and associated equipments including check and isolation valves, flow meters, local control panels, and a surge tank (size to be determined during preliminary design). In addition, a separate electrical equipment building or room will be required to house switchgears, VFDs, motor control centers, and other electrical equipments. The pumps themselves would be mounted on top of a clear well, but would be housed in a building to protect them from local environmental conditions. A backup power generator will also be required on-site. **Figure 5-10** and **Figure 5-11** show typical pump station layouts.



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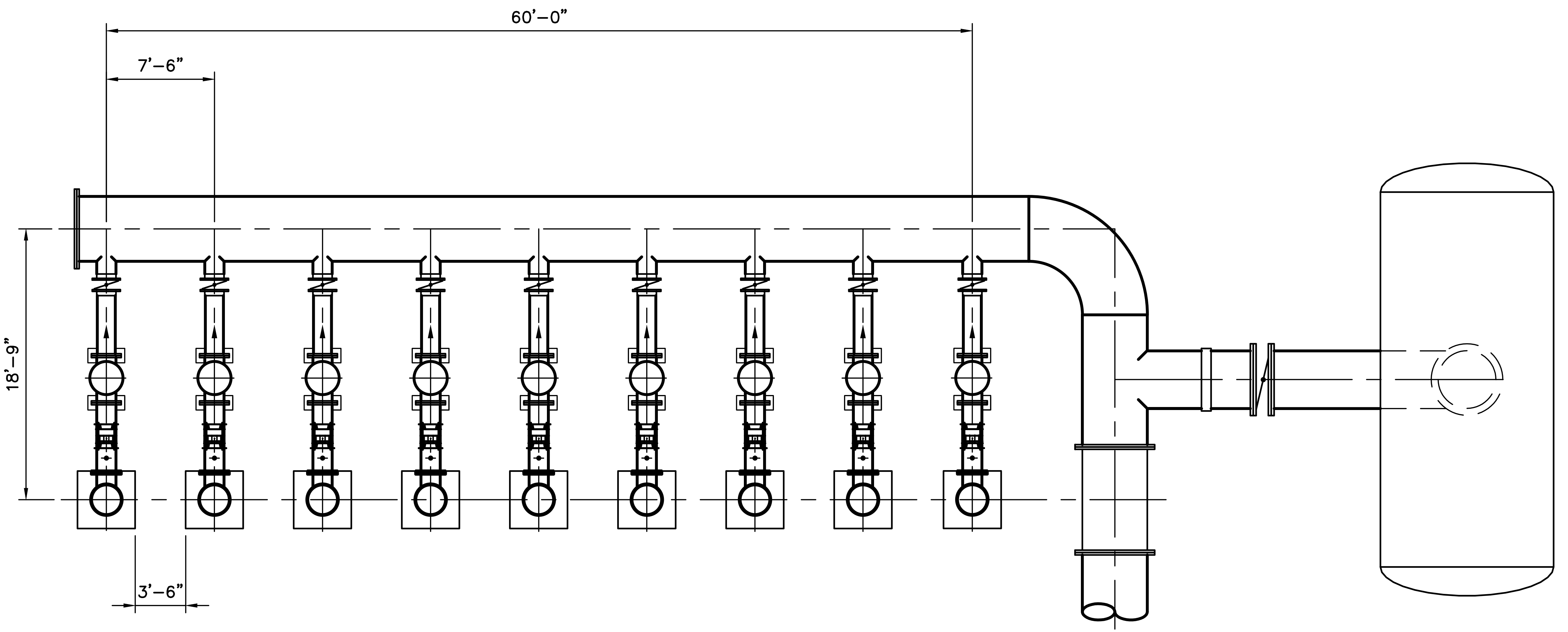
OCEAN WATER DESALINATION
PROGRAM MASTER PLAN (PMP)

NRG ENERGY, INC. – 301 VISTA DEL MAR, EL SEGUNDO, CA. 90245
PRODUCT WATER PUMP STATION – 20 MGD
SCALE: AS NOTED

JANUARY 2013

FIGURE 5–10



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WEST BASIN MUNICIPAL WATER DISTRICT
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OCEAN WATER DESALINATION
PROGRAM MASTER PLAN (PMP)

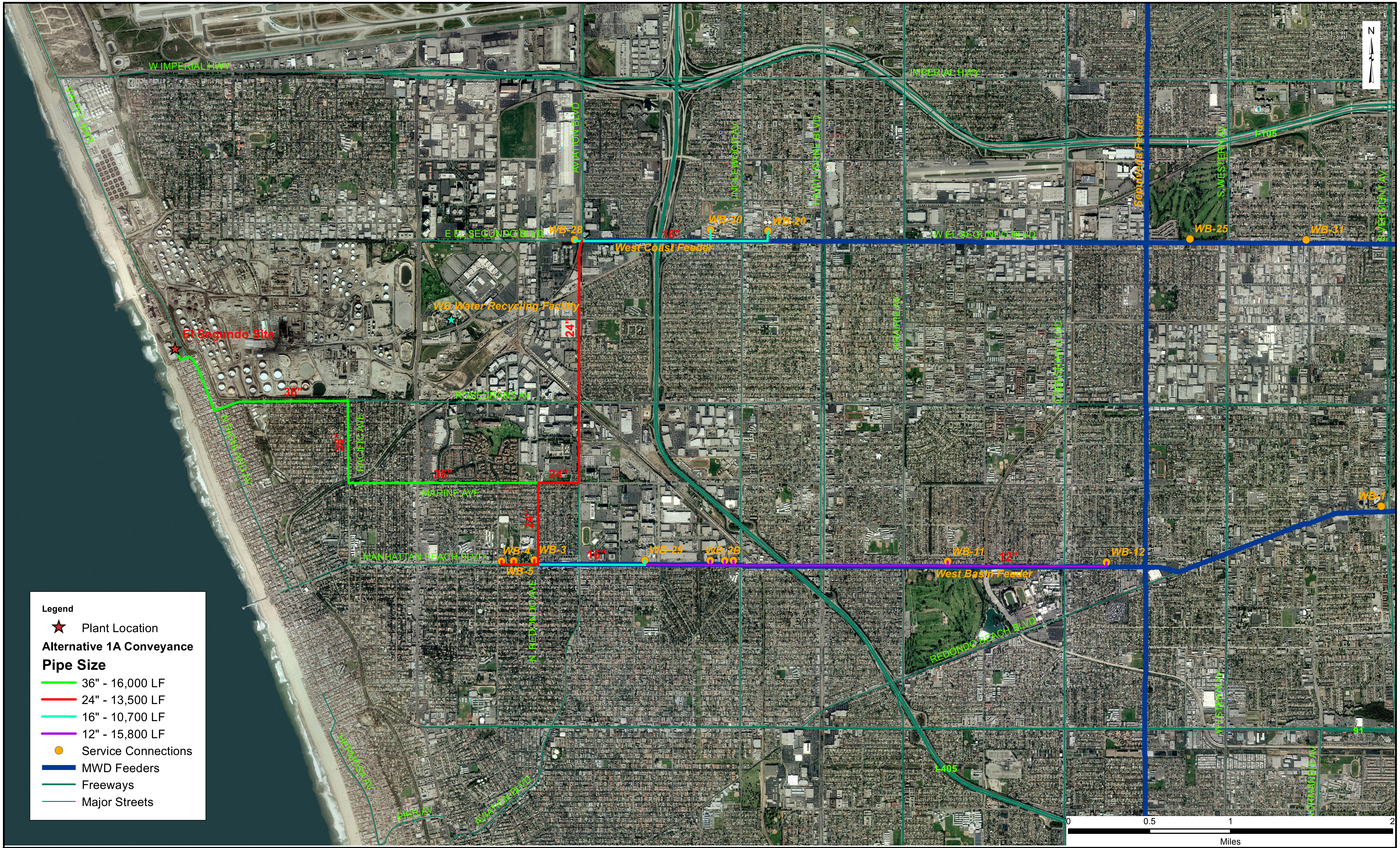
NRG ENERGY, INC. – 301 VISTA DEL MAR, EL SEGUNDO, CA. 90245
PRODUCT WATER PUMP STATION – 60 MGD
SCALE: AS NOTED

JANUARY 2013
FIGURE 5–11

Conveyance Alternatives

Additional conveyance alternatives were evaluated by MWD with different alignments to those presented in the previous section. These alignments are included in the Draft MWD Integration Study. These additional conveyance alternatives are alignment variations based on MWD's field investigations (visual observations), and are discussed summarily in the subsequent sections.

Figures 5-12 through 5-17 show the alternative alignments identified by MWD and connections from the NRG and AES sites. **Tables 5-7** and **Table 5-8** summarize the required pipes and pipeline lengths for these alternatives. These alternatives are denoted with an "A" after the corresponding West Basin alternative number (i.e., "1A" for alternative of WB alternative "1").



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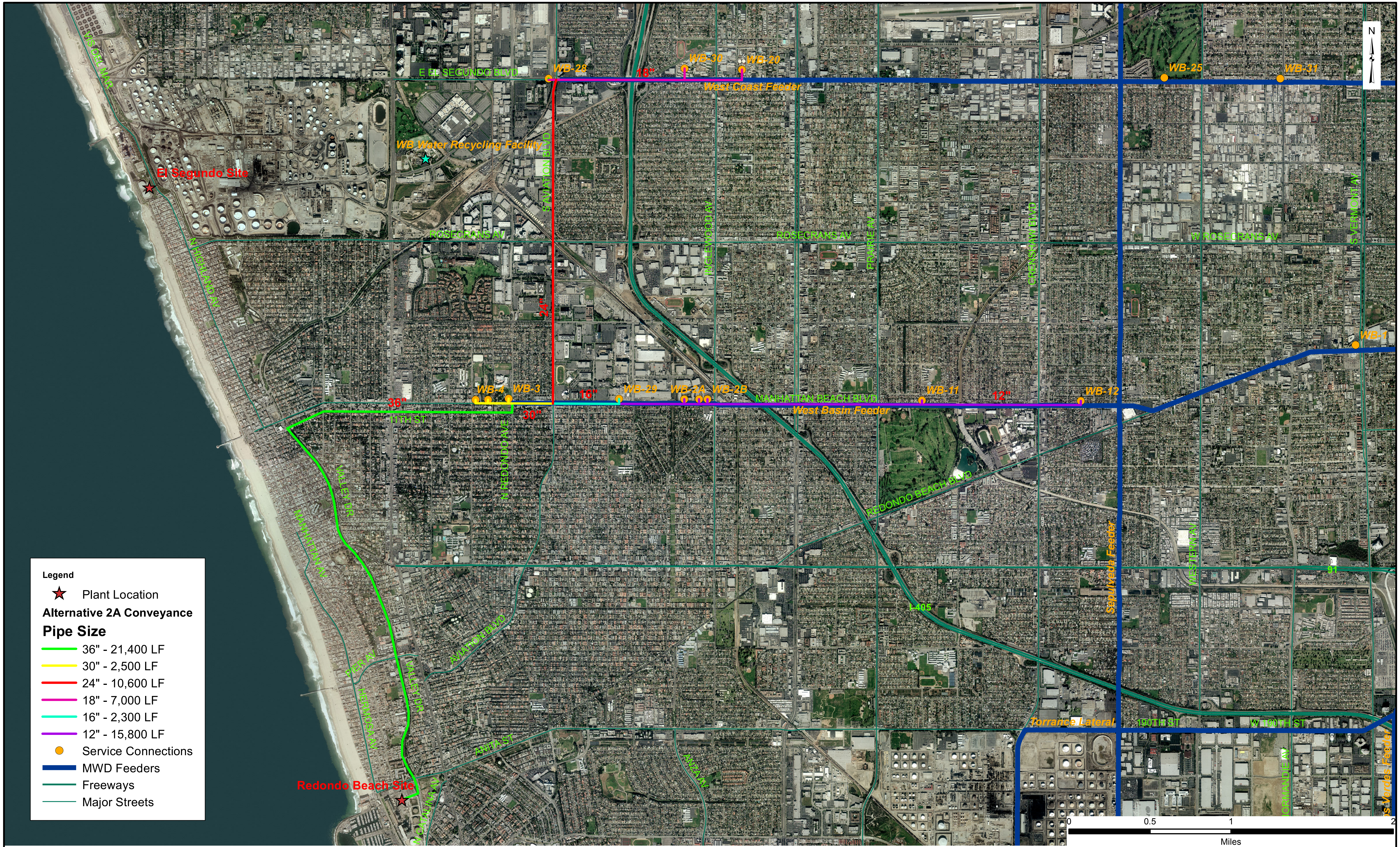
EL SEGUNDO SITE - LOCAL CONNECTIONS
CONVEYANCE ALTERNATIVE 1A

PIRNIE/ARCADIS U.S.
JANUARY 2013
FIGURE 5-12



WEST BASIN MUNICIPAL WATER DISTRICT 17140 S AVALON BLVD, STE 210, CARSON, CA 90746 OCEAN WATER DESALINATION PMP CONTRACT NO. 05052016.0000	REDONDO BEACH SITE - LOCAL CONNECTIONS CONVEYANCE ALTERNATIVE 2A	PIRNIE/ARCADIS U.S. JANUARY 2013 FIGURE 5-13

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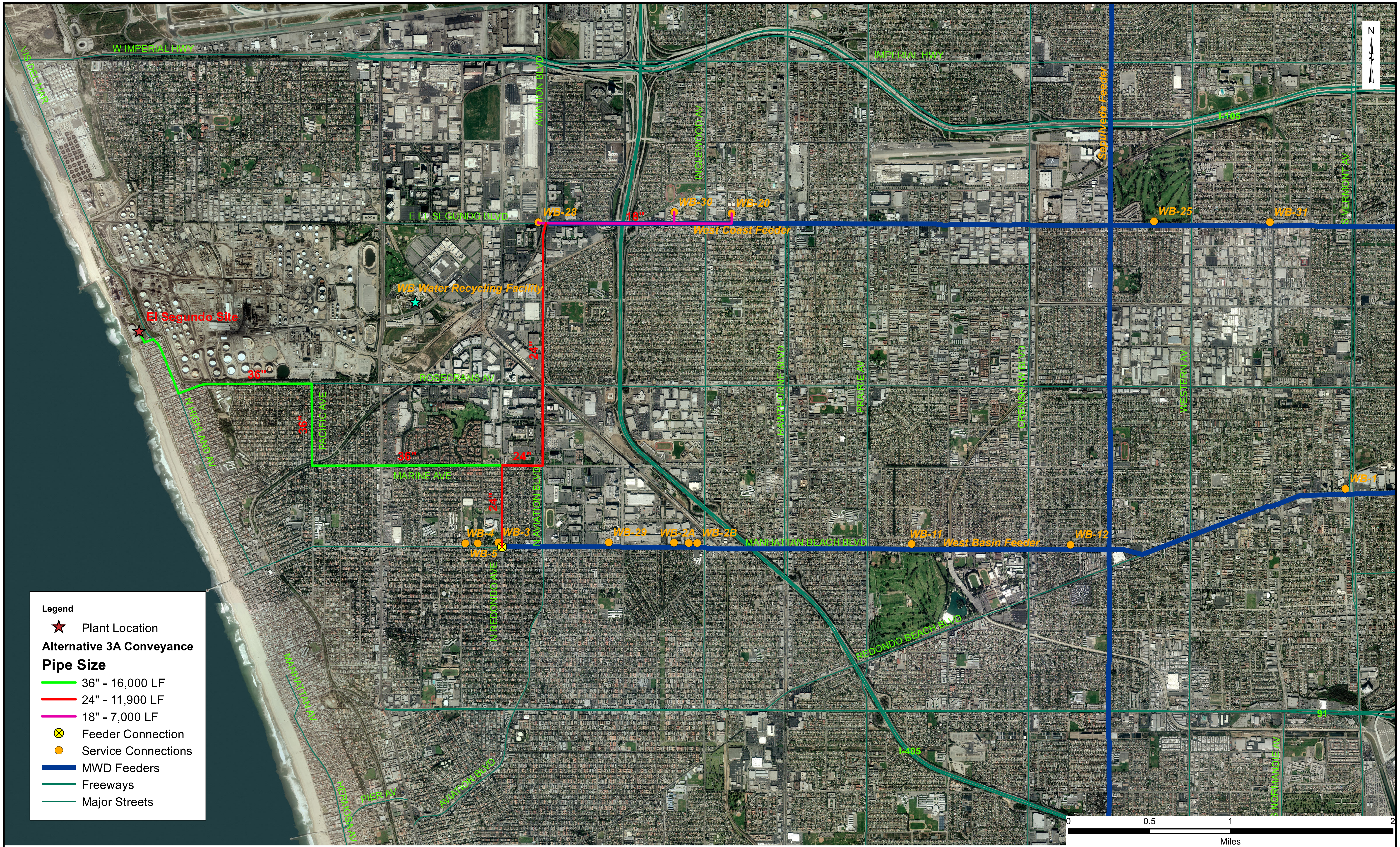

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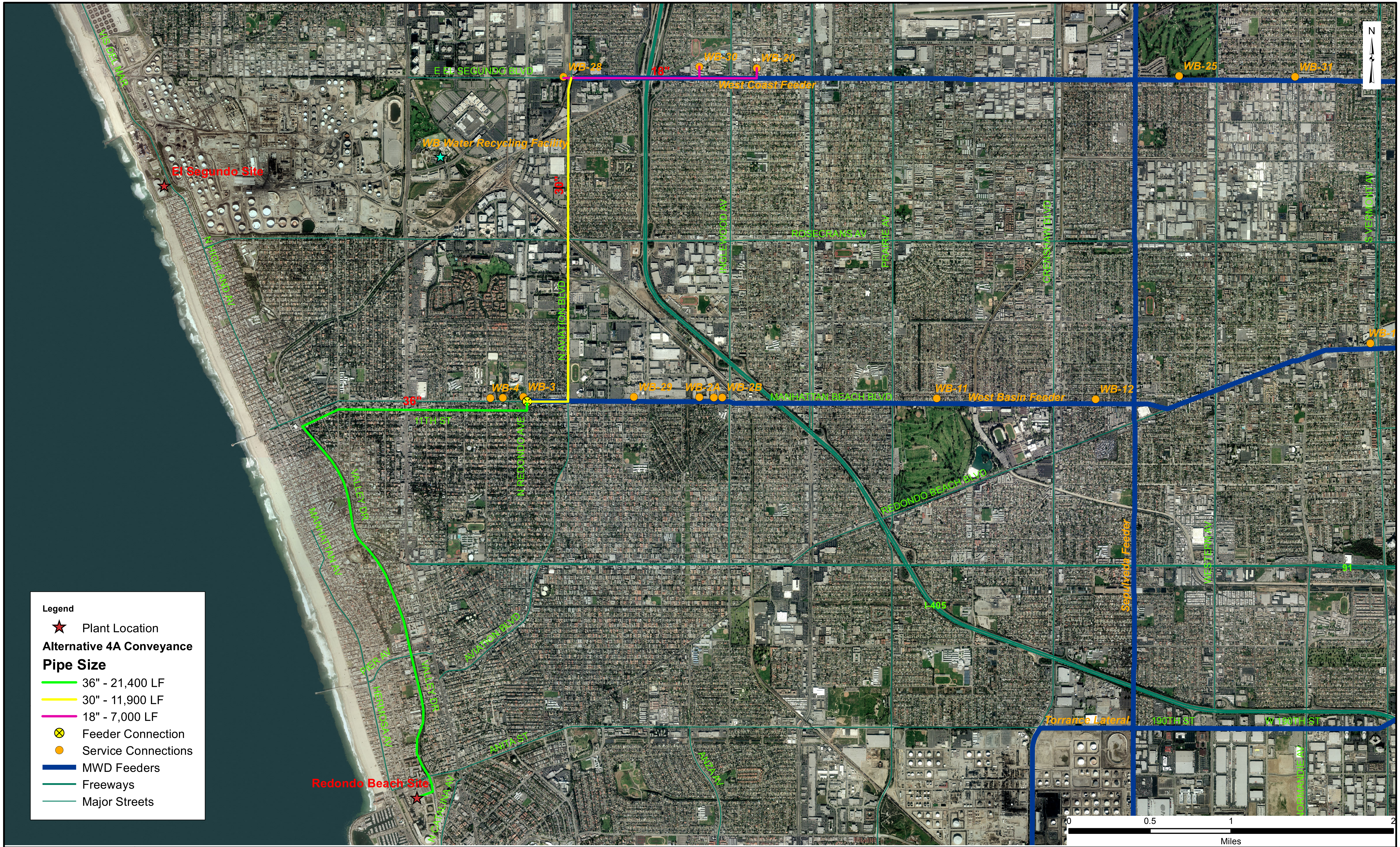
EL SEGUNDO SITE - LOCAL CONNECTIONS
CONVEYANCE ALTERNATIVE 3A

PIRNIE/ARCADIS U.S.
JANUARY 2013
FIGURE 5-14



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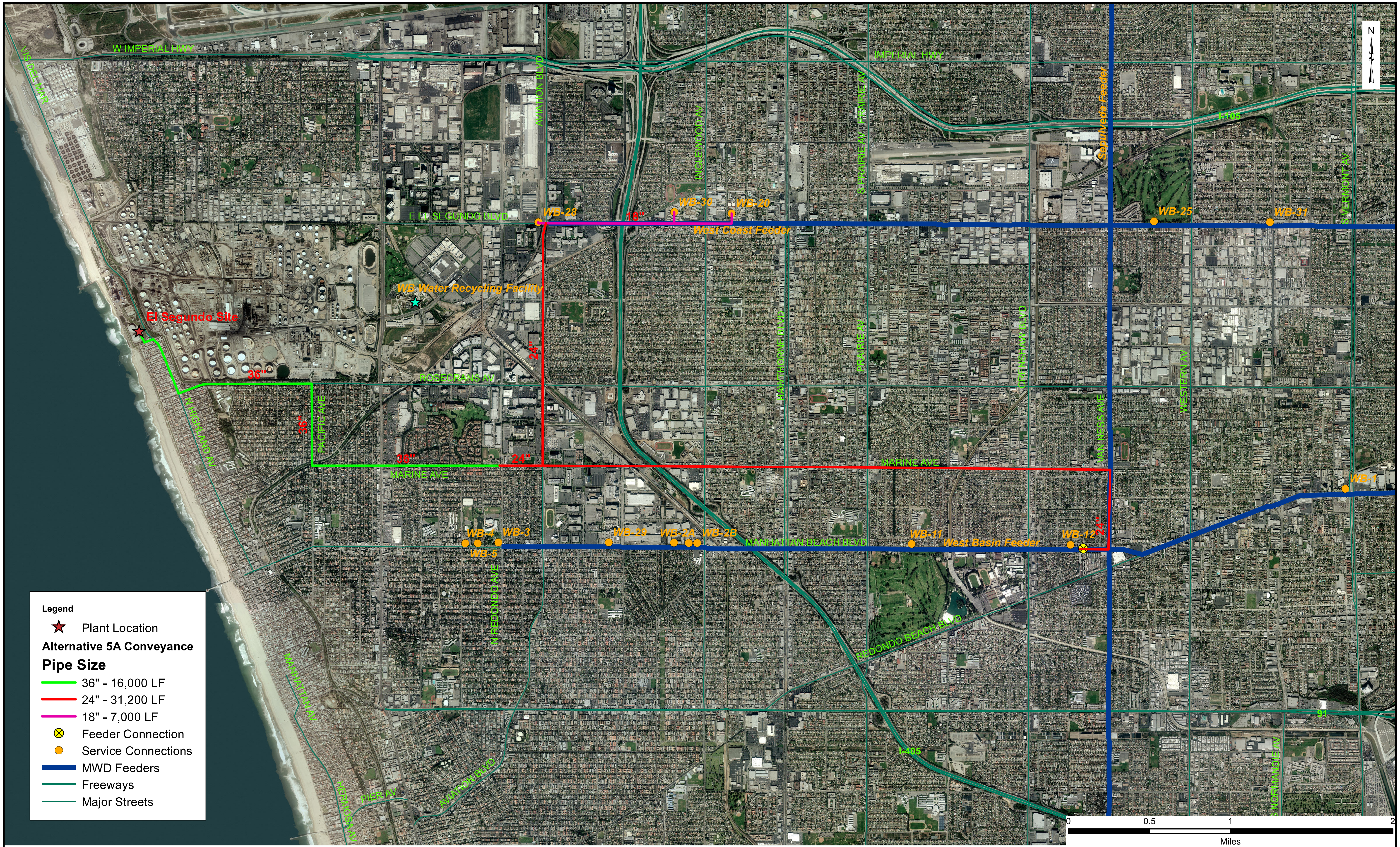
REDONDO BEACH SITE - LOCAL CONNECTIONS
CONVEYANCE ALTERNATIVE 4A

PIRNIE/ARCADIS U.S.
JANUARY 2013
FIGURE 5-15



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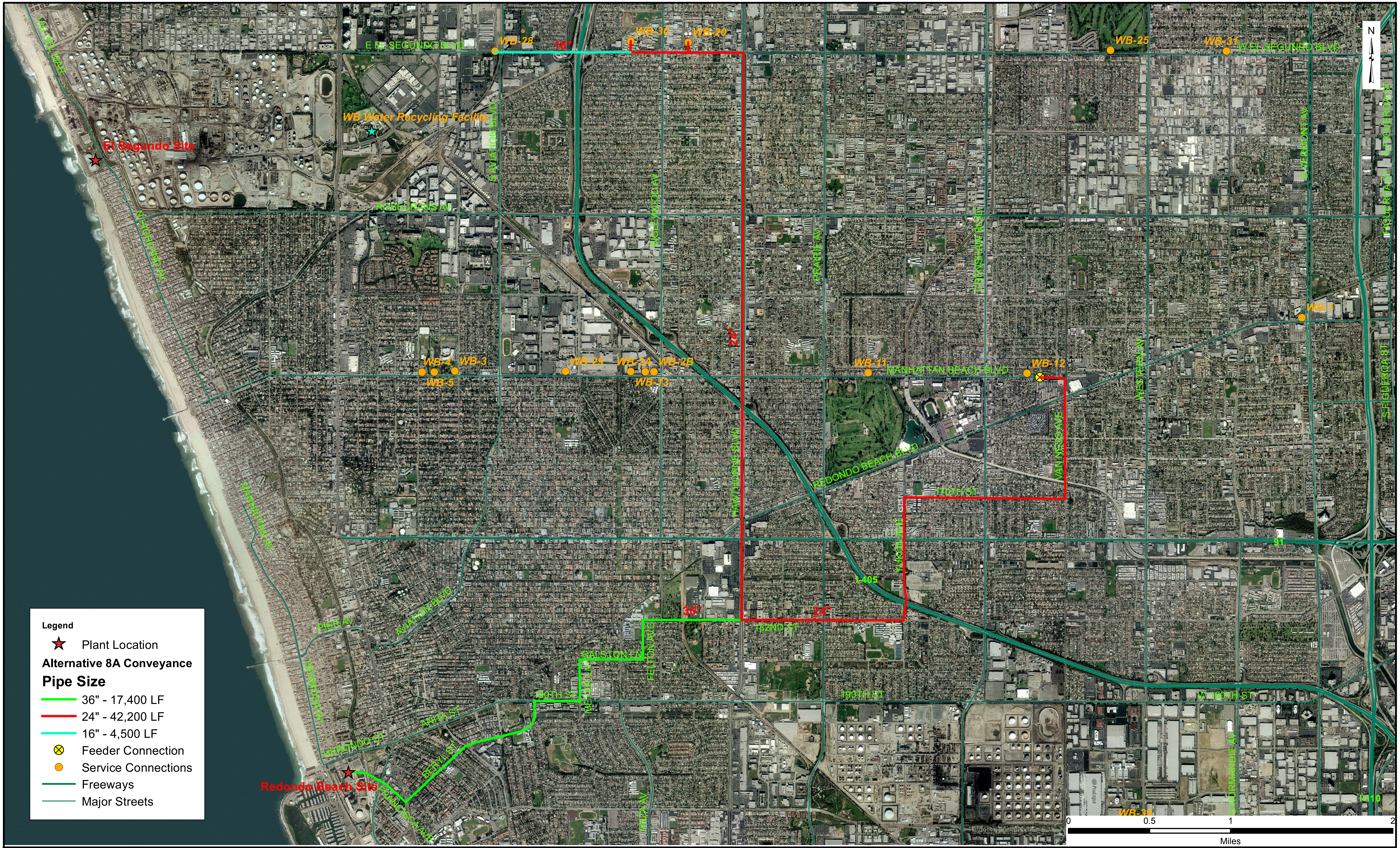
EL SEGUNDO SITE - LOCAL CONNECTIONS
CONVEYANCE ALTERNATIVE 5A

PIRNIE/ARCADIS U.S.
JANUARY 2013
FIGURE 5-16



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17140 S AVALON BLVD, STE 210, CARSON, CA 90746
OCEAN WATER DESALINATION PMP
CONTRACT NO. 05052016.0000

REDONDO BEACH SITE - LOCAL CONNECTIONS
CONVEYANCE ALTERNATIVE 6A

PIRNIE/ARCADIS U.S.
JANUARY 2013
FIGURE 5-17

Table 5-7: Summary of Preliminary Pipe Sizes and Lengths (Alternatives)

Alt.	Backbone Feeder Alignment	WB Feeder Alignment	WC Feeder Alignment
1A	36" ~ 16,000 LF 24" ~ 10,600 LF	24" ~ 2,900 LF 16" ~ 4,200 LF 12" ~ 15,800 LF	16" ~ 6,500 LF
2A	36" ~ 21,400 LF 24" ~ 10,600 LF	30" ~ 2,500 LF 16" ~ 2,300 LF 12" ~ 15,800 LF	18" ~ 7,000 LF
3A	36" ~ 16,000 LF 24" ~ 9,200 LF	24" ~ 2,700 LF	18" ~ 7,000 LF
4A	36" ~ 21,400 LF 30" ~ 11,900 LF	-	18" ~ 7,000 LF
5A	36" ~ 16,000 LF 24" ~ 1,400 LF	24" ~ 22,300 LF	24" ~ 7,500 LF 18" ~ 7,000 LF
6A	36" ~ 17,400 LF 24" ~ 18,500 LF	24" ~ 18,800 LF	24" ~ 4,900 LF 16" ~ 4,500 LF

Table 5-8: Summary of Preliminary Pump Requirements (Alternatives)

Alt.	No. of Pumps	Description	Total Dynamic Head (feet)	Pump (Hp)
1A	5	7.5 MGD Vertical Turbine Pumps	489	800
2A	5	7.5 MGD Vertical Turbine Pumps	483	800
3A	5	7.5 MGD Vertical Turbine Pumps	498	800
4A	5	7.5 MGD Vertical Turbine Pumps	482	800
5A	5	7.5 MGD Vertical Turbine Pumps	489	800
6A	5	7.5 MGD Vertical Turbine Pumps	605	1000

5.2.3. Evaluation of Conveyance Alternatives

Evaluation of each conveyance alternatives include preliminary pipe and pump sizing and rough order of magnitude cost opinions. Detailed pipe and pump sizing calculations and cost opinions can be found in **Appendix 1:E**. **Table 5-9** summarizes the pipeline and pump cost opinions.

Additional pipe and pump sizing calculations and cost opinions are included in the Appendix for 10 MGD and 40 MGD scenarios for both sites. See Section 7 of this TM for a complete list of scenarios. Conveyance figures for these alternatives are included in the PFP.

Table 5-9: Summary of Conveyance Alternatives Cost Opinion

Alt.	Desal Loc	Description	Pipeline	Pumps	Total
1	NRG	Local Service Connections	$18.1 M	$4.7 M	$22.8 M
2	AES	Local Service Connections	$20.9 M	$4.7 M	$25.6 M
3	NRG	WB Feeder Connection (West End)	$16.2 M	$5.2 M	$21.4 M
4	AES	WB Feeder Connection (West End)	$17.2 M	$5.2 M	$22.4 M
5	NRG	WB Feeder Connection (East End)	$23.0 M	$5.2 M	$28.2 M
6	AES	WB Feeder Connection (East End)	$28.4 M	$5.8 M	$34.1 M
7	NRG	Sepulveda Feeder Connection	$56.2 M	$16.5 M	$72.7 M
8	AES	Sepulveda Feeder Connection	$61.7 M	$16.5 M	$78.2 M
1A	NRG	*Local Service Connections*	*$20.4 M*	*$5.8 M*	*$26.2 M*
2A	AES	*Local Service Connections*	*$24.2 M*	*$5.8 M*	*$30.0 M*
3A	NRG	*WB Feeder Connection (West End)*	*$17.5 M*	*$5.8 M*	*$23.3 M*
4A	AES	*WB Feeder Connection (West End)*	*$40.2 M*	*$5.8 M*	*$46.0 M*
5A	NRG	*WB Feeder Connection (East End)*	*$25.1 M*	*$5.8 M*	*$30.9 M*
6A	AES	*WB Feeder Connection (East End)*	*$26.8 M*	*$7.0 M*	*$33.8 M*

Based on the preliminary evaluation, Alternatives 1 and 3 have the two lowest capital costs for pipeline due to smaller pipe sizes and shorter pipe lengths, respectively. Alternatives 1 and 2 have the two lowest capital costs for pump stations due to smaller pump requirements for local service connections.

In addition, MWD charges separate conveyance fees for connections to MWD Feeders (alternatives 3 through 8 and 3A through 6A). The conveyance fees include:

System Access Rate – All users of the MWD system pay the System Access Rate, which recovers a portion of the costs associated with the conveyance and distribution system, including capital, operating and maintenance costs.

Water Stewardship Rate – The Water Stewardship Rate is charged for every acre-foot of water conveyed by the MWD, which supports MWD's financial commitment to conservation, water recycling, groundwater recovery and other water management programs approved by the Board.

Table 5-10 summarizes the estimated MWD charges per acre-foot.

Table 5-10: Summary of Additional MWD Charges per Acre Foot

Alt.	2011	2012	2013	2014	2015	2016	2017	2018	2019
Tier 1 Supply	$155	$164	$164	$168	$173	$180	$188	$198	$214
Tier 2 Supply	$280	$290	$300	$311	$322	$333	$345	$357	$369
System Access Rate	$204	$217	$234	$250	$270	$294	$318	$339	$357
Water Stewardship Rate	$41	$43	$46	$51	$54	$55	$58	$58	$58
Treatment Surcharge	$127	$136	$136	$136	$136	$145	$151	$163	$179
System Power Rate	$217	$234	$253	$272	$287	$296	$308	$321	$338

Based on the estimated MWD fees, the additional MWD fees for feeder connection will result in a fee increase per acre-foot by as much as 57% and 47% in Tier 1 and 2 Supplies, respectively, in year 2019.

In addition to the costs associated with the conveyance, there are other potential challenges that may impact the overall costs and require further evaluation during the preliminary design. These potential challenges include right-of-way issues, traffic and access issues, utility conflicts, and local agency coordination.

Right-of-Way Issues – Generally, work within the public right-of-way is allowed without easements, except for work within the Caltrans right-of-way (such as the Pacific Coast Highway or the 405 Freeway) which may require easements and/or encroachment permits. All of the preliminary pipe alignments and pump stations are located either on the plant site or within the public right-of-way with minimal work within the Caltrans right-of-way for required crossings.

Traffic and Access Issues – Traffic control and proper access will be required for all work within the public right-of-way. Work within the major arterial streets, such as El Segundo Boulevard and Manhattan Beach Boulevard, will result in greater traffic impacts and traffic control costs but may have less space constraints and more direct pipe alignments. On the other hand, work within smaller local streets will have less traffic impacts and traffic control costs but may have result in more space constraints. The West Basin alternatives present pipe alignments based on most direct routes on major arterial streets and the MWD alternatives present pipe alignments that present less direct routes on smaller local streets.

Utility Conflicts – Some level of utility conflicts are expected for all work within the public right-of-way, but most of these issues can be worked around during the detailed design phase with a thorough research of existing utilities through record drawings and field investigations. Potential utility conflicts include water, sewer, drainage, electrical, oil, gas, and telephone facilities.

Local Agency Coordination – Coordination with local agencies are required for all local service connections. The local agencies include West Basin, Golden State Water Company, Cal Water Service Company – Hermosa/Redondo, City Manhattan Beach, and City of El Segundo for the West Basin Feeder. The local agencies include West Basin, Golden State Water Company, and Cal Water Service Company – Hawthorne for the West Coast Feeder service connections. The coordination effort could be exhaustive and time consuming depending on the level of commitment from the local agencies.

For the purposes of this preliminary evaluation, it is assumed that these potential challenges stated above present similar risks for all alternatives. Then, based on the overall capital costs and MWD fees, Alternatives 1 and 2 (local service connections) appear to be the most attractive for the conveyance alternatives.

6. Power Supply

This section discusses the power demands and introduces various power supply option concepts. A further detailed discussion of Power Supply is included in TM-2 (PSP).

6.1. Power Demands

The power demand is estimated at approximately 0.5 to 0.6 MW/MGD. However, with efficiency improvement the power demand can be reduced to between 0.4 -0.5 MW/MGD. It is likely that the distribution network will require additional pumping power, however the exact amount is undetermined at this time.

Using the above factors, the total power requirement for the local supply option (20 MGD) is estimated at approximately 12 MW, while the total power requirement for the regional supply option (60 MGD) is estimated at approximately 36 MW,

6.2. Power Supply Options

6.2.1. Power Supply Alternative

6.2.1.1. NRG El Segundo Generating Station

ESGS has been operating as an electric generating station since May 1955. The facility was comprised of four gas-fired conventional, electric power generating units. Units 1 and 2 have been demolished at the site and construction of a combined cycle power plant within the footprint of the demolished units is in progress by the current owner NRG. The current operating capacity of Unit 3 and 4 at El Segundo Power Plant is 670MW. Units 3-4 are used infrequently, with reported capacity factor for combined units 3 and 4 at 10.5% in 2006.

The new combined cycle unit will consist of two combustion gas turbine generators (CTGs), two heat recovery steam generators (HRSGs), and one steam turbine generator (STG). Total output of the combined cycle plant will be 550 MW. Heat rejection from the STG will be accomplished with an air cooled condenser, thus eliminating the once through ocean water cooling. Natural gas will be the fuel utilized by the two new CTGs. **Table 6-1** is a summary of the new configuration for the NRG El Segundo power plant.

Table 6-1: NRG El Segundo Power Plant

Unit	In Year Service	Rated Capacity (MW)	Cooling Water Flow[12] (gpm)
Unit 3	1964	335	132,400
Unit 4	1965	335	131,000
GT 1	2013	185	-
GT 2	2013	185	-
STG	2013	180	Air Cooled
ESPS total		1,220	263,400

Figure 6-1 depicts the site layout showing the existing operating units 3 and 4 and proposed location for new combined cycle units under construction and the existing SCE electrical switchyard.

Figure 6-1: NRG ESGS Site Layout

Electricity generated by the El Segundo Power Redevelopment Project will be delivered to the existing Southern California Edison (SCE) substation located on a separate parcel immediately adjacent to the ESGS property. From SCE's El Segundo 220 kV substation,

[12] Tetra Tech Report – California Coastal Power Plants, Alternative Cooling System Analysis NRG ESGS

electricity will be transmitted to users by the existing transmission and distribution network.

The existing 220 kV SCE switchyard on site can be available to draw power for the new desalination plant. Alternately, the site also has a 61 kV feed (to be verified). Nexant has contacted SCE and requested details on 220 kV and 61 kV switchyard configurations after NRG's tie-in when the new combined cycle plant is completed.

6.2.1.2. AES Redondo Beach Generating Station

AES Redondo Beach, LLC, owns and operates 4 steam generating units (Units 5–8) at RBGS in the city of Redondo Beach, Los Angeles County.

Four other steam units (Units 1-4) have been retired but remain on the facility property. Units 5-8 at RBGS are used infrequently; with the 2006 combined capacity utilization rate at approximately 5 percent.

Table 6-2: RBGS General Information

Unit	In Service Year	Rated Capacity (MW)	Cooling Water Flow[13] (gpm)
Unit 5	1954	175	72,000
Unit 6	1957	175	72,000
Unit 7	1967	480	234,000
Unit 8	1967	480	234,000
RBGS total		1,310	612,000

Figure 6-2 shows the site layout for the RBGS station with 220 kV and 61 kV switch yard.

[13] Tetra Tech Report – California Coastal Power Plants, Alternative Cooling System Analysis AES RBGS

Figure 6-2: AES RBGS Site Layout

The California Coastal Commission has issued a directive to phase out once through cooling of coastal power plants, however the AES's future plan for the RBGS is unknown at this time.

6.2.2. SCE Rate Structure

For the West Basin desalination project only the SCE rate structure is evaluated, as the option of procuring power from another electric service provider is not currently available.

6.2.2.1. Procuring Power from Another Electric Service Provider

The right of retail customers to elect to procure power from electric service providers other than SCE was suspended by the California Public Utilities Commission on September 20, 2001. Customers currently receiving services from an electric service provider other than SCE (third-party provider, or Energy Service Provider [ESP]) will continue to be billed for the non-generation charges through the applicable SCE tariff, while their generation cost components will be billed according to the terms and charges agreed upon with their ESP.

SCE customers' electricity rates are established by the California Public Utilities Commission (CPUC), the government body that regulates all investor-owned utilities in the state. The CPUC assesses rates every three years through General Rate Case proceedings.

6.2.2.2. SCE Business Rates

SCE Business rate plans are determined by the amount of electricity used and by the nature of the business or operation. SCE's business classification based on peak annual demand is as follows:

Small Business Customers (0-20 kW)

Medium-Sized Business Customers (20kW to 500 kW)

Large Businesses and Industrial Customers (above 500 kW)

It is stipulated that the West Basin desalination plant will require a minimum of 12 MW of power on 24/7 basis. This will put the desalination plant under large industrial customer category. SCE offer two rates for large industrial customers, 1) TOU-8 or Time of Use General Services – Large and 2) RTP-2 or General Services Large, Real Time Pricing.

6.2.2.3. SCE Rate Schedule TOU-8

TOU-8 rate schedule[14] is applicable to general service including lighting and power, except agricultural water pumping accounts. This Schedule is applicable to and mandatory for all customers whose monthly maximum demand, in the opinion of SCE, is expected to exceed 500 kW or has exceeded 500 kW in any three months during the preceding 12 months.

Service under this Schedule is <u>subject to meter availability</u>.

TOU-8 Schedule contains four rate structures; Critical Peak Pricing (CPP), Option A, Option B, and Option R. Details of these plans are available upon formal request for utility connection. West Basin will have to make a formal request to SCE for details on these rates.

Rate Schedule TOU-8 separates basic charges into:

1) A monthly Customer Charge that covers a portion of basic services, such as meter reading and customer billing;

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[14] SCE TOU -8 rates, Advise 2550-E, effective March 3, 2011. www.sce.com

2) Energy Charges per kilowatt-hour (kWh) consumed that vary by season and time of day; and
3) Demand Charges consisting of Time-Related Demand;
4) and Facilities-Related Demand charges.

The Time-Related Demand Charge is applied only during SCE's summer season. This charge helps recover part of SCE's higher costs of providing transmission and distribution services during the high demand summer season. It is a per-kW charge applied to the greatest amount of registered demand in each summer season billing period (note: Time interval to measure for Time-Related Demand Charges is not spelled out in the published rate structure, and will have to be clarified with SCE).

The Facilities-Related Demand Charge is also billed on a per-kW basis, yet it is in effect in each billing period throughout the year. It is applied to the greatest amount of registered demand in each billing period. This charge is necessary to recover costs for the installed transmission and distribution facilities required to serve customer's highest demand during the year.

6.2.2.4. SCE Rate Schedule RTP-2

SCE rate schedule RTP-2[15] is applicable to Bundled Service Customers eligible for service under Schedule TOU-8, General Service - Large. This Schedule is limited to customers who agree to participate in the Real Time Pricing ("RTP") program and is subject to meter availability. Under this rate schedule the following is applicable:

Maximum Demand: The Maximum Demand for the billing month shall be the measured maximum average kilowatt input indicated or recorded by instruments, during any 15-minute metered interval in that billing month. Where the demand is intermittent or subject to violent fluctuations, a 5-minute interval may be used.

Billing Demand: The Billing Demand shall be the kilowatts of Maximum Demand determined to the nearest kW. The kW of Billing Demand used to determine the Facilities Related Demand Charge shall be based on the kilowatts of Maximum Demand recorded during (or established for) the monthly billing period. However, when SCE determines the customer's meter will record little or no energy use for extended periods of time or when the customer's meter has not recorded a Maximum Demand in the preceding eleven months, the Facilities Related Demand Charge may be established as 50 percent of the customer's connected load.

Real Time Pricing: As used in this schedule, Real Time Pricing is the practice of continuously varying prices to customers to reflect simulated hourly variations in the

[15] SCE RTP-2 rates, Advise 2577-E-A, effective June 1, 2011. www.sce.com

marginal costs of generating electricity. Detailed hourly rates for each month can be downloaded from SCE web site.

Voltage Discounts: Bundled Service Customers will have the Distribution rate component of the applicable Delivery Service charges reduced by the corresponding Voltage Discount amount for service metered and delivered at the applicable voltage level as shown in the Rates section above. In addition, Customers receiving service at 220 kV will have the Utility Retained Generation (URG) rate component of the applicable Generation Charges for service above 50 kV reduced by the corresponding Voltage Discount amount for service metered and delivered at 220 kV as shown in the Rates section.

Power Factor Adjustment: The customer's bill will be increased each month for power factor by the amount shown in the Rates section above for service metered and delivered at the applicable voltage level, based on the per kilovar of maximum reactive demand imposed on SCE.

The maximum reactive demand shall be the highest measured maximum average kilovar demand indicated or recorded by metering during any 15-minute metered interval in the month.

The kilovars shall be determined to the nearest unit. A device will be installed on each kilovar meter to prevent reverse operation of the meter.

The daily maximum temperature, as recorded by the National Weather Service, at its Downtown Los Angeles site, will be used to determine the hourly rates for the following day according to the RTP-2 rate schedule. It is the responsibility of the customers to acquire the daily maximum temperature at the Los Angeles Downtown site. SCE is not required to provide the daily maximum temperature. In the event that data is unavailable from Downtown LA as the primary source, data collected by the National Weather Service from Long Beach Airport shall be used. Where data is not available from either site, SCE shall enact its procedure for emergency data collection in order to provide substitute temperature data.

6.2.2.5. Additional Rate Options

SCE offers additional rate options, if the facility is eligible for Rate Schedule TOU-8, it may be eligible for other pricing options that may further lower the electric bills. These options include:

Load reduction rate incentive programs such as TOU-BIP and I-6, which offer financial incentives year round, for complying with requests by SCE to interrupt power usage when an interruptible event is initiated. These programs are offered on a contract basis only, and eligibility requirements vary.

SCE offers other programs to the customers to help better manage electricity costs, such as rebates, incentives, energy surveys and payment options.

The specifics about the large customer rate schedule or other programs will have to be sorted out with SCE account representative.

6.2.3. SCE Rate Analysis

Table 6-3 is a summary of the SCE rate basis for large users with electrical load >500 kW.

Table 6-3: Large User Rate Basis

Rate Schedule	Eligibility	Rate Type	Customer Charge	Demand Charge	Energy Charge	Other Options
RTP-2	Bundled service customers >500kW	Optional for TOU-8 accounts Seasonal Temperature driven hourly pricing	Charge per meter, per month	Facilities Related	Temperature Driven	Power factor adjustment per kVAR Voltage discount as applicable Interval meter requires
TOU-8* (Primary voltage 2k-50w)	>500kW	Mandatory for accounts >500kW Seasonal Time of Use	Charge per meter, per month	Facilities Related On-peak & mid peak demand charges	On peak, mid peak and off peak energy charges that are lower in winter and higher in summer	Power factor adjustment per kVAR Voltage discount as applicable Interval meter required

SCE uses four different periods for TOU metering purpose during summer months and three periods during the winter months. **Table 7-4** is summary of TOU period currently defined by SCE and estimated hours in the year for each period. The hours are calculated based on SCE definition for holidays and based on 52 weeks. Actual hours in a period may vary slightly from year to year, depending on if the holidays fall on weekend or weekdays.

Table 6-4: Time of Use Periods for TOU-8

Time of Use Periods		Mon	Tue	Wed	Thur	Fri	Sat	Sun
Summer Season	8 AM - Noon							
June 1 - September 30	Noon- 6 PM							
	6 PM - 11 PM							
	11PM - 8 AM							
Winter Season	8 AM - 9 PM							
October 1 - May 31	9 PM - 8 AM							
				Summer	Winter	Total		
			Days	122	243	365		
On Peak - Highest Energy Charge			Hrs	516	0	516		
Mid Peak - Medium Energy Charge			Hrs	774	2171	2945		
Off Peak - Lower Energy Charge			Hrs	1638	3661	5299		

The current SCE electricity charges for TOU-8 for large users are outlined in **Table 6-5**. This includes energy charges, kW demand charges, power factor adjustment, and reactive power charges. These are indicative rates, and for TOU billing scheme. SCE will provide detailed breakdown of billing charges based on overall service requested by the customer.

Table 6-5: Electricity Charges for TOU for >500kW

Time Period				
Delivery Service Charges	$/kWh	0.01616	0.01616	0.01616
Energy Charges Summer	$/kWh	0.1261	0.09968	0.07139
Energy Charges - Winter	$/kWh	0	0.09318	0.07101
		For All Periods		
Customer Charge	$/meter/month	2376.08		
Demand Charges	$/kW /month	4.63		
PF Adjustment	$/kVAR	0.32		
Demand Charge Discount	$/kW /month	-1.99		

The next step is to determine actual power usage by the proposed desalination plant. Once, the power usage is determined, monthly and annual electricity bill can be estimated for planning and for cost analysis.

The following two figures outline the SCE transmission lines serving the proposed two sites and a metering scheme for the TOU-8 rate base.

6.3. Power Supply

The option considered for onsite generation is a small combined cycle plant with gas turbine and steam turbine generator in a combined cycle mode. The gas turbine is fired with pipeline natural gas already available at both the El Segundo and Redondo Beach sites. The hot exhaust from the gas turbine is directed to a heat recovery steam generator where high pressure steam is generated. The high pressure steam is run through a steam turbine generator to generate additional power.

The gas turbines are available in standard size from many vendors. These gas turbines are available in the range of approximately 1 MW to 180+MW. The proposed new NRG combined cycle plant will be utilizing two 180 MW gas turbine generators. However, for the proposed desalination facility, the actual power required will be in the range of 15 MW to 40 MW, based on desalination plant capacity.

6.3.1. Power Plant Considerations

Figure 6-3 shows a typical combined cycle configuration – gas turbine, heat recovery steam generator (HRSG), exhaust stack, steam turbine generator, steam condenser, and HRSG feed water system, etc. The vendors offering this configuration include – GE, Siemens, Dresser Rand, Solar Turbine (a division of Cater Pillar), and Rolls Royce. There are other GT manufacturers including ALSTOM, Mitsubishi, and Hitachi; however, they offer only large frame machines with size range from 80+ MW. These GT are too large for the specific application for West Basin desalination plant and are not evaluated here. The steam turbines are custom designed and can be ordered in size desirable for the particular application.

Figure 6-3: AES RBGS Site Layout

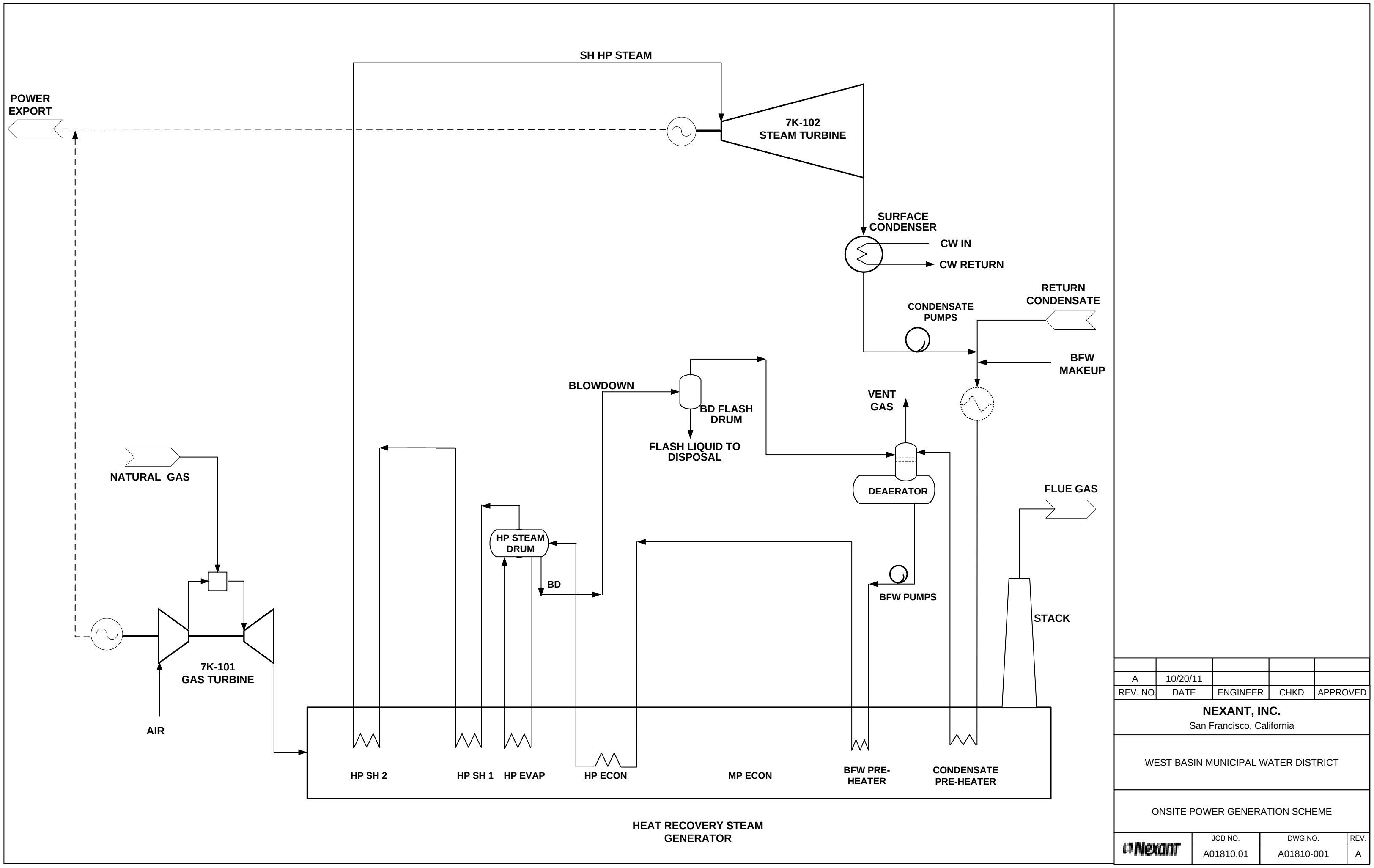


Table 6-6 lists some of the possible on-site power generation configurations. It should be noted that other configurations are possible and the options in **Table 6-6** are provided for illustrative purposes only. If higher power output is desired, one method is to use two identical gas turbines in parallel with two HRSG to generate the steam. The steam from the two HRSG is combined to run a larger steam turbine, thereby doubling the output from the plant. The configuration in **Table 6-6** is referred to as 1x1, i.e. one gas turbine and one steam turbine. Configuration with 2 gas turbines is referred to 2x1 or two gas turbines and one steam turbine.

Table 6-6: Possible Power Plant Configurations

Model	GT Power	ST Power	Net Combined Cycle Output
	kW	kW	kW
Dresser Rand KG2-3E	1,895	682	2,526
Pratt & Whitney ST40	4,039	1,454	5,383
Mercury50	4,600	1,656	6,131
Taurus 60	5,670	2,041	7,557
Taurus 65	6,300	2,268	8,397
Rolls Royce 501-KH5	6,447	2,321	8,593
Taurus70	7,520	2,707	10,023
Mars 100	10,430	3,755	13,901
Siemens SGT-400	12,900	4,644	17,193
Titan 130	15,000	5,400	19,992
GE LM2000 PJ	17,657	6,816	23,911
GE LMS2000PS	17,657	6,357	23,533

A further detailed discussion of Power Supply will be included in the overall Master Plan.

7. Conceptual Plant Design

The objective of this Section is to define conceptual criteria for the West Basin Ocean Water Desalination Treatment Plant at both of the site alternatives, El Segundo and Redondo Beach, to serve as a basis for this planning phase. As discussed in previous sections, additional studies are pending and identified for developing further understanding of the intake structure configuration, product water quality requirements, and conveyance solution. Additional testing, assessment and optimization of treatment system alternatives, including results from the current demonstration testing are pending and will also affect the ultimate treatment train selected for design.

The assessment and criteria presented in this section is based on previous efforts conducted to date by West Basin and its consultants, including the El Segundo Pilot Study and the West Basin Ocean Water Desalination Demonstration Program, in addition to consideration for current practices implemented for Ocean Water Desalination Plants worldwide. Until detailed design is performed, the preliminary criteria values function as placeholders pending a more detailed assessment.

7.1. Project Definition Summary

The project definition presented in this section is a compilation and summary of components developed in preceding sections. The data is presented here to provide a concise description of the basis used for development of the process treatment trains, layouts, and costs.

As noted in the previous sections, substantial efforts have been completed by West Basin and its consultants on the development of project conditions for both sites, including raw water quality and process treatment assessment and selection. The project conditions and definition presented will utilize this data to the extent available, supplemented by newly available relevant data from current sampling, analyses, and testing results.

7.1.1. Source Water Quality

As presented in Section 5, the preferred intake alternative for supplying raw ocean water to the treatment plant utilizes (and modifies, as discussed in Section 5) the existing open intake tunnel structures at both site locations. As such, the water quality data collected from the existing site intakes will be used as the basis for this evaluation. For the Redondo Beach site, water quality data collected from the demonstration testing is used to supplement the historical data collected from the existing open intake structures used for the AES power generating station.

The raw water quality data representative of the two alternative sites were obtained from the following data sources:

- Final Comprehensive Report 2002-2009, September 2, 2010, SPI
- WBMWD, Ocean Water Desalination Demonstration project, TM-1 Water Assessment, October 16, 2006, TTI/MWH
- WBMWD, Temporary Ocean Water Desalination Demonstration project, TM-2 Process Requirements, February 9, 2007, TTI/MWH
- West Basin OWDDF operations Monitoring Data, March, 2011 - August, 2011

Table 7-1 summarizes the raw water quality for this project for the El Segundo location based on these sources of data.

Table 7-1: El Segundo Raw Water Quality Summary

Parameter	Units	Average	Minimum	Maximum
Inorganics				
Calcium	mg/L	400	343	506
Magnesium	mg/L	1,280	1,110	1,620
Sodium	mg/L	10,800	8,880	13,100
Potassium	mg/L	391	41	478
Silica	mg/L	<10	<10	<10
Fluoride	mg/L	0.94	0.80	1.10
Phosphorous	mg/L	0.07	0.02	0.10
Arsenic	µg/L	9.90	0.90	57
Strontium	mg/L	7,190	6,820	7,660
Aluminum	mg/L	101	99	110
Selenium	mg/L	51	0.40	194
Iron	mg/L	283	250	336
Nitrate	mg/L as N	<25	NA	NA
Nitrite	mg/L as N	<25	NA	NA
Ammonia	mg/L	0.03	0.005	0.01
Chlorate	µg/L	<1,000	<1,000	<1,000
Chloride	mg/L	18,974	18,000	20,100
Sulfate	mg/L	2,531	2,230	2,650
Alkalinity	mg/L as CaCO3	113	99	130
Total Hardness	mg/L as CaCO3	6,200	3,340	7,940
Ca Hardness	mg/L as CaCO3	980	860	1,260
Boron	mg/L	3.5	2.6	4.2
Bromide	mg/L	59	45	91
Perchlorate	µg/L	<200	<200	<200

Parameter	Units	Average	Minimum	Maximum
Chromium	µg/L	0.21	0.19	0.55
Hex. Chromium	µg/L	1.15	0.01	9.70
Silver	µg/L	<10	<10	<10
Beryllium	µg/L	0.64	0.02	1.40
Copper	µg/L	32	0.10	174
Lead	µg/L	0.17	0.07	0.47
Zinc	µg/L	1.04	0.50	3
Thallium	µg/L	0.02	0.02	0.02
Mercury	µg/L	1.65	0.02	4.80
General Physical Parameters				
Total Dissolved Solids	mg/L	35,000	32,000	38,000
Turbidity	NTU	1.6	0.1	8.3
pH	s.u.	8	7.2	8.4
Temperature (Influent)	^{O}C	18.1	8.7	25.9
Color	Color Units	3	1	5
UV	abs/cm	0.01	0.01	0.02
Total Organic Carbon	mg/L	1.2	0.3	3.4
Microbial				
E. Coli	MPN/100ml	3.5	0	27
Fecal Coliform	MPN/100ml	<1.1	<1.1	4
Total Coliform	MPN/100ml	7.6	<2	50
Enterococci	MPN/100ml	12	<2	23
Heterophic Plate Count	CFU/ml	20	1	47
Cryptosporidium	oocysts	<1	<1	<1
F-Specific Phage	PFU/l	ND	ND	ND
Giardia	cysts	ND	ND	ND
Somatic	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	7.20
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
Toluene	µg/L	<0.5	<0.5	0.92
Algal Toxins				
Domoic Acid	µg/L	0.30	<0.002	2.57

Table 7-2 summarizes the raw water quality representative of the Redondo Beach site.

Table 7-2: Redondo Beach – Raw Water Quality Summary

Parameter	Units	Average	Minimum	Maximum
Inorganics				
Calcium	mg/L	373	360	400
Magnesium	mg/L	1,254	1,200	1,400
Sodium	mg/L	10,833	10,000	13,000
Potassium	mg/L	468	390	580
Silica	mg/L	0.78	0.52	1.30
Fluoride	mg/L	<0.5	<0.5	<0.5
Phosphorous	mg/L	NS	NS	NS
Arsenic	mg/L	0.98	0.85	1.10
Strontium	mg/L	7.07	7.00	7.10
Aluminum	mg/L	<0.01	<0.01	<0.01
Selenium	mg/L	<0.1	<0.1	<0.1
Iron	mg/L	<0.05	<0.05	<0.05
Nitrate	mg/L as N	NS	NS	NS
Nitrite	mg/L as N	NS	NS	NS
Ammonia	mg/L	2,200	2,200	2,200
Chlorate	mg/L	<10	<10	<10
Chloride	mg/L	20,542	20,000	21,000
Sulfate	mg/L	2,713	2,500	2,900
Alkalinity	mg/L as CaCO3	109	37	120
Total Hardness	mg/L as CaCO3			
Ca Hardness	mg/L as CaCO3			
Boron	mg/L	4.7	4.1	5.3
Bromide	mg/L	65	59	70
Perchlorate	µg/L			
Chromium	µg/L	0.0004	0.0004	0.0004
Hexavalent Chromium	µg/L	<1.5	<1.5	<1.5
Silver	µg/L	<0.05	<0.05	<0.05
Beryllium	µg/L	<0.05	<0.05	<0.05
Copper	µg/L	2.3	1.5	3.1
Lead	µg/L	0.07	0.05	0.10
Zinc	µg/L	0.5	0.3	0.7
Thallium	µg/L	<0.0004	<0.0004	<0.0004
Mercury	µg/L	0.0004	0.0004	0.0004
General Physical Parameters				
Total Dissolved Solids	mg/L	37,917	34,000	41,000

Parameter	Units	Average	Minimum	Maximum
Turbidity	NTU	1.8	0.1	9.7
pH	s.u.	8.2	6.5	8.4
Temperature (Influent)	^{O}C	17.8	11.5	24.6
Color	Color Units	< 3	< 3	< 3
UV	abs/cm			
Total Organic Carbon	mg/l	0.97	0.3	1.7
Microbial				
E. Coli	MPN/100ml	9.4	2	41
Fecal Coliform	MPN/100ml	3.6	2	11
Total Coliform	MPN/100ml	3.4	2	11
Enterococci	MPN/100ml	5	2	10
Heterophic Plate Count	CFU/ml	9	1	170
Organics				
MTBE	µg/L	<0.002	<0.002	<0.002
Toluene	µg/L	<0.0005	<0.0005	<0.0005

7.1.2. Water Quality Treatment Objectives

The product water quality goals for the proposed Ocean Water Desalination Plant discussed in Section 5 are summarized in **Table 7-3** below. These product water quality goals would be applicable to both of the alternative site locations.

Table 7-3: Product Water Quality Goals

Water Quality Parameter or Category	Desalination Plant Product Water Goal
Pathogens	
Cryptosporidium	3-log (99.9%) reduction
Giardia	3-log (99.9%) reduction
Viruses	4-log (99.99%) reduction
Turbidity	
Membrane filtration (each train)	Cannot exceed 0.15 NTU for more than 15 minutes
Disinfectants	
Chloramines	2.5 to 3.0 mg/L
Disinfection Byproducts	
Total trihalomethanes (TTHMs)	< 0.040 mg/L (50% of MCL)
Haloacetic acids (HAA5)	< 0.030 mg/L (50% of MCL)
Chlorite	< 0.8 mg/L (80% of MCL)
Bromate	< 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 to 8.5
Chloride	< 100 mg/L
Total Dissolved Solids	450 to 500 mg/L
Other secondary parameters	FDEP MCLs
Unregulated Parameters	
Calcium carbonate Precipitation potential	> 0 mg/L (minimum) 4 – 10 mg/L (target)
Langelier saturation index	> 0 (minimum) > 0.2 (target)
Boron	< 0.5 mg/L
Bromide	< 0.3 mg/L

The 8.2 pH goal that was given in Section 5 will require a high degree of remineralization to achieve the Langelier saturation index (LSI) and calcium carbonate precipitation potential (CCPP) objectives and may need to be revisited as the project progresses. In addition to regulated parameters, the mineralogical characteristics of the desalinated

water should be broadly consistent with the Suppliers own water supplies. Additional testing is recommended to confirm the bromide goal as discussed in Section 5.

7.1.3. Plant Treatment Capacity

Treatment capacities for the Ocean Water Desalination Plant are based on the Regional and Local cases supply and demand assessment performed in Section 2.

Table 7-4 summarizes the capacity and phasing requirements considered within this conceptual design for the Local and Regional cases.

Table 7-4: Treatment Plant Capacity

		Treatment Capacity (MGD)	
Scenario	**Case**	**El Segundo**	**Redondo Beach**
1	Local	Initial: 10-MGD Build-out: 20-MGD	Initial: 10-MGD Build-out: 20-MGD
2	Regional	Build-out: 60-MGD	Build-out: 60-MGD

Base demands were evaluated for both local and regional scale projects. The local project focuses on MWD service connections along the West Coast and West Basin Feeders west of the Sepulveda Feeder, which services the majority of West Basin's service area. The local demand supports up to a 20-MGD plant. Although the regional MWD conveyance system is capable of taking upwards of 60-MGD, the regional plant demand based on existing MWD operational constraints is 25-MGD. West Basin continues to work with MWD to evaluate regional supply approach options and approaches to limit operational constraints. Although it has not yet been determined if a larger facility is necessary, a regional plant size of 60-MGD has been selected for conceptual development within this study. Both the El Segundo and Redondo Beach sites can support up to a 60-MGD ocean water desalination plant. A total of five scenarios were considered for cost development in Section 2 of the PFP:

1) Fully built-out 10-MGD facility

(2) Fully built-out 20-MGD facility

(3A) 10-MGD facility with 40-MGD backbone for expansion

(3B) Fully built-out 40-MGD facility

(4) Fully built-out 60-MGD facility

However, as identified in **Table 7-1**. conceptual development was performed only for the fully built-out 20-MGD and 60-MGD facility options.

The recovery of a seawater reverse osmosis treatment plant, defined as the quantity of finished water divided by the raw water supplied, is expected to be in the range of 50 percent with a two pass/recycle system. Pretreatment capacity also needs to account for plant availability, and any additional intake requirement for backwash or other raw water requirements. On this basis, all pretreatment processes need to be designed for approximately two times the projected finished water capacity of the desalination facility, with additional redundant capacity as necessary. Intake design also needs to consider potential future capacity increase requirements.

7.2. Process Treatment Train

7.2.1. Overview Processes

The currently proposed process train is predicated on several important factors, including: 1) the use of reverse osmosis (RO) for desalination; 2) the use of an open intake; 3) source water quality and local environmental conditions in the vicinity of the intake, as identified in previous and ongoing studies conducted by West Basin; and 4) regulatory requirements. Based on these factors, the ocean water desalination plant will most likely include the following component processes:

- 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

The following subsections discuss each of these respective component processes in the context of site-specific considerations (including performance objectives, as applicable) for the West Basin Ocean Water Desalination Plant.

7.2.1.1. Intake

Section 4 assesses the alternative intake solutions and identifies a preferred intake configuration utilizing the existing open intake/tunnel structures. A summary of intakes of major seawater reverse osmosis (SWRO) plants around the world shows a majority of open sea intakes, as opposed to subsurface intakes that take advantage of infiltration wells or galleries. Open sea intake will generally result in entrained sediments and increased potential for biological growth, whereas subsurface intakes are likely to reduce the presence of these particles and minimize the potential for biological fouling. Open sea intakes will therefore generally require a higher degree of pretreatment than subsurface intakes prior to the desalination process

Pretreatment process selection will be strongly influenced by the type of intake adopted in the plant design. There are a large number of possible variants of intake design selection of which is project specific and is influenced by sea water quality, maintenance/biofouling control, design capacity, geotechnical conditions, marine conditions, construction risk, cost and time frame. A detailed discussion of the advantages and disadvantages of the various types, and when each may be considered, are presented in Section 4.

Open sea intakes include both onshore and offshore intakes. There are numerous examples of open intakes for large SWRO plants with production capacities of 20-100+ MGD.

7.2.1.2. Pretreatment

In the selection of pretreatment requirements, key elements are the type of intake structure and location of the inlet. These elements will have a direct affect on the quality and variability of feed water to the plant and will help to dictate the need for pretreatment to improve the performance of downstream processes. As discussed in the previous section, an open intake is proposed for the West Basin Ocean Water Desalination Plant. Pretreatment processes need to be established to produce a water quality suitable for optimum membrane treatment. In terms of water quality, there are several factors that should be considered in pretreatment process selection to reduce membrane fouling, minimize the risk of damage to the membranes, and enhance membrane life expectancy by minimizing the chemical cleaning. These factors are as follows:

- Particle fouling of RO membranes can be minimized if turbidity of less than 0.5 NTU and silt density index (SDI) below 3 is maintained to comply with membrane warranties. Suspended solids may be either inorganic or organic.

- Biological fouling, or biofouling, is a widespread challenge with RO membranes. Therefore, minimization of both organic content (which serves as a food source for biological agents) and algae, such as that experienced in "red tides" along California's coastline, should be given appropriate consideration.
- Organic fouling commonly occurs from natural organic matter (NOM) such as organic carbon and biopolymers. Entrained hydrocarbons, such as tars and oils, must be removed if present. It is generally recommended that oils must be maintained at levels below 0.1 mg/L to protect the membranes; thus, plant shutdown would be necessary at concentrations in excess of this threshold.
- Oxidant / disinfectant dosing should be avoided if possible, given that currently available RO membrane have limited oxidant tolerance. For example, typical membrane warranties require chlorine exposure to be less than 0.1 mg/L and exposure limited to 200-1000 mg-hrs/L over the life of the membrane. However; the membranes have a greater tolerance of chloramines based on ongoing work at the WB Ocean Water Desalination Demo plant, preformed chloramines are preferred for biofouling control on the membranes.
- Mineral scaling occurs when levels of sparingly soluble salts are concentrated in the RO process. Salts of calcium, magnesium, barium, and strontium are common scalants, precipitating at the surface of the membrane and resisting the flushing action of the concentrate flow.

Specific disinfection pretreatment, such as oxidation or ultraviolet irradiation, is not normally necessary for destroying pathogenic organisms from feed water provided that appropriate pretreatment processes are selected. Many plants however, including the Tampa Bay SWRO facility, inject chlorine or chlorine dioxide upstream of physical treatment to kill any biological contaminants and add a de-chlorination agent before the RO process. Oxidants such as chlorine, chlorine dioxide, and ozone, will react with source water constituents to form disinfection by-products (DBPs) such as trihalomethanes, haloacetic acids, chlorite, and bromate, and should be used with caution in seawater treatment. The demonstration testing currently underway is evaluating the use of preformed chloramines for this application.

The choice of pretreatment also influences wastewater treatment and solid waste disposal requirements. Some pretreatment processes, for example dual media filtration and membrane filtration, generate significant quantities of wastewater in the form of filter backwash, which must be treated and disposed. Selection of an appropriate pretreatment system must consider wastewater treatment and solid waste disposal issues.

For the purposes of pretreatment objectives related to RO membrane protection, the following criteria have been considered as the SWRO feed water objectives (as shown in **Table 7-5**):

Table 7-5: Pretreatment Objectives

Parameter	Objective	Remark
SDI	<3	95% of time
TOC (mg/L)	<3	
Oil and grease (mg/L)	0	Warranty Condition
Chlorine (mg/L)	0	Warranty Condition
BOD_5 (mg/L)	<5	
Iron (mg/L)	<0.05	
Aluminum (mg/L)	<0.05	
Turbidity (NTU)	<0.5	95% of time (IESWR requirement)

The following processes can be considered in sequence to reduce fouling potential.

- Screening
- Coagulation and flocculation
- Clarification
- Filtration
- Cartridge filtration

Each of these processes is discussed in the following subsections. As a point of reference, **Table 7-6** provides a list of similarly sized ocean water desalination facilities around the world, identifying the selected pretreatment approach in each case. Each of the plants in the table are either in operation or currently in the planning phase. The plants are listed chronologically.

Table 7-6: International Installations – Pretreatment Approaches

Plant	Location	Capacity (MGD)	Year	Owner	Delivery Method	Pretreatment	RO	Membranes
Larnaca	Cyprus	17	1999	Larnaca Desal Partners	DBOOT	Sand Filters	2-pass	Hydranautics
Point Lisas	Trinidad & Tobago	29	2002	WASA	DBOOT	Floc/sed + Sand Filters	2-pass	Toray
Fujairah	UAE	45	2003	UWEC	DB/IWPP	1-stage Sand Filters: Plan to be retro-fitted with DAF	2-pass	Hydranautics
Tuas	Singapore	36	2005	Singsing (Hyflux)	DBOO	DAF + Sand Filters	2-pass	
Ashkelon	Ashkelon, Israel	85	2005	VID (IDE, Veolia, Elran)	BOT	1-stage Sand Filters	Cascade	Filmtec
Kwinana	Perth, WA	26	2007	Water Corp.	Alliance	1-stage Sand Filters	Partial 2nd Pass	Filmtec
Tampa Bay	Tampa Bay, FL	21	2007	Tampa Bay Water	DBOOT	1-stage Sand Filters	Partial 2nd Pass	Filmtec
Rabigh IWSPP	Saudi Arabia	58	2007	Rabigh Arabian Water and	BOOT/IWSPP	2-stage Sand Filters	Three-pass RO	Hydranautics
Hamma	Algeria	53	2008	HWD	BOO	Floc/Sed + Sand Filters	Partial 2nd Pass	Toray
Alicante 1 & 2	Spain	35	2008	Municipality of Alicante	DBO	1-stage Sand Filters	Single Pass	Toray
Tugun	Gold Coast, QLD	33	2009	GCD Alliance	Alliance	Sand Filters	Partial 2nd Pass	Hydranautics
Barcelona-Llobregat	Barcelona, Spain	53	2009	Aigues Ter Llobregat	DBO	DAF + 2-stage Sand Filters	2-pass	Hydranautics
Barka 2 IWPP	Oman	33	2009	Oman Water and Power	BOOT/IWPP	2-stage Sand Filters	2-pass	Hydranautics
Tianjin Dajang News	China	26	2009	City of Tianjin	BOO	1-stage Sand Filters	2-pass	Hydranautics
Chennai Minjur	India	26	2009	City of Chennai	BOOT	1-stage Sand Filters	2-pass	Hydranautics
Skikida	Algeria	26	2009	Skikida	BOOT	1-stage Sand Filters	2-pass	Filmtec
Hadera	Hadera. Israel	87	2010	H2ID	BOT			
Kurnell	Sydney, NSW	66	2010	Sydney Water	BDOM	1-stage Sand Filters	2-pass	Filmtec
Wonthaggi	Melbourne, NSW	108	2012	AquaSure	BOT	1-stage Sand Filters		
Binningup	Perth, WA	36/72	2011/ 2013	Southern Seawater	DBOM	UF Membrane		
Port Stanvac	Adelaide	73	2011	SA Water	DBOM	UF Membrane		
Fujairah II	UAE	36	2011	UWEC	DB/IWPP	DAF + Sand Filters		Toray
Palmachim	Israel	60.8	2012	Mekorot	BOOT	1-stage Sand Filters	Four-stage RO	Hydranautics
Shuwakah	Kuwait	36	2012	Kuwait	BOOT	UF Membrane	Two-pass	Filmtec
Mostaganem	Algeria	52	2012	Algeria	BOOT	1-stage Sand Filters	Two-pass	Hydranautics
Tenes	Algeria	52	2012	Algeria	BOOT	1-stage Sand Filters	Two-pass	
Mactaa	Algeria	132	2012	Algeria	BOOT	1-stage Sand Filters	Two-pass	Hydranautics
Carlsbad	Carlsbad, CA	50	2014	Poseidon	DBOOT	Sand Filters	Cascade	

7.2.1.2.1 Screening

All open intakes require screening to keep out larger species of aquatic life and larger floating or suspended debris. Velocity through the screens is also kept low to prevent impingement of smaller mobile aquatic species. Onshore intakes, such as a wet-well or concrete forebay structures draw water from the upper layers of the sea, and as such are subject to higher water quality risks and/or variability compared to deeper intakes. These risks include greater salinity variation (due to the direct effects of rain), temperature variability, higher algal loads, floating material (including potentially higher risk of exposure to oil), wave -or wind-induced disturbance of sediments.

Offshore intakes normally include passive coarse bar screens at the offshore end and active medium screens at the onshore end, with the two connected by pipe or tunnel conduits. The intakes themselves are typically 30 feet to ideally 60 feet deeper than onshore intakes. Both temperatures and light levels are lower than at the surface, and the water quality is typically better and more stable. The intakes are deep enough to be less affected by ocean swells and are positioned above the local floor to minimize sediment entrainment into the intake conduits. However, continuous intake of seawater past the screens provides an ideal growth environment for marine organisms such as filter feeding mollusks (e.g., mussels) both on the screens and potentially within the conduit itself. These growths do not have a significant impact on the major pretreatment process selection but need to be accounted for hydraulically. Moreover, suitable maintenance and biofouling control strategies (such as shock chlorination and anoxic environment control) should be implemented to prevent hydraulic restrictions to the intake itself.

Screening requirements will vary according to the selected intake design and the environmental permitting requirements. For the open intakes similar to that proposed for this application, both coarse and medium screens are often implemented. Screening for open intakes are specified to exclude aquatic macro-life such as fish, seaweed, or seaborne debris. This is normally achieved by a combination of coarse screens at the point of intake in the ocean, followed by medium screening (e.g., drum or band screens) on-shore. Medium screens eliminate smaller particles down to 2-3 mm (0.1”) size. Disc or fine mesh screens can be used to remove particles down to 80 µm, which can be required in combination with membrane filtration.

7.2.1.2.2 Coagulation and Focculation

Chemical coagulation and flocculation can be necessary in seawater for enhanced removal of dissolved organic contaminants and suspended solids to optimize the clarification or media filtration process, as well as to produce suitable feed water quality for RO treatment. The coagulation process requires rapid mixing of chemical coagulants to impart the correct mixing intensity and begin floc (particle) formation. Static devices are generally suitable for more steady flow rates and are commonly employed with fixed flow SWRO plants. Coagulants, such as ferric sulfate or ferric chloride are added ahead of the filtration or clarification treatment process to enhance solids and organics removal. Acid may be added to enhance the coagulation process by depressing the pH. The flocculation process agitates the water at low velocity after rapid mixing to allow continued formation of the floc. Flocculation is often accomplished in multiple stages of lessening mixing intensity to optimize floc formation. If clarifiers are not necessary due to low suspended solids or organic content, but flocculation is still found to be beneficial upstream of filters, direct filtration processes can be used.

7.2.1.2.3 Clarification

Clarification can be considered following coagulation/flocculation with open sea intakes to minimize solids loading to the filtration process and reduce particulate fouling in the RO membranes. A clarification process has been selected for a few SWRO plants worldwide, particularly in the case of open intakes which are susceptible to storm induced sea-bed disturbances, high sediment transport or algal blooms. Clarification can be achieved in sedimentation basins or dissolved air flotation basins. Several common clarification processes are discussed as follows.

Conventional Sedimentation

Sedimentation basin sizing is dependent on flow rate and recommended detention time to encourage settlement. A 25 MGD plant (60 MGD raw water) could require total basin footprint up to 120,000 square feet at a typical overflow rate of 500 - 800 gpd/sf and two hour detention time. Sedimentation basins have a high capital cost but require low to medium operating budget and operator skill level. Sedimentation basins include horizontal flow tanks and radial flow. Horizontal tanks are more suited to high solids loading.

High-Rate Settlers

High rate settlers include plate or tube settlers, solids contact clarifiers and sand-ballasted flocculation systems and occupy a smaller footprint than conventional sedimentation basins. Inclined plate or lamella settlers have been included in SWRO plant designs in India and Algeria. Solids contact clarifiers require fairly constant water characteristics, particularly with respect to temperature, and are therefore not recommended for SWRO.

The hydraulic detention time for sedimentation can be decreased through the use of inclined plate technology. Up to ten square feet of settling area are provided by an inclined plate module for each one square foot of conventional settling area. Thus, the floor space required for sedimentation can be reduced significantly. For the purposes of this evaluation, it is estimated that the addition of lamella settlers would reduce the required hydraulic detention time by 50 percent. Sedimentation basins with lamella settlers can be thus sized for one hour of detention time.

The ActiFlo® process combines coagulation, sand-ballasted flocculation, and lamella settling in a single unit. The process is suitable for removal of algae, protozoa, precipitated metals, and color and can give a significant reduction in organic carbon content of source water.

Dissolved Air Flotation Basins

Dissolved air flotation (DAF) units are in operation at large SWRO treatment plants in Chile and Singapore. The DAF process introduces air, typically at 5 to 6 times atmospheric pressure, into the water to be treated. When the pressure dissipates into the water stream, air in excess of atmospheric saturation comes out of solution in the form of tiny air bubbles, which attach to the suspended solids and float them to the surface. For water treatment applications requiring delicate floc removal, part of the clarified effluent is recycled, pressurized, saturated with air, and released to the flocculated inflow. DAF is particularly effective in removing low-density solids, including up to 95 percent of algae, protozoa, and precipitated organics and metals, together with associated turbidity and color. DAF is not effective in removing heavy silts and sands, which may be prevalent with on-shore intakes. DAF units have medium to low capital cost relative to conventional sedimentation basins primarily due to their potentially substantially smaller size. DAF operating costs are medium but require a higher operator skill level than for conventional clarifiers. However, operational cost savings can be gained in reduced sludge volume production.

The footprint of a DAF basin is typically approximately half or less of that of a conventional sedimentation basin due to shorter flocculation times as well as higher loading rates/ lower retention times. Tanks are often covered to prevent floc breakup from wind and rain. DAF can handle rapid changes in water quality and temperature and will remove suspended solids up to an order of ten times smaller than sedimentation. The sludge produced typically has a higher range of solids content in comparison to conventional sedimentation, thereby reducing sludge handling volumes.

7.2.1.2.4 Filtration

There are a number of different filtration processes that can provide pretreatment to RO processes by effectively reducing particulate matter, including membrane filtration, gravity filters, pressure filters, and diatomaceous earth filters. Each of these processes is discussed as follows.

Membrane Filtration

Microfiltration (MF) and ultrafiltration (UF) are membrane filtration processes primarily used for particle removal. MF and UF may be installed as an alternative to pressure or gravity sand filtration in conventional treatment plants, or as pretreatment to processes such as RO. SWRO plants in Japan and Saudi Arabia operate UF systems used as standalone pretreatment systems for low turbidity feed waters with a benefit of low sludge production, given that coagulants are not required for particulate removal with membrane filtration. MF and UF have been demonstrated to be capable of removing *Giardia* and *Cryptosporidium* to below detection, as well as for meeting the turbidity requirements of surface water treatment regulations. However, only UF is able to achieve any significant removal of viruses.

There are two general types of MF/UF systems: encased (which operate under pressure) and submerged (which operate under vacuum). In encased systems, a membrane module generally consists thousands of hollow fibers housed in a pressure vessel. The flow pattern through a membrane fiber may be either inside-out or outside-in. In submerged systems, a membrane module still consists of thousands of hollow fibers, but the exposed fibers are immersed in a treatment basin and a vacuum is applied to draw water through the membrane into the lumen (i.e., outside-in flow pattern).

Maximum removal of bacteria and algae upstream of the RO membranes is considered desirable to minimize biofouling. Pathogenic organisms, algae (>1 micron) and protozoa (>2 micron) can be completely removed by MF, which has a nominal pore size of approximately 0.1 to 0.2 microns. Smaller organisms, such as bacteria (>0.1 micron) and viruses (>0.01 micron), will be removed by UF membranes with a nominal pore size of approximately 0.01 microns. Importantly, there is growing experience with UF in SWRO applications. SDI achieved is always <3, and may approach 2, without the need for coagulant. This results in extension of SWRO membrane life due to reduced cleaning frequencies. Upstream fine screening (80 or 100 micron) is generally required by MF/UF suppliers to protect the membranes from mechanical damage.

Gravity Filters

Granular media filtration via gravity is primarily used as a particle removal technology, although there are some media types that are able to remove dissolved contaminants as well. Rapid sand filtration is the most common filtration method employed in water treatment today. Rapid sand filtration refers to filtration rates on the order of 2 to 6 gpm/sf or higher, as opposed to slow sand filtration, in which filtration rates are generally less than 0.1 gpm/sf. There are three basic media configurations: monomedia (a single media type), dual media (two media types), and mixed or multi-media (more than two media types). The most common media types are sand, anthracite, and GAC. Monomedia filters are generally sand. Dual media filters are most commonly sand and anthracite, and mixed media filters are typically sand, anthracite, and garnet.

Dual media rapid gravity filtration is common in larger capacity water treatment plants. Multi-media filtration may not improve water quality over dual media filtration; its use is project-specific, with selection based on laboratory and pilot testing. Dual media filters for large SWRO plants are typically open cell concrete construction, containing crushed anthracite overlying silica sand filter layers in a down-flow configuration. Typical filtration rates of 3 to 6 gpm/sf are employed. There is also limited experience with open upflow filters, but this experience to date indicates difficulty with consistently meeting SDI targets, thus requiring supplementary polishing (i.e., secondary filtration). Open filters should be roofed or enclosed to prevent light stimulating biological growth within the filters. Relative to pressure filters, gravity filters are more flexible in media design and customization to enable depth filtration. The required footprint for dual media filters for a 25 MGD plant (60 MGD raw water feed) operating at a 4 gpm/sf loading rate would be approximately 10,000 square feet.

Pressure Filters

Pressure filters have similar media configuration and loading rate to gravity filters. While they are difficult to troubleshoot, they have an extensive application record at SWRO facilities in Spain and the Middle East, and are manufactured in standard sizes (typically 13-feet diameter, 42-feet long, horizontal, lined mild steel construction). If the water is moderately difficult to treat, but not to the extent that warrants pre-clarification, second stage polishing pressure filters are easily provided to augment the first stage. These operate with finer filter media and at higher loading rates (5-7 gpm/sf) compared to the primary pressure filters.

Diatomaceous Earth Filters

Diatomaceous earth (DE) filters are pressure filters sometimes included only as a second polishing stage after conventional filtration ahead of RO treatment. Filter media grading can be selected to remove particles down to 1 micron size. The media is regularly metered into the influent water flow to maintain permeability, as the filter process proceeds. When pressure drop exceeds a maximum value, the media is back-flushed for removal and disposal of captured particles. The Tampa Bay Seawater Desalination Plant (TBSDP) has been retrofitted with DE filters after sand filters to improve turbidity of the feed water to cartridge filters and membranes. Operation of DE filters presents a low risk of media shedding and consequential particulate fouling of downstream membranes.

7.2.1.2.5 Cartridge Filtration

Cartridge filters are invariably included as standard equipment in association with RO when the process follows media filtration and even after UF in some cases. Cartridge filters provide a final mechanical barrier from particulates ahead of the RO membranes. Wound, melt-blown, and thermal bonded filters are available with minimum pore size ranging between 1 microns and 50 microns; 5-micron cartridge filters are suitable for membrane pretreatment filters. Filters cartridges are replaced when the pressure drop exceeds a predetermined value. The cartridges are typically installed in lined steel housings.

7.2.1.3. Desalination

7.2.1.3.1 Performance

Performance of membranes currently used for seawater treatment has improved over the past decades in terms of salt rejection and operating pressures. Membranes are available with a molecular weight cutoff (MWCO) value to suit the raw water analysis. Molecules with low molecular weights and uncharged ions, such as boron, dissolved gasses, and some organic carbon and hydrocarbons, are poorly rejected. A generalized salt rejection rate of approximately 99.5 percent can be expected at typical anticipated TDS levels in seawater. Turbidity and colloidal particles must be removed almost completely from the feedwater before reaching the membranes. The SDI, as an indicator of the colloidal fouling potential of feedwater, needs to be maintained below a value 3 for optimal membrane performance. Acid and scale inhibitors may be required upstream of the RO process to produce a negative Langelier Saturation Index (LSI) at reduced pH and limit carbonate and sulfate scale formation.

7.2.1.3.2 System Configuration

SWRO membrane trains can be configured as single or two pass systems. A single pass system will give approximately 50 percent recovery at 99.5 percent salt rejection. Certain predominant ions of concern, such as chloride, sodium, boron, and bromide, will be present in permeate from a single pass at potentially high levels which could cause taste, dietary (sodium), irrigation (boron), disinfectant stability (bromide), and/or corrosion (chloride) issues. The use of a two-pass system will further reduce the levels of these constituents. One two-pass configuration will allow the first-pass permeate to be split, such that the front end high purity permeate is sent to product storage and the rear end low purity permeate feeds the second pass membrane train. At the SWRO plant in Sydney Australia, the second pass operated in this manner provides total TDS rejection to approximately 99.8 percent, which would significantly reduce chloride, sodium, boron, and bromide concentration in the combined permeate. The concentrate from the second pass in a two-pass system has a TDS concentration well below seawater and, although its volume would constitute only a small percentage of total feedwater flow, can be recycled upstream of the first pass to improve recovery. This practice is utilized at the Tampa Bay facility.

7.2.1.4. Post Treatment

7.2.1.4.1 Objectives

Following desalination through SWRO membranes, permeate (desalinated seawater) will contain negligible amounts of calcium, magnesium, and alkalinity. The permeate pH may range from 6 to 9 according to the mode of operation of the first and second pass RO. The water will be extremely soft, unbuffered, and highly corrosive to metals and concrete/ cement products and cannot be put into a drinking water supply system without post-treatment to provide chemical stability and prevent corrosion. Final disinfection is also required to comply with drinking water disinfection requirements.

7.2.1.4.2 Stabilization and Corrosion Control

The most common chemicals used for re-mineralization and stabilization of RO permeate are lime (various forms) and carbon dioxide, while sulfuric acid, sodium hydroxide, and soda ash (sodium carbonate) can also be used, mostly for fine pH adjustment. Mineral deficiencies and low alkalinity are adjusted to maintain a positive LSI and CCPP. Lime slurry with carbon dioxide is commonly used at large SWRO plants, such as those at Kwinana, Gold Coast, and Sydney (Australia); Tampa Bay (USA); and Almeria Cartagena (Spain). Other major SWRO plants use limestone filters in conjunction with acid or carbon dioxide, such as Ashkelon and Palmachim (Israel); Hamma and Skikda (Algeria); and Sur (Oman). Calcite limestone (high calcium) and in some cases dolomitic limestone (calcium/ magnesium) may also be used.

The application of lime as a lime slurry will create post turbidity impacts due to impurities in the lime, as well as the presence of slowly dissolving microcrystals of calcium carbonate. Lime saturators, or limestone filters can be selected to avoid the very significant post treatment turbidity impacts associated with direct feeding of slurries. All of the major Australian SWRO plants to date have included lime saturators. A typical lime saturator is effectively a recirculation solids contact clarifier consisting of a central feed to dissolve and mix lime slurry in the water, and a settling zone to allow the separation of the un-dissolved lime impurities from the lime water for removal with a bottom scraper. Lime saturators require regular cleaning, and thus it is desirable to have standby capacity. Limestone filters require a retention time of about 20 minutes to dissolve the limestone (calcium carbonate). These may be conventional gravity concrete filters or circular vessels. The limestone is typically supplied as fine gravel, which must be replenished within the filters to replace the dissolved limestone. The capital cost of limestone contactors is higher than for lime slurry systems. However, the merits of lime slurry versus limestone, and the various supply forms will be thoroughly evaluated as the project develops, taking into account local availability, purity, cost, ease of operation and maintenance, as well as waste disposal issues.

Carbon dioxide is added to increase the acidity and carbonate of permeate, either before or after lime treatment. In some plants sulfuric acid dosing is used in lieu of carbon dioxide, though this is dependent on the finished water stabilization targets adopted. The combination of lime and carbon dioxide directly produce the calcium hardness and alkalinity (bicarbonate) needed, and it is not always necessary to use supplementary chemicals for pH correction.

7.2.1.4.3 Disinfection

Health risks from pathogenic contaminants must be eliminated by disinfection. Permeate that is produced by RO membranes is virtually free of pathogenic organisms and will have a low chlorine demand in comparison to that produced by other forms of water treatment. Chloramines will be used to carry a residual in the finished water to allow blending compatibility with MWD water and to control biofouling.

The typical project-specific average 65 mg/L bromide concentration in seawater, if not reduced significantly during the coagulation/clarification process, can be expected to result in an RO permeate bromide concentration up to 0.5 mg/L in a single pass desalination system. Bromide ions can be oxidized in chlorinated water (hypochlorous acid) in the presence of organics to form brominated trihalomethanes, a regulated DBP. Iodide ions have a similar influence on DBP formation. Pilot testing in Phase 2 will determine bromide and iodide concentrations and evaluate available treatment requirements, if necessary, to ensure that the MCL is not exceeded for any DBPs.

A minimum finished water storage volume of 25 percent of the system's maximum day demand was assessed as a baseline value, factoring in additional requirements for contact time and diurnal flow patterns (refer to **Appendix 1:C** for assessment). At 25 percent of average production capacity, this volume will provide adequate storage for chlorine contact time (including a baffling factor of 0.5) to achieve inactivation requirements noted below and allow for temporary production interruptions as well as minor fluctuations in Supplier demand.

In order to meet surface water treatment regulations, inactivation of *Giardia* will drive primary disinfection requirements when using chlorine or chloramines as a primary disinfectant. The Surface Water Treatment Rule requires 3-log removal/inactivation of *Giardia*, with a 2.5-log credit given to those systems achieving the turbidity requirements of the Interim Enhanced Surface Water Treatment Rule (IESWTR). The remaining 0.5-log *Giardia* credit must be obtained via disinfection / chemical inactivation.

UV was also considered for inactivation requirements. However, in the case of UV, inactivation of viruses will drive primary disinfection requirements. The Surface Water Treatment Rule requires 4-log removal/inactivation of viruses with a 2-log credit given to those systems achieving the turbidity requirements of the Interim Enhanced Surface Water Treatment Rule (IESWTR). The remaining 2-log virus credit must be obtained via disinfection / chemical inactivation. The UV dose required for 2-log virus inactivation is extremely energy intensive (100 mJ/cm^2), and could be cost prohibitive for this project. Given that there should be enough storage to achieve inactivation (CT) requirements through chloramines disinfection, UV was not further considered.

7.2.1.5. Residuals Handling and Disposal

SWRO plants produce three separate waste streams that require direct disposal or treatment prior to disposal:

- The concentrate stream, with the largest flow rate and negligible chemical modification, can be returned to the ocean. Concentrate disposal is commonly practiced throughout the world via ocean outfalls with single or multi-port diffusers. A detailed alternatives assessment is completed as part of section 5.0.
- The waste sludge produced from coagulation and flocculation processes during filtration, and from lime saturators, will have high organic and inorganic contaminant concentrations and will likely need to be consolidated in a belt press or centrifuge for disposal to landfill or other solid waste disposal method. The filtrate or centrate can be combined with the concentrate stream or plant effluent.
- The third waste stream from the membrane cleaning system will contain high TDS wastes with alternating high and low pH values. A neutralization tank will be required to allow effluents time to blend with other plant effluents for pH stabilization before disposal either to a sanitary sewer system, if acceptable to a local municipality, or treatment in the backwash recovery system described above.

7.2.2. Treatment Process Alternatives

7.2.2.1. Intake

The detailed analysis of intake alternatives in Section 5 indicated that use of the existing intake infrastructure at both the Redondo Beach or El Segundo sites was acceptable and the most cost-effective option. Although additional studies were recommended in Section 4.8, the use of open intakes is assumed for the purposes of assessing the recommended treatment train.

7.2.2.2. Fine Screening

In addition to the screening associated with intakes (as discussed in Section 7.2.1.2.1), fine screens are usually provided for SWRO desalination plants that utilize membrane filtration (MF/UF) pretreatment. Shore-based intake screens (often drum or band screens for large SWRO Plants) typically have openings of 3-10 mm. However, these do not provide adequate protection for the MF or UF membranes. Membrane fiber breakage can be caused or instigated by small sharp objects in the source water such as broken shells, which will pass through screens of this size. Typically fine screens with aperture size < 120 μm are required to provide adequate protection for the membranes, while 80 μm will exclude barnacle larvae from entry, and eliminate risk of their growth within the membrane system. In fact, MF or UF manufacturers often require the feed water to be filtered with < 80 μm screen as a warranty condition. In this application, the fine screens are normally not selected for removal of suspended solids or algae, and at the 80-100 μm screen size recommended for UF will still allow passage of the majority of turbidity and algal mass onto the downstream UF/ MF membranes.

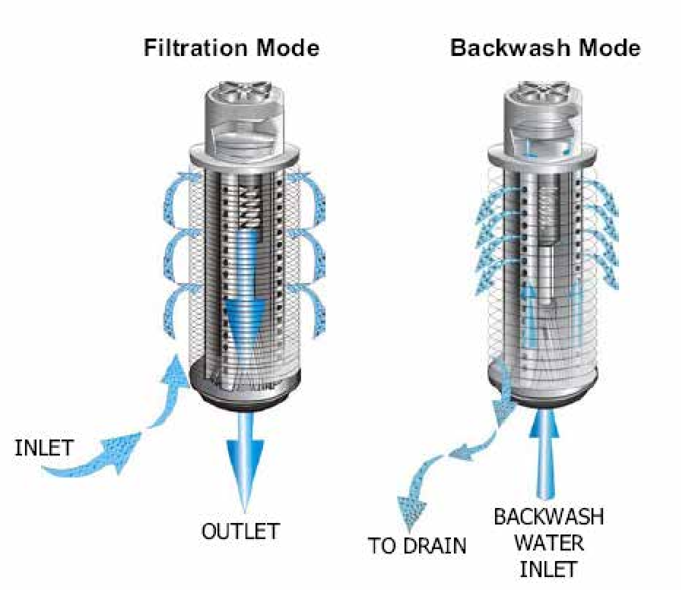
There are number of fine screen systems available. Their configuration varies based on the type of the filter medium and the backflush/backwash mechanisms. While many fine screens are described as being self-backflushing, effectively this means that a certain driving head (pressure) is required from the discharge. Backflush pressures required can be 30-50 psi, and thus can have a significant energy impact if this pressure is not part of the design/ available from the downstream system. As with typical filtration systems, backflush flow is typically provided by the filtrate from on-line operating screens, and adequate balancing storage, multiple units, and/or redundancy must be provided to avoid impact on the downstream processes during backflush. For some system designs, backflush water may be more efficiently supplied by dedicated backflush pumps. While notionally the screen backflush operations are triggered by differential pressure, this is not practical in large systems with multiple screening units manifolded together. Consequently, backflush tends to be initiated on a time basis.

The following subsections provide a general overview of some of the available proprietary fine screen products currently in use. Two additional subsections discuss the non-proprietary options of slow sand filters and high rate granular media filtration. Although media filtration can also be used as primary filtration steps, these processes can also be employed as pretreatment for MF/UF in place of the proprietary technologies discussed in this section, thus effectively functioning as fine screening.

7.2.2.2.1 Arkal Galaxy Spin Kiln Battery

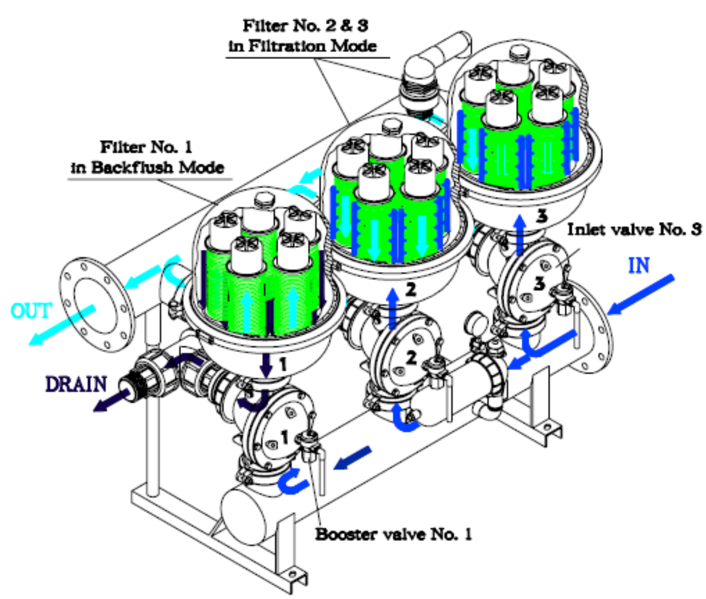
The Arkal filtration system uses compressed grooved discs as a screening medium. The aperture size range available is in the range of 20-400 μm. Feed water is introduced to the external circumference of stacked discs, which are compressed by the feed pressure to maintain the design aperture size. In backflush mode, flow reverse releases compression in the disc stacks, increasing the aperture size and enabling dislodgement of particles deposited on the filter disc by tangential water jets. **Figure 7-1** shows the stacked disc used in Arkal filtration system under filtration and backflush mode.

Figure 7-1: Disc Stack Used in the Arkal Filtration System



A single unit can contain multiple disc stacks, and a number of units can be installed in parallel, depending on the capacity required as shown in **Figure 7-2**. When one filter is being backflushed, the other filters remain on line, effectively maintaining continuous filtration.

Figure 7-2: Typical Arkal Filtration System Installation (Three Units in Parallel)



A summary of the Arkal system is provided in **Table 7-7**. Arkal systems have a good track record for smaller systems, with polypropylene materials favored for seawater applications. Compared to other screens types they require a larger number of units and this becomes less favorable at large flows.

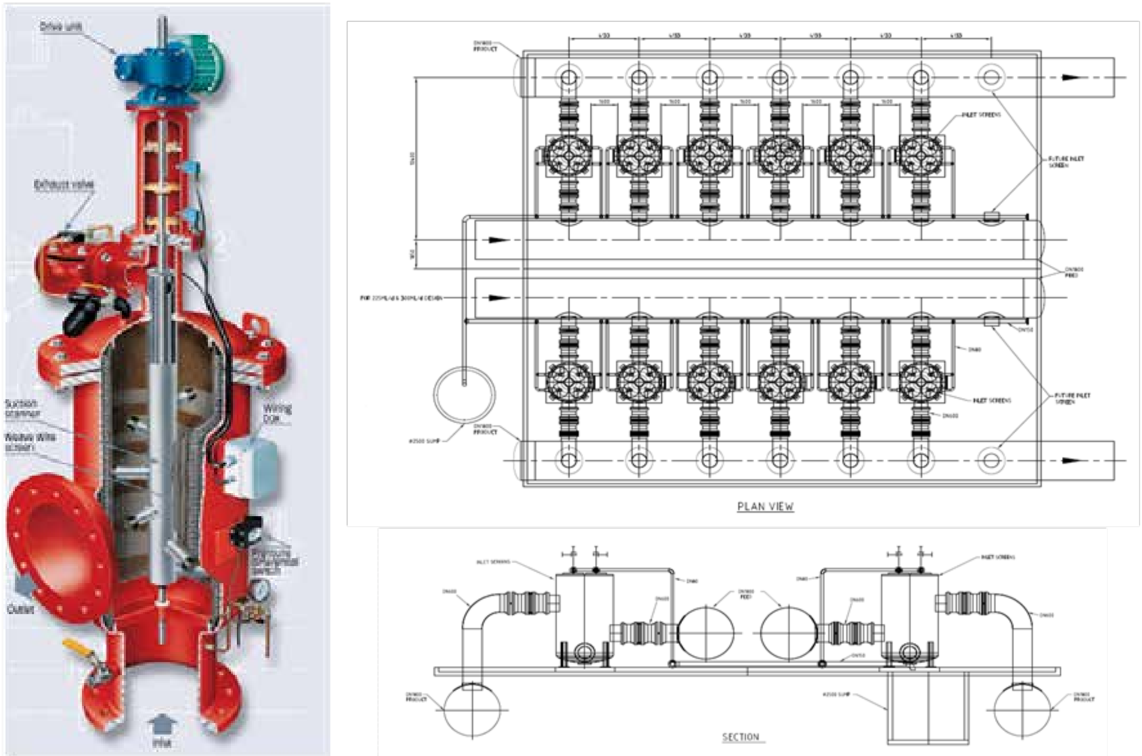
Table 7-7: System Requirements and Characteristics for the Arkal Filtration System

Requirements	Unit	Value(s)
Minimum Pressure Required	psi	40.6 * (If Self-Backflush)
Maximum Operating Pressure	psi	145
Requirement for Pre-Screen		No
External Backflush Requirement		Optional*
Typical Head Loss Through Clean Screen	psi	2.2
Materials of Construction	Filter Housing/Manifolds	SS316, Coated Steel or Polypropylene
	Disc	Polypropylene
	Springs / Fasteners	Teflon-Coated SS316

7.2.2.2.2 Amiad EBS Filter

The Amiad EBS filter has a cylindrical micro-screen. The aperture size can be selected between 10 to 800 μm. This system provides continuous filtration during backflush. Feed water is introduced inside of the cylinder. Backflush is achieved by a series of suction nozzles sweeping across the active screen area, removing the deposited particulate matter and discharging to an internal drain pipe, and a drain valve opens during the backflush to create suction from the backpressure on the filtered water side. An electric motor drives the nozzle to sweep the screens. An example of a large scale installation layout is shown in **Figure 7-3**. A summary of the Amiad system is provided in **Table 7-8**.

Figure 7-3: Amiad EBS Filter



(a) Amiad EBS filter element

(b) Typical installation layout, showing 12 modules with each module contains 4 filter elements.

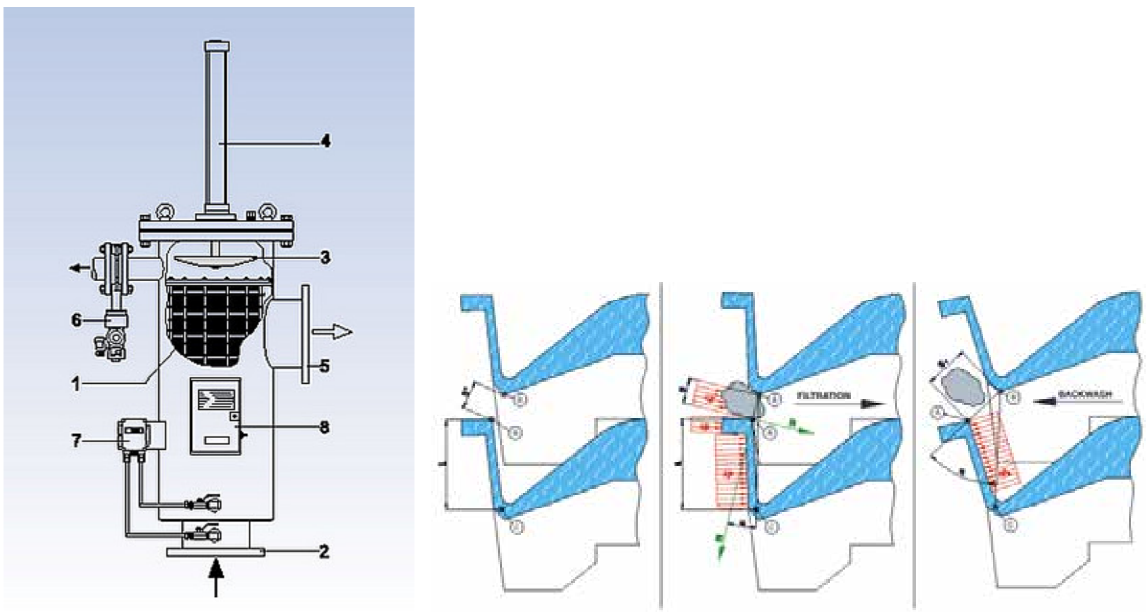
Table 7-8: System Requirements and Characteristics for the Amid EBS Filter

Requirements	Unit	Value(s)
Minimum Pressure Required	psi	29
Maximum Pressure	psi	145
Requirement for Pre-Screen		No
External Backflush Requirement		No
Typical Headloss Through Clean Screen	psi	1.5
Materials of Construction	Filter Housing / Manifolds	Rubber-Lined Carbon Steel
	Mesh	SMO 254
	Springs, Fasteners	SS316

7.2.2.2.3 Taprogge Dynamicfilter

The Dynamicfilter utilizes a cylindrical wedge wire or perforated steel screen, with an aperture size available ranging from 50 to 5000 µm. Like the filtration mode in the Amiad system, raw seawater is introduced inside the filter cylinder. The backflush sequence consists of two phases. In the first phase, the waste drain valve opens to release the more easily detachable particles, whereas In the second phase, a flushing disc travels along the screen to dislodge more tightly trapped particles in the screen openings. Similar to the Amiad EBS system, filtration takes place continuously during backflush. Diagrams of a Taprogge Dynamicfilter are shown in **Figure 7-4**. A summary of the fine screening system is provided in **Table 7-9**.

Figure 7-4: Taprogge Dynamicfilter



a) Filter Design

(b) Active Filter During Filtration and Backflush

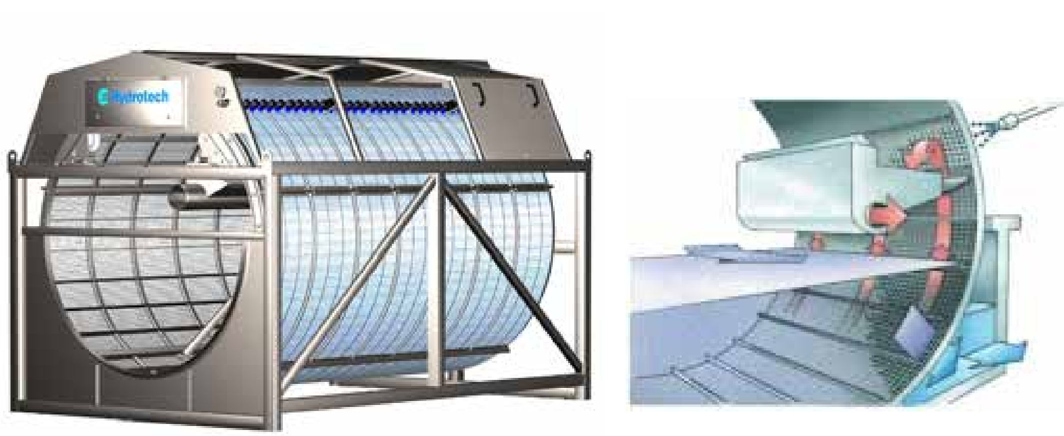
Table 7-9: System Requirements and Characteristics for the Taprogge Dynamicfilter

Requirements	Unit	Value(s)
Minimum Pressure Required	psi	50.8
Maximum Pressure	psi	145
Requirement for Pre-Screen		Required – 3 mm
External Backflush Requirement		No
Typical Headloss Through Clean Screen	psi	1.2
Materials of Construction (Typical)	Filter Housing	Rubber Lined Carbon Steel
	Mesh	Delrin
	Spring, Fasteners	Duplex

7.2.2.2.4 Hydrotech Drumfilter

The Hydrotech Drumfilter is a drum screen with a aperture sizes available between 30 and 500 μm. Although the Drumfilter offers simpler mechanisms with only a few slow moving parts, it requires substantially greater civil works for its installation. Unlike the aforementioned filters, the Drumfilter creates a break in the hydraulic pressure, necessitating either pumping or gravity flow to other open hydraulic processes. A sketch of the Drumfilter is shown in **Figure 7-5**, and a summary of the product is provided in **Table 7-10.**

Figure 7-5: Hydrotech Drumfilter



(a) Drumfilter (b) Screenings Collection

Table 7-10: System Requirements and Characteristics for the Hyrotech Drumfilter

Requirements	Unit	Value(s)
Minimum Pressure Required	psi	N/A
Maximum Pressure	psi	N/A
Requirement for Pre-Screen		Required – 3 mm
External Backflush Requirement		Yes – Potable Water or RO Permeate
Typical Headloss through Clean Screen	psi	N/A
Materials of Construction (Typical)	Drum and Frame	Duplex
	Mesh	Polypropylene and Polyethylene

7.2.2.2.5 Slow Sand Filtration

Pilot studies with slow sand filters have indicated excellent results in coping with turbidity, algae, and reducing associated TOC. However, filtration rates are typically limited to 0.05 to 0.15 gpm/sf, resulting in very large process footprints. Consequently, slow sand filters are generally not suitable for large seawater desalination plant, particularly those located in developed areas and/or with site constraints.

7.2.2.2.6 High Rate Granular Media Filtration

High rate granular media filtration (GMF) involves operating dual media filters at rates that exceed those that would normally be utilized to achieve pathogen removal credit under state and federal surface water treatment regulations. As such, this process is utilized as a type of roughing filter, providing pretreatment for downstream filtration processes. High rate GMF has been piloted by West Basin, using 90 inches of media depth to filter coagulated seawater at rates in the range of 15 to 23 gpm/sf as pretreatment for membrane filtration. Note that polymer, which can foul the membranes if carryover occurs, is only expected to be used during high turbidity feed water events. Testing of high rate GMF successfully decreased the transmembrane pressure (TMP) across the membranes and increased the interval between chemical cleans. The net wash water consumption was also comparable to that required for proprietary fine screening technologies.

7.2.2.2.7 Fine Screening Summary

There are several proprietary fine screen systems available in the market that can provide protection for membrane filtration, as discussed in the previous sections. A comparison of these technologies is provided in **Table 7-11** for the 60 MGD case only. These systems offer a range of aperture sizes, covering the nominal requirement of 80mm. Average backflush requirements can be of the order of 0.5 to 1% of the feed flow, with short-term higher discharge rates. The backflush waste is normally returned to the sea with the concentrate.

Table 7-11: Fine Screen Systems Comparison

Item	Manufacturer			
	Arkal	Amiad	Taprogge	Hydrotech
Product Name	Galaxy Spin Kiln Battery	EBS Filter	Dynamicfilter	Drumfilter
Screen Configuration	Stacked Disc	Cylindrical Perforated Screen	Cylindrical Perforated or Wedge Wire Screen	Drum
Backflush Mechanism	Pressurised Backflushing	Suction Nozzle Utilizing Back Pressure	Back Pressure Induced Suction	Potable Water (or RO Permeate) Spray
Continuous Operation During Backflush	Yes (multiple units)	Yes	Yes	Yes
External Water Source	Not Required	Not Required	Not Required	Required (spray)
Minimum Operating Back Pressure	40.6 psi Back Pressure	29 psi Back Pressure	50.8 psi Back Pressure	NA
Indicative Footprint @ 60 MGD	8,000ft2	6,000ft2	4,000ft2	3,000ft2
Facilities Required	Backflush Pump Can Be Used If Back Pressure Not Available)	None	Pre-Screening (3 mm)	Spray Water System
Civil Works	Concrete Pad	Concrete Pad	Concrete Pad	Large structure

The Arkal system has been tested by West Basin, and results to-date indicated that it is not providing effective and efficient pretreatment for the downstream membrane filtration process. Results have indicated significantly lower efficiency during high sediment feed water conditions. In addition, both the Arkal system and the other proprietary processes evaluated in the table above utilize a physical sieving process for filtration, which is more likely to lyse algal cells than media filters, releasing the contents to potentially foul the membrane filtration or RO process. Thus, considering the performance of the Arkal system, as well as the potential concerns for lysing algal cells for all for all of the proprietary fine screening processes evaluated, coupled with West Basin's successful piloting of high rate GMF, it is recommended that high rate GMF be tested at demonstration scale. High rate GMF can also potentially accommodate in-filter dissolved air flotation, as discussed in Section 7.2.2.3.3, if needed to improve algae removal. It is also recommended that the high rate GMF process be tested under conditions of high feed water turbidity in which polymer might be utilized in order to optimize process control and evaluate the potential for carryover that might foul the downstream membranes.

7.2.2.3. Clarification

Clarification pretreatment reduces solids loading on the downstream filtration processes, allowing for higher filtration rates. In addition, clarification processes can provide a buffer against the impact of red tide events, enabling seawater desalination plants to operate under base loaded conditions when such an event occurs by removing algae that would otherwise cause rapid fouling of the filters. While there is limited data on the composition of raw seawater under red tide conditions, raw seawater turbidity level in excess of 20 NTU have been reported (Sommariva et al., 2011; Kim and Yoon, 2005), whereas typical raw seawater turbidity would range between 2 to 10 NTU (Ding et al, 2005; Voutchkov and Dietrich, 2005). In order to reduce turbidity from above 20 NTU to approximately 2 NTU, which is optimal for downstream prefiltration, sedimentation basins require upstream coagulation and flocculation. Several potential clarification (including coagulation and flocculation) alternatives are evaluated in the following subsections, including conventional sedimentation, high rate settlers, and dissolved air flotation.

7.2.2.3.1 Conventional Sediments

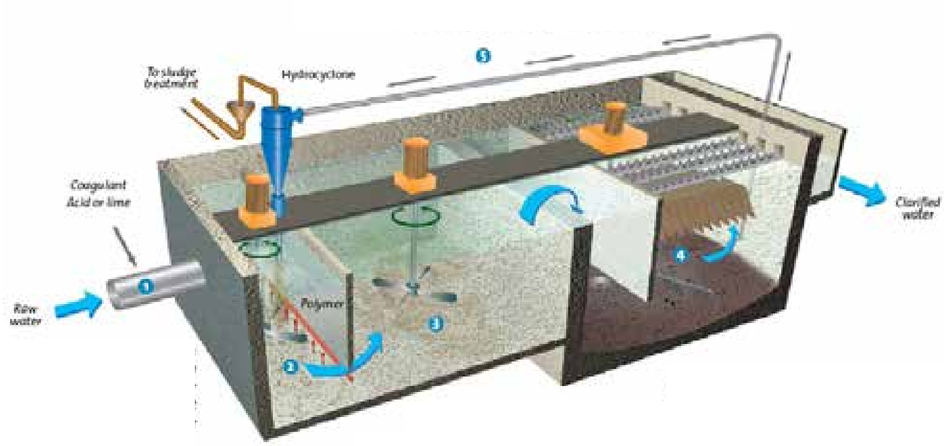
Conventional sedimentation basins have large footprints due to low surface loading rates, which are about 0.4 gpm/sf for radial types and up to 0.8 gpm/sf for horizontal types. Solids contact and sludge blanket clarifiers may operate at up to 1.2 gpm/sf. The footprint may be reduced further if lamella plate settlers are used. All of these conventional sedimentation basin variants require flocculation periods of 15 to 30 minutes. However conventional clarification is designed to settle suspended solids enhanced by high coagulant doses to achieve rapidly settling floc and are not ideal for removing algae, which are naturally buoyant. Thus, in order to effectively remove algae, more conservative loading rates are required.

In addition to the relatively large footprint compared to high rate settlers, dissolved air flotation (DAF) and GMF, conventional clarification is more prone to temperature upsets, requires more operator attention, and may also need flocculent polymers to achieve high settling efficiency. Notably, any carryover of these polymers can cause irreversible fouling of MF/UF and/or RO membranes. Furthermore, the metal rakes and skirts are relatively expensive due to the corrosive seawater environment. Clarifiers are difficult to bring on and off line very quickly, particularly in the case of sludge blanket and solids contact types. It is also not practical to cover large clarifiers, and consequently they may contribute to increased algal activity and dissolved organic carbon levels. Conventional clarifiers do not provide any process advantages.

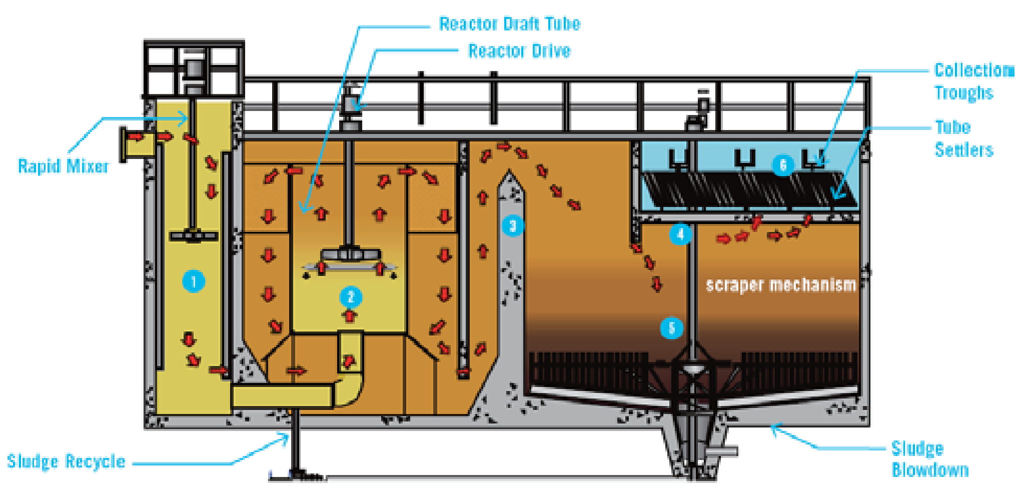
7.2.2.3.2 High Rate Settlers

High rate settlers include proprietary technologies such as Actiflo and Densadeg, as shown in **Figure 7-6**. Both these technologies have lamella plates, but also incorporate patented technologies to enhance settling rates, which are nominally an order of magnitude larger than conventional clarifiers.

Figure 7-6: Example High Rate Settling Technologies



(a) Actiflo by Veolia



(b) Densadeg from Degremont

Actiflo utilizes "microsand" both as a seed for floc formation and as ballast to enhance the settling rate. The sand is recovered from the sludge stream via a hydrocyclone. On advantage of Actiflo is that start-up is relatively fast. Densadeg uses a portion of settled sludge collected in the clarifier as a seed material by recycling into the flocculation chamber. Vendor literature indicates high maximum design surface loading rates (up to about 16 gpm/sf for Actiflo and 15 gpm/sf for Densadeg), but lower rates may be required, depending on the application.

Both technologies may remove algae and reduce turbidity, but as with conventional clarifiers, algae removal will not necessarily be highly efficient. Moreover, different algae types will respond differently, including through the lamella plate section of the settlers. Also, both systems require coagulants and flocculant polymers to achieve the high rates for their process, which may cause irreversible membrane (MF/UF and/or RO) if process control is not precise and polymer carryover occurs. These technologies are generally not utilized in conjunction with SWRO plants, and thus global experience in applying these to seawater desalination is limited.

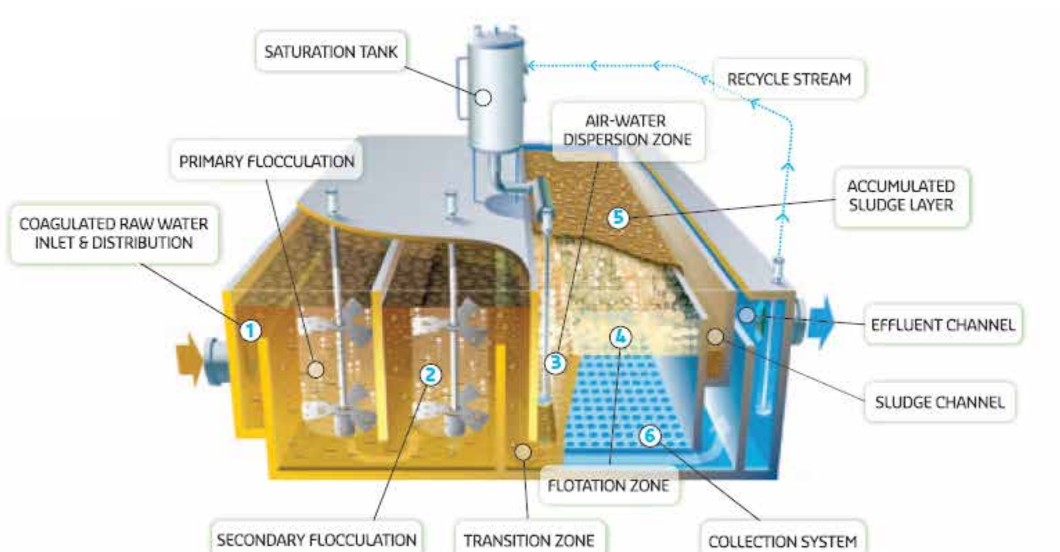
7.2.2.3.3 Dissolved Air Flotation

Solid separation by dissolved air flotation (DAF) relies on attachment of micro bubbles to the coagulated / flocculated solids and induces the solids to float on the surface for removal. Removal of the floated solids can be accomplished hydraulically or by a mechanical scraper. Because DAF utilizes upflow removal of solids, it is synergistic with buoyant algae; thus, DAF is widely used for removal of algae. DAF is also effective for turbidities up to 50-100 NTU. Accordingly, the use of DAF as a pretreatment technology in SWRO applications is becoming increasingly common, especially in cases in which plant availability cannot be compromised by red tide events. Pilot studies have indicated that use of DAF upstream of dual media filters during red tide events resulted in pre-treated seawater quality equivalent to that of normal seawater conditions demonstrating, Moreover, DAF is a relatively gentle process, and lysing of algal cells is not expected, reducing the potential for the contents of the algal cells to foul the downstream membrane processes. As a result of these benefits, many new plants considered to be at risk from red tides are being constructed with DAF, and the Fujairah I plant will be retrofitted with DAF following the success of Fujairah II (Sommariva et al, 2011). DAF also is effective in removing oils, which may advantageous if open ocean intakes are used in a SWRO plant. DAF cells need to be to enclosed and covered to protect wind and rain from disrupting the floated solids. However, this is not a significant additional cost for a SWRO application, as the cells would need to be enclosed in any case to prevent algae growth.

There are a variety of types of DAF, most of which require flocculation times of about 10 minutes. Early "standard" DAF arrangements employed surface loading rates of about 2-3 gpm/sf. In-filter DAF (DAFF), which involves the combination of DAF and filtration in one structure with very little impact on footprint, is increasingly common. Floated solids accumulate at the water surface above the filter. DAFF achieves reliably higher flotation rates and utilizes the filters as both a ”safety net” and for drawing off clarified water through the large filter area, creating stable hydraulic conditions. Filter / float rates are limited to about 6 gpm/sf. DAFF was used at the Tuas I plant in Singapore to address the difficult raw seawater quality with a design suspended solids load of 37mg/L. Pilot studies also suggested DAFF’s potential ability to handle up to 300 mg/L of diesel (Huijbresgsen et al). The DAFF system at the Tuas I plant is designed to operate at a filter / float rate of 3.3 gpm/sf. Notably, the DAF component of the filter-DAF combination can be turned off when not required, allowing the plants equipped with this technology to be operated in “direct” filtration mode.

Proprietary high-rate DAF systems with optimally designed entry conditions and specialized floor collection systems that create very predictable flow patterns have enabled loading rates up to about 15 gpm/sf to be achieved, with rates of about 10 gpm/sf more common in seawater applications (Bonnelye et al., 2005. High rate DAF is the most compact form of DAF technology). An example of a high-rate DAF system is shown in **Figure 7-7**.

Figure 7-7: Example High Rate DAF System – Degremont’s AQUADAF



7.2.2.3.4 Clarification Summary

A comparative summary of some of the key characteristics of the common clarification evaluated in the section is provided in **Table 7-12**. Note that standard DAF is not included in the table, as this technology would not be recommended due to the advantages of DAFF or high rate DAF. Previous and ongoing testing at West Basin has determined that clarification is not necessary with the use of high rate GMF, as discussed in Section 7.2.2.2.6. In addition, the footprint of high rate GMF is smaller than conventional sedimentation, and the process is non-proprietary, in contrast with high rate settlers, high rate DAF, and DAFF. Moreover, the high rate GMF does not require the use of air and less prone to upset. Another potential issue is the use of polymer in conjunction with clarification processes, which is generally not necessary with high rate GMF; polymer carryover can result in rapid and irreversible fouling of the downstream membranes.

As a result, the incorporation of clarification into the seawater desalination treatment process is not recommended at this time. However, clarification could be necessary in the future if a severe red tide events compromises the ability of the high rate GMF to produce suitable water quality for the downstream filtration and desalination processes. Thus, it is recommended that DAFF be considered for future evaluation on an as-needed basis. DAFF could potentially be integrated with the media filters that would be used for the high rate GMF process, with the objective of ensuring that the seawater desalination treatment process could be operated continuously under base loaded conditions during a severe red tide event.

Table 7-12: Comparison of Clarification

Characteristic	Conventional Sedimentation	High Rate Settlers	DAF	
			DAFF	High Rate DAF
Standard / Proprietary Technology	Standard	Proprietary	Proprietary	Proprietary
Indicative Surface Loading Rate	0.4-1.2 gpm/sf	Up to about 16 gpm/sf	6 gpm/sf	Up to about 15 gpm/sf
Flocculation Time	15-30 min	10 min	10 min	10 min
Separation Mechanism	Gravity Settling	Enhanced gravity settling	Floatation over filter	Floatation
Start Up From Offline	1-20 days	1-3 days	<0.5 days	1 day
Algae Removal	~70%	~90%	~95%	~95%
Established Technology	Yes, but not for SWRO red tide	Yes, but not for SWRO red tide	Yes	Yes
Algal Cell Lysing Risk	Low	Low	Low	Low

7.2.2.4. Filtration

West Basin has extensively tested MF/UF as prefiltration for RO, successfully demonstrating the effectiveness of the technology for protecting the RO membranes from particulate fouling. The testing reinforces the reported effectiveness of membrane filtration as SWRO pretreatment at full scale seawater desalination plants in other countries around the globe.

MF/UF has a more compact footprint than media filtration processes such as diatomaceous earth or conventional dual media filtration and provides significantly better filtered water quality, with turbidity levels as much as an order of magnitude lower in some cases. Thus, MF/UF provides the best available particulate removal pretreatment for RO, minimizing fouling potential and augmenting RO membrane life. Moreover, although in general, comparable pathogen removal credit is awarded for both membrane and media filtration, the actual pathogen removal achieved by MF/UF is generally 1 to 2 orders of magnitude higher, providing an additional level of pathogen protection. Also, unlike most media filters, MF/UF does not require the use of polymer to coagulate particles for efficient removal, thus precluding the routine use of a chemical that could rapidly and irreversibly foul the downstream RO membranes.

Although MF/UF is susceptible to rapid fouling during red tide events in the absence of sufficient pretreatment, West Basin's testing has shown that the use of high rate GMF (as recommended in Section 7.2.2.2.6) has allowed the MF/UF system to operate normally throughout a typical red tide event. If extreme red tide events prove to be problematic to accommodate using high rate GMF, DAFF can be integrated into the high rate GMF process (as recommended in Section 7.2.2.3.4) at demonstration scale and subsequently tested for its ability to improve algae removal under extreme circumstances.

Based on these considerations, the use of MF/UF for filtration is recommended for continued use in West Basin's Ocean Water Desalination Program.

7.2.2.5. Desalination

7.2.2.5.1 Reverse Osmosis

There are two primary types of technologies that are used around the world for seawater desalination: thermal processes and membrane processes. Thermal processes have been historically implemented in the Middle East, a region that was utilizing seawater desalination for potable water supply prior to the development of RO technology. Although thermal processes require roughly an order of magnitude more energy than RO, thermal desalination plants are often co-located with power plants, thereby allowing for the use of waste heat. This practice, which is common in the Middle East, results in more equitable energy use between the two technologies. However, even with the benefit of co-location, membrane desalination still generally more economical than thermal processes, resulting in the majority of seawater desalination plants under contract today utilizing RO technology. In addition, SWRO plants have much smaller footprints than thermal desalination plants, which have the added disadvantage of resembling a less-aesthetic industrial facilities. Based on these considerations, as well as the efforts developed to date for this project, RO is considered the process to be currently recommended for large-scale seawater treatment to drinking water standards.

A partial two-pass RO process will increase overall salt rejection to approximately 99.8 percent, compared to a single pass value of up to 99.5 percent. In addition, there are some newer high rejection membranes that can achieve 99.8 percent rejection in a single pass. In general, an assessment of using a single pass versus a two-pass RO configuration will need to consider the offsets in higher energy usage compared to footprint and capital expenditure impacts. In this application, and based on current results from the demonstration testing, the RO configuration design appears to be driven by meeting the treated water quality goal. However, in view of the high levels of predominant ions in seawater, such as chloride, sodium, and bromide, a partial two-pass system will also reduce the concentration of these predominant ions, which will limit potential formation of disinfection byproducts and maximize compatibility with the local suppliers. The piloting and demonstration testing performed by West Basis has evaluated, and is continuing to assess, the performance of a two-pass configuration, and opportunities for optimization of this configuration.

As noted above, the factors in selecting a single pass system with high rejection membranes, versus the use of a two –pass system to meet the boron, bromide, and chloride water goals are driven by the feed water quality of those constituents, in addition to temperature and pH factors. The trade-offs are primarily based on additional OPEX associated with the single-pass (if feasible to meet the treated water quality requirements) compared to the additional capital cost associated with a second pass. Previous work performed to date on this project has assessed these trade-offs leading to the inclusion of a partial second pass in the demonstration facility. **Table 7-13** is presented below to illustrate the differing requirements for a high rejection SWRO membrane versus a standard rejection SWRO membrane with temperature variability. The membranes selected in this assessment are based on current demonstration testing.

Table 7-13: Second Pass RO Assessment

Temperature	Standard Rejection 1st Pass RO Membrane[1]	Boron Selective 1st Pass RO Membrane[1]
	Percent 2nd Pass RO	
10	2	0
15	15	2
17.5	23	10
20	35	18
25	50	35

1. Based on Hydranautics SWC Membranes SWC4+ and SWC5, and Hydranautics IMS Design Projection Software
2. Based on Target Boron Concentration of 0.5 mg/l in combined RO permeate.
3. Percentage based on first pass.

As illustrated above, a second pass RO system is required for all but the minimum temperature range. At the average temperature, the difference in second pass requirements is approximately 13% of the first pass. Also, given that a second pass is required in either scenario, and that current testing facilities have been designed for and are providing data based on a two-pass configuration, it is recommended that two-pass configuration be included in this planning phase.

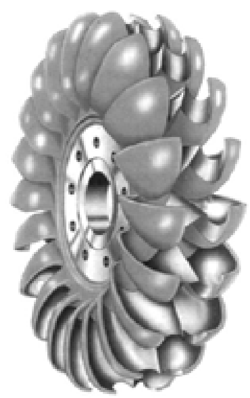
7.2.2.5.2 Energy Recovery

The largest energy consumption area for an RO ocean water desalination plant is the high pressure feed pumps. The bulk of the energy imparted to the RO feed water leaves the membrane system in the concentrate stream. Energy recovery devices (ERDs) capture the residual energy used in the RO process to reduce net power requirements for the facility. The categories of energy recovery devices considered for ocean water desalination facilities include:

- Centrifugal, Turbine-Based Devices
- Hydraulic Turbochargers
- Isobaric Devices

Centrifugal ERDs were introduced approximately 25 years ago. The most common form of turbine-based, centrifugal ERDs are Pelton turbines (or Pelton wheels), in which the high-pressure membrane concentrate is ejected through nozzles onto a turbine wheel. The turbine is mechanically coupled to the membrane feed pump shaft, assisting the motor in driving high-pressure flow. However, because energy is transformed twice, once by the turbine and once by the pump impeller, significant energy loss occurs, resulting in efficiencies of up to about 75 percent. Although Pelton turbines have a relatively low capital cost, these devices typically have more associated design considerations and require more maintenance. An example of a Pelton wheel is shown in **Figure 7-8.**

Figure 7-8: Pelton Wheel ERD



(a) Pelton wheel

(b) Commercially available product (Calder)

Hydraulic turbochargers combine a turbine and a pump as one device mounted on a single shaft. Since turbochargers are centrifugal devices, their efficiency improves with an increase in size of the unit. Thus, larger turbocharger devices have seen significant efficiency gains over the past decade and are able to achieve efficiencies of approximately 80 percent. These units are the least expensive ERD and achieve higher efficiencies than Pelton turbines; however, they are not as efficient as isobaric devices. An example hydraulic turbocharger manufactured by Pump Engineering, Inc. is shown in **Figure 7-9**.

Figure 7-9: Hydraulic Turbochargers

Isobaric ERDs are a more recent development, employing a positive-displacement energy transfer mechanism. A booster or circulation pump sends high-pressure concentrate stream to the ERD. The ERD transfers the energy from the concentrate to a feed water side streams, which is then merged with the discharge of the high-pressure membrane feed pumps. This positive displacement mechanism provides a high hydraulic transfer efficiency of around 97 percent. The two types of isobaric ERDs are:

- Work exchanger: These systems use control valves to manage the flows in and out of the pressure vessel, where the energy exchange occurs. Some systems incorporate a piston (Calder's DWEER or KSB's SALTEC), while others, such as Aqualyng's Recuperator, do not.
- Pressure exchanger: These devices have the same positive displacement energy exchange as work exchangers but are essentially self-regulating and operate at higher speeds, allowing them to be smaller utilize only one moving part.

Although the capital costs of isobaric ERDs are higher than other types of units, it has been reported that energy consumption of a seawater RO process can be reduced by as much as 50 percent when compared to a system without an ERD, or by as much as 25 percent compared to a system with a turbine-type ERD. Another benefit of isobaric ERDs is an increase in operational flexibility, as these types of units provide a high and constant energy transfer efficiency over a wide range of flows and pressures. Thus. the membrane recovery can be adjusted without significantly increasing the energy required on a per unit of permeate basis. These adjustments could allow for more efficient operation of the facility during changes in feed water temperature, water quality, membrane fouling, and other variable conditions.

Figure 7-10: Isobaric ERDs

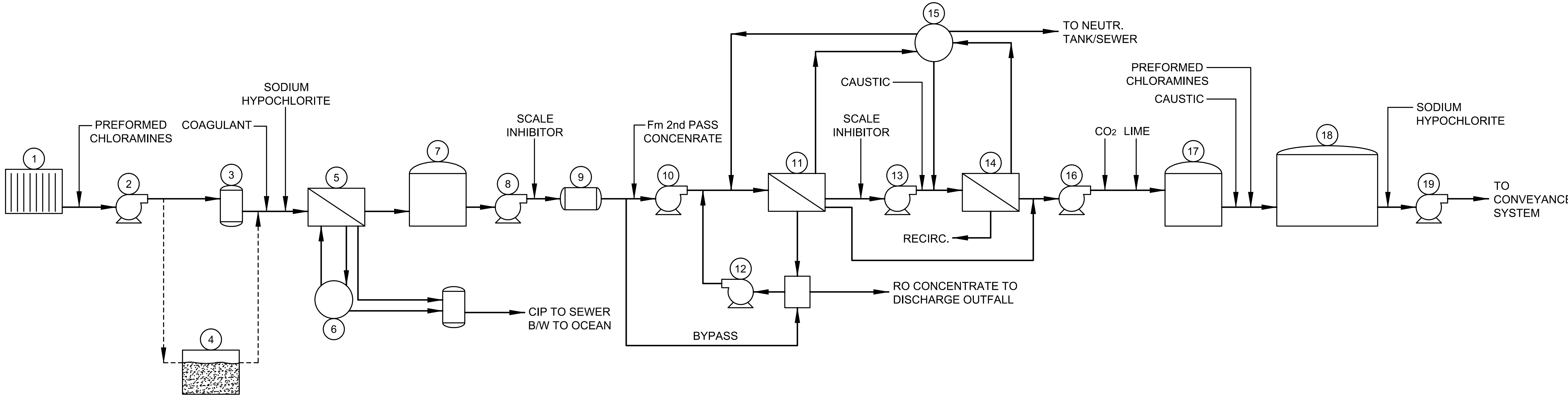
(a) Work exchangers (Calder DWEER) (b) Pressure exchangers (ERI)

Ongoing studies conducted by West Basin have demonstrated the efficiency and effectiveness of ERI's pressure exchangers for minimizing energy consumption of the SWRO process with little or no maintenance. Consequently, these devices are currently recommended for use in energy recovery.

7.2.3. Recommended Process Train

Based on the above assessment and the treatment train selected for the Demonstration Testing, a similar approach to that selected for the demonstration testing is recommended for this planning phase. The approach during this planning phase was to identify the recommended treatment trains using the evaluations and performance results related to the demonstration testing facility, as well as to identify potential alternatives that may be considered in the future based on the availability of recent data.

The anticipated treatment train for both site locations is presented in **Figure 7-11**.



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.

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OCEAN WATER DESALINATION PLANT
PROCESS FLOW DIAGRAM (PFD)
SCALE: NONE

JANUARY 2013

FIGURE 7–11

7.3. Preliminary Criteria

As a basis for site layout development and preparing cost opinions, preliminary criteria have been selected for each of the unit processes. These criteria were selected primarily on the performance of the demonstration testing facility. It is expected that these criteria will change as the demonstration testing continues and additional results are obtained. Additionally, with the case of high rate GMF, testing has not been conducted to date. The refinement of criteria, based on additional pending testing of the high rate GMF, will need to be reflected in final process treatment train, criteria, footprint, and other areas, for the next phases of work. As an example, **Table 7-14** shows the unit process flow rates are for the 20 MGD treatment train provided in the previous section.

Table 7-14: Unit Process Flow Rates for 20 MGD Process Train

	No. of Units	Feed Flow Rate Total, Max. (MGD)	Feed Flow Rate per Unit, Max. (MGD)	Permeate/Discharge Flow Rate per Unit, Max. (MGD)	Permeate/Discharge Flow Rate Total, Max. (MGD)	Combined Permeate Flow Rate, Max. (MGD)
Raw Water PS	4	45.1	11.3	11.3	45.1	
Disk Filter/GMF	2	45.1	22.6	22.6	44.2	
UF/MF	8	44.2	5.5	5.2	42.0	
Booster Pumps	4	42.0	10.5	10.5	42.0	
RO Feed Pumps	4	42.0	10.5	10.5	42.0	
1st Pass RO		42.0			21.0	10.7
2nd Pass Pumps	2	10.3	5.1	5.1	10.3	
2nd Pass RO	2	10.3	5.1	4.6	9.3	9.3
Post-Treatment Pumps	4	20.0	5.0	5.0	20.0	20.0
Lime Slurry Contactor	2	20.0	10.0	10.0	20.0	20.0
PWPS	4	30.0	7.5	7.5	30.0	30.0

7.4. Site Layouts

This section addresses the primary considerations involved in accounting for the specific footprint requirements associated with this new desalination facility at both siting alternatives.

The proposed West Basin Ocean Water Desaliantion Plant would treat raw ocean water collected at the existing intake structures and conveyed to the raw water pumping stations located on site. The primary treatment process for this desalination facility would include seawater reverse osmosis membranes (SWRO).

SWRO membranes require special consideration for pre-treatment and post-treatment to ensure long-term system reliability and acceptable product water quality. The proposed SWRO pre-treatment systems include the following:

- Intake Screens
- Fine Screening
- Filtration: Dual Media or Membrane Filtration
- Cartridge Filtration
- Chemical Conditioning (i.e. Scale Inhibitors, pH adjustment)

After the SWRO process, the product water (permeate) requires post-treatment conditioning to provide a stable and compatible product water. This entails the addition of minerals to the RO permeate to mitigate the corrosive nature of the permeate and to ensure compatibility with current water supplies. Post-treatment process includes:

- Lime addition
- Carbon Dioxide Addition
- pH adjustment with Caustic Soda
- Chloramine Disinfection

Table 7-16 identifies the footprint requirements for each of the unit processes, for 20 and 60 MGD.

Table 7-15: Unit Process Flow Rates

<table>
<tr><th rowspan="2">Process/ Equipment No..</th><th rowspan="2">Description</th><th rowspan="2">Comments</th><th colspan="2">No. of Units</th><th colspan="2">Surface Area</th><th colspan="2">Dimensions</th></tr>
<tr><th>20-MGD</th><th>60-MGD</th><th>20-MGD</th><th>60-MGD</th><th>20-MGD</th><th>60-MGD</th></tr>
<tr><td>1</td><td>Screens</td><td colspan="7">Offsite</td></tr>
<tr><td>2</td><td>Feed Water Pump Station</td><td colspan="7">Offsite</td></tr>
<tr><td>3</td><td>Strainers</td><td>Disk Filters</td><td>2</td><td>5</td><td>1,250 ft^2</td><td>3,125 ft^2</td><td>50' x 25'</td><td>125' x 25'</td></tr>
<tr><td>4</td><td>High Rate Granular Media Filtration (FUT.)</td><td>High Rate Granular Media Filtration (Alt.)</td><td>4</td><td>12</td><td>4,000 ft^2</td><td>10,000 ft^2</td><td>80' x 50'</td><td>200' x 50'</td></tr>
<tr><td>5</td><td>MF/UF</td><td>MF/UF</td><td>10</td><td>30</td><td rowspan="2">15,000 ft^2</td><td rowspan="2">30,000 ft^2</td><td rowspan="2">150' X 100'</td><td rowspan="2">300' x 100'</td></tr>
<tr><td>6</td><td>MF/UF CIP System</td><td>CIP System & Discharge Neutralization Tank</td><td>1</td><td>1</td></tr>
<tr><td>7</td><td>MF/UF Filtrate Storage</td><td>Filtrate Tank</td><td>1</td><td>1</td><td>2,800 ft^2</td><td>7,850 ft^2</td><td>60' Ø</td><td>100' Ø</td></tr>
<tr><td>8</td><td>MF/UF Filtrate Booster P.S.</td><td>Booster Pumps</td><td>1</td><td>1</td><td colspan="2">4,500 ft^2</td><td colspan="2">50' X 90'</td></tr>
<tr><td>9</td><td>Cartridge Filters</td><td>Cartridge Filters</td><td>4</td><td>12</td><td rowspan="7">30,000 ft^2</td><td rowspan="7">70,000 ft^2</td><td rowspan="7">300'x100'</td><td rowspan="7">350'x200'</td></tr>
<tr><td>10</td><td>RO Feed P.S. – 1st Pass</td><td>RO Feed P.S. – 1st Pass</td><td>4</td><td>12</td></tr>
<tr><td>11</td><td>RO System – 1st Pass</td><td>RO System – 1st Pass</td><td>4</td><td>12</td></tr>
<tr><td>12</td><td>Energy Recovery</td><td>Energy Recovery</td><td>4</td><td>12</td></tr>
<tr><td>13</td><td>RO Feed P.S. – 2nd Pass (%)</td><td>RO Feed P.S. – 2nd Pass</td><td>2</td><td>6</td></tr>
<tr><td>14</td><td>RO System – 2nd Pass</td><td>RO System – 2nd Pass</td><td>2</td><td>6</td></tr>
<tr><td>15</td><td>RO CIP</td><td>RO CIP</td><td>1</td><td>1</td></tr>
<tr><td>16</td><td>Post-Treatment P.S.</td><td>Post-Treatment P.S.</td><td>1</td><td>1</td><td colspan="2">1,500 ft^2</td><td colspan="2">30' x 50'</td></tr>
<tr><td>17</td><td>Post-Treatment</td><td>Post-Treatment</td><td>1</td><td>1</td><td>4,000 ft^2</td><td>10,000 ft^2</td><td>80' x 50'</td><td>200' x 50'</td></tr>
<tr><td>18</td><td>Clearwell</td><td>Clearwell</td><td>1</td><td>1</td><td>22,270 ft^2</td><td>70,700 ft^2</td><td>170' Ø</td><td>300' Ø</td></tr>
<tr><td>19</td><td>Product Water P.S.</td><td>Product Water P.S.</td><td>1</td><td>1</td><td colspan="2">1,500 ft^2</td><td colspan="2">30' x 50'</td></tr>
<tr><td>20</td><td>Electrical Substation</td><td>Electrical Substation</td><td>1</td><td>1</td><td>10,000 ft^2</td><td>30,000 ft^2</td><td>100' x 100'</td><td>100' x 250'</td></tr>
<tr><td>21</td><td>Chemical Storage Area</td><td>Chemical Storage Area</td><td>1</td><td>1</td><td>8,000 ft^2</td><td>15,000 ft^2</td><td>80' x 100'</td><td>150' x 100'</td></tr>
<tr><td>22</td><td>Administration & Maintenance Bldg.</td><td>Administration & Maintenance Bldg..</td><td>1</td><td>1</td><td colspan="2">28,000 ft^2</td><td colspan="2">175' x 80'</td></tr>
</table>

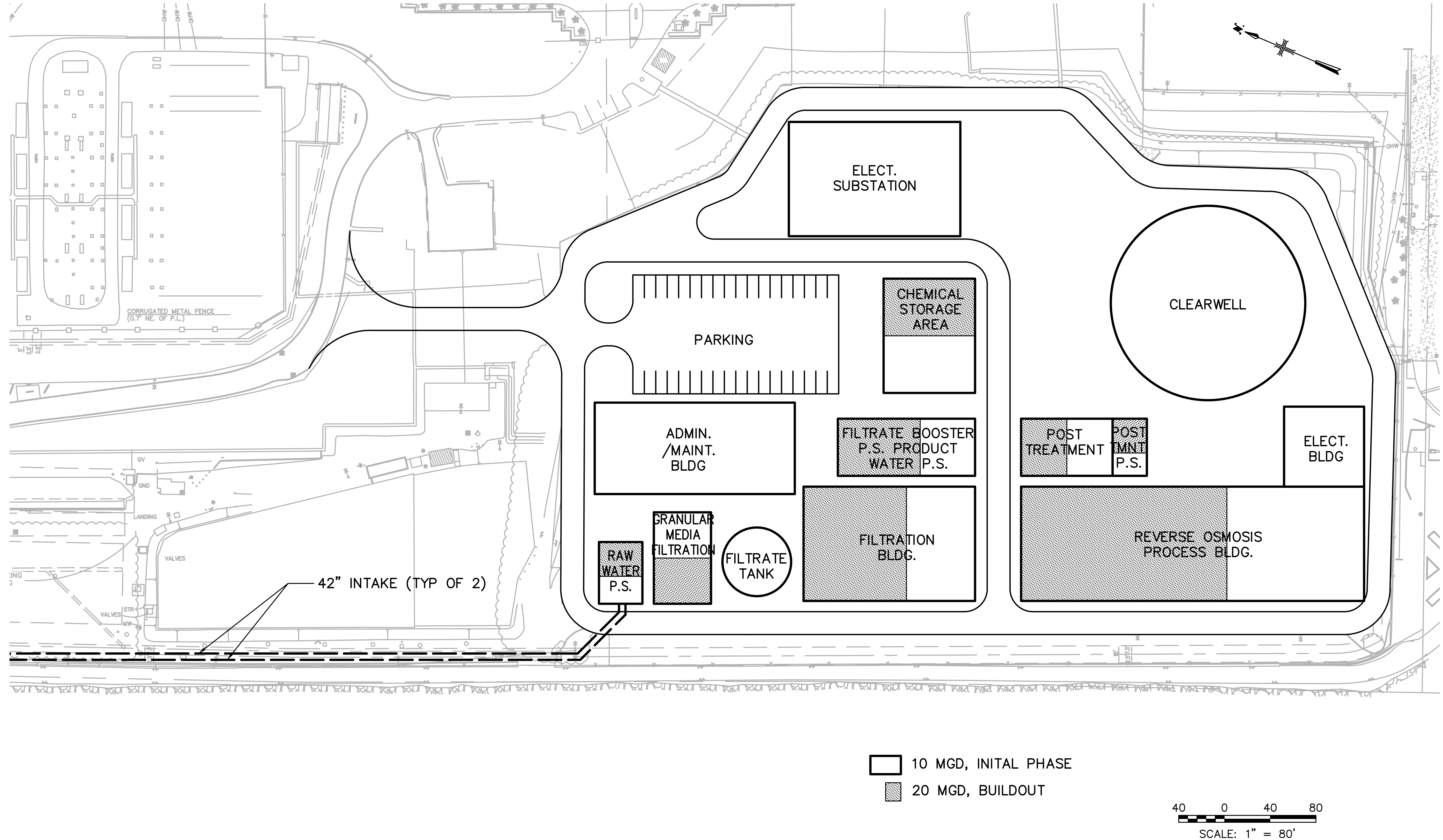
7.4.1. Peripheral Facilities

In addition to the processes and facilities described above, footprint consideration is also required for the following peripheral, or appurtenant, facilities:

- Raw Water Pumping
- Chemical Storage and Handling
- Product Water Storage/ Clearwell
- Product Water Pumping
- Administrative Area/Control Room
- Education Center
- Electrical/MCC Buildings
- Maintenance Areas
- Power Sub-Stations.
- Residuals Handling

7.4.2. Preliminary Site Layout

This section identifies preliminary layouts for the required facilities associated with the West Basin Ocean Desalination Plant. Based on the site evaluation performed in Section 4.0, both the Redondo and El Segundo sites were recommended for further evaluation. As such, layouts have been developed for both locations. **Figures 7-12 and 7-13** present layouts for the local project; a 20 MGD treatment facility at build-out, with a 10 MGD initial phased construction. **Figures 7-14 and 7-15** present layouts for the regional case; a 60 MGD treatment facility at buildout.



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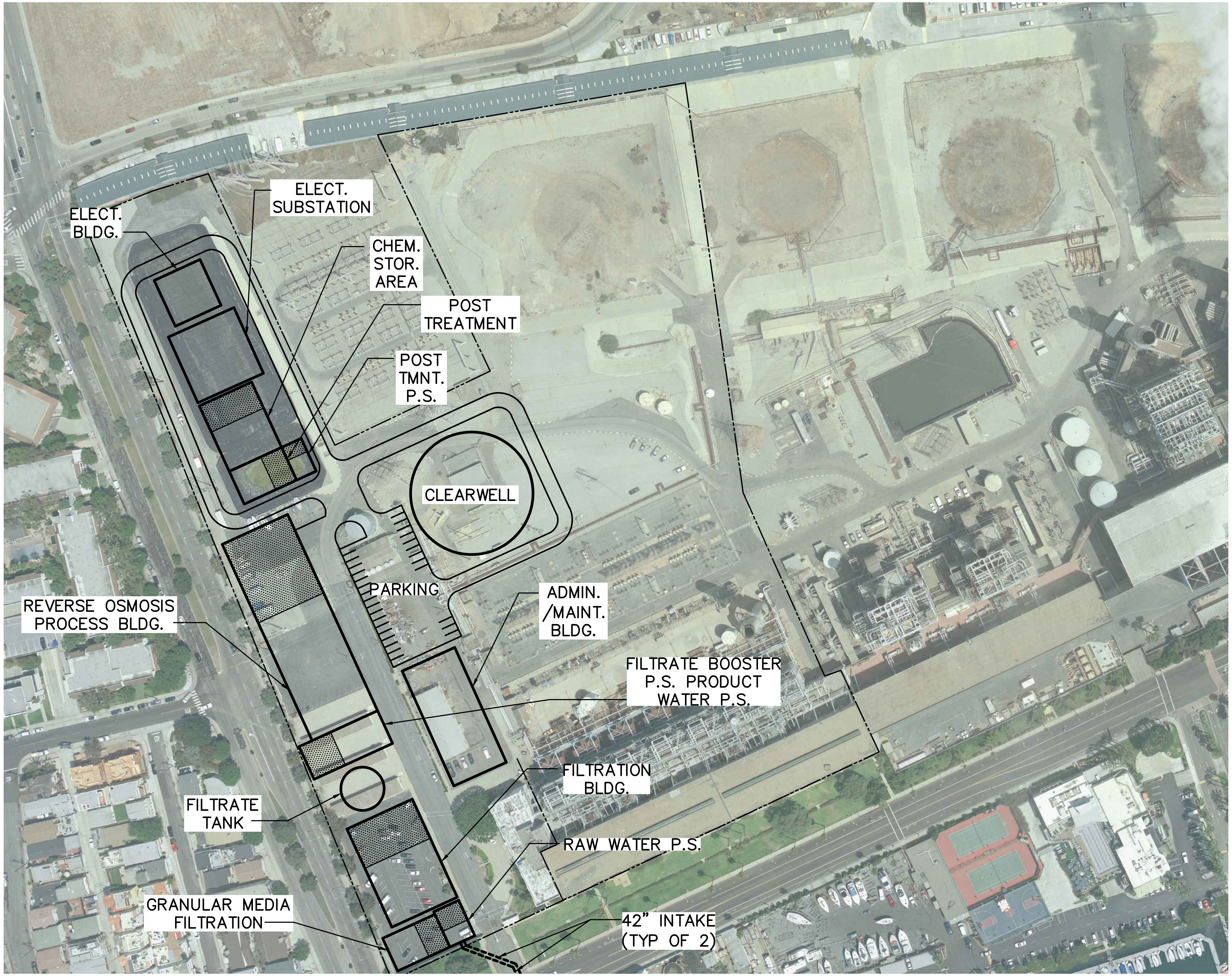
PROGRAM MASTER PLAN (PMP)

NRG ENERGY, INC. – 301 VISTA DEL MAR, EL SEGUNDO, CA. 90245
PRELIMINARY SITE LAYOUT – 10 & 20 MGD
SCALE: AS NOTED

JANUARY 2013
FIGURE 7–12



10 MGD, INITAL PHASE

20 MGD, BUILDOUT

75 0 75 150

SCALE: 1" = 150'

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OCEAN WATER DESALINATION
PROGRAM MASTER PLAN (PMP)

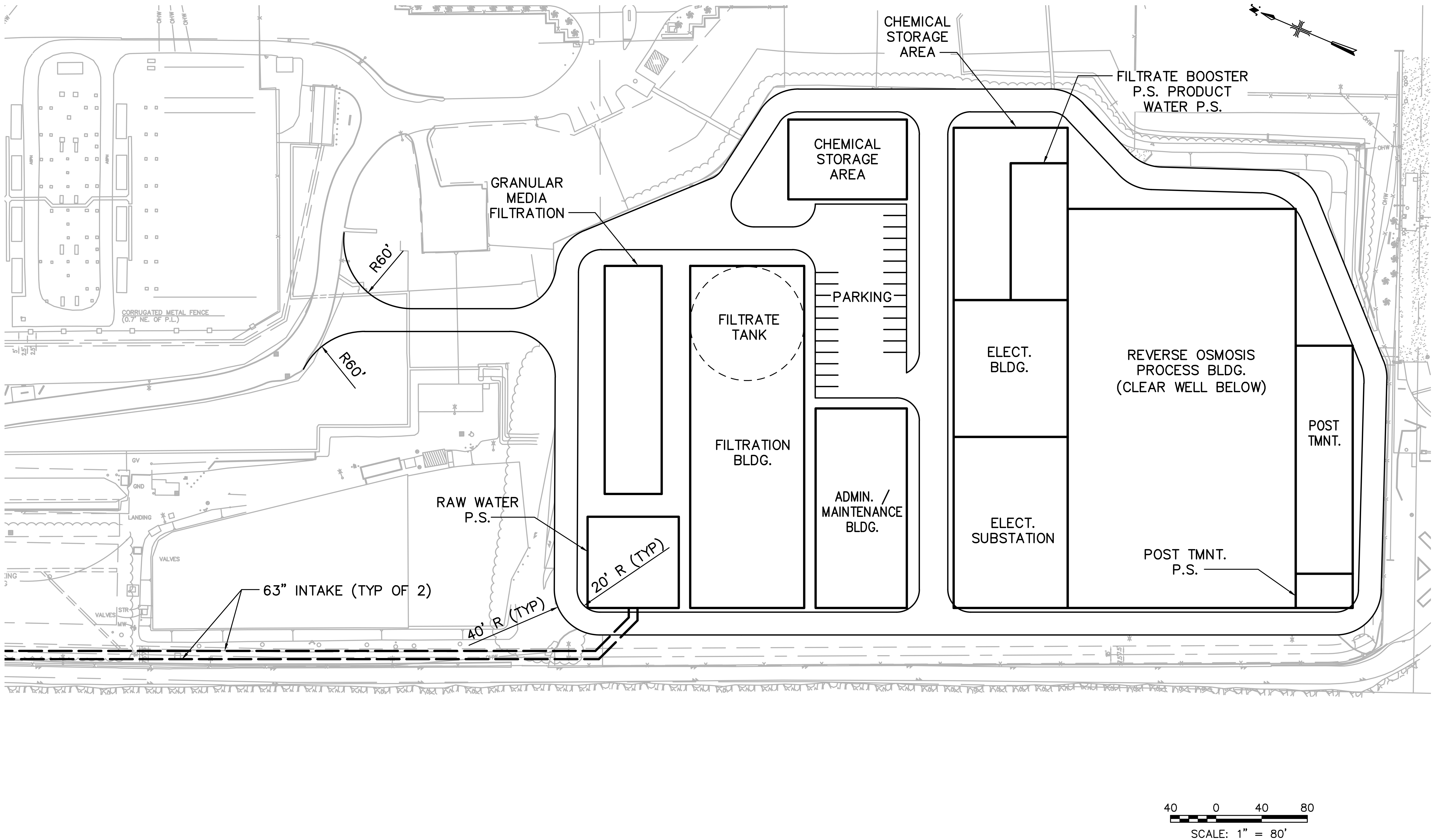
AES CORPORATION – 1100 N. HARBOR DR., REDONDO BEACH, CA. 90277

PRELIMINARY SITE LAYOUT – 10 & 20 MGD

SCALE: AS NOTED

JANUARY 2013

FIGURE 7–13



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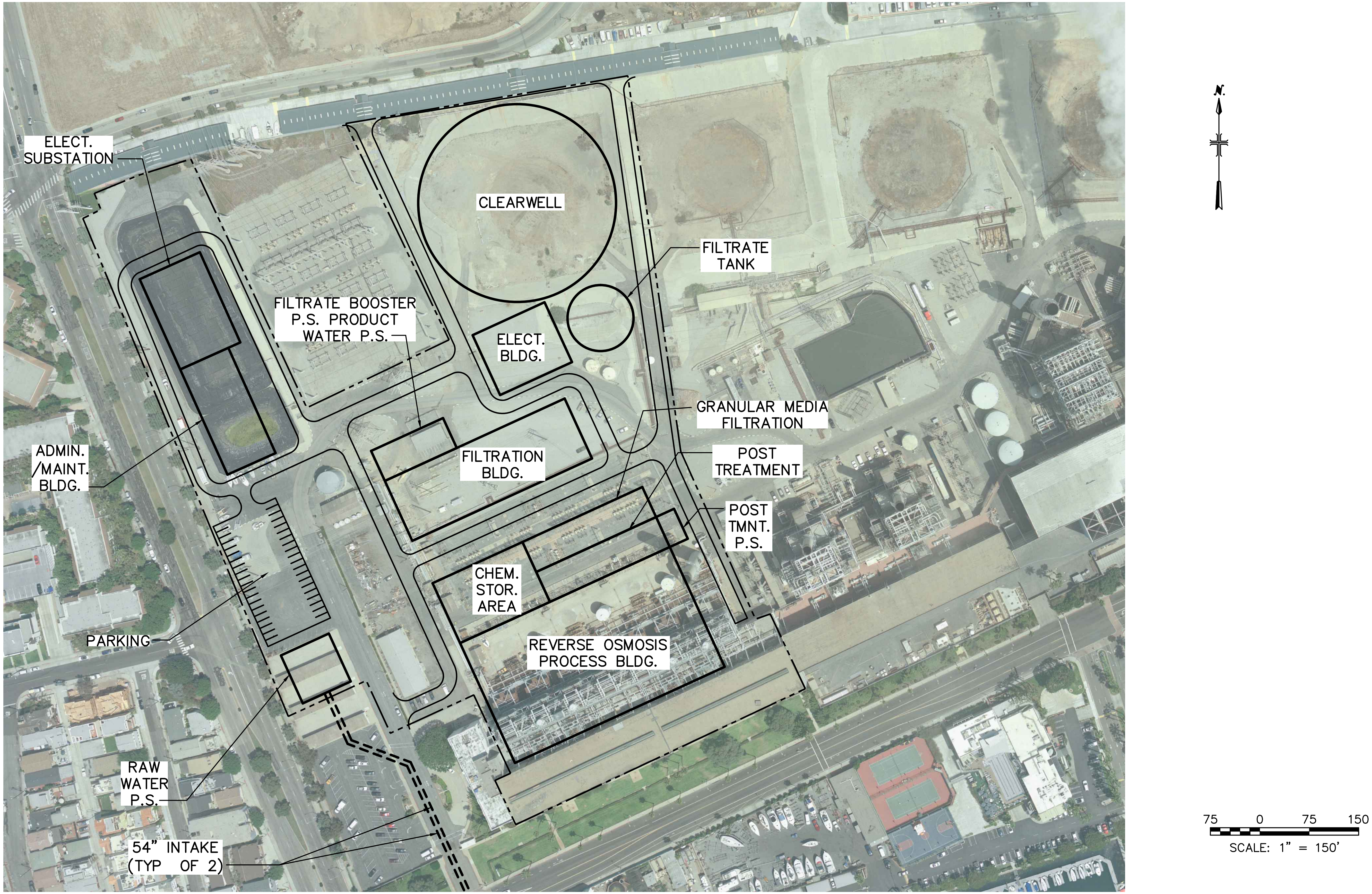
PRELIMINARY SITE LAYOUT – 60 MGD
SCALE: AS NOTED

JANUARY 2013
FIGURE 7–14



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PRELIMINARY SITE LAYOUT – 60 MGD
SCALE: AS NOTED

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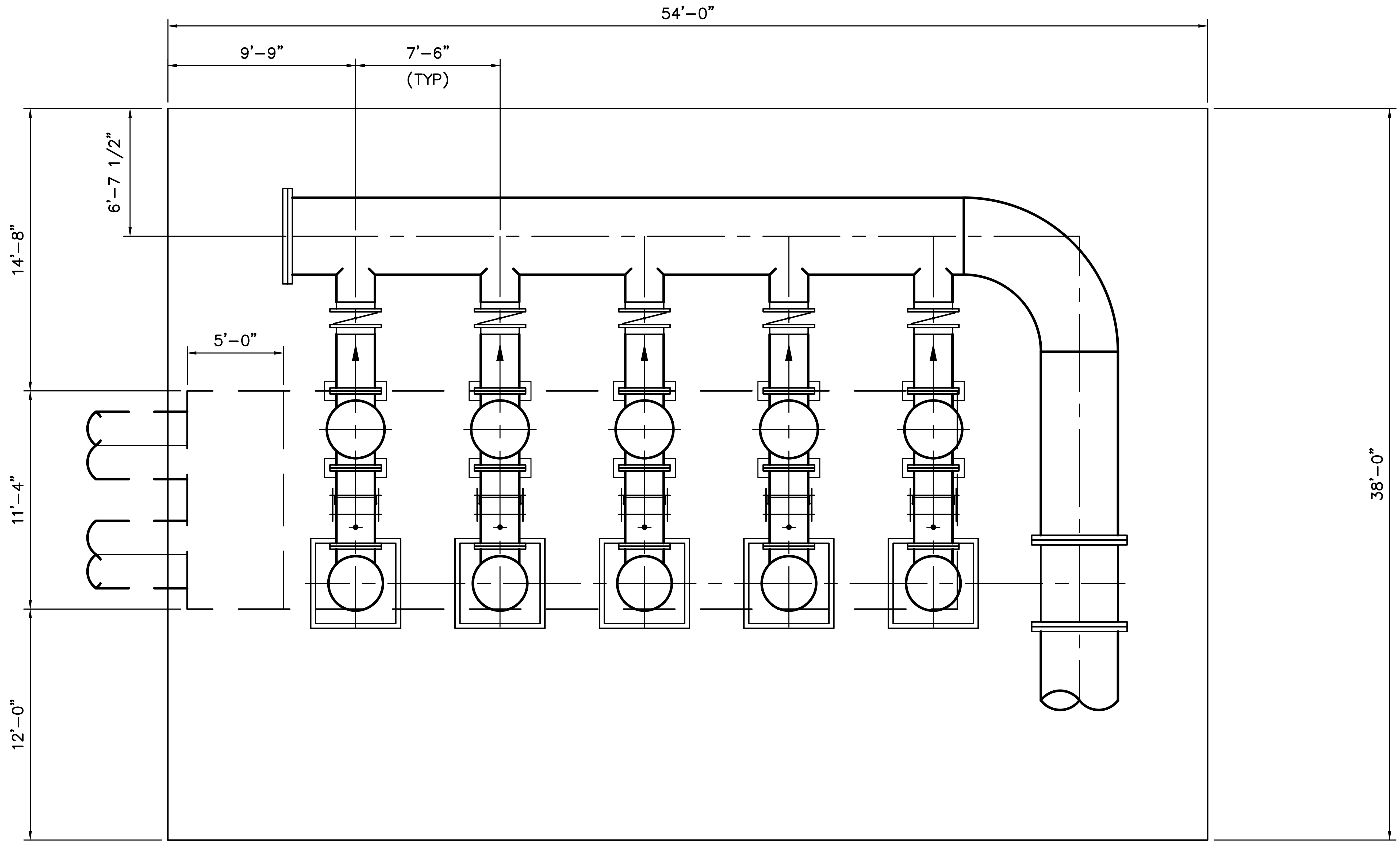
FIGURE 7–15

Preliminary layouts of the raw water pump station are also included as **Figures 7-16 and 7-17**. Based on these facility layouts, further development of the site, including preliminary grading requirements were developed.

Tables 7-16 through 7-19 provide estimate elevation summary and footprint requirements for each of the facilities and structure.

Architectural renderings for the 10-MGD initial installation/40-MGD build-out scenario are included in **Appendix 1:I**.



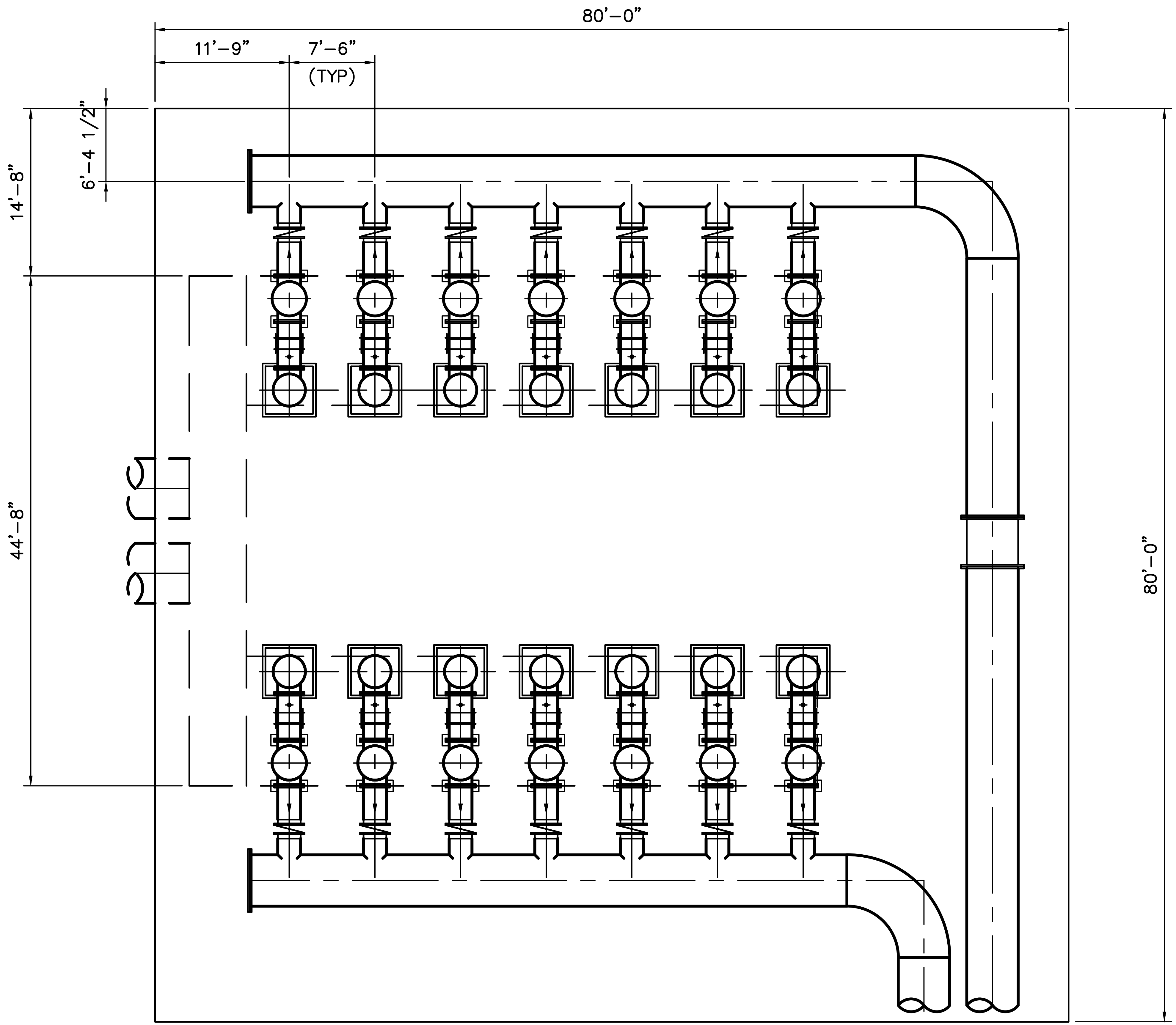
NRG ENERGY, INC. – 301 VISTA DEL MAR, EL SEGUNDO, CA. 90245

RAW WATER PUMP STATION – 10 & 20 MGD

SCALE: AS NOTED

JANUARY 2013

FIGURE 7–16



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NRG ENERGY, INC. – 301 VISTA DEL MAR, EL SEGUNDO, CA. 90245
RAW WATER PUMP STATION – 60 MGD
SCALE: AS NOTED

JANUARY 2013

FIGURE 7–17

Table 7-16: Facilities Footprint & Elevations Summary: El Segundo / 20 MGD

Process	Floor Elevation (ft)	Roof Elevation (ft)	Length (x) (ft)	Width (y) (ft)	Diameter (ft)	Layout Area ft^2
Raw Water P.S. Building	41	71	54	38	X	2,052
Granular Media Filtration Building	41	71	80	50	X	4,000
Filtration Building	42	72	150	100	X	15,000
Filtrate Tank (outdoor, at grade)	41	71	X	X	60	2,800
Filtrate Booster P.S. Building	43	73	90	50	X	4,500
Reverse Osmosis Process Building	43	73	300	100	X	30,000
Post Treatment P.S. Building	43	73	50	30	X	1,500
Post Treament (outdoor, at grade)	43	X	80	50	X	4,000
Clearwell (outdoor, at grade)	45	30	X	X	170	22,270
Product Water P.S. Building	43	73	50	30	X	1,500
Electrical Substation Building	44	74	100	100	X	10,000
Administration/Maintenance Building - First Floor	42	53	175	80	X	14,000
Administration/Maintenance Building - Second Floor	53	64	175	80	X	14,000
Chemical Storage Area	44	X	100	80	X	8,000

Table 7-17: Facilities Footprint & Elevations Summary: Redondo / 20 MGD

Process	Floor Elevation (ft)	Roof Elevation (ft)	Length (x) (ft)	Width (y) (ft)	Diameter (ft)	Layout Area ft^2
Raw Water P.S. Building	17	47	54	38	X	2,052
Granular Media Filtration Building	25	55	80	50	X	4,000
Filtration Building	21	51	150	100	X	15,000
Filtrate Tank (outdoor, at grade)	25	55	X	X	60	2,800
Filtrate Booster P.S. Building	25	55	90	50	X	4,500
Reverse Osmosis Process Building	26	56	300	100	X	30,000
Post Treatment P.S. Building	23	53	50	30	X	1,500
Post Treament (outdoor, at grade)	23	X	80	50	X	4,000
Clearwell (outdoor, at grade)	22	52	X	X	170	22,270
Product Water P.S. Building	25	55	50	30	X	1,500
Electrical Substation Building	25	55	100	100	X	10,000
Administration/Maintenance Building - First Floor	25	36	175	80	X	14,000
Administration/Maintenance Building - Second Floor	36	47	175	80	X	14,000
Chemical Storage Area	24	X	100	80	X	8,000

Table 7-18: Facilities Footprint & Elevations Summary: El Segundo / 60 MGD

Process	Floor Elevation (ft)	Roof Elevation (ft)	Length (x) (ft)	Width (y) (ft)	Diameter (ft)	Layout Area ft^2
Raw Water P.S. Building	41	71	80	80	X	6,400
Granular Media Filtration Building	42	72	200	50	X	10,000
Filtration Building	42	72	300	100	X	30,000
Filtrate Tank (buried)	10	40	X	X	100	7,850
Filtrate Booster P.S. Building	44	74	90	50	X	4,500
Reverse Osmosis Process Building	43	73	350	200	X	70,000
Post Treatment P.S. Building	43	73	50	30	X	1,500
Post Treament (outdoor, at grade)	43	X	200	50	X	10,000
Clearwell (outdoor, at grade)	10	40	X	X	300	22,270
Product Water P.S. Building	44	74	50	30	X	1,500
Electrical Substation Building	42	72	250	100	X	25,000
Administration/Maintenance Building - First Floor	42	53	175	80	X	14,000
Administration/Maintenance Building - Second Floor	53	64	175	80	X	14,000
Chemical Storage Area	44	X	150	100	X	15,000

Table 7-19: Facilities Footprint & Elevations Summary: Redondo / 60 MGD

Process	Floor Elevation (ft)	Roof Elevation (ft)	Length (x) (ft)	Width (y) (ft)	Diameter (ft)	Layout Area ft^2
Raw Water P.S. Building	23	73	80	80	X	6,400
Granular Media Filtration Building	17	47	200	50	X	10,000
Filtration Building	20	50	300	100	X	30,000
Filtrate Tank (outdoor, at grade)	21	51	X	X	100	7,850
Filtrate Booster P.S. Building	20	50	90	50	X	4,500
Reverse Osmosis Process Building	19	49	350	200	X	70,000
Post Treatment P.S. Building	23	53	50	30	X	1,500
Post Treament (outdoor, at grade)	23	X	200	50	X	10,000
Clearwell (outdoor, at grade)	5	35	X	X	300	22,270
Product Water P.S. Building	20	50	50	30	X	1,500
Electrical Substation Building	25	55	250	100	X	25,000
Administration/Maintenance Building - First Floor	23	34	175	80	X	14,000
Administration/Maintenance Building - Second Floor	34	45	175	80	X	14,000
Chemical Storage Area	20	X	150	100	X	15,000

The estimated space requirements for each facility are included in **Table 7-8** above. **Tables 7-20 and 7-21** includes a detailed breakdown of the estimated facilities and space requirements within the Administration/Education Center Building for the 20 MGD and 60 MGD cases.

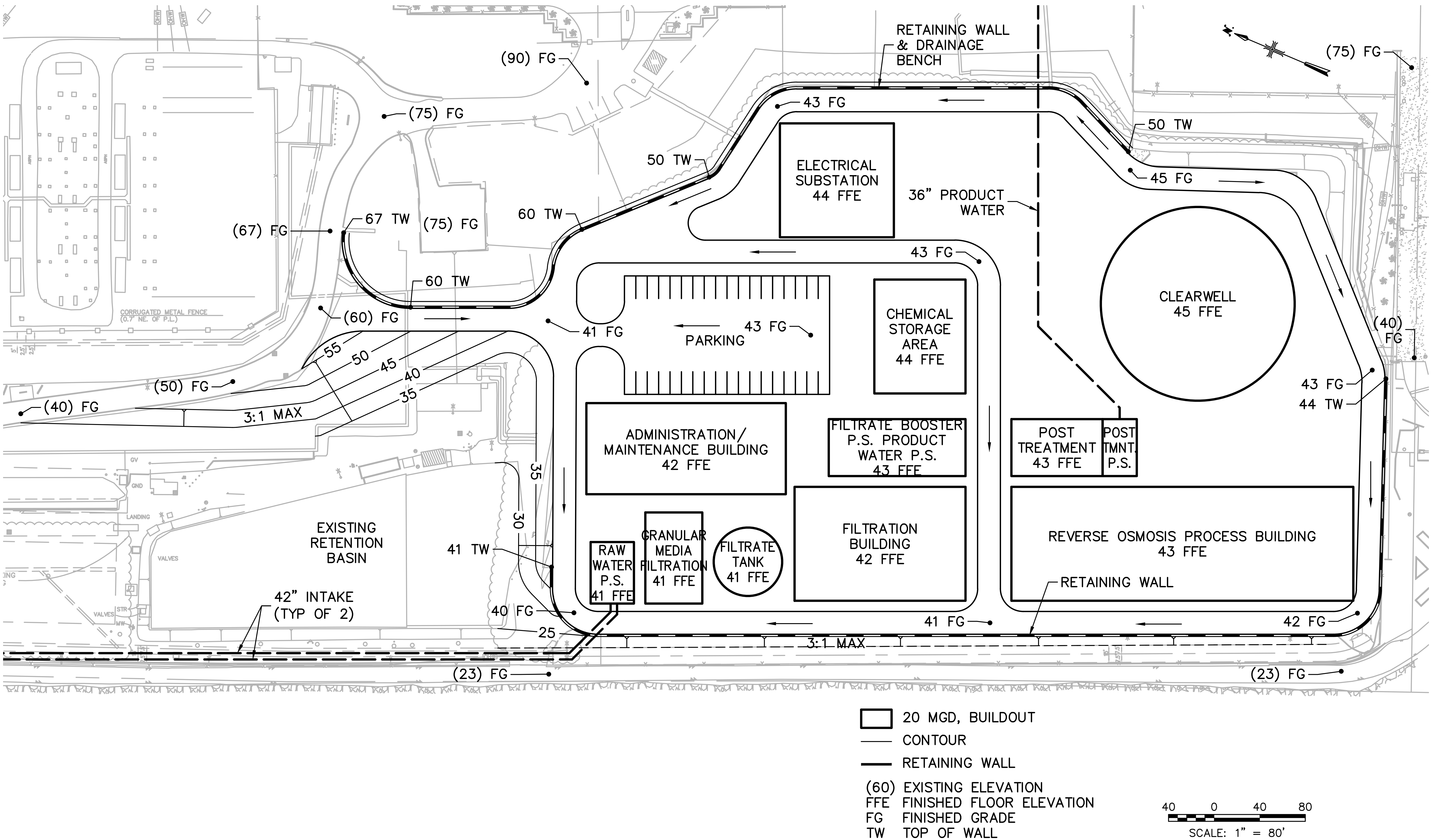
Table 7-20: Footprint Requirements: Administration Building/Education Center / 20 MGD

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 7-21: 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**

Figures 7-18 through 7-21 illustrate the site grading requirements for each case and site.



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The Water Division of ARCADIS

WEST BASIN MUNICIPAL WATER DISTRICT
17140 S. AVALON BLVD., SUITE 120, CARSON, CA 90746
OCEAN WATER DESALINATION
PROGRAM MASTER PLAN (PMP)

NRG ENERGY, INC. – 301 VISTA DEL MAR, EL SEGUNDO, CA. 90245

PRELIMINARY GRADING & UTILITY PLAN – 20 MGD

SCALE: AS NOTED

JANUARY 2013

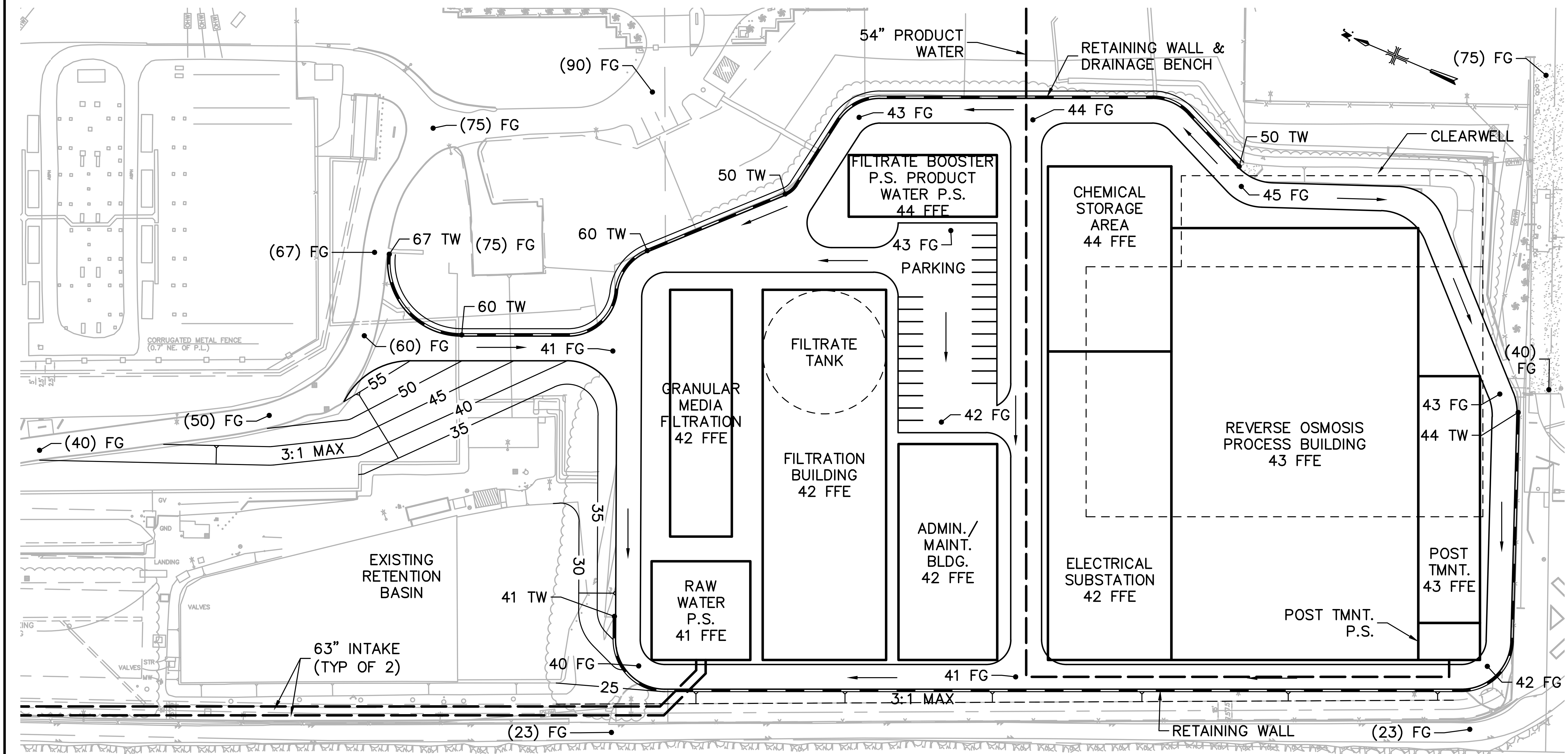
FIGURE 7–18

20 MGD, BUILDOUT

(60) EXISTING ELEVATION
FFE FINISHED FLOOR ELEVATION
FG FINISHED GRADE

75 0 75 150
SCALE: 1" = 150'

MALCOLM PIRNIE / ARCADIS — The Water Division of ARCADIS	WEST BASIN MUNICIPAL WATER DISTRICT 17140 S. AVALON BLVD., SUITE 120, CARSON, CA 90746 OCEAN WATER DESALINATION PROGRAM MASTER PLAN (PMP)	AES CORPORATION – 1100 N. HARBOR DR., REDONDO BEACH, CA. 90277 PRELIMINARY GRADING & UTILITY PLAN – 20 MGD SCALE: AS NOTED	JANUARY 2013 FIGURE 7–19



60 MGD, BUILDOUT
CONTOUR
RETAINING WALL
(60) EXISTING ELEVATION
FFE FINISHED FLOOR ELEVATION
FG FINISHED GRADE
TW TOP OF WALL

40 0 40 80
SCALE: 1" = 80'

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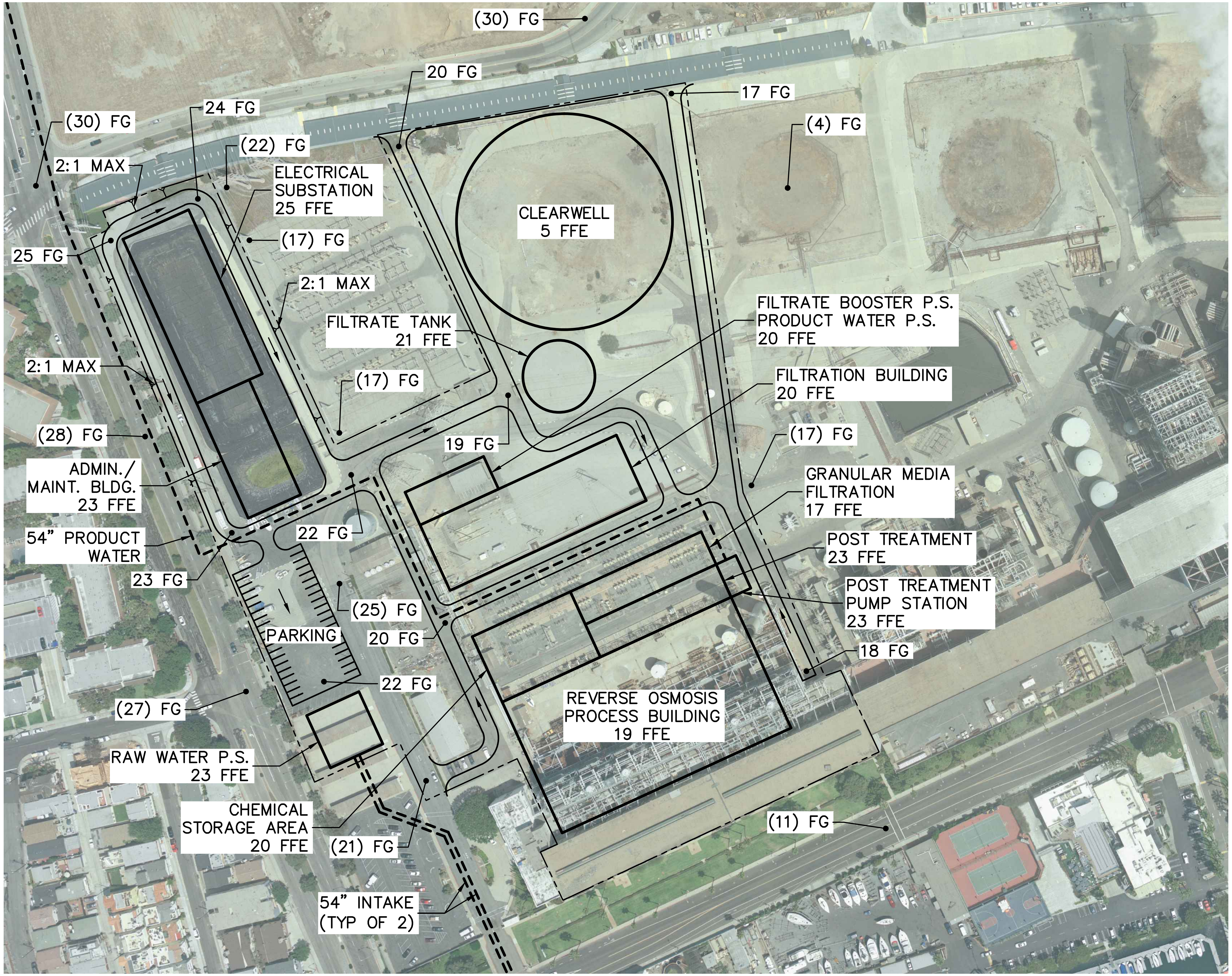
OCEAN WATER DESALINATION
PROGRAM MASTER PLAN (PMP)

NRG ENERGY, INC. – 301 VISTA DEL MAR, EL SEGUNDO, CA. 90245
PRELIMINARY GRADING & UTILITY PLAN – 60 MGD
SCALE: AS NOTED

JANUARY 2013
FIGURE 7–20



20 MGD, BUILDOUT

(60) EXISTING ELEVATION
FFE FINISHED FLOOR ELEVATION
FG FINISHED GRADE

75 0 75 150
SCALE: 1" = 150'

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WEST BASIN MUNICIPAL WATER DISTRICT
17140 S. AVALON BLVD., SUITE 120, CARSON, CA 90746
OCEAN WATER DESALINATION
PROGRAM MASTER PLAN (PMP)

AES CORPORATION – 1100 N. HARBOR DR., REDONDO BEACH, CA. 90277

PRELIMINARY GRADING & UTILITY PLAN – 60 MGD

SCALE: AS NOTED

JANUARY 2013

FIGURE 7–21

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User: Dmytryshyn Spec: PIRNIE STANDARD File: G:\CADD\ACAD\PROJ\05052016 West Basin MWD\Figures\AES 60 MGD GRADING PLAN.DWG Scale: 1:1 Date: 12/13/2012 Tim

7.5. Capital Cost Summary

The cost opinions provided in this Program Master Plan for the two alternative site locations are based on the conceptual criteria provided in the above sections. The cost estimation provided herein is considered by the AACE criteria as a Class 4 estimate. A Class 4 estimate is defined as a Planning Level or Design Technical Feasibility Estimate. Typically, engineering is from 1 percent to 15 percent complete. The expected accuracy for Class 4 estimates typically range from -30 percent to +50 percent, depending on the technological complexity of the project, appropriate reference information, and the inclusion of an appropriate contingency determination.

7.5.1. Work Area Breakdown

This cost opinions are divided into distinct process areas, or work areas, to assess and present the capital costs. These divisions are broken down into the following work areas:

Intake and Raw Water Conveyance:	Covers the complete intake system including screens, conveyance piping inside the existing tunnel, conveyance to the on-shore, raw water pumping station, and the raw water pumping station.
Pretreatment:	This sub-section includes the pretreatment systems required for conditioning and delivery of the raw ocean water to the RO Treatment including membrane filtration pre-treatment (disk screens), membrane filtration and appurtenances (i.e., CIP), Filtration Building, Filtrate storage and pumping, and pre-treatment chemical storage and handling systems.
Reverse Osmosis:	Covers the SWRO first pass treatment trains and second pass treatment trains, including RO CIP, cartridge filtration, and RO Building.
Post-Treatment:	This sub-section covers the post-treatment systems required for conditioning and disinfection of the RO permeate. It includes the post stabilization chemical storage and handling systems (carbon dioxide, lime slurry, lime saturators, storage tanks), lime contact tanks, transfer pumping station, and sodium hypochlorite and ammonia storage and handling systems.

Product Water Pumping & Storage: Addresses the product water pumping and storage for each scenario, including clearwell, product water pump station, and conveyance pipeline (conveyance to tie-in location per local Scenario 1 in Section 5 for 20-MGD costs, and regional case tie-in location for the 60-MGD costs.

Residuals Handling & Concentrate Discharge:

Covers the concentrate conveyance pipeline, diffuser system, backwash handling and CIP Neutralization, storage and discharge..

Power Supply: Includes the on-site electrical substation. The capital cost for this work area is not included in this estimate. It will be developed and added to the project costs during the power supply development task.

Electrical Building: Includes the building for housing the plant electrical gear in a centralized location, including MCC's, switchgear and variable frequency drives. The costs for the electrical gear are not included in this work area – they are derived as a percentage of the applicable work areas.

Administrative/ Education Center Building:

This area includes the buildings for administrative, operations, and laboratory personnel, including control room, offices, laboratory, and education center facilities. A detailed description of this building is included in the site layout discussion above.

Costing assumptions include the following:

- Plant Capacity of 20-MGD (Local Case), and 60-MGD (Regional Case)
- Treatment Train assumptions provided by West Basin based on current pilot study and demonstration testing efforts, and as summarized in previous section.
- Buildings required for screening, filtration, RO, pumping stations, electrical and administrative/education center. Chemical storage tanks are covered but not enclosed

- Plant Electrical, SCADA/I&C, Civil Sitework, Structural, Architectural and HVAC cost based on percentage of equipment costs. Percentages are included in the assumptions tab of the cost spreadsheet.
- Cost for purchase or leasing of on-shore (Land), or off-shore facilities (tunnel structures) is not included in this estimate.

Estimates are based on January 2012 costs. The Engineering News Record (ENR) City Cost Index (CCI) for January 2012 in Los Angeles is 10091.80.

7.5.2. Indirect Project Costs

To account for a range of values associated with the various indirect project costing assumptions used in this estimate, and to assess the sensitivity of the estimate to this potential variability, three costing categories were selected:

High:

This category reflects the high cost estimate and is based on a more conservative range of percentages used for project indirect costs. This category also includes a 50% partial second pass RO.

Mobilization/Demobilization:	2.0%
Bonds & Insurance:	1.5%
Contractors Overhead and Profit:	15%
Professional Services:	20%
Un-Priced Allowances:	30%

Base:

This category reflects an anticipated range of percentages used for project indirect costs based on anticipated construction market trends and a higher level of preliminary design development associated with various plant components.

Mobilization/Demobilization:	2.0%
Bonds & Insurance:	1.0%
Contractors Overhead and Profit:	12%
Professional Services:	18%
Contingency:	20%

Low:

This category reflects the low cost estimate and is based on a low level of conservatism associated with the range of percentages used for project indirect costs.

Mobilization/Demobilization:	1.0%
Bonds & Insurance:	0.5%
Contractors Overhead and Profit:	8%
Professional Services:	15%
Contingency:	15%

Tables 7-22 and 7-23 present the capital cost summaries for the local case 20-MGD El Segundo and Redondo Beach sites, respectively. The detailed backup for these cost opinions are provided in **Appendix 1:G**.

Table 7-22: Capital Cost Opinion El Segundo: Local Case / 20 MGD

	Work Area Description	Project Cost	% of Total		
Capital Cost					
1.0	Intake	$7,580,000	4%		
2.0	Pretreatment	$46,050,000	25%		
3.0	Reverse Osmosis	$73,240,000	40%		
4.0	Post-Treatment & Disinfection	$8,340,000	5%		
5.0	Product Water Pumping, Storage & Conveyance	$33,030,000	18%		
6.0	Residuals Handling & Concentrate Discharge	$3,790,000	2%		
7.0	Power Supply (Redundancy Setup Fee Only)	$2,000,000	1%		
8.0	Electrical Building	$1,230,000	1%		
9.0	Admin / Maint	$7,570,000	4%		
	Subtotal	**$182,830,000**	**100%**		
			LOW	**BASE**	**HIGH**
	Mobilization / Demobilization		$1,828,300	$3,656,600	$3,656,600
	Bonds & Insurance		$914,150	$1,828,300	$2,742,450
	Overhead & Profit		$14,626,400	$21,939,600	$27,424,500
	Un-Priced Allowances (Contingency)		$27,424,500	$36,566,000	$54,849,000
	Subtotal Construction Cost		**$227,623,350**	**$246,820,500**	**$271,502,550**
	Professional Services		$34,143,503	$44,427,690	$54,300,510
	Total Capital Cost		**$261,766,853**	**$291,248,190**	**$325,803,060**

Table 7-23: Capital Cost Opinion Redondo: Local Case / 20 MGD

	Work Area Description	Project Cost	% of Total		
Capital Cost					
1.0	Intake	$6,970,000	4%		
2.0	Pretreatment	$46,050,000	25%		
3.0	Reverse Osmosis	$73,240,000	39%		
4.0	Post-Treatment & Disinfection	$8,340,000	4%		
5.0	Product Water, Pumping, Storage & Conveyance	$36,790,000	20%		
6.0	Residuals Handling & Concentrate Discharge	$3,480,000	2%		
7.0	Power Supply (Redundancy Setup Fee Only)	$2,000,000	1%		
8.0	Electrical Buliding	$1,230,000	1%		
9.0	Admin / Maint	$7,570,000	4%		
	Subtotal	**$185,670,000**	**100%**		
			LOW	**BASE**	**HIGH**
	Mobilization/ Demobilization		$1,856,700	$3,713,400	$3,713,400
	Bonds & Insurance		$928,350	$1,856,700	$2,785,050
	Overhead & Profit		$14,853,600	$22,280,400	$27,850,500
	Un-Priced Allowances (Contingency)		$27,850,500	$37,134,000	$55,701,000
	Subtotal Construction Cost		**$231,159,150**	**$250,654,500**	**$275,719,950**
	Professional Services		$34,673,873	$45,117,810	$55,143,990
	Total Capital Cost		**$265,833,023**	**$295,772,310**	**$330,863,940**

Tables 7-24 and 7-25 include the capital cost summaries for the regional case 60-MGD El Segundo and Redondo Beach sites, respectively. The detailed backup for these cost opinions are provided in **Appendix 1:G**.

Table 7-24: Capital Cost Opinion El Segundo: Regional Case / 60 MGD

	Work Area Description	Project Cost	% of Total		
Capital Cost					
1.0	Intake	$16,207,000	4%		
2.0	Pretreatment	$112,882,206	25%		
3.0	Reverse Osmosis	$171,989,000	39%		
4.0	Post-Treatment & Disinfection	$17,579,000	4%		
5.0	Product Water Pumping, Storage & Conveyance	$102,512,000	23%		
6.0	Residuals Handling & Concentrate Discharge	$7,654,000	2%		
7.0	Power Supply (Redundancy Setup Fee Only)	$2,000,000	0.5%		
8.0	Electrical Building	$2,958,000	1%		
9.0	Admin / Maint	$9,734,000	2%		
	Subtotal	**$443,515,206**	**100%**		
			LOW	**BASE**	**HIGH**
	Mobilization / Demobilization		$4,435,152	$8,870,304	$8,870,304
	Bonds & Insurance		$2,217,576	$4,435,152	$6,652,728
	Overhead & Profit		$35,481,216	$53,221,825	$66,527,281
	Un-Priced Allowances (Contingency)		$66,527,281	$88,703,041	$133,054,562
	Subtotal Construction Cost		**$552,176,431**	**$598,745,528**	**$658,620,081**
	Professional Services		$82,826,465	$107,774,195	$131,724,016
	Total Capital Cost		**$635,002,896**	**$706,519,723**	**$790,344,097**

Table 7-25: Capital Cost Opinion Redondo: Regional Case / 60 MGD

	Work Area Description	Project Cost	% of Total		
Capital Cost					
1.0	Intake	$15,206,000	3%		
2.0	Pretreatment	$112,459,206	25%		
3.0	Reverse Osmosis	$171,989,000	38%		
4.0	Post-Treatment & Disinfection	$17,579,000	4%		
5.0	Product Water Pumping, Storage & Conveyance	$108,634,000	24%		
6.0	Residuals	$7,262,000	2%		
7.0	Power Supply (Redundancy Setup Fee Only)	$2,000,000	0.4%		
8.0	Electrical Building	$2,958,000	1%		
9.0	Admin / Maint	$9,734,000	2%		
	Subtotal	**$447,821,206**	**100%**		
			LOW	**BASE**	**HIGH**
	Mobilization / Demobilization		$4,478,212	$8,956,424	$8,956,424
	Bonds & Insurance		$2,239,106	$4,478,212	$6,717,318
	Overhead & Profit		$35,825,696	$53,738,545	$67,173,181
	Un-Priced Allowances (Contingency)		$67,173,181	$89,564,241	$134,346,362
	Subtotal Construction Cost		**$557,537,401**	**$604,558,628**	**$665,014,491**
	Professional Services		$83,630,610	$108,820,553	$133,002,898
	Total Capital Cost		**$641,168,011**	**$713,379,181**	**$798,017,389**

8. Additional Studies

This section discusses additional studies needed to further develop the alternatives.

8.1. Additional Studies

Additional studies that will be needed to support and further develop the alternatives include:

- Investigating the structural integrity of the existing tunnels at El Segundo to determine if they can be used as casing for pipes to be placed within the tunnels.
- Investigating whether the Redondo Beach discharge tunnel can be used under pressure conditions.
- Studying sediment transport at the sites in detail to evaluate the effect of waves in eroding the seafloor and to determine the potential amounts of sediment in suspension.
- Bench- or pilot-scale testing is needed to identify the effective chemical doses and operating conditions for the variety of pipe materials in the West Basin service areas.
- Compatibility testing of stabilized product water with local groundwater is also recommended to capture potential issues that may arise from blending, such as impacts of water quality on existing pipe corrosion products particularly in systems using groundwater of variable quality.

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

Power Supply Plan (PSP)

January 2013

Report Prepared By:

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5052-016

The Water Division of ARCADIS

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Appendices

1. Introduction

1.1. Objectives

The objective of this Power Supply Plan (PSP) is to define power demand requirements, and subsequently identify and assess a range of power supply alternatives for West basin's proposed Ocean Water Desalination Facility. This memorandum will address the key issues associated with developing power supplies and evaluations criteria for comparing the alternatives. Preferred power supply alternatives, as well as their associated costs, will be presented to assist West Basin with their planning and budgeting activities for a full-scale facility.

2. Power Demands

West Basin Municipal Water District is developing a comprehensive ocean water desalination Program Master Plan that will be utilized by West Basin as the supporting document to plan, permit, design, and construct a full-scale ocean water desalination facility and distribution system within its service area. As a new alternative for water supply the District is developing integration of desalinated ocean water as a portion of the local water supply portfolio. To accomplish this objective, West Basin has directed the ARCADIS project team to evaluate power supply alternatives. This section provides an estimate for the electrical power consumption for the desalination plant.

2.1. Desalination Project Power Demand

The power demand is estimated at approximately 0.6-0.8 MW/MGD. However, with additional efficiency improvements, this can potentially be reduced to 0.5 -0.7 MW/MGD.

Using the above factors, the total power requirement for the local supply option (20 MGD) is estimated at approximately 14 MW, while the total power requirement for the regional supply option (60 MGD) is estimated at approximately 46 MW.

A detailed breakdown of the electrical load for the desalination plant is provided in Conceptual System Design and Program Requirements Report. **Table 1-1** is a summary of expected electrical power requirements for plant operation.

Table 2-1: Estimate for the Desalination Project Power Demand

Process	Capacity, MGD Description	10		20		40		60	
		Operating Pumps	Power kW	Operating Pumps	Power kW	Operation Pumps	Power kW	Operating Pumps	Power kW
2	Feed Water Pump Station	1	300	3	900	7	2,100	10	3,000
3	Arkal Filter Backwash Pumps	0	0	0	0	1	10	2	20
3	Arkal Filter Shock Pumps	0	0	0	0	0	0	2	0
6	AF/UF CIP Pump	0	0	0	0	0	0	1	0
8	MF/UF Filtrate Booster P.S.	1	260	3	780	7	1,820	10	2,600
10	RO Feed P.S. – 1st Pass	2	4,780	4	9,560	8	19,120	12	28,680
12	Energy Recovery Devices	2	(300)	4	(600)	8	(1,200)	12	(1,800)
13	RO Feed P.S. – 2nd Pass	1	110	2	220	4	440	6	660
15	RO CIP Pump	1	40	1	40	1	40	1	40
16	Post-Treatment P.S.	1	60	3	180	7	420	10	600
19	Product Water P.S.	1	300	3	1,560	4	4,480	7	7,840
	Total		5,550		12,640		27,230		41,640
	Misc @10% of Total		555		1,264		2,723		4,164
	Total Load		6,105		13,904		29,953		45,804
	Power use kW/MGD		611		695		749		763

Notes:
1. Energy recovery devices will be in operation when desalination plant is operating.
2. Misc. Power includes power for administration building

2.2. Plant Site Power Demand[1]

Plant site power demand is estimated in Section 5.2 in Ocean Water Desalination Program Master Plan (PMP) Conceptual System Design and Program Requirements Report. As stated in Section 5.2 of the PMP Report, for pumps 400 HP or less, a 480 V supply will be used. For pumps >400 HP, a 4160V load center will have to be installed locally to supply power to the pump.

2.3. Distribution Power Demand

The power required with the distribution/transmission system for the connections to local retailer will be a relatively small requirement. In general the electrical requirement will be for SCADA system, flow meter, instruments, lighting, and valve actuator. The load will be supplied through individually metered SCE local connections at each connection point. Supply will be either 480V or 220 V.

[1] The tables and sections referred in this section are presented in Ocean Water Desalination Program Master Plan (PMP) Conceptual System Design and Program Requirements Report Draft Report submitted to West Basin MWD.

3. Power Supply Considerations

3.1. Power Supply Options

3.1.1. Legal Review of Power Supply Options

West Basin conducted a review of the legal aspects of the power supply options for the proposed power demand scenario. The four options that underwent this review are summarized here:

1. Electric service provided directly by SCE
2. Service from an Energy Service Provider ("ESP") under California's Direct Access program
3. Direct purchase from NRG (El Segundo) or AES (Redondo Beach) under Public Utilities Code Section 218
4. Self-generation, joint venture, or other arrangement with a third-party independent power producer ("IPP"), pursuant to Water Code Section 71663.5

Under the state and federal regulatory provisions, of the four supplier options, it appears that only two - SCE service and self-generation - are viable options for West Basin at this time. These options were evaluated for the two selected sites, AES's RBGS and NRG's ESGS. The summary of options evaluated from a legal perspective is listed here.

Option 1: Service from SCE

Three possibilities for SCE service **–**

A. SCE service at the 66KV voltage (transmission level service), B. service under a special "desalination plant" rate; and C. service using SCE's Economic Development Rate. Only the first of these options is available to West Basin.

A. SCE can provide service to the Project at SCE's transmission level voltage (66kV) rate tariff. Further investigation by SCE will be necessary to determine whether the 66kV option could be provided by SCE as standard service or whether West Basin would incur additional costs to qualify for the service. This service will have no legal barriers, since SCE itself has said the tariff can be used.

B. SCE service - Subsidized "Desalination Plant Service" Rate: The California Public Utilities Commission ("CPUC") regulates the terms and conditions under which SCE and other investor-owned utilities ("IOUs") offer retail service, including the rates for electric service. In 2005, the CPUC staff examined whether to recommend

CPUC adoption of subsidized rates for desalination projects. The report noted that the CPUC generally has deferred to the Legislature to determine whether and how much a rate subsidy should be given. While not stating absolutely that the CPUC could not administratively require IOUs to offer a subsidized rate, the staff report stated that providing a discount would have an inevitable corresponding increase of rates for other customers and that, given the "uncertain" benefits (in the staff's view), the rate could run afoul of the CPUC's responsibility to set electrical rates that are just and reasonable.

C. SCE's Economic Development Rate ("EDR"). SCE offers a special EDR to business customers of up to a 12% discount for a five year period. In order to be eligible for the discount, an applicant must sign an affidavit attesting that "but for" the discount, either on its own or in combination with a package of incentives made available to the customer from other sources, "the customer would not have located operations or added load within the state of California. In addition to these issues, EDR is not available to "local government customers."

SCE representative confirmed that public agencies are ineligible

Option 2: Service from an Energy Service Provider ("ESP") Under California's Direct Access Program

The second option is West Basin purchasing power for the desalination plant from an Energy Service Provider ("ESP") under California's Direct Access program. Unfortunately, SCE has closed the program to new participants and it is unclear whether this option will become available in the future.

Option 3: Direct purchase from NRG (El Segundo) or AES (Redondo Beach) under Public Utilities Code Section 218

The direct purchase of power from a non-IOU independent power producer ("IPP") using the provisions of Public Utilities Code section 218. While theoretically this option might exist, in reality it does not. Because the El Segundo and Redondo Beach power plants use natural gas as their fuel, NRG and AES would no longer be exempt from CPUC regulation if they sold power to West Basin from those power plants, since the fuel used at those plants (natural gas) does not qualify under the exemption from CPUC regulation allowed by section 218. AES, NRG and other IPPs operate under a business model outside of CPUC jurisdiction. By being exempt from CPUC jurisdiction they are not subject to the CPUC's rate and service regulation. IPPs will not enter into sales that could make them subject to the agency's oversight, much less dictate the terms under which they sell power.

Under California Public Utilities Code Section 218(b), a power plant owner may use electricity on-site for its own use and it may sell excess electricity directly to an adjacent property without becoming an “electrical corporation”. This provision is known as the “over-the-fence” law, because it allows sales to electric loads on property immediately adjacent to the power plant property. This exemption matters because under Public Utilities Code section 216(a) electrical corporations are “public utilities” subject to the jurisdiction, control, and regulation of the CPUC. Thus, this exemption allows generators to sell excess power to loads on adjacent properties to their power plants, without becoming utilities subject to CPUC jurisdiction.

The section 218 exemption is limited. It only covers sales from “non-conventional” power plants. Both the Redondo Beach plant and the El Segundo plant generate electricity by the use of natural gas. Therefore, these plants will not be eligible for the over-the-fence exemption and could not sell power to a desalination project located adjacent to the plants without being subject to CPUC jurisdiction. In addition, IOUs, such as SCE, have exclusive franchises to operate as public utilities in their service area and would vigorously oppose any attempt by an IPP to encroach on that franchise. Thus, section 218 does not allow the option of a direct sale from AES or NRG to West Basin for a desalination plant located adjacent to the El Segundo or Redondo Beach power plants.

Option 4: Self-generation, joint venture or other arrangement using Water Code Section 71663.5

The option of self-generation using Water Code 71663.5 option is legally available to West Basin under the state and federal energy regulatory framework and offers considerable flexibility in developing a power supply for the desalination project, via either self-generation done alone by West Basin or in a joint venture or other arrangement with NRG or AES. The later could allow West Basin potentially significant opportunities to minimize risks and maximize economic benefits.

Conclusion

Based on WB Legal Service review, the two feasible supplies of power for West Basin’s proposed desalination plant are service from SCE and development of a power supply relying upon the authority provided to West Basin in Section 71663.5. The latter appears to be a matter of first impression and will require further analysis to analyze the economics of this option as well as structures that best comply with state and federal energy laws and provide the maximum economic benefit and lowest risk to West Basin.

3.1.2. Technical Evaluation of Various Power Supply Options

The three power supply options considered are:

1. Onsite power generation with conventional means
2. Onsite power generation by renewable resources
3. Power supply directly purchased from SCE

Following is the technical analysis of these three power supply options.

3.2. Onsite Power Generation Options

The California Public Utilities Commission's (CPUC) Self-Generation Incentive Program (SGIP) provides incentives to support existing, new, and emerging distributed energy resources. The SGIP provides rebates for qualifying distributed energy systems installed on the customer's side of the utility meter. Qualifying technologies include wind turbines, fuel cells, and corresponding energy storage systems. The SGIP was established in 2001 as a peak-load reduction program seeking to encourage the development and commercialization of new distributed generation (generation installed on the customer's side of the utility meter). Incentive payments to SGIP participants benefit all ratepayers by reducing the need for utilities to invest in expensive transmission and distribution infrastructure. Senate Bill 412, also extends the SGIP from January 1, 2012, to January 1, 2016.

The program is available to customers of Pacific Gas and Electric Company, Southern California Edison, Southern California Gas Company, and San Diego Gas & Electric.

The SGIP was created by the CPUC to offer financial incentives to customers who install certain types of distributed generation facilities to meet all or a portion of their energy needs. Self-generation benefits both the local utility and its customers by reducing electrical system demand, which in turn reduces the need to build expensive fossil fuel-fired power plants. SGIP functions by providing one-time upfront incentives for the installation of new, qualifying self-generation equipment installed to meet all or a portion of the electric needs of a facility.

Effective September 2011, the eligibility for participation in the SGIP will be based on greenhouse gas (GHG) emissions reductions. Technologies that achieve reductions of GHG emissions will be eligible for the program, including wind turbines, fuel cells, organic Rankine cycle/waste heat capture, pressure reduction turbines, advanced energy storage, and combined heat and power gas turbines, micro-turbines, and internal combustion engines.

Participants will receive up-front and performance-based incentives (PBI). The incentives will apply only to the portion of the generation that serves a project's on-site electric load.

SCE Program

SCE's SGIP provides financial incentives for the installation of new, qualifying customer self-generation equipment for their own on-site usage. Technologies currently eligible for SGIP incentives are wind and fuel cell generation. Incentives are also provided for advanced energy storage when coupled with an eligible self-generation technology.

The SGIP program is designed primarily with business and large institutional customers in mind.

Rebates for renewable generation—such as wind turbines or fuel cell—that generate less than 30 kilowatts of energy are available through the California Energy Commission's Emerging Renewables Program (ERP). Fuel cells of any size using non-renewable fuels may receive incentives under the SGIP program.

Solar rebates are currently administered under SCE's California Solar Initiative program.

3.2.1. Conventional Power Supply

SGIP program participants are eligible to receive incentives under this program for installing self-generation technologies. Only commercially available and factory new equipment are eligible for incentives, which are based on system type, size, fuel source and out-of-pocket costs. Rebuilt or refurbished equipment is not eligible to receive incentives under this program. The maximum system size is 5 megawatts (MW), although the incentive payment for 2011 was capped at 3 MW and SCE has continued the program for 2012 at the 2011 level.

Eligible generation equipment must be certified to operate in parallel with the electric system grid (not back-up generation) and meet eligibility and GHG emission criteria established by the California Public Utilities Commission (CPUC)[2].

SCE Incentive Program for Self Generation

The CPUC has authorized eligible wind turbine, fuel cells, and combined heat and power (CHP) systems to receive incentives for up to 3 MW of capacity from prior years' carryover funding for 2008 and 2009 and is carried over into 2012. As part of the CPUC decision, incentives for systems larger than 1 MW up to 3 MW will be paid a tiered incentive. SCE Incentives for systems >1 MW are summarized in **Tables 2-1 and 2-2**.

[2] See SGIP Handbook - http://www.cpuc.ca.gov/NR/rdonlyres/5F55B951-9152-4FAE-84BB-0854688472F9/0/SGIPHandbook2011v9.pdf

Table 3-1: SCE Incentives for the Installation of Qualifying Equipment

Incentive Levels[1]	Eligible Technology	Incentive ($/watt)[2]	Minimum System Size[3]
Level 2 Renewable	Wind Turbines	$1.50	30 kW
	Fuel Cells (Renewable fuel)	$4.50	30 kW
Level 3 Non-Renewable	Fuel Cells (Nonrenewable fuel)[4]	$2.50	None
Advanced Energy Storage[5]	Advanced Energy Storage	$2.00	Capped at DG Systems Size

Notes:

1. Level 1 previously included solar generation, now administered through the California Solar Initiative. www.gosolarcalifornia.ca.gov.
2. An additional incentive of 20% will be provided for the installation of eligible Distributed Generation (DG) technologies from a California supplier
3. Maximum incentive payout capped at 3 MW and maximum system size is 5 MW
4. Systems must utilize waste heat recovery meeting Public Utilities Code 216.6
5. Advanced energy storage must be coupled with a wind or fuel cell system to qualify for incentives

The incentives are adjusted to account for the size of the project as per **Table 2-2**.

Table 3-2: Tiered Incentive Rate for Projects up to 3 MW

Capacity	Incentive Rate as % of base in Table 2-1
0 - 1 MW	100%
>1 MW - 2 MW	50%
>2 MW - 3 MW	25%

Conventional Onsite Generation

One option considered for onsite generation is a small combined cycle (CC) plant with gas turbine and steam turbine generator in a combined cycle mode. The gas turbine is fired with pipeline natural gas already available at both NRG and AES sites. The hot exhaust from the gas turbine is directed to a heat recovery steam generator where high pressure steam is generated. The high pressure steam is run through a steam turbine generator to generate additional power.

The gas turbines are available in standard size from many vendors. These gas turbines are available in ~ 1 MW range to 180+MW. The proposed new NRG combined cycle plant will be utilizing two 180 MW gas turbine generators. However, for the proposed desalination facility, the actual power required will be in the range of 15 MW to 40 MW range, based on desalination plant capacity. A power plant in the size > 50 MW will require a detailed review and evaluation by California Energy Commission (CEC). This is an exhaustive process, subject to public hearing and review. Only standard combined cycle configurations offered by vendors in the range of 2.5 MW to 24 MW were reviewed. Other power generation options are available, such as gas reciprocating engines, and may be feasible depending on size and power supply framework utilized.

Power plant configuration

Table 2-3 lists some of the possible on-site combined cycle generation configuration in the range of 2.5 – 24 MW.

Table 3-3: Possible Power Plant Configuration

Model	GT Power	ST Power	Net CC Output
	kW	kW	kW
Dresser Rand KG2-3E	1,895	682	2,526
Pratt & Whitney ST40	4,039	1,454	5,383
Mercury50	4,600	1,656	6,131
Taurus 60	5,670	2,041	7,557
Taurus 65	6,300	2,268	8,397
Rolls Royce 501-KH5	6,447	2,321	8,593
Taurus70	7,520	2,707	10,023
Mars 100	10,430	3,755	13,901
Siemens SGT-400	12,900	4,644	17,193
Titan 130	15,000	5,400	19,992
GE LM2000 PJ	17,657	6,816	23,911
GE LMS2000PS	17,657	6,357	23,533

Figure 2-1 show typical combined cycle configuration – gas turbine, heat recovery steam generator (HRSG), exhaust stack, steam turbine generator, steam condenser, and feed water pump, etc. The vendors offering these configurations include – GE, Siemens, Dresser Rand, Solar Turbine (a division of Cater Pillar), and Rolls Royce. There are other GT manufacturers including ALSTOM, Mitsubishi, and Hitachi; however, they offer only large frame machines with size ranging from 80+ MW. These GT are too large for the application for West Basin desalination plant and are not evaluated here. The steam turbines are custom designed and can be ordered in the size desirable for the application.

Typical footprint and a possible suggested plant layout is shown in **Figure 2-2**. The electrical single line for onsite generation is also included in **Appendix 2:C**.

The cost estimate for different combined cycle plant offered by different vendors is provided in Section 5 Cost Estimates.

Figure 3-1: Typical Combined Cycle Schematic

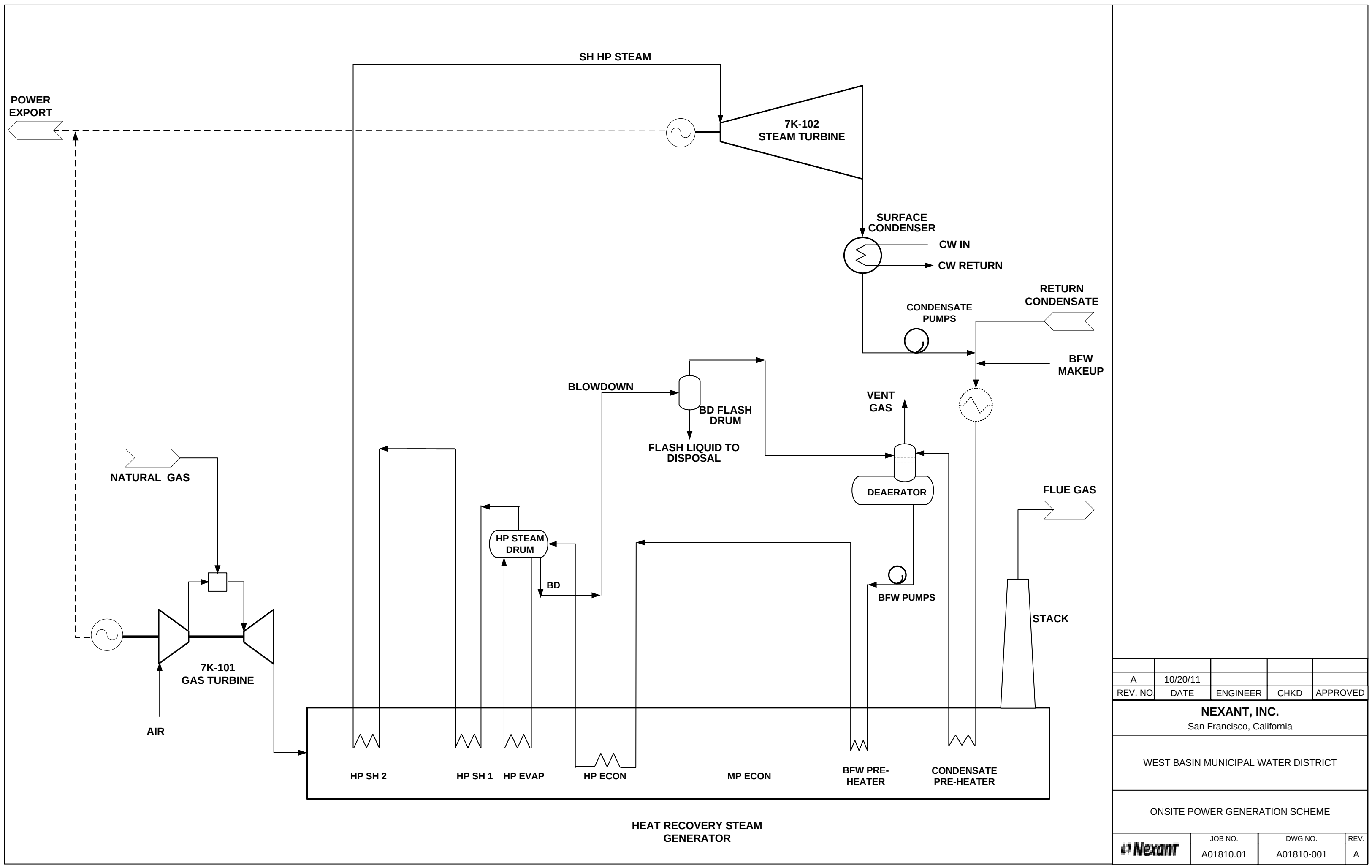
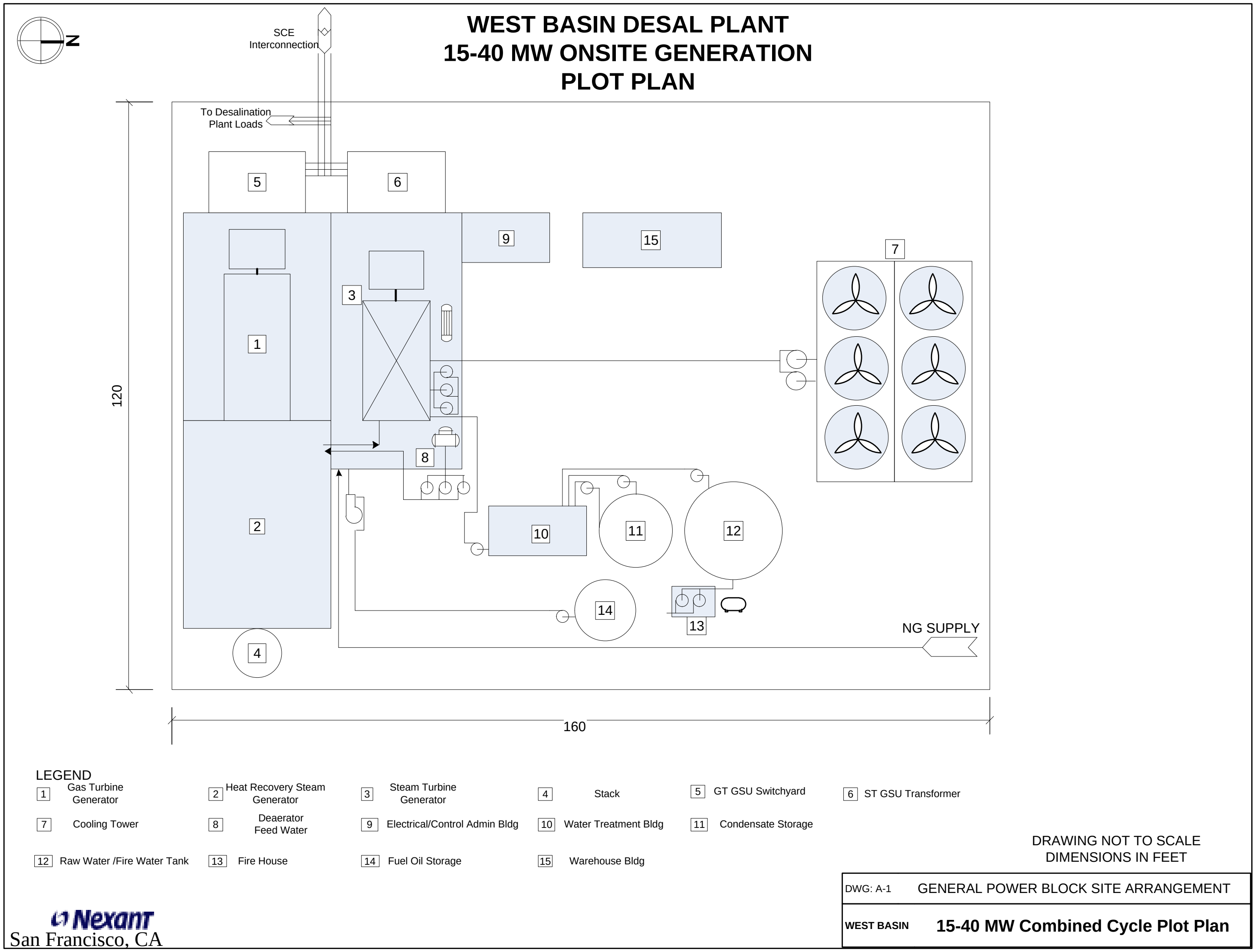


Figure 3-2: Typical Layout and Footprint for Combined Cycle Plan



Under local power supply options scenario with conventional onsite power generation, there will be no renewable credits and no carbon offsets considered.

3.2.2. Renewable Power Supply and Fuel Cell Option

Under renewable power generation, wind, solar, qualifying biomass, geothermal, and small hydro are eligible. However, biomass, geothermal, and small hydro are not feasible at the two proposed sites, so only feasibility of wind and solar is examined. We also evaluated fuel cells. Under California Public Utilities Commission (CPUC) rules, on site fuel cell installation is eligible for incentive from SCE.

Wind Power

Based on California Energy Commission's ("CEC") California Wind Resources Report (April 2005), approximately 4 acres are needed for each 1 MW of wind capacity. The basis for the acreage per MW is numerous, including the type of terrain at a potential site and the size and type of proposed wind turbines. However, at a fundamental level there is a logistical limitation for how many wind turbines can be located at a given site due to the sheer size of the individual units and also to avoid affecting other wind turbines located nearby.

The largest land-based wind turbines are approximately 3.5 MW in capacity and have blade spans of approximately 328 feet. Due to the limited space at the two plant sites it is likely that only one or two large wind turbines could be logistically sited at these sites for a maximum of 3.5 to 7 MW of capacity. Even then, the wind resource maps in the CEC report shows that these two sites are not in locations that could support wind turbines due to the insufficient wind speeds in the area. Therefore, for the reasons described above, wind generation potential at either site is not considered a viable alternative.

Fuel Cells

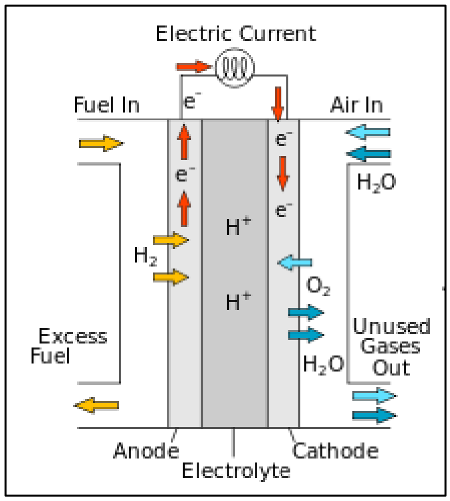
A fuel cell is a device that converts the chemical energy from a fuel into electricity through a chemical reaction with oxygen or another oxidizing agent. Hydrogen is the most common fuel, but hydrocarbons such as natural gas and alcohols like methanol are sometimes used. Fuel cells are different from batteries in that they require a constant source of fuel and oxygen to run, but they can produce electricity continually for as long as these fuel and oxidant inputs are supplied.

Fuel cells are used for primary and backup power for commercial, industrial and residential buildings and in remote or inaccessible areas with no transmission or grid power.

There are many types of fuel cells, but they all consist of an anode (negative side), a cathode (positive side) and an electrolyte that allows charges to move between the two sides of the fuel cell. Electrons are drawn from the anode to the cathode through an external circuit, producing direct current electricity. As the main difference among fuel cell types is the electrolyte, fuel cells are classified by the type of electrolyte they use. Fuel cells come in a variety of sizes. Individual fuel cells produce very small amounts of electricity, about 0.7 volts, so cells are "stacked", or placed in series or parallel circuits, to increase the voltage and current output to meet an application's power generation requirements. In addition to electricity, fuel cells produce water, heat and, depending on the fuel source, very small amounts of nitrogen dioxide and other emissions. The energy efficiency of a fuel cell is generally between 40-60%, or up to 85% efficient if waste heat is captured for use.

Figure 2-3 is a schematic representation of hydrogen fuel cell.

Figure 3-3: Schematic Representation of Hydrogen Fuel Cell



Solar Power

The CEC California Solar Resources Report (April 2005) clearly shows that the various available solar generation technologies would not be viable at these two sites for multiple reasons. The technical potential for concentrated solar power (CSP) in California is limited to areas of sufficient solar resources. On average, the physical space needed for each MW of CSP capacity is 3-5 acres. The CEC and NREL solar insolation data shows that the coastal California is not in a solar resource area that is recommended for CSP technology. The solar resource maps clearly show CSP technology to be best applied in the inland southwest region where significant solar radiation occurs throughout the year. Therefore, solar power generation is not thought to be economically viable in the coastal zone.

For all of these reasons, solar generation on large scale is not a viable alternative at either of the two sites being evaluated for the desalination project. However, roof top PV panels for admin and process buildings are feasible. Although detailed design and layout of these buildings is not developed, based on current design and sizes of PV panels, about 120 -150 square feet of roof area will be required per kW of peak power (11-14 m^2/kW).

It will be feasible to install PV panels on office, administrative building, RO and chemical treatment buildings, operation and maintenance buildings. Total available roof top area will depend on building layouts. For analysis purpose, we assume about 12,000 square feet of roof top area or 100 kW of PV system will be available on individual building. **Table 2-4** is summary of 100 kW DC PV system.

Table 3-4: PV System Design Analysis

Plant Location	Los Angeles /Long Beach CA
Plant Size, kW DC	100
Panel (Module) Size W DC	250
No. of Modules	400
PV Panel efficiency	17.3%
Area/Panel m2	1.95
Area required m2	780
Area required square feet	8,392
Roof Top Area Available square feet	12,000
PV Panel Area/Roof Area	70%
Plant AC Output kW AC	84.265
Plant Capacity Factor (Calculated)	17.10%
Annual Output, kWh	126,226
Estimated Cost $/W	4.9
Total Install Cost, $	490,000
Estimated LCOE $/kWh (no incentives)	$0.124

The 100 kW DC system outlined here is for illustrative purpose, but can be scaled up or down based on available roof area available.

For comparison, a 10 MGD facility will require about 6,100 kW of power. It the facility operates at 90% capacity factor, the annual energy requirement for the facility will be 48+ million kWh. The 100 kW roof top PV will provide 126,226 kWh of energy, or about 0.3% of the total power need. A scale up of 100 kW system to 1 MW system with 100,000 – 120,000 square feet of roof area, it will provide <5% of the energy need for the 10 MGD desalination plant.

3.3. Permitting Requirements for Self Generation

The regulatory permits required to construct on site power generation facility for the desalination plant will have to be prepared in conjunction with the desalination project. The Project Permitting Plan (PPP)[3] developed separately for the desalination plant addresses the key regulatory permits that will need to be obtained by West Basin and MWD in order to complete the desalination project. In the PPP document, critical issues for each permit are identified, along with additional data and studies needed in order to prepare the permit. Content for permit applications and suggestions to negotiate favorable permit provisions and conditions are also discussed. Finally, this plan will also define the scope and budget for the implementation of the engineering support studies needed for project permitting. This plan broadly discusses but does not focus on general construction permits that would be needed. Discussions with lead and supporting Agencies will be critical to refining the information presented in the PPP and honing in on which of the discretionary studies will truly be needed.

For the onsite power generation California Energy Commission (CEC) is responsible entity to permit all power projects >50 MW. Since WB desalination plant power plant will be in the range of 10-30 MW, the permitting requirements fall on the local jurisdiction referred to as Authority of Jurisdiction –AOJ.

Under a self- generation plan, Owner/Operator of the generating facility will be required to obtain:

1. Interconnection agreement with SCE (Island operation without SCE connection is not practical. Redundancy requirements for reliable power under island operation will be cost prohibitive)
2. County/City permit or AOJ to construct a new facility
3. Stationary source air emission permit from South Coast Air Quality Management District (SCAQMD)

There is no comprehensive list of documents required by various city, county, or air quality management district. Based on CEC review process, it is expected that the local

[3] Permitting Plan Technical Memorandum (TM), Draft Project Permitting Plan (PPP) by Arcadis, March 2011; and Project Entitlements Acquisition Plan (PEAP) for Ocean Water Desalination Program Management Plan (PMP), March 2011.

AOJ will also require following technical documents for compliance with typical laws, ordinances, regulations, and standards:

Air Quality, Public Health, Worker Safety, Fire Protection, Transmission Line Safety and Nuisance, Hazardous Materials Management, Waste Management, Land Use, Traffic and Transportation, Noise, Visual Resources, Cultural Resources, Socioeconomics, Biological Resources, Soil & Water Resources, Geological and Paleontological Resources, Power Plant Efficiency, and Transmission System Engineering, if applicable.

A brief description of SCAQMD requirement and process for the permit is described here.

SCAQMD is the air pollution control agency for all of Orange County and the urban portions of Los Angeles, Riverside and San Bernardino counties.

- **Background on AQMD's Permitting Program**
  The AQMD's permitting program has been established to implement the requirements of the federal and state Clean Air Act (CAA), the Air Quality Management Plan (AQMP) and air quality rules and regulations by specifying operating and compliance requirements for stationary sources that emit air contaminants. In order to comply with federal and state CAA requirements, all major and non-major sources in South Coast Air Basin (SOCAB) are subject to "no net emission increase" and Best Available Control Technology (BACT) and/or Lowest Achievable Emission Rates (LAER) for stationary sources-specific, prohibitory and toxics rules (federal, state and local) as well as other applicable requirements.

- **Permit Required from AQMD for WBMWD Self Generation Project**
  The applications to be filed at AQMD are for Permit to Construct (PC) and or Permit to Operate (PO). Prior to installation of new or relocated equipment, or prior to modification of an existing equipment, the operator of the equipment is required to obtain a PC from the AQMD. Once a piece of equipment is installed, modified and/or operated, AQMD processes the application for a PO. In cases where equipment is installed without a prior PC, the AQMD also processes the application directly for a PO. In cases of off the shelf type equipment, the AQMD issues a one-step PC/PO.

- **Types of Permit Applications for WBMWD Project**

  - ***Permit to Construct (P/C)*** - for a new or relocated equipment as well as alteration (both physical modification and change of operating conditions) of existing equipment. These applications always receive a high priority for processing.

- o ***Permit to Operate (P/O)*** - for equipment that is installed and/or is operated with or without a prior P/C (a prior P/C or in cases where no prior P/C was issued, the application acts as a temporary P/O until a final P/O is processed).

- **Permitting Program**

  All applications for permit to construct and Permit to Operate are evaluated for compliance with the prohibitory rules, one or more source specific rules, new source review rules for criteria and toxic air contaminants and other applicable rules and regulations.

  In addition, all applications have to meet the requirements for Public Notice, if applicable. Public notices are required for facilities that have risks or emissions that exceed the specified thresholds or for equipment located within 1,000 feet of a school. All such public notices are distributed to the communities near the project and parents of children attending nearby schools and are subject to a 30-day public comment period.

  For Title V permits, public notices are required for Initial Title V permits, Renewals (5 years) and Revisions. For Tile V permits, in addition to the 30-day public comment period, there is also a requirement for a 45-day review period by EPA. Title V permits can only be issued after the public notice period is concluded and after taking into consideration any comments received during the public and EPA comment periods.

Emission permit from SCAQMD will be a challenge, as it will require West Basin to obtain emission credits that are higher than 1:1 (e.g. for NOx SCAQMD required 1.2:1 credit). Although credits are available in the market, there is no established trading system. Without emission offsetting credits, SCAQMD will not grant permit to construct a power generation facility of any size in the SOCAB (emergency backup power is exempt, but restricted to <200 hrs/year). Once emission credits are obtained, it will require filing for application, public hearing period, and final approval that can take over one year.

All units with a potential to emit greater than 25 pounds per day of a criteria pollutant will be required to apply district BACT. The SCAQMD follows CARB's guidance for permitting of electric generating technologies. For control of NOx from turbines and internal combustion engines following are the limit[4]:

[4] http://www.eea-inc.com/rrdb/DGRegProject/States/California/SCAQMD.html

For 3-50 MW combined cycle units the NOx limit is <5 ppm.

Sources with potential emissions of 120 pounds per day or greater are required to complete air quality modeling.

- **Permitting Time Line:**

SCAQMD permitting and obtaining offsets will require maximum time. SCAQMD will inform applicant about all regulatory and technical data adequacy within 30-45 days. Once all necessary data are received the review process can take six months to one year. This is subject to WB obtaining necessary emissions offsets, and public hearing outcome.

3.4. SCE Retail Power Supply Option

The power demand per **Table 1-1** is estimated at 6.1 MW for 10 MGD plant and 45.8 MW for 60 MGD Plant. The SCE supply option analysis is based on power demand of <50 MW. Various loads for the desalination plant will require voltage from 120-480 to 4160 V and for very large motors to run at 11-13 kV range. Based on this power demand, the two proposed sites were evaluated for SCE retail power. A brief description of the two sites is provided here.

3.4.1. NRG Segundo Generating Station

ESGS has been operating as an electric generating station since May 1955. The facility was comprised of four gas-fired conventional, electric power generating units. Units 1 and 2 have been demolished at the site and construction of a combined cycle power plant within the footprint of the demolished units is in progress by the current owner NRG. The current operating capacity of Unit 3 and 4 at El Segundo Power Plant is 670MW. Units 3-4 are used infrequently, with reported capacity factor for combined units 3 and 4 was 10.5% in 2006. The annual capacity factors for unit 3 and 4 in 2011 were 2.7 and 3.4% respectively[5].

The new combined cycle unit will consist of two combustion gas turbine generators (CTGs), two heat recovery steam generators (HRSGs), and one steam turbine generator (STG). Total output of the combined cycle plant will be 550 MW. Heat rejection from the STG will be accomplished with an air cooled condenser, thus eliminating the once through ocean water cooling. Natural gas will be the fuel utilized by the two new CTGs. **Table 2-5** is summary of new configuration for the NRG El Segundo power plant.

[5] CEC Plant G0195 (El Segundo) annual Statistics

Table 3-5: NRG Segundo Power Plant

Unit	In Year Service	Rated Capacity (MW)	Cooling Water Flow[6] (gpm)
Unit 3	1964	335	132,400
Unit 4	1965	335	131,000
GT 1	2013	185	-
GT 2	2013	185	-
STG	2013	180	Air Cooled
ESPS total		1,220	263,400

Figure 2-4 is site layout showing the existing operating units 3 and 4 and proposed location for new combined cycle units under construction and the existing SCE electrical switchyard.

Figure 3-4: NRG ESGS Site Layout

Electricity generated by the El Segundo Power Redevelopment Project will be delivered to the existing Southern California Edison (SCE) substation located on a separate parcel

[6] Tetra Tech Report – California Coastal Power Plants, Alternative Cooling System Analysis NRG ESGS

immediately adjacent to the ESGS property. From SCE's El Segundo 220 kV substation, electricity will be transmitted to users by the existing transmission and distribution network.

The existing 220 kV SCE switchyard on site can be available to draw power for the new desalination plant. Alternately, the site also has a 66 kV feed. Nexant has contacted SCE and requested details on 220 kV and 66 kV switchyard configurations after NRG tie in with new combined cycle plant is completed. The 66 kV switch yard provide double loop feed and is able to support the project need for up to 50+ MW of power.

3.4.2. AES Redondo Beach Generating Station

AES Redondo Beach, LLC, owns and operates 4 steam generating units (Units 5–8) at RBGS in the city of Redondo Beach, Los Angeles County.

Four other steam units (Units 1-4) have been retired but remain on the facility property. Units 5-8 at RBGS are used infrequently; with the 2006 combined capacity utilization rate was approximately 5 percent. The 2011 AES reported capacity factors for Units 5, 6, 7 and 8 were 2.5%, 1.2%, 8.9%, and 0.2% respectively[7].

Table 3-6: RBGS General Information

Unit	In Service Year	Rated Capacity (MW)	Cooling Water Flow[8] (gpm)
Unit 5	1954	175	72,000
Unit 6	1957	175	72,000
Unit 7	1967	480	234,000
Unit 8	1967	480	234,000
RBGS total		1,310	612,000

Figure 2-5 show site layout for the RBGS station with 220 kV and 66 kV switch yard.

[7] CA CEC form 1304 Annual Energy statistics for Plant ID G04090.
[8] Tetra Tech Report – California Coastal Power Plants, Alternative Cooling System Analysis AES RBGS

Figure 3-5: AES RBGS Site Layout

California Coastal Commission has issued directive to phase out once through cooling of coastal power plants. At present, AES's future plan for the RBGS is unknown. However, AES has indicated through public workshops with the City of Redondo Beach that they are pursuing submitting an Application for Certification (AFC) for repowering of RBGS.

The onsite 66 kV line at RGBS station has Triple feed and will be able to support desalination plant load. The line has in excess of 50+ MW of electricity carrying capacity.

4. SCE Supply Options

4.1. Basic Services

The SCE service for the desalination plant will fall under large users with electrical load >500 kW. SCE can supply power under standard distribution voltages. The distribution voltages offered by SCE are: 120, 120/240, 240, 240/480, 277/480, 2,400, 4,160 volts; or, depending on location, 4,800, 12,000, 14,400/24,900, 16,500 or 33,000 volts.

Two sites under consideration have following features:

1. The NRG El Segundo Site- this site is served with a 220 kV line used for power evacuation. The site is also served by two 66 kV lines on opposite sides of the property. However, SCE will have to verify how the 66 kV lines are fed. To best of SCE's records, the 66 kV feed lines were used to start-up old units and are not actively being used.

2. AES Redondo Beach Site – this site is served by a 220 kV transmission line that is also used to evacuate station power when the AES Redondo Beach plant is running. The site is also served by three 66 kV lines with onsite substation. These were used for the old units at the site and now are used for power feed to the station. With the current 66 kV feed lines, there will be sufficient redundancy for the desalination plant. SCE has capability to feed this from different sources.

3. SCE mentioned in a meeting with WB and consultants that engineering study will be required to determine how the site will be fed. The cost of such study will be $75K -$100K.

For both sites, 66 kV feed to the customer under Standard Service contract will likely be a no cost to customer. However a basic service determination would be required by SCE to confirm 66 kV is basic service and not something smaller.

Under the basic services, SCE customers' electricity rates are established by the California Public Utilities Commission (CPUC), the government body that regulates all investor-owned utilities in the state. The CPUC assesses rates every three years through General Rate Case proceedings.

SCE Rates can be evaluated under three different scenarios and some variations of it. The three options are:

Option 1: SCE provides 66 kV service with meter installed at the 66 kV line with a breaker provided by SCE. Customer installs necessary transformer and downstream breaker and is responsible for capital and maintenance cost of the transformer. From Energy delivery this is the least cost option for SCE charges (it excludes capital and O&M charges for the 66 kV transformer).

Option 2: SCE provides 66 kV service as per Option 1, but also installs 66 kV transformer and contracts for maintenance. SCE will recover the capital and O&M costs through a fixed monthly charge to West Basin. SCE selling point for Option 2 was it can provide better reliability and prompt service for maintenance than any third party providers. O&M costs are approximately $100k per year.

Option 3: SCE provides 4 kV/12 kV service to customer under Standard Service Contract. There is no charge for 66 kV switchyard or transformer. However, energy cost under current rate schedule will be highest.

An outline of these options is presented in **Appendix 2:B**.

4.2. SCE Rate Structure

SCE tariffs and programs for large power customers, also called General Service (GS) customers is determined by the demand thresholds. GS customers are also eligible for various demand response programs. Detailed information on demand response programs is available online at www.sce.com/drp.

Table 3-1 is summary of SCE rate basis for large users with electrical load >500 kW.

Table 4-1: Large User Rate Basis

Rate Schedule	Eligibility	Rate Type	Customer Charge	Demand Charge	Energy Charge	Other Options
RTP-2	Bundled service customers >500 kW	Optional for TOU-8 accounts Seasonal Temperature driven hourly pricing	Charge per meter, per month	Facilities Related	Temperature Driven	Power factor adjustment per kVAR Voltage discount as applicable Interval meter required
TOU-8 (primary voltage 2 kV-50 kV)	>500 kW	Mandatory for accounts >500kW Seasonal Time of Use	Charge per meter, per month	Facilities Related On-peak & mid peak demand charges	On peak, mid peak and off peak energy charges that are no lower in winter and higher in summer	Power factor adjustment per kVAR Voltage discount as applicable Interval meter required

Figure 3-1 and **Figure 3-2** outline the SCE transmission lines serving the proposed two sites and a metering scheme for the TOU-8 rate base. Additional metering options are provided in **Appendix 2:B**.

Figure 4-1: Power Supply Arrangement from SCE – 220 kV Supply

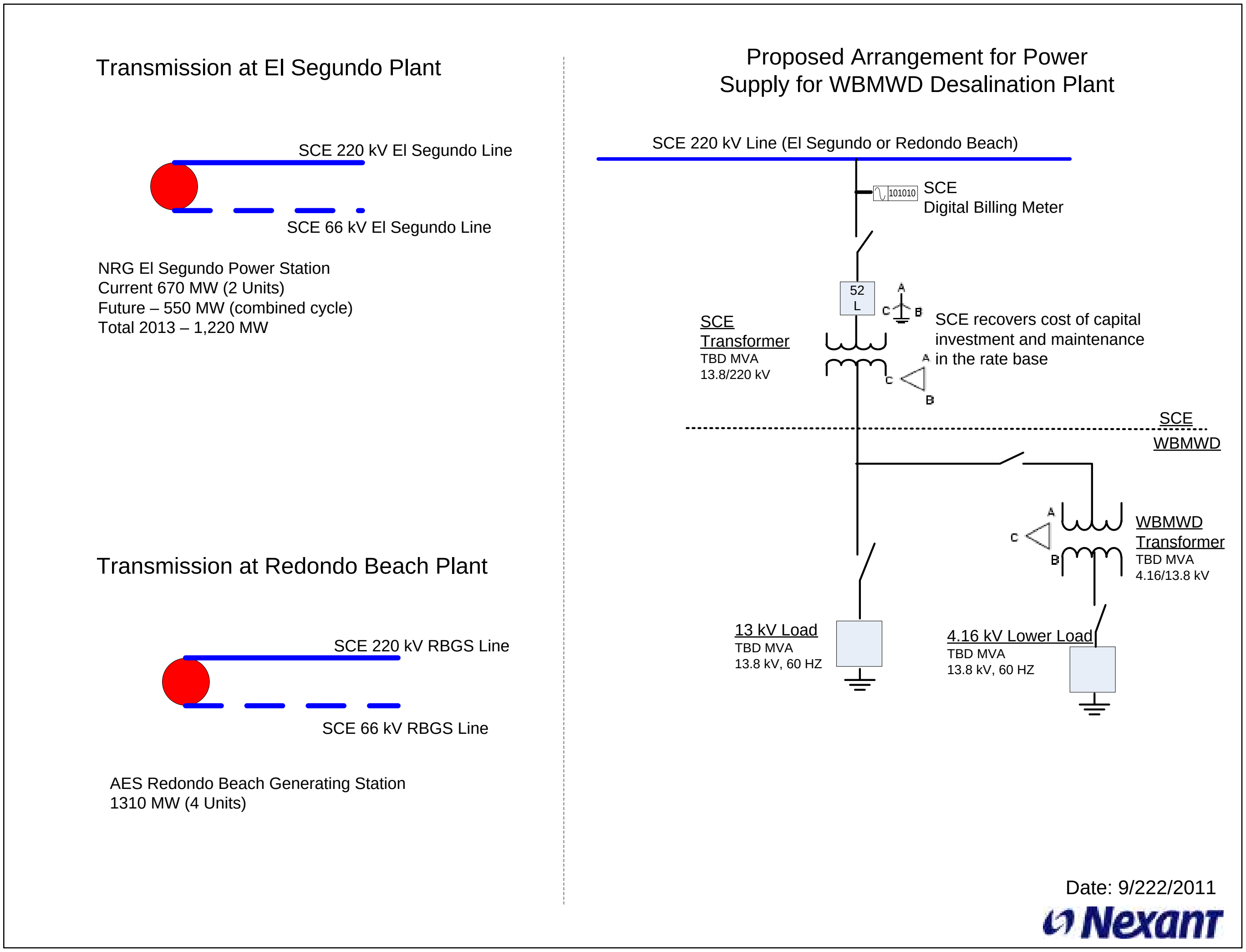
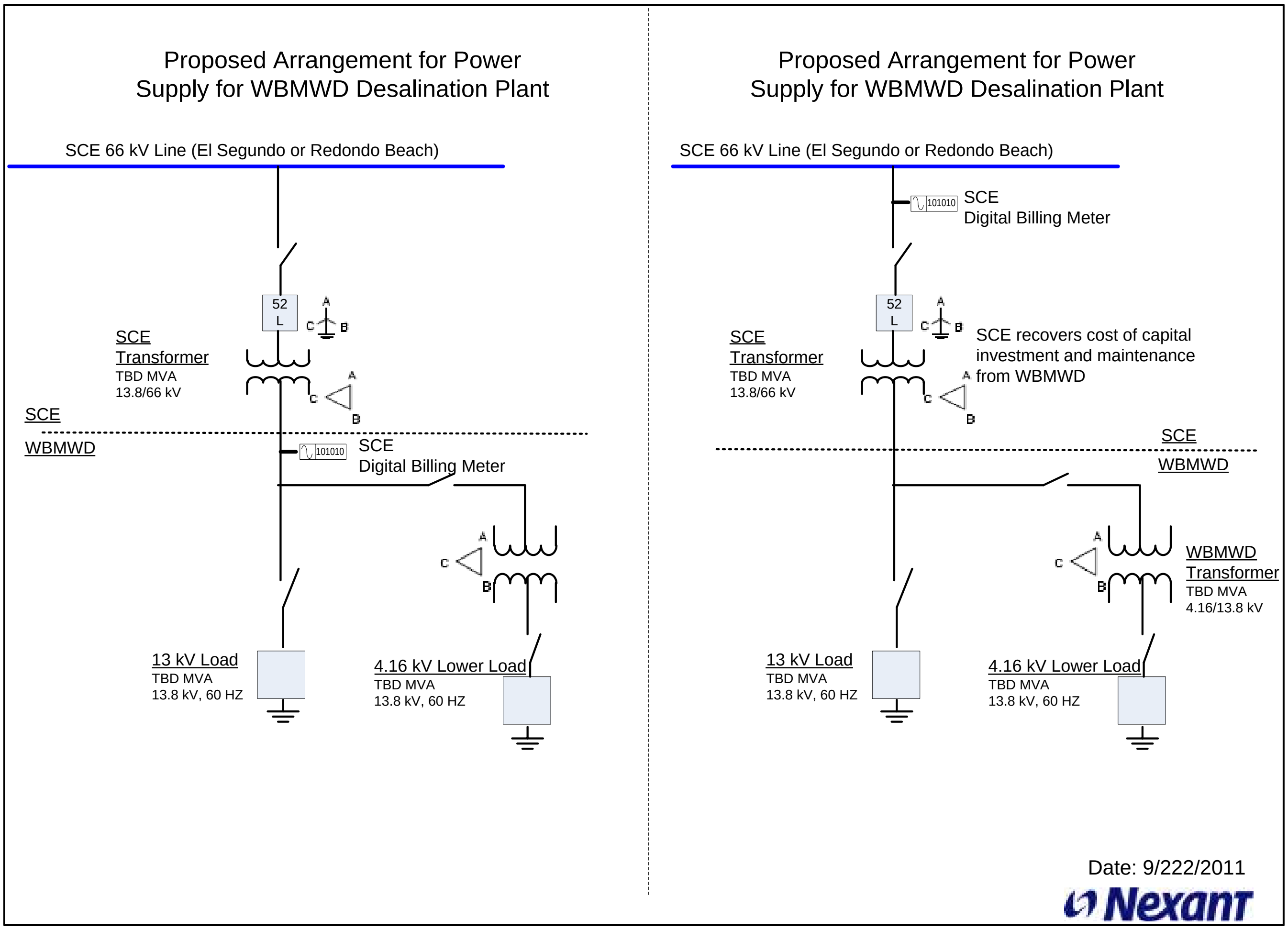


Figure 4-2: Power Supply Options from SCE – 66 kV Supply



4.2.1. Energy Charges

Energy charges are determined based on rate schedule selected by the customer. As shown in **Table 3-1**, under real time pricing, the energy charges are temperature driven and determined by average hourly temperature at the LA City Hall. For TOU-8, energy charges fall under three different periods shown in **Table 3-2**. The highest charges are for summer mid-day, and are lowest during off-peak hours and during weekend throughout the year.

4.2.2. Transmission Charges

Facilities-Related Demand charges reflect the cost of transmission and distribution facilities built to meet customers' peak power demands and are applied all year round. These charges recover SCE's costs for transporting electricity over long distances, such as from generating stations to substations at the plant location. An example of transmission charges is provided in **Table 3-3**.

4.2.3. Maintenance Charges

Monthly charges for repair and replacement of the meters or Metering Facilities that are not provided by SCE but requested by the customer vary based upon installation costs and type of equipment to be maintained. Metering Services include services provided by SCE that are in addition to and/or associated with the services described in the rate schedule and/or in the Interval Data Recorder (IDR) that are requested by the customer. Such services shall be charged on a time and materials basis (T&M). The charges are calculated based on SCE’s total costs to provide Other Metering Services.

1. Metering Facilities installed by SCE on a time and materials basis in accordance with SCE rate Schedule; Other Metering Services include services provided by SCE that are in addition to and/or associated with the services described in this Schedule and/or in the Interval Data Recorder (IDR) Metering and Metering Facilities Agreement (Form 14-655). Such services shall be charged on a time and materials basis (T&M).

2. IDR meters over one (1) year old which were not installed by SCE; and

3. IDR meters over one (1) year old which were installed by SCE, but were not continuously maintained by SCE during the life of the meter.

These charges cover standard installation on a customer-owned meter panel which is in good condition. Unusual installations will be charged on a time and materials basis, in accordance with SCE maintenance Schedule.

Maintenance of customer or SCE installed switchyard and transformer for the benefit of customer will be based on fixed contract terms and services required by

4.2.4. Standard vs. Added Facilities

Added Facilities are:

a) Facilities requested by customer which are in addition to or in substitution for standard facilities (such as SCE’s standard line and service extension facilities), which would normally be provided by SCE for delivery of service at one point, through one meter, at one voltage class under its tariff schedules, or

b) A pro rata portion of the facilities requested by an applicant, allocated for the sole use of such applicant, which would not normally be allocated for such sole use.

Added Facilities may include, but are not limited to, all types of equipment normally installed by SCE in the development of its electrical transmission and distribution systems and facilities or equipment related to SCE's provision of service to a customer or a customer's receipt or utilization of SCE's electrical energy. Added Facilities also include the differential costs for equipment for electrical transmission and distribution systems designed by SCE which, in SCE's sole opinion, is in excess of equipment required for SCE's standard serving system. Added Facilities may include poles, lines, structures, fixtures, transformers, service connections, load control devices and meters.

However, the installation of meters capable of recording and providing interval data that are in addition to or in substitution for standard meters shall be provided under the provisions of Interval Metering Facilities as Added Facilities.

Added facilities will be installed under the terms and conditions of a contract in the form on file with the California Public Utilities Commission. Such contract will include, but is not limited to, the following terms and conditions:

a. Where new facilities are to be installed for applicant's use as added facilities, the applicant shall advance to SCE the additional installed cost of the added facilities over the cost of standard facilities. At SCE's option, SCE may finance the new facilities.

b. The following monthly ownership charges are applicable to Added Facilities
   1. Applicants being served by SCE-financed added facilities shall pay a monthly ownership charge of 1.33% of the cost associated with the added facilities.
   2. Applicants being served by the Customer-financed added facilities shall pay a monthly ownership charge of 0.47% of the cost associated with the added facilities.

4.3. Time of Use (TOU) Rates

TOU-8 rate schedule[9] is applicable to general service including lighting and power, except agricultural water pumping accounts. This Schedule is applicable to and mandatory for all customers whose monthly maximum demand, in the opinion of SCE, is expected to exceed 500 kW or has exceeded 500 kW in any three months during the preceding 12 months.

Service under this Schedule is subject to meter availability.

TOU-8 Schedule contains four rate structures; Critical Peak Pricing (CPP), Option A, Option B, and Option R. Details of these plans are available upon formal request for utility connection. West Basin will have to make a formal request to SCE for details on these rates.

[9] SCE TOU -8 rates, Advise 2550-E, effective March 3, 2011. www.sce.com

Rate Schedule TOU-8 separates basic charges into:

- A monthly Customer Charge that covers a portion of basic services, such as meter reading and customer billing;
- Energy Charges per kilowatt-hour (kWh) consumed that vary by season and time of day; and
- Demand Charges consisting of Time-Related Demand and Facilities-Related Demand charges.
    - The Time-Related Demand Charge is applied only during SCE's summer season. This charge helps recover part of SCE's higher costs of providing transmission and distribution services during the high demand summer season. It is a per-kW charge applied to the greatest amount of registered demand in each summer season billing period (note: Time interval to measure for Time-Related Demand Charges is not spelled out in the published rate structure, and will have to be clarified with SCE).

The Facilities-Related Demand Charge is also billed on a per-kW basis, yet it is in effect in each billing period throughout the year. It is applied to the greatest amount of registered demand in each billing period. This charge is necessary to recover costs for the installed transmission and distribution facilities required to serve customer's highest demand during the year.

Table 3-2 is summary of TOU period currently defined by SCE and estimated hours in the year for each period. The hours are calculated based on SCE definition for holidays and based on 52 weeks. Actual hours in a period may vary slightly from year to year, depending on if the holidays fall on weekend or weekdays.

Table 4-2: Time of Use Periods for TOU-8

Time of Use Periods		Mon	Tue	Wed	Thur	Fri	Sat	Sun
Summer Season	8 AM - Noon							
June 1 - September 30	Noon- 6 PM							
	6 PM - 11 PM							
	11PM - 8 AM							
Winter Season	8 AM - 9 PM							
October 1 - May 31	9 PM - 8 AM							
				Summer	Winter	Total		
			Days	122	243	365		
On Peak - Highest Energy Charge			Hrs	516	0	516		
Mid Peak - Medium Energy Charge			Hrs	774	2171	2945		
Off Peak - Lower Energy Charge			Hrs	1638	3661	5299		

The current SCE electricity charges for TOU-8 for large users are outlined in **Table 3-3**. This includes energy charges, kW demand charges, power factor adjustment, and reactive power charges. These are indicative rates, and for TOU billing scheme. SCE will provide detailed breakdown of billing charges based on overall service requested by the customer.

Table 4-3: Electricity Charges for TOU for >500 kW at >50 kV

Time Period		On Peak	Mid Peak	Off Peak
Delivery Service Charges	$/kWh	0.01616	0.01616	0.01616
Energy Charges Summer	$/kWh	0.1261	0.09968	0.07139
Energy Charges – Winter	$/kWh	0	0.09318	0.07101
		For All Periods		
Customer Charge	$/meter/month	2376.08		
Demand Charges	$/kW /month	4.63		
PF Adjustment	$/kVAR	0.32		
Demand Charge Discount	$/kW /month	-1.99		

4.4. Real Time Pricing (RTP)

SCE rate schedule RTP-2[10] is applicable to Bundled Service Customers eligible for service under Schedule TOU-8, General Service - Large. This Schedule is limited to customers who agree to participate in the Real Time Pricing ("RTP") program and is subject to meter availability. Under this rate schedule the following is applicable:

- Maximum Demand: The Maximum Demand for the billing month shall be the measured maximum average kilowatt input indicated or recorded by instruments, during any 15-minute metered interval in that billing month. Where the demand is intermittent or subject to violent fluctuations, a 5-minute interval may be used.
- Billing Demand: The Billing Demand shall be the kilowatts of Maximum Demand determined to the nearest kW. The kW of Billing Demand used to determine the Facilities Related Demand Charge shall be based on the kilowatts of Maximum Demand recorded during (or established for) the monthly billing period. However, when SCE determines the customer's meter will record little or no energy use for extended periods of time or when the customer's meter has not recorded a Maximum Demand in the preceding eleven months, the Facilities Related Demand Charge may be established as 50 percent of the customer's connected load.
- Real Time Pricing: As used in this schedule, Real Time Pricing is the practice of continuously varying prices to customers to reflect simulated hourly variations in the marginal costs of generating electricity. Detailed hourly rates for each month can be downloaded from SCE web site.

[10] SCE RTP-2 rates, Advise 2577-E-A, effective June 1, 2011. www.sce.com

- Voltage Discounts: Bundled Service Customers will have the Distribution rate component of the applicable Delivery Service charges reduced by the corresponding Voltage Discount amount for service metered and delivered at the applicable voltage level as shown in the Rates section above. In addition, Customers receiving service at 220 kV will have the Utility Retained Generation (URG) rate component of the applicable Generation Charges for service above 50 kV reduced by the corresponding Voltage Discount amount for service metered and delivered at 220 kV as shown in the Rates section.
- Power Factor Adjustment: The customer's bill will be increased each month for power factor by the amount shown in the Rates section above for service metered and delivered at the applicable voltage level, based on the per kilovar of maximum reactive demand imposed on SCE.
    - The maximum reactive demand shall be the highest measured maximum average kilovar demand indicated or recorded by metering during any 15-minute metered interval in the month.
    - The kilovars shall be determined to the nearest unit. A device will be installed on each kilovar meter to prevent reverse operation of the meter.

The daily maximum temperature, as recorded by the National Weather Service, at its Downtown Los Angeles site, will be used to determine the hourly rates for the following day according to the RTP-2 rate schedule. It is the responsibility of the customers to acquire the daily maximum temperature at the Los Angeles Downtown site. SCE is not required to provide the daily maximum temperature. In the event that data is unavailable from Downtown LA as the primary source, data collected by the National Weather Service from Long Beach Airport shall be used. Where data is not available from either site, SCE shall enact its procedure for emergency data collection in order to provide substitute temperature data.

4.5. Added Facilities Costs

Added Facilities is defined as:

a. Facilities requested by an applicant which are in addition to or in substitution for standard facilities (such as SCE's standard line and service extension facilities), which would normally be provided by SCE for delivery of service at one point, through one meter, at one voltage class under its tariff schedules, or
b. A pro rata portion of the facilities requested by an applicant, allocated for the sole use of such applicant, which would not normally be allocated for such sole use.

Added Facilities may include, but are not limited to, all types of equipment normally installed by SCE in the development of its electrical transmission and distribution systems and facilities or equipment related to SCE's provision of service to a customer or a customer's receipt or utilization of SCE's electrical energy. Added Facilities also include the differential costs for equipment for electrical transmission and distribution systems designed by SCE which, in SCE's sole opinion, is in excess of equipment required for SCE's standard serving system. Added Facilities may include poles, lines, structures, fixtures, transformers, service connections, load control devices and meters.

Added facilities will be installed under the terms and conditions of a contract in the form on file with the California Public Utilities Commission.

4.6. Interruptible Power Option

The Time-of-Use Base Interruptible Program (Schedule TOU-BIP) is open customers who have monthly demands (or aggregated demands) that reach or exceed 200 kW. Customers or aggregated groups who select this program are required to choose a Firm Service Level (FSL) that reflects the amount of electricity the customer determines is necessary to meet their operational requirements during a TOU-BIP event. They must also choose a participation option, which is the amount of time (15 or 30 minutes) the customer requires in order to respond to a TOU-BIP event. Customers must make a commitment to reduce at least 15% of their maximum demand (but no less than 100 kW) during TOU events.

In exchange for participating in TOU-BIP, customers or aggregators receive monthly credits based on the difference between their average peak period demand for each month and their selected FSL. TOU-BIP credits for each billing period will be applied to the current month’s bill. Excess energy charges (penalties) apply for failure to reduce power to the customer-selected FSL within the selected participation option (15 or 30 minutes). Some restrictions apply. For example, Essential Use* and Exempt** customers cannot set their FSL to less than 50% of their average maximum demand.

The credits under TOU-BIP will depend on amount of load reduction agreed by customer. In general terms for the desalination plant, if WB agrees to reduce the load by 1 MW (to a pre-committed firm service level – FSL) during peak demand period month, SCE credits will be in the range of $18,000 to $19,000/MW for the month. For mid peak period, the credits will be ~$5,000/MW and only about $1,000/MW during off peak winter months.

Eligibility - Schedule TOU-BIP is optional to TOU-GS-3, TOU-8 and Real-Time Pricing (RTP-2) customers. Participation in Other Demand Response Programs with limitations, customers participating in TOU-BIP may also participate in other demand response programs for additional incentives.

Customer Obligations - Directly-enrolled customers and aggregators taking service under TOU-BIP must agree to the following conditions:

- Firm Service Level (FSL): The customer must establish a FSL, which is the amount of electricity a TOU-BIP customer determines is necessary to meet their operational requirements during a TOU-BIP event. This is also the amount of load that would not be subject to interruption during a TOU-BIP event. TOU-BIP customers are required to reduce their electrical load to their designated FSL within the time frame of their selected participation option.
- Participation Option (15 or 30 Minutes): Customers must select an amount of time they need in order to respond to the TOU-BIP event — 15 minutes (Option A) or 30 minutes (Option B) after receiving a notice of interruption.
- Remote Terminal Units for Notices of Interruption: TOU-BIP customers must have a working remote terminal unit (RTU) to receive a notice of interruption. The RTU will be provided by SCE.
- Telephone lines: TOU-BIP customers must have one dedicated, unlisted telephone line and telephone for the sole purpose of receiving official TOU-BIP event notifications, and may be required to have an additional dedicated phone line for the RTU.
- Interval meter: Customers must have an interval meter capable of recording usage in 15-minute intervals. If the customer does not already have an interval meter, SCE will provide and install one at no charge (certain restrictions apply).

Program Operation

Interruption Frequency and Duration - A TOU-BIP event may occur after SCE receives a request from CAISO to reduce a specific amount of electrical load. SCE will notify its TOU-BIP customers to reduce electrical usage to their FSL within their selected participation option time frame - 15 minutes (Option A) or 30 minutes (Option B) - of receiving the notification, to avoid penalties. TOU-BIP interruption events are limited to:

- No more than one event per day (up to 6 hours), or
- No more than 10 events per calendar month, or 120 hours per calendar year
- CAISO can call for a TOU-BIP event at any time, 24 hours a day, 7 days a week, 365 days a year

Initiation of TOU-BIP events - Events initiated by CAISO: A TOUBIP event may be triggered by CAISO at a Stage 2 Emergency.

Events initiated by SCE: SCE may trigger a TOU-BIP event, upon the determination of the need to implement load reduction in our service territory; or for test purposes, program evaluation or system contingencies.

Penalties, or “excess energy charges”, are applicable when a customer fails to reduce their electrical usage to their FSL during these events.

5. Power Supply Development

5.1. Reliability & Integration Standards

Federal Energy Regulatory Commission (FERC) has established North American Electric Reliability Corporation (NERC) and developed rules for reliability of electric supply throughout North America. SCE as provider of the electricity in the region is required to follow these rules and meet the reliability standards set by NERC.

Under FERC rules, electricity industry is required to operate under mandatory, enforceable reliability standards. The NERC is responsible for developing and enforcing these standards as one means of improving the reliability of North America's bulk power system. The bulk power system consists of the power plants, transmission lines and substations, and related equipment and controls, that generate and move electricity in bulk to points from which local electric companies distribute the electricity to customers.

Reliability Standards address aspects of the operation and planning of the bulk power system such as: real-time transmission operations, balancing load and generation, emergency operations, system restoration and black start, voltage control, cyber security, vegetation management, facility ratings, disturbance reporting, connecting facilities to the grid, certifying system operators, and personnel training. Standards detail how the system should perform, but not how the system should be designed. Individual owners, operators and users of the bulk power system determine if the system should be expanded or changed, and how, in order to achieve the standards.

Stated in simpler terms, these are federal enforceable standards that require that utilities and transmission operators provide dependable and clean power (set frequency and voltage to protect customer installation) 24/7 with very high reliability. Utilities are required to compile statistics on customer outages, and reasons for such outages, remedial action to prevent future occurrence on regular basis and file such reports with FERC. FERC has enforceable power to require utilities and transmission operators to upgrade their system and procedures to maintain these reliability standards.

5.2. Transmission Requirements

Both sites under consideration – NRG's ESGS and AES's RBGS have 66 kV transmission line services. The 66 kV line at ESGS was installed for starting the old ESGS plant. The substation is outside the fence as shown in **Figure 3-2**. However, the substation is active and available to tap into and can support the required load up to 50 MW for the desalination plant.

The 66 kV substation at RGBS is active and was used to evacuate power from old units 1-4, which are decommissioned. The substation has dual feeds to meet reliability requirements and it can support the required load for the desalination plant of 20 – 60 MGD capacity.

For either site, if West Basin decides to utilize SCE transmission and substation facilities, SCE will have to conduct a power flow analysis based on desalination plant size and power requirement to determine adequacy of the current installed system and if any upgrades are required. Per SCE, such study can cost in the range of $100K, but SCE can absorb such costs for the new customers.

5.3. Design Requirements

General single line scheme for power supply by SCE is provided in **Appendix 2:B**. For self-generation a single line scheme is presented in **Appendix 2:C**.

The detailed transformer specification for power supply options from SCE 66 kV line will be developed after detailed desalination power requirements are determined and SCE has conducted power flow analysis.

6. Power Supply Cost Analysis

6.1. On Site Generation Cost Estimates

Table 5-1 is budgetary cost estimate based on current NG fuel price of $4.50/MMBtu and recently published costs for the combined cycle plants in Gas Turbine World[11]. The following assumptions were used in developing **Table 5-1**.

1. CC Net output was developed from GTW Handbook for typical configuration with standard manufacturer's offering without duct firing
2. Heat Rate was based on published GT heat rate and for ST efficiency
3. Annual power generation was estimated based on 92% capacity factor
4. Fuel cost was estimated at $4.5/MMBtu and heat rate for the individual model
5. Capital cost were based on GT World estimate and recent available cost data
6. Cost data are for turnkey EPC work for a developed site. Does not include land lease or land acquisition cost, Owner's cost (permitting, and financing cost, etc.) and switchyard development or gas supply infrastructure cost outside the fence.
7. Annual Capex was estimated at 25 year bond financing for 100% debt at 5 ¼ % interest rate, no taxes or other fees
8. Fixed and variable O&M costs were estimated based on Nexant's in-house experience and data base for CC units from various sources including DOE, EPRI, and standard offering by IPP in their PPAs.

[11] Gas Turbine World 2010 Handbook, Vol. 28. Gas Turbine World, P.O. Box 447, Southport, CT 06890, USA,, Gas Turbine World, P.O. Box 447, Southport, CT 06890, USA

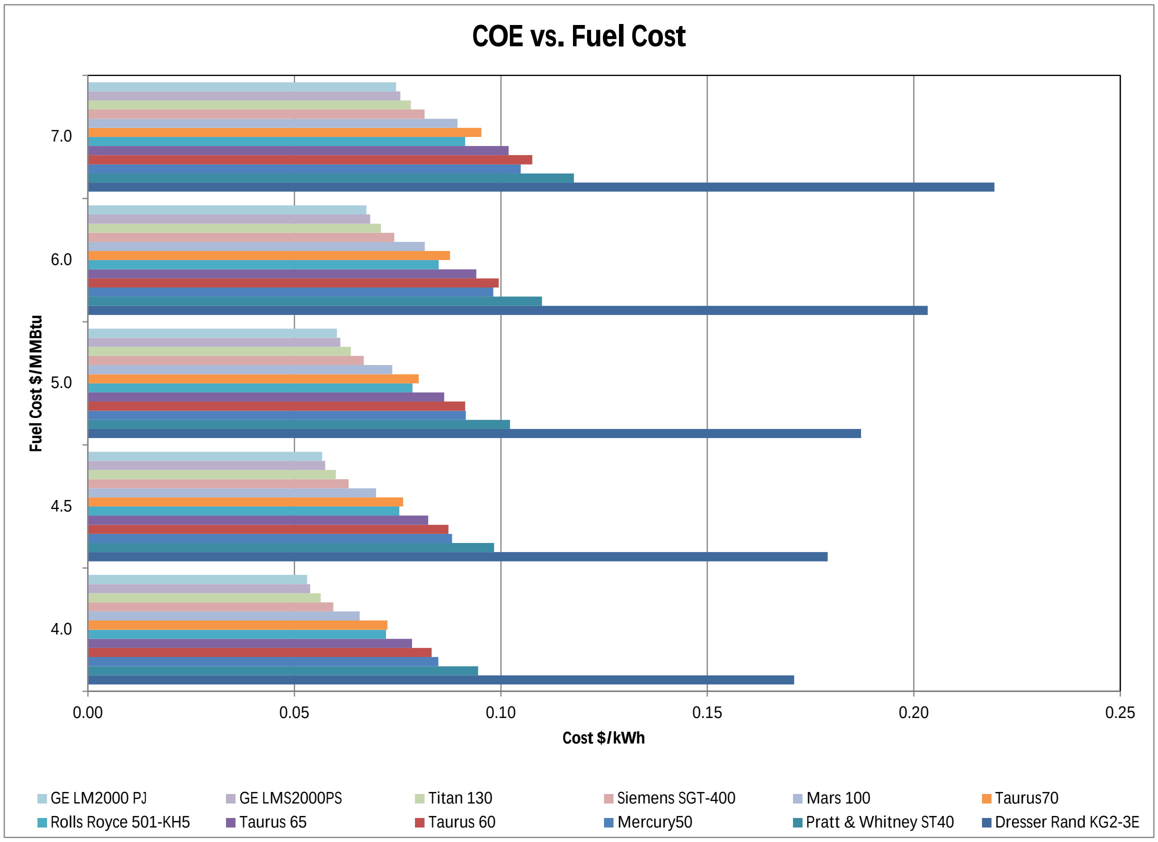
Table 6-1: Budgetary Cost Estimate for Combined Cycle Generation

Combined Cycle	Continued Cycle Net Output	Heat Rate	Annual Power Generation	Annual	CAPEX	Estimated CapEx	Annual CapEx	CapEx Cost	Fuel Cost	Estimated O&M Cost	Total Estimated Cost
Model 1	**MW**	**Btu/kWh**	**Annual GWh**	**Fuel Cost $**	**$/kW**	**Million $**	**$**	**$/kWh**	**$/kWh**	**$/kWh**	**$/kwH**
Dresser Rand KG2-3E	2,526	16,164	20	2,303,061	3,136	8	576,121	0.028	0.113	0.08	0.22
Pratt & Whitney ST40	5,383	7,736	43	2,349,214	2,317	12	907,219	0.021	0.054	0.04	0.12
Mercury 50	6,131	6,650	49	2,300,004	2,199	13	980,850	0.020	0.047	0.04	0.10
Taurus 60	7,557	8,126	61	3,464,188	2,023	15	1,111,982	0.018	0.057	0.03	0.11
Taurus 65	8,397	7,784	68	3,687,386	1,939	16	1,184,547	0.018	0.054	0.03	0.10
Rolls Royce 501-KH5	8,593	6,384	69	3,094,754	1,922	17	1,201,054	0.017	0.045	0.03	0.09
Taurus 70	10,023	7,578	81	4,284,787	1,807	18	1,317,281	0.016	0.053	0.03	0.10
Mars 100	13,901	7,889	112	6,187,049	1,585	22	1,602,944	0.014	0.055	0.02	0.09
Siemens SGT-400	17,193	7,366	139	7,144,208	1,456	25	1,820,965	0.013	0.052	0.02	0.08
Titan 130	19,992	7,274	161	8,204,064	1,371	27	1,993,437	0.012	0.051	0.01	0.08
GE LMS 2000PS	23,533	7,283	190	9,669,231	1,284	30	2,198,356	0.012	0.051	0.01	0.08
GE LM 2000PJ	23,911	7,168	193	9,669,092	1,276	31	2,219,461	0.012	0.050	0.01	0.07

It should also be noted that onsite generation will require SCE back-up power during forced and planned outages. The standby charges will be based on Schedule S as outlined under Section 3.7 Standby Charges. These are over and above COE estimated in **Table 5-1** above. An example of SCE standby charges is provided in Section 5.4.

Sensitivity Analysis: As estimated in **Table 5-1**, the major element in COE is fuel cost. Current NG fuel cost for generating electricity in California (2012 spot market price per CEC and CPUC) is between $4 - $4.50 /MMBtu gas delivered at site. However, in the past the price has fluctuated between $3.85 - $9 /MMBtu. US DOE projection for long term NG price is to remain soft and in the range of $3.50 - $4.50 /MMBtu. The Chart 5-1 show impact of fuel price on COE.

Figure 6-1: COE vs. Natural Gas Price



Stand by Charges for Onsite Generation

Onsite generation will require backup power during scheduled and unscheduled plant outages. Most combined cycle units have high availability, and range in 90-95%. The above analysis has assumed 92% availability factor. SCE will provide the required backup power that will be uninterruptible power with seamless auto transfer. SCE will assess standby charges. An analysis for standby charges is provided in Section 5-4. Redundant units to avoid stand by charges is not considered, as it will be cost prohibitive. The redundant unit will have a design capacity factor of 15-20%. At this capacity factor capital recovery cost of second unit will be higher than stand by charges from SCE. However, a small emergency generator or UPS system should be part of any power system design to safely shutdown both desalination plant and power plant in case of loss of power.

6.2. SCE Supply Cost Estimates

Table 5-2 is estimate of SCE cost of electricity based on TOU-8 rates services offered by SCE. These rates do not include any monthly charges for added facilities and applicable taxes. SCE calculated these costs based on peak demand of 15 MW and 33 MW and an estimate of annual energy use for 20 MGD and 40 MGD plants. Although, electrical load for these two cases is estimated at 14 MW and 30 MW respectively, SCE calculates peak demand charge on maximum load over any 15 minute interval for the month. If there is power surge due to major equipment starts, this will be counted toward fixed demand charge for the month. In order to be conservative in their estimate, SCE assumed 15 and 33 MW to calculate demand charges for the two cases.

Table 6-2: SCE Costs Under TOU-8 Rate

Plant Size (Peak Load) / Voltage	Total Cost (c/kWh)	Demand (c/kWh)	Energy (c/kWh)
15 MW at Less than 50kV	9.56	2.76	6.80
15 MW at Greater than 50kV	7.46	1.60	5.85
33 MW at Less than 50kV	9.56	2.76	6.80
33 MW at Greater than 50kV	7.45	1.60	5.84

Note:
2012 rates
>50kV is for 66 kV line

It should also be noted that SCE will require a study for any non-standard configuration which will be billed to WBMWD. Any other facility upgrades requested by WBWMD for SCE supply option will be billed separately.

6.3. Standby Costs for Self Generation

For self-generating power customers SCE rate schedule S or standby charges may apply. SCE's Rate Schedule S is mandatory for customers who self-generate all or a portion of their electrical power from their own generating facility, or from a third-party's generating facility.

Under Schedule S, SCE provides "standby" service, which is usually during the generator's scheduled or unscheduled outages (other than power outages or rotating outages). Schedule S ensures that customer's business will not be compromised when its generator is not operating.

One or more of the following basic charges may be applicable. Schedule S basic charges:

- Capacity Reservation Charge (CRC), based on the Standby Demand level (in kilowatts) set by the customer, and usually equal to the nameplate rating of the generator.

- Generation Demand Charges for backup service, consisting of Time-Related Demand (TRD) charges.

Note: All other charges will be billed at the customer's Otherwise-Applicable Tariff (OAT), including energy charges per kilowatt hour consumed, customer charges and demand charges for supplemental service (consisting of TRD charges and Facilities-Related Demand [FRD] charges). However, before rates are applied, any FRD charges will be offset by Standby Demand (in kilowatts) and any TRD charges will be offset by any Generation Demand TRD for backup service.

Schedule S requires:

- a contract,
- the presence of primary power equipment, and
- a generating facility interconnection agreement.

Under certain conditions, additional connection and metering equipment may be necessary.

Determining the level of standby demand - Standby Demand represents the entire reserve capacity needed to serve the customer's load that is usually provided when the generator is not operating. The level of Standby Demand is designated by the customer, but cannot exceed the nameplate capacity of the generator, the customer's connected load, or the prior 12-month peak demand (whichever is less). If, in any billing period, SCE determines the standby demand is too low or too high, SCE will increase or decrease the standby demand to reflect the actual required reserve capacity.

6.3.1. Basis for Standby Charges

Standby Charges were estimated based on the following assumptions:

Assumptions:

- 33 MW Standby (assuming that for desalination plant to run at full capacity at 33 MW power. This is for illustrative purpose. Other sizes can be used with similar results)
- No use of the standby (to keep it simple)

SCE's Demand charges were calculated based on the following formula provided by SCE.

Cost per year for Standby Service (At voltages less than 50 kV) –

33,000 KW X 5.13 X 12 (for T&D for the year) + 33,000 KW X 4 X 10.99 (Time Related Demand Charge for 4 Summer Peak months) + 33,000 X 4 X 2.78 (Time Related Demand

Charge for 4 Summer Mid Peak months) -

Cost per year for Standby Service (At voltages greater than 50 kV)

33,000 KW X 1.11 X 12 (for T&D for the year) + 33,000 KW X 4 X 9.83 (Time Related Demand Charge for 4 Summer Peak months) + 33,000 X 4 X 1.82 (Time Related Demand Charge for 4 Summer Mid Peak months)

Nexant has requested SCE for verification of these rates based on SCE published Standby rate schedule. We have not been able to obtain a written confirmation from SCE, but the following estimate represents a good maximum estimate. Actual cost for standby charges can be negotiated with SCE based on operational regime of the desalination plant.

6.3.2. Estimate for Standby Charges

The following **Table 5-3** is Nexant estimate for the annual standby charges. This does not include charges for energy that will depend on amount of electricity used and will be calculated on TOU-8 rate basis.

The Standby Charges were calculated for 33 MW service. Actual standby charges will depend on contract for the peak load for the desalination plant.

Table 6-3: SEC Standby Charges Estimate for a 33 MW Demand

Standby Charges for 33 MWs	**Reservation Charge**	**Time Related Demand Charges**		**Reservation Charge (T&D)**	**Time Demand Charge**	**Total Annual Charges**
	Reservation Charge Total T&D Factor	Time Related Summer On peak	Time Related Summer Mid Peak	Reservation Charge (T&D)	Time Demand Charge	Total Annual Charges
Less than 50kv	5.13	10.99	2.78	2,031,480.00	1,817,640.00	3,849,120.00
Greater than 50kv but less than 220kv	1.11	9.83	1.82	439,560.00	1,537,800.00	1,977,360.00

The accurate cost of standby charges per kWh of energy consumed will depend on many factors. This is an estimate. Based on current configuration of desalination plant, the standby charges are estimated at $0.015/kWh to $0.025/kWh. The above **Table 5-3** covers all periods during the year.

7. Preferred Alternatives

7.1. Ranking of Options

The power supply options analyzed in this report are ranked in **Table 6-1**.

Table 7-1: Ranking of Options

Power Supply Option	Advantages	Disadvantages	Conclusions	Cost Range
Onsite power generation with conventional means	Lower cost. Local control of power source and agreement terms.	Will require permitting and regulatory approval. Potential SCE standby charges. No renewable credits.	Obtaining emissions offsets and permitting is major hurdle. Economics marginal. WB has no experience in operating power plant but joint option could make feasible.	7-10 ¢/kWh (@$4.5/MMBtu gas price) + SCE stand by charges estimated at 1.5 – 2.5 ¢/kWh[1]
Onsite power generation by renewable resources	Attractive – green power.	Not very good wind or solar resources at site, not practical. Highest cost, with SCE supplying remaining power.	If implemented, on site renewable will generate <5% of power need of the desalination plant.	8 – 12 ¢/kWh for wind, 14-18 ¢/kWh for solar with SCE make up power at 7.5 – 9.6 ¢/kWh[2]
Power supply directly purchased from SCE	System reliability, defined contract terms and most accurate cost estimate. Will have 20-33% renewable component.	Current cost are well defined, but future escalation is subject to PUC process, and can have negative impact for large user to subsidize residential customers.	SCE >50 kV supply rates are competitive. SCE will work with WB within PUC guideline for best rates.	7.5 – 9.6 ¢/kWh[3]

Notes:

1. Nexant estimate calculated based on Gas Turbine World 2012 GTW Handbook, Volume 29 capital costs and estimated performance, Nexant in-house O&M cost estimate and DOE projected gas price for electricity generation
2. NREL Energy Analysis, July 2012 Update http://www.nrel.gov/analysis/tech_lcoe.html
3. SCE Cost Analysis – Based on work performed with SCE TOU -8 Rate Tables, and input from SCE Business Customer Division

7.2. Recommendations

Two options are recommend for WBMWD to evaluate going forward on site self-generation and direct purchase from SCE. Both options will require further detailed analysis of terms and conditions to determine the best alternative.

8. Next Steps and Schedule

8.1. Next Steps

Further negotiation will be required with SCE on standby charges, added facilities charges. If power is purchased from third party, wheeling costs will have to be negotiated with SCE.

For the self-generation option, WB may have to secure emission off-sets. Although, emission offsets have been available, there is no regulated market for the SCAQMD area. Individual entity deal with project developers and work out a price for selling or acquiring the off-sets. Since, these trades are few and commercial terms are not published, cost of acquiring the offsets, specifically for NOx, CO and particulates (PM_{10} and $PM_{2.5}$), are not available.

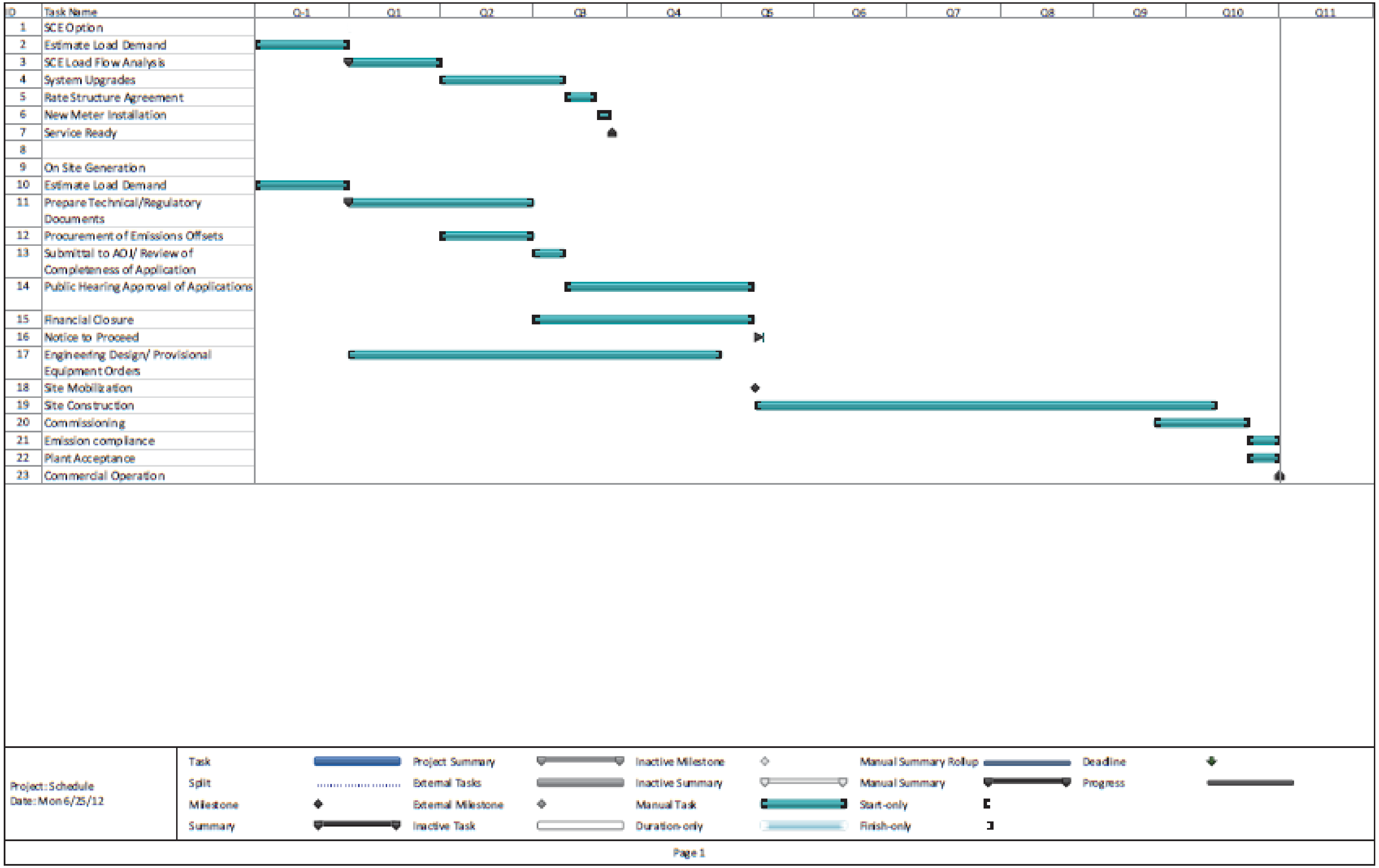
8.2. Schedule

Power supply option schedule should be integral part of overall PMP project. It is not a standalone power project. **Figure 7-1** presents a timeline for the SCE connection as well as for onsite self-generation.

Power purchase arrangement from SCE at high voltage should not take more than 3 quarters, including any system upgrades that may be required.

Self-generation option will require considerable upfront engineering and environmental work, and over all power project may take 10+ quarters.

Figure 8-1: Estimated Time Schedule for SCE and Self Generation Option



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

Project Entitlements Acquisition Plan (PEAP)

January 2013

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1. Introduction

1.1. Objective

The purpose of the Project Entitlement Acquisition Plan (PEAP) is to identify key project entitlements needed for the implementation of the Ocean Water Desalination Project (alternatives are noted in the West Basin Municipal Water District Ocean Water Desalination Program Master Plan, Conceptual System Design and Program Requirements Report (TM-1)) and to develop a plan and schedule for their acquisition. Many of the engineering support studies developed for the acquisition of project entitlements will also be used for the development of the conceptual project design, environmental review and permitting as well.

2. Project Entitlement Acquisition Plan (PEAP)

2.1. Site Option / Lease

a. Description

Preliminary site layouts for both the local and regional sized facilities are included as Figures 7-12 through 7-15 in the CSDPR (TM-1). For both sizing cases, facilities for the proposed West Basin Ocean Water Desalination Facility are located at either the NRG El Segundo Generating Station (ESGS) property or AES Redondo Beach Generating Station (RBGS) property, and are entirely within the jurisdiction of the City of El Segundo or City of Redondo Beach, respectively. Site Boundary sketches are included in TM-1 as Figures 3-1 and 3-2. Proposed layouts and access to the site will require review and approvals by the owner, NRG or AES, throughout the planning, design, and construction process. Plans to remove facilities that exist on the site and to construct the proposed project will undergo review and approval by the City of El Segundo or City of Redondo Beach, the California Coastal Commission, and other regulatory agencies.

The El Segundo Generating Station is located on Santa Monica Bay within the City of El Segundo, California. At this location two pairs of tunnels exist. The intake and discharge tunnels on the north side of the property, used for cooling water of units 1 and 2, have been decommissioned and would not be available for use. The intake and discharge tunnels on the south side of the property, used for cooling water of units 3 and 4, are currently operational. It is expected, per statements of NRG staff during the site visit on June 21 2011 that units 3 and 4 would be converted to air cooling in the near future and therefore its tunnels could be used for the desalination plant. Units 3 and 4 tunnels are 12-foot inside diameter, shore-perpendicular concrete pipes, buried approximately 5 feet under the seafloor in the offshore area and at about 10 feet across the beach area. The offshore end of the intake tunnel, at approximately 2,300 feet from the shoreline at a water depth of approximately -35 feet Mean Lower Low Water (MLLW), features a vertical 16 x 21-foot internal cross section structure, with a velocity cap, which extends approximately 10 feet above the seafloor (SCE, 1982). The shorter discharge tunnel is approximately 1,800 feet from the shoreline at a water depth of approximately -29 feet MLLW. (SCE, 1982).

For the purposes of this assessment, it is assumed that the ocean currents are parallel to the shore in a northwestward direction on flood tide and southeastward on an ebb tide, with a net drift to the south induced by the dominant northwestern waves and wind. Therefore, the intake would be placed to the north of the discharge and the northern tunnel would be used.

The RBGS, at the south end of Santa Monica Bay, features three pairs of tunnels that were designed for ocean water intake and discharge for the station's cooling system. The pair of tunnels located to the north of the King Harbor breakwater are considered for the desalination plant in the PMP. These tunnels have been used alternatively as intake and discharge facilities. The longer tunnel extends offshore approximately 2,000 feet to a water depth of approximately -33 feet MLLW. The shorter tunnel extends offshore approximately 1,800 feet to a water depth of approximately - 30 feet MLLW. Both tunnels are 10-foot inside diameter, shore-perpendicular concrete pipes, buried approximately 4 feet under the seafloor. Both tunnels feature a vertical intake structure with a 14-foot internal diameter cross section.

Similar to the ESGS, currents in the vicinity of Redondo Beach run parallel to the coast. However, the presence of the King Harbor breakwater affects the direction of the current inducing eddies and flows with directions that are difficult to determine. Given the conceptual nature of this study, it is assumed that current patterns are, in general, parallel to the coast and the breakwater, with currents flowing in the northwestward direction on flood tide, southeastward on an ebb tide, and with a net drift to the south induced by the dominant northwestern waves and wind. Therefore, the intake would be placed to the north of the discharge and would use the northern tunnel.

This section addresses the primary considerations involved in accounting for the specific footprint requirements associated with this new desalination facility at both siting alternatives.

The proposed West Basin Ocean Water Desalination Plant would treat raw ocean water collected at the existing intake structures and conveyed to the raw water pumping stations located on site. The primary treatment process for this desalination facility would include seawater reverse osmosis membranes (SWRO).

SWRO membranes require special consideration for pre-treatment and post-treatment to ensure long-term system reliability and acceptable product water quality. The proposed SWRO pre-treatment systems include the following:

- Intake Screens
- Coagulation/Flocculation
- Dissolve Air Flotation (DAF), or Sedimentation – to be further evaluated
- High rate Granular Media Filtration (GMF)
- Membrane Filtration and appurtenant systemsCartridge Filtration
- Chemical Conditioning (i.e. Scale Inhibitors, pH adjustment)

After the SWRO process, the product water (permeate) requires post-treatment conditioning to provide a stable and compatible product water. This entails the addition of minerals to the RO permeate to mitigate the corrosive nature of the permeate and to ensure compatibility with current water supplies. Post-treatment process includes:

- Lime addition via Calcite Beds
- Carbon Dioxide Addition
- pH adjustment with Caustic Soda, Sodium Hydroxide
- Disinfection

In addition to the processes and facilities described above, footprint consideration is also required for the following peripheral, or appurtenant, facilities:

- Chemical Storage and Handling
- Product Water Storage/ Clearwell
- Product Water Pumping
- Administrative Area/Control Room
- Electrical/MCC Buildings
- Maintenance Areas
- Power Sub-Stations.
- Residuals Handling

b. Timeframe

As the site option/lease is between two private entities determining a timeframe would be difficult at this time.

2.2. Product Water Pipeline Easement / Right of Way

a. Description

From TM1, there are a total of eight conveyance alternatives from both the ESGS Site and the RBGS Site to inland users as outlined in **Table 2-1**.

Table 2-1: Summary of West Basin Preliminary Conveyance Schemes

Alternative	Plant Site	Conveyance Scheme
1	NRG	Local Service Connections – WB and WC Feeders
2	AES	
3	NRG	Feeder Connection – WB Feeder West End Local Service Connections – WC Feeder
4	AES	
5	NRG	Feeder Connection – WB Feeder East End Local Service Connections – WC Feeder
6	AES	
7	NRG	Regional Feeder Connection – Sepulveda Feeder
8	AES	

All of the preliminary alternative alignments are located within the public right-of-ways (ROWs) including California Department of Transportation (Caltrans), Los Angeles County Department of Public Works (LADPW), and the Cities of El Segundo, Manhattan Beach, Redondo Beach, Hawthorne, Lawndale, and Gardena. Major streets affected include: Aviation Boulevard, Rosecrans Avenue, Manhattan Beach Boulevard, El Segundo Boulevard, and Vista del Mar. Many of these streets are expected to have extensive utilities located within their ROWs. The majority of the preliminary alternative alignments are located within incorporated city ROWs; however, there are some crossings over Sepulveda Boulevard and the 405 Freeway, which are within Caltrans ROWs. There are also several crossings over the Dominguez Channel, an open flood control channel, which is within the LADPW ROW.

Based on TM-1, which assumes that there is no need for intermediate booster pump stations, and based on the preliminary alternative alignments, it is anticipated that acquisition of ROWs or easements is not necessary for the construction of conveyance systems. However, for all of the ROWs, the construction of conveyance systems will require an encroachment permit, or a variation thereof from the respective jurisdictional agencies. The encroachment permit will typically regulate traffic control, stormwater pollution control, excavation and trenching, work hour, contractor license and insurance, construction, and inspection requirements.

In addition, there are other ROW-related issues such as traffic conditions and utility conflicts that had considerable impacts on the selection of preliminary alternative alignments. For each of the preliminary alternative alignments, analysis was conducted to determine street widths and lengths, number of traffic lanes and intersections, major utilities, and ROW jurisdictions based on the data available from the MWD Integration Study, aerial images, and limited Geographic Information Systems (GIS) databases. The ideal street section would need to have low traffic volume and intersection counts, sufficient widths and traffic lanes to avoid closure of at least one lane, few utilities, and sufficient space for construction.

All of the preliminary alternative alignments are subject to multiple jurisdictional agencies, utility conflicts, and traffic conditions. Obtaining encroachment permits from the respective jurisdictional cities would require the processing of a simple form (1-2 pages) and can be obtained in a relatively short timeframe (less than 3 months). Obtaining encroachment permits from Caltrans or LADPW, however, typically requires more effort and lengthier processing times. Within most street ROWs, utility conflicts with sanitary sewer lines, storm drains, and other water pipes are fairly common, especially when crossing street intersections. Caution would be taken when underground electrical, oil, gas, or communications lines (including fiber optics) are present.

A key factor in limiting the difficulties associated with ROW issues is the length, size, and alignment of pipes. Once a conveyance scheme is selected, a detailed street alignment and utility survey would be recommended in the future to develop the alignments and to analyze traffic conditions and utility conflicts in greater detail. Any alternative that crosses Caltrans ROW would require an approved Caltrans encroachment permit prior to submitting a local city encroachment request.

b. Timeframe

The Caltrans Encroachment Permit process would be expected to take between 12 and 24 months and the MWD Encroachment Permit process would be expected to take between 12 and 24 months. Local Encroachment Permits could take between 3 and 6 months.

2.3. Power Supply Agreement

a. Description

The power demand is estimated at approximately 0.5 to 0.6 MW/MGD. However, with efficiency improvement the power demand can be reduced to between 0.4 -0.5 MW/MGD. It is likely that the distribution network will require additional pumping power, however the exact amount is undetermined at this time.

Using the above factors, the total power requirement for the local supply option (20 MGD) is estimated at approximately 12 MW, while the total power requirement for the regional supply option (60 MGD) is estimated at approximately 36 MW.

West Basin is evaluating power procurement options as part of this effort. Direct purchase of electricity from SCE is one of the main considerations along with self-generation. However, on-site/off-site self-generation options are evaluated in TM-2, Power Supply Plan (PSP).

The existing 220 kV SCE switchyard on site can be available to draw power for the new desalination plant. Alternately, the site also has a 61 kV feed (to be verified). Details on 220 kV and 61 kV switchyard configurations, after NRG's tie-in, will be coordinated with SCE when the new combined cycle plant is completed.

The California Coastal Commission (CCC) has issued a directive to phase out once through cooling of coastal power plants, however the AES's future plans for the RBGS is not clear at this time.

b. Timeframe

The process of completing a Power Supply Agreement with SCE is expected to take between 12 and 24 months.

2.4. Negotiation of Intake/Outfall Easement

a. Description

The California State Lands Commission (SLC) has jurisdiction and management control over approximately four million acres of land underlying the State's navigable and tidal waterways, including the State's tide and submerged lands along the California's 1,100 miles of coastline and offshore islands extending from the mean high tide line to three nautical miles offshore.

The SLC holds these lands for the benefit of all the people of the State, subject to the Public Trust for water related commerce, navigation, fisheries, recreation, open space and other recognized Public Trust uses. Accordingly, the SLC maintains a multiple use management policy to assure the greatest possible public benefit is derived from these lands.

Upon receipt of an inquiry about the proposed use of State lands, the SLC Title Unit reviews its files and information submitted to determine the extent of the State's property interest in the project site. If agency staff determines that the proposed project is within SLC jurisdiction, an application must be submitted. No project can proceed until the SLC has considered and taken action on the application. The issuance by the SLC of any lease, permit or other entitlement for use of State lands is reviewed for compliance with the provisions of the California Environmental Quality Act (CEQA). The SLC may also consult with California Department of Fish and Game in the review of lease application.

Permit Requirements

Prior investigations conducted by ARCADIS for the project entitlements research indicated that the site for the ocean water desalination plant at the El Segundo Power Generating Station or Redondo Beach Generating Station is subject to an SLC lease for operating the existing intake and outfall. Therefore, if this existing infrastructure were used in the operation of the ocean water desalination plant, there would be several options for obtaining authorization from the SLC:

- Obtain a new lease; or
- Amend the current lease held by NRG/AES (subject to agreement by the lessee); or
- Sublease the use of the existing infrastructure from NRG/AES

For any of these options, a new SLC Application for Lease of State Lands would be required. In conjunction with the application, the SLC requires a completed CEQA document and a Mitigation / Monitoring Program. After all of the required materials have been submitted, the SLC would then notify the project proponent that the application is complete, initiating the formal review process.

As part of the lease application to use the existing intake and outfall infrastructure system, additional scope of works and studies would be required to complete the SLC Application for Lease of State Lands.

b. Additional Studies

i. *Scope of Work for Configuration and Capacity of Intake/Outfall System*

It was determined in TM1 that the existing Units 3 & 4 intake and discharge tunnels at the El Segundo Power Generating Station Site or the existing pair of tunnels located to the north of the King Harbor breakwater at the RBGS would be considered for the desalination plant. To meet the plant scenarios of 20 MGD or 60 MGD capacity, new smaller diameter piping would be placed within the existing larger tunnels.

For the 20 MGD scenario, the total intake volume is estimated to be 45.1 MGD and total discharge volume is estimated to be 30 MGD. The preliminary piping design for intake flows at ESGS includes two 42 in. diameter pipes installed within the existing 12 ft. diameter intake tunnel. For discharge flows at ESGS, one 42 in. diameter pipe is installed within the existing 12 ft. diameter outfall tunnel. The piping design for intake flows at RBGS includes two 42 in. diameter pipes installed within the existing 10 ft. diameter intake tunnel. For discharge flows at RBGS, one 42 in. diameter pipe is installed within the existing 10 ft. diameter outfall tunnel.

For the 60 MGD scenario, the total intake volume is estimated to be 135.3 MGD and total discharge volume is estimated to be 60 MGD. The preliminarypiping design for intake flows at ESGS include two 63 in. diameter pipes installed within the existing 12 ft. diameter intake tunnel. For discharge flows at ESGS, one 63 in. diameter pipe is installed within the existing 12 ft. diameter outfall tunnel. The piping design for intake flows at RBGS include two 54 in. diameter pipes installed within the existing 10 ft. diameter intake tunnel. For discharge flows at RBGS, one 63 in. diameter pipe is installed within the existing 10 ft. diameter outfall tunnel.

Model data for intake and outfall flows under the currently chosen scenario were estimated at 5.3 fps. The Approach Velocities at the Intake Screens should not exceed 0.30 fps with a 2.4 mm mesh screen to reduce impingement and entrainment of aquatic organisms.

ii. *Intake Impingement and Entrainment Study*

The annual entrainment estimates, in conjunction with demographic data collected from the fisheries literature, were used in modeling intake effects using adult equivalent loss (*AEL*) and fecundity hindcasting (*FH*). Data for the same target taxa from sampling of the entrained larvae and potential source populations of larvae were used to calculate estimates of proportional entrainment (*PE*) that were used to estimate the probability of mortality (P_m) due to entrainment using the Empirical Transport Model (*ETM*). In the ESGS and RBGS entrainment studies each approach (e.g., *AEL*, *FH*, and *ETM*), as appropriate for each target taxon, was used to assess effects of desalination facility losses.

iii *Flow Impingement and Entrainment Minimization Plan*

A seawater intake located at the ESGS site and designed with the approach velocities and intake screens as noted above, is be expected to reduce annual entrainment losses and combined total losses of Essential Fish Habitat (EFH) and California Department of Fish and Game special-status species. However since some of the individual species of fish in the EFH and special status categories were entrained in greater numbers at the El Segundo site (e.g. California halibut), it is important to consider effects on individual species in any comparison of the alternative sites.

iv. *Wetland Restoration Plan*

The scope of work for the Wetland Restoration Plan for the ESGS or RBGS will consist of the following steps and products:

- Pre-project site inventory to include at a minimum:
  1. Characterization of existing conditions including
     a. habitat type
     b. percent cover
     c. habitat assessment
     d. species identification (floral and faunal)
     e. identification of endangered/threatened and species of concern with potential to occur

2. Potential hazardous materials.

3. Existing overriding permitting and regulatory conditions, i.e. California Coastal Commission; Local considerations; etc.

- Document summary, history, background, and regulatory environment.
- Identification of species to be reintroduced (plants) and appropriate elevations by mean high tide mark.
- Identification of resource supplier and installation contractor.
- Guidelines for appropriate actions regarding irrigation, soil amendments, weeding, and monitoring.
- Restoration target goals as compared with pre-project conditions.
- Project lifetime/closure conditions (agency write-off).

v. Energy Minimization and Greenhouse Gas Reduction Mitigation Plan

As part of the lease application to the SLC, an Energy Minimization and Greenhouse Gas Reduction Plan (GHG Plan) would need to be prepared. This plan would need to be approved by the California Coastal Commission (CCC) prior to submittal to the SLC. Consistent with CCC protocols, this plan would:

- Identify GHG emissions expected from the project's electricity use;
- Identify on-site and project-related measures to reduce expected operational emissions; and
- Identify potential off-site mitigation measures to offset remaining emissions.

GHG emissions associated with the project are a function of the amount of energy used by the project, the source of the energy, and the energy avoided as a result of the project's operations. Electricity use by the project for the production of desalinated water as well as the conveyance and delivery of the water will be the predominant source of project-related energy use. Certified emission factors for delivered electricity will be obtained from the utility's annual emissions report.

A consult with the project proponent to determine planned on-site and project-related GHG reduction measures that would reduce the project's potential GHG emissions. After discussions with the proponent, the consultant will research and recommend additional on-site GHG reduction measures. Offsite reductions of GHGs that are not part of the project would also be considered.

These measures would be cost-effective measures that the project would not otherwise be able to reduce. A schedule for the implementation of the project's GHG Plan will be developed and include the identification of the reduction measure, the process required for the measure, and the timing of the measure.

The consultant will organize and attend a pre-application meeting with CCC staff at their headquarters in San Francisco to discuss the GHG Plan to allow for input from the CCC to minimize any delays in the permitting process.

c. Timeframe

This process would be expected to take between 12 and 24 months. Restoration goals are often set with 2, 3, 5, or 10 year timeframes upon completion. Given the relatively small size of impact a 2-3 year lifespan seems reasonable.

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

Environmental Review Plan (ERP)

January 2013

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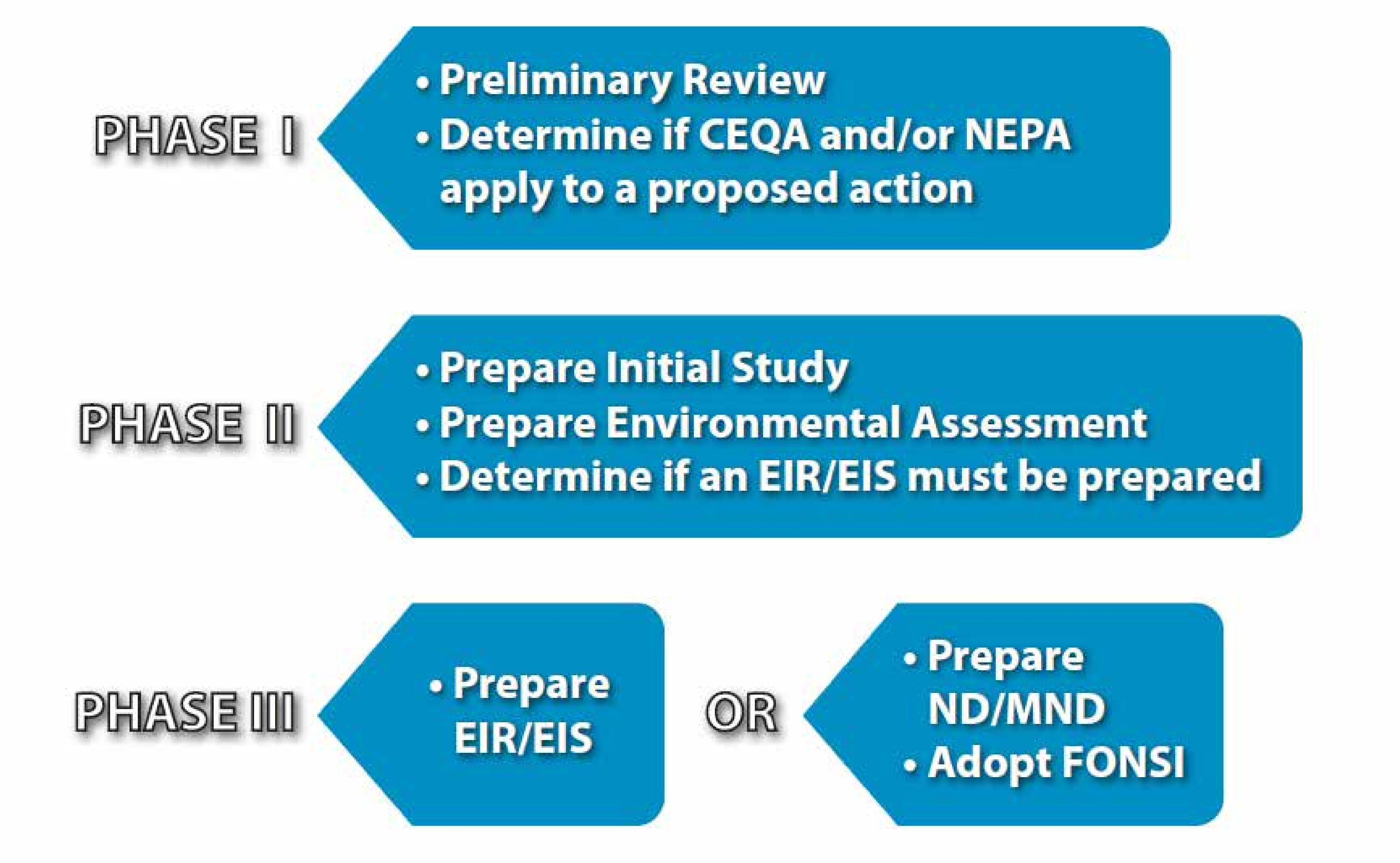
1. Introduction

To successfully navigate the California Environmental Quality Act/National Environmental Policy Act (CEQA/NEPA) compliance process, a lead agency must balance three considerations: an acceptable level of risk, time, and budget. Depending on the likelihood of public controversy, the complexity of the project, funding considerations, and agency involvement, lead agencies may make different decisions regarding the type of environmental documentation to prepare. This Environmental Review Plan (ERP) provides an overview of the CEQA and NEPA processes, makes recommendations based on available information about the proposed project, and discusses the pros and cons of taking one course of action versus another. The primary purpose of the ERP is to provide enough information about the environmental review process so that the West Basin Municipal Water District (WBMWD) can make decisions about what to prioritize, which studies to prepare, and what the likely schedule and cost implications are for the environmental documentation phase of the project.

The environmental process begins with determining the appropriate level of analysis, followed by scoping of environmental issues and preliminary design. Information derived from scoping then feeds into the preparation of environmental analyses and documentation. Public outreach can and should occur during scoping and ideally would continue through preparation of the environmental documentation. The CEQA process is designed to provide opportunities for public input throughout the process, but it may be necessary to supplement the environmental scoping process with a separate public outreach program to educate the public about the project and its purpose as well as gather input about the project along the way, which can inform the design of the project. The environmental process proceeds from preliminary review and preparation of an Initial Study, to the determination of which type of environmental document is required, and then to preparation of the document (see **Figure 1-1**, Overview of the CEQA/NEPA Process). Depending on the timing and sequencing details involved in the overall project design development, specific details or design options may not be fully known or decided within the time frame of the environmental analysis. Therefore, an important consideration in scoping and developing the EIR Project Description is providing sufficient flexibility and/or options to allow for evolutions in the project design.

Figure 1-1: Summary or Technical Studies and Data Needs



1.1. Objective

This Environmental Review Plan (ERP) is a component of the Ocean Water Desalination Program Master Plan (PMP). It defines and scope the environmental review process, including the technical data obtained through investigative studies related to siting and design. The ERP is intended to provide a "roadmap" of the environmental review process and outline the critical issues and decision points in that process. As noted below, the anticipated form of the environmental document is an Environmental Impact Report (EIR) under CEQA, which assumes that compliance with NEPA would be pursued separately for the federal components of the project. However, the scope of the environmental review should include options to process a joint environmental document (EIR/Environmental Impact Statement (EIS)). The EIR will be used by West Basin to support discretionary actions of the district as lead agency, and will also be used by other state agencies that have permitting and/or other approval responsibilities for the project.

2. Technical Studies and Data Needs

Data and technical studies to be used in preparation of the full-scale desalination plant EIR are available from a variety of sources, including information collected as part of the existing Demonstration Project, this PMP, as well as technical studies that are in progress and ongoing. These studies and others will be completed prior to or during EIR development and will support preparation of the EIR, while other studies are specifically required to be included as part of the EIR process. A summary of the technical studies that will be available and/or needed for preparation of the EIR is provided in **Table 2-1**.

Table 2-1: Summary of Technical Studies and Data Needs

Issue	EIR Study	Pre-EIR Study	Scope
Aesthetics (Visual Impacts)	X		Photo simulations of the desalination plant site shall be conducted to assess the visual impacts and effects on views from construction of the plant and appurtenant facilities.
Air Quality/Greenhouse Gas Emissions	X		The air quality and greenhouse gas (GHG) study shall evaluate the direct and indirect emissions associated with both construction and operation of the desalination plant and facilities, including an assessment of the indirect GHG emissions related to energy use. An Energy Minimization and GHG Reduction Plan should be prepared to address how the project relates to existing water supplies and what measures are needed to reduce energy-related GHG emissions.
Biological Resources		X	**Marine:** Studies that provide historical data on the marine environment in the vicinity of the RBGS and ESGS intake and outfall should be used to characterize the existing marine environment.
		X	**Impingement and Entrainment:** Impingement and entrainment studies are ongoing and will be available for use in the EIR to characterize effects from a screened intake. Supplemental information and analyses may be required.
		X	**Salinity Tolerance:** Salinity tolerance studies that assess acute and chronic toxicity

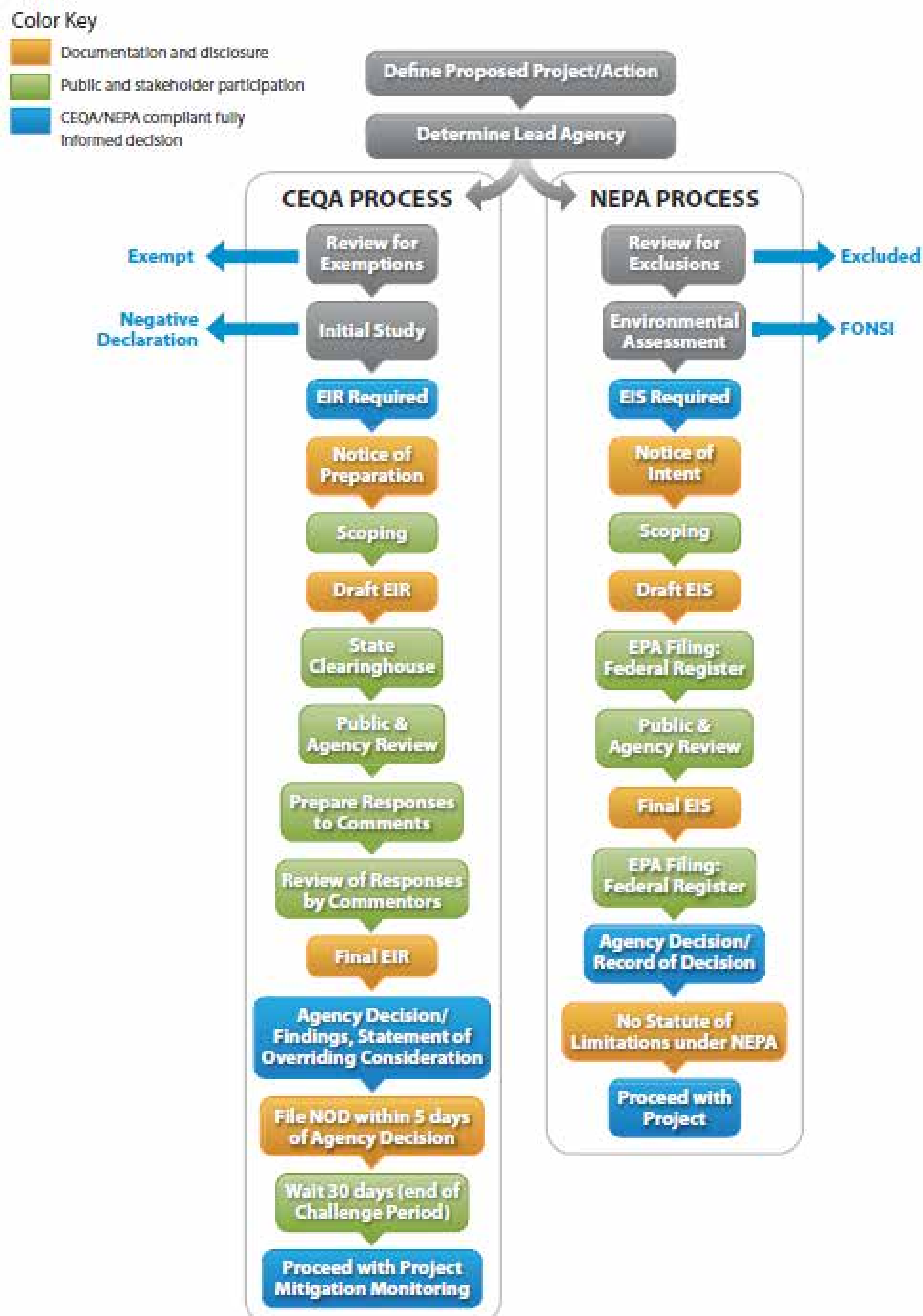
Issue	EIR Study	Pre-EIR Study	Scope
			levels of brine discharge on marine organisms are ongoing.
	X		**Terrestrial Biological Resources:** The EIR shall address terrestrial biological resources that may be affected at the plant sites and in locations where off-site conveyance facilities will be located. Included in the study will be an assessment of jurisdictional wetlands and waters in accordance with the criteria of the U.S. Army Corps of Engineers, the California Department of Fish and Game, and the California Coastal Commission.
Cultural Resources	X		EIR-level studies shall be conducted to assess potential effects on historic, cultural, and paleontological resources.
Geology/Soils		X	Geophysical/bathymetry/geotechnical studies will be provided to the EIR consultant for use in the analysis.
Hazards/Hazardous Materials		X	Hazardous materials investigations will be provided to the EIR consultant for use in the analysis.
Hydrology/Water Quality		X	Hydrology and receiving water hydrodynamic modeling studies will be provided to the EIR consultant. The information from these studies will be used to assess the effects of brine disposal on the receiving ocean waters, and to assess potential effects related to flooding, drainage, and water quality.
Noise (Acoustical Assessment)	X		The EIR-level studies shall address both construction and operational noise and vibration.
Transportation/Traffic	X		The EIR shall address short-term construction-related traffic and traffic disruption, as well as mitigation in the form of traffic control measures.

3. Environmental Review Plan

3.1. Scoping and Preliminary Design

Organization of the environmental review process involves decisions that weigh the advantages of having various elements of the environmental scoping, preliminary design, and public outreach efforts overlap. Performing these tasks simultaneously in the beginning of a project often requires more time up front to complete the scoping and initial design phases, but when these phases are complete, the project typically experiences less delay since information from public input and technical work has already been incorporated in the design of the project. **Figure 3-1**, shows the typical steps in the EIR/EIS process. Opportunities for public input on the scope of the environmental document occur at the Initial Study, during public review of the Draft EIR/EIS, during public review of the Final EIR/EIS, and at public hearings.

Figure 3-1: Overview of Environmental Issues



3.2. Defining the Project

One of the most important tasks in the overall environmental process is to adequately define the project. The Project Description must contain sufficient detail in order for the environmental analyses to be conducted, but should also provide flexibility to allow for consideration of variances in project design and for selection of different design options. Key considerations in developing the Project Description include the following elements.

3.2.1. Project Purpose and Objectives

It is important to carefully describe the purpose for the project, as well as the project objectives that underlie that purpose. Project purpose in this case is greatly influenced by local and regional water demand projections. Decisions on plant capacity or a capacity range need to be carefully integrated with and scaled to water supply master planning. The most fundamental policy issue likely to be raised in the environmental review process is population growth and development. Therefore, it is critically important that the analysis of project purpose demonstrate how the project will be carried out, and be consistent with water supply planning and how that planning is related to growth projections.

The project objectives need to clearly state the project's method of carrying out the stated purpose. Important to developing the project objectives is the understanding of their relationship to project alternatives. Under CEQA, a lead agency is required to examine a reasonable range of alternatives to the project that are capable of reducing or eliminating significant environmental effects while achieving the basic project objectives. The level of detail and specificity in discussing the project's purpose and objectives can greatly affect both the range and scope of project alternatives.

3.2.2. Intake and Discharge Options

Potential effects on marine biological resources from seawater intake systems are related to impingement and entrainment of marine organisms in the source water withdrawal. Impingement occurs when larger fishes and invertebrates are trapped against the seawater intake screens, while entrainment occurs when small planktonic organisms are drawn through the intake screens. Pressure and turbulence created from pumping processes result in damage or mortality of the affected organisms. Various design options may avoid or reduce these effects, such as intake screening technologies and subsurface intake systems. As noted in Section 4 of the PMP, such systems pose implementation challenges, such as the availability of suitable geophysical conditions, pumping/energy requirements, potential fouling and maintenance issues associated with screening and infiltration systems, and impacts from pump facilities (such as construction of beach wells along the coastline). Because of the wide range of considerations and effects of intake design options, the availability of specific studies and data that may be helpful in defining the appropriate range of alternative design options would have a significant influence on the scope of the environmental analysis.

Similarly, with discharge options, methods for dilution and dispersion of the brine vary in their potential effects and in their effectiveness. Information on the range of dilution and dispersion methods is outlined in Section 4 of the PMP. The resulting analysis in the EIR will depend greatly on the hydrodynamic modeling data and results. Information from the pilot studies on salinity tolerance, along with other published and available data, will also inform the analysis of effects on marine life. The EIR analysis should also carefully consider ongoing studies and policy development coming out of the State Water Resources Control Board efforts to amend the California Ocean Plan to address brine disposal.

3.2.3. Power Supply Options

Power supply options are addressed in Section 6 of the PMP and Power Development Memo, and generally consist of on-site generation or tie-in to the grid. Those basic options are important in the context of the EIR analysis, both from the standpoint of the Project Description and analysis of the physical effects of power supply facilities, but also from the standpoint of determining the project's air emissions. Of particular note is how the decision would affect the analysis of greenhouse gas (GHG) emissions. On-site generation would be a new source of emissions in the South Coast Air Basin, and would affect the baseline emission factor used in calculating the project's GHG contributions, as compared to the emissions factor associated with purchased electricity from Southern California Edison.

3.2.4. Alternative Site Selection

The timing of site selection of site options relative to the EIR has significant effects on the EIR scoping. Advancing two equivalent alternatives for analysis in the EIR phase of the project would add considerable additional effort and cost to the EIR and the supporting technical studies, based on the need to obtain data and analyze effects that are discrete to one site or the other.

Additional detail and consideration of issues that would be unique to a particular site would be needed. For example, land use and visual/aesthetic considerations would be framed differently for each of the alternative sites. In addition, the technical studies related to intake and discharge, and geophysical, hydrological, biological, and other resource areas would be expanded in scope, based on analysis of the two sites.

3.2.5. Conveyance Facilities

The EIR should include a discussion of all potential pipeline alignments and related conveyance facilities. It may be considered prudent to map and describe all potential alignments, and analyze them in detail in the EIR, even though not all of the cumulative alternative alignments would be built. This would enable more flexibility in the ultimate design and decision making.

3.2.6. Construction Methods/Schedule Sequence

The EIR should include information about the construction schedule and equipment; site location(s), including proximity to sensitive land uses, capacity/throughput, and other design criteria and/or specifications; site plan layout; nature of the inwater work and the federal nexus; permit requirements and reviewing agencies; and key CEQA and NEPA concerns or issues or areas of known controversy.

3.2.7. Operational Characteristics

The Project Description should also describe how the project is going to operate. If the project is going to use an existing intake and discharge system, or if a new or combined intake or discharge system is going to be developed, that information needs to be clearly discussed. Information about the marine-based project elements, including seafloor pipelines versus sub-seafloor tunneling, and screened open ocean intake versus subsurface intake options, should be discussed in the Project Description. If sufficient information about these details is not known, then assumptions need to be made by the lead agency so that the environmental analysis can be conducted. Sometimes when there are too many unknowns about the Project Description, the lead agency chooses to delay the project until sufficient preliminary design and engineering work can be completed in order to narrow the range of project design considerations that are in flux.

3.3. The CEQA Lead Agency

The CEQA lead agency is the agency responsible for proposing, carrying out, and approving the project. Usually this is the agency that owns the site or facility and that will be responsible for seeking funding and permitting actions necessary to complete the project. There is only one CEQA lead agency. According to CEQA Guidelines Section 15051(b)(1), "the lead agency will normally be the agency with general governmental powers, such as a city or county, rather than an agency with a single or limited purpose, such as an air pollution district or district which will provide a public service or public utility to the project." If more than one public agency equally meet the criteria above, the agency that will act first on the project in question will be the lead agency (CEQA Guidelines Section 15051(c)). If a lead agency cannot be chosen or if agencies cannot agree as to which agency is the lead agency for a project, the Office of Planning and Research (OPR) will resolve the dispute and choose the lead agency. It is anticipated that West Basin will be the CEQA lead agency for the full scale ocean water desalination facility.

3.4. The Federal Lead Agency

After choosing the CEQA lead agency and reviewing the Project Description, it is important to determine if there is a federal action being proposed that would require preparation of a NEPA document. In this case, if marine construction is involved, the most likely federal agency would be the U.S. Army Corps of Engineers (ACOE) because the work that is being proposed would likely 1) involve dredging or placement of fill material (triggering Section 404 of the Clean Water Act) and 2) be conducted in or over navigable waters of the U.S. (triggering Section 10 of the Rivers and Harbors Act). If a federal action is proposed, it is best to identify the action and the agency early in the process and discuss with the federal agency the type of environmental document to be prepared.

Based on recent actions by ACOE, it is anticipated that their federal action would be confined to the inwater work, and that they may elect not to encompass the entire project in their NEPA review. Therefore, in circumstances where the federal action is defined similarly to the local/state action, the most efficient environmental analysis document would be a joint CEQA/NEPA document; in this case, it may be more practical to approach CEQA and NEPA compliance separately. These decisions should be discussed in early consultation with the federal lead agency so that the environmental consultant can provide a scope of work and cost estimate for the appropriate CEQA/NEPA document(s). For purposes of outlining this process, the subsequent discussion will assume that a joint EIR/EIS document may be required.

Another benefit to early consultation is the opportunity to discuss key controversies for each lead agency and how to handle them. This type of communication may lead to solutions that neither agency would have developed on its own. A benefit to coordination is that the federal lead agency can assist the state lead agency in setting up consultation meetings with other federal agencies throughout the environmental scoping phase. These meetings are often valuable in gathering input from other agencies and defining their concerns so they can be addressed early on in the design of the project or in the approach to the environmental analysis.

3.5. Significance Thresholds

Section 15064.7 of the CEQA Guidelines discusses the establishment of significance thresholds and indicates that the lead agency has the discretion to establish or adopt significance thresholds, and indicates that the selected thresholds must be supported by substantial evidence. Subsection (c) further states that when adopting thresholds of significance, a lead agency may consider thresholds of significance previously adopted or recommended by other public agencies or recommended by experts, provided the decision of the lead agency to adopt such thresholds is supported by substantial evidence. Also, note that the lead agency may use a significance threshold it determines is applicable to the project. The three basic options available in determining appropriate significance thresholds are as follows:

OPTION 1: Select from existing adopted threshold that applies to the project—this usually is the simplest approach, and often involves use of the CEQA Guidelines sample checklist questions. It could also involve use of an established threshold from an agency with appropriate oversight, such as air emissions thresholds established by the governing air pollution control district or a local noise ordinance, etc. However, in many cases, the available thresholds may not be a good fit for a particular impact, and therefore may not be appropriate.

OPTION 2: Develop a unique standard or threshold for certain impacts of the project. In cases where there are no existing applicable thresholds available that would fit a particular impact or topic area, this option would entail developing a unique threshold for those project effects. As noted in Section 15064.7 of the CEQA Guidelines, the lead agency has the authority and responsibility to establish thresholds, and must provide substantial evidence as to why the threshold is appropriate and applicable. For impacts requiring such unique thresholds, it will be very important that substantial evidence supporting all of the thresholds used be contained within the Administrative Record for the EIR.

OPTION 3: The third approach would be to demonstrate that a particular environmental effect would not occur. For example, where it can be clearly shown that, either through impact-avoiding measures or other conditions, the project would not result in any change beyond baseline conditions, then no effect would occur. This approach obviates the need to establish a qualitative, quantitative, or numeric threshold because it avoids all potentially significant adverse effects.

It is also important to note that, to the extent that a joint document may be required, the CEQA and NEPA significance thresholds may differ. One example is that adopted guidance with regard to GHG emissions varies and the South Coast Air Quality Management District and the U.S. Environmental Protection Agency (EPA) have different guidance. Furthermore, if a joint document is to be prepared, an analysis of environmental justice, which is the potential for the project to have disproportionate impacts to low-income or minority communities, will have to be included. This is a federal requirement only. Because there are areas where the analysis in the documents will diverge, it is important to discuss these areas with the federal lead agency to make sure the federal significance thresholds are accounted for and will be handled appropriately. Decisions such as these may also influence the form of the document template and it is well worth the time to make these decisions early on rather than later.

3.6. Identification of Stakeholders

Since stakeholders will likely have some amount of influence over the proposed project, it is valuable to identify the key stakeholders early on in the process. Depending on their number and the controversy involved, it may be worthwhile to develop a public outreach plan. The public outreach plan can be part of the EIR scope or it can be contracted separately. If it is included as part of the environmental scope of work, it will be important for the selected environmental consultant to demonstrate competence and experience in public outreach, or to hire a subcontractor that specializes in public outreach. At a minimum, the public outreach effort would involve the following:

A. Notification – developing and distributing CEQA/NEPA public notices.

B. Logistics – Securing meeting venues, enlisting court reporters, making room arrangements, securing audio/visual equipment, and coordinating any vendor arrangements necessary for hosting meetings and hearings.

C. Materials Development – Includes meeting handouts, visuals, exhibits, presentations, sign-in sheets, nametags, comment cards, and speaker cards. Depending on the presence of local non-English-speaking attendees and their anticipated participation in the process, these may require translation services into multiple languages.

D. Attendance and Facilitation – Attend and facilitate scoping meetings and public hearings, including setup and breakdown of all meeting materials, exhibits, and signage.

E. Documentation – Preparation of a summary of comments received at the scoping meetings and public hearings.

The goal of the public outreach is to educate, inform, and gather input about the proposed project along the way so that the project proposal put forward for consideration by the agency decision-makers has credibility with the community and agency stakeholders.

3.7. Preliminary Engineering and Design

The preliminary engineering and design is critical to the environmental process. The reports, plans, and preliminary alternatives that come out of this effort are citable documents used in the initial preparation of the environmental documentation (e.g., the Initial Study). Studies prepared during preliminary engineering and design include investigational studies (e.g., screened intake effects, subsurface intake feasibility, offshore geotechnical studies, watershed surveys, brine dilution studies, salinity tolerance testing). Design-related studies might include the feasibility of various plant designs or water delivery pipeline route alternatives as well as coordination with utility providers for potential conflicts with underground utilities. Finally, there are the EIR specific studies, which are the technical analyses used to support the significance determinations made in the environmental document. As the project evolves, there will likely be draft and final versions of each of these reports. Some lead agencies want only the final versions to be part of the Administrative Record, so it is helpful to communicate this intent to the environmental consultant who will likely cite the draft versions of these reports if that is all that is initially available.

3.8. Identification of Alternatives

CEQA requires the analysis of a reasonable range of feasible alternatives. There is no specified number, but alternatives should be developed with input from the federal lead agency, if applicable. The development of alternatives to be considered in the environmental document is driven by the need to reduce the environmental impacts of the proposed project. This means that the alternatives developed during the preliminary engineering and design phase may not represent a sufficient range of alternatives from an environmental point of view. Engineering and design alternatives may be numerous, but if none reduces the significant environmental impacts of the proposed project, then they will not be considered adequate for the purposes of CEQA. Regulatory considerations from the California Coastal Act, the California Water Code, and related policies from the California Ocean Plan and other guidance documents typically involve comparison of alternatives to reduce or avoid adverse effects on the environment. Through the regulatory permitting and approval process, careful consideration of regulatory requirements, and how those requirements are interpreted by the permitting agencies, can be influenced by how the project is framed in relation to potential alternatives

Alternatives may also include non-desalination alternatives (e.g., conservation, curtailment, other water supply alternatives) that are tied to project purpose and need. It is important to consider and quantify WBMWD's efforts to manage demand and to maximize reuse, recycling, and conservation as part of an integrated strategy to address water supply reliability.

The alternatives analysis also includes a discussion of other alternatives considered but determined infeasible. This information likely can be drawn from preliminary engineering and design reports since a wider range of alternatives were probably considered initially and only a smaller subset were determined feasible to carry forward for environmental analysis.

If the project will require a NEPA document, it is critical to seek federal lead agency input on the least environmentally damaging practicable alternative because this will become the only alternative that the federal lead agency can permit. It may be advantageous, and may be the preference of the federal lead agency to limit the NEPA documentation to only those components of the project that involve a federal action, such as the subsurface intake and discharge facilities. If such an approach is chosen, the NEPA documentation can and should be prepared separately.

Finally, alternatives evaluated for CEQA do not have to be assessed at the same level of detail as the proposed project. However, as noted above, if alternative sites are examined and are expected to be carried forward for decision-makers' consideration, it may be necessary to fully examine these alternatives in an equal level of detail so that the decision-making body has the same level of information for each site and can make a fully informed decision.

3.9. Environmental Analyses and Documentation

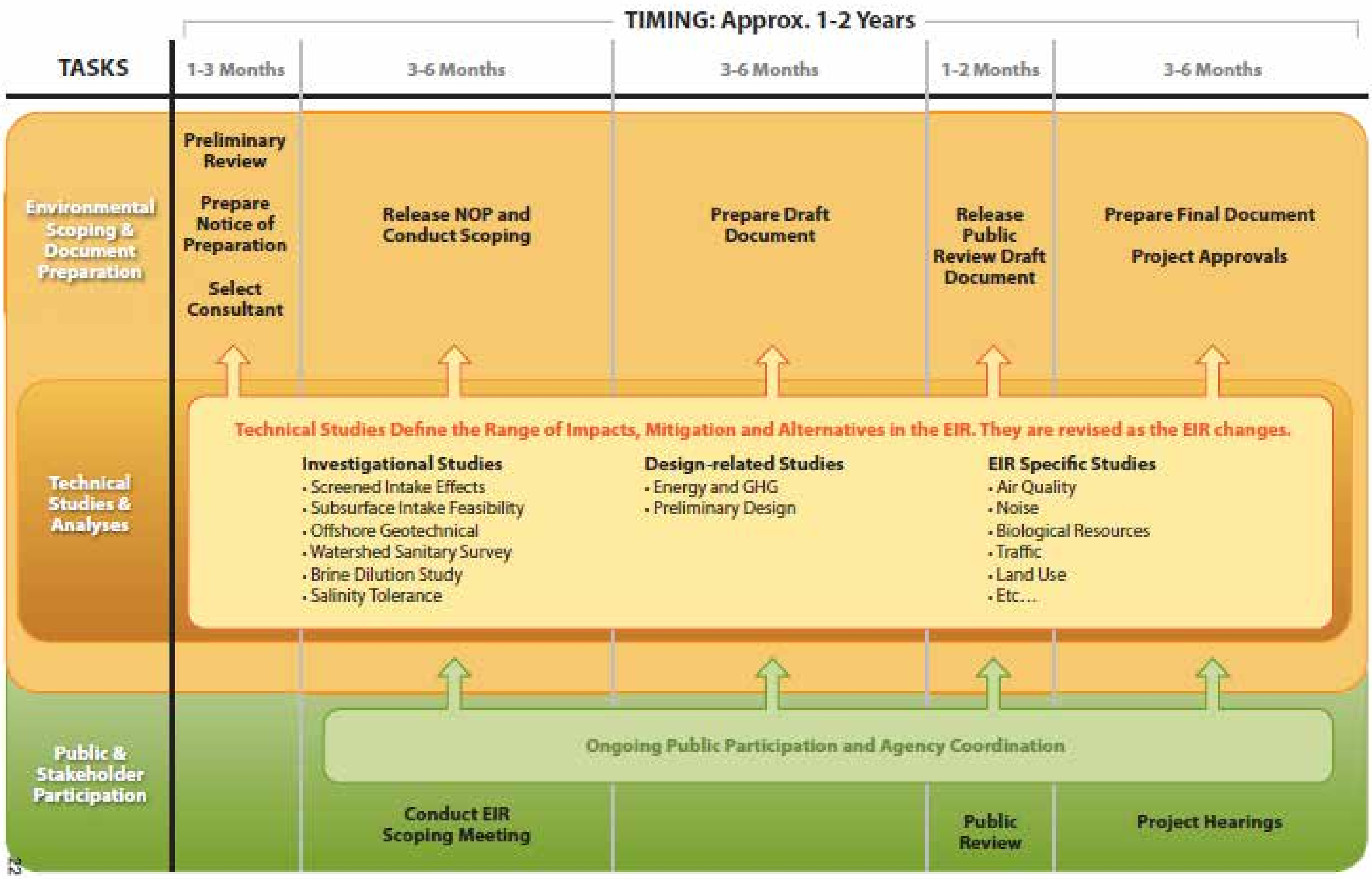
Once the preliminary engineering and constraints and investigational reports have been completed, and a preferred alternative has been identified, the environmental analysis can proceed. **Figure 3-1** shows the steps in the process, which begins with preparation of an Initial Study and Notice of Preparation (NOP). If it is a joint federal project, a Notice of Intent (NOI) will be prepared by the federal agency and circulated for a 30-day review period. The NOP and NOI review periods do not necessarily have to coincide, although it is helpful to reviewing agencies if they do. During the NOP/NOI review period, the lead agency would hold a scoping meeting(s) to gather public and agency input as to the scope of the environmental document. Then the technical studies would be started, as shown in **Table 3-1** below. **Figure 3-2**, Overview of Environmental Process Table, gives an overview of the anticipated environmental process and schedule. While the Initial Study is out for a 30-day public review, the lead agency should refine the Project Description and alternatives to be carried forward into the EIR, particularly in light of any new or unexpected comments from reviewing agencies.

After the Initial Study and NOP have been out for public review and comments have been received, the lead agency starts to prepare the draft environmental document. This process can take 3 to 6 months or longer, depending on the number of alternatives and the complexity of the analysis. If a joint CEQA/NEPA document is required, the alternatives must be analyzed in equal detail as the preferred project, and this can take more time since alternatives analyzed under CEQA alone do not require an equal level of detail. For each resource topic, the analysis in the environmental document includes the existing environmental setting, the impact analysis, significance determination prior to mitigation, mitigation measures, and the significance determination after application of mitigation.

Once the draft document is complete, it is distributed for public review for a minimum of 45 days. If it is a joint document, the federal lead agency may require a longer review period of 60 or 90 days. During the public review period, it is advisable to hold public meetings on the project to gather public comment.

Once the public review period has ended, the lead agency must respond in writing to comments (CEQA Guidelines Section 15088). This can be a lengthy process if there are an extraordinary number of comments. Sometimes comments on the document require modification to the project or to project mitigation. Depending on the extent of modification, and whether or not these modifications are covered in alternatives, the draft document may have to be recirculated for public review (CEQA Guidelines Section 15088.5).

Figure 3-2: Anticipated Environmental Schedule



If recirculation is not required, then the lead agency proceeds with preparation of the final environmental document. In addition, the lead agency must prepare the findings of fact (these represent the agency's rationale for adoption of the project as proposed) and a Statement of Overriding Considerations (why the decision-makers are approving the project and adopting the environmental document despite significant adverse environmental effects that are outweighed by other considerations). After the environmental document has been certified by the lead agency, and the project or an alternative are approved, the Notice of Determination (NOD) is filed with the County Clerk and OPR. After the NOD is filed, a statute of limitations to file a legal challenge runs for 30 days. If it is a joint document, then the federal lead agency prepares the Record of Decision (ROD) and files it in the Federal Register. Under NEPA, there is no statute of limitations to file a legal challenge. Once the ROD is filed, the project permit plan can be prepared. Ideally the permit plan would be prepared concurrent with the start of the environmental analysis so prior to this point the federal lead agency could start to review the permit application.

3.10. Key environmental Issues in Scope of Environmental Document

Below is **Table 3-1** that presents the key environmental issues that likely will need to be addressed in the EIR or EIS and will not be screened out in the Initial Study. Besides serving as a disclosure document, the Initial Study can be helpful in focusing the scope of the environmental document on the issues that are potentially significant and warrant more in-depth analysis. Therefore, it is recommended that an Initial Study be prepared as part of the initial scoping process for the EIR. In the table below, construction and operational impacts are identified, as well as the type of technical report that would be prepared and the timing of the analysis. Separate technical reports are proposed where it is anticipated that agencies may require review of the technical analysis separate from review of the EIR or EIS. The table is meant to serve as a guide for the anticipated scope of environmental work.

Table 3-1: Overview of Environmental Issues

<table>
<tr><th colspan="2">Resource Analysis</th></tr>
<tr><td colspan="2">Aesthetics</td></tr>
<tr><td colspan="2">Construction:
Short-term temporary impacts will be assessed, but most likely will not need to be considered significant given temporary nature of change. Exceptions would be long construction periods (over 1 year) where large equipment is visible to sensitive receptors (e.g., visitors to coastal recreational areas).
Operation:
· Public scenic views, introduction of new sources of light and glare, and compatibility of the proposed project with adjacent local aesthetic resources should be considered, particularly for coastal projects. Visual considerations and view blockage is of particular importance at the El Segundo site, due to the proximity of residential uses.
· Desirable to have photo simulations for visual impact assessments for CEQA/NEPA projects—including plant site, pump sites, or other aboveground features.
· Focus on the visual significance criteria found in CEQA, but consistency with relevant planning and visual impact criteria of the Cities of Redondo Beach and El Segundo, and relevant Local Coastal Programs and the California Coastal Act will also need to be assessed.
· Assess progressive view blockage or other anticipated changes.</td></tr>
<tr><td>Deliverable</td><td>Visual analysis in EIR, as chapter in document. Photo simulations included as EIR graphics.</td></tr>
<tr><td>Timing of Deliverable</td><td>EIR</td></tr>
<tr><td colspan="2">Air Quality</td></tr>
<tr><td colspan="2">Construction:
· Short-term air quality impacts during demolition, grading, and construction operations.
· Clearing, grading, excavating, and using heavy equipment or trucks creating fugitive dust.
· Evaluate vehicle exhaust emissions of commuting construction workers and trucks hauling equipment and materials.
· Application of asphalt and surface coatings creates reactive organic gas emissions, which are ozone precursors.
Operation:
· The operation of the proposed project involves three primary activities (some of which may be cumulative in nature) that would generate air emissions, all of which would occur at the desalination plant. These activities are:
o Electricity generation either on site or by others to operate the project facilities and equipment
o Electricity generation either on site or by others for consumption related to pump station operations
o Mobile source emissions from employee and truck delivery operations.
· Power supply options will need to be addressed, and implications of indirect emissions attributable to power generation within the Southern California Air Basin need to be discussed and analyzed.
Federal Conformity Analysis (NEPA only; preferred alternative only)
Under Section 176(c)(1) of the federal Clean Air Act (CAA), federal agencies that “engage in, support in any way, or provide financial assistance for, license</td></tr>
</table>

or permit, or approve any activity" must demonstrate that such actions do not interfere with state and local plans to bring an area into attainment with the National Ambient Air Quality Standards (NAAQS) (42 USC 7506(c)). To comply with the CAA in achieving the NAAQS, the California Air Resources Board (CARB) develops State Implementation Plans (SIPs) for federal non-attainment and maintenance areas. Conformity is required under the CAA to ensure that federally supported projects "conform to" the purpose of the SIP. Conformity to the purpose of the SIP means that federally supported activities will not cause new air quality violations, worsen existing violations, or delay the timely attainment of the relevant NAAQS. Therefore, it is the responsibility of each federal agency to make its own conformity determinations for its actions and to be able to justify its own application of the conformity requirements. The general conformity rule applies only to nonattainment and maintenance areas, so in Southern California, the rule applies because the South Coast Air Basin is a nonattainment area for ozone, oxides of nitrogen, particulate matter ($PM_{2.5}$ and PM_{10}), carbon monoxide, and nitrogen dioxide. Under the general conformity rule, conformity determinations are made on a project-by-project basis; however, the EPA included de minimis levels in the rule to serve as cutoff points to focus the federal actions likely to have the most significant impacts on air quality. The general conformity analysis is performed for the preferred alternatives and can be in the Draft or Final EIR/EIS. If the analysis is lengthy, it can be appended to the Draft or Final EIR/EIS.	
Deliverable	Air quality analysis in EIR; Federal Conformity Analysis, if applicable.
Timing of Deliverable	EIR
Biological Resources	
Terrestrial	
Construction and Operation: · Mostly disturbed, assuming pipeline alignments will be under existing public rights of way. · Focus on wetland mapping sufficient to support the EIR—detailed wetlands delineation report(s) and associated agency verification can be completed in permitting phase.	
Impingement and Entrainment	
Construction: · No impacts related to impingement and entrainment would occur during the construction phase of the project. **Operation:** · Effects related to proposed and alternative intake design and screening. · The project intake effects analysis should include an assessment of the proposed screened intake system relative to avoidance and minimization of impingement and entrainment effects. Information from pilot testing of the careened intake should be used to assess the level of impingement that would be anticipated for the appropriate flow rates and volumes of the facility. To evaluate entrainment effects, the source water should be analyzed to establish population characteristics (relative abundance) to determine the baseline conditions for potential impacts. The source water characterization examines the type and quantity of organisms that have the potential to encounter the seawater intake structure (the desalination feedwater) that could subsequently be impacted by the desalination plant operations. Samples of the source water are collected for laboratory processing, which typically consists of sorting (removing), identifying, and enumerating all larval fishes and invertebrates from the samples.	

The Empirical Transport Model (ETM) and/or other accepted protocol should be used to assess entrainment effects. The ETM is recommended and approved by the California Energy Commission, California Coastal Commission, Regional Water Quality Control Boards, and other regulatory and resources agencies for analyzing impacts to fisheries. Entrainment modeling is necessary to predict the regional effects on appropriate adult populations of affected fish species.	
Concentrated Brine Discharge to Ocean/Marine Impacts	
Construction: · No impacts related to brine discharge would occur during the construction phase of the project. **Operation:** · There will be elevated salinity levels entering the ocean due to the brine discharge from the desalination plant. Concentrations to the ocean are dependent on the operational parameters of the desalination plant, including flow rate and recovery ratio, and the flow rate and volume of dilution water. · The California Ocean Plan sets forth objectives for water quality characteristics, including: o Marine communities, including vertebrate, invertebrate, and plant species, shall not be degraded o Ocean discharges must be designed and operated in a manner that will maintain the indigenous marine life and a healthy and diverse marine community o Ocean discharges must be essentially free of substances that will accumulate to toxic levels in marine waters, sediments, or biota. · The EIR needs to consider the effects of the proposed amendments to the California Ocean Plan, and how they would influence the analysis and whether the project is consistent with the plan. · The EIR would cite available surveys of the marine resources in the area to determine the significance of impacts of brine disposal. · The EIR would cite salinity dispersal modeling to show less-than-significant or no impacts on marine life and ocean water quality. · The EIR would cite benthic community data to characterize the proposed sub-seafloor intake area. If sufficient data does not exist or has not been collected, additional surveys will be needed to collect site-specific data. · A defined sampling area would need to be determined based on flow calculations—design sampling plan, etc.	
Deliverable	Intake Effects Assessment Report Hydrodynamic Modeling/Brine Disposal Report Terrestrial and Marine Biological Resources Report(s)
Timing of Deliverable	EIR
Cultural Resources	
Construction: · A cultural resources report would be required in order to assess potential cultural resources (archaeological and historical) at the desalination facility site as well as along the pipeline alignment, as the federal lead agency would require that a Section 106 evaluation be done. · A records search would be recommended to identify whether or not any potentially significant cultural resources might exist within the vicinity of the proposed conveyance pipelines. · During trenching activities associated with the water conveyance pipeline, any discovery of buried historical/archaeological resources would require that construction be halted or diverted until a qualified archaeologist can evaluate the nature and significance of the finds.	

· This issue may be limited to discussing available data, acknowledging the developed nature of the study area, and developing monitoring protocols to be followed during construction. · For marine cultural analysis, conduct records of search of shipwrecks and other submerged cultural resources in the area. If no known submerged cultural resources, may be able to stop at this point. If there are submerged cultural resources in the area where work will be conducted, will have to assess whether magnetometer studies are needed or whether the federal lead agency will accept a Memorandum of Understanding that details how the marine cultural investigation will be conducted when a preferred alternative is chosen and the definitive study area is known. **Operation:** · No impacts are anticipated with project operation. Note: Marine cultural studies may or may not be needed depending on how subsurface intake alternatives are addressed.		
Paleontological Resources		
Construction: · Conduct paleontological records search for vertebrate fossils. · Obtain pertinent geological maps and literature on the geology and paleontology of the area and establish what rock units are present near and within the search area. · Identify the paleontological potential of each rock unit based on the most widely accepted methodology for categorizing such potential. · Disturbance of previously undisturbed sediments of at least some of the above noted formations may result in significant impacts under CEQA, requiring mitigation in the form of construction monitoring **Operation:** · No impacts are anticipated with project operation.		
Deliverable	Cultural Resources Report, Paleontological Report	
Timing of Deliverable	EIR	
Geology		
Construction: · Construction of the proposed seawater desalination facility and water delivery pipelines would require the analysis of the geologic features of the proposed project site. The project site should be assessed to determine the stability of the soils, including but not limited to the potential for earthquake shaking hazards, surface rupture, tsunami, shallow groundwater, and unstable soils (liquefaction, subsidence, lateral spread) to support the construction of the proposed seawater desalination facility. **Operation:** · While no impacts are expected related to project operation, the project could be subject to geological effects from earthquakes, unstable soils, etc., during operation. These sorts of impacts are usually addressed through engineering and design, and the expectation would be that geological impacts related to operations would be less than significant. **Marine Geology:** · Assumes offshore geotechnical investigations and bathymetric analysis is conducted as part of preliminary engineering and design to determine suitability		

of placement of structure on ocean floor.	
Deliverable	Geotechnical Report
Timing of Deliverable	ENG
GHGs	
Construction and Operation: · The project would produce potable water using reverse osmosis membrane separation. The treatment processes would not generate GHGs directly. · Because seawater desalination is generally more energy-intensive than most other water supply methods in California, the issue of energy use and GHG emissions is one of high profile throughout the regulatory process for desalination projects. It is therefore important to carefully study and quantify the potential GHG emissions of desalination proposals. The analysis should also consider a comparison of energy use with traditional water supply components, to the extent that desalinated water would replace or offset such supplies. The project is unlike most land use projects in terms of its GHG emissions profile, in that the vast majority of its GHG effects would be associated with indirect emissions related to site-generated or purchased electricity. Determining the appropriate CEQA significance threshold and assessing project effects will depend greatly on the policy approach to carbon emissions for the project. For example, if it is mandated that the project be carbon-free or carbon-neutral, the analysis would involve a different set of parameters for significance, as compared to a typical development project. WBMWD may elect to prepare a plan for minimization of energy use and/or reduction of carbon emissions that may be part of a voluntary commitment to account for indirect GHG emissions from the project.	
Deliverable	GHG analysis in EIR
Timing of Deliverable	EIR
Hazards and Hazardous Materials	
Construction and Operation: · The proposed seawater desalination facility would involve the storage, handling, and use of hazardous materials. The plant would therefore be required to comply with all the appropriate regulations concerning hazardous materials. Hazardous materials would likely be utilized for three components of desalination facility operation: 1) periodic cleaning of the reverse osmosis membranes that filter impurities from seawater, 2) treatment of potable product water, and 3) storage of diesel fuel for emergency backup electricity generators at the desalination plant (however, it may be determined that a redundant power supply would be implemented in lieu). Hazardous materials would need to be transported, stored, handled, and disposed of using all necessary precautions to avoid releases and associated impacts to facility employees, the local water table, and the general public. In accordance with applicable regulatory requirements, the desalination facility operator would be required to prepare an accident prevention plan. The means of transportation should also be addressed.	
Deliverable	Phase I Environmental Site Assessment for the proposed desalination plant site(s)
Timing of Deliverable	ENG
Hydrology and Water Quality	

<table>
<tr><td colspan="2">Construction and Operation:
· The hydrology and water quality section of the EIR will need to describe: 1) existing water quality, drainage, and groundwater conditions at the project site; 2) the applicable regulatory requirements; 3) potential changes in hydrologic and water quality conditions due to the proposed project and alternatives; 4) an assessment of the significance of potential project impacts; and 5) recommendations for mitigation measures, as necessary, to reduce these impacts to the extent feasible. The topics to be addressed in this section of the EIR, and associated analytical approach, are identified below.
o Product Water Quality: To be based on technical memos and other available information.
o Marine Water Quality: A major component of the marine water quality analysis will be review of brine dilution modeling to assess whether the concentrated residual brine will impact receiving waters.
o Surface Hydrology and Water Quality: Potential effects to surface hydrology and water quality near the proposed site of the desalination facility and pipeline alignments will be assessed. Potential impacts to drainage patterns and water quality resulting from construction, operation, and maintenance of the desalination plant and pipelines will be described and mitigation measures will be recommended to reduce any identified significant impacts. Would be helpful to have storm drain plan and capacity constraints in downstream conveyance.
o Flooding/Tsunami/Sea Level Rise: Federal Emergency Management Agency (FEMA) flood maps will be evaluated to determine whether the proposed sites are within the FEMA 100-year floodplain, and/or tsunami inundation mapping areas, and mitigation measures will be recommended if necessary. Assess how 100-year flood elevations and inundation areas would likely change due to predicted sea-level rise. May require design modifications.</td></tr>
<tr><td>Deliverable</td><td>Hydrology and water quality analysis in EIR; Water Supply Assessment to be conducted by water district.</td></tr>
<tr><td>Timing of Deliverable</td><td>EIR</td></tr>
<tr><td colspan="2">Land Use and Planning</td></tr>
<tr><td colspan="2">Construction and Operation:
· Description of existing land uses at and adjacent to each of the sites under consideration for the proposed project and alternatives.
· Identify sensitive land uses, if any.
· Incorporate land use and zoning maps for the project area, and discuss the project’s relationship with existing relevant plans and policies.
· Relationship of project elements to the California Coastal Zone will also be identified and mapped. All applicable adopted land use plans, policies, and regulations that relate to the proposed project will be identified and analyzed.
· The intent of the analysis will be to determine whether any of the project elements may affect existing and/or planned land uses in or around the project vicinity. Any conflicts with existing or planned land uses or with any adopted plans in the area will be identified and discussed.
· Focus will be on applicable land use plans and policies. It is not anticipated that approval from the California Energy Commission will be required as the proposed project does not fall within the categories of projects under that agency’s jurisdictional oversight.</td></tr>
<tr><td>Deliverable</td><td>Land use analysis in EIR</td></tr>
<tr><td>Timing of Deliverable</td><td>EIR</td></tr>
<tr><td colspan="2">Noise</td></tr>
<tr><td colspan="2">Construction:
· High ground-borne noise levels and other miscellaneous noise levels can be created by the construction equipment including heavy-duty trucks, backhoes,</td></tr>
</table>

bulldozers, excavators, front-end loaders, compactors, graders, and other heavy-duty equipment.

- Assess noise impacts in the grading and construction phase of the project.
- Assess potential for ground-borne vibration or ground-borne noise levels related to construction activities.

Operation:

- Assess noise effects from pumps and other noise-generating equipment, and their effects on surrounding sensitive receptors, including wildlife receptors, as appropriate.

Deliverable	Noise analysis in EIR
Timing of Deliverable	EIR

Population and Housing (Growth Inducement)

Construction:

- • Analyze number of new construction jobs created by the proposed project as a percentage of the local area and region.

Operation:

- • Infrastructure projects may have characteristics “which would remove obstacles to population growth” or “which may encourage and facilitate other activities that could significantly affect the environment, either individually or cumulatively” (14 CCR 15126.2(d)). In the specific example cited by the CEQA Guidelines, “a major expansion of a waste water treatment plant might ... allow for more construction in service areas” (14 CCR 15126.2(d)). Infrastructure projects may be found to be indirectly growth-inducing.
- • The EIR should discuss the potential for indirect growth inducement when the “sole reason to construct” an infrastructure improvement project “is to provide a catalyst for further development in the immediate area” (*City of Antioch v. City Council of the City of Pittsburg* 1986) as compared to the analysis required for a project “designed to accommodate a development whose growth-inducing impact had already been addressed” (*Merz v. Monterey County Board of Supervisors; California Court of Appeal* 1983).
- • The EIR should focus on the extent to which the proposed project would provide a catalyst for further development in the project’s service area as compared to the extent to which the proposed project has been designed to accommodate existing demand and planned development. Dependent on assessment of local and regional demand projections.
- • The construction of the proposed seawater desalination facility and associated capital improvement projects, such as new water pipelines, would increase the amount of locally produced drinking water supplied to the region. How that water is used in relation to existing imported water supplies is a key issue. Specifically, the EIR needs to address to what extent the project’s product water replaces imported water, for purposes of meeting existing and projected demand.
- • Analyze number of new permanent operations jobs created by the proposed project as a percentage of the local area and region.

Socioeconomics and Environmental Justice (NEPA only):

In 1994, President Clinton issued the “Executive Order on Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations” (Executive Order 12898) designed to focus attention on environmental and human health conditions in areas of high minority populations and low-income communities, and promote non-discrimination in federal programs and projects substantially affecting human health and the environment (59 FR 7629). The order requires the EPA and all other federal agencies (as well as state agencies receiving federal funds) to develop strategies to address this issue. The agencies are required to identify and address any disproportionately high and adverse human health or environmental effects of the programs, policies,

and activities on minority and/or low-income populations. Environmental justice considerations relate to the distributional patterns of high-minority and low-income populations on a regional basis in relation to the proposed project. **Construction:** · Would the project's construction disproportionately impact a low-income or minority community? Includes analysis of census regional, local, and census tract-level data to assess the communities located in proximity to the project site, their income, and the numbers of construction jobs that would be generated by the project in the area. **Operation:** · Would the project's operation disproportionately impact a low-income or minority community? Includes analysis of regional, local, and census tract-level data to assess the communities located in proximity to the project site, their income, and the numbers of permanent jobs that would be generated by the project in the area.	
Deliverable	Population and housing section in EIR; growth-inducement section in EIR; Environmental Justice for EIS, if applicable
Timing of Deliverable	EIR
Public Services and Utilities	
· Depending on the location of the proposed pipeline alignment, impacts to underground utilities may occur. If the installation of the proposed off-site pipelines would occur within existing street right-of-way, an assessment would be needed to determine if the pipes would consume underground space for utilities (telephone, cable television, electricity, small-diameter pipes) along the streets the pipeline is proposed to occupy. · The project may result in the need for additional solid waste disposal services. An assessment should be performed to determine which landfill has the capacity to accept construction debris from the proposed project. In addition, the applicant would prepare a Waste Reduction Plan for the construction waste generated from this project. · Public services and utilities, including law enforcement, fire protection, emergency medical services, wastewater services, water, solid waste, electricity and natural gas, schools, and parks and recreation, may be affected by the project, both in terms of service disruption during construction and potential increase in demand for services. This will require contacting these service providers with a questionnaire about potential impacts to their services or service area.	
Deliverable	Analysis of impacts to public services and utilities in EIR
Timing of Deliverable	EIR
Recreation	
Construction and Operation: · The proposed project does not include the construction or expansion of any recreational facilities that would adversely affect the environment. The proposed desalination facility would be sited on developed industrial land, which already limits coastal access and associated recreational uses. · However, additional impacts to marine recreational issues, such as beachfront, surf, and fishing, will have to be addressed in the environmental document. · Construction of the pipelines would potentially affect the use of existing neighborhood and regional parks or recreational facilities depending on the alignment of the conveyance pipelines, and will have to be evaluated accordingly.	

Deliverable	Analysis of recreational impacts in EIR
Timing of Deliverable	EIR
Traffic and Circulation	
Construction and Operation: · Include descriptions of the local roadway network in the vicinity of the alternative sites and pipeline alignments. · Collect and document existing daily traffic volumes on these roadways. · Assess the effects of construction- and operation-related project traffic on existing transportation and traffic. · Issues to be addressed in the analysis include: potential traffic impacts to the local roadway system caused by construction-related project traffic, potential traffic impacts to the local roadway system caused by operation-related project traffic, and potential effects to local transportation systems caused by disruption of the roadway network caused by construction of ancillary facilities such as pipelines.	
Deliverable	Traffic Impact Analysis (typically a separate report, but can also be analysis in EIR)
Timing of Deliverable	EIR
Other Sections	
Energy · • Energy-related implications associated with the implementation of the project will be evaluated in the EIR with respect to: energy demand during the construction process, ongoing project operational energy use, potential effects of the project on local and regional energy supplies and infrastructure, and the effect of the project on peak and base-period energy demand. · • The Energy Minimization and GHG Reduction Study is expected to provide detailed and thorough analyses of projected energy demand of facility operation, as well as options to reduce demand by various amounts through the implementation of a range of different measures (e.g., energy-conserving plant equipment, green building design, alternative energy power generation, etc.). **Cumulative Impacts** The cumulative impact analysis analyzes the incremental impact of a project in connection with other projects causing related impacts. The cumulative impact analysis can be integrated into each resource chapter (the benefit of this organization is that the analysis will be completed at the time the individual impact analysis is conducted), or it can be evaluated in a separate chapter at the end of the document that usually ends up being prepared later. The cumulative impact analysis methodology and geographic scope varies by resource, so it can be a more complicated analysis to conduct because one size does not fit all areas of analysis. “The cumulative impact from several projects is the change in the environment which results from the incremental impact of the project when added to other closely related past, present, and reasonably foreseeable probably future projects. Cumulative impacts can result from individually minor but collectively significant projects taking place over a period of time” (CEQA Guidelines Section 15355(b)). Even if a tiny portion of the cumulative impact is caused by the proposed project, the EIR must analyze it. The ultimate goal of the analysis is to determine whether the proposed project’s incremental contribution is “cumulatively considerable.” A project that has less-than-significant individual effects may be cumulatively considerable when combined with other projects. **Alternatives Analysis** In accordance with CEQA, the reasonable range of alternatives to be evaluated in the EIR will focus on avoiding or reducing any significant impacts that may	

be identified for the proposed project, while feasibly attaining most of the project objectives. Alternatives can be developed by combining potential desalination plant sites, potential intake systems, and several potential pipeline routes. Since this project is likely to receive a high level of public scrutiny and will be subject to a rigorous permitting process, and the project will likely be subject to NEPA compliance, the desalination alternatives selected for analysis in the environmental document should be comprehensive, and may benefit from a separate screening study that outlines the feasibility of, or rationale for rejecting, various alternatives that have been considered in the planning and design process. The discussion of non-desalination alternatives (e.g., conservation, curtailment, and other water supply alternatives) in the EIR will be based on the WBMWD planning documents, discussion of alternatives, and any updated information from WBMWD about the status of these alternatives. It is assumed that as part of the preliminary engineering, the seawater intake pipeline, the brine discharge pipeline, the product water delivery pipeline, the sanitary sewer line, and any new distribution lines and interties would be evaluated, and only viable routes carried forward for analysis in the EIR.

Notes:
ENG = Timing is during preliminary engineering/design.
EIR = Timing is during environmental documentation phase.
Agricultural Resources and Forestry Resources and Mineral Resources are expected to be eliminated (in Initial Study) from requiring further analysis in EIR.

4. Risks to Schedule, Document Defensibility, and Budget Considerations

There are various risks to schedule, document defensibility, and the budget during the environmental process. For example, providing a complete and comprehensive Project Description, well-reasoned project objectives, and a reasonable range of project alternatives, as well as other issues as described in this section, are important in appropriately addressing concerns that may be raised by the public and interested parties, and can help avoid potential litigation risks.

Document defensibility can also be at risk if there hasn't been sufficient stakeholder involvement because then opponents use the document to find flaws and delay the project. Furthermore, taking too much creative license with CEQA or NEPA, which could include not following procedural requirements or leaving out critical sections of the document, are easy red flags for opponents to find and use to challenge the document.

Budgets are always affected by unanticipated delays, multiple revisions to the Project Description necessitating new and revised technical analyses, or the addition of new alternatives late in the environmental analysis.

In conclusion, a critical first step to avoiding these risks is ensuring that the scoping of the work effort is done in a comprehensive manner, and that the project team selected to execute the work has familiarity and experience in dealing with the unique environmental and regulatory issues associated with seawater desalination.

West Basin Municipal Water District

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Ocean Water Desalination Program Master Plan (PMP)

Project Permitting Plan (PPP)

January 2013

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1. Introduction

1.1. Objective

The Project Permitting Plan (PPP) addresses the key regulatory permits that will need to be obtained by West Basin and the Metropolitan Water District of Southern California (MWD) in order to complete the desalination project. Critical issues for each permit are identified, along with additional data and studies needed in order to prepare the permit. Content for permit applications and suggestions to negotiate favorable permit provisions and conditions are also discussed. Finally, this plan will also define the scope and budget for the implementation of the engineering support studies needed for project permitting. This plan broadly discusses but does not focus on general construction permits that would be needed. Discussions with lead and supporting Agencies will be critical to refining the information presented in the PPP and honing in on which of the discretionary studies will truly be needed.

Alternatives of each key project component (intake, pretreatment, reverse osmosis desalination system, post-treatment and product delivery) will be subjected to a more detailed environmental review during the environmental impact report (EIR) phase of the project. Land use, lease agreements, lease modifications, and easements will also need to be further identified. While these items are integral to the permitting process, EIR and entitlements will be discussed separately in the *Environmental Review Plan (ERP)* and *Project Entitlement Acquisition Plan (PEAP)* respectively.

2. Anticipated Project Permits and Supporting Studies

The following Sections identify the permits that are anticipated to be required for West Basin's proposed Ocean Water Desalination Facility. The permit discussions are categorized by permit type. Most permits are issued by a lead agency, but can require coordination with multiple agencies, as discussed in each Section below.

2.1. Domestic Water Supply Permit Amendment (DWSP)

2.1.1. Permit Overview and Lead Agency

The 1974 Federal Safe Drinking Water Act (SDWA) along with the 1986 and 1996 amendments provide the statutory basis for the water supply permit program. The SDWA allows the US Environmental Protection Agency (USEPA) to delegate their authority to state governments, enabling states to perform many of the permitting, administrative, and enforcement aspects of the water supply program.

The California Department of Public Health (CDPH) is responsible for developing, implementing, and enforcing of the drinking water laws of California. A water system that intends to serve potable drinking water to the public may not operate without having secured a domestic water supply permit (DWSP) from CDPH. The field operations branch staff perform field inspections, issue operating permits, review plans and specifications for new facilities, and review water quality monitoring results. The CDPH works with the USEPA, the State Water Resources Control Board, Regional Water Quality Control Boards (RWQCBs), and a wide variety of other parties interested in the protection of drinking water supplies.

The State water supply permit is a one-time permit and is issued prior to the operation of a drinking water system. In order to ensure that the system will be able to provide a safe and reliable supply of drinking water with the capability of meeting regulatory requirements, CDPH will conduct a thorough evaluation of the proposed system before issuing a water supply permit.

2.1.2. Permit Requirements and Process

Because the development of a new seawater desalination plant would represent West Basin's first drinking water treatment infrastructure, a new CDPH-issued DWSP must be obtained. In addition to the desalination plant itself, the DWSP encompasses all of the associated drinking water conveyance, storage, and appurtenant equipment, as well. The first step in this process is the preparation and submittal of a 1-page Domestic Water

Supply Permit Application Form. This action is the procedural equivalent of opening a ticket with CDPH, initiating the subsequent process of working with the CDPH to secure the permit. While there are relatively few requirements for obtaining a DWSP that are specified in the California Code of Regulations, it is important to note that the CDPH has broad authority over the issuance of permits. Thus, the local District Engineer, who is ultimately responsible for approving the permit amendment, has wide discretionary latitude to require studies and impose both conceptual and detailed design features as precursors for permit approval. Consequently, obtaining CDPH approval is one of the most extensive and time-consuming steps in the implementation of a seawater desalination plant.

A summary of the studies and reports that may be necessary to obtain CDPH approval for a DWSP amendment for a new seawater desalination plant are summarized in **Table 2-1**. The table differentiates those elements that are specifically required by mandate from those that are likely to be required by the CDPH as conditions for permit approval. For those studies, reports, and analyses not specifically mandated under California regulatory code, the CDPH has the discretion to vary the requirements of those elements. Additional studies and reports may be required at the discretion of the CDPH.

In some cases, the CDPH also has the authority to waive permit requirements under certain conditions. For example, the CDPH allowed Sand City to forego the preparation of a watershed sanitary survey in exchange for achieving a higher level of pathogen removal and inactivation through the treatment process of its seawater desalination plant. Due to the anticipated complexity, time, and cost of conducting the watershed sanitary survey for a small 300,000 gpd plant, the City considered this to a beneficial agreement with the CDPH.

In addition to the permit components summarized in **Table 2-1**, the CDPH will also require a review of the preliminary design report and associated drawings for the desalination plant and all related infrastructure (e.g., conveyance, storage tanks, etc.), as well as alarm and control descriptions. The CDPH will provide comments on the design, requiring any changes it determines to be necessary as a condition of permit approval. It is also likely that a staff engineer for the CDPH will field verify the control logic and alarms.

Table 2-1: Summary of DWSP Amendment Components

Permit Component	Required?	Description / Necessary Element
Technical, Managerial, and Financial (TMF) Capacity	Required	Detailed information to demonstrate to the CDPH that West Basin has technical, managerial, and financial capacity to deliver potable drinking water in accordance with state regulations
Technical / Engineering Report	Required	Detailed information about the desalination facility source water, treatment processes, and design, as well as new conveyance and storage associated with the plant and new supply
Operations Plan	Required	Detailed information about the desalination plant and operations, including system descriptions, design criteria, chemical usage, water quality monitoring, control systems, alarms, staffing, and operational procedures (e.g., startup, shutdown, etc.)
Water Quality Emergency Notification Plan	Required	Description of notification procedures to be followed in the event of a water quality emergency, including contact information for key water agency and CDPH personnel, as well as notification language to be used
Distribution System Monitoring Plan		Monitoring plan for compliance with regulations application to distribution system water quality, including the Stage 2 Disinfectants and Disinfection By-Products Rule, the Total Coliform Rule, and Lead & Copper Rule
Watershed Sanitary Survey		Source water characterization, treatment plant influent specifications, finished water quality specifications, inventory of potential pollution sources, water quality monitoring plant (source and finished water), and treatment performance
Drinking Water Source Assessment and Protection (DWSAP) Program Documentation		Delineation of the area around a drinking water source through which contaminants might move and reach that drinking water supply, an inventory of possible contaminating activities (PCAs) that might lead to the release of microbiological or chemical contaminants within the delineated area, and a determination of the PCAs to which the drinking water source is most vulnerable
Tracer Study		Determine pathogen inactivation (i.e., CT) achieved in pipelines, treatment processes, and/or storage (e.g., clearwells) in which primary disinfection is applied
CT Analysis		Detailed description of the use of the treatment plant processes to achieve required pathogen control levels (i.e., for *Giardia*, *Cryptosporidium*, and virus) via a combination of physical removal and physical / chemical inactivation

Permit Component	Required?	Description / Necessary Element
Operations Maintenance and Monitoring Plan	Required at CDPH Discretion	Detailed operations and maintenance plan for both the desalination plant, including water quality sampling
Chlorine / Chloramine Residual Stability Analysis	Required at CDPH Discretion	Analysis of the decay profile of chlorine and chloramines used in secondary (i.e., residual) disinfection in desalinated seawater
DBP Formation and Blending Analysis	Required at CDPH Discretion	Analysis of the formation of disinfection by-products in desalinated seawater supplies, and the impact of blending on DBP levels in distributed supplies
Corrosion Control Analysis	Required at CDPH Discretion	Assessment of corrosion potential of desalinated seawater (and blended supplies, as applicable) and measures to control corrosion in the distribution system and household plumbing
Algal Toxin Monitoring, Rejection, and Control Analysis	Required at CDPH Discretion	Assessment of algal toxin monitoring and control in the desalination plant
Endocrine Disruptor Monitoring, Rejection, and Control Analysis	Required at CDPH Discretion	Assessment of endocrine disruptor monitoring and control in the desalination plant
Seawater Desalination Integration Plan	Required at CDPH Discretion	Strategic approach for introducing desalinated seawater into the existing system, including blending strategy, public notification, and water quality monitoring (as applicable)
Volumetric Concentration Factor (VCF) Testing	Conditionally Required at CDPH Discretion	Site-specific assessment of the magnitude of particulate concentration associated with a membrane filtration system (i.e., microfiltration (MF) or ultrafiltration (UF))
Integrity Verification Program (IVP)	Conditionally Required at CDPH Discretion	Document describing the site-specific monitoring MF/UF system integrity, including integrity test procedures, calculations, as-needed corrective action, and reporting

2.1.3. Critical Issues

There are two critical issues associated with obtaining a DWSP, both of which are interconnected. First, depending on CDPH work backlog, review and approval of submittals may require more time than expected, potentially resulting in project delays. Consequently, it is important the CDPH be involved very early in the planning and design process, and that the District Engineer is kept up-to-date on the project schedule. It is also important to receive CDPH feedback on the anticipated review duration for the various required submittals early in the process when developing a schedule. It is likewise important to clarify the required permit elements with the CDPH very early in the process, as well as to document these discussions. Because the CDPH has such broad discretionary authority over imposing permit requirements, it is essential to get formal CDPH input into the required elements at the project outset to avoid delays due to otherwise unanticipated and unarticulated studies, reports, and analyses.

2.1.4. Permit Documents

The following documents provide the forms, instructions, and additional guidance needed for this permit and are included in **Appendix 5:A**.

- DWSP Application Form
- DWSP Applicant Instructions
- TMF Assessment Form
- TMF Criteria
- Water Quality Emergency Notification Plan Form
- DWSAP Program overview and guidance document

2.2. National Pollution Discharge Elimination System (NPDES) Permit

2.2.1. Permit Overview and Lead Agency

The 1972 amendments to the Federal Water Pollution Control Act (known as the Clean Water Act or CWA) provide the statutory basis for the National Pollution Discharge Elimination System (NPDES) permit program and the basic structure for regulating the discharge of pollutants from point sources to waters of the United States. Section 402 requires the USEPA to develop and implement the NPDES program. The CWA gives the USEPA the authority to set effluent limits on an industry-wide basis and on a water quality basis, which ensures the protection of receiving waters. Brine and concentrate disposal from desalination plants are regulated as a point source of pollution through the NPDES Permit Program. The CWA allows the USEPA to delegate the authority to state governments, enabling states to perform many of the permitting, administrative, and enforcement aspects of the NPDES Program. In states that have been authorized to implement CWA programs, USEPA still retains oversight responsibilities.

In California, the NPDES is enforced by the Regional Water Quality Control Boards. NPDES permits almost exclusively regulate the discharge of pollutants from point sources, such as industrial effluent from an outfall pipe or stormwater from a municipal storm system. This would also include concentrate discharges from the desalination plant. In addition, NPDES permits are also used to regulate intakes used by thermal power plants that use ocean water for cooling. A NPDES permit for these facilities must determine that these systems use the best technology available to minimize adverse impacts due to their location, design, construction, and capacity. Desalination facilities proposing to reuse existing infrastructure assets may therefore be subject to NPDES requirements associated with their intakes. A NPDES General Construction Permit is also required for stormwater runoff associated with construction activity. The permit(s) must be adopted by the State or Regional Water Quality Control Board (RWQCB) before any activity can occur.

In addition to the RWQCB, other Agencies play a consultation role providing feedback before issuance of the permit. The U.S. Fish & Wildlife Service (USFWS) provides consultation on impacts to fish and wildlife and the California Department of Fish and Game (CDFG) may also review the NPDES permit.

2.2.2. Permit Requirements and Process

An application must be submitted to the appropriate Regional Water Board, in this case the Los Angeles Regional Water Quality Control Board (LARWQCB). The application must describe the wastes to be discharged, the setting for the discharge, and the method of treatment or containment. The LARWQCB determines if the discharge is to be permitted or prohibited and may request additional information. If a permit is needed and the application is complete, staff prepares a draft, sends out a notice for a 30-day public comment period and holds a public hearing. A majority vote of the Water Board members is required to adopt the permit. USEPA has 30 days to object to the draft permit. In a permit modification, only the conditions subject to change are reconsidered while all other permit conditions are allowed to remain in effect. Major permit modifications require public notice, while public notice associated with minor permit modifications would be at the discretion of the LARWCB.

The 2009 California Ocean Plan sets standards for the discharge of waste to ocean water in order to prevent degradation to marine species and to protect public health. There are currently no Ocean Plan Water Quality Objectives that apply specifically to brine waste discharges from desalination plants; however, an amendment to the Ocean Plan is in progress and is likely to contain a narrative objective for salinity as well as limits on impingement and entrainment from desalination intakes. Expert panels, studies, and public information workshops that will inform this amendment to the Ocean Plan have been ongoing. It is anticipated that the Ocean Plan amendment will be completed by late 2013. It is important to note that the final version of this amendment could significantly affect the permitting process that is described in this technical memorandum. In addition, the State Water Resources Control Board (SWRCB) is also attempting to collaborate with other applicable agencies (e.g., the California Coastal Commission (CCC), State Land

Commission (SLC), etc.) to establish more consistent state regulatory policies; although this effort is expected to result in some degree of streamlining, these resulting changes will likewise have some impact on the permitting process discussed in this document.

Finally, while there is some uncertainty as to what additional requirements will be in the Ocean Plan Amendments, the existing studies at the OWDDF appear to parallel the expert panels and topics of interest by the SWRCB. Previous experience has shown that good faith efforts to appropriately characterize water quality and associated impacts have been taken into consideration by the regulating entity.

Table 2-2: Summary of NDPES Permit or Amendment Studies and Plans

Study/Plan	Description	Notes
Intake Impingement and Entrainment Study	Determine the baseline conditions and potential impingement and entrainment impacts to marine organisms at the seawater intake for the desalination plant via sampling and monitoring.	This study is already being performed
Flow, Impingement and Entrainment Minimization Plan	Identification of mitigation measures to minimize the impacts to marine organisms at the desalination plant intake.	
Wetland Restoration Plan for Impingement and Entrainment Mitigation	Identification and implementation of one or more activities which preserve, restore, and enhance existing wetlands, lagoons or other high-productivity near-shore coastal areas located in the vicinity of the project site.	This approach may change pending adoption of the SWRCB Desalination Policy.
Hydrodynamic Modeling of Desalination Plant Discharge	Investigate the potential impact of hypersaline desalination plant discharge via an outfall at the project site	
Characterization of Desalination Plant Discharge	Determine compliance requirements with Numeric Water Quality Objectives of 2009 California Ocean Plan	
Whole Effluent Toxicity Study of Desalination Plant Discharge	Determine whether discharge from the desalination plant will disrupt the integrity of the receiving ecosystem	Existing study is being completed at the OWDDF. Expected completion - Fall 2012.

Study/Plan	Description	Notes
Discharge Salinity Tolerance Investigation	Predict the salinity range of the discharge (including the R.O. concentrate), evaluate if the salinity will impact biological resources, and evaluate mitigation of these impacts	Existing study is being completed at the OWDDF. Expected completion - Fall 2012.
Desalination Plant Discharge Monitoring Plan	Establish monitoring and reporting requirements	

In addition to the discharge permit, the following are steps needed for the NPDES General Construction Permit for stormwater runoff associated with construction activity:

- Compile data on content and anticipated rate of discharge
- Submit a Notice of Intent (NOI)
- Prepare a Storm Water Pollution Prevention Plan (SWPPP). The SWPPP should specify best management practices (BMPs) and pollution prevention monitoring
- Implement monitoring plan with monthly reports to RWQCB
  - Submit a Notice of Termination upon completion of the project

2.2.3. Critical Issues

Salinity issues may become a key point of discussion if there are limited dilution opportunities due to low or infrequent flows. The level of local mixing, dispersion, and dilution and the presence of any special status species should be understood in order to better facilitate discussions with the LARWQCB. It will be important to ensure that concentration based limits or biomonitoring are set at appropriate locations that are reflective of coastal conditions (rather than in concentrated locations such as the inside of the discharge pipe).

2.2.4. Permit Documents

The following documents provide the forms, instructions, and additional guidance needed for this permit and are included in **Appendix 5:A**.

- Federal National Pollutant Discharge Elimination System (NPDES) permit application form
- RWQCB Permit Application Form 200
- Certification Requirement For Application
- Permit Writer's Manual

- Notice of Intent Form
  - Notice of Intent Instructions

2.3. Coastal Development Permit / Local Program / Harbor Access Permits

2.3.1. Permit Overview and Lead Agency

The California Coastal Act (CCA) was enacted by the Legislature in 1976 to ensure long-term protection of the State's 1,100 miles of coastline. The CCA includes polices related to the following:

- Protection and expansion of public access to the shoreline
- Protection, enhancement, and restoration of important habitats and biological communities
- Protection of areas of the coast used for priority purposes, such as coastal recreation, coastal agriculture, and others
- Preventing sprawl
- Providing public education about the coast and coastal issues
- Establishing local controls for coastal development

The CCC is charged with implementing the CCA in the context of these policies. As a result, the CCC has authority to approve all proposed development within the Coastal Zone, an area encompassing the coastline and spanning a distance of three miles offshore and up to five miles inland. In order to facilitate the project review and approval process, proponents must apply for a Coastal Development Permit (CDP). Although in some cases coastal municipalities are empowered with development control authority through pre-approved Local Development Programs that are consistent with the CCA, the CCC retains ultimate approval authority over all major public works projects, which includes seawater desalination plants. The City of El Segundo and City of Redondo Beach have Local Coastal Programs, including a Coastal Zone Specific Plan which provides detailed land use proposals as well as ordinances for the City's coastal zone. Therefore, City of El Segundo and City of Redondo Beach would complete its permit review separate from any review by the Coastal Commission, although the processes may be coordinated and generally require similar information.

Because the CCC takes into account approvals granted by other agencies, along with the corresponding application forms and supporting materials, the CDP is typically one of the last permits awarded to any project. Accordingly, the CCC often conducts reviews in conjunction with other agencies, such as the California Department of Fish and Game, the United States Fish and Wildlife Service, the Regional Water Quality Control Board, etc. (Note that some permits cannot precede the CDP. For example, the Domestic Water Supply Permit issued by the CDPH cannot be issued until the desalination plant concept and detailed design are nearly complete, steps which would not occur unless the project was previously approved by the CCC.)

2.3.2. Permit Requirements and Process

Project proponents must complete the CDP Application Form, which stipulates specific information that must be provided in conjunction with the permit application, including: site development details, location, adjacent land use, site maps, the presence of historic and/or cultural resources. Most of this information is provided directly on the application form in responses to short-answer questions, many of which are Yes/No boxes. A number of attachments are also specifically required by the application form, as summarized in **Table 2-3**. Additional details on the requirements for each of the items listed in the table are included on the application form.

Table 2-3: Summary of Requirements CDP Application Attachments

No.	Item
1	Proof of applicants legal interest in the property
2	Assessor's parcel map
3	Copies required local approvals
4	Stamped envelopes addressed to each property owner and occupant of property situated within 100 feet of the property lines of the project site (excluding roads), along with a list containing the names, addresses and assessor's parcel numbers of same.
5	Stamped, addressed envelopes and a list of names and addresses of all other parties known to the applicant to be interested in the proposed development
6	A vicinity or location map with the project site clearly marked
7	Copies of plans drawn to scale, including (as applicable): 1.Site plans 2.Floor plans 3.Building elevations 4.Grading, drainage, and erosion control plans 5.Landscape plans 6.Septic system plans
8	If *septic systems* are proposed: Evidence of County or Regional Water Quality Control Board Approval If *water wells* are proposed: Evidence of County review and approval

No.	Item
9	A copy of any Draft or Final Negative Declaration, Environmental Impact Report (EIR), or Environmental Impact Statement (EIS) prepared for the project, including comments and responses
10	Verification of all other permits, permission, or approvals either applied for, or granted by, any public agency; examples include (but are not limited to) the following: 7.California Department of Fish and Game 8.State Lands Commission 9.Army Corps of Engineers 10. U.S. Coast Guard
11	Geology and soils report (as applicable), including maps

In addition to the items specified in the application form, the instructions also note that additional materials may be required in conjunction with the review process. Because CDP reviews are site-specific, the CCC has broad discretion to request supporting information, primarily examining four general project aspects in keeping with its mandate: 1) environmental; 2) technological; 3) social; and 4) economic. Therefore, although there are no prescribed supplemental materials for seawater desalination projects, the information and studies likely to be required can be summarized based on prior CCC approvals of similar projects in *Desalination and the California Coastal Act*, as follows:

- Hazardous chemical use
- Growth inducement potential
- Intake alternatives analysis
- Impingement and entrainment study
- Impingement and entrainment minimization plan (based on study results)
- Mitigation plan for impingement / entrainment and other environmental impacts
- Concentrate discharge study and alternatives analysis
- Plan for minimizing impact of concentrate discharge on marine life (based on study results)
- Energy requirements
- Energy minimization plan
- Greenhouse gas minimization and mitigation plan
- Water supply alternatives analysis, including:

- Conservation (mandatory measures, voluntary measures, market-based incentives, etc.)
- Recycled water
- Reallocating existing supplies
- Treatment technology alternatives analysis, including an examination of:
- Chemical use
- Energy consumption
- Emissions
- Footprint

2.3.3. Critical Issues

One of the CCC's most significant concerns associated with seawater desalination are impingement / entrainment of marine life. Thus, the CCC prefers lower impact intake alternatives that minimize impingement and entrainment, such as beach wells and infiltration galleries. Consequently, it is vital that the CDP application for any project incorporating an open-ocean intake (either dedicated or shared) includes a detailed study with clear justification to articulate the infeasibility of lower impact intake approaches. Another primary CCC concern is the growth-inducement potential of seawater desalination. Therefore, it is likewise critical that the CDP application include a detailed study to demonstrate that water supply augmentation alternatives that do not utilize the development of a new source (e.g., conservation or reuse) are insufficient to meet projected demand.

Another critical issue is the timely and complete disclosure of requested information. The CCC staff have been openly critical of other seawater desalination project proponents that it perceives as not having been fully forthcoming in a timely manner, attributing significant permit evaluation and approval delays to this disclosure issue (whether fairly or not). Thus, it is important to meet CCC staff early in the permitting process to describe the project concept and get a documented list of site-specific information and studies that the CCC expects to be provided in conjunction with the CDP application. Any subsequent questions posed by the CCC after the CDP application has been submitted should be expediently and thoroughly addressed to avoid scheduling delays.

2.3.4. Permit Documents

The following documents provide the forms, instructions, and additional guidance needed for this permit and are included in **Appendix 5:A**.

- CDP Instructions and Application Form

- Seawater Desalination and the Coastal Development Act (March 2004)

2.4. Permit to Construct/Operate

2.4.1. Permit Overview and Lead Agency

The South Coast Air Quality Management District (SCAQMD) permitting program implements the requirements of the federal and state Clean Air Act (CAA), the Air Quality Management Plan (AQMP), and air quality rules and regulations by specifying operating and compliance requirements for stationary sources that emit air contaminants. Examples of equipment for the full-scale facility that could potentially require an SCAQMD Permit are pumps and back-up generators. To comply with federal and state CAA requirements, all major and non-major sources in the Basin are subject to “no net emissions increase” and source-specific, prohibitory and toxics rules (federal, state, and local). A permit to construct is required prior to installation of new or relocated equipment or modification (both physical modification and change or operating conditions) of existing equipment. Once a piece of equipment is installed, modified and/or operated, SCAQMD processes the application for a Permit to Operate.

2.4.2. Permit Requirements and Process

Applications for a permit to construct new or relocated equipment as well as alteration (both physical modification and change of operating conditions) of existing equipment typically receive a high priority for processing. The application will be reviewed to determine whether proposed equipment will be built and operated consistent with AQMD regulations and policies. For equipment that is installed, the permit to operate application may act as a temporary permit until a final one is processed. After construction, AQMD will inspect the equipment to verify that it has been built and installed as required by the Permit to Construct. Once they have confirmed that the equipment operates in compliance with AQMD rules and regulations, the permit to operate is issued. Public notification is also required for facilities that have risks or emissions that exceeding specified thresholds or for equipment located within 1,000 feet of a school. Notices must be distributed to the communities near the project and parents of children attending nearby schools and are subject to a 30-day public comment period.

Rule 1401 specifies limits for maximum individual cancer risk (MICR), cancer burden, and noncancer acute and chronic hazard index from new permit units, relocations, or modifications to existing permit units which emit specifically listed toxic air contaminants. There is also a requirement to use Best Available Control Technology (BACT) for such sources.

Table 2-4 shows the categories that are reviewed when evaluating the permit and supporting information that could help facilitate discussions with and permit review by SCAQMD.

Table 2-4: Summary of AQMD Permit Review Elements

Permit Review Elements	Supporting Information
Permit History	
Equipment Description	Conceptual Design of Air Emissions Source
CEQA Analysis	CEQA Documentation
Emission Control Description	Energy Minimization and Greenhouse Gas Reduction Mitigation Plan
Emission Calculations	Calculation of Controlled and Uncontrolled Emissions for VOC, NOx, SOx, CO, PM10
Rules Evaluation	A. Map showing proximity to nearest school B. Modeling (if emissions are higher than screening values) C. Risk Assessment for Toxic Air Contaminants

2.4.3. Critical Issues

The following documents provide the forms, instructions, and additional guidance needed for this permit and are included in **Appendix 5:A**.

- Application Form for Permit or Plan Approval (Form 400-A)
- Form 400-A Instructions
- California Environmental Quality Act (CEQA) Applicability (Form 400-CEQA)
- Form 400-CEQA Instructions
- Plot Plan and Stack Information Form (Form 400-PS)
- General Information Summary (Form 400-E-GI)
- Risk Assessment Procedures
- SCAQMD Tools (Links for models and Calculator

2.5. Clean Water Act (CWA) Section 404 Permit

2.5.1. Permit Overview and Lead Agency

The Clean Water Act was passed by Congress in 1977, establishing the basic framework for regulating discharges from navigable waters of the United States, which includes both the ocean and all wetlands. Section 404 of the CWA pertains to the discharge of dredged or fill material. For a seawater desalination plant, a Section 404 permit would be required for any offshore intake and/or outfall, along with all associated offshore infrastructure. The Act authorizes the United States Army Corps of Engineers (ACOE) with issuing permits for these activities.

A Section 404 permit may be either "individual" or "general," with the latter applicable to more minor projects with minimal anticipated impact. The type of permit pertaining to a specific project is determined in consultation with the ACOE prior to filing a application form. For individual permits, the ACOE must notify the applicant within 15 days if there are any deficiencies. Once the application is designated as complete, the ACOE must issue a public notice to this effect, allowing 30 days to receive any comments. A general permit may be either "regional" or "nationwide," and in both cases the approval process is more streamlined (both in terms of paperwork and time) than for individual permits. A permit application form may not be required in conjunction with a general permit.

The US Environmental Protection Agency (USEPA) develops the requirements against which a Section 404 permit is reviewed, and the CWA also authorizes the USEPA to veto any permit issued by ACOE if it believes the proposed activities will have an unacceptable effect on municipal water supplies, shellfish beds and fisheries, wildlife, or recreational areas. In the course of reviewing a Section 404 permit, the ACOE may consult with the following:

- US Fish and Wildlife Service
- National Marine Fisheries Service
- Regional Water Quality Control Board
- California Department of Fish and Game
- US Coast Guard

Additional discussion of consultation requirements can be found in Section 2.7 below.

2.5.2. Permit Requirements and Process

Rivers and Harbors Appropriation Act (RHAA) Section 10 (discussed in Section 2.7, below) and CWA Section 404 permits are similar. A single application process and corresponding form is used for both permits, and the ACOE conducts projects reviews for both permits in parallel. However, different supplement information may be required for each respective permit.

An initial consultation with the ACOE is required to determine whether the permit for the proposed project will be individual or general. Individual and some general permits require the project proponent to submit Engineering Form 4345 – Application for Department of the Army Permit. In conjunction with this application, illustrations, maps, and/or drawings are required to properly depict the project for ACOE review. In addition to the specific details about the project required in the application form (e.g., description of the work, quantities of dredge and/or fill material, etc.), the ACOE has the discretion require additional project information in order to designate the application "complete," and therefore sufficient for review. This information generally includes demonstration of the following, in accordance with USEPA guidelines:

- Avoidance of wetlands impacts, where practical
- Minimization of potential impact to wetlands
- Compensation for any unavoidable impacts on wetlands via activities to restore or create wetlands

2.5.3. Critical Issues

As noted above, prior to submitting an application, an initial consultation with the ACOE is necessary to determine whether an individual or general is required. Consequently, it is imperative that the concept for the intake and outfall (as well as any other offshore infrastructure associated with the seawater desalination project) be well-defined prior to engaging the ACOE. This is also critical for the application process, in which the ACOE will require detailed information about the project in order to designate the application as complete (a prerequisite for review). Thus, having a well-defined concept for intake and outfall prior to engaging the ACOE is essential for facilitating the permitting process. Note that the initial consultation can also be used to confirm in advance the supplemental information that is likely to be required by the ACOE.

2.5.4. Permit Documents

The following documents provide the forms, instructions, and additional guidance needed for this permit and are included in **Appendix 5:A**.

- Engineering Form 4345 – Application for Department of the Army Permit

2.6. CWA Section 401 Water Quality Certification

2.6.1. Permit Overview and Lead Agency

Section 401 of the CWA requires that activities permitted under Section 404 meet state water quality standards. The LARWQCB is responsible for issuing Water Quality Certifications for discharges requiring ACOE Section 404 permits for fill and dredge discharges. "Fill" includes intake or outfall pipelines, beach wells, transmission pipelines, or other similar structures. Issuance of a certification means that the LARWQCB anticipates that the applicant's project will comply with state water quality standards and other aquatic resource protection requirements under LARWQCB's authority. The Section 401 Water Quality Certification can cover both the construction and operation of the proposed project. Conditions of the 401 Certification become conditions of the Federal permit or license.

Obtaining a Section 401 Water Quality Certification is a prerequisite to receiving a Section 404 permit. The application processes should be completed concurrently.

2.6.2. Permit Requirements and Process

An application for a Section 401 Water Quality Certification must provide sufficient information for LARWQCB to determine whether the project complies with State water quality standards and will not result in adverse impacts to waters of the State. The application includes detailed information on the type, amount, and locations of materials to be discharged and/or dredged. A Mitigation Plan must be included in the application package if the project involves temporary or permanent impacts to wetlands and/or other waters of the State. The Mitigation Plan should describe the project's physical and biological impacts, mitigation goals, a mitigation work plan, a management and maintenance plan, success criteria and performance indicators, a monitoring plan, site protection measures, and financial assurance. Other information required in the application package includes site maps depicting watershed boundaries, wetland delineations, endangered species surveys, and CEQA documentation. The LARWQCB may also require additional information, such as hydrologic and geologic studies, groundwater studies, and soil sampling reports.

The review period, as required by 33 CFR 325.2 (b)(ii), is 60 days from when the LARWQCB receives a complete application package; however, the 60-day review period can be extended up to one year under special circumstances. Additionally, the review process can be delayed if the LARWQCB determines during its initial review than an application is incomplete and that additional information or studies are required.

Table 2-5 summarizes the elements of a Section 401 Water Quality Certification application package.

Table 2-5: Summary of Section 401 Water Quality Certification Review Elements

Permit Review Elements	Supporting Information
Applicant Information	
Project Information	Site and Watershed Boundary Map Stormwater Pollution Prevention Plan Wildlife and Endangered Species Surveys Wetland Delineations Hydrologic and Geologic studies Groundwater Studies Soil Sampling Reports
Dredge and Fill Information	Type and amount of material to be discharged/dredged, location(s), and surface area(s) affected
Mitigation	Flow, Impingement and Entrainment Minimization Plan Wetland Restoration Plan for Impingement and Entrainment Mitigation (Note: Extent of mitigation supporting information is unknown due to the SWRCB Desalination Policy)
CEQA	CEQA Documentation
Additional Information	List of required permits Draft or final permit documents Federal notifications for federal permits

2.6.3. Critical Issues

Timing is a key issue with the Section 401 Water Quality Certification. The Section 404 permit cannot be issued until the Section 401 certification has been received, and the Section 401 certification cannot be issued until the CEQA documentation is complete. Early coordination with the LARWQCB to determine which documents need to be included in the application package is recommended to prevent delays associated with the application being deemed incomplete during review.

2.6.4. Permit Documents

The following documents provide the forms, instructions, and additional guidance needed for this permit and are included in **Appendix 5:A**.

- Section 401 Water Quality Certification Application Form
- Wetland, Riparian, and Eelgrass Project Data Form

2.7. Rivers and Harbors Appropriation Act (RHAA) Section 10 Permit

2.7.1. Permit Overview and Lead Agency

Section 10 of the Rivers and Harbors Appropriation Act 1899 requires authorization from the ACOE for any project affecting the navigable waters of the United States (including the ocean) as follows:

- Construction (either in or over)
- Excavation / dredging of materials
- Deposition of materials
- Obstruction
- Alteration

Thus, any seawater desalination plant involving marine construction (e.g., intake and/or outfall and related infrastructure) is subject to a RHAA Section 10 permit.

A Section 10 permit may be either "individual" or "general," with the latter applicable to more minor projects with minimal anticipated impact. The type of permit pertaining to a specific project is determined in consultation with the ACOE prior to filing an application form. For individual permits, the ACOE must notify the applicant within 15 days if there are any deficiencies. Once the application is designated as complete, the ACOE must issue a public notice to this effect, allowing 30 days to receive any comments. A general permit may be either "regional" or "nationwide," and in both cases the approval process is more streamlined (both in terms of paperwork and time) than for individual permits. A permit application form may not be required in conjunction with a general permit. In the course of reviewing a Section 10 permit, the ACOE may consult with the following:

- US Fish and Wildlife Service
- National Marine Fisheries Service
- Regional Water Quality Control Board of jurisdiction
- California Department of Fish and Game
- US Coast Guard

2.7.2. Permit Requirements and Process

RHAA Section 10 and CWA Section 404 permits (discussed in Section 2.5, above) are similar. A single application process and corresponding form is used for both permits, and the ACOE conducts projects reviews for both permits in parallel. However, different supplement information may be required for each respective permit. In addition, unlike a

CWA Section 404 permit, the USEPA does not have veto authority over an ACOE-issued RHA Section 10 permit.

An initial consultation with the ACOE is required to determine whether the permit for the proposed project will be individual or general. Individual and some general permits require the project proponent to submit Engineering Form 4345 – Application for Department of the Army Permit. In conjunction with this application, illustrations, maps, and/or drawings are required to properly depict the project for ACOE review. In addition to the specific details about the project required in the application form (e.g., description of the work, quantities of dredge and/or fill material, etc.), the ACOE has the discretion to require additional project information in order to designate the application "complete," and therefore sufficient for review. This information generally includes details in regard to the applicable structure(s), as well as the construction methods.

2.7.3. Critical Issues

As noted above, prior to submitting an application, an initial consultation with the ACOE is necessary to determine whether an individual or general is required. Consequently, it is imperative that the concept for the intake and outfall (as well as any other offshore infrastructure associated with the seawater desalination project) be well-defined prior to engaging the ACOE. This is also critical for the application process, in which the ACOE will require detailed information about the project in order to designate the application as complete (a prerequisite for review). Thus, having a well-defined concept for intake and outfall prior to engaging the ACOE is essential for facilitating the permitting process. Note that the initial consultation can also be used to confirm in advance the supplemental information that is likely to be required by the ACOE.

2.7.4. Permit Documents

The following documents provide the forms, instructions, and additional guidance needed for this permit and are included in **Appendix 5:A**.

- Engineering Form 4345 – Application for Department of the Army Permit

2.8. Incidental Take Permit and Incidental Take Statement

2.8.1. Permit Overview and Lead Agency

An Incidental Take Permit is required for activity where a State-listed candidate, threatened, or endangered species under the California Endangered Species Act (ESA) may be present in the project area and a State agency is acting as the lead agency for CEQA compliance. Sections 2081(b) and (c) of the California ESA allow the California Department of Fish and Game (CDFG) to issue an incidental take permit for a State listed threatened and endangered species only if specific criteria are met, including 1) the authorized take is incidental to an otherwise lawful activity; 2) the impacts of the authorized take are minimized and fully mitigated; 3) the measures required to minimize and mitigate the impacts of the authorized take are roughly proportional in extent to the impact, maintain the applicant's objectives, and are capable of successful implementation; 4) adequate funding is provided to implement the minimization and mitigation measures; and 5) Issuance of the permit will not jeopardize the continued existence of a State-listed species. The CDFG maintains a list of threatened and endangered species designated under California Fish and Game Code 2070.

In addition to the State ESA, the National Oceanic and Atmospheric Administration (NOAA) National Marine Fisheries Service (NMFS) and the U.S. Fish & Wildlife Service (USFWS) share responsibility for implementing the Federal ESA. Generally, the USFWS is responsible for terrestrial and freshwater aquatic species while NMFS is responsible for listed marine mammals, anadromous fish, and other living marine resources. NMFS also issues permits for incidental taking of listed fish species during other activities such as state-run hatchery operations and commercial or recreational fisheries. In some cases these responsibilities overlap and the agencies work closely together.

Federal agencies must consult with the U.S. Fish & Wildlife Service (USFWS) to determine the potential for effects to protected species. An Incidental Take Statement in accordance with Section 7 of the Endangered Species Act (ESA) may be required. Similar to the CDFG, the USFWS maintains a list of endangered species and threatened species and may use their existing authority to conserve threatened and endangered species and ensure that proposed actions do not jeopardize listed species or destroy or adversely modify critical habitat.

While Federal agencies do not have to abide by state legislation or policies, such as the SWRCB desalination policy, they generally acknowledge them and attempt to arrive at non-conflicting solutions.

2.8.2. Permit Requirements and Process

The Incidental Take Permit process is normally initiated in the Region where the permitted activity will take place by contacting the appropriate Regional Office (Region 5). Measures to minimize the take of species covered by the permit (Covered Species) and to mitigate the impacts caused by the take will be set forth in one or more attachments to the permit. The following information may be needed to support the application and aid in discussions and coordination with CDFG staff:

- Review and Analysis of Incidental Take Permit Compliance History for Existing Intake
- Intake Impingement and Entrainment Study

- Flow, Impingement and Entrainment Minimization Plan (Mitigation Plan and Habitat Conservation Plan)

For the Incidental Take Statement, a Section 7 consultation is an element of the ACOE Section 404 permitting process; therefore, an Incidental Take Statement would be issued under the Section 7 consultation process for this project. Coordination with the NMFS under Section 104, Marine Mammal Protection Act, and Section 305(b) Magnuson-Stevens Fishery Conservation and Management Act would take place simultaneously with the Section 7 consultation.

When non-Federal entities such as states, counties, local governments, and private landowners wish to conduct an otherwise lawful activity that might incidentally, but not intentionally, take a listed species, an incidental take permit (ESA Section 10(a)(1)(B)) must first be obtained from NOAA NMFS. To receive a permit, the applicant must submit a Habitat Conservation Plan (HCP) that meets the criteria included in the ESA and its implementing regulations. The HCP process is designed to address non-Federal land or water use or development activities that do not involve a Federal action that is subject to Section 7 consultation. The USFWS can require a desalination plant to prepare a formal biological opinion if the plant operation may impact endangered species. It will be important to identify any potentially affected federally listed species (**Table 2-6**). Discussions held during the Section 7 consultation should also address the need for an Incidental Take Permit (ITP) under the Migratory Bird Treaty Act (MBTA).

Table 2-6: Potentially Impacted Federal and State Listed Species for Redondo Beach or El Segundo

Scientific Name	Common Name	Federal Status	California Status	Department of Fish and Game Status[1]	California Native Plant Society List[1]
		Wildlife			
Agelaius tricolor	tricolored blackbird	None	None	SSC	
Anniella pulchra pulchra	silvery legless lizard	None	None	SSC	
Athene cunicularia	burrowing owl	None	None	SSC	
Buteo regalis	ferruginous hawk	None	None	WL	
Charadrius alexandrinus nivosus	western snowy plover	Threatened	None	SSC	
Chelonia mydas	green turtle	Threatened	None		
Coccyzus americanus occidentalis	western yellow-billed cuckoo	Candidate	Endangered		
Empidonax traillii extimus	southwestern willow flycatcher	Endangered	Endangered		
Empidonax traillii extimus	southwestern willow flycatcher	Endangered	Endangered		
Emys marmorata	western pond turtle	None	None	SSC	
Eumops perotis californicus	western mastiff bat	None	None	SSC	

Scientific Name	Common Name	Federal Status	California Status	Department of Fish and Game Status[1]	California Native Plant Society List[1]
Glaucopsyche lygdamus palosverdesensis	Palos Verdes blue butterfly	Endangered	None		
Lasiurus xanthinus	western yellow bat	None	None	SSC	
Microtus californicus stephensi	south coast marsh vole	None	None	SSC	
Neotoma lepida intermedia	San Diego desert woodrat	None	None	SSC	
Nyctinomops femorosaccus	pocketed free-tailed bat	None	None	SSC	
Passerculus sandwichensis beldingi	Belding's savannah sparrow	None	Endangered		
Pelecanus occidentalis californicus	California brown pelican	Delisted	Delisted	FP	
Perognathus longimembris pacificus	Pacific pocket mouse	Endangered	None	SSC	
Phrynosoma blainvillii	coast horned lizard	None	None	SSC	
Polioptila californica californica	coastal California gnatcatcher	Threatened	None	SSC	
Rallus longirostris levipes	light-footed clapper rail	Endangered	Endangered	FP	
Riparia riparia	bank swallow	None	Threatened		
Rynchops niger	black skimmer	None	None	SSC	
Siphateles bicolor mohavensis	Mohave tui chub	Endangered	Endangered	FP	
Sorex ornatus salicornicus	southern California saltmarsh shrew	None	None	SSC	
Spea hammondii	western spadefoot	None	None	SSC	
Sternula antillarum browni	California least tern	Endangered	Endangered	FP	
Taxidea taxus	American badger	None	None	SSC	
Plants					
Aphanisma blitoides	aphanisma	None	None		1B.2
Astragalus pycnostachyus var. lanosissimus	Ventura Marsh milk-vetch	Endangered	Endangered		1B.1
Astragalus tener var. titi	coastal dunes milk-vetch	Endangered	Endangered		1B.1
Atriplex coulteri	Coulter's saltbush	None	None		1B.2
Atriplex pacifica	South Coast saltscale	None	None		1B.2
Atriplex parishii	Parish's brittlescale	None	None		1B.1
Atriplex serenana var. davidsonii	Davidson's saltscale	None	None		1B.2
Calochortus plummerae	Plummer's mariposa-lily	None	None		1B.2
Calochortus weedii var. intermedius	intermediate mariposa-lily	None	None		1B.2
Calystegia sepium ssp. binghamiae	Santa Barbara morning-glory	None	None		1B.1

Scientific Name	Common Name	Federal Status	California Status	Department of Fish and Game Status[1]	California Native Plant Society List[1]
Centromadia parryi ssp. australis	southern tarplant	None	None		1B.1
Chloropyron maritimum ssp. maritimum	salt marsh bird's-beak	Endangered	Endangered		1B.2
Crossosoma californicum	Catalina crossosoma	None	None		1B.2
Dudleya virens ssp. insularis	island green dudleya	None	None		1B.2
Lasthenia glabrata ssp. coulteri	Coulter's goldfields	None	None		1B.1
Lycium brevipes var. hassei	Santa Catalina Island desert-thorn	None	None		1B.1
Nama stenocarpum	mud nama	None	None		2.2
Nasturtium gambelii	Gambel's water cress	Endangered	Threatened		1B.1
Navarretia fossalis	spreading navarretia	Threatened	None		1B.1
Navarretia prostrata	prostrate vernal pool navarretia	None	None		1B.1
Nemacaulis denudata var. denudata	coast woolly-heads	None	None		1B.2
Orcuttia californica	California Orcutt grass	Endangered	Endangered		1B.1
Pentachaeta lyonii	Lyon's pentachaeta	Endangered	Endangered		1B.1
Phacelia stellaris	Brand's star phacelia	Candidate	None		1B.1
Sagittaria sanfordii	Sanford's arrowhead	None	None		1B.2
Sidalcea neomexicana	Salt Spring checkerbloom	None	None		2.2
Suaeda esteroa	estuary seablite	None	None		1B.2
Symphyotrichum defoliatum	San Bernardino aster	None	None		1B.2

[1] SCC = Species of Special Concern; WL = Watch List; FP = Federally Protected; 1B.1 = Plants Rare, Threatened, or Endangered in California and Elsewhere; Seriously threatened in California; 1B.2 =Plants Rare, Threatened, or Endangered in California and Elsewhere, Fairly threatened in California; 2.2 = Plants Rare, Threatened, or Endangered in California, But More Common Elsewhere; Fairly threatened in California

The first step in the Section 7 consultation process is to identify federally listed species potentially affected by the project and to conduct an informal consultation with the NMFS to allow for early consideration of listed species concerns. If it is determined that a federally listed species or critical habitat may be affected by the project, the lead agency must prepare a Biological Assessment within 180 days for review by the NMFS. NMFS will review of the Biological Assessment and will respond within 30 days with its opinion as to whether the project is likely to adversely affect species or critical habitat. If it is determined that the project may adversely affect listed species or critical habitat, a formal consultation is required.

Formal consultations determine whether a proposed agency action(s) is likely to jeopardize the continued existence of a listed species or destroy or adversely modify critical habitat. They also determine the amount or extent of anticipated incidental take in an incidental take statement. To initiate the formal consultation process, the lead agency (ACOE) would request initiation of the formal consultation process and would submit the following information to the NMFS:

- A description of the action being considered
- A description of the specific area that may be affected by the action;
- A description of any listed species or critical habitat that may be affected by the action;
- A description of the manner in which the action may affect any listed species or critical habitat, and an analysis of any cumulative effects;
- Relevant reports, including any environmental impact statements, environmental assessments, biological assessment or other analyses prepared on the project; and
- Any other relevant studies or other information available on the action, the affected listed species, or critical habitat.

Within 90 days of a complete submittal, the NMFS will review the information and will formulate a Biological Opinion and incidental take statement in conjunction with the lead agency and applicant. A Biological Opinion includes 1) the opinion of the NMFS as to whether or not the project is likely to jeopardize the continued existence of listed species or result in destruction of critical habitat; 2) a summary of information on which the opinion is based; and 3) a detailed discussion of the effects of the action on listed species or designated critical habitat. If it is determined under the Biological Opinion that the project is likely to adversely affect listed species or critical habitat, a formal Section 7 consultation is required in order to obtain an Incidental Take Statement.

The lead agency and applicant will review the draft Biological Opinion, and within 45 days of completion of their review the NMFS will deliver a final Biological Opinion and Incidental Take Statement to the lead agency, concluding the formal consultation process.

2.8.3. Critical Issues

Consultation under section 7 of the ESA is the Federal agency's responsibility (ACOE), not the applicant's. In the case of issuance of a Section 404 permit, ACOE must conduct an interagency consultation to ensure compliance of permit issuance with the provisions of section 7. However, although the consultation responsibilities is not the permit applicants, the applicant should help ensure that those considerations required of the NMFS by Section 7 have been addressed in the application and associated documentation. Additionally, early consultation with all involved agencies is recommended, as incomplete information will delay the process. It is recommended that the process be initiated with an informal consultation at least one year before the Incidental Take Statement is needed.

2.8.4. Permit Documents

The following documents provide the forms, instructions, and additional guidance needed for this permit and are included in **Appendix 5:A**.

- ESA Instructions
- Endangered Species Consultation Handbook

2.9. Encroachment Permits

2.9.1. Permit Overview and Lead Agencies

An encroachment permit must be obtained for any proposed activities related to the placement of encroachments such as pipe, pipeline, fencing, or structures within, under, or over the a public right-of-way or State highway right-of-way. As discussed in the *Project Entitlement Acquisition Plan (PEAP)*, a number of cities may be impacted by the construction of conveyance facilities from the plant site to the distribution system, based upon which plant site and conveyance alternative are selected.

For the NRG site, the following local entities could be impacted:

- El Segundo
- Manhattan Beach
- Redondo Beach
- Lawndale
- Hawthorne
- Gardena
- Caltrans
- LA County Department of Public Works (LACDPW)

For the AES (Redondo Beach) site, the following local entities could be impacted:

- Torrance
- Redondo Beach
- Hermosa Beach
- Manhattan Beach
- Lawndale

- Hawthorne
- Gardena
- Caltrans
- LACDPW

These cities typically require those encroachment permits, excavation permits, construction permits, and/or right-of way permits for construction, excavation, or encroachment in public right-of-ways. Encroachments include any obstruction, including pipe, placed in, along, under, over, or across a public right-of-way. The organization of these permits varies somewhat among the cities; however, the requirements are typically the same. Therefore, the discussion of these permits has been consolidated, and the permits are referred to as "encroachment permits" in this section.

A National Pollution Discharge Elimination System (NPDES) General Construction Permit is also required for stormwater runoff associated with construction activity. See Section 2.2 of this document for further information.

Each of the two potential project sites and associated conveyance facilities would require placement of pipeline within a State highway. Therefore, an encroachment permit must also be obtained from the California Department of Transportation (Caltrans) for any proposed activities related to the placement of encroachments such as pipe, pipeline, fencing, or structures within, under, or over the State highway right-of-way.

The California State Mining and Geology Board (SMGB) represents the State's interest in the development, utilization and conservation of mineral resources; reclamation of mined lands; development of geologic and seismic hazard information. The Surface Mining and Reclamation Act of 1975 provides the State's surface mining and reclamation policy with the regulation of surface mining operations to minimize environmental impacts and reclaim mined lands to a usable condition. The Act does not apply to onsite excavation and earthmoving activities that are an integral part of a construction project and are undertaken to prepare a site for construction of structures, landscaping, or other land improvements associated with those structures, including the related excavation, grading, compaction, or the creation of fills, road cuts, or embankments, provided that all required permits have for construction have been approved by a public agency and that the lead agency's approval of the project included consideration of the onsite excavation and earthmoving activities.

Early coordination with the SMGB is recommended to determine with tunneling associated with conveyance facilities for the project would require any mitigation or reclamation actions under the Surface Mining and Reclamation Act.

2.9.2. Permit Requirements and Process

Encroachment permits are generally issued by the City Engineer or Public Works Director within the City's discretion. To be eligible for an encroachment permit, projects must conform to the City's Building Code, Municipal Code, and Standard Specifications and typically must not adversely affect the general plan of the City. Projects plans and specifications, along with a detailed description of work, are submitted to the City with the permit application, and are reviewed and approved by the City Engineer prior to issuance of a permit. Additionally, a copy of the contractor's State license, City business license, and insurance certificate may be required. Projects must also comply with the City's Traffic Control Provisions. Multiple application forms and project plan reviews may be required concurrently in cities where construction permits, encroachment permits, and right-of-way permits are processed separately.

Work performed under an encroachment permit must comply with all California/OSHA safety orders. Work must also comply with the CWA and NPDES requirements and to the selected Best Management Practices (BMP) plan. Trenches or excavation that are five feet or more in depth require a separate shoring permit from California/OSHA (State Division of Industrial Safety). For projects subject to NPDES requirements, a NPDES certification form may also need to be completed. The form states that a Notice of Intent has been filed with the SWRCB and that a Stormwater Pollution Prevention Plan has been completed, approved, and fully implemented to the satisfaction of the City Engineer.

Table 2-7: Summary of Encroachment Permit Components

Permit Component	Required	Description / Necessary Element
Sketch/Plans	Required	Sketch/Plans with a detailed description of work approved by the City Engineer
Business License	Required	Business license for City in which work is to be performed.
Contractor's State License	Required	Valid and applicable Contractor's State License
Liability Insurance	Required	Valid liability insurance covering General Liability of at least $1,000,000 with the City additionally insured and named.
Current Worker's Compensation Policy	Required	Current Worker's Compensation Policy, $1,000,000.

Permit Component	Required	Description / Necessary Element
NPDES Certification	Required in Some Cities	For projects subject to NPDES requirements, a NPDES certification form may also need to be completed. The form states that a Notice of Intent has been filed with the SWRCB and that a Stormwater Pollution Prevention Plan has been completed, approved, and fully implemented to the satisfaction of the City Engineer.
California/OSHA Shoring Permit	Possibly	Trenches or excavation that are five feet or more in depth require a separate shoring permit from California/OSHA (State Division of Industrial Safety).

To obtain a permit from Caltrans, applicants must complete a Standard Encroachment Permit Application along with documentation and submit this information to the District Encroachment Permits Office (District 7 for Los Angeles). Caltrans is required to either approve or deny an Encroachment Permit Application within 60 calendar days, upon determination that the submittal is complete.

The Caltrans Standard Encroachment Permit Application (TR-0100) includes project information such as location and cost; impacts to environmental, cultural, and scenic resources; and prior approvals from other agencies. Applicants must complete and attach supporting documentation such as: plans, location map, environmental documentation, letter of authorization, surety bonds, liability insurance, etc. and submit them to the appropriate District 7 Encroachment Permits Office. The permit also requires that work be conducted in compliance with Caltrans' NPDES permit which includes the preparation and approval of a Storm Water Pollution Protection Plan. A summary of the information and reports that may be necessary to obtain Caltrans approval for an encroachment is provided in **Table 2-8**.

Table 2-8: Summary of Caltrans Standard Encroachment Permit Components

Permit Component	Description / Necessary Elements
Project Plans and Specifications	Complete sets of plans and any applicable specification, calculations, maps, etc. Application form also requires details such as highway number and postmile, location relative to nearest cross street, maximum depth, average depth, average width and length, and pipe material and diameter
Cost Estimate	Estimated cost for all work to be done within the State right-of-way, and funding sources
Environmental Impact Report	Environmental Impact Report and a copy of the Notice of Determination from other agency from which permit or approval was received. Application also requires indication of whether the project will cause a substantial change in the significance of a historical resource or removal or a scenic resource.
Area of Disturbance of Soil	If the project will require the disturbance of soil, application must include the area of disturbance of soil within and outside of the right-of-way in square footage and acres.
Storm Water Pollution Prevention Plan	If the project will require dewatering, application must include estimated volume per month and source (Storm Water or Non-Storm Water) and must indicate how any storm water or ground water will be disposed of from or near the limits of the proposed project.

2.9.3. Critical Issues

Timing is a critical issue in the encroachment permitting process. Encroachment permits are typically valid for a period of six months from the date with the permit was granted, and are void if not utilized within this period. A single extension of time, not to exceed six months, may be applied for and issued or denied by the director of public works. To satisfy NPDES certification requirements, a Notice of Intent must be filed with the SWRCB and a Stormwater Pollution Prevention Plan must be completed prior to the issuance of an encroachment permit.

As the Caltrans application relies on prior approval of an Environmental Impact Report from another agency, as well as completion of a Storm Water Pollution Prevention Plan, these documents will need to be completed prior to the permit application. The California Streets and Highways Code stipulates that an Encroachment Permit Application submittal is complete only when all other statutory requirements, including CEQA, have been complied with. While Caltrans is required to approve or deny a permit application submittal within 60 calendar days upon determination that the submittal is complete, it has the authority to determine what constitutes a complete submittal. Therefore, coordination with Caltrans throughout the application process to ensure that all requirements are met is recommended to prevent delays in the review process.

2.9.4. Permit Documents

The following documents provide the forms, instructions, and additional guidance needed for this permit and are included in **Appendix 5:A**.

- City of El Segundo Encroachment Permit Conditions
- City of Gardena Encroachment Permit Application Form
- City of Gardena Application For Excavation – Construction Permit
- City of Lawndale Encroachment and Excavation Permit
- City of Manhattan Beach Construction and Landscaping on Public Property Booklet
- City of Manhattan Beach Encroachment Permit Application
- City of Redondo Beach Engineering Permit Guidelines
- City of Redondo Beach Engineering Permit Application
- City of Redondo Beach NPDES Certification Form
- LACDPW Construction and Encroachment Permit Requirements
- LACDPH Road Closure Permit Guidelines
- Caltrans Standard Encroachment Permit Application
- Caltrans Instructions for Completing the Standard Encroachment Permit Application

2.10. Right-of-way Permit / Land Use Lease

2.10.1. Permit Overview and Lead Agency

The California SLC has jurisdiction and management control over approximately four million acres of land underlying the State's navigable and tidal waterways, including the State's tide and submerged lands along the California's 1,100 miles of coastline and offshore islands extending from the mean high tide line to three nautical miles offshore. The SLC holds these lands for the benefit of all the people of the State, subject to the Public Trust for water related commerce, navigation, fisheries, recreation, open space and other recognized Public Trust uses. Accordingly, the SLC maintains a multiple use management policy to assure the greatest possible public benefit is derived from these lands. A Right-of-Way Permit or Land Use Lease is required for issuance of a grant of right-of-way across state lands. Desalination facilities proposing to place new intakes or outfalls on state tidelands, or to change existing intakes or outfalls, will generally be required to obtain a lease modification from the CSLC.

Upon receipt of an inquiry about the proposed use of State lands, the SLC Title Unit reviews its files and information submitted to determine the extent of the State's property interest in the project site. If staff determines that the proposed project is within SLC jurisdiction, an application must be submitted. No project can proceed until the SLC has considered and taken action on the application. The issuance by the SLC of any lease, permit or other entitlement for use of State lands is reviewed for compliance with the provisions of the California Environmental Quality Act (CEQA). The SLC may also consult with California Department of Fish and Game in the review of lease application.

2.10.2. Permit Requirements and Process

As discussed in the *Project Entitlement Acquisition Plan (PEAP)*, the preferred site for the seawater desalination plant at the El Segundo Power Generating Station is subject to an SLC lease for operating the existing intake and outfall. Thus, if this existing infrastructure is used in conjunction with the seawater desalination plant, there are several options for obtaining authorization from the SLC:

- Obtain a new lease
- Amend the current lease held by NRG (subject to agreement by the lessee)
- Sublease the use of the existing infrastructure from NRG

For any of these options, new SLC Application for Lease of State Lands is required. In conjunction with the application, the SLC requires a completed CEQA document and a Mitigation/Monitoring Program. After all of the required materials have been submitted, the SLC will notify the project proponent that the application is complete, initiating the formal review process.

2.10.3. Critical Issues

No proposed project will be considered by the SLC until the requirements of the CEQA document have been satisfied. Therefore, it is critical to complete the CEQA process prior to applying for lease with the SLC. Local approvals (city or county) for the project must be received prior to consideration by the SLC. Letters of Concurrence or Biological Opinions from the USFWS or NMFS may also be required prior to consideration of an application. The wetland restoration plan and greenhouse gas monitoring program, if required, also need to be included with the application.

2.10.4. Permit Documents

The following documents provide the forms, instructions, and additional guidance needed for this permit and are included in **Appendix 5:A**.

- Application for Lease of State Lands
- Application Guidelines Regarding Leasing of State Lands

2.11. Other

2.11.1. Waste Discharge Requirements

The Porter-Cologne Water Quality Control Act (California Water Code 13000, et seq) is the principal legislation for controlling storm water pollutants in California. The act requires development of basin plans for drainage basins within California. Each plan serves as a blueprint for protecting water quality within various watersheds. These basin plans are used in turn to identify more specific controls for discharges (e.g. wastewater treatment plant effluent, urban runoff, and agriculture drainage). Under the Porter-Cologne Act, specific controls are implemented through permits called Waste Discharge Requirements issued by the nine Regional Water Quality Control Boards (RWQCBs). The project site is included within the Water Quality Control Plan for the Los Angeles Basin and thus is subject to all applicable rules and regulations contained within the Water Quality Control Plan for the Los Angeles Basin.

2.11.2. National Historic Preservation Act (NHPA) Consultation

As discussed in the *Environmental Review Plan (ERP)*, The National Historic Preservation Act (NHPA) directed federal agencies to integrate historic preservation into all activities which either directly or indirectly involve land use decisions. The NHPA is administered by the National Park Service, the Advisory Council on Historic Preservation, State Historic Preservation Officers (California Department of Parks and Recreation Office of Historic Preservation), and each federal agency. Section 106 of the NHPA requires federal agencies to take into consideration the impact that an action may have on historic properties which are included on, or are eligible for inclusion on, the National Register of Historic Places. The Section 106 review process is usually carried out as part of a formal consultation with the State Historic Preservation Officer, the Advisory Council on Historic Preservation, and other parties, such as Indian tribes, that have knowledge of, or a particular interest in, historic resources in the area of undertaking. There are no specific times restrictions for the completion of this process. Once the State Historic Preservation Officer receives the appropriate documentation, they have 30 days to review and comment. If the Advisory Council on Historic Preservation is consulted, they have an additional 15 days. NHPA consultation is typically completed prior to or during the CEQA application process.

2.11.3. Lake or Streambed Alteration Agreement

The California Department of Fish and Game (CDFG) requires a streambed alteration agreement for activities within inland waters and within some areas of bays and estuaries. If CDFG determines that a proposed activity may substantially adversely affect fish and wildlife resources, a Lake or Streambed Alteration Agreement will be prepared. The Lakebed or Streambed Alteration Agreement includes conditions necessary to protect those resources and must comply with the California Environmental Quality Act (CEQA). The entity may proceed with the activity in accordance with the agreement.

2.11.4. Remedial Action Plan

Existing hazardous materials contamination at a project site may require permits and/or approvals from the California Department of Toxic Substances Control (DTSC), the RWQCB, and/or the Local Enforcement Agency. Should contamination be present, the site must be remediated, and to the satisfaction of the DTSC, a Remedial Action Plan would be required and implemented for the proposed project. Should the site require "corrective action" (have contamination, either surface or groundwater, that exceeds a minimum action level), it may take two or more years to go through the DTSC site remediation and site clearance process.

2.11.5. Review of Changes to Power Plants

For desalination facilities proposing to locate at power plants, the California Energy Commission (CEC) is likely to review proposed changes to the power plant needed to accommodate the desalination facility. Some of those changes may require approval from the Energy Commission. The review may also evaluate the effects of the desalination facility on the power plant's operations, its effect, if any, on the local facilities or regional transmission lines, and other aspects of the desalination facility's impact on energy use.

Early consultation with the CEC is recommended to determine if they need to have a role in the project and, if so, what information and actions they will require. For example, a Post Certification Amendment might be needed to include the new desalination plant and associated operations on the power plant site. If the CEC determines that this amendment is appropriate, any required documentation would be submitted through the power plant owner.

While the California Public Utilities Commission (PUC) has authority over the electric rates of investor owned electric utilities, municipalities, water districts, and mutual water companies do not fall under the PUC's jurisdiction.

3. Permitting Approach, Schedule, and Budget

3.1. Permitting Approach

Both West Basin and the regulatory community have a common goal: To develop a long-term, sustainable, and reliable water supply through a project that is technologically and economically feasible, environmentally sound, and socially acceptable. Yet despite this shared vision, the permitting process can be daunting. In addition to the sheer number of coordination points, a complicating factor is that some agencies may wait for other agencies to review the permit before they will review or approve the permit, as in the case of the Coastal Development Permit (CDP) from the California Coastal Commision (CCC).

Each regulatory agency maintains various goals and objectives. Early and on-going consultation and support from these agencies is a fundamental requirement for project advancement.

In order to increase the potential for dialogue and productivity, initial scoping meetings with the various agencies should be considered. It is recommended to hold meetings with multiple agencies simultaneously, especially in situations where multiple agencies are consulting on the same permit.

It will be important to not only understand the critical elements, but also the level of detail desired for those elements. Often times, there is agreement on the type of information needed to support a project, but the parties involved may each have a different interpretation for burden of proof of that information, resulting in a bottleneck until these interpretations are resolved. It is important that the full range of issues and opinions are clearly vetted, maintain a constructive tone and exchange of information, and identify areas where additional information is needed to fill gaps or build consensus. On the flip side, the agency may be able to verify that the information provided to date is sufficient, thus saving West Basin from embarking on additional studies.

By identifying concerns and permit needs at the outset, the project can be planned effectively and key information can be obtained and provided along the way. This minimizes the frustration of having to backtrack to collect data, or proceeding to the next phase of the project only to halt progress because a regulatory need was not addressed at a previous point in the process.

Once the initial scoping meetings have been conducted, it is important to have continued dialogue to provide updates on studies and milestones. This allows the regulatory agency to stay engaged and familiar with the project which can facilitate review since the reviewer will not have the burden of needing to get up to speed on the project elements and supporting studies. A suggested frequency is at least quarterly while initial studies are being conducted, moving to monthly once there are findings to present or if there are differences of opinion that need to be resolved. Given that schedules of multiple agencies can be challenging to coordinate, the earlier these can be confirmed the better. It is also recommended to get future meetings (or a recurring meeting) on the calendar in advance, as they can always be rescheduled if necessary. This also sends the message to the regulatory agencies that West Basin is serious and committed to moving this project forward.

Table 3-1 shows the various agencies that are involved in the review, consultation, and approval of each permit discussed in Section 2. A series of meetings should be set up to discuss each permit. In the case of the Clean Water Act (CWA) Section 404 Permit and the Rivers and Harbors Appropriation Act (RHAA) Section 10 Permit a single series of meetings can be used to cover discussion of both permits since the agencies involved would be the same. It is also recommended to hold a single series of meetings with the local jurisdictions involved in the various encroachment and right-of-way permits, as there may be opportunities to discuss common application elements and information that can satisfy multiple jurisdictional requirements, thus lessening the burden on West Basin.

Table 3-1: Agencies Involved in Review, Consultation, and Approval of Permits

	Federal					State														Local								
	U Environmental Protection Agency	US Army Corps of Engineers	US Coast Guard	National Marine Fisheries Service	US Fish and Wildlife Service	CA Department of Public Health	CA Coastal Commission	CA Department of Fish and Game	CA Department of Transportation	South Coast Air Quality Management District	Department of Parks and Recreation	Department of Water Resources	Public Utilities Commission	CA State Lands Commission	CA Energy Commission	State/Regional Water Quality Control Board	CA State Dept of Toxic Substances Control	California/OSHA	State Mining and Geology Board	City of Redondo Beach	City of El Segundo	City of Manhattan Beach	City of Hermosa Beach	City of Lawndale	City of Hawthorne	City of Gardena	City of Torrance	LA County Department of Public Works
Domestic Water Supply Permit	C					L										C												
NPDES Permit	C			C	C	L		C								C												
Coastal Development Permit		C	C		C		L	C						C		C					L							
Permit to Construct/ Operate										L																		
Section 404 Permit	C	L	C	C	C			C								C												
Section 401 Certification		C														L												
Section 10 Permit		L	C	C	C			C								C												
Incidental Take Permit/Statement		C		L	L			L																				
Encroachment Permits									L									C	C	L	L	L	L	L	L	L	L	L
Right-of-Way Permit/Land Use Lease								C						L														
Waste Discharge Requirements																L												
NHPA (Section 106) Consultation											L																	
Lake or Streambed Alteration Agreement								L																				
Remedial Action Plan																C	L											
Review of Changes to Power Plants															L													

3.2. Permitting Schedule and Budget

Table 3-2 shows the various agencies that will likely be consulted with, the steps taken to work with each agency, the approximate timeframe needed for the consultation/permit approval, and a rough budget for the assumed set of activities.

Table 3-2: Summary of Permit Requirements, Duration, and Cost

Regulatory Agency	Regulatory Permit, Authorization or Approval	Key Requirements and General Permit Acquisition Approach	Anticipated Permit Acquisition Timeline	Comments	Estimated Cost
Federal Agencies					
U.S. Fish and Wildlife Service (USFWS), Ecological Services Branch	Incidental Take Statement and coordination under Section 7 Endangered Species Act of 1973, as amended (ESA)	Under Section 7 of the ESA, Federal agencies must consult with the USFWS to determine the potential for effects to protected species and whether an Incidental Take Statement (ITS) may be required. Key permit acquisition steps include: · Identify federally listed species potentially affected · Initiate early, informal Section 7 consultation and provide a project description with existing special studies · Conduct any additionally required flora and fauna surveys and evaluate the potential for 'take' · Prepare draft Biological Assessment (BA) for federal agency · Coordinate final BA with federal agency prior to submittal to USFWS and the National Marine Fisheries Service (NMFS) · Obtain USFWS/NMFS review and Biological Opinion (BO), and determine need for formal Section 7 consultation - Support USFWS consultation under Section 106 of the National Historic Preservation Act (NHPA), as described below · As necessary, complete consultation and obtain ITS	12-18 months	Finished prior to completion of NEPA/CEQA document	Highly variable. Dependant on the number of species associated with the site. $100,000 - $500,000 or up (Total)
	Incidental Take Permit (ITP) under the Migratory Bird Treaty Act (MBTA) (16 USC 703–711)	This Act prohibits the take of any migratory bird or any part, nest, or eggs of any such bird without an Incidental Take Permit (ITP) from USFWS. For acquisition of this permit: · Coordinate with USFWS simultaneously with the Section 7 ESA review regarding potential "take" and the need for a MBTA ITP · Obtain formal USFWS comment and, if needed, a ITP			
	Consultation under the Fish and Wildlife Coordination Act (16 U.S.C. 661-667c)	This Act authorizes USFWS to review and comment on project effects to fish and wildlife for activities undertaken or permitted by a federal agency. To assist this federal consultation: · Coordinate with USFWS simultaneously with Section 7 ESA process regarding the need for a ITP under MBTA · Obtain USFWS comment under the Act			
NOAA National Marine Fisheries Service (NMFS)	Consultation and biological opinion in accordance with Section 7 ESA	Any federal permitting agency for this project must consult with the NMFS to determine whether the proposed action is likely to have an adverse effect to a federally listed marine species or designated critical habitat for such species; jeopardize the continued existence of such species that are proposed for listing under the ESA; or adversely modify proposed critical habitat. An ITP may be required. Consultation with the NMFS is the same as that described above for the USFWS under Section 7. (If no federal approval is required, an ITP would be issued in accordance with ESA Section 10).	12-18 months	Finished prior to completion of NEPA/CEQA document	Highly variable. Dependant on the number of species associated with the site $100,000 - $500,000 or up (Total)
	ITP per Section 104, Marine Mammal Protection Act of 1972 (MMPA) (16 U.S.C. § 1374)	The MMPA prohibits unauthorized "take" of marine mammals in U.S. waters. NOAA NMFS will review project impacts to marine mammals and may authorize an incidental take. Coordinate with the NMFS for ITPs under the MMPA simultaneously with consultation under Section 7 of the ESA, as discussed above, and assist with federal agency consultation under Section 106 of the National Historic Preservation Act (NHPA), as discussed below.			
	Consultation under Section 305(b), Magnuson-Stevens Fishery Conservation and Management Act (16 U.S.C. § 1855(b))	Also known as the Sustainable Fisheries Act, NMFS consultation is required whenever a federal or state approval is required for an activity that may adversely affect designated essential fish habitat (EFH). Coordination with NMFS would occur for the Sustainable Fisheries Act simultaneously with consultation under Section 7 of the ESA.			

Regulatory Agency	Regulatory Permit, Authorization or Approval	Key Requirements and General Permit Acquisition Approach	Anticipated Permit Acquisition Timeline	Comments	Estimated Cost
Federal Agencies					
U.S. Army Corps of Engineers (USACE)	Individual Permit inaccordance with Section404 Clean Water Act(33 U.S.C. § 1344)	Activities that result in discharges of dredged or fill material into Waters of the United States are regulated by the USACE. Perform the following steps to facilitate acquisition of a Department of the Army permit:- Coordinate early with USACE and other reviewing agencies (USFWS, NMFS, Regional Water Quality Control Board, US Coast Guard)- Confirm permit type (Individual or General), application content, public notification process and likely permit stipulations- Prepare diagrams of alternatives and jurisdictional delineations of affected wetlands/Waters of the US- Prepare Engineer Form 4345, *Application for a Department of the Army Permit* for an Individual Permit- Coordinate with USACE regarding reviewing agency/public comments and permit conditions- Monitor progress of other reviewing agency approvals and USACE issuance of a permit	6 - 18 months	Application cannot be submitted until after NEPA/CEQA document certified and after submission to obtain a RWQCB 401 permit	$100,000
	Individual Permit under Section 10 Rivers and Harbors Appropriation Act (33 U.S.C. §403)	Under Section 10 of the Act, the building of any wharfs, piers, jetties, pipelines, and other in-water structures is prohibited without the approval of the USACE. USACE concerns include contaminated sediments from dredge or fill activity in navigable waters. For acquisition of this permit: · Submit Section 10 permit application simultaneously with a CWA §404 permit application, and processed by the USACE together · Monitor U.S. Coast Guard consultation with the USACE regarding marine traffic safety and navigational hazards, including underwater intake and outfall pipelines · Coordination under Section 106 of the National Historic Preservation Act · Consultation under Section 7 of the federal ESA · Consultation under Section 305(b), Sustainable Fisheries Act · Respond to requests for additional information and review permit conditions prior to permit approval			$50,000

Regulatory Agency	Regulatory Permit, Authorization or Approval	Key Requirements and General Permit Acquisition Approach	Anticipated Permit Acquisition Timeline	Comments	Estimated Cost
State Agencies					
Regional Water Quality Control Board (RWQCB)	National Pollutant Discharge Elimination System (NPDES) General Permit For Storm Water Discharges Associated With Construction Activity (WQO No. 99-08-DWQ)	A NPDES General Construction Permit is required for stormwater discharges associated with construction activity totaling over 1 acre that would result in waste discharges into surface waters of the state. To acquire this permit: · Conduct early coordination with the RWQCB regarding the proposed action and anticipated post-project monitoring and annual certification requirements · Compile data on content and rate of discharge anticipated for the proposed action · Submit a Notice of Intent (NOI) to the RWQCB for a General Construction Permit. · Prepare and implement a Storm Water Pollution Prevention Plan (SWPPP) specifying best management practices (BMPs) andpollution prevention monitoring · Obtain General Permit and implement monitoring plan with monthly reports to the RWQCB · Submit a Notice of Termination to the RWQCB upon completion of the project	12 - 24 months	Required prior to construction	$100,000
	NPDES Permit in accordance with Clean Water Act Section 402 (33 U.S.C. § 1342)	The proposed project will genrate waste brine and discharge through the the power plant deepwater outfall. West Basin will need to either: 1) obtain a separate NPDES Permit, or 2) modify the power plants existing NPDES permit. As there is an existing NPDES Permit, certain technical studies have already been completed for the outfall. To acquire this permit: · Develop and submit a Report of Waste Discharge (ROWD) describing the nature of the discharge including chemical testing results · Prepare a filing of federal forms package for a NPDES Permit(s) · Facilitate RWQCB technical analysis to determine the applicable receiving water quality objectives and effluent limitations (with conditions) · Consultation with NMFS under Section 305(b) of the Sustainable Fisheries Act · Draft NPDES permit is developed as a Tentative Order · Ensure CEQA and NEPA requirements are fulfilled prior to a public hearing for this permit · The Draft Permit may be altered based on public comment and is adopted as a Final Permit. The RWQCB then sends the Permit to the SWRCB and EPA for approval · Existing or planned studies to determine the effects of mixing brine with the treated effluent would provide the technical analysis needed in the CEQA/NEPA document		Required prior to operation	$100,000
	Waste Discharge Requirements (WDR) per Porter-Cologne Water Quality Control Act (Water Code § 13000 et seq.)	Any activity that results or may result in a discharge of waste that directly or indirectly impacts the quality of waters of the State (including groundwater or surface water) or the beneficial uses of those waters is subject to WDRs. For acquisition of this permit: · Identify the need for WDRs under the Porter-Cologne Water Quality Control Act and coordinate with the RWQCB to confirm required WDRs · This will be done concurrently with the NPDES permit process described above		Typically issued with NPDES Permit	$50,000
	Water Quality Certification in accordance with Section 401 Clean Water Act (33 U.S.C. § 1341)	Any applicant for a federal license or permit to conduct any activity including, but not limited to, the construction or operation of facilities, which may result in any discharge into navigable waters, must provide the licensing or permitting agency a certification that the activity meets State water quality standards. To acquire this permit initiate Section 401 Water Quality Certification studies and seek approval concurrent with the USACE Section 404 CWA application process.		Required prior to construction	$75,000

Regulatory Agency	Regulatory Permit, Authorization or Approval	Key Requirements and General Permit Acquisition Approach	Anticipated Permit Acquisition Timeline	Comments	Estimated Cost
State Agencies					
California State Lands Commission	Land Use Lease (Right-of-Way Permit) (Pub. Res.Code § 6000 et seq.; 14 Cal. Code Regs. § 1900 et seq.)	A Right-of-Way Permit for use of state tidelands and submerged lands within 3 nautical miles seaward of the ordinary high water mark is required. To acquire this permit: · Coordinate with State Lands Commission (SLC) staff early and continuously, and submit a complete project description and review all physical and technical project alternatives · Assist in the formation and management of a joint local/state/federal Joint Review Panel (JRP) via formal Memorandum of Understanding, with West Basin as the Chair of any JRP; other agencies may participate (e.g., CCC, NOAA) · Coordinate with the SLC (via the JRP) and other reviewing agencies to identify and define anticipated lease conditions and support the SLC staff report and presentation for approval by the SLC	12 – 24 months	Requires certified NEPA/CEQA document and 401 permit to be underway	$50,000
California Department of Fish andGame (CDFG)	Incidental Take Permit in accordance with theCalifornia EndangeredSpecies Act (CESA)(Fish & Game Code § 2081)	A “take” of any endangered, threatened, or candidate species may be allowed by permit if it is incidental to an otherwise lawful activity and if the impacts of the authorized “take” are minimized and fully mitigated. CDFG maintains a list of threatened and endangered species designated under California Fish and Game Code 2070. To acquire this permit:- Coordinate with CDFG regarding affected habitats that may support state-listed rare, threatened, and endangered species and species of special concern- Determine whether a “take” of species designated by the California Fish and Game Commission as endangered or threatened- Apply for Incidental Take Permit, if required	6 - 12months	Certified NEPA/CEQA document required	Highly variable. Dependant on the number of species associated with the site$100,000 - $300,000 or up
	Lake/Streambed Alteration Agreement (Fish & Game Code §1602)	Under California Fish and Game Code Sections 1600–1607, CDFG may require agreements for projects that would substantially divert, obstruct, or change the natural flow of a river, stream, or lake; substantially change the bed, channel, or bank of a river, stream, or lake; or use material from a streambed. In practice, such agreements occur for projects that alter streambed lands up to the top of the stream bank, the outer edge of the riparian vegetation, or the edge of the 100-year floodplain. This permit requires: · Coordinate with CDFG regarding jurisdiction and potentially affected stream, riparian, and floodplain systems- Seek CDFG determination whether a Section 1601 agreement is necessary for the proposed project · Prepare Notification of Lake or Streambed Alteration (FG 2023) and Project Questionnaire (FG 2024) · Coordinate with CDFG regarding site inspections, additional information, approvals, and conditions · Facilitate consultation under Section 305(b) of the Sustainable Fisheries Act and the Fish and Wildlife Coordination Act · Obtain signed Agreement	6 - 12 months	Certified NEPA/CEQA document required	$50,000
California Coastal Commission (CCC)	Coastal Development Permit in accordance with the California Coastal Act (Pub. Res. Code § 30000 et seq.)	Development proposed within the state Coastal Zone requires a Coastal Development Permit issued by the CCC, except where a Local Coastal Plan (LCP) applies. For acquisition of this permit: · Consult early and continuously with the CCC regarding the proposed action, as well as physical and technological alternatives · Identify affected and important coastal zone resources · If appropriate, prepare a Memorandum of Agreement for the formation of a Joint Review Panel (JRP) · Coordinate the scope of marine biology and other marine resource evaluations · Facilitate review of proposed actions under the Coastal Act with the CCC, and actions evaluated under the City’s LCP. · Facilitate consultation under Section 305(b) of the Sustainable Fisheries Act · Facilitate a Coastal Act consistency determination for lead federal agency involvement · Prepare responses to CCC inquiries and comments and represent West Basin during public meetings · Provide approved CEQA/NEPA documents and other information required for permit approval	24-36 months	Requires certified NEPA/CEQA document	$500,000

Regulatory Agency	Regulatory Permit, Authorization or Approval	Key Requirements and General Permit Acquisition Approach	Anticipated Permit Acquisition Timeline	Comments	Estimated Cost
State Agencies					
California Department of Public Health (CDPH)	Permit to Operate a Public Water System (Health & Safety Code § 116525)	A permit from CDPH to operate a public water system is required to manage water quality and protect public health. This following components are required by regulatory mandate and/or are likely to be requried at the discretion of the CDPH District Engineer: · TMF Capacity · Technical / Engineering Report · Operations Plan · Water Quality Emergency Notification Plan · Distribution System Monitoring Plan · Watershed Sanitary Survey · Drinking Water Source Assessment and Protection Program Documentation · CT (Disinfection) Analysis · Operations Maintenance and Monitoring Plan · Chlorine / Chloramine Residual Stability Analysis · DBP Formation and Blending Analysis · Corrosion Control Analysis · Algal Toxin Monitoring, Rejection, and Control Analysis · Endocrine Disruptor Monitoring, Rejection, and Control Analysis · Seawater Desalination Integration Plan · Volumetic Concentration Factor Testing (if MF/UF is utilized in the treatment process) · Tracer Study · Integrity Verification Program (if MF/UF is utilized in the treatment process)	24 – 36 months		$1,100,000
California Department of Parks and Recreation Office of Historic Preservation	Coordination underSection 106 of the National Historic Preservation Act (NHPA) (16 USC 470 et seq.)	Section 106 of NHPA requires a federal agency with jurisdiction over a federally funded, federally assisted, or federally licensed activity to consider the effects of the agency's action on properties listed or eligible for listing in the National Register of Historic Places (NRHP). To acquire this permit:- Conduct an informal consultation with the State Historic Preservation Officer (SHPO) early in the project development stage- Identify and evaluate historic properties (literature search and Phase 1 terrestrial survey)- Evaluate properties eligible for listing in the NRHP- Formal consultation with the SHPO seeking agreement on effect and treatment of historic properties (if any)	6 -12 months	Finished prior to completion of NEPA/CEQA document	$20,000
California Department of Transportation (Caltrans)	Encroachment Permit (Streets & Highway Code § 660 et seq.)	Encroachments in, under, or over any portion of a state highway right-of-way, such as state Highway 1 (Sepulvada Ave). To acquire this permit: · Coordinate with Caltrans Permit Engineer · Complete an Encroachment Permit Application, including project information, drawings, plans and any prior approvals · Respond to Caltrans inquiries and facilitate permit approval process, as needed	12 – 24 months	Required prior to local ROW/Encroachment applications	$50,000

Regulatory Agency	Regulatory Permit, Authorization or Approval	Key Requirements and General Permit Acquisition Approach	Anticipated Permit Acquisition Timeline	Comments	Estimated Cost
Regional					
South Coast Air Quality Management District	Permit to Construct	All applications for permit to construct and Permit to Operate are evaluated for compliance with the prohibitory rules, one or more source specific rules, new source review rules for criteria and toxic air contaminants and other applicable rules and regulations. In addition, all applications have to meet the requirements for Public Notice, if applicable. Public notices are required for facilities that have risks or emissions that exceed the specified thresholds or for equipment located within 1,000 feet of a school. All such public notices are distributed to the communities near the project and parents of children attending nearby schools and are subject to a 30-day public comment period.	6 - 12 months	Required prior to construction	Variable dependant on the number of pieces of equipment that require permitting $100,000 - $250,000
	Permit to Operate	All applications for permit to construct and Permit to Operate are evaluated for compliance with the prohibitory rules, one or more source specific rules, new source review rules for criteria and toxic air contaminants and other applicable rules and regulations. In addition, all applications have to meet the requirements for Public Notice, if applicable. Public notices are required for facilities that have risks or emissions that exceed the specified thresholds or for equipment located within 1,000 feet of a school. All such public notices are distributed to the communities near the project and parents of children attending nearby schools and are subject to a 30-day public comment period.	6 - 12 months	Required prior to operations	Variable dependant on the number of pieces of equipment that require permitting $100,000 - $250,000
Metropolitan Water District of Southern California	Encroachment permit for work within Metropolitan Right-of-Way		12 – 24 months		$50,000
Local					
City of Redondo Beach	Encroachment Permit	The encroachment permit will typically regulate traffic control, stormwater pollution control, excavation and trenching, work hours, contractor license and insurance, construction, and inspection requirements	3 – 6 months	Dependant on which alternative is selected. May not be required	$20,000
City of El Segundo	Encroachment Permit	The encroachment permit will typically regulate traffic control, stormwater pollution control, excavation and trenching, work hours, contractor license and insurance, construction, and inspection requirements	3 - 6 months	Dependant on which alternative is selected. May not be required	$20,000
City of Manhattan Beach	Encroachment Permit	The encroachment permit will typically regulate traffic control, stormwater pollution control, excavation and trenching, work hours, contractor license and insurance, construction, and inspection requirements	3 – 6 months	Dependant on which alternative is selected. May not be required	$20,000
City of Hermosa Beach	Encroachment Permit	The encroachment permit will typically regulate traffic control, stormwater pollution control, excavation and trenching, work hours, contractor license and insurance, construction, and inspection requirements	3 – 6 months	Dependant on which alternative is selected. May not be required	$20,000
City of Lawndale	Encroachment Permit	The encroachment permit will typically regulate traffic control, stormwater pollution control, excavation and trenching, work hours, contractor license and insurance, construction, and inspection requirements	3 – 6 months	Dependant on which alternative is selected. May not be required	$20,000
City of Hawthorne	Encroachment Permit	The encroachment permit will typically regulate traffic control, stormwater pollution control, excavation and trenching, work hours, contractor license and insurance, construction, and inspection requirements	3 – 6 months	Dependant on which alternative is selected. May not be required	$20,000
City of Gardena	Encroachment Permit	The encroachment permit will typically regulate traffic control, stormwater pollution control, excavation and trenching, work hours, contractor license and insurance, construction, and inspection requirements	3 – 6 months	Dependant on which alternative is selected. May not be required	$20,000
City of Torrance	Encroachment Permit	The encroachment permit will typically regulate traffic control, stormwater pollution control, excavation and trenching, work hours, contractor license and insurance, construction, and inspection requirements	3 – 6 months	Dependant on which alternative is selected. May not be required	$20,000

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

Facility Operations & Maintenance Plan (OMP)

January 2013

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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.

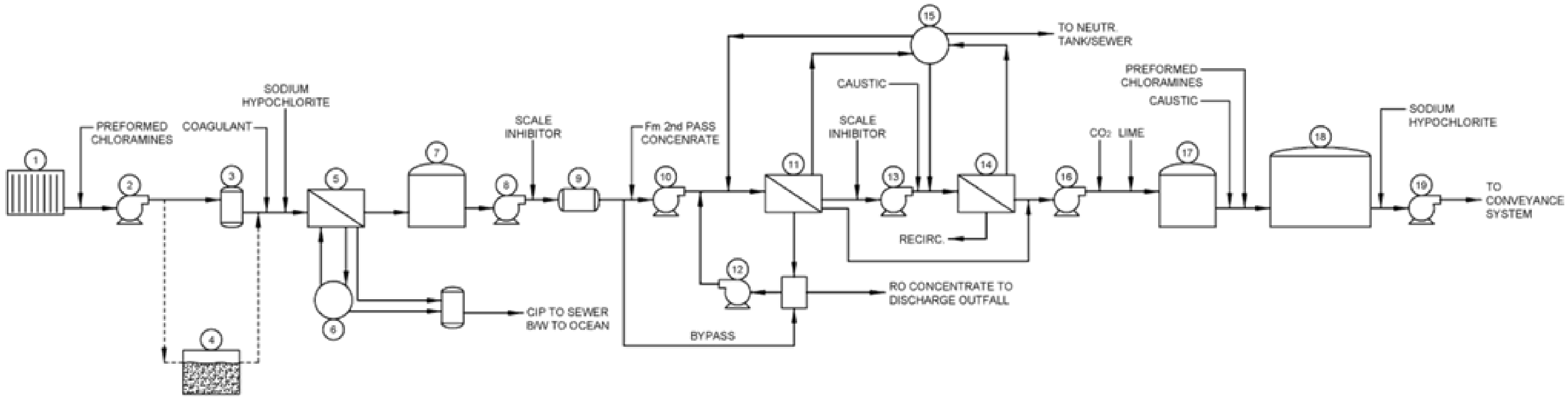
2.6. Treatment Process Overview

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

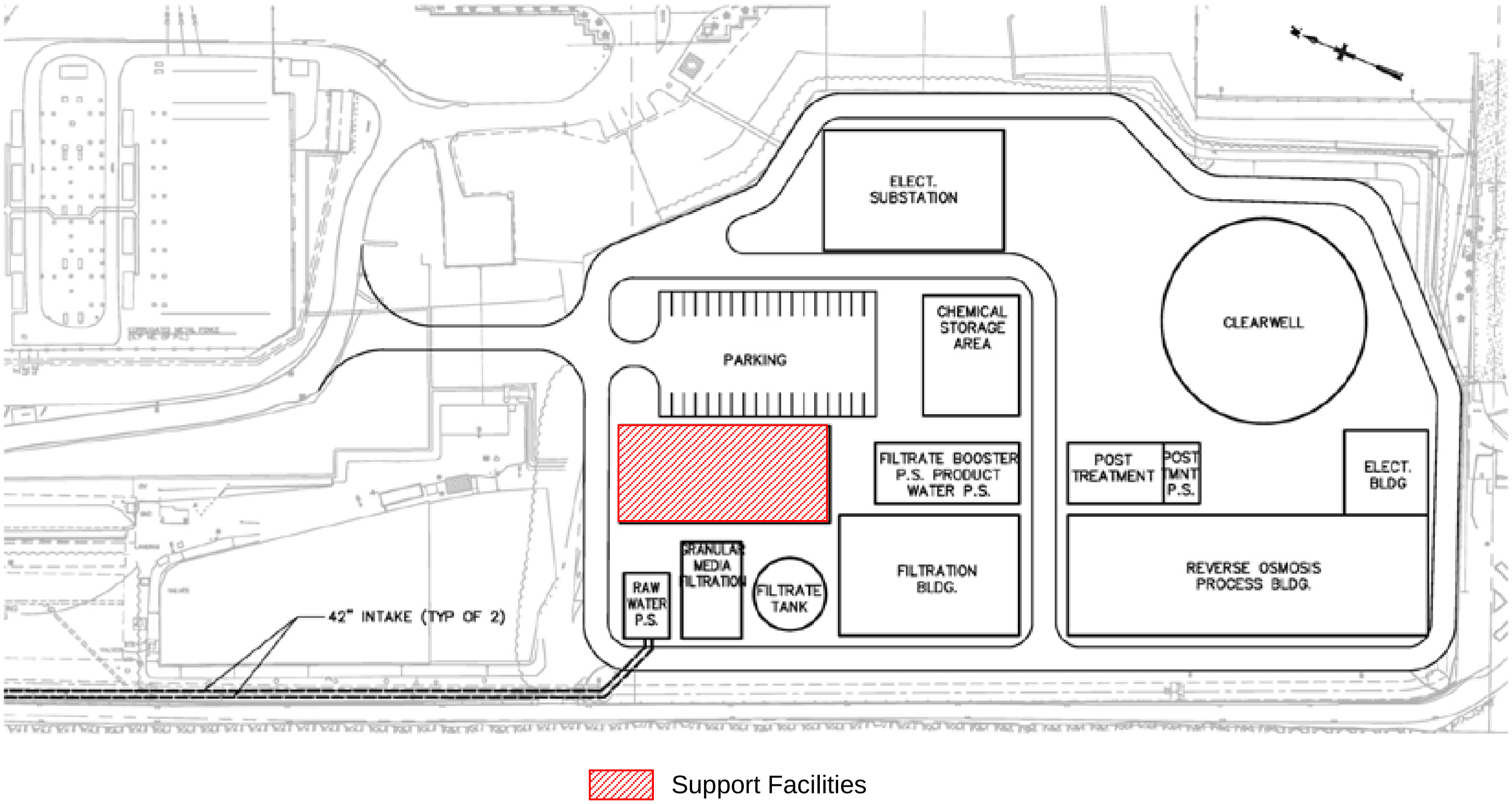


Figure 6-2: AES Preliminary Site Layout – 20 MGD Support Facilities

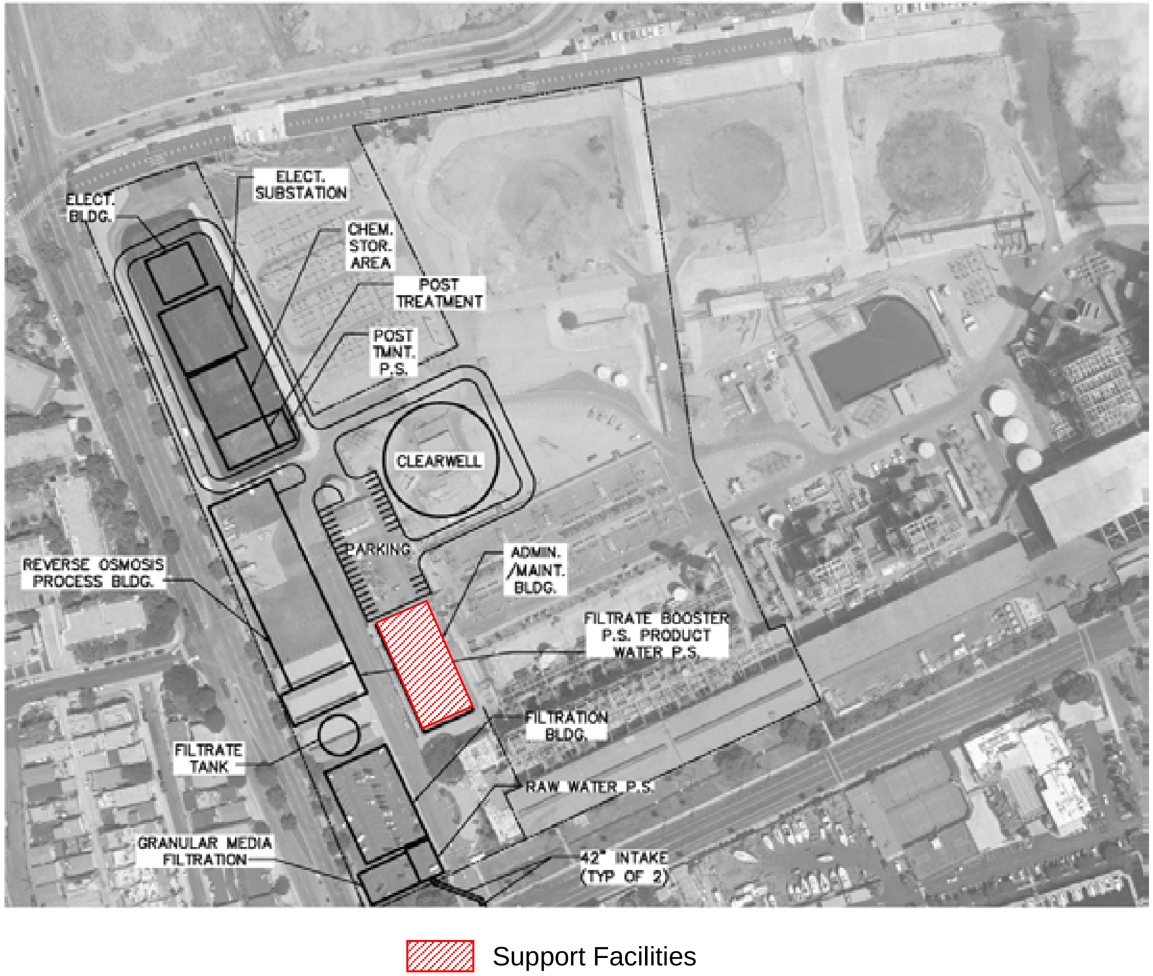


Figure 6-3: NRG Preliminary Site Layout – 60 MGD Support Facilities

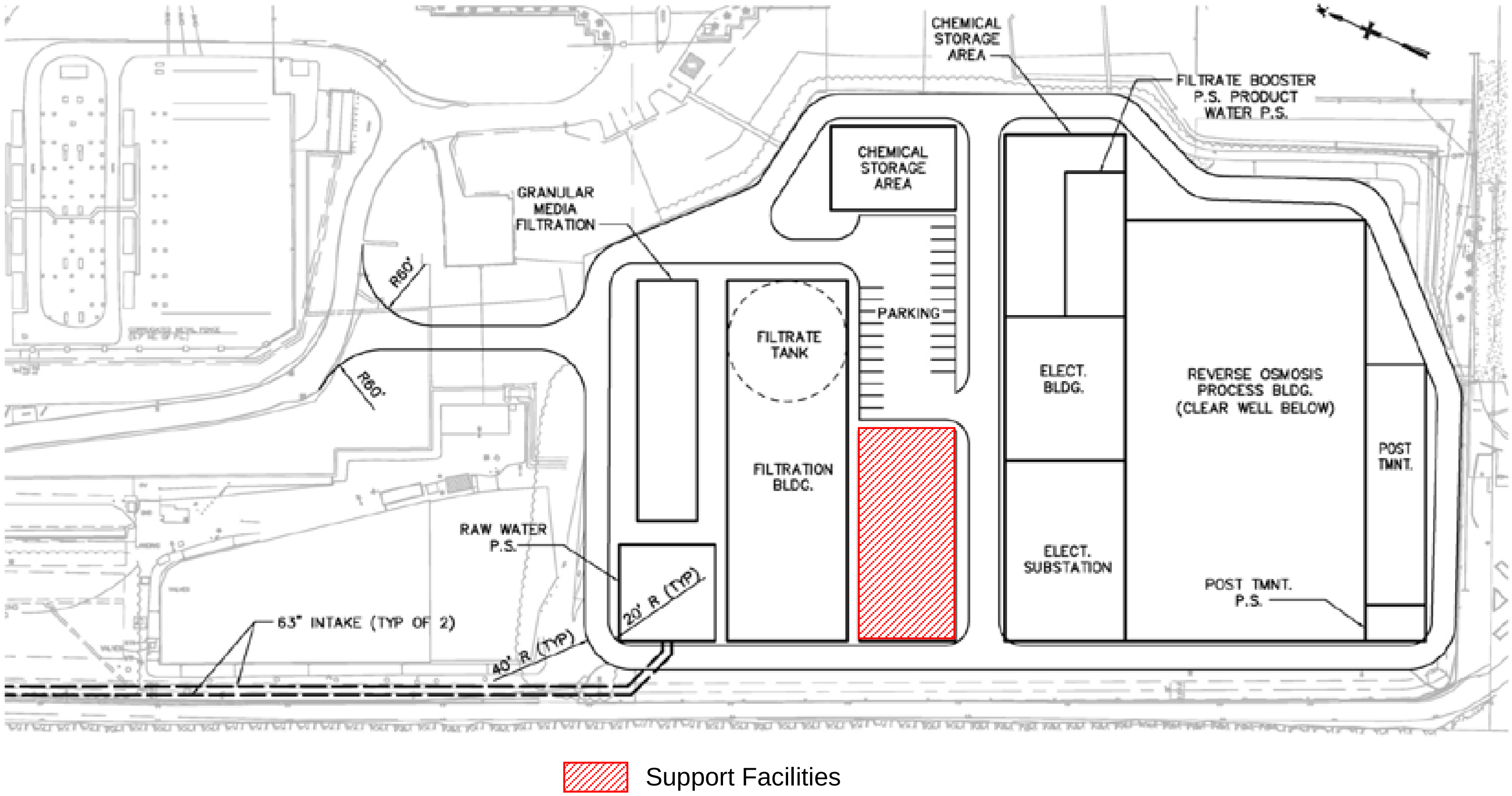
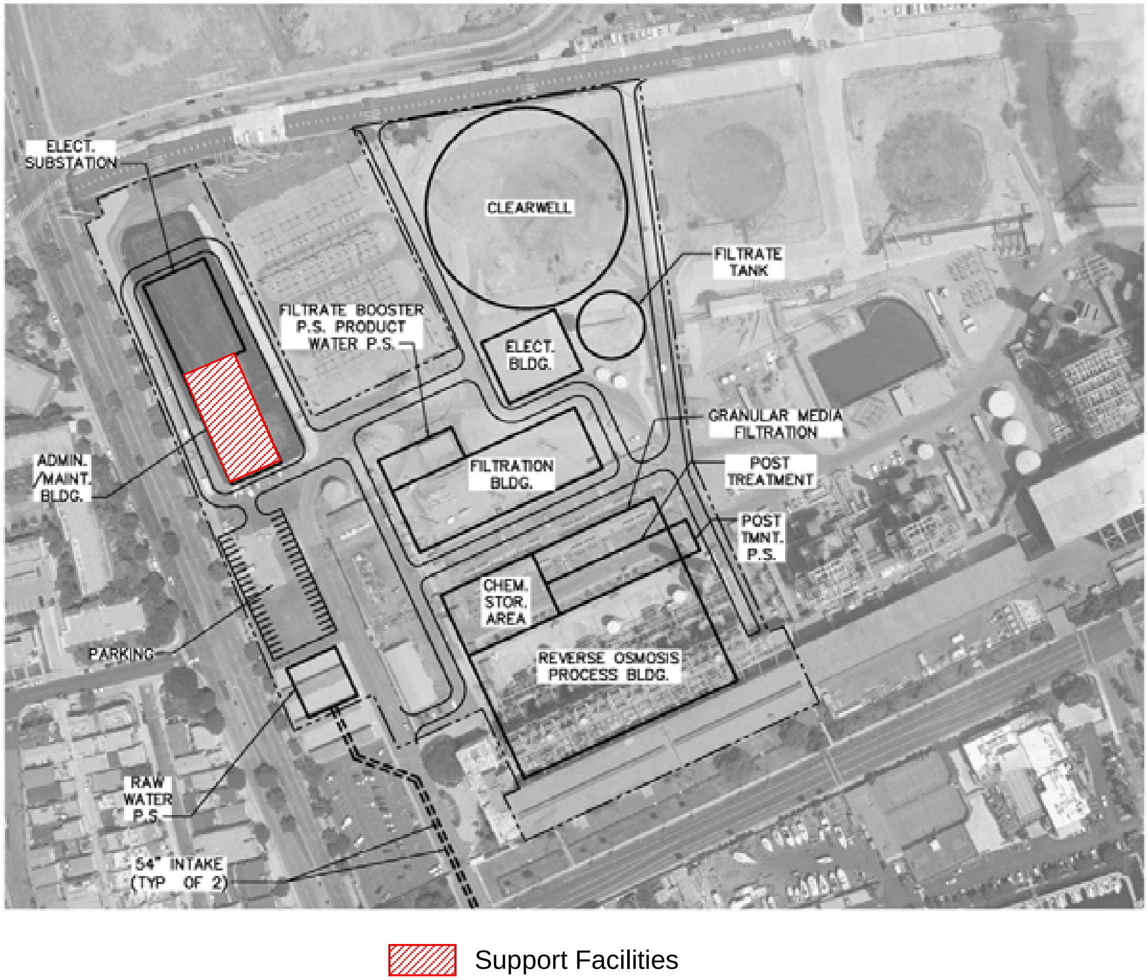


Figure 6-4: AES Preliminary Site Layout – 60 MGD Support Facilities



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

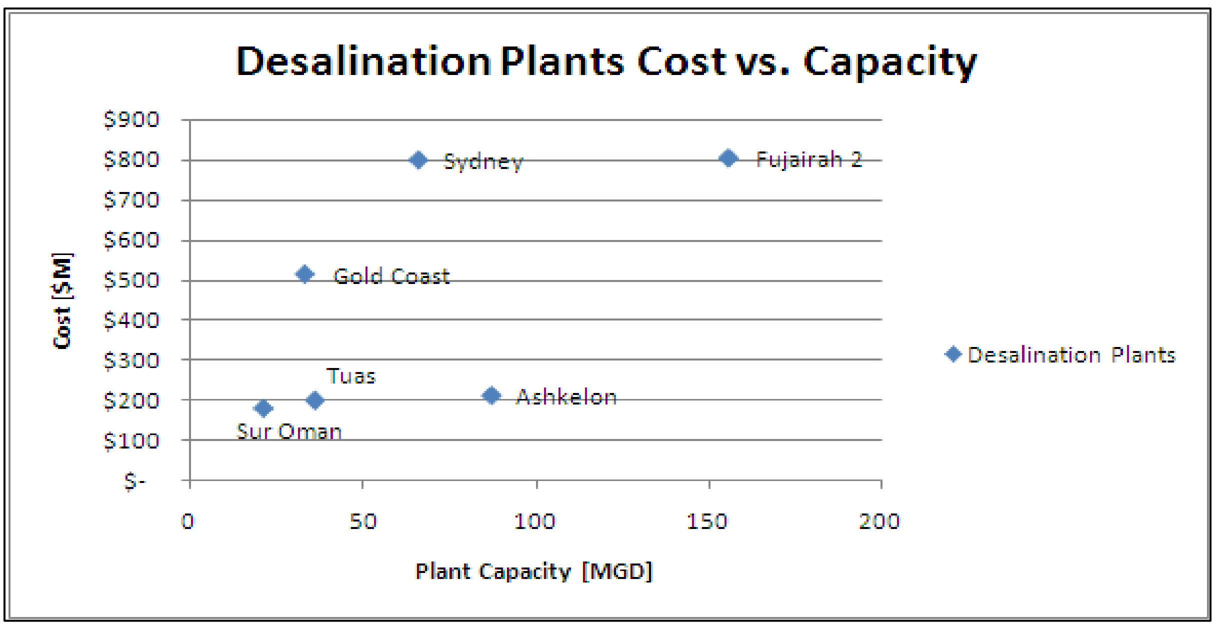


Table 8-2: Example of Desalination Projects

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.

West Basin Municipal Water District

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Ocean Water Desalination Program Master Plan (PMP)

Project Costs & Funding Plan (PFP)

January 2013

Report Prepared By:

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Appendices

Acronyms Used in the Technical Memo

AACE	American Association of Cost Engineering
ACOE	Army Corps of Engineers
ARRTA	American Recovery and Reinvestment Tax Act of 2009
AF	Acre-Foot
BABS	Build America Bonds
CIP	Clean-In-Place
CSDPR	Conceptual System Design and Program Requirements
CREWS	Clean Renewable Water Supply Bond Act of 2009
DB	Design-Build
DBB	Design-Bid-Build
DBO	Design-Build Operate
DBOOT	Design Build Own Operate Transfer
EWD	Energy and Water Development
FTE	Full Time Equivalent
FY	Fiscal Year
I&C	Instrumentation and Control
IRWM	Integrated Regional Water Management
IRWMP	Integrated Regional Water Management Plan
JPA	Joint Powers Authority
KV	Kilovolt
LRP	Local Resources Program
MCC	Motor Control Center
MGD	Million Gallons per Day
NCPPP	National Council on Public-Private Partnerships
O&M	Operations and Maintenance
OM&M	Operations, Maintenance, and Management
OWDPMP	Ocean Water Desalination Program Master Plan
P3	Public Private Partnerships

PPP	Public Private Partnerships
PSC	Public Sector Comparator
QTCB	Qualified Tax Credit Bond
RO	Reverse Osmosis
SCADA	Supervisory Control and Data Acquisition
SDP	Seawater Desalination Program
SPV	Special Purpose Vehicle
SRF	State Revolving Fund
SWRO	Surface Water Reverse Osmosis
VfM	Value for Money
WIFIA	Water Infrastructure Finance and Innovation Authority

1. Introduction

1.1. Objective

This Technical Memorandum addressing Project Costs and Funding (PFP) was prepared for the West Basin Municipal Water District (West Basin) to accomplish the following:

- Provide an overview of complete project costs for all plant sizes and capacity buildout scenarios.
- Outline the potential sources of project funding at local, state, and federal levels available to West Basin.
- Identify viable project funding structures available for funding the desalination facility.
- Develop funding schedule and sequence, including detail of the debt amount, financing vehicle, rates, repayment, and other financial considerations.

A summary of capital and annual O&M costs is provided in Section 2. An overview of complete project costs, including planning phase through construction/operation is provided in **Table 2-22**.

Funding options, and associated advantages and disadvantages, presented in Section 3 of this Technical Memo include:

- Federal
  - U.S. Bureau of Reclamation
  - U.S. Army Corp of Engineers
  - Water Infrastructure Finance and Innovation Authority (WIFIA)
- State
  - Proposition 84
  - Safe, Clean and Reliable Drinking Water Supply Act of 2012
- Regional
  - Metropolitan Local Resources Program (LRP)
  - Metropolitan Seawater Desalination Program (SDP)
- Public Private Partnerships (PPP)
  - Investment Funds
  - Qualified Tax Credit Bond (QTCB)

The cost of water parameters in this PMP will feed into West Basin's financial impact analysis.

The funding schedule/sequence is provided in Section 4. This section discusses the timing of borrowings, including project schedule, discrete project elements, financing vehicles, and customer rate impact considerations.

2. Capital and O&M Cost Summary

2.1. Cost Opinion Development

The cost opinions provided in this TM address both of the alternative site locations identified the in the CSDPR (TM-1), and are based on the conceptual criteria also provided in TM-1. The TM-1 and project scope originally identified a single local and single regional project. The scope of this PMP has since been expanded to include a range of treatment and delivery strategies, which are outlined in Section 2.1.2. The cost opinions provided herein are considered by the American Association of Cost Engineering (AACE) criteria as a Class 4 estimate. A Class 4 estimate is defined as a Planning Level or Design Technical Feasibility Estimate. Typically, engineering is from 1 percent to 15 percent complete. The expected accuracy for Class 4 estimates typically range from -30 percent to +50 percent, depending on the technological complexity of the project, appropriate reference information, and the inclusion of an appropriate contingency determination.

2.1.1. Work Area Breakdown

The cost opinions are divided into distinct process areas, or work areas, to assess and present the capital costs. These divisions are broken down into the following work areas:

Intake and Raw Water Conveyance:	Covers the complete intake system including screens, conveyance piping inside the existing tunnel, conveyance to the on-shore raw water pumping station, and the raw water pumping station.
Pretreatment:	This sub-section includes the pretreatment systems required for conditioning and delivery of the raw ocean water to the RO Treatment including membrane filtration pre-treatment (disk screens), membrane filtration and appurtenances (i.e., CIP), Filtration Building, Filtrate storage and pumping, and pre-treatment chemical storage and handling systems.
Treatment:	Covers the SWRO first pass treatment trains and second pass treatment trains, including RO CIP, cartridge filtration, energy recovery systems, and RO Building.
Post-Treatment:	This sub-section covers the post-treatment systems required for conditioning and disinfection of the RO permeate. It includes the post stabilization chemical storage and handling systems (carbon dioxide, lime

slurry, lime saturators, storage tanks), lime contact tanks, transfer pumping station, sodium hypochlorite storage and handling system, and ammonia storage and handling system.

Product Water Pumping & Storage: Addresses the product water pumping and storage for each scenario, including clearwell, product water pump station, and conveyance pipelines.

Residuals Handling & Concentrate Discharge:

Covers the concentrate conveyance pipeline, diffuser system, backwash handling, and CIP Neutralization storage and handling.

Power Supply: Includes the on-site electrical substation/transformer. The cost for this work area is reflected in the estimates as a fixed monthly charge from SCE, which covers capital and O&M costs. See Power Supply TM.

Electrical Building: Includes the building for housing the plant's electrical gear in a centralized location, including MCC's, switchgear and variable frequency drives. The costs for electrical gear are not included in this work area – they are derived as a percentage of the applicable work areas.

Administrative/ Education Center Building:

This area includes the buildings for administrative, operations, and laboratory personnel, including a control room, offices, laboratory, and education center facilities.

2.1.2. Scenarios

The CSPDR identified two flow scenarios, specifically local and regional cases of 20-MGD and 60-MGD, respectively. In coordination with West Basin, these cases were expanded to include a total of five scenarios which are described below.

2.1.2.1. 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.

2.1.2.2. 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.

2.1.2.3. 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.

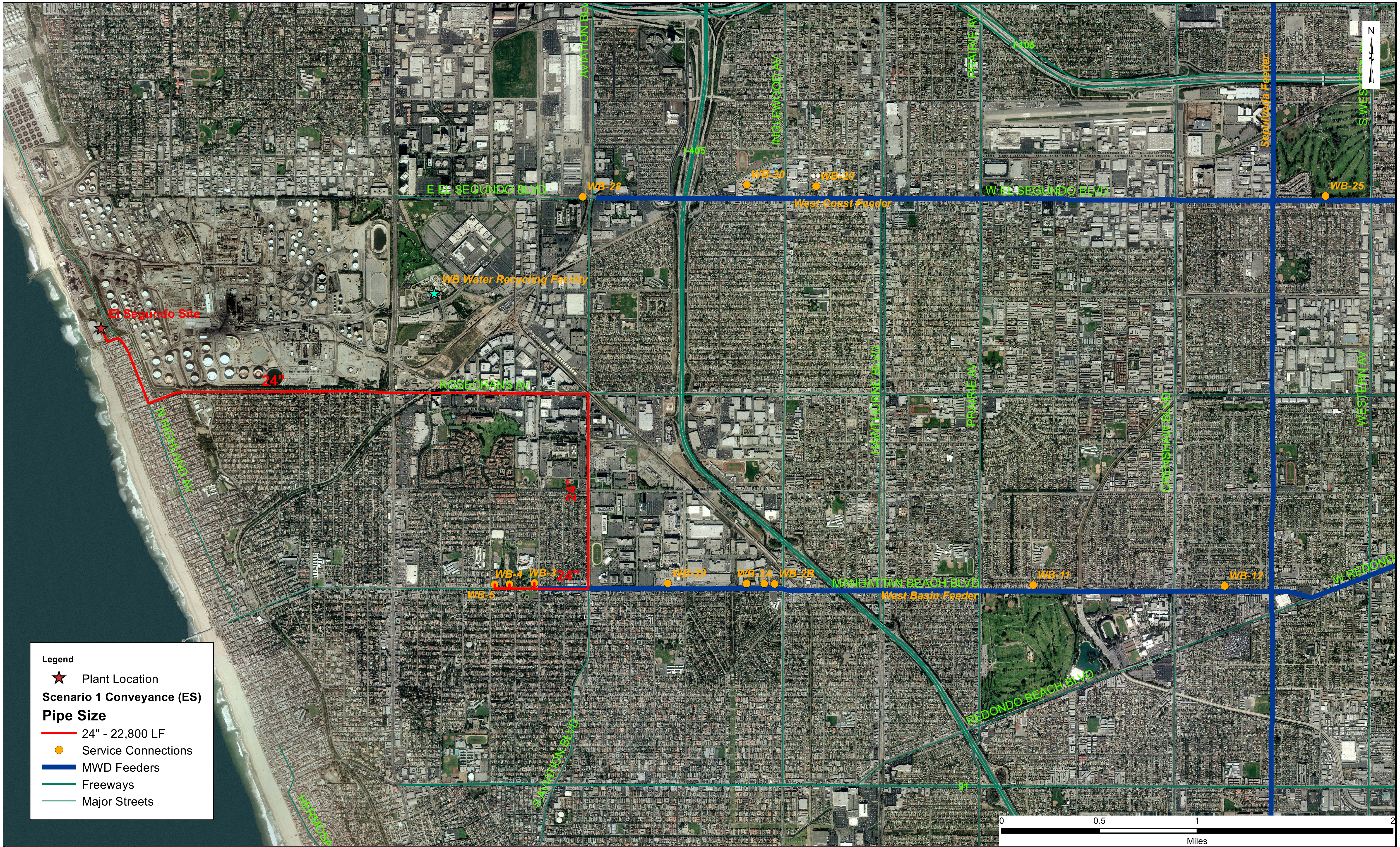
2.1.2.4. Scenario 3B: 40-MGD Facility

Scenario 3B is a fully built-out 40-MGD facility. No provisions are included for future expansion of the plant.

2.1.2.5. 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.

Figures 2-1 through 2-8 depict the preliminary pipeline alignments, sizing, and connections for these scenarios.



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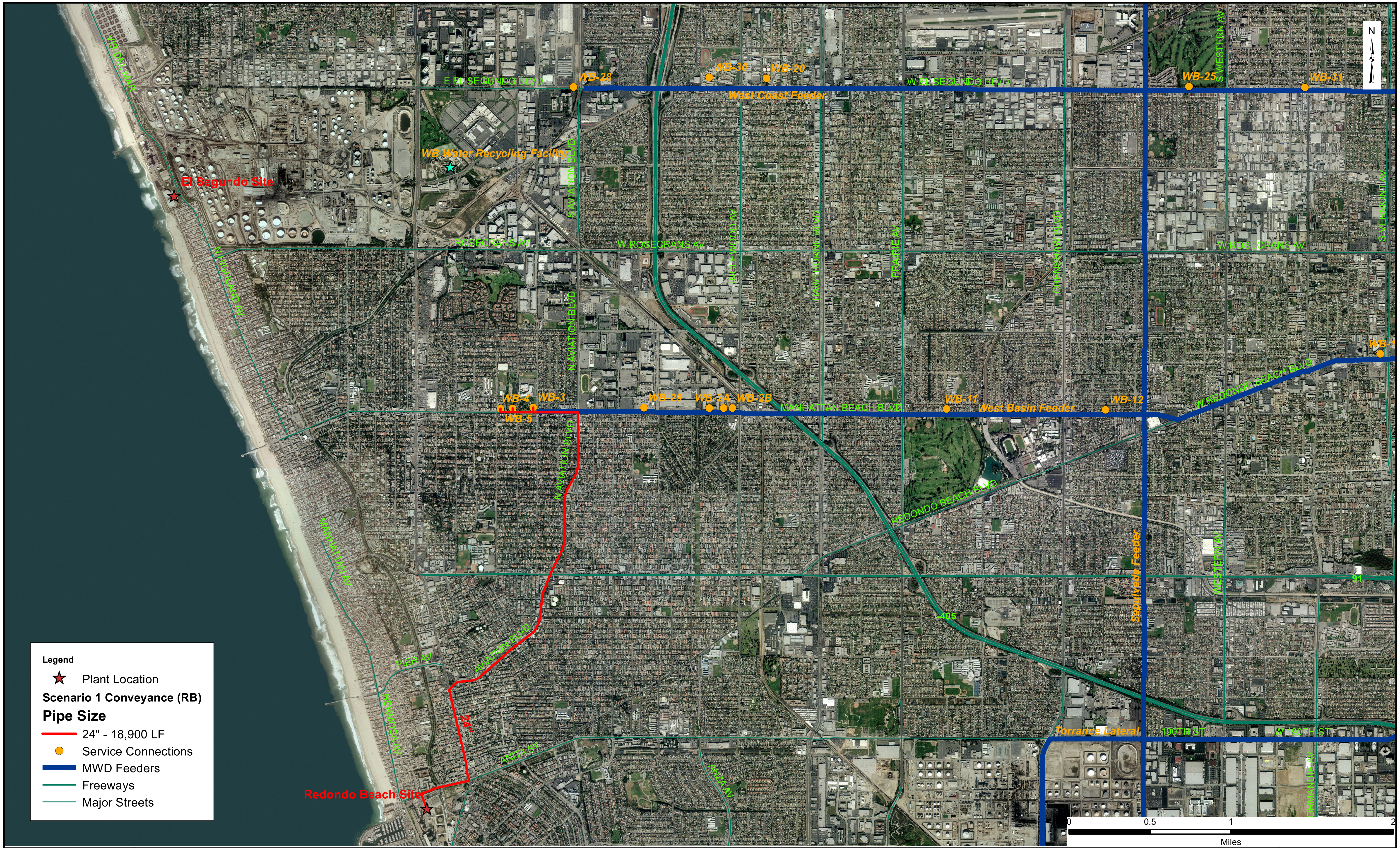
EL SEGUNDO SITE - LOCAL CONNECTIONS
CONVEYANCE PIPING
SCENARIO 1: 10-MGD FACILITY

PIRNIE/ARCADIS U.S.
JANUARY 2013
FIGURE 2-1



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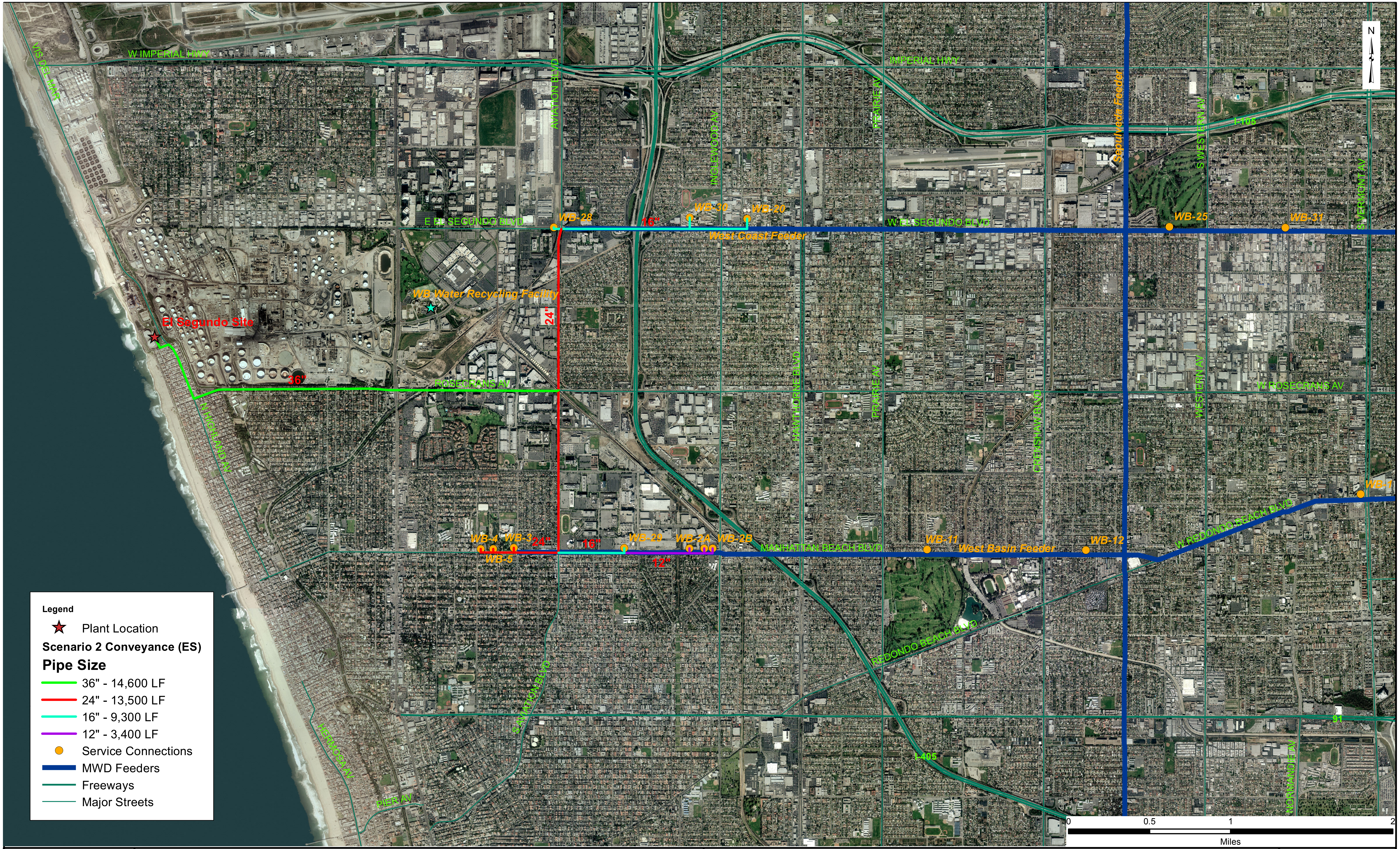
REDONDO BEACH SITE - LOCAL CONNECTIONS
CONVEYANCE PIPING
SCENARIO 1: 10-MGD FACILITY

PIRNIE/ARCADIS U.S.
JANUARY 2013
FIGURE 2-2



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EL SEGUNDO SITE - LOCAL CONNECTIONS
CONVEYANCE PIPING
SCENARIO 2: 20-MGD FACILITY

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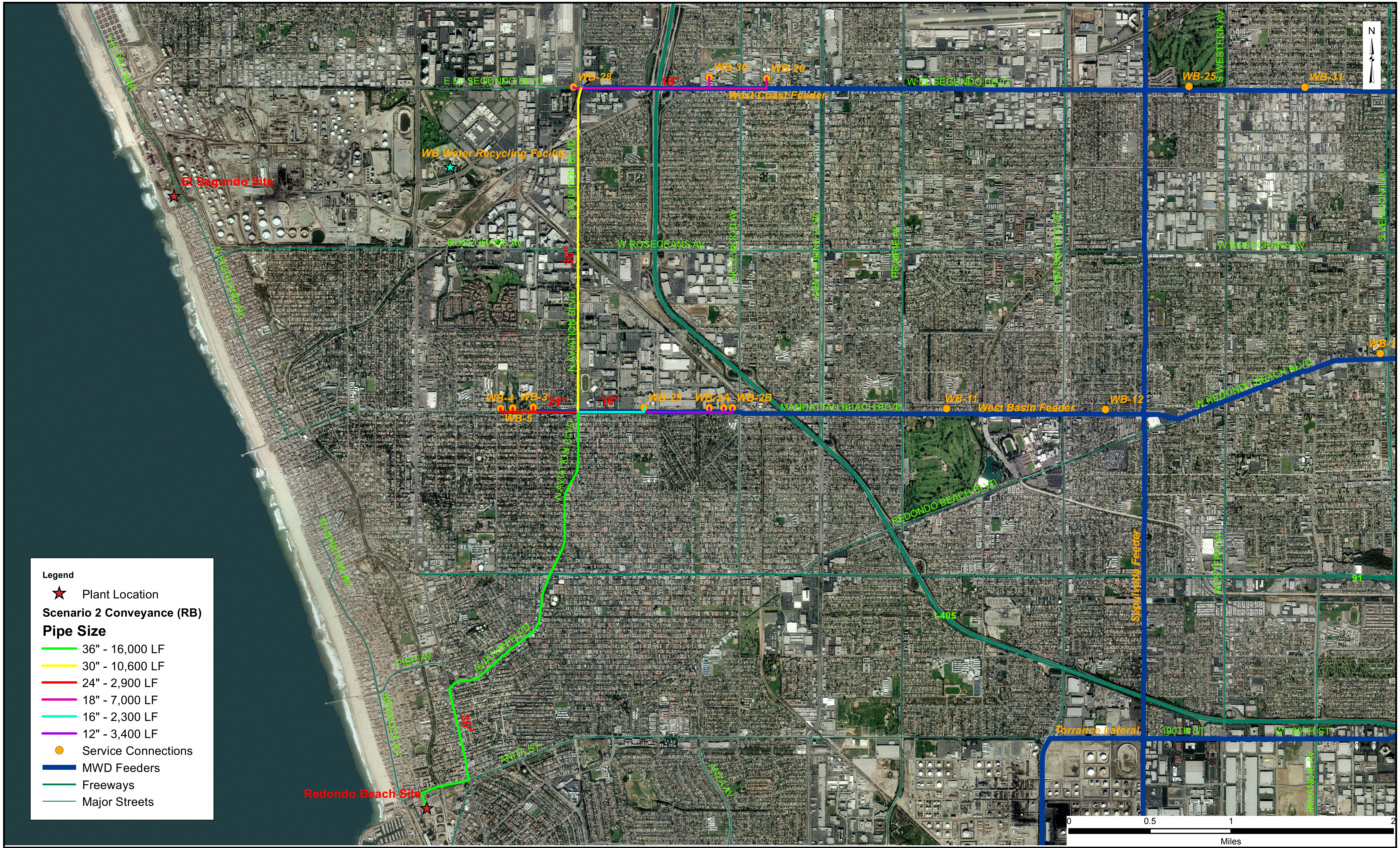
JANUARY 2013
FIGURE 2-3



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REDONDO BEACH SITE - LOCAL CONNECTIONS
CONVEYANCE PIPING
SCENARIO 2: 20-MGD FACILITY

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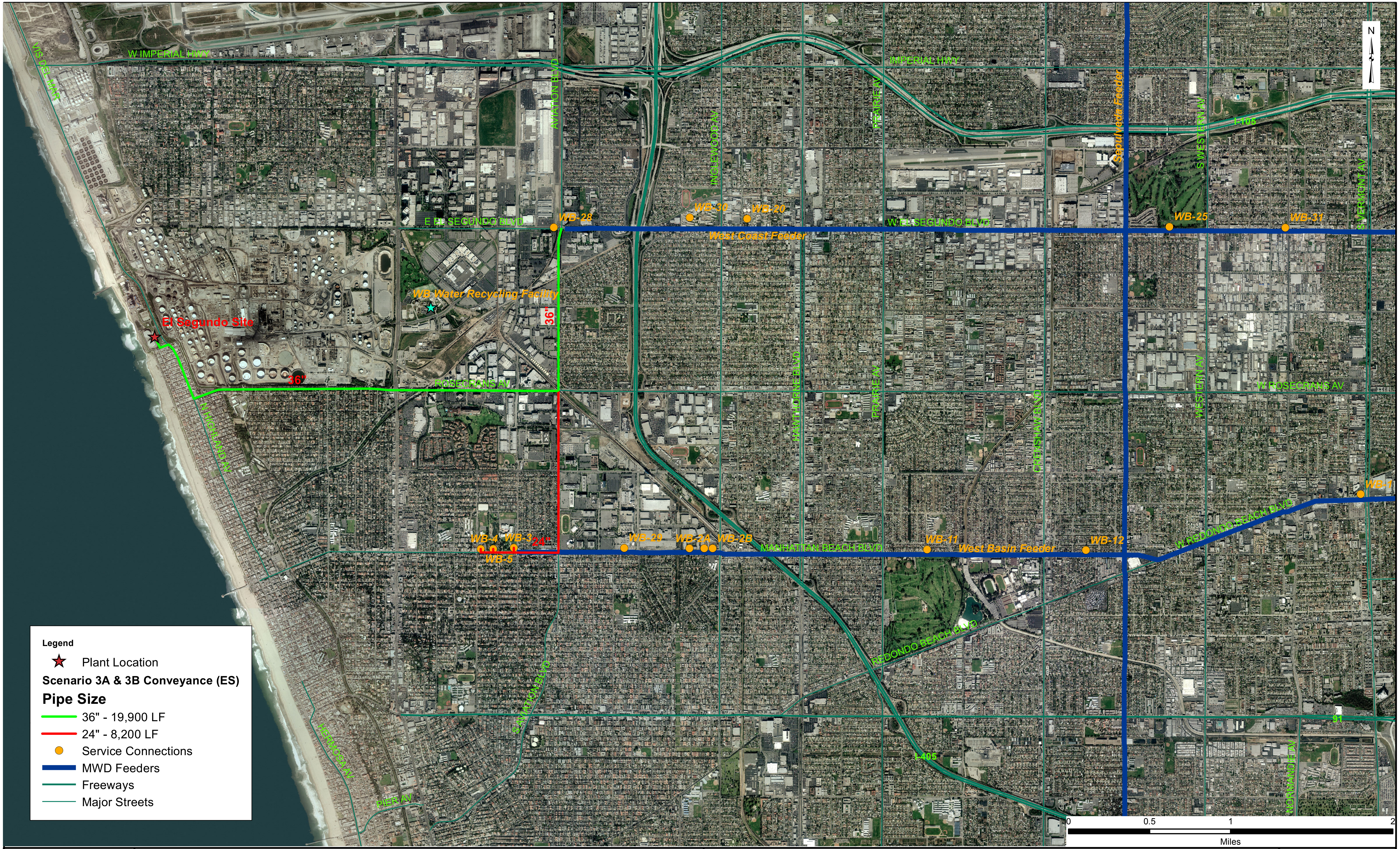
JANUARY 2013
FIGURE 2-4



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EL SEGUNDO SITE - LOCAL CONNECTIONS
CONVEYANCE PIPING
SCENARIO 3A: 10-MGD (WITH 40-MGD BACKBONE) & 3B: 40-MGD FACILITY

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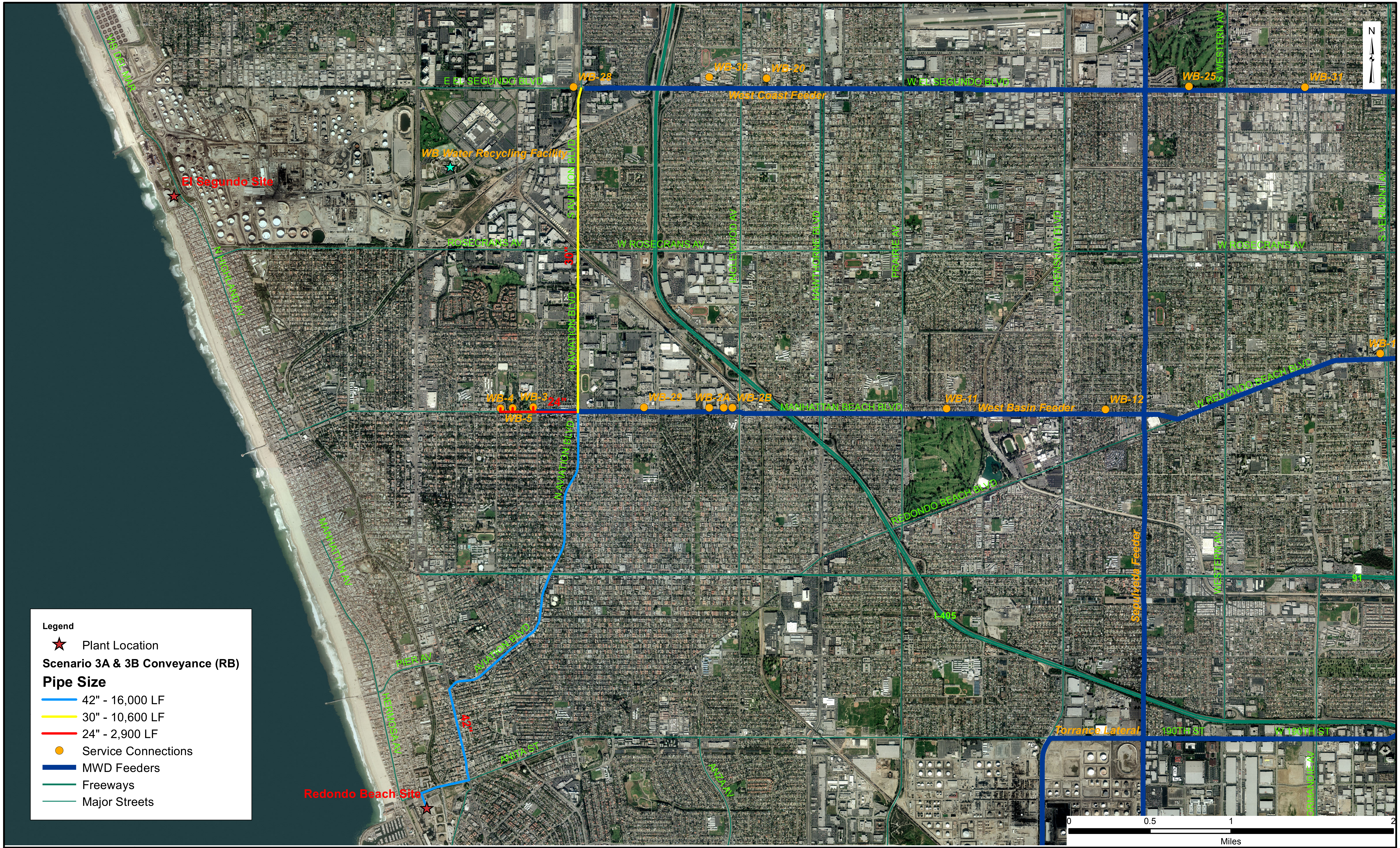
JANUARY 2013
FIGURE 2-5



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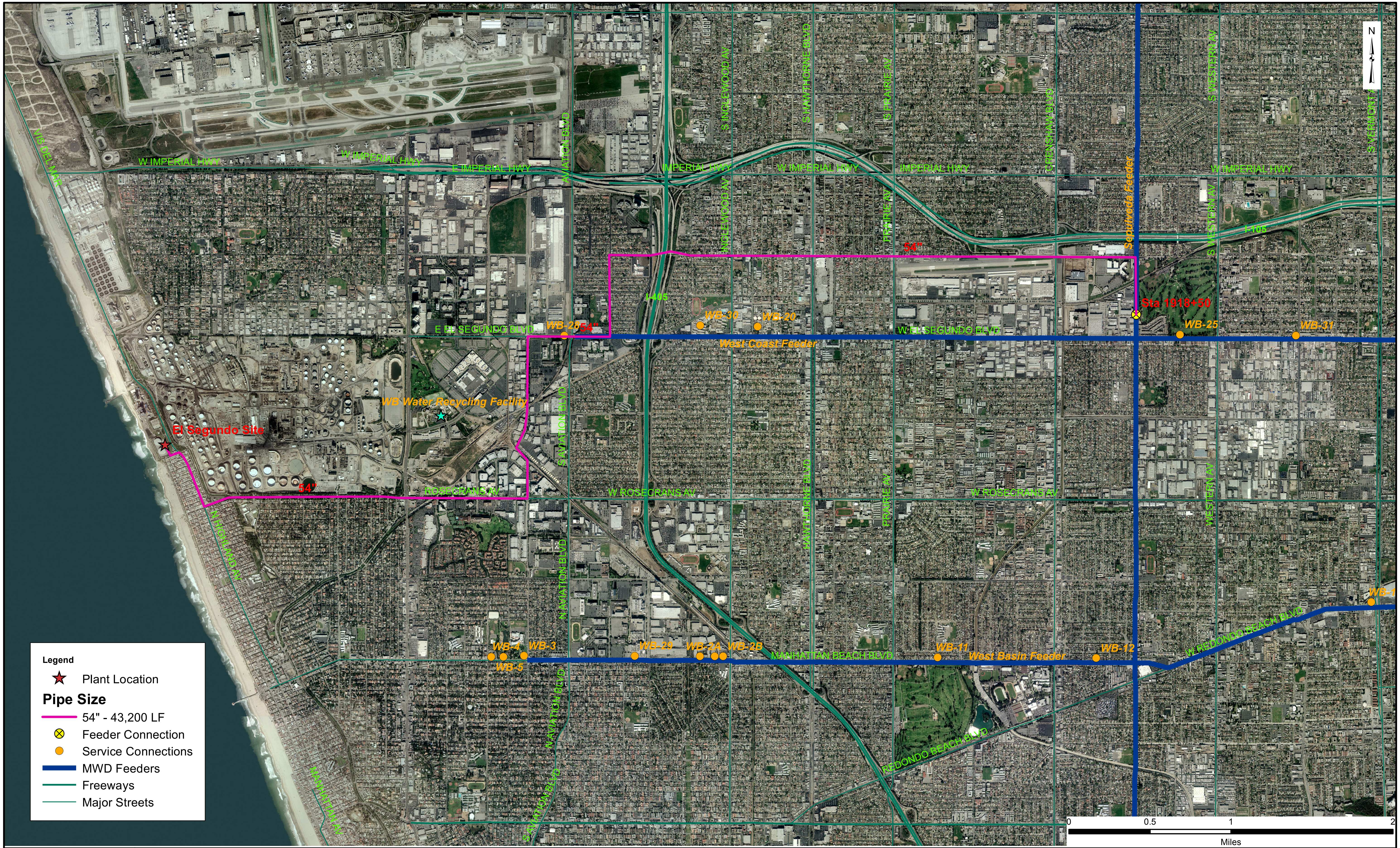
REDONDO BEACH SITE - LOCAL CONNECTIONS
CONVEYANCE PIPING
SCENARIO 3A: 10-MGD (WITH 40-MGD BACKBONE) & 3B: 40-MGD FACILITY

PIRNIE/ARCADIS U.S.
JANUARY 2013
FIGURE 2-6



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OCEAN WATER DESALINATION PMP

CONTRACT NO. 05052016.0000

EL SEGUNDO SITE - CONNECTION TO SEPULVEDA FEEDER

CONVEYANCE PIPING
SCENARIO 4: 60-MGD FACILITY

PIRNIE/ARCADIS U.S.

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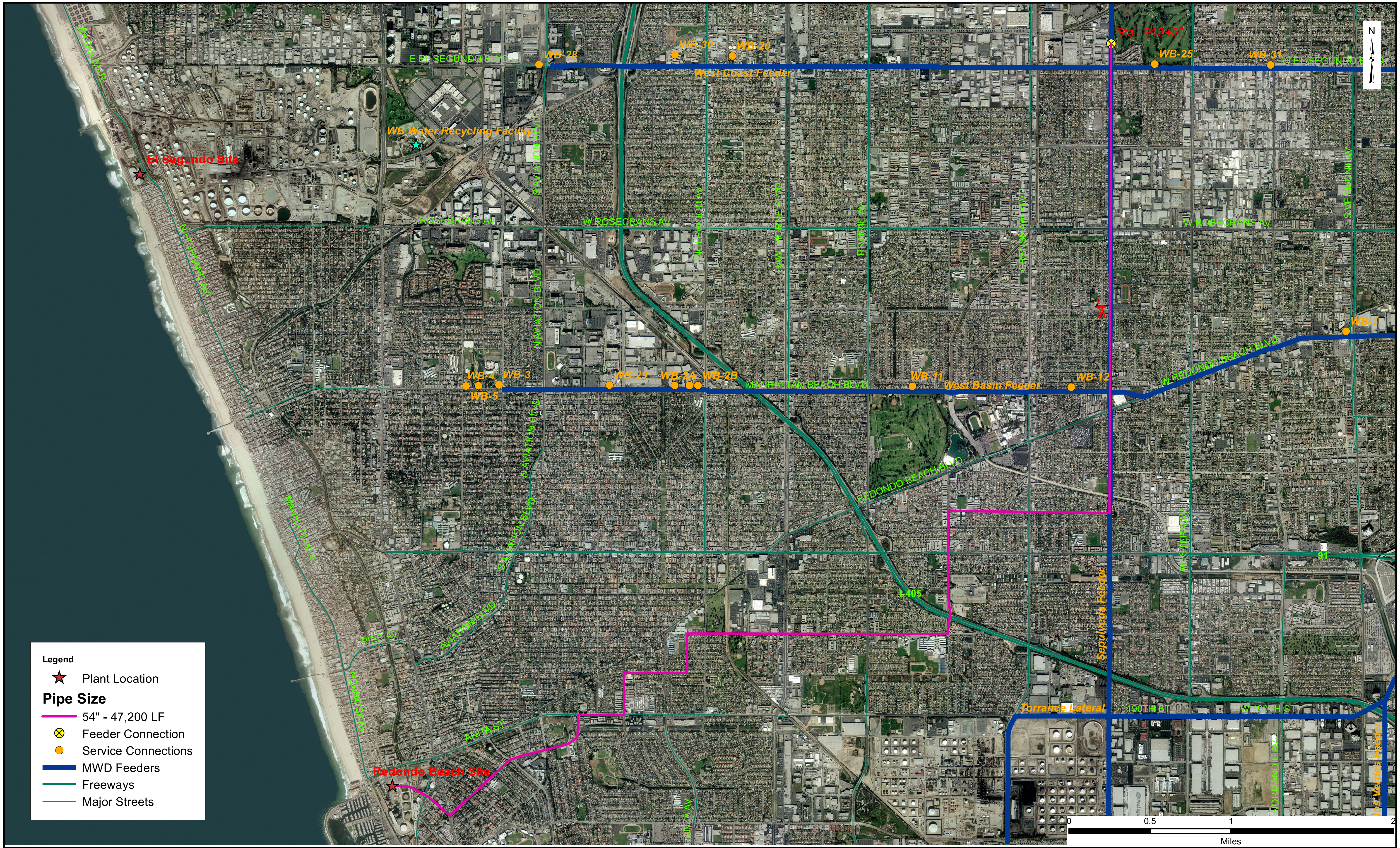
FIGURE 2-7



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OCEAN WATER DESALINATION PMP
CONTRACT NO. 05052016.0000

REDONDO BEACH SITE - CONNECTION TO SEPULVEDA FEEDER
CONVEYANCE PIPING
SCENARIO 4: 60-MGD FACILITY

PIRNIE/ARCADIS U.S.
JANUARY 2013
FIGURE 2-8

2.2. Capital Cost

Costing assumptions include the following:

- Plant capacities as stated for the scenarios listed in Section 2.1.2.
- Treatment Train assumptions provided by West Basin based on current pilot study and demonstration testing efforts, and as summarized in previous sections.
- Buildings required for screening, filtration, RO, pumping stations, electrical and administrative/education. Chemical storage tanks are covered but not enclosed.
- Interconnecting Piping, Plant Electrical, SCADA/I&C, Architectural and HVAC, and Civil/Sitework costs are based on percentage of equipment costs. Percentages are included in the assumptions tab of the cost spreadsheet.
- Cost for purchase or leasing of on-shore (Land), or off-shore facilities (tunnel structures) is not included in this estimate. However, cost for a switchyard lease is included in this estimate under the O&M cost section.

2.2.1. Indirect Project Costs

To account for a range of values associated with the various indirect project costing assumptions used in this estimate, and to assess the sensitivity of the estimate to this potential variability, three costing categories were selected:

High:

This category reflects the high cost estimate and is based on a more conservative range of percentages used for project indirect costs. This category also includes a 50% partial second pass RO.

Mobilization/Demobilization:	2.0%
Bonds & Insurance:	1.5%
Contractors Overhead and Profit:	15%
Professional Services:	20%
Contingency:	30%

Base:

This category reflects an anticipated range of percentages used for project indirect costs based on anticipated construction market trends and a higher level of preliminary design development associated with various plant components.

Mobilization/Demobilization: 2.0%

Bonds & Insurance: 1.0%

Contractors Overhead and Profit: 12%

Professional Services: 18%

Contingency: 20%

Low:

This category reflects the low cost estimate and is based on a low level of conservatism associated with the range of percentages used for project indirect costs.

Mobilization/Demobilization: 1.0%

Bonds & Insurance: 0.5%

Contractors Overhead and Profit: 8%

Professional Services: 15%

Contingency: 15%

2.2.2. Capital Cost Summaries

Tables 2-1 and 2-2 present the capital cost summaries for the 10-MGD Scenario at El Segundo and Redondo Beach sites, respectively. The detailed backup for these cost opinions are provided in **Appendix 7:A**.

Table 2-1: Capital Cost Opinion El Segundo: 10 MGD Scenario 1

	Work Area Description	**Project Cost**	**% of Total**		
Capital Cost					
1.0	Intake	$5,800,000	6%		
2.0	Pretreatment	$24,130,000	24%		
3.0	Reverse Osmosis	$36,640,000	37%		
4.0	Post-Treatment & Disinfection	$4,530,000	5%		
5.0	Product Water Pumping, Storage & Conveyance	$16,290,000	16%		
6.0	Residuals Handling & Concentrate Discharge	$2,570,000	3%		
7.0	Power Supply (Redundancy Setup Fee Only)	$2,000,000	2%		
8.0	Electrical Building	$620,000	1%		
9.0	Admin/Maint	$6,940,000	7%		
	Subtotoal	**$99,520,000**	**100%**		
			Low	**Base**	**High**
	Mobilization / Demobilization		$995,200	$1,990,400	$1,990,400
	Bonds & Insurance		$497,600	$995,200	$1,492,800
	Overhead & Profit		$7,961,600	$11,942,400	$14,928,000
	Un-Priced A (CONTINGENCY)		$14,928,000	$19,904,000	$29,856,000
	Subtotal Construction Cost		**$123,902,400**	**$134,352,000**	**$147,787,200**
	Professional Services		$18,585,360	$24,183,360	$29,557,440
	Total Capital Cost		**$142,487,760**	**$158,535,360**	**$177,344,640**

Table 2-2: Capital Cost Opinion Redondo: 10 MGD Scenario 1

	Work Area Description	Project Cost	% of Total		
Capital Cost					
1.0	Intake	$5,240,000	5%		
2.0	Pretreatment	$24,130,000	25%		
3.0	Reverse Osmosis	$36,640,000	38%		
4.0	Post-Treatment & Disinfection	$4,530,000	5%		
5.0	Product Water Pumping, Storage & Conveyance	$14,090,000	15%		
6.0	Residuals Handling & Concentrate Discharge	$2,280,000	2%		
7.0	Power Supply (Redundancy Setup Fee Only)	$2,000,000	2%		
8.0	Electrical Building	$620,000	1%		
9.0	Admin/Maint	$6,940,000	7%		
	Subtotal	**$96,470,000**	**100%**		
			Low	**Base**	**High**
	Mobilization / Demobilization		$964,700	$1,929,400	$1,929,400
	Bonds & Insurance		$482,350	$964,700	$1,447,050
	Overhead & Profit		$7,717,600	$11,576,400	$14,470,500
	Un-Priced Allowances (Contingency)		$14,470,500	$19,294,000	$28,941,000
	Subtotal Construction Cost		**$120,105,150**	**$130,234,500**	**$143,257,950**
	Professional Services		$18,015,773	$23,442,210	$28,651,590
	Total Capital Cost		**$138,120,923**	**$153,676,710**	**$171,909,540**

Tables 2-3 and 2-4 include the capital cost summaries for the 20-MGD Scenario at El Segundo and Redondo Beach sites, respectively. The detailed backup for these cost opinions are provided in **Appendix 7:A**.

Table 2-3: Capital Cost Opinion El Segundo: 20 MGD Scenario 2

	Work Area Description	**Project Cost**	**% of Total**		
Capital Cost					
1.0	Intake	$7,580,000	4%		
2.0	Pretreatment	$46,050,000	25%		
3.0	Reverse Osmosis	$73,240,000	40%		
4.0	Post-Treatment & Disinfection	$8,340,000	5%		
5.0	Product Water Pumping, Storage & Conveyance	$33,030,000	18%		
6.0	Residuals Handling & Concentrate Discharge	$3,790,000	2%		
7.0	Power Supply (Redundancy Setup Fee Only)	$2,000,000	1%		
8.0	Electrical Building	$1,230,000	1%		
9.0	Admin/Maint	$7,570,000	4%		
	Subtotal	**$182,830,000**	**100%**		
			Low	**Base**	**High**
	Mobilization / Demobilization		$1,828,300	$3,656,600	$3,656,600
	Bonds & Insurance		$914,150	$1,828,300	$2,742,450
	Overhead & Profit		$14,626,400	$21,939,600	$27,424,500
	Un-Priced Allowances (Contingency)		$27,424,500	$36,566,000	$54,849,000
	Subtotal Construction Cost		**$227,623,350**	**$246,820,500**	**$271,502,550**
	Professional Services		$34,143,503	$44,427,690	$54,300,510
	Total Capital Cost		**$261,766,853**	**$291,248,190**	**$325,803,060**

Table 2-4: Capital Cost Opinion Redondo: 20 MGD Scenario 2

	Work Area Description	Project Cost	% of Total		
Capital Cost					
1.0	Intake	$6,970,000	4%		
2.0	Pretreatment	$46,050,000	25%		
3.0	Reverse Osmosis	$73,240,000	39%		
4.0	Post-Treatment & Disinfection	$8,340,000	4%		
5.0	Product Water Pumping, Storage & Conveyance	$36,790,000	20%		
6.0	Residuals Handling & Concentrate Discharge	$3,480,000	2%		
7.0	Power Supply (Redundancy Setup Fee Only)	$2,000,000	1%		
8.0	Electrical Building	$1,230,000	1%		
9.0	Admin/Maint	$7,570,000	4%		
	Subtotal	**$185,670,000**	**100%**		
			Low	**Base**	**High**
	Mobilization / Demobilization		$1,856,700	$3,713,400	$3,713,400
	Bonds & Insurance		$928,350	$1,856,700	$2,785,050
	Overhead & Profit		$14,853,600	$22,280,400	$27,850,500
	Un-Priced Allowances (Contingency)		$27,850,500	$37,134,000	$55,701,000
	Subtotal Construction Cost		**$231,159,150**	**$250,654,500**	**$275,719,950**
	Professional Services		$34,673,873	$45,117,810	$55,143,990
	Total Capital Cost		**$265,833,023**	**$295,772,310**	**$330,863,940**

Tables 2-5 and 2-6 include the capital cost summaries for the 10-MGD (with 40-MGD Backbone) Scenario at El Segundo and Redondo Beach sites, respectively. The detailed backup for these cost opinions are provided in **Appendix 7:A**.

Table 2-5: Capital Cost Opinion El Segundo: 10 MGD (with 40-MGD Backbone) Scenario 3A

	Work Area Description	Project Cost	% of Total		
Capital Cost					
1.0	Intake	$7,313,000	6%		
2.0	Pretreatment	$24,318,040	21%		
3.0	Reverse Osmosis	$36,690,000	32%		
4.0	Post-Treatment & Disinfection	$4,682,000	4%		
5.0	Product Water Pumping, Storage & Conveyance	$28,580,000	25%		
6.0	Residuals Handling & Concentrate Discharge	$3,022,000	3%		
7.0	Power Supply (Redundancy Setup Fee Only)	$2,000,000	2%		
8.0	Electrical Building	$616,000	1%		
9.0	Admin/Maint	$8,535,000	7%		
	Subtotal	**$115,756,040**	**100%**		
			Low	**Base**	**High**
	Mobilization / Demobilization		$1,157,560	$2,315,121	$2,315,121
	Bonds & Insurance		$578,780	$1,157,560	$1,736,341
	Overhead & Profit		$9,260,483	$13,890,725	$17,363,406
	Un-Priced Allowances (Contingency)		$17,363,406	$23,151,208	$34,726,812
	Subtotal Construction Cost		**$144,116,270**	**$156,270,654**	**$171,897,720**
	Professional Services		$21,617,441	$28,128,718	$34,379,544
	Total Capital Cost		**$165,733,711**	**$184,399,372**	**$206,277,264**

Table 2-6: Capital Cost Opinion Redondo: 10 MGD (with 40-MGD Backbone) Scenario 3A

	Work Area Description	Project Cost	% of Total		
Capital Cost					
1.0	Intake	$6,462,000	5%		
2.0	Pretreatment	$24,318,040	21%		
3.0	Reverse Osmosis	$36,690,000	31%		
4.0	Post-Treatment & Disinfection	$4,682,000	4%		
5.0	Product Water Pumping, Storage & Conveyance	$32,364,000	27%		
6.0	Residuals Handling & Concentrate Discharge	$2,819,000	2%		
7.0	Power Supply (Redundancy Setup Fee Only)	$2,000,000	2%		
8.0	Electrical Building	$616,000	1%		
9.0	Admin/Maint	$8,535,000	7%		
	Subtotal	**$118,486,040**	**100%**		
			Low	**Base**	**High**
	Mobilization / Demobilization		$1,184,860	$2,369,721	$2,369,721
	Bonds & Insurance		$592,430	$1,184,860	$1,777,291
	Overhead & Profit		$9,478,883	$14,218,325	$17,772,906
	Un-Priced Allowances (Contingency)		$17,772,906	$23,697,208	$35,545,812
	Subtotal Construction Cost		**$147,515,120**	**$159,956,154**	**$175,951,770**
	Professional Services		$22,127,268	$28,792,108	$35,190,354
	Total Capital Cost		**$169,642,388**	**$188,748,262**	**$211,142,124**

Tables 2-7 and 2-8 include the capital cost summaries for the 40-MGD Scenario at El Segundo and Redondo Beach sites, respectively. The detailed backup for these cost opinions are provided in **Appendix 7:A**.

Table 2-7: Capital Cost Opinion El Segundo: 40 MGD Scenario 3B

	Work Area Description	Project Cost	% of Total		
Capital Cost					
1.0	Intake	$11,913,000	4%		
2.0	Pretreatment	$74,999,569	27%		
3.0	Reverse Osmosis	$115,761,000	42%		
4.0	Post-Treatment & Disinfection	$12,230,000	4%		
5.0	Product Water Pumping, Storage & Conveyance	$42,015,000	15%		
6.0	Residuals Handling & Concentrate Discharge	$5,615,000	2%		
7.0	Power Supply (Redundancy Setup Fee Only)	$2,000,000	1%		
8.0	Electrical Building	$1,972,000	1%		
9.0	Admin/Maint	$8,535,000	3%		
	Subtotal	**$275,040,569**	**100%**		
			Low	**Base**	**High**
	Mobilization / Demobilization		$2,750,406	$5,500,811	$5,500,811
	Bonds & Insurance		$1,375,203	$2,750,406	$4,125,609
	Overhead & Profit		$22,003,246	$33,004,868	$41,256,085
	Un-Priced Allowances (Contingency)		$41,256,085	$55,008,114	$82,512,171
	Subtotal Construction Cost		**$342,425,508**	**$371,304,768**	**$408,435,245**
	Professional Services		$51,363,826	$66,834,858	$81,687,049
	Total Capital Cost		**$393,789,334**	**$438,139,626**	**$490,122,294**

Table 2-8: Capital Cost Opinion Redondo: 40 MGD Scenario 3B

	Work Area Description	Project Cost	% of Total		
Capital Cost					
1.0	Intake	$11,063,000	4%		
2.0	Pretreatment	$74,717,569	27%		
3.0	Reverse Osmosis	$115,761,000	42%		
4.0	Post-Treatment & Disinfection	$12,230,000	4%		
5.0	Product Water Pumping, Storage & Conveyance	$44,086,000	16%		
6.0	Residuals Handling & Concentrate Discharge	$5,412,000	2%		
7.0	Power Supply (Redundancy Setup Fee Only)	$2,000,000	1%		
8.0	Electrical Building	$1,972,000	1%		
9.0	Admin/Maint	$8,535,000	3%		
	Subtotal	**$275,776,569**	**100%**		
			Low	**Base**	**High**
	Mobilization / Demobilization		$2,757,766	$5,515,531	$5,515,531
	Bonds & Insurance		$1,378,883	$2,757,766	$4,136,649
	Overhead & Profit		$22,062,126	$33,093,188	$41,366,485
	Un-Priced Allowances (Contingency)		$41,366,485	$55,155,314	$82,732,971
	Subtotal Construction Cost		**$343,341,828**	**$372,298,368**	**$409,528,205**
	Professional Services		$51,501,274	$67,013,706	$81,905,641
	Total Capital Cost		**$394,843,102**	**$439,312,074**	**$491,433,846**

Tables 2-9 and 2-10 include the capital cost summaries for the 60-MGD Scenario at El Segundo and Redondo Beach sites, respectively. The detailed backup for these cost opinions are provided in **Appendix 7:A**.

Table 2-9: Capital Cost Opinion El Segundo: 60 MGD Scenario 4

	Work Area Description	Project Cost	% of Total		
Capital Cost					
1.0	Intake	$11,913,000	4%		
2.0	Pretreatment	$74,999,569	27%		
3.0	Reverse Osmosis	$115,761,000	42%		
4.0	Post-Treatment & Disinfection	$12,230,000	4%		
5.0	Product Water Pumping, Storage & Conveyance	$42,015,000	15%		
6.0	Residuals Handling & Concentrate Discharge	$5,615,000	2%		
7.0	Power Supply (Redundancy Setup Fee Only)	$2,000,000	1%		
8.0	Electrical Building	$1,972,000	1%		
9.0	Admin/Maint	$8,535,000	3%		
	Subtotal	**$275,040,569**	**100%**		
			Low	**Base**	**High**
	Mobilization / Demobilization		$2,750,406	$5,500,811	$5,500,811
	Bonds & Insurance		$1,375,203	$2,750,406	$4,125,609
	Overhead & Profit		$22,003,246	$33,004,868	$41,256,085
	Un-Priced Allowances (Contingency)		$41,256,085	$55,008,114	$82,512,171
	Subtotal Construction Cost		**$342,425,508**	**$371,304,768**	**$408,435,245**
	Professional Services		$51,363,826	$66,834,858	$81,687,049
	Total Capital Cost		**$393,789,334**	**$438,139,626**	**$490,122,294**

Table 2-10: Capital Cost Opinion Redondo: 60 MGD Scenario 4

	Work Area Description	Project Cost	% of Total		
Capital Cost					
1.0	Intake	$11,063,000	4%		
2.0	Pretreatment	$74,717,569	27%		
3.0	Reverse Osmosis	$115,761,000	42%		
4.0	Post-Treatment & Disinfection	$12,230,000	4%		
5.0	Product Water Pumping, Storage & Conveyance	$44,086,000	16%		
6.0	Residuals Handling & Concentrate Discharge	$5,412,000	2%		
7.0	Power Supply (Redundancy Setup Fee Only)	$2,000,000	1%		
8.0	Electrical Building	$1,972,000	1%		
9.0	Admin/Maint	$8,535,000	3%		
	Subtotal	**$275,776,569**	**100%**		
			Low	**Base**	**High**
	Mobilization / Demobilization		$2,757,766	$5,515,531	$5,515,531
	Bonds & Insurance		$1,378,883	$2,757,766	$4,136,649
	Overhead & Profit		$22,062,126	$33,093,188	$41,366,485
	Un-Priced Allowances (Contingency)		$41,366,485	$55,155,314	$82,732,971
	Subtotal Construction Cost		**$343,341,828**	**$372,298,368**	**$409,528,205**
	Professional Services		$51,501,274	$67,013,706	$81,905,641
	Total Capital Cost		**$394,843,102**	**$439,312,074**	**$491,433,846**

2.3. Annual O&M Cost

Annual O&M costs are divided among the following categories: Power, Chemicals, Maintenance & Materials, Labor, and Replacement. Costing assumptions used for each of these categories are summarized under the respective headings below.

2.3.1. Power

Two electrical service options, 12 KV and 66 KV, are compared on a total present worth basis using a 20-year time horizon. The comparison includes an analysis of the electricity rate, equipment electrical demands, switchyard lease agreement (required for 66 KV service), and initial redundancy setup fees. The switchyard lease agreement is assumed to be $100,000 per year for the 66 KV service per discussion with Nexant and SCE (see Power Supply TM). One-time redundancy setup fees are assumed to be $1,000,000 for the 12 KV service and $2,000,000 for the 66 KV service per discussion with Nexant and SCE (see Power Supply TM). Electricity rates are taken to be $0.095/kWh for 12 KV service and $0.075/kWh for 66 KV service. Taking these factors and assumptions into consideration, the 66 KV service is found to be a more economical electrical service option for all scenarios under consideration. The electricity rate for 66 KV service is used in calculating the annual power cost for all scenarios.

Electrical demand (in kWh) for pumps and other equipment is estimated by calculating the brake horsepower based on anticipated design flow and head and applying factors for pump and motor efficiencies. Anticipated frequency and duration of operation are also taken into consideration for determining the annual demand for each piece of equipment.

2.3.2. Chemicals

Annual chemical usage and unit pricing for each scenario is based on dosing and cost criteria from the CSDPR. Chemical dose assumptions are explained in the CSDPR. Cost information was obtained from chemical suppliers and is based on bulk delivery.

2.3.3. Maintenance & Materials

The Maintenance & Materials category includes costs for both maintenance labor and materials such as lubricants, gaskets, bearings, etc. required to keep equipment in proper working condition. Maintenance & Materials costs are presented on a lump sum basis and are determined from past project experience. The maintenance cost associated with the intake screens is not included in the estimates.

2.3.4. Labor

Annual labor cost is based on staffing requirements. A best fit regression curve of full time equivalents (FTEs) versus plant size (MGD) was developed from previous project experience with similar facilities. Using this curve, FTEs can be determined for the plant size for each scenario. A burdened labor rate of $100/hr is used to calculate the annual labor cost from the FTEs.

2.3.5. Replacement

Replacement costs are calculated for the major components of each system and pieces of equipment. Replacement costs are taken to be a percentage of the equipment capital cost. Replacement frequency is determined for each component and is used to calculate annual and present worth replacement costs on a 20-year time horizon. A replacement cost breakdown is provided in **Appendix 7:B**.

2.3.6. Annual O&M Cost Summaries

Tables 2-11 and 2-12 present the annual O&M cost summaries for the 10-MGD Scenario at El Segundo and Redondo Beach sites, respectively. The detailed backup for these cost opinions are provided in **Appendix 7:A**.

Table 2-11: O&M Cost Opinion El Segundo: 10 MGD Scenario 1

	Annual O&M Costs	Annual Cost	Present Worth	% of Total	
1.0	Power (66 KV Service)	$3,630,000	$48,050,000	37%	
2.0	Chemicals	$1,496,000	$19,800,000	15%	
3.0	Maintenance and Materials	$620,000	$8,210,000	6%	
4.0	Labor (14 FTE @ $100/hr)	$2,912,000	$38,540,000	29%	
5.0	Replacement	$1,286,423	$17,027,519	13%	
	Total O&M Cost	**$9,944,423**	**$131,627,519**	**100%**	

Table 2-12: O&M Cost Opinion Redondo: 10 MGD Scenario 1

	Annual O&M Costs	Annual Cost	Present Worth	% of Total	
1.0	Power (66 KV Service)	$3,615,000	$47,850,000	36%	
2.0	Chemicals	$1,495,000	$19,790,000	15%	
3.0	Maintenance and Materials	$620,000	$8,210,000	6%	
4.0	Labor (14 FTE @ $100/hr)	$2,912,000	$38,540,000	29%	
5.0	Replacement	$1,283,065	$16,983,070	13%	
	Total O&M Cost	**$9,925,065**	**$131,373,070**	**100%**	

Tables 2-13 and 2-14 include the annual O&M cost summaries for the 20-MGD Scenario at El Segundo and Redondo Beach sites, respectively. The detailed backup for these cost opinions are provided in **Appendix 7:A**.

Table 2-13: O&M Cost Opinion El Segundo: 20 MGD Scenario 2

	Annual O&M Cost	Annual Cost	Present Worth	% of Total	
1.0	Power (66 KV Service)	$7,239,000	$95,820,000	41%	
2.0	Chemicals	$3,144,000	$41,620,000	18%	
3.0	Maintenance & Materials	$651,000	$8,620,000	4%	
4.0	Labor (20 FTE @ $100/hr)	$4,160,000	$55,060,000	24%	
5.0	Replacement	$2,475,126	$32,761,587	14%	
	Total O&M Cost	**$17,669,126**	**$233,881,587**	**100%**	

Table 2-14: O&M Cost Opinion Redondo: 20 MGD Scenario 2

	Annual O&M Cost	Annual Cost	Present Worth	% of Total	
1.0	Power (66 KV Service)	$7,219,000	$95,550,000	41%	
2.0	Chemicals	$3,144,000	$41,620,000	18%	
3.0	Maintenance & Materials	$654,000	$8,660,000	4%	
4.0	Labor (20 FTE @ $100/hr)	$4,160,000	$55,060,000	24%	
5.0	Replacement	$2,479,007	$32,812,960	14%	
	Total O&M Cost	**$17,656,007**	**$233,702,960**	**100%**	

Tables 2-15 and 2-16 include the annual O&M cost summaries for the 10-MGD (with 40-MGD Backbone) Scenario at El Segundo and Redondo Beach sites, respectively. The detailed backup for these cost opinions are provided in **Appendix 7:A**.

Table 2-15: O&M Cost Opinion El Segundo: 10 MGD (with 40-MGD Backbone) Scenario 3A

	Annual O&M Costs	**Annual Cost**	**Present Worth**	**% of Total**	
1.0	Power (66 KV Service)	$4,038,000	$53,450,000	39%	
2.0	Chemicals	$1,496,000	$19,800,000	14%	
3.0	Maintenance and Materials	$620,000	$8,210,000	6%	
4.0	Labor (14 FTE @ $100/hr)	$2,912,000	$38,540,000	28%	
5.0	Replacement	$1,325,483	$17,544,533	13%	
	Total O&M Cost	**$10,391,483**	**$137,544,533**	**100%**	

Table 2-16: O&M Cost Opinion Redondo: 10 MGD (with 40-MGD Backbone) Scenario 3A

	Annual O&M Costs	**Annual Cost**	**Present Worth**	**% of Total**	
1.0	Power (66 KV Service)	$4,036,000	$53,420,000	39%	
2.0	Chemicals	$1,496,000	$19,800,000	14%	
3.0	Maintenance and Materials	$620,000	$8,210,000	6%	
4.0	Labor (14 FTE @ $100/hr)	$2,912,000	$38,540,000	28%	
5.0	Replacement	$1,338,835	$17,721,267	13%	
	Total O&M Cost	**$10,402,835**	**$137,691,267**	**100%**	

Tables 2-17 and 2-18 include the annual O&M cost summaries for the 40-MGD Scenario at El Segundo and Redondo Beach sites, respectively. The detailed backup for these cost opinions are provided in **Appendix 7:A**.

Table 2-17: O&M Cost Opinion El Segundo: 40 MGD Scenario 3B

	Annual O&M Costs	**Annual Cost**	**Present Worth**	**% of Total**	
1.0	Power (66 KV Service)	$16,280,000	$215,490,000	48%	
2.0	Chemicals	$5,967,000	$78,980,000	18%	
3.0	Maintenance & Material	$769,000	$10,180,000	2%	
4.0	Labor (32 FTE @ $100/hr)	$6,656,000	$88,100,000	20%	
5.0	Replacement	$4,024,196	$53,265,583	12%	
	Total O&M Cost	**$33,696,196**	**$446,015,583**	**100%**	

Table 2-18: O&M Cost Opinion Redondo: 40 MGD Scenario 3B

	Annual O&M Costs	**Annual Cost**	**Present Worth**	**% of Total**	
1.0	Power (66 KV Service)	$16,200,000	$214,430,000	48%	
2.0	Chemicals	$5,967,000	$78,980,000	18%	
3.0	Maintenance & Material	$769,000	$10,180,000	2%	
4.0	Labor (32 FTE @ $100/hr)	$6,656,000	$88,100,000	20%	
5.0	Replacement	$4,029,499	$53,335,779	12%	
	Total O&M Cost	**$33,621,499**	**$445,025,779**	**100%**	

Tables 2-19 and 2-20 include the annual O&M cost summaries for the 60-MGD Scenario at El Segundo and Redondo Beach sites, respectively. The detailed backup for these cost opinions are provided in **Appendix 7:A**.

Table 2-19: O&M Cost Opinion El Segundo: 60 MGD Scenario 4

	Annual O&M Costs	**Annual Cost**	**Present Worth**	**% of Total**	
1.0	Power (66 KV Service)	$23,559,000	$311,830,000	48%	
2.0	Chemicals	$8,950,000	$118,470,000	18%	
3.0	Maintenance & Materials	$1,052,000	$13,920,000	2%	
4.0	Labor (48 FTE @ $100/hr)	$9,984,000	$132,150,000	20%	
5.0	Replacement	$6,009,298	$79,541,043	12%	
	Total O&M Cost	**$49,554,298**	**$655,911,043**	**100%**	

Table 2-20: O&M Cost Opinion Redondo: 60 MGD Scenario 4

	Annual O&M Costs	**Annual Cost**	**Present Worth**	**% of Total**	
1.0	POWER (66 KV SERVICE)	$23,634,000	$312,830,000	48%	
2.0	CHEMICALS	$8,950,000	$118,470,000	18%	
3.0	MAINTENANCE & MATERIALS	$1,052,000	$13,920,000	2%	
4.0	LABOR (48 FTE @ $100/hr)	$9,984,000	$132,150,000	20%	
5.0	REPLACEMENT	$6,010,891	$79,562,135	12%	
	Total O&M Cost	**$49,630,891**	**$656,932,135**	**100%**	

2.4. Overall Capital and O&M Summary

Table 2-21 presents an overall comparison of capital and O&M costs among the scenarios. It also shows annualized costs for each scenario including both capital and O&M.

Table 2-21: Overall Capital and O&M Summary and Annualized Cost Comparison

	Scenario 1		Scenario 2		Scenario 3A				Scenario 3B		Scenario 4	
	10 MGD		20 MGD		10/40-MGD Phase 1[1]		10/40-MGD Phase 2[2]		40 MGD		60 MGD	
	ES	RB	ES	RB	ES	RB	ES	RB	ES	RB	ES	RB
Total Capital Cost PW ($/1000)												
Low	$142,488	$138,121	$261,767	$265,833	$165,734	$169,642	$262,264	$258,981	$393,789	$394,843	$635,003	$641,168
Base	$158,535	$153,677	$291,248	$295,772	$184,399	$188,748	$291,801	$288,148	$438,140	$439,312	$706,520	$713,379
High	$177,345	$171,910	$325,803	$330,864	$206,277	$211,142	$326,422	$322,335	$490,122	$491,434	$790,344	$798,017
Total Annual O&M Cost ($/1000)	$9,944	$9,925	$17,669	$17,656	$10,391	$10,403	$23,305	$23,219	$33,696	$33,621	$49,554	$49,631
O&M PW ($/1000)	$131,628	$131,373	$233,882	$233,703	$137,545	$137,691	$266,517	$265,526	$446,016	$445,026	$655,911	$656,932
Total PW (CAP and O&M) ($/1000)												
Low	$274,120	$269,490	$495,650	$499,540	$303,280	$307,330	$528,780	$524,510	$839,800	$839,870	$1,290,910	$1,298,100
Base	$290,160	$285,050	$525,130	$529,480	$321,940	$326,440	$558,320	$553,670	$884,160	$884,340	$1,362,430	$1,370,310
High	$308,970	$303,280	$559,680	$564,570	$343,820	$348,830	$592,940	$587,860	$936,140	$936,460	$1,446,260	$1,454,950
Annualized Cost ($/1000)												
Low	$20,710	$20,360	$37,450	$37,740	$22,910	$23,220	$39,950	$39,630	$63,450	$63,450	$97,530	$98,070
Base	$21,920	$21,540	$39,670	$40,000	$24,320	$24,660	$42,180	$41,830	$66,800	$66,810	$102,930	$103,530
High	$23,340	$22,910	$42,280	$42,650	$25,980	$26,350	$44,800	$44,410	$70,730	$70,750	$109,260	$109,920
Annualized Cost PER 1,000 GAL												
Low	$5.67	$5.58	$5.13	$5.17	$6.28	$6.36	$3.65	$3.62	$4.35	$4.35	$4.45	$4.48
Base	$6.01	$5.90	$5.43	$5.48	$6.66	$6.76	$3.85	$3.82	$4.58	$4.58	$4.70	$4.73
High	$6.39	$6.28	$5.79	$5.84	$7.12	$7.22	$4.09	$4.06	$4.84	$4.85	$4.99	$5.02
Annualized Cost Per AF												
Low	$1,849	$1,818	$1,672	$1,685	$2,045	$2,073	$1,189	$1,179	$1,416	$1,416	$1,451	$1,459
Base	$1,957	$1,923	$1,771	$1,785	$2,171	$2,202	$1,255	$1,245	$1,491	$1,491	$1,531	$1,540
High	$2,084	$2,045	$1,887	$1,904	$2,319	$2,352	$1,333	$1,322	$1,579	$1,579	$1,626	$1,636

1. Scenario 3A, Phase 1 is the initial 10-MGD plant with a 40-MGD backbone for expansion.
2. Scenario 3A, Phase 2 is the 30-MGD expansion of the initial 10-MGD plant to the full 40-MGD capacity.

2.5. Overview of Complete Project Costs

Complete project costs are divide among the following categories: retaining owner's representative, continuing studies, environmental documentation, permitting and approvals, design/construction, retaining operations team, and O&M. A description for each of these categories is provided below.

2.5.1. Retaining Owner's Representative

The Owner's representative is part of the project delivery team. They help the owner to develop and coordinate major components of the program delivery. This entity is particularly useful where multiple contracts and delivery methods are employed. The Retaining Owner's Representative activity includes the following sub-activities: RFP/Retain Project Team, Project Description, Construction Impacts Report, Preliminary Engineering and DB Bid Package, and Preliminary Opinion of Project Cost.

2.5.2. Continuing Studies

Current investigation studies include pilot and demonstration scale testing. It is anticipated that there will be additional costs associated with studies that are expected to continue past notice to proceed. Additional investigational studies include instrumentation and electrical, brine discharge, and an integration study to assess the impacts of introducing desalinated water into the MWD system.

2.5.3. Environmental Documentation

This category refers primarily to the CEQA/NEPA process, including the EIR/EIS preparation and supporting technical studies and data needs. Documentation requirements are outlined in the Environmental Review Plan (ERP) TM of the PMP.

2.5.4. Permitting and Approvals

There are various permits required for the desalination program. A description of each of the anticipated permits, including the estimated cost and acquisition timeline, are provided in the Project Permitting Plan (PPP) TM of the PMP.

2.5.5. Design/Construction

This category includes costs for activities associated with design and construction, including design/equipment procurement, contractor bidding/award (where applicable, depending on delivery method), and construction/start-up/acceptance testing.

2.5.6. Retaining Operations Team

This category includes costs for activities associated with retaining the operations team, including preparation of the RFQ, review of SOQ submittals, operations team selection, operation plan development/review, and negotiation of an operations contract.

2.5.7. Overall Comparison of Complete Project Costs

Table 2-22 presents an overall comparison of complete project costs, from planning phase through construction/start-up and operation of the full scale facility.

Table 2-22: Program Development Costs Comparison

	Program Development Costs, $K[1]				
	Scenario				
	1	2	3A[2]	3B[3]	4
Major Activity	**10-MGD**	**20-MGD**	**10/40-MGD**	**40-MGD**	**60-MGD**
Retaining Owner's Representative	4,500	8,500	13,000	11,500	18,000
Continuing Studies	2,500	2,500	2,500	2,500	2,500
Environmental Documentation	2,000	2,000	2,000	2,000	2,000
Permitting and Approvals	2,000	2,500	3,000	3,000	3,500
Design/Construction (Present Worth)	155,000	295,000	475,000	440,000	710,000
Retaining Operations Team	700	800	900	900	1,000
Total	**166,700**	**311,300**	**496,400**	**459,900**	**737,000**

1. Values shown are in 1,000s of dollars, using the base costing category, averaged among site locations, and rounded to nearest $5M for comparative illustration purposes.
2. Values shown for Scenario 3A are for the phased plant at full build-out capacity of 40-MGD.
3. Values shown for Scenario 3B are for the 40-MGD plant built all at once (not phased).

3. Project Funding Options

3.1. Introduction

The following section provides an overview of the project funding sources and mechanisms available to West Basin at local, state, and federal levels. Existing and future funding programs are discussed. Recommendations are provided for the most viable funding option(s), considering power ownership, delivery method, and West Basin's current financial structure.

3.2. Internal Funding

West Basin will weigh options to fund the Ocean Water Desalination Program Master Plan (OWDPMP) through rates, taxes, and/or fixed charges with West Basin staff. These efforts include the development of Long-Range Finance Plan model by the West Basin financial team to assess the impacts of different financing approaches for the OWDPMP on overall water rates and charges, debt levels, interest rates and timing of debt. The modeling involves the establishment of the baseline case based on current operations and capital projects with signed agreements as well as a series of alternatives based on different sizes for the desalination facility ranging from 20 MGD to 60 MGD.

One option that West Basin may explore is fixed payments similar to those charged as part of the district's recycled water program. West Basin's agreements with its largest recycled customers include provisions for fixed payments to help defray a portion of the capital costs of the construction of the recycled program facilities.

3.3. External Funding

External funding for the OWDPMP could come from a number of both public and/or private sources. The following is an overview of those potential sources.

3.3.1. Federal Funding

Federal funding for desalination projects on non-military facilities has traditionally been included in the budgets of either the U.S. Bureau of Reclamation or the U.S. Army Corp of Engineers. Proposed funding levels for these two sources are identified annually the Energy and Water Development Appropriations Bill (EWD Appropriations Bill) of the U.S. Congress. According to the EWD Appropriations Bill report for the U.S. Senate's (Senate) Committee on Appropriations (Committee), "congressionally directed spending has become synonymous with earmarks in recent debates, even for agencies such as the Bureau of Reclamation where the majority of the budget request is based on individual line-item studies and projects. Due to this ongoing debate, the Committee has voluntarily refused all congressionally directed spending requests for fiscal year 2013." The U.S. House of Representatives' (House) agreed to similar action for FY2013.

The Senate Committee's FY2013 EWD Appropriations Bill, released on April 26th, totals $33.4B, which is $372M less than the FY2012 appropriations. On March 25, 2012, The House Committee released its draft FY2013 EWD Appropriations Bill, which calls for total spending of $32.1B, or $87.5M more than the House appropriated in fiscal year 2012.

3.3.1.1. U.S. Bureau of Reclamation

Title II of the Senate version of the FY2013 EWD Appropriations Bill calls for $1B in funding for the Bureau of Reclamation, which is $19.8M less than the FY2012 enacted amount. The House EWD Appropriations Bill recommends $967M in funding for the Bureau of Reclamation, which is approximately $81M below the House appropriation in FY2012.

The Water and Related Resources account of Title II supports the development, construction, management, and restoration of water and related natural resources in the 17 western states. The account includes funds for operating and maintaining existing facilities and conducting studies on ways to improve the use of water and related natural resources. For FY 2013, the House recommends $833M, which is $61M below fiscal year 2012. Included in this budget item is just under $2.9M for the Desalination and Water Purification Program under the Research and Development budget and $483K for the planned desalination plant in Long Beach under the TITLE XVI Water Reclamation and Reuse Program. The Senate recommendation calls for $892M in spending, which is roughly $3M below the FY2012 appropriation. The recommendation contains $2.9M for the Desalination and Water Purification Program under the Research and Development budget and $500K under the TITLE XVI Water Reclamation and Reuse Program for the Long Beach Plant.

The Senate Committee did note that it "is concerned that constrained budgets impact the research and development initiatives vital to improvements in water recycling and desalination technologies development and applications. The Committee believes that only through enhanced Federal and non-Federal research partnerships can research and development vital to much needed improvements in water recycling and desalination technologies development and applications be accomplished. The Bureau of Reclamation should consider budgeting for extramural cost-shared research grants to fund high-priority research and development initiatives on water reuse, recycling and desalination by not-for-profit organizations who often partner with the Bureau of Reclamation."

3.3.1.2. U.S. Army Corp of Engineers

The House FY2013 EWD Appropriations Bill requests $4.7B in funding for the Civil Works program of the U.S. Army Corp of Engineers (ACOE), or a reduction of $271M from FY2012. As in previous years, the largest dollar reduction is in the Construction account ($223 million).

The Senate request is also $4.7B. There is no explicit funding for desalination projects by the ACOE called for in either the House or Senate versions of the EWD Appropriations Bill.

3.3.1.3. Water Infrastructure Finance and Innovation Authority

With total Federal appropriations for water projects likely to decrease and specific appropriations for individual projects as part of the budget process becoming more difficult with the current moratorium on “earmarks,” some organizations, such as the American Water Works Association, have begun to focus on Federal actions to lower the cost of infrastructure investments and increase the availability of lower-cost capital. To this end, these organizations are urging Congress to create a “Water Infrastructure Finance Innovations Authority” (WIFIA), modeled after the successful Transportation Infrastructure Finance and Innovations Authority (commonly called TIFIA). Such a mechanism could lower the cost of capital for water utilities while having little or no long-term effect on the federal budget. As proposed, WIFIA would access funds from the U.S. Treasury at long-term Treasury rates and use those funds to provide loans or other credit support for water projects. Funds would flow from the Treasury, through WIFIA, to larger water projects or to State Revolving Funds (SRF) wishing to borrow and enlarge their pool of capital. Loan repayments – with interest – would flow back to WIFIA and thence into the Treasury – again, with interest.

Proponents claim that this funding mechanism would allow the WIFIA to:

- Offer loans, loan guarantees, and other credit support for large water infrastructure projects. These large projects often find it difficult or impossible to access SRF loans, and in many states large projects are expressly excluded from SRF eligibility because they would leave little room to finance other projects.
- Reduce the cost of leveraging for State Revolving Fund (SRF) programs by lending to them directly. The WIFIA could lend to those State Revolving Funds wishing to leverage their state or federal capitalization grants at the lowest possible interest rates. This would allow SRFs to make more loans and would increase their ability to offer special assistance to hardship communities if they chose to do so.
- Ensure a streamlined approach to financing. WIFIA should be directed to develop a streamlined review and application process and make decisions with no more burden to the applicant than required by traditional credit markets.

This is not the first time the concepts associated with WIFIA have been brought forth to Congress. The 110th Congress (2009-2010) attempted to pass legislation entitled the Water Infrastructure Financing Act (S. 1005), which would have amended the Federal Water Pollution Control Act and the Safe Drinking Water Act to improve water and wastewater. S. 1005 was not passed and is no longer active, but promoted support for an infrastructure bank that would have provided low-cost capital to water utilities needing to invest in infrastructure and supported expanded capitalization for the State Revolving Funds.

3.3.2. State Funding

The last two decades have seen an unprecedented series of bond measures passed by the voters of California to fund water resource development throughout the State including desalination projects. Beginning in 1996, voters passed a water related proposition roughly every four years as highlighted in the list below.

- Proposition 204 – Safe, Clean, Reliable Water Supply Act. (1996)
- Proposition 13 – Safe Drinking Water, Clean Water, Watershed Protection, and Flood Protection Bond Act. (2000)
- Proposition 40 – The California Clean Water, Clean Air, Safe Neighborhood Parks, and Coastal Protection Act of 2002 (2002)
- Proposition 50 – Water Quality, Supply and Safe Drinking Water Projects. Coastal Wetlands Purchase and Protection. Bonds. (2002)
- Proposition 84 – Bonds for clean water, flood control, state and local park improvements, etc. (2006)

3.3.2.1. Proposition 84

The latest of the propositions to pass was Proposition 84, which allowed the State to sell $5.4B in bonds to fund programs for water supply, water quality, flood control, park improvements and natural resource protection. Proposition 84 passed with 54% approval. According to the State Department of Finance, over 83% of the Proposition 84 funds have been committed and approximately 54% of the $1.53B identified for Safe Drinking Water and Water Quality Projects (Chapter 2), the most likely source of desalination funding, has been committed.

Within Chapter 2 is the funding for Integrated Regional Water Management (IRWM). The IRWM awards funds to local public agencies and non-profit organizations for projects and programs to improve water supply reliability and improve and protect water quality. Such projects and programs must be consistent with an adopted Integrated Regional Water Management Plan (IRWMP).

West Basin has been a significant participant in the Greater Los Angeles County Region IRWMP, which is comprised of 5 sub-regions and spans from Ventura County to Orange County. It is anticipated that West Basin will continue to participate in this process and identify potential funding sources for its desalination program.

3.3.2.2. Safe, Clean and Reliable Drinking Water Supply Act of 2012

As part of the comprehensive water package enacted in 2009, the State Legislature approved a water bond now tentatively slated for the November 2012 ballot. If approved by voters, the Safe, Clean and Reliable Drinking Water Supply Act would provide $11.14 billion in general obligation bond funds for water infrastructure as well as projects and programs to improve water supply reliability and ecosystem health in the Delta.

The bond would allocate over $4 billion for local resources development, $4 billion for ecosystem restoration and $3 billion for the public benefits associated with new surface and groundwater storage projects. Of the over $4B in funding for local resource development, Chapter 6 calls for $1.4B in Water Supply Reliability funding to support local and regional projects including water recycling, local conveyance and desalination projects. Of this amount, $413 million would be available for the Los Angeles and Ventura County watersheds (Los Angeles subregion), the Santa Ana River watershed and Southern Orange County (Santa Ana subregion), and the watersheds of San Diego County (San Diego subregion).

3.3.3. Regional Funding

In addition to Federal and State funding, the Metropolitan Water District of Southern California (Metropolitan) also provides financial assistance to its member agencies, including West Basin, through its Local Resources Program (LRP). Under the LRP, Metropolitan provides financial assistance up to $250 per AF to participating projects that displace a demand on Metropolitan's imported water supplies. Annual LRP incentive payments for FY 2011/12 are projected to be about $33 million for the 87 currently eligible projects.

3.3.3.1. Seawater Desalination Program

In addition to the LRP, Metropolitan created its Seawater Desalination Program (SDP) in 2001 to encourage the development of seawater desalination by local agencies. Like the LRP after which it was modeled, it offers sliding-scale incentives that provide up to $250 per AF for produced supplies. The incentive is designed accelerate the development of expensive local supply projects by local agencies by lowering their cost. Metropolitan has entered into four SDP agreements, including the West Basin Seawater Desalination Project, while a fifth potential project is currently on hold.

Since April 2011, Metropolitan has been working with its member agencies through the Local Resources Development Strategy Task Force (Task Force) to review the current LRP and identify program improvements and alternative mechanisms to support local resource development. Changes to the program could affect the way Metropolitan supports future local resource projects including recycled water, groundwater recovery, seawater desalination, and other local supplies. At its November 2011 Water Planning and Stewardship meeting, Metropolitan staff presented information on the following nine financial assistance approaches for discussion:

- Status quo
- Reduced maximum incentive
    - Sliding scale incentive
    - Fixed incentive
- Reduced agreement term
- Competitive proposals

- Construction fund (revolving fund)
- Co-ownership
- Full ownership
- Metropolitan water rates (no incentives)
- Design-Build-Own-Operate-Transfer (DBOOT)

The Task Force is expected to continue meeting to discuss potential changes to the LRP and SDP.

3.3.4. Public Private Partnerships

Public–private partnership (PPP or P3) describes an agreement between a public sector authority and a private party in which the private party provides a public service or project and assumes substantial financial, technical and operational risk in the project. In some types of PPP, the cost of using the service is borne exclusively by the users of the service and not by the taxpayer. In other types (notably the private finance initiative), capital investment is made by the private sector on the strength of a contract with government to provide agreed services and the cost of providing the service is borne wholly or in part by the government. Government contributions to a PPP may also be in kind (notably the transfer of existing assets). In projects that are aimed at creating public goods like in the infrastructure sector, the government may provide a capital subsidy in the form of a one-time grant, so as to make it more attractive to the private investors. In some other cases, the government may support the project by providing revenue subsidies, including tax breaks or by providing guaranteed annual revenues for a fixed period.

Contracts for operations, maintenance and management (OM&M) -- or some combination of the three -- have been around for decades, at least in the United States. A January 1997 a change in Internal Revenue Service regulations regarding private activity bonds had a profound effect on the entire industry. Previously, the basic rule was if a public agency had tax-exempt debt outstanding, it couldn't enter into a service contractual arrangement with private parties for more than five years without losing that tax-exempt status.

Generally, the new rules permit private operation or ownership of a facility while maintaining the tax-exempt status of the bonds used to finance that facility. For "public utility property," contracts may now extend to 20 years (or 80 percent of the useful life of the facility) as long as at least 80 percent of the compensation under the contract consists of a periodic fixed fee.

Typically, a private sector consortium forms a special company called a "special purpose vehicle" (SPV) to develop, build, maintain and operate the asset for the contracted period. In cases where the government has invested in the project, it is typically (but not always) allotted an equity share in the SPV. [1] The consortium is usually made up of a building contractor, a maintenance company and bank lender(s). It is the SPV that signs the contract with the government and with subcontractors to build the facility and then maintain it. In the infrastructure sector, complex arrangements and contracts that guarantee and secure the cash flows and make PPP projects prime candidates for project financing. A typical PPP example would be a hospital building financed and constructed by a private developer and then leased to the hospital authority. The private developer acts as the landlord, providing housekeeping and other non-medical services while the hospital itself provides medical services.

While public agencies in the United States enjoy lower interest rates through tax exempt borrowing, a key motivation for government agencies considering a PPP is the possibility of bringing in new sources of funding for public infrastructure and service needs that can be more flexible.

According to National Council for Public-Private Partnerships (NCPPP), what distinguishes public-private partnerships in the United States from private financial initiatives in Europe is the continuous and lasting participation of the government in the project. Where foreign governments often turn projects entirely over to their private partners and then buy them back over 20 or 30 years, U.S. partnerships often bring in private firms to add expertise and sometimes financing, but retain ultimate control.

The National Council on Public-Private Partnerships identifies the following as critical components of any successful public-private partnership (PPP):

1. **Statutory and political environment -** the most senior public officials must be actively involved in supporting the concept of PPPs and taking a leadership role in developing each given partnership. A well-informed political leader can play a critical role in minimizing misperceptions about the value to the public of an effectively developed partnership. Equally important, there should be a statutory foundation for the implementation of each partnership.
2. **Public sector's organized structure -** once a partnership has been established, the public sector must remain involved in the project or program. Ongoing monitoring of the performance of the partnership is important in assuring its success. Monitoring should be done daily, weekly, monthly or quarterly for different aspects of each partnership (the frequency is often defined in the business plan and/or contract).
3. **Detailed business plan (contract) -** a carefully developed plan will substantially increase the probability of success of the partnership. The plan most often will take the form of an extensive, detailed contract, clearly describing the responsibilities of the public and private partners. In addition, a good plan or contract will include a clearly defined method of dispute resolution.
4. **Guaranteed revenue stream -** while the private partner may provide the initial funding for capital improvements, there must be a means of repayment of the investment over the long term of the partnership. The income stream can be generated by a variety and combination of sources (fees, tolls, shadow tolls, tax increment financing, etc.), but must be assured for the length of the partnership.

5. **Stakeholder support -** more people will be affected by a partnership than just the public officials and the private-sector partner. Employees, the portions of the public receiving the service, the press, labor unions and relevant interest groups will all have opinions about a partnership and its value. It is important to communicate openly and candidly to minimize potential resistance to a partnership.

6. **Pick your partner carefully -** the best value in a partner (not just a low bid) is critical in a long-term relationship that is central to a successful partnership. A candidate's experience in the specific area of partnership is an important factor in identifying the right partner.

3.3.4.1. Analyzing the Potential Benefits

One common method of analyzing the potential benefits of a PPP is a value for money (VfM) analysis. The VfM evaluates future cash flows to determine whether a capital project is best suited for a traditional public-procurement option or a public-private partnership. Usually conducted by multiple independent third parties with specialized operations, costing, and engineering expertise, a VfM assessment measures relative financial benefit.

A major component of VfM analysis is the public-sector comparator (PSC), which is a hypothetical, risk-adjusted cost estimate for a project, were that project to be financed, owned, and implemented by the public sector. Employing financial and statistical modeling techniques to estimate costs provides a baseline against which to compare future bids as well as a benchmark to measure value for money.

VfM analysis allows well-informed, accurate and full-cost pricing early in a project. It also encourages competition from bidders, who are aware that a genuine benchmark exists that will have to be beaten. By clarifying project requirements and risks and offering a standard for decision making for the duration of procurement process, the PSC can serve as a negotiating tool during the bidding stage of a PPP.

VfM has been a requirement for all projects in the United Kingdom since the early 1990s and is now standard practice in much of Australia as well. However, no uniform global method exists to calculate VfM analysis or simulate the public-sector comparator as standards vary by country.

3.3.4.2. Investment funds

Many investment funds have specific funds that make direct investments in infrastructure and infrastructure related assets and companies. According to a 2010 Pensions & Investments magazine survey, major infrastructure investment funds had a combined $131.69 billion in institutional assets under management in infrastructure. Such investments are not common in the United States, but have existed in the United Kingdom for nearly 30 years and are increasingly popular in the rest of the world.

For investors, infrastructure is typically not considered a high growth investment, but highly safe. While each fund has unique expectations when in comes to a rate of return on such investments, it is generally assumed investors are looking for a rate of return roughly equivalent to the rate of return that a public utilities commission (e.g., California Public Utilities Commission) would approve for a Class A or B utility. These rates currently have ranges from approximately 8.5 – 10%.

One example is the Goldman Sachs Infrastructure Partners family of funds, which pursues a buy-and-hold strategy that invests in assets with strong, stable cash flows. Since 2006, Goldman Sach's Merchant Banking group has raised $10 billion of capital through two investment funds to make such direct investments. Direct investments in traditional infrastructure sectors include transport infrastructure, such as toll roads, airports and ports, as well as regulated gas, water and electrical utilities. Goldman Sachs Infrastructure Partners has considered investments in various desalination and groundwater storage programs in southern California. The California Public Employees' Retirement System has also made direct investments in infrastructure and recently bought a 12.7% interest in England's second most active airport, Gatwick Airport for $163.69 million in 2009.

3.3.4.3. Other Potential Investors

With corporate profits at historic highs, interest rates at historic lows and unemployment above normal, a range of potential investors has expressed interest in helping finance construction projects including public sector work. There are reports that construction firms, who have accumulated large cash balances are willing to utilize these funds to encourage construction especially when compared to the low interest rates these cash balances would be earning in investment accounts. Additionally, there are indications that some trade unions may be willing to make investments from retirement funds in order to spur employment opportunities for members.

3.3.4.4. Qualified Tax Credit Bond

Another approach recently considered to attract private funding for local water resource projects was the establishment of Federal Qualified Tax Credit Bonds (QTCB). Under this approach, Congress would authorize the issuance of tax credit bonds enabling lenders to provide zero-interest capital financing to water agencies for qualifying new projects. Instead of the agency having to make interest payments to the bondholders, as would be the case with conventional tax-exempt municipal bonds, the Federal government would provide the bondholders with a tax credit equal to what the interest payments would have been for the life of the loan.

Prior to 2008, Congress had authorized the issuance of QTCBs in three instances. QTCBs were used in the mid-1990s for the construction of inner city schools, in 2005 for renewable energy projects and Gulf Coast reconstruction after Hurricanes Katrina and Rita, and starting in 2008 additional Federal legislation, including the American Recovery and Reinvestment Tax Act of 2009 (ARRTA), modified and expanded the use of QTCBs to include the introduction of Build America Bonds (BABS).

The Clean Renewable Water Supply Bond Act of 2009 (CREWS) was introduced in the House of Representatives and championed by the New Water Supply Coalition (Coalition), a national organization of water agencies. Under CREWS, public water agencies would have been authorized to issue tax credit bonds to finance water recycling, brackish and seawater desalination and contaminated groundwater recovery projects. At the time, it was estimated that an agency would save over $60 million in interest payments on a $100 million water supply project, which is the type of subsidy necessary to offset the large upfront capital expenditures associated with such projects. CREWS bonds would have also provided significant federal assistance to projects under the tax code without having to contend with the annual federal appropriations process.

As supported by the Coalition, the legislation would have allowed water agencies to repay the principal in a single balloon payment at the conclusion of the typical 20 year loan period and would thus only incur the project operation and maintenance costs during the life of the loan. Water agencies would have had the option of refinancing the balloon payment through traditional tax-free bonds for another 20 years. This has the effect of spreading the cost to future beneficiaries when the project had fully matured. The legislation failed to gain Congressional approval and CREWS bonds were not made available.

In 2011, a variation on the BABS was introduced at the State level under SB 867 (Padilla) titled Build California Bonds (BCB). SB 867 would have authorized $5 billion in bonds with up to $1 billion per year for 5 years to be issued through the California Transportation Financing Authority (CTFA). The CTFA would have entered into financing agreements with local transportation agencies to finance highway and transit projects.

The BCBs would have had a 30-year maximum maturity. Local sources would be used to repay the bond principal and the interest would be paid by the state in the form of annual tax credits not to exceed $250 million per year or 5% of the principal amount of BCBs outstanding. The tax credits would have been applied against California personal income or corporate income tax and could be carried over for up to 10 years. The tax credits were expected to be non-taxable for federal purposes. SB 867 failed to pass the California State Senate in 2012.

3.4. Funding Options Analysis Recommendations

The recent economic recession has created significant uncertainty regarding the availability of funding from various sources that may have historically been accessed to fund the desalination facility. Potential funding sources such as earmarks from the U.S. Congress have temporarily been suspended and a planned State bond measure to fund water infrastructure has been postponed. Further, West Basin continues to develop its analysis of the potential financial impacts of internally funding the range of desalination facility sizes. Due to uncertainty at this point, it would be premature to recommend particular funding options until the availability and impact of the various sources becomes clearer.

4. Funding Schedule/Sequencing

4.1. Overview

Funding needs and scheduling the timing of borrowings could be significantly different across the five capital scenarios and four broad-based funding options. However, based on a 2018 on-line date for several of the capital scenarios West Basin may have limited flexibility in terms of the timing of borrowings via the funding scenarios. Subsequent expansions/phases might provide great opportunity for varying the timing of borrowings in light of the anticipated rate impact.

Under a P3 option that includes private funding West Basin would likely only be responsible for annual payments to the P3 provider who would be responsible for obtaining the required capital funds.

In general it would be critical to look at the design, construction and future expansion segments of the project in terms of scheduling borrowings and structuring the repayment provisions (e.g., traditional principal and interest payments versus interest-only payments for a defined, initial period).

An important consideration regarding the timing of borrowings is the impact on rates during the periods of design, construction and after the on-line date when incremental project-related O&M expenses would begin. This impact will likely be significantly influenced by the borrowing terms, debt service coverage requirements and potential reserve requirements such as debt service, operating and rate stabilization.

4.2. Metropolitan Offsets

As a potential "off-set" to the rate increases needed to fund this project, the Metropolitan SDP incentive of up to $250 per acre foot should be considered in the financial planning element of the project funding and scheduling.

Under the LRP Metropolitan would pay an annual incentive of up to $250/AF based on the difference between actual project unit costs and Metropolitan's water rates. Eligible project costs include the agency's out of pocket costs normally associated with local resource projects including capital, O&M and replacements. At the beginning of each fiscal year, Metropolitan provides an advance or estimated incentive rate for deliveries during that year. At the end of each fiscal year, Metropolitan conducts a cost reconciliation analysis to determine the actual incentive rate for that year based on actual project cost and production data. Adjustments for under- or over-payments would be included in subsequent water service invoices from Metropolitan.

Additionally, the current LRP has other provisions that may reduce or end Metropolitan's incentive payments. For example, financial incentives would likely only be paid for desalinated water delivered by the proposed projects for beneficial use. There may also be a termination clause for nonperformance in the event construction does not commence within a reasonable time frame of 2 years of agreement execution or water deliveries are not realized within a specified number of years, 5 from agreement execution. If the project falls short of production targets measured in four-year intervals throughout the agreement term, Metropolitan may reduce its contract commitment.

West Basin Municipal Water District

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Ocean Water Desalination Program Master Plan (PMP)

Project Delivery Plan (PDP)

January 2013

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5052-016

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Acronyms Used in the Technical Memo

ACOE	Army Corps of Engineers
APD	Alternative Project Delivery
CDPH	California Department of Public Health
CM	Construction Manager
DB	Design-Build
DBB	Design-Bid-Build
DBO	Design-Build Operate
DBOOT	Design Build Own Operate Transfer
DDC	Design Develop and Construct
DEIR/DEIS	Draft Environmental Impact Report/Draft Environmental Impact Statement
GMP	Guaranteed Maximum Price
JPA	Joint Powers Authority
NEPA	National Environmental Policy Act
OWDPMP	Ocean Water Desalination Program Master Plan
RWQCB	Regional Water Quality Control Board

1. Introduction

1.1. Objective

This Technical Memorandum on the Project Delivery Plan (PDP) was prepared for the West Basin Municipal Water District (West Basin) to accomplish the following:

- Provide an overview of the Alternative Project Delivery (APD) options,
- Highlight the advantages and disadvantages of each APD option, and
- Provide a more detailed comparison of Design-Bid-Build, Design-Build, and Design-Build Operate, including an analysis of cost and schedule impacts and contractor procurement requirements for project delivery.

The APD options, and associated advantages and disadvantages, presented in Sections 2 and 3 of this Technical Memo include:

- Design-Bid-Build (DBB)
- Design-Build (DB)
- Design-Build Operate (DBO)
- Construction Manager (CM) at Risk
- Design Build Own Operate Transfer (DBOOT)
- Alliance

In Sections 4-6, a comparison of DBB, DB, and DBO options for the OWDPMP is provided to highlight the key differences of these approaches. Included in this comparison is a review of Project Costs and Schedules.

2. Alternative Project Delivery Methods

2.1. Alternative Project Delivery Methods

For each Project Delivery option discussed below, a general description of the approach is provided highlighting key features. Also, the allocation of risk between the Owner and the private sector (for options other than DBB) is discussed in this section

The Project Delivery methods have been arranged in approximately increasing order of private sector involvement.

- Design-Bid-Build (DBB)
- Design-Build (DB)
- Design-Build Operate (DBO)
- Construction Manager (CM) at Risk
- Design Build Own Operate Transfer (DBOOT)
- Alliance (Note that this is discussed only for informational purposes, since there is currently no legal precedent for use of this method in the U.S.)

2.2. Design-Bid-Build (DBB)

This Project Delivery method involves the Owner appointing a Project Manager to sequentially manage performance requirements/demand, investigation, and planning approvals followed by separate stages for design and construction. Construction is by lowest cost competitive bidding. The Owner takes over and operates the delivered project after acceptance tests. The participants and their interrelationships under design-bid-build are illustrated in **Figure 2-1**.

The Owner typically is involved throughout the project and provides its input at each stage. The Owner requirements can be incorporated in regard to design issues and operational requirements.

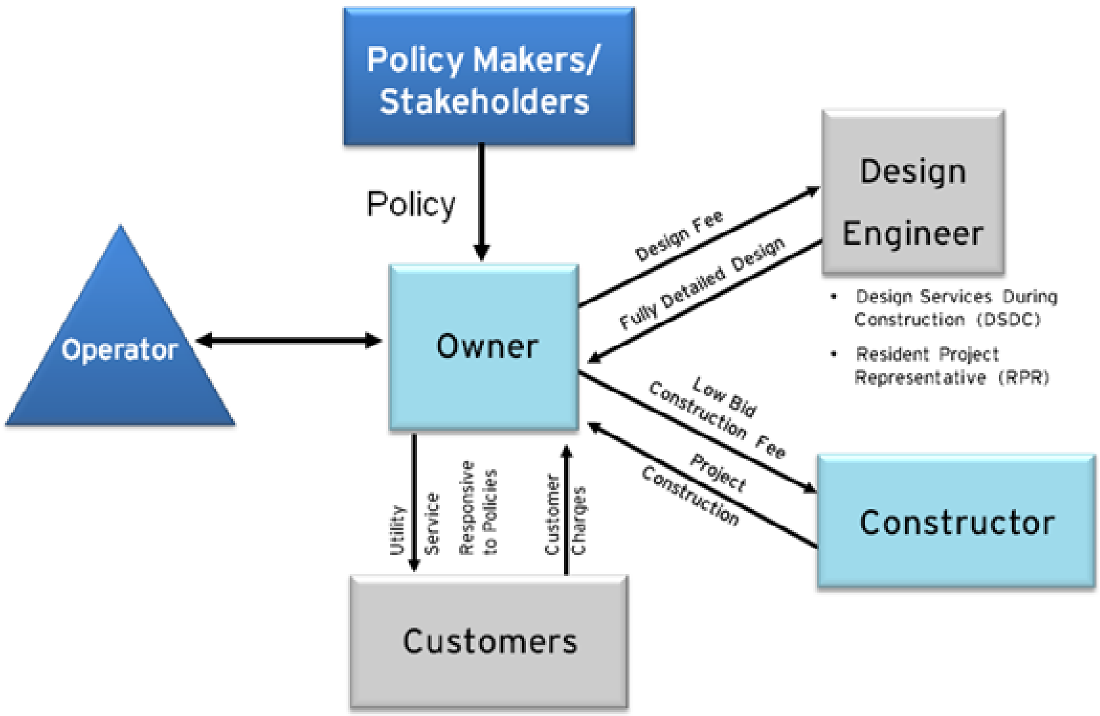
DBB relies on the skill and experience of the concept designer together with value management, etc. to obtain a best value capital facility solution rather than the market place pressure provided by other methods.

In this method, the risk of negligent design lies with the design consultant. Construction risk lies with the Contractor given adequate contract documentation. The Project

Manager is allocated the risk associated with poor contract administration. The Owner assumes risks associated with operation, financial, and planning components such as plant capacity.

There is standard documentation for supply of professional services, and low contractual risk because of the large amount of work done this way. The technical documentation needs to be of a high standard to minimize contractual disputes.

Figure 2-1: Participants Under DBB



2.3. Design-Build (DB)

In this method, a single entity takes the responsibility for the design and construction of a project. The design of the project is based on meeting explicit performance requirements for the operating facility. The company may subcontract some of the tasks required, for example a contractor often uses a separate consulting company to undertake some technical design tasks. When the construction of the facility is completed, the Owner is responsible for subsequent operation or for retaining an operator. The participants and their interrelationships under design-build are illustrated in **Figure 2-2**.

There are numerous examples of this delivery mode in the water and wastewater sector, and in other sectors. The method can in some cases deliver assets in a shorter total time than DBB. Costs can be reduced for some types of assets because the design is driven by the contractor with a focus on winning a competitive bid. All of the bidders have to complete a proportion of the design to finalize their financial bids; hence, there is a duplication of design effort but an opportunity to assess different design approaches. The degree of specification for the contract will reflect the potential for innovation and cost savings. Over specification for example will provide less potential for innovation than a DB project which involves a performance only specification.

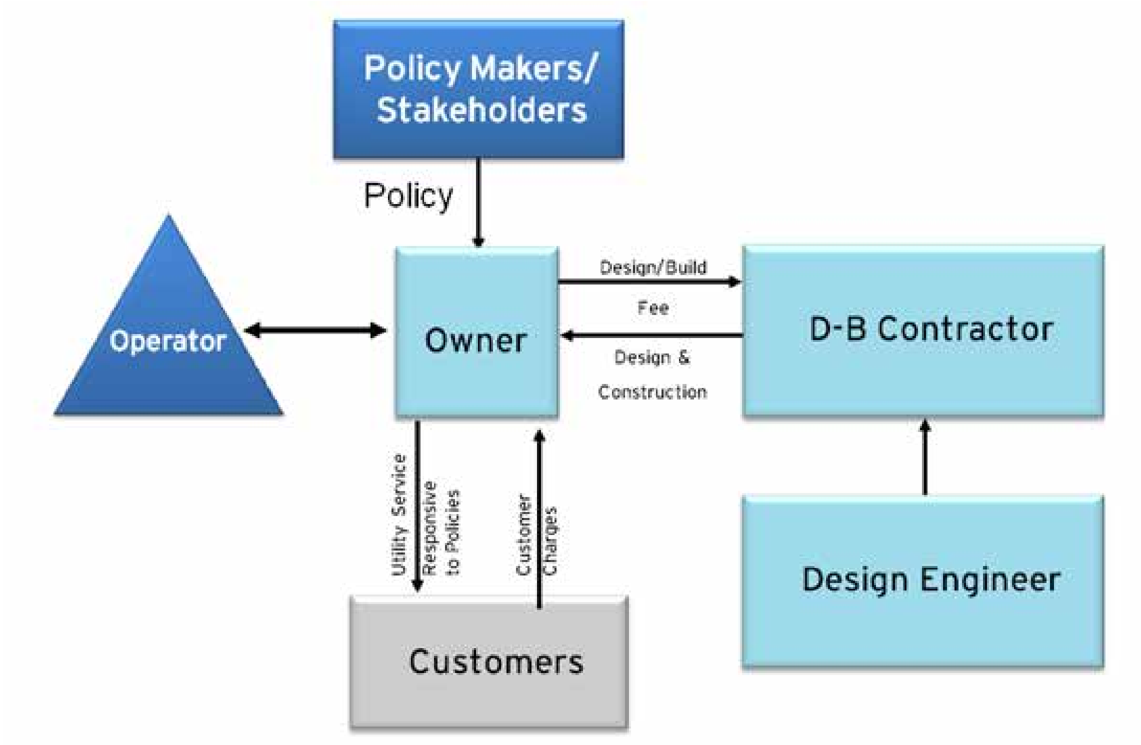
The design risk in this method is allocated to the private sector. Construction risk is also the responsibility of the private sector. However, there is some extension of time risk to the Owner, and there is much greater risk to the Owner due to variations if changes are initiated by the Owner. The operation, financial, demand, and planning process risk are with the Owner.

There is standard documentation for DB contracts and these are now well understood in the market place.

The Owner needs to be able to unambiguously specify the performance requirements of the project and be able to effectively assess the relative merits of different processes and systems. This is not a simple task and warrants careful attention.

This method can be more or less prescriptive depending on the client's preferences and can sometimes take a form that is more similar to DBB than traditional DB.

Figure 2-2: Participants Under DB



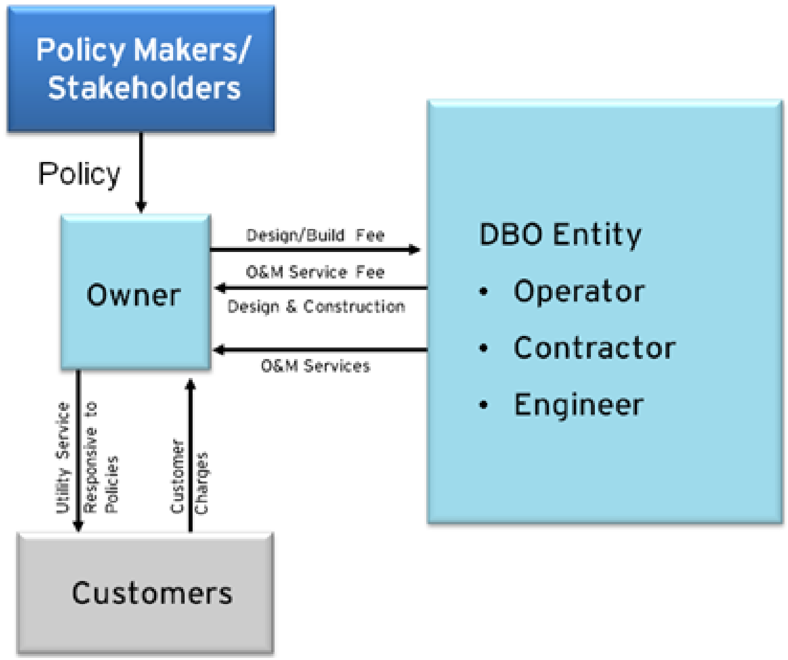
2.4. Design-Build Operate (DBO)

In this method, a company contracts to design, construct and operate a facility, and upon completion, transfers the ownership to Owner. The Owner then enters into a lease agreement with the contractor to operate the facility for a specified time period (typically 10 to 25 years). Longer operating contracts tend to ensure that higher quality equipment is used in the construction of the facility, since the Contractor will be responsible for the satisfactory operation of the equipment for a longer period. It also helps ensure that the Contractor performs the necessary maintenance to maximize the life of the equipment over the contract period. The Contractor is typically reimbursed for operations on a fixed cost plus variable payment structure. The contract is based on meeting specified performance requirements during the build and operate phase. The construction is funded by the Contractor, but upon completion and subject to meeting performance requirements, is reimbursed by the Owner. The participants and their interrelationships under design-build-operate are illustrated in **Figure 2-3**.

A high level of Owner involvement would be required at an early stage to define performance requirements both in the build and operate phase. As the Contractor only gets paid according to meeting performance requirements very clear acceptance testing procedures need to be developed. There is an ongoing requirement for the Owner to administer operational performance (availability, volume, and service).

The risks associated with design, construction, and operation are allocated to the private sector.

Figure 2-3: Participants Under DBO



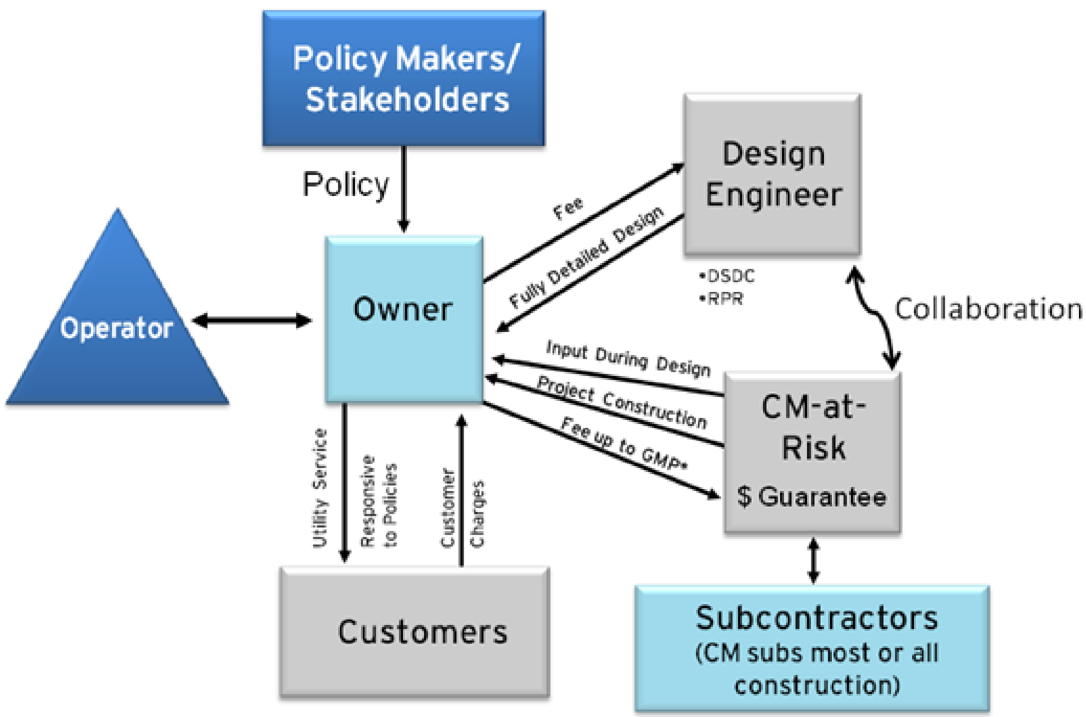
2.5. Construction Manager (CM) at Risk

This method is a modification to the DBB delivery method that provides for qualifications-based selection, early in the design phase, of the general contractor that will ultimately construct the project. The owner holds the contracts of the design engineer and CM@Risk contractor separately during the design and construction phases. The participants and their interrelationships under CM@Risk are illustrated in **Figure 2-4**.

The CM@Risk contractor and the design engineer work together as a team to develop a constructible and biddable set of contract documents for the project. The design engineer retains responsibility for the quality of the finished design. The CM@Risk contractor retains responsibility for management of the cost and schedule models during design to the point where a guaranteed maximum price (GMP) proposal can be submitted to the owner for the construction. The GMP proposal can be requested by the owner at any time in the design development process, which maintains the validity of the cost and schedule models throughout design. However, the GMP is generally accepted from the CM@Risk contractor after all work on the project has been bid to the contracting community.

If the CM@Risk contractor wishes to self-perform any of the work, the owner can request them to bid for the work with the contracting community. If successful, they can self-perform. If not, they receive their fee during the construction phase to serve as the construction manager for the project, but they remain at risk for delivery of the work within GMP proposal provisions. The construction phase contracting mechanism is optimally recommended as a cost plus fixed fee contract with a guaranteed maximum price, but lump sum delivery is an option following receipt of project bids.

Figure 2-4: Participants Under CM@Risk



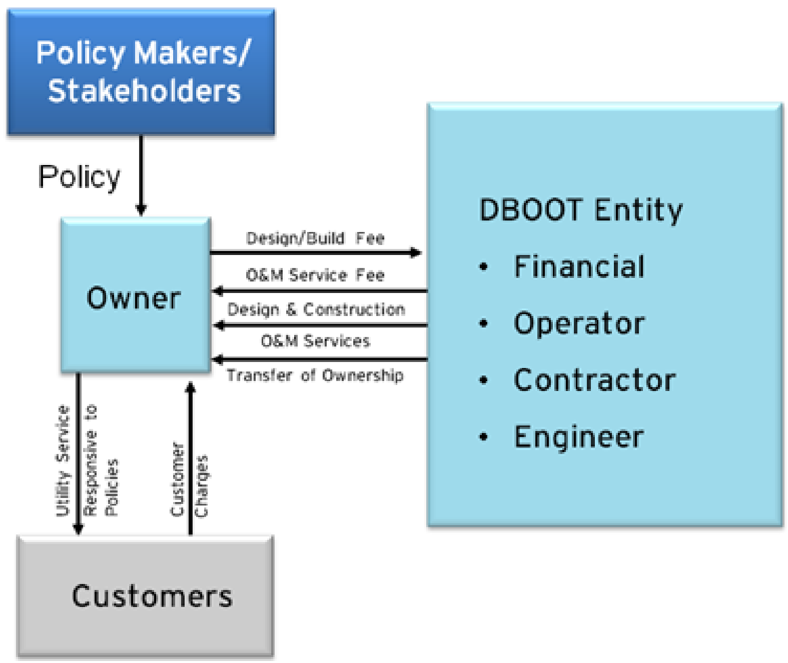
2.6. Design Build Own Operate Transfer (DBOOT)

In this method, a consortium is chosen to build, own, operate, and eventually transfer the asset back to the Owner after an agreed period. A high level of Owner involvement is required at an early stage to define all project requirements. The participants and their interrelationships under design-build-own-operate-transfer are illustrated in **Figure 2-5**.

Close monitoring of performance is required over the life of the project to administer payment to the consortium. The risks associated with design, construction, operation, financial, and commerce are allocated primarily to the private sector. The degree of allocation is dependent on individual contract arrangements.

Since the legal arrangements must cover all aspects of the project including design, construction, operation, financing, and transfer of asset, they are clearly substantial documents.

Figure 2-5: Participants Under DBOOT



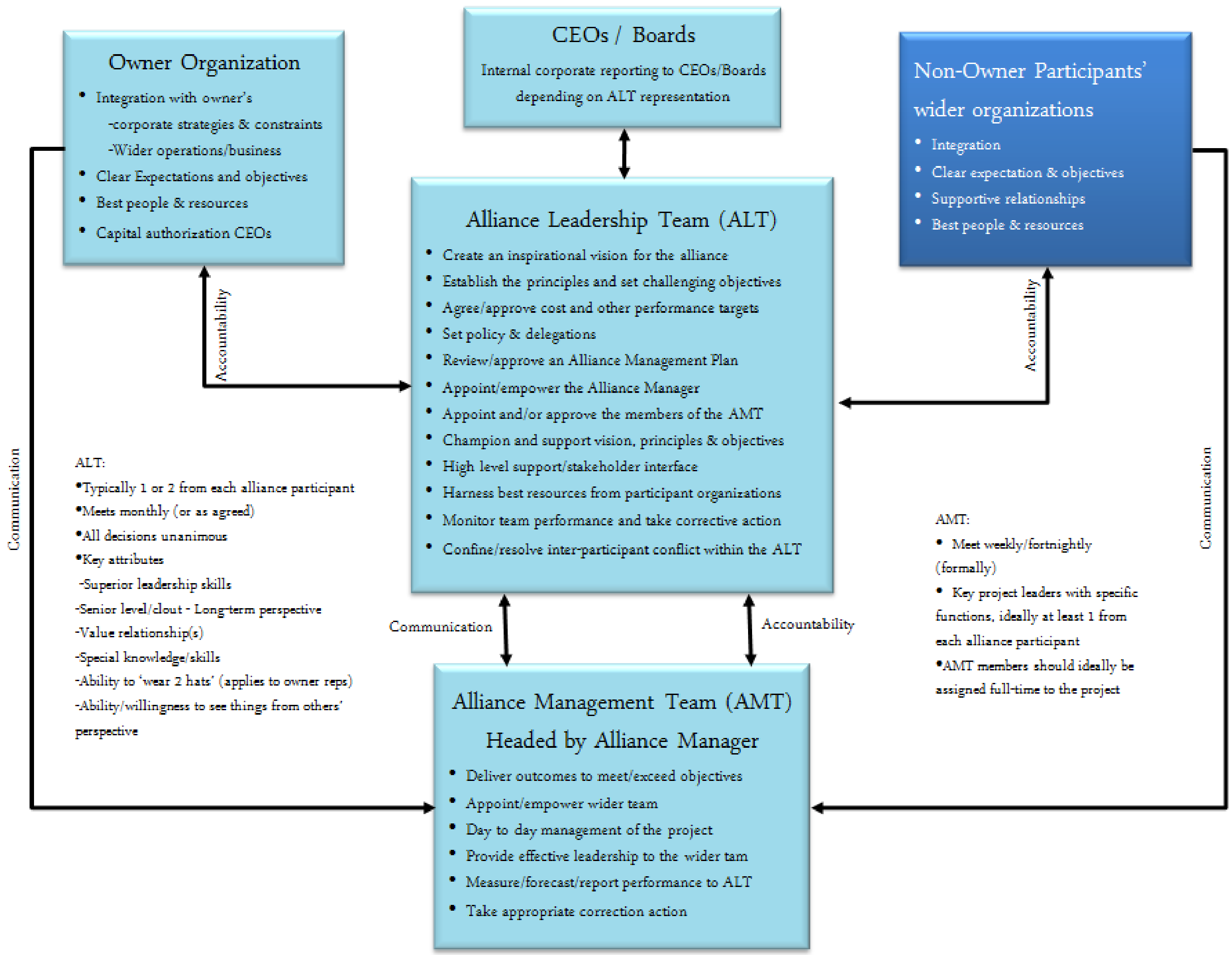
2.7. Alliance Contract

In this method, in order to deliver a large project, several companies, agencies and/or the Owner work together as partners in an "Alliance" to deliver the project. The Alliance partners enter into an agreement with the Owner to deliver a new asset on an agreed fee basis. The partners apportion tasks and the overall profits or losses that accrue. The participants and their interrelationships under Alliance are illustrated in **Figure 2-6**.

This form of Project Delivery provides a focused team that includes the Owner, designer, builder and operator that combine to deliver the best product. This has been employed for very large projects, such as construction of an oil platform and has been used for the Northside Storage Tunnel in Sydney and desalination plants, such as the Gold Coast Desalination Plant. The method is ideally suited to projects where risk cannot be quantified at time of bid. This can happen due to overwhelming time constraints, e.g. the Northside Storage Tunnel which needed to be in operation prior to Sydney Olympics. It can also happen when risks are extremely difficult to quantify and to do so prior to awarding the contract could see the Owner pay an excessive risk premium under traditional methods of delivery.

This type of delivery mechanism is unlikely to be attractive for small projects or those that have a low degree of technical complexity. The Owner needs to be able to accurately determine the project costs for other delivery methods and be prepared to participate in the alliance as an equal but not dominant partner. As all decisions must be unanimous this can be difficult for owners accustomed to a traditional method of delivery. In this method risks are shared between the participants but ultimate risk lies with the Owner.

Figure 2-6: Participants Under Alliance



3. Evaluation of Alternatives

The selection of the Project Delivery method which best meets the requirements of West Basin needs to be made in the context of the overall strategic plan for the organization. This strategic plan will outline the organizational objectives, principles, and vision. Then, once having clearly understood the strategic context of the decision, the Owner is in a good position to assess the wide range of delivery methods open to them including:

DBB

DB

DBO

CM@Risk

DBOOT

There are a number of factors which should be taken into consideration when making this assessment and these include:

Capital cost and complexity of project

Government policy

Finance

Regulatory approvals

Timing

Design

Type of site (Brownfield or Greenfield)

Operations

Owner resources, staffing and experience

Project risk

Project Flexibility / Owner Control

These factors are explained below:

Capital Cost and Complexity of Project

In general as the scale and complexity of project increases more delivery methods become feasible. For smaller projects which are simple in nature the DBB method has a proven track record and minimizes the cost of bidding to the industry.

As the project value increases larger contractors become more interested in bidding and they offer innovations in the design, construction and operation of facilities. They are also prepared to invest more in developing their ideas if the ultimate reward is large.

Government Policy

Some government policies may preclude certain methods of delivery. This is particularly true of private ownership of assets. In this case the DBB, DB, and DBO methods would still be feasible options. In some jurisdictions owners may not be able to share risks which they are not directly responsible for.

Finance

In the U.S., as a result of the availability of tax exempt financing, the relatively high cost of private financing makes it a less common approach than in the rest of the world, where tax exempt financing is not available. There are some advantages to private financing, however, including increased flexibility in operating contract compensation (e.g. commodity based concessions), limiting impact on bonding capacity, and the possibility of lower overall cost due to more financial control. Regardless of the financing method, a rate increase will likely be required, which may make revenue bonds more difficult to obtain. This is less likely to affect West Basin, on account of the District being a water wholesaler requiring approval from the California Public Utilities Commission (PUC).

Regulatory Approvals

Where detailed designs are needed to obtain regulatory approval, DBB is one of the best suited options.

Timing

For projects where very tight delivery times are required, the best suited options include DB and DBO delivery methods.

Design

Where the contractor/operators are highly skilled to undertake the design then DBO, DBOOT and Alliance models can be preferred.

Type of Site (Co-Location vs. Previously Undeveloped)

Where there are existing assets and operators which need to be taken into account (i.e., co-location) then the DBB method allows a high level of client/owner interaction.

For Greenfield projects which have a high degree of complexity and the potential for innovation is high then DB, DBO, and DBOOT delivery methods are best suited.

Operations

Where the Owner has a high level of skill in operations and this is seen as core business then DBB and DB models are best suited.

Where operations is not a core skill, or current operators are at lower than industry benchmark levels, then DBO, and DBOOT are favored. A separate operations contract could also be written to accompany the DBB and DB models. The operations contract would need to be highly prescriptive and may include periodic contract negotiations/renewals to help ensure that long term performance requirements are met satisfactorily. Such a highly prescriptive contract should be acceptable to most contract operators considering present desalination project offerings and prevailing economic factors.

The current model implemented by West Basin for their Recycled Water Facilities is to employ contract operations. The delivery model for these facilities has been predominantly a design-build method, with a prescriptive specification for the facilities. The contract operations have been supplied on a time reimbursable basis. See Owner Resources, Staffing and Experience section below for more detail on West Basin's historical experience with project delivery.

Owner Resources, Staffing and Experience

Similar to operations skills, the owner may be better suited for methods with more or less owner control depending on their available resources, staffing and experience.

West Basin has historically utilized a descriptive approach to DB project delivery for several of its existing treatment plant expansions. This approach has typically included a 20-30% level preliminary design, pre-qualification stage, and RFP process for Best-Value DB team selection. West Basin's most recent DB projects have utilized this prescriptive approach primarily to maintain continuity with existing processes and operational considerations. This prescriptive approach also provides West Basin a higher confidence level in ensuring contractual customer water quality and capacity requirements are met. For West Basin, selection of project delivery approach has been evaluated on a project-by-project basis and does not mandate use of prescriptive or performance based delivery methods.

Project Risk

Where project risks are well understood or where there is a high likelihood of performance requirements changing, then the DBB method is preferred.

If demand/load projections are likely to change dramatically then it is best to avoid methods with long-term operational terms. In this case, DBB and DB methods are preferred.

Project Flexibility / Owner Control

The amount of control afforded to the owner differs among project delivery methods. **Figure 3-1** presents a graphical representation of how project flexibility and owner control compares among the methods.

Figure 3-1: Project Flexibility/ Owner Control

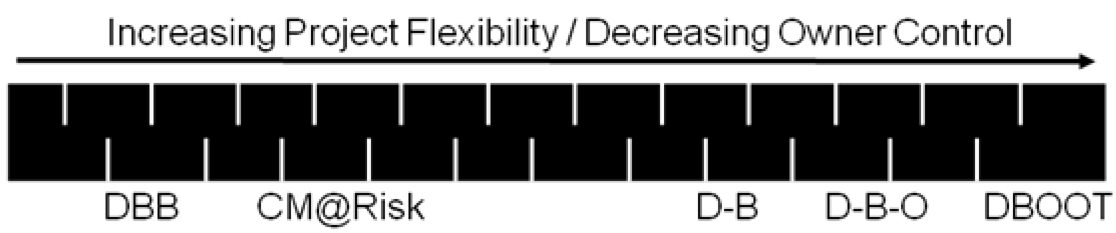


Table 3-1: Advantages/Disadvantages for DBB Delivery Method

Advantages	Disadvantages	Projects Suited to Method
This method of Project Delivery is commonly used in the U.S. and most water agencies are generally comfortable with the approach for typical water infrastructure. The Owner chooses the design consultant, has close control of concept and detailed design development, and can ensure that the features the Owner wants in the infrastructure are incorporated. The Owner can obtain competitive prices for construction of its chosen design. Within reason the Owner can adjust the design and extent of work and can cope with varied ground conditions by paying for actual conditions.	The process can be lengthy as tasks are sequential. When construction or operational problems occur, disputes on responsibility (Owner, Project Manager, designer, and Contractor) can be difficult to resolve. Limited opportunity for innovation and hence cost savings once the concept design has been adopted. Interface/lack of integration between designer, constructor, and operator. The Owner is responsible for finding skilled operations staff, which can be difficult for complex systems and if they don't currently have these skilled operators employed. Litigation is a risk as the form of contract is adversarial in nature.	Where, because of the nature and location of the works, there is little scope innovation, DBB is often the best approach. This method should include schedule of rates items where there are large costs associated with uncertainty in foundation or excavation conditions. DBB is also suited for projects involving augmentation of existing works where most of the project parameters have been set and there is a need to conform to the overall design of the facility.

Table 3-2: Advantages/Disadvantages for DB Delivery Method

Advantages	Disadvantages	Projects Suited to Method
Contractor has a clear responsibility to deliver a facility which meets performance requirements and thus is responsible for adequacy of both design and construction. This minimizes problems in responsibility and resolution of faults. The method is often adopted to shorten the delivery time. However, time savings vary widely with the type of project. If site conditions are predictable and scope is well defined, control of the design by the contractor should lead to a low capital cost facility. In some cases, design and construction contractors have process knowledge, patented equipment not available to design consultants.	A thorough knowledge of the performance requirements is needed prior to soliciting qualifications/bids/proposals. It is not suitable when the Owner objectives may change during project execution. Although proposals should be evaluated on the basis of life cycle costs, proposers may concentrate on reducing the capital cost as they are not responsible for long-term operation; this could lead to high operational costs. However, recent proposals have a proving period of up to three years to overcome this concern. A high level of expertise is required to define performance requirements and incorporate these into contractual documents. Litigation is a risk as the form of contract is adversarial in nature.	DB is well suited to projects with simple investigation and planning approval needs where the time frame to completion is required to be shortened. DB is well suited to large projects (e.g. treatment works or major pumping stations) where there are a number of options which could satisfactorily meet performance. It is more suited to assets where most of the total life cycle cost is in the initial capital cost. If it is to be used for assets with high operating costs (like desalination plants) then these costs need to be provided in the proposal and a proving period incorporated in the contract to demonstrate their appropriateness.

Table 3-3: Advantages/Disadvantages for DBO Delivery Method

Advantages	Disadvantages	Projects Suited to Method
Contractor is responsible for design, construction, and operation and this should help achieve a minimum cost solution provided reasonable design freedom is possible and foundation cost, and process uncertainties are not overly significant. The Owner retains ownership of the facility and thus has some control to cope with unexpected changes in performance requirements. In some cases, DBO contractors have process knowledge and patented equipment not available to design consultants. AS with DB, the DBO method has the potential to utilize alternate proposals to obtain creative solutions. The owner may choose to request proposals as a combination of a base bid (with rigid prescriptive requirements) for some project components and an alternate bid (where a number of options could satisfactorily meet performance requirements) for other components. The DBO method helps manage risk by transferring much of it to the private sector, which is particularly advantageous given the cost and complexities of desalination technology.	This method requires intensive effort from the Owner to define project requirements and risks prior to initiating the bidding process. Significant bidding costs are involved. Extensive administration over the life of the project is also required. Changes cannot be made after awarding the contract without significant technical, administrative, and commercial effort. Litigation is a risk as the form of contract is adversarial in nature.	One of the main drivers to using DBO is to allocate technology risk to the private sector. Worldwide desalination projects are largely developed via full service methods given the costs and complexities of designing, constructing, and operating these technologies. The DBO method suits projects with capital values exceeding $5M involving a water treatment works or sewage treatment works. The method ensures operation factors are considered. The method is more suited to projects where operational costs are a significant proportion of total life cycle costs. The method is suited to Owners who do not wish to transfer ownership of facilities to the private sector but wish to introduce a competitive model into their existing system. At a minimum, it would provide useful benchmarking data for Owners other facilities. The method is suited to Owners where operation of facilities is not seen as core business. The method is suited to Owners looking to achieve minimum cost solutions and to lock these in over a long time frame.

Table 3-4: Advantages/Disadvantages for CM@Risk Delivery Method

Advantages	Disadvantages	Projects Suited to Method
Significant contractor input into the design development. Delineation during design by the prospective contractor of risk elements that the owner may elect to manage separately, as opposed to within the contract. Reduced bid phase pricing volatility. Opportunity for the owner to construct a synergistic team of the design engineer and the contractor who will ultimately construct the project.	May not be well known by the local contracting community. Requires an investment of time and energy on the part of the owner not typically required under DBB or DB to deliver. Requires careful development of contract documents and management of the project development to maintain compliance with procurement laws. CM@Risk has not been established in California. For a municipality that has not already adopted CM@Risk as an acceptable alternative, it will be challenging to implement.	Projects that require specific contractor capabilities and project conditions that can be most properly addressed with a qualification-based selection process. The owner wants to maintain an independent relationship with its design engineer. Significant risk elements that are best managed with the input of a competent contractor. Requires significant construction phase operations coordination that is best coordinated and priced prior to commencing construction.

Table 3-5: Advantages/Disadvantages for DBOOT Delivery Method

Advantages	Disadvantages	Projects Suited to Method
The method obtains competition for design, construction, operation, and finance of the project. It should therefore achieve a minimum cost solution provided reasonable design freedom is possible and uncertainties, such as foundation costs are not overly significant. The vast majority of project risk is allocated to the private sector. The interface between maintenance and replacement costs is eliminated during the Operations phase of the project.	This method requires intensive effort from the Owner to define project requirements and risks prior to initiating the bidding process. Very significant bidding costs and complex negotiations are required before signing the contract. The Owner has less control than under DBO to deal with unexpected changes in performance requirements since the site and the asset are under the control of the consortium. This method is not flexible, e.g. changing regulatory requirements or changing demand.	Greenfield projects over $20M are suited to this method. Projects where the operational costs are a significant proportion of total life cycle costs. Projects with some complexity and scope for innovation are suited to this method. Projects which are easily separable from the rest of the Owners business are suited to this method. The method is suited to Owners where operation of water supply and sewerage facilities is not seen as core business. The method is suited to Owners looking to achieve minimum cost solutions and to lock these in over a long time frame.

Table 3-6: Advantages/Disadvantages for Alliance Delivery Method

Advantages	Disadvantages	Projects Suited to Method
It can deliver a project quickly. Where projects have objectives other than cost, this method can directly incorporate these considerations into the reimbursement of the Alliance members. For example, in the Northside Storage Tunnel the project had time, environment, safety and community objectives in addition to cost. This allows the focus of the team to be more balanced than in the DBB method. It allows risks to be managed in an equitable manner and generally reduces potential for conflict. All costs are open book and therefore transparent to the Owner and Project Partners, which builds trust. It encourages all participants to focus on solving problems in a collaborative manner. Changes to scope are priced in a transparent manner with no opportunity for windfall profits to be made by Project Partners. · It can include an operating period if required.	It requires a high level of expertise of team members from all Alliance parties. Value for money can be difficult to prove objectively. · There is no precedent for Alliance in the United States, as it is currently not a legal approach.	Projects where the history of existing methods of delivery projects is poor (e.g. tunnels, ocean works). This being due to the inability to fairly allocate and quantify risk at the time of bid. Projects where the required outcomes are developed during the currency of the project. For example, projects where community consultation strongly influences project details. Projects where time is of the essence. Projects where objectives other than cost rank highly in the Owner's opinion. This could be operation, safety, environment and maintenance objectives. High level of interaction with existing assets. Projects which require all parties to closely collaborate in order to determine optimum solution.

Preferred Delivery Methods

A project delivery workshop was conducted on April 11th 2012 to provide West Basin with an overview of the alternatives and discuss some specific drivers in the delivery method selection. At the workshop, the following drivers were noted by West Basin to be of importance:

- Based on multiple years of project development and site specific understanding gained, West Basin is likely in a more knowledgeable position on the preferred treatment system performance than industry. As such, West Basin would likely consider providing the definition on the technical/treatment components (i.e. prescriptive approach).
- Technically qualified and experienced staff in alternative delivery
- Flexibility in contractor selection – ability to select based on best value
- Cost impacts
- Schedule (no regulatory constraints for expedited schedule)

By comparing the advantages/disadvantages identified above with the initial preferences/concerns provided by West Basin during the project delivery workshop, the CM@Risk, DBOOT and Alliance methods fall out of consideration. DBOOT and Alliance methods rely on private financing which is typically cost prohibitive and relinquishes some control of the project to the private sector. For a municipality that has not already adopted CM@Risk as an acceptable alternative, implementation would be challenging since the method has not been established in CA. There is also currently no legal precedent for the Alliance contracting method in the U.S.

The OWDPMP project can be broken down into three distinct components: the Intake/Discharge Structure, the Desalination Plant, and the Conveyance System. Among these components, the Desalination Plant and the Conveyance System components can be clearly defined by West Basin and a descriptive method of procurement may be warranted. For these two components, a traditional DBB, or descriptive specified DB method, could be appropriate. The Conveyance System requirements would need to be closely specified from the outset in order to satisfactorily integrate into the local distribution system. With more risk associated to the intake/discharge structures, and the industry proprietary solutions associated with this component, a procurement method with performance based requirements may be considered. DBO should also be included in the preferred delivery options as it presents the unique advantage of incorporating long term operational considerations into design and construction.

4. Risk Profile of Preferred Delivery Methods

To present an overview of the preferred Project Delivery options, a framework is provided in this section to address the following two questions in terms of general or typical applications:

- What are the potential Project Risk Factors?
- When is it most appropriate to use which model?

The major Project Risk Factors are shown below in **Table 4-1.**

Table 4-1: Project Risk Factors

Type of Project Risk Factor	Description
Performance Requirements/Demand	This is the risk that actual performance requirements and/or demand will differ from those planned
Planning/Permitting Approvals	This is the risk that outcomes from environmental studies and community consultation processes may affect project viability
Design	This is the risk that the design of the project is faulty and may lead to unexpected construction costs or operational problems in meeting performance requirements
Construction	This is the risk that construction will exceed budgeted cost, contain faults and be completed late
Operation	This is the risk that required performance will not be achieved because of operational problems
Financial	This is the risk associated with changes to interest rates, inflation, availability of finance, taxation, financial ability and security on loans
Commercial	This is the risk that changes to the corporate environment, e.g. structure of company, taxation, insurance, viability and other rates and charges may affect project viability
Government Policies	This is the risk that government may change policies, which may affect project viability
Political	This is for public perception or criticism, i.e. ultimate responsibility for performance of the system

As the methods allocate risk differently between the Owner and the private sector it is necessary to examine the implications for the Owner of choosing a one method over the other. It is also important that the Owner understand the implications of the Project Delivery options and associated risks. The Owner will need to define the project which will require some basic investigation and initial planning approvals.

This section provides a detailed comparison between DBB, DB, and DBO. Using the Project Risk Factors presented above, **Table 4-2** provides a relative comparison of risks to the Owner associated with the three approaches.

Table 4-2: DBB, DB, and DBO Risk Profiles

	Design Bid Build (DBB)		Design Build (DB)		Design Build Operate (DBO)	
Type of Risk	**Description of Impact**	**Risk Level**	**Description of Impact**	**Risk Level**	**Description of Impact**	**Risk Level**
Performance Requirements/ Demand – performance requirements and/or demand differing from planned.	Risk is with Owner. Peformance requirements are well defined prior to initiating bidding but not as intensively as in DB and DBO. The Owner's contractual relationship with the design consultant allows for owner input throughout concept and detailed design, helping to manage performance and demand risks.	Medium to High	Risk is with Owner. Performance requirements are well defined prior to initiating bidding. Contractor is responsible for adequacy of both design and construction. However, performance and demand changes during design phase are less easily accommodated than in DBB approach.	Medium	Some risk transferred to private sector. Performance requirements and risks are thoroughly defined prior to initiating the bidding process and therefore carry a low risk of differing from the plan. However, there may be problems in making changes to long-term operational contracts if there are changes to the performance requirements.	Low to Medium

Table 4-2: DBB, DB, and DBO Risk Profiles (Continued)

	Design Bid Build (DBB)		Design Build (DB)		Design Build Operate (DBO)	
Type of Risk	**Description of Impact**	**Risk Level**	**Description of Impact**	**Risk Level**	**Description of Impact**	**Risk Level**
Planning/Permitting Approvals – environmental studies and community consultation may affect project viability.	Risk is with Owner. Where detailed design information is needed to obtain regulatory approval, DBB is well suited due to relatively early start to design.	Low	Risk is primarily with Owner. Due to ongoing nature of design, complete detailed design information may not be readily available for obtaining regulatory approval.	Low to Medium	Allocation of risk is dependent on contract arrangement. Some risk can be transferred to private sector. Permitting generally begins prior to design on account of a lengthy DBO team procurement process, meaning that detailed conceptual design information may not be readily available for use in permit applications.	Medium

Table 4-2: DBB, DB, and DBO Risk Profiles (Continued)

	Design Bid Build (DBB)		Design Build (DB)		Design Build Operate (DBO)	
Type of Risk	**Description of Impact**	**Risk Level**	**Description of Impact**	**Risk Level**	**Description of Impact**	**Risk Level**
Design – faulty design leading to higher construction costs or operational problems.	Risk is with designer. The Owner has close control of concept and detailed design development, can adjust the design and extent of work, and can cope with varied ground conditions by paying for actual conditions and quantities through a schedule of rates contract.	Low	Risk is with DB Contractor. A high level of expertise is required to define performance requirements and incorporate these into contractual documents. Contractor is responsible for design and construction which helps ensure that construction costs are considered. However, since the DB Contractor is not responsible for long-term operation and may concentrate on reducing capital cost, high operational costs and problems could result. Including a proving period helps to reduce operational risk.	Medium	Risk is with private sector. This method requires intensive effort from the Owner to define project requirements and risks prior to initiating the bidding process. Contractor is responsible for design, construction, and operation which helps ensure that all related factors including construction cost and operational issues are considered.	Low to Medium

Table 4-2: DBB, DB, and DBO Risk Profiles (Continued)

	Design Bid Build (DBB)		Design Build (DB)		Design Build Operate (DBO)	
Type of Risk	**Description of Impact**	**Risk Level**	**Description of Impact**	**Risk Level**	**Description of Impact**	**Risk Level**
Construction – construction finished over budget, with faults or completed late.	Risk is with Contractor. When construction or operational problems occur, disputes on responsibility (Owner, Project Manager, designer, and Contractor) can be difficult to resolve.	Medium to High	Risk is with DB Contractor. Contractor is responsible for both design and construction. This helps to minimize problems in responsibility and resolution of faults.	Low to Medium	Risk is with private sector. Contractor is responsible for design, construction, and operation. This further minimizes potential problems in responsibility and resolution of faults as most risk is transferred to private sector.	Low
Operation – required performance not achieved due to operational problems.	Risk is with Owner. May be problems with DBB approach managing interfaces and allocating responsibilities for operational problems.	High	Operational risk is mostly with Owner. Fewer interface problems than with DBB approach. Tight performance specification is required.	Medium	Operational risk is with private sector. Managing the interfaces and resolution of interface problems are a matter for the private sector operator.	Low

Table 4-2: DBB, DB, and DBO Risk Profiles (Continued)

	Design Bid Build (DBB)		Design Build (DB)		Design Build Operate (DBO)	
Type of Risk	**Description of Impact**	**Risk Level**	**Description of Impact**	**Risk Level**	**Description of Impact**	**Risk Level**
Financial – changes in interest rate, loan availability, taxation, etc.	Risk is with Owner. DBB does not transfer risk associated with financing of project.	Medium	Risk is with Owner. DB does not transfer risk associated with financing of project.	Medium	Risk is with Owner (except during construction). DBO does not transfer risk associated with financing of project.	Medium
Commercial – changes in the corporate environment e.g. company structure, taxation, etc.	Risk is with Contractor.	Low	Risk is with Contractor.	Low	Risk is with private sector.	Low
Governing Policies – impact of changes in government policies on project viability.	Risk is with Owner. Risk of policy changes can be best managed under a Sequential approach.	Medium to High	Risk is primarily with Owner.	Medium	Allocation of risk is dependent on the contract arrangements.	Low to Medium
Political – ultimate responsibility for performance of system.	Risk is with Owner. Owner bears ultimate responsibility for performance of system.	High	Risk is with Owner. Owner bears ultimate responsibility for performance of system.	High	Risk is primarily with Owner. Owner primarily bears responsibility for performance of system.	Medium to High

5. Delivery Method Cost & Schedule Comparison

5.1. Cost & Schedule Comparison

Table 5-1 below presents a general comparison of cost and schedule for the three delivery methods. An explanation of the primary differences in activities and durations among the three methods are presented in Section 5.2.

Table 5-1: Relative Schedule/ Cost Comparison for DBB, DB, and DBO

Delivery Method	Cost w/ Operations	Cost w/o Operations	Schedule
Design-Bid-Build (DBB)	DBB Capital Cost (baseline for comparison) DBB Life Cycle Cost (baseline for comparison)	DBB Capital Cost (baseline for comparison) DBB Life Cycle Cost (baseline for comparison)	DBB (baseline for comparison)
Design-Build (DB)	Lower than DBB Capital Cost (15-35% lower) Higher than DBB Life Cycle Cost (5-15% higher)	Same as DBB Capital Cost Same as DBB Life Cycle Cost	Shorter than DBB (0 to 10% shorter)
Design-Build-Operate (DBO)	Lower than DBB Capital Cost (10 to 25% lower) Lower than DBB Life Cycle Cost (10 to 25% lower)	N/A N/A	Shorter than DBB (0 to 10% shorter)

5.2. Project Schedules

Included in this comparison of DBB, DB, and DBO are more detailed project schedules developed for each approach. These Project Schedules are included in **Appendix 8:A**.

As illustrated in the project schedules, the primary differences are:

- Retaining Owners Representatives: This activity is associated with the DB and DBO approaches. For the DB and DBO approaches, this activity reflects a significant duration, including the following sub-activities and durations.

RFP/ Retain Project Team	6 months
Project Description	6 months
Construction Impacts Report	6 months
Preliminary Engineering and DB Bid Package	9 months
Preliminary Opinion of Project Cost	2 months

  For the DBB approach, some of the associated sub-activities (i.e., Project Description, Construction Impacts Report, Preliminary Design, and Preliminary Cost Estimate) roll up under the Designer/Engineering responsibilities, and therefore, do not reflect a significant difference in the Project Schedules.

- DB/DBO Team Procurement: For a two step DB/DBO approach, which includes prequalification and sort listing of teams prior to the RFP, this activity reflects a significant duration, including the following sub-activities and durations.

Prepare RFQ/ SOQ Submittal	4 months
Short List DB/DBO Teams	2 months
Prepare RFP/ Basis of Design	4 months
DB/DBO Response	6 months
Review/Select/Approval	2 months

  With the DBB approach, these activities are replaced with Design Engineer Procurement, reflecting a shorter duration of approximately six months. However, the DBB approach also typically involves a longer design period, a longer contractor bidding and selection period, and a longer construction period (i.e., as a result of more involved submittal process).

Despite the activity and schedule differences between the approaches, given typical conditions and requirements, there is not a significant difference in the total project implement schedules. However, should an expedited schedule be required, as does not appear to be the case for the OWDPMP project, a DB or DBO approach can be a more effective tool in requiring and realizing a shorter project duration.

6. Contractor Procurement Process

6.1. Introduction

The contractor procurement process is different for each of the delivery methods discussed. The following sections describe the contractor procurement process associated with each method, including the following:

- Purpose of the procurement process,
- Scope and format of the procurement documentation, and
- Assessment of the time and budget needed for contractor procurement.

A description of procuring a separate operations contract is also provided.

6.2. DBB Contractor Procurement

The Design-Bid-Build method is typically used on projects where the Owner wishes to exhibit a fair amount of control over the technical aspects of the project. In the Design-Bid-Build method, the Design Engineer is procured and the Contractor is chosen through a contractor bidding and selection period following design. Procurement of the Design Engineer typically follows the format below:

- Owner prepares Design RFP which describes the Design Engineer's scope for the project.
- Design Engineers submit proposals and/or Statement of Qualifications (SOQ) to Owner providing justification for their abilities to complete the required scope.
- Owner reviews proposals and/or SOQs and short lists Design Engineers who may then be asked to interview before final selection.

Following design and potential pre-purchase of equipment, the Contractor is chosen through a bidding and selection period.

Design Engineer Procurement typically has a shorter duration compared to DB Contractor Procurement and DBO 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, as discussed in Section 5.2. The additional activities required in the DBB approach, combined with the additional level of effort associated with the design and contractor bidding phases typically make a DB or DBO approach less costly, depending on the owner's experience and the specific nature/scope of the project.

6.3. DB Contractor Procurement

The Design-Build method can often be used for requiring and realizing a shorter project duration, incorporating best-value team selection and potential cost savings. Prescriptive forms of this method can also grant the Owner a fair amount of control over technical aspects of the project. In the Design-Build method, the Owner's Representatives are retained and the DB Team is procured. DB Team Procurement typically follows the format below.

- Owner prepares Owner's Representative RFP and retains Project Team (Engineering, Technical, Permitting, & Management).
- Owner's Representatives prepare Project Description/Construction Impacts Report, Preliminary Engineering (10-30%) and DB Bid Package, and Preliminary Opinion of Project Cost.
- Owner prepares DB RFQ which describes the DB Team's scope for the project.
- DB Teams submit Statement of Qualifications (SOQ) to Owner providing justification for their abilities to complete the required scope.
- Owner reviews SOQs and short lists DB Teams.
- Following pre-qualification, DB 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 DB Team bids and technical proposals and makes final selection.

DB Contractor Procurement typically has a longer duration compared to Design Engineer Procurement and about the same as DBO 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, as discussed in Section 5.2.

6.4. DBO Contractor Procurement

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 Owner's Representative RFP and retains Project Team (Engineering, Technical, Permitting, Legal, & Management/Financial).
- Owner's Representatives prepare 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, as discussed in Section 5.2.

6.5. Contract Operations Procurement

Contract O&M, when properly implemented, is used to provide greater accountability for operations and to transfer operation risk 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 (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.

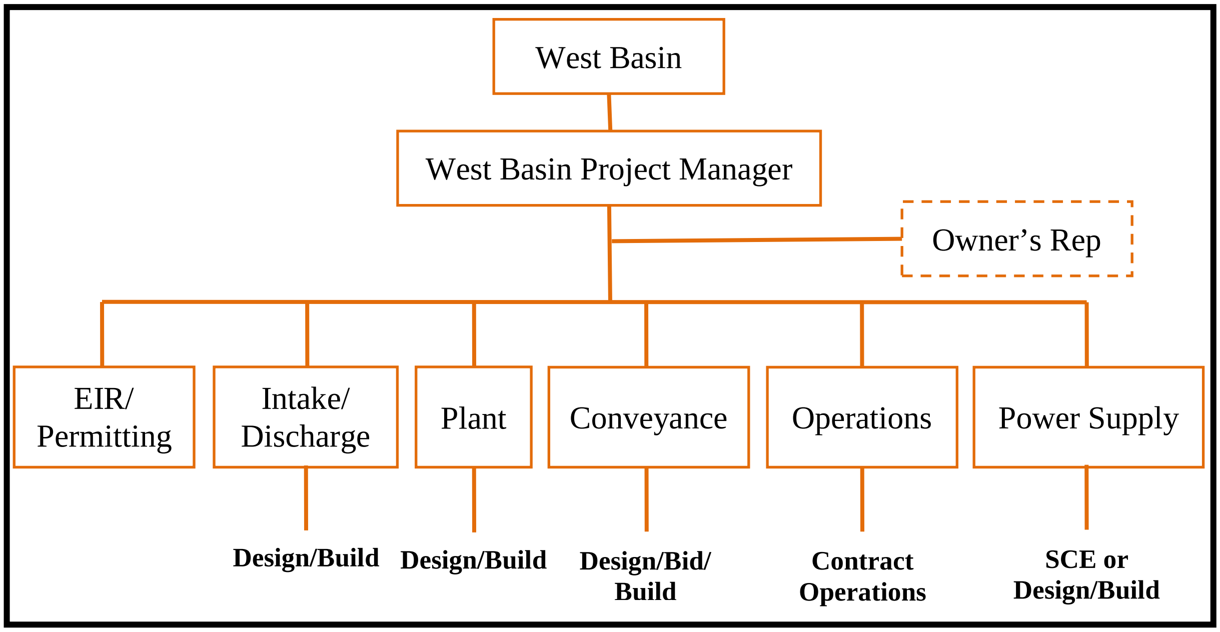
7. Conclusions

7.1. Conclusions

The OWDPMP project can be broken down into three distinct components: the Intake/Discharge Structure, the Desalination Plant, and the Conveyance System. Among these components, the Desalination Plant and the Conveyance System components can be clearly defined by West Basin and a descriptive method of procurement is warranted, and preferred by West Basin. For these two components, a traditional DBB, or descriptive specified DB method, are appropriate. West Basin identified these two methods as ones to be considered further. The Conveyance System requirements would need to be closely specified from the outset in order to satisfactorily integrate into the local distribution system. With more risk associated to the intake/discharge structures, and the industry proprietary solutions associated with this component, a procurement method with performance based requirements may be considered. DBO should also be included in the preferred delivery options as it presents the unique advantage of incorporating long term operational considerations into design and construction.

The use of multiple contracts would however bring its own risks associated with the overlapping and interconnecting components. Careful consideration to the management of such a hybrid delivery model will need to be undertaken, developed and implemented. Based on the assessment provided within this TM, the hybrid organization might look like the Program Delivery Model shown below in **Figure 7-1**.

Figure 7-1: Example Program Delivery Model



Within this type of Program Delivery Model that includes a hybrid set of delivery methods and contracts, additional development and coordination is often recommended and provided by an Owner's Representative. In general, this support can help to define and drive the program, in addition to providing significant coordination between the major components.

An overall schedule for the Program Master Plan that takes into account use of the hybrid delivery model described above is included in Appendix A.