BAY AREA REGIONAL
Desalination Project

Volume I

BAY AREA REGIONAL
Desalination Project Feasibility Study

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Prepared for:

CONTRA COSTA WATER DISTRICT

EBMUD

SFPUC
Water
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Clean Water

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By:

URS

The Bay Area's four largest water agencies, the Contra Costa Water District (CCWD), the East Bay Municipal Utility District (EBMUD), the San Francisco Public Utilities Commission (SFPUC), and the Santa Clara Valley Water District (SCVWD) (collectively referred to as "the agencies"), are jointly exploring the development of regional desalination facilities that would benefit the 5.4 million Bay Area residents and businesses served by these agencies. The agencies' service area boundaries are shown in Figure ES-1.

PROJECT GOALS AND OBJECTIVES

The goal of the Bay Area Regional Desalination Project (BARDP) is to develop one or two desalination plants that will produce reliable potable water to help the agencies meet their water needs during droughts, emergencies,[1] and maintenance-related facility outages. The agencies would leverage existing infrastructure to receive desalination product water or transfer water among their distribution systems. As a regional project, the BARDP would reduce the costs that any one agency would otherwise incur from developing desalination as an alternative water supply. Finally, a regional desalination facility that serves multiple water agencies could reduce the potential for adverse environmental impacts.

The agencies have undertaken this Feasibility Study to meet these goals and objectives and to help identify challenges, evaluate options, and plan the continued development of the BARDP.

FEASIBILITY STUDY GOALS AND OBJECTIVES

The goals and objectives of this Feasibility Study are to:

- Develop a process for evaluating the feasibility of regional collaboration for seawater/brackish water[2] desalination.
- Evaluate institutional options for the BARDP. Identify the mechanisms (such as a Memorandum of Understanding [MOU] or Joint Powers Authority) that can be implemented by multiple participants to own and operate a regional desalination project.
- Develop and implement a process by which various criteria relevant to desalination projects can be evaluated to select the optimal site(s). These criteria would include issues such as physical infrastructure, environmental issues, permitting, and cost. Apply this process to the BARDP sites and select a site or sites for detailed evaluation.
- Provide information about the costs and benefits of a centralized regional approach to desalination to the public, other water agencies, and environmental groups.
- Conduct a public, stakeholders, and agency outreach program.

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[1] Drought is defined differently by each of the BARDP partner agencies but is generally defined as when water supplies drop below a predetermined level. Emergency needs may include water needs during a catastrophic event such as an earthquake or levee failure.

[2] Seawater is from the ocean and typically has salinity—the salt content of water as expressed in total dissolved solids (TDS)—of about 35,000 parts per million. Brackish water has higher salinity than freshwater but lower salinity than seawater, often as a result of mixing of the two waters as occurs in estuaries.

- Provide a foundation for future project phases. Prepare a preliminary site layout for selected BARDP site(s) and a scope of work for environmental impact analysis of the proposed BARDP.
- Produce a template that can be replicated elsewhere in the state, potentially reducing adverse environmental and socioeconomic effects along the California coast.

In addition to these goals and objectives, this Feasibility Study includes a discussion of climate change and how the BARDP fits into the current thinking about potential climate change effects in California.

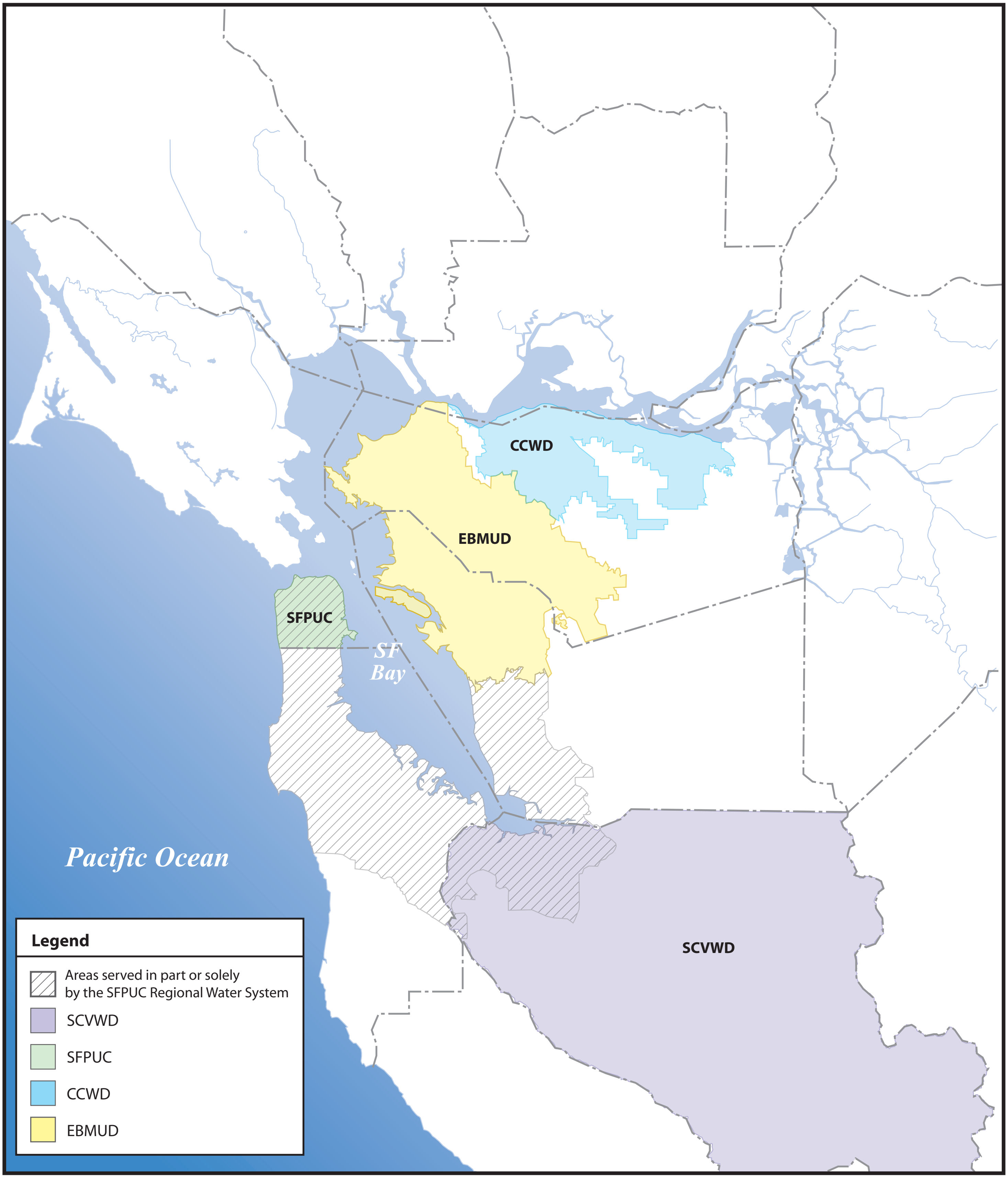
BARDP STUDY CHRONOLOGY

In 2003, the agencies entered into a MOU to explore the initial viability of the BARDP through a pre-feasibility analysis. The agencies initially considered the construction and operation of up to a 120 million gallon per day (mgd) desalination plant. In October 2003, the agencies completed a Phase 1 Pre-Feasibility Study that included a permit reconnaissance, an evaluation of desalinated water quality, and a siting study. The siting study included an assessment of site-specific feedwater quality and a review of permitting/water rights issues and environmental justice considerations. The study resulted in the short-listing of three of 22 potential sites considered. In June 2004, the agencies entered into a second (Phase 2) MOU to conduct preliminary environmental screening and an evaluation of conveyance options for the three short-listed sites. At this time, the agencies modified the projected capacity of the proposed regional desalination plant to 80 mgd. Nine operational scenarios involving the three top-ranked sites were developed based on a plant capacity of 80 mgd.

The agencies applied for a grant from the California Department of Water Resources (DWR) in January 2005 to conduct a Feasibility Study to further advance the development of the BARDP. The agencies were awarded the grant and initiated the Feasibility Study tasks, building on the work they had already completed during the two phases of the pre-feasibility study. The agencies assessed their individual needs for desalination water at that time and determined that two agencies would ultimately need a total of 25 mgd during all years, while the other two agencies would need a total of 40 mgd during drought years only, requiring a total plant capacity of 65 mgd. Seven operational scenarios involving the three top-ranked sites were developed based on a plant capacity of 65 mgd, with 25 mgd needed every year and 65 mgd needed during drought years.

In November 2005, the agencies revisited their need for desalination water and determined that the cumulative water needs of all four agencies would be 65 mgd but during dry years, emergencies, and some maintenance-related facility outages only; the agencies would not require wet and normal year supply from a desalination plant. Two of the seven operational scenarios were dropped, and the remaining five operational scenarios still included supplying 25 mgd during all years to reduce overall product water cost per acre-foot. The agencies initiated a market study analysis to identify other potential wet year customers for BARDP product water.

Recently, the SFPUC increased its estimated need for desalination water from 20 mgd to 26 mgd, consistent with the SFPUC's planning projections for 2030 and with its other planning documents. The revised need would result in a cumulative project need of 71 mgd. The



Source: Adapted from BAIRWMP 2006

URS	26814534.14000 Bay Area Regional Desalination Project	Bay Area Water Agencies	Figure ES-1

operational scenarios and conveyance options have not been revised to reflect this increased capacity, but this Feasibility Study acknowledges this increased projected need.

Table ES-1 lists the assumed desalination water needs for each of the agencies, which forms the basis for the evaluation presented in this Feasibility Study.

Table ES-1
Summary of Desalination Water Needs During Dry Years

Agency	Annual Desalination Water Needs (mgd)
CCWD	15
EBMUD	20
SFPUC	20*
SCVWD	10

***** As of November 2006, the SFPUC revised its desalination water need estimate from 20 mgd to 26 mgd, consistent with SFPUC planning projections and other planning documents. However, the Feasibility Study was developed assuming a need of 20 mgd for SFPUC.

FEASIBILITY STUDY ELEMENTS

The following activities were performed to meet the goals and objectives of the project and the Feasibility Study.

Assessment of Site and Infrastructure Options

Pre-Feasibility Study Site Identification. Twenty-two sites that represent a wide range of locations were initially identified as potential sites for BARDP plant facilities, as described in **Section 2.1**. Nine sites were eliminated due to potential environmental concerns or the potential lack of community acceptance for a single desalination facility that could meet agencies' needs. Evaluation criteria were developed to rank the remaining 13 sites for suitability for a regional desalination project. The three top-ranked sites that emerged from the evaluation represent a range of locations and feedwater types—the Mirant Pittsburg Plant site in Pittsburg (Bay/Delta water), the Near Bay Bridge site in Oakland (Bay seawater), and the Oceanside site in San Francisco (ocean seawater). The locations of the top-ranked sites are shown in Figure ES-2.

The Mirant Pittsburg Plant site was subsequently renamed the East Contra Costa site, and its geographic location was broadened to include the portion of Contra Costa County bordering the Sacramento River/New York Slough/San Joaquin River from Mallard Slough east to Antioch. The East Contra Costa site location was generalized until more rigorous site selection analyses (e.g., hazardous waste site investigation, geotechnical investigation) can be performed. Similarly, the Oceanside site represents a generalized location on the western shore of the Peninsula.

The agencies reserve the right to revisit any of these sites, or other sites, in the future should their needs, objectives, or the partnership structure change.

Conveyance Options. Next, conveyance options were evaluated to identify the potential pathways and water volumes that could be transferred among the BARDP agencies from a single desalination plant at each of the three top-ranked sites. **Section 2.2** describes the evaluation that was developed based on existing water conveyance facilities and capacities. Five potential water transfer locations were identified (see Figure ES-2).

Two dry year conveyance scenarios and one emergency conveyance scenario were developed for each of the three potential plant locations. The dry year conveyance scenarios represented the water transfer pathways required for each agency to receive its allotment of desalinated water. For each plant location, one pathway was developed that included transferring water in the Sacramento–San Joaquin River Delta (Delta), and one pathway was developed to avoid Delta water transfers, which may be subject to institutional issues, historical water rights, and constraints involving potential impacts to fisheries (see Figure ES-3). The emergency conveyance scenarios identified potential water transfer pathways required to deliver up to 65 mgd to each individual agency from a single 65 mgd plant at each of the three top-ranked sites identified in Section 2.1 (see Figure ES-4).

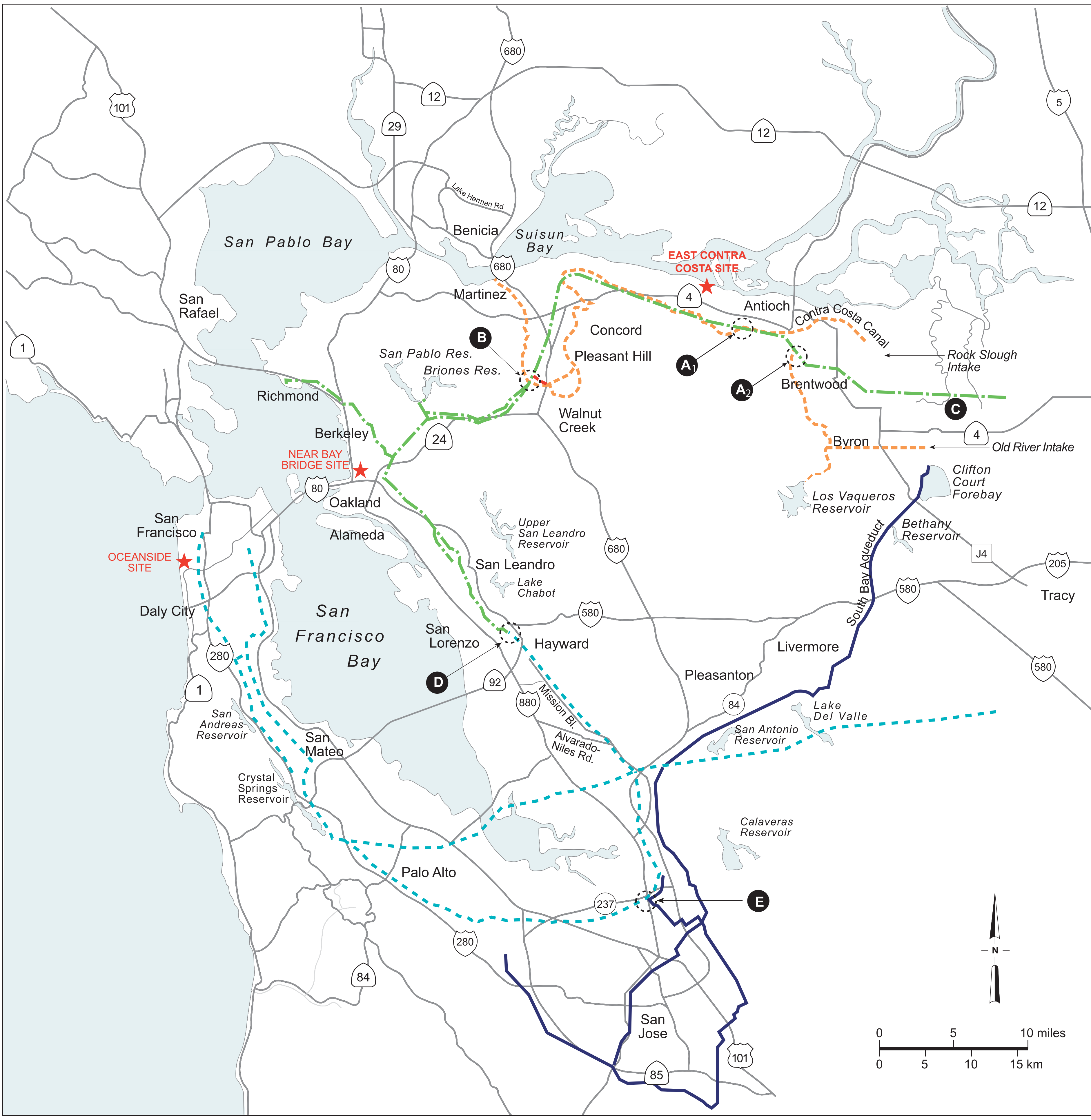
Both the dry year and emergency conveyance options would be subject to physical capacity limitations of the existing infrastructure. Transfers between the SFPUC and EBMUD would be limited to 30 mgd due to the size of the EBMUD/SFPUC Emergency Intertie in Hayward. Transfers between the SFPUC and SCVWD would be limited to 40 mgd due to the size of the SFPUC/SCVWD Emergency Intertie in Milpitas. An opportunity for additional transfers between the SFPUC and SCVWD would exist if deliveries to common customers could be modified by an agreement between the SFPUC and SCVWD.

The capacity of the existing infrastructure between EBMUD and CCWD and between CCWD and SCVWD is greater than the amount of water that would be transferred as part of the BARDP. For the East Contra Costa and Near Bay Bridge sites, it is possible to distribute 65 mgd among the agencies without requiring a Delta water transfer. However, with a single 65 mgd plant at Oceanside, a water transfer in the Delta would be required for EBMUD and CCWD to receive their full allotments.

In most cases, supplying any agency with the total plant capacity of 65 mgd during an emergency would require Delta water transfers between CCWD and SCVWD. A desalination plant at East Contra Costa would require a Delta transfer in order for the SFPUC and SCVWD to collectively receive 65 mgd. Without a Delta transfer, SFPUC and SCVWD could receive a maximum of 30 mgd. With a plant at the Near Bay Bridge site, only EBMUD could receive 65 mgd without a Delta transfer. The same is true for the SFPUC with a plant at Oceanside.

The development of a desalination plant at any of the three sites would require construction of interconnection pipelines and pump stations. A plant at the Near Bay Bridge or Oceanside site may require additional infrastructure. In addition, Memoranda of Understanding among the agencies for use of the existing interties would have to be revised to allow for water transfers under the BARDP.

Changes in agency needs/plant capacity would be affected by physical infrastructure constraints. The SFPUC's revised desalination water needs from 20 mgd to 26 mgd would affect the conveyance options by increasing the desalination plant capacity from 65 mgd to 71 mgd. Because the existing infrastructure at the EBMUD/SFPUC Emergency Intertie limits water transfers to 30 mgd, Delta transfers between CCWD and SCVWD would be required to distribute each agencies' allotment. This would apply to a single 71 mgd facility at any of the three sites.



LEGEND

★ Top-Ranked Site Location

Transmission Lines

SFPUC

CCWD

SCVWD

EBMUD

Water Transfer Location	Between	Capacity
A_1	CCWD/EBMUD	20 mgd (untreated)
A_2	CCWD/EBMUD	100 mgd (untreated)
B	CCWD/EBMUD	15 mgd (treated)
C	CCWD/SCVWD	>65 mgd (untreated)
D	EBMUD/SFPUC	30 mgd (treated)
E	SFPUC/SCVWD	40 mgd (treated)

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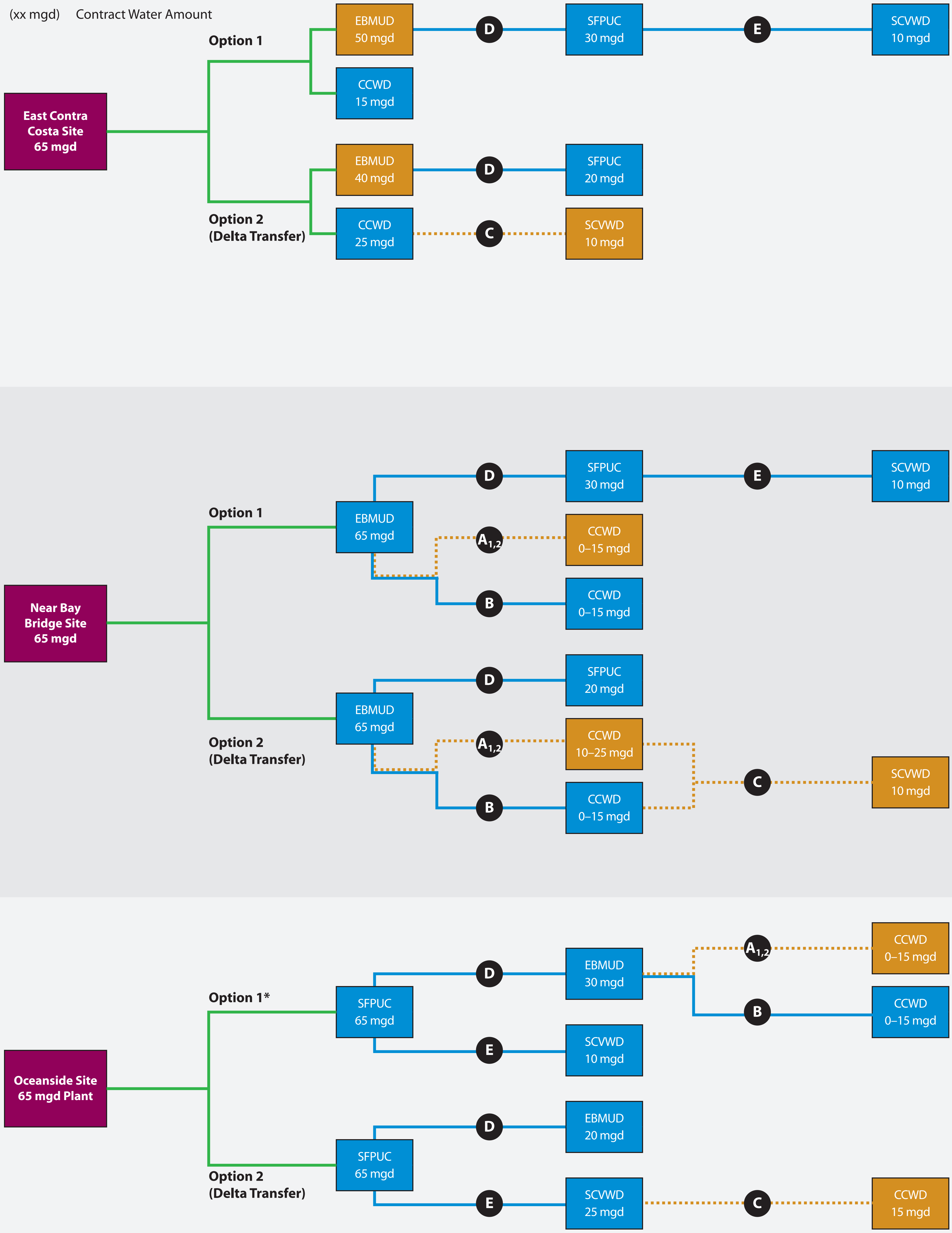
TRANSMISSION PIPELINE AND EXISTING/POTENTIAL WATER TRANSFER LOCATIONS

Figure ES-2

Dry Year Water Allotments (2030)

Agency	Volume (mgd)
CCWD	15
EBMUD	20
SFPUC	20
SCVWD	10
(xx mgd)	Contract Water Amount



Water Transfer Location (see Figure 2-2) Between		Capacity
A_1	CCWD/EBMUD	20 mgd
A_2	CCWD/EBMUD	100 mgd
B	CCWD/EBMUD	15 mgd
C	CCWD/SCVWD	>65 mgd
D	EBMUD/SFPUC	30 mgd
E	SFPUC/SCVWD	40 mgd

mgd Million Gallons per Day

Treated Water

Raw Water

Desal Water

*Without a Delta Transfer, EBMUD and CCWD would share 30 mgd instead of their combined allotment of 35 mgd.

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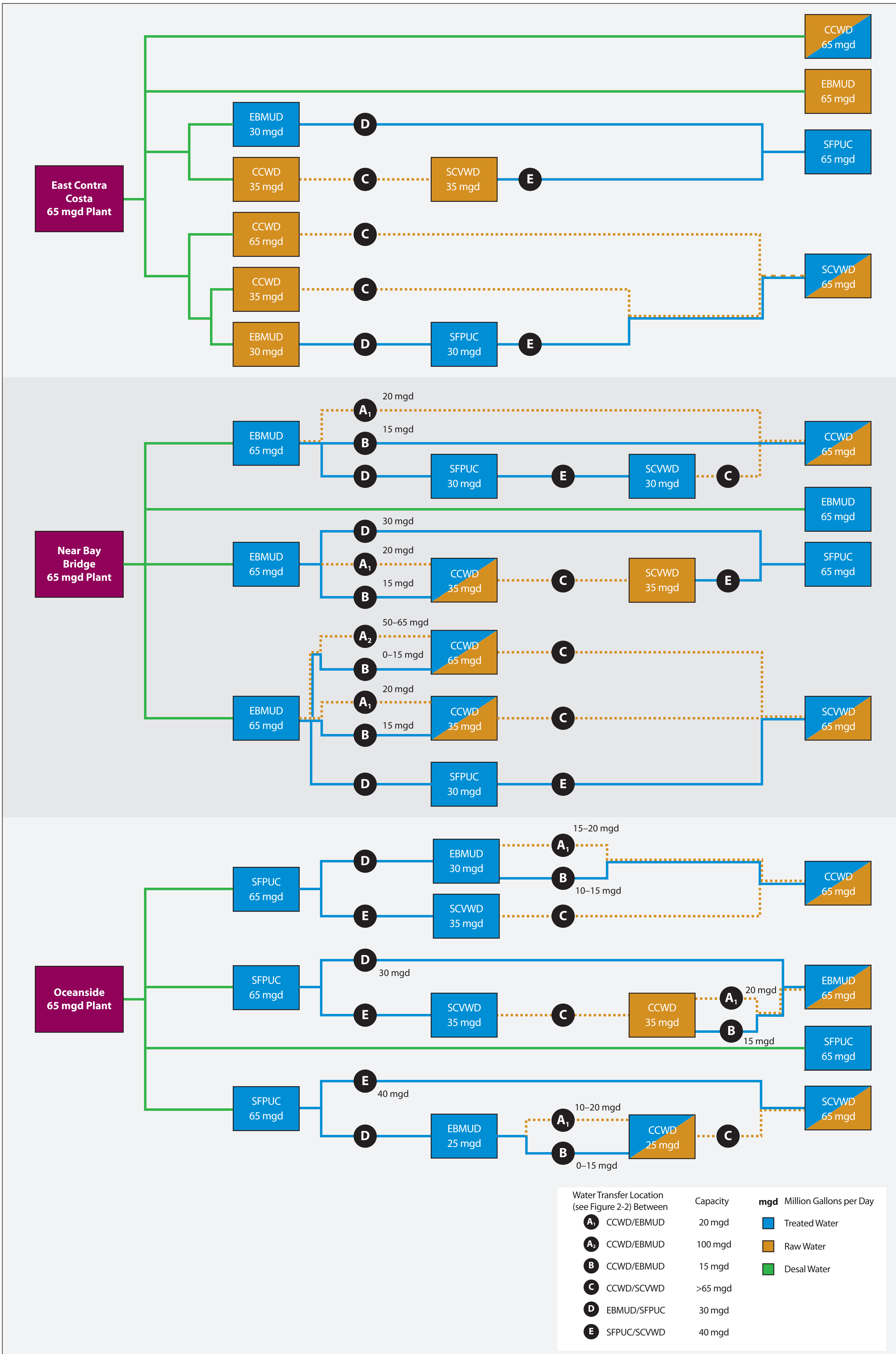
DRY YEAR CONVEYANCE OPTIONS

FIGURE ES-3



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EMERGENCY CONVEYANCE OPTIONS

FIGURE ES-4

The conveyance evaluation identified water quality impacts that could result from transferring water. Therefore, blending studies would have to be conducted for all of the water sources that could be exchanged to determine any potential limitations.

Ranking of Operational Scenarios. Seven operational scenarios consisting of combinations of different desalination plant capacities at the three top-ranked sites were developed, as described in **Section 2.3**. Two of the seven operational scenarios were eliminated due to “fatal flaws,” resulting in five feasible scenarios.

The five feasible operational scenarios were then subjected to a formal evaluation process. The evaluation process accounted for both the individual and collective objectives and constraints of each BARDP agency. Six issues (environmental, permitting, institutional/legal, cost, public perception, and reliability) with related subissues were considered based on factors that one or more of the agencies viewed as important in selecting a site, and formed the criteria by which the scenarios were ranked. The agencies collectively rated each of the five scenarios for each subissue except cost using a rating scale of –2 to +2, with –2 representing the least desirable outcome and +2 representing the most desirable outcome. For cost, all agencies agreed that the lowest cost would be rated most favorably.

As part of the evaluation process, feasibility-level cost estimates for each of the three top-ranked sites and the five scenarios were developed. Table ES-2 presents feasibility-level capital cost estimates for each site and scenario as described in Appendix A. The capital costs are for the desalination facilities, intake, and concentrate disposal but do not include potential conveyance system improvements.

Table ES-3 presents the feasibility-level operation and maintenance (O&M) costs for each site and scenario as described in Appendix A. An on-stream factor of 95 percent was assumed for the plant operation. The operating costs do not include wheeling and post-treatment. These costs will differ for each agency. Desalination water conveyed using raw water conveyance facilities would require post-treatment. O&M costs were developed on an annual basis assuming that the plant operates every year. The use of existing water infrastructure for treatment and conveyance has a significant cost. This capital system recovery cost is not included in this estimate. The capital system recovery cost will depend on water quantity and frequency of use of the infrastructure.

Table ES-4 summarizes year 2007 product water costs for each site and scenario. The product water cost is the sum of the annual (amortized) capital cost plus annual O&M costs divided by the volume (acre-feet per year) of product water. The capital costs for each scenario were annualized to account for the interest rate (5.5 percent) and plant life (30 years). The cost estimates assume operation of the desalination facility during dry years only (that is, 1 out of 3 years. Note that the predicted frequency of use of the desalination facility for varying capacities was later refined as discussed below. O&M costs for wet and dry years were developed. Wet year O&M costs assume that an offline desalination plant must sustain a reduced flow to maintain the integrity of the reverse osmosis membranes. Wet year O&M costs were assumed at 20 percent of the dry year O&M costs. For all dry years, the costs assume that the plant operates at full capacity. An annual inflation rate of 3 percent was applied to the O&M costs to estimate product water costs for 2007.

Table ES-2
Desalination Facility Feasibility-Level Capital Cost Estimates by Plant Site and Scenario
($, in Millions)

Project Cost Component	Scenario 1	Scenario 2		Scenario 3		Scenario 4		Scenario 5	
	East Contra Costa (65 mgd)	**Oceanside (40 mgd)**	**East Contra Costa (25 mgd)**	**Near Bay Bridge (40 mgd)**	**East Contra Costa (25 mgd)**	**Oceanside (30 mgd)**	**East Contra Costa (35 mgd)**	**Oceanside (20 mgd)**	**East Contra Costa (45 mgd)**
Desalination Facility and Intake Costs	**163.1**	**199.1**	**71.8**	**206.8**	**71.8**	**161.0**	**97.1**	**114.3**	**117.1**
Non-construction Costs (15% of Desalination Facility Cost) (incl. Planning, Permitting, Engineering & Administrative Costs)	24.5	29.9	10.8	31.0	10.8	24.1	14.6	17.1	17.6
Project Cost without Contingency	187.6	229.0	82.5	237.8	82.5	185.1	111.7	131.4	134.6
Contingency (25%)	46.9	57.2	20.6	59.4	20.6	46.3	27.9	32.9	33.7
Project Cost per site with Contingency (Rounded up)	**234.5**	**286.2**	**103.2**	**297.2**	**103.2**	**231.4**	**139.6**	**164.3**	**168.3**
Project Cost per Scenario with Contingency (Rounded up)	**234**	**389**		**400**		**371**		**333**	

Notes:
1. Costs reflect the estimation performed in November 2005. No inflation was applied to the costs.
2. No contractor mark-up was included to the construction cost estimate.

Table ES-3
Desalination Facility Feasibility-Level Operation and Maintenance Cost Estimates by Plant Site and Scenario ($, in Millions)

O&M Cost Items	Scenario 1	Scenario 2		Scenario 3		Scenario 4		Scenario 5	
	East Contra Costa (65 mgd)	Oceanside (40mgd)	East Contra Costa (25mgd)	Near Bay Bridge (40 mgd)	East Contra Costa (25 mgd)	Oceanside (30 mgd)	East Contra Costa (35 mgd)	Oceanside (20 mgd)	East Contra Costa (45 mgd)
Labor	1.3	1.0	0.5	1.0	0.5	0.7	0.7	0.5	1.0
Electrical	13.5	24.4	5.2	21.1	5.2	18.3	7.3	12.2	9.4
Membrane Replacement	1.8	3.6	0.8	3.5	0.8	2.7	1.0	1.8	1.3
Chemical Feed System	5.1	4.5	2.2	4.4	2.2	3.4	2.9	3.3	3.6
Miscellaneous Maintenance	3.3	4.0	1.4	4.1	1.4	3.2	1.9	2.3	2.3
O&M Cost per site	**25.0**	**37.4**	**10.1**	**34.1**	**10.1**	**28.2**	**13.8**	**20.1**	**17.6**
O&M Cost per Scenario	**25.0**	**47.5**		**44.2**		**42.1**		**37.7**	

Notes:
1. O&M costs assume an on-stream factor of 95 percent.
2. Costs reflect the estimation performed in November 2005. No inflation was applied to the costs.
3. Costs assume continuous operation (every year) of the desalination facilities.
4. Wheeling and post-treatment costs are not included.
5. Costs assume that full-capacity is needed in every dry years.

Table ES-4
Dry Year Product Water Costs by Plant Site and Scenario (Year 2007)

	Scenario	Year 2007 Product Water Cost ($/acre-foot)		
		East Contra Costa Site	Near Bay Bridge Site	Oceanside Site
1	Single 65 mgd Facility at East Contra Costa	1,237	-	-
2	40 mgd Facility at Oceanside and 25 mgd Facility at East Contra Costa	1,363	-	2,694
3	40 mgd Facility at Near Bay Bridge and 25 mgd Facility at East Contra Costa	1,363	2,633	-
4	30 mgd Facility at Oceanside and 35 mgd Facility at East Contra Costa	1,325	-	2,808
5	20 mgd Facility at Oceanside and 45 mgd Facility at East Contra Costa	1,271	-	2,994

Notes:
1. Product water costs reflect operation during dry years only. It was assumed that there would be 1 dry year for every 2 wet years.
2. Product water costs are for water leaving the desalination plant and do not include conveyance improvements, wheeling, and post-treatment. Wheeling and treatment costs will be different for each agency. For CCWD with the plant at East Contra Costa, product water cost will be for treated water.

The agencies then subjected the ratings developed for the issues and subissues to a seven-step process that included assessments of intra-issue and inter-issue values and a sensitivity analysis to produce an overall ranking for each of the five plant scenarios. Scenario 1 (“Single 65 mgd Facility at East Contra Costa”) ranked the highest. Scenario 3 (“40 mgd Plant at Near Bay Bridge and 25 mgd Plant at East Contra Costa”) had the second-highest score.

Although the sites were ranked based on the agencies’ views on and sensitivity to the criteria described in Section 2.3, no sites or scenarios were eliminated from future consideration through this analysis. Other scenarios could rank higher as agencies’ needs and priorities shift. If the objectives and/or constraints of any agency participating in the BARDP change, or if there is a change in the makeup of the participating agencies, the scenarios may need to be reassessed, and this process would be triggered again.

Although the evaluation process was designed to be as objective as possible, the rating of individual issues and subissues was sometimes subjective, depending on the views of the individual or agency. Such level of subjectivity is inherent in any multi-criteria evaluation process involving human judgment. Also, it should be noted that this evaluation process took place in September 2005. There was an awareness that the Delta smelt was a federally listed threatened species; however, issues regarding the recent decline of Delta smelt and other pelagic organisms were beginning to emerge but were not widely publicized in the popular media. Therefore, the recent pelagic organism decline was not considered in this evaluation.

Plant Capacity and Operational Assessment

Assuming that desalination would serve as an alternative regional water supply during dry years and emergencies, an assessment was conducted to identify the optimum capacity and frequency of operation of a desalination plant based on individual agency needs, as described in **Section 3**. Each agency considered its projected demand, available alternative water sources, and objectives for meeting demands. The assessment compared each agency’s needs with the water supply record for the years 1920 to 2002 to identify years in which an additional reliable supply of water, if available, would have been used.

Table ES-5 quantifies the supplies that would have been needed for the 83-year period of 1920 to 2002. For that period, desalination water could have been used in 44 years (53 percent of the time), in amounts ranging from 10 mgd (1 percent of the time) to the maximum predicted demand of 65 mgd (4 percent of the time). In terms of capacity needed, a demand for 20 to 29 mgd occurred the most times during the analysis period (22 years or 27 percent of the time), followed by 40 to 49 mgd (9 years or 11 percent of the time) and 50 to 59 mgd (5 years or 6 percent of the time).

Table ES-5
Distribution and Quantity of Annual Desalination Supply, 1920–2002

Total Annual Desalination Supply	Number of Years with Desalination Supply	Frequency of Desalination Supply (Percent of Years)	Frequency of Desalination Supply When Operating (Percent of Years with Desalination Supply)
0 mgd	39	47%	
10-19 mgd	1	1%	2%
20-29 mgd	22	27%	50%
30-39 mgd	4	5%	9%
40-49 mgd	9	11%	20%
50-59 mgd	5	6%	11%
> 60 mgd	3	4%	7%

The analysis indicated that plant use would occur in "clusters" averaging 3.7 years followed by an average of 3 years of nonuse. The actual distribution of plant use was highly variable, with up to 11 consecutive years of use and up to 7 consecutive years of nonuse. Further, the plant would be used by one agency 52 percent of the time and by two agencies 30 percent of the time. The plant would operate about 33 percent of the time in a range of 10 to 40 mgd. The operating cost estimate was developed assuming that the plant would operate once every 3 years at full capacity.

Based on these findings, risk and benefit-to-cost analyses were performed to determine the optimum plant capacity. Optimization analyses were developed using the revised SFPUC need of 26 mgd. The risk analysis shows that if the agencies are comfortable with accepting a level of risk of not meeting the demand in all dry years, the plant capacity could be reduced. The benefit-to-cost ratio analysis suggests that the optimal plant capacity would be approximately 40 mgd instead of equal to the revised cumulative needs of 71 mgd.

The analysis was performed using historical data and frequency of plant operation that could change significantly due to climate change.

Preliminary Site Layout

A preliminary design was developed to identify a practical process flow and associated components for a BARDP desalination plant based on the site, infrastructure, and operational options described in Sections 2 and 3. Generic site layouts were developed for two potential desalination plant configurations: a 20 mgd seawater reverse osmosis (SWRO) plant and a 65 mgd brackish water reverse osmosis (BWRO) plant. These configurations represent both the highest and lowest potential raw water salinity and the highest and lowest plant capacities considered in the various scenarios described in Sections 2 and 3. In addition, the 20 mgd SWRO plant was designed with a compact layout for a location where space is limited.

Section 4 describes the RO desalination process used in the preliminary plant designs in terms of the equipment, facilities, and chemicals required to purify water to a quality that meets drinking water standards. Key equipment shown in the plant layout diagrams is illustrated with pictures and schematics to provide a clear overview of the desalination process flow.

Institutional Agreement

The partner agencies would enter into a series of institutional agreements to implement the BARDP. **Section 5** provides a brief overview of the types of agreements the agencies may consider in setting up a desalination plant and delivering water through existing infrastructure. It describes the three general categories of agreements by which the agencies can define their roles, responsibilities, and legal obligations: the Joint Powers Agreement (JPA), the MOU, and the standard contract. The type of agreement adopted will depend on key issues such as the structure for the ownership, operation, and maintenance of the facility. Based on the guiding structure for the principal agreement among the agencies, other issues may also require institutional arrangements including how the desalination water may be distributed and transferred among the agencies, how water banking may be used, and how capacity and pipeline constraints may be managed. These issues may be addressed within the principal agreement governing the BARDP, through modifications to existing agreements, through separate agreements, or through a combination of the above. The issues listed, in turn, will have important implications on cost, water delivery, conditions of use, and water quality. Once member agencies are in agreement on how the issues will be handled for the purposes of the BARDP, appropriate contractual mechanisms can be identified and executed.

The discussion in this section serves as a decision-making guide for managers as they consider the agreements that the agencies would have to enter into in order to implement the BARDP. This guide places the necessary agreements into the context of an inter-agency institutional framework. This discussion does not include legal advice or opinions, and it does not replace or otherwise advise any review of contractual agreements by the agencies’ respective legal counsels.

Key issues requiring agreements may include, but not be limited to: facility ownership, operations, and maintenance; water supply distribution; water supply rights and entitlements; water banking; water capacity constraints; and pipeline design constraints.

Market Analysis

A BARDP desalination facility used for dry years and emergencies would likely operate in clusters of years and potentially experience consecutive years of nonuse, as described in Section 3. A plant that produces desalination water during wet years would be used more often, reduce unit water production costs by about 50 percent, and address issues associated with intermittent operation. **Section 6** describes agency efforts to identify potential customers from the public and private sectors for collaboration on the BARDP, as well as to determine the feasibility of selling desalination water on the open market and to the CALFED Environmental Water Account (EWA).

Ten private industrial and agency customers were identified (Zone 7 Water Agency, PG&E/Mirant, City of Pittsburg, City of Antioch, USS-Posco Industries, Dow Chemical, Calpine Corporation, GWF Power Systems, Alameda County Water District, and Marin Municipal Water

District) and provided with a survey questionnaire. Follow-up meetings and telephone conversations were held to discuss the feasibility of using BARDP water during wet years. In general, it does not appear that the potential customers need water to meet supply shortages during wet years. Certain candidates (Zone 7 Water Agency, City of Antioch, and Marin Municipal Water District) stated that they would consider using BARDP water if the cost is economical, the water quality meets desired criteria, the plant is operational in time to suit the candidate's needs, and an economical water transport method can be provided.

The opportunity for the agencies to achieve premium prices for BARDP water on the open market would depend on the ability to structure a package that includes reliable conveyance and storage. Recent average prices for EWA water acquisitions have been between $120 and $160 per acre-foot, which is substantially lower than the projected BARDP water cost. Current funding for the EWA will expire on December 31, 2007, unless renewed; however, the U.S. Bureau of Reclamation, DWR, U.S. Fish and Wildlife Service, National Marine Fisheries Service, and California Department of Fish and Game are currently analyzing a Long-Term EWA program, which could become a long-term customer for the agencies.

Public Outreach

The agencies have conducted a number of outreach efforts to inform and solicit input from the public, regulatory agencies, and stakeholder groups about the BARDP. **Section 7** discusses the key public outreach activities conducted during the Feasibility Study, which included preparing informational materials, including a project website, fact sheet, and letter to stakeholders; making presentations to six interest groups; conducting two public forums; conducting regulatory agency outreach; and responding to public inquiries and comments. Public interest in the BARDP was high. The public outreach will be continued into subsequent project steps. The website will be maintained and updated. Information collected during the pilot program and future project phases will help the agencies respond to comments and questions from the public and regulatory agencies.

Climate Change

California's complex water system will be vulnerable to changes in water supply and demand related to climate change. The three general areas of impact from climate change—increases in temperature, precipitation, and sea level—are multifaceted, interrelated, and likely to affect California's water supply, demand, and system planning. **Section 8** provides an overview of potential climate-related changes such as flooding and extreme weather, salt water intrusion, and degraded water quality, and investigates the role of desalination technologies and programs such as the BARDP in California's water future. Although this section does not present additional analysis or studies specific to the BARDP, it presents a review of the existing literature pertaining to climate change in California and, when possible, to climate change as it could affect the BARDP. As climate change alters local hydrology and affects the resilience and variability of the existing water supply, desalination systems can provide a buffer, but they are not without cost and feasibility issues, energy and emissions considerations, and potential climate change–related implementation concerns.

Modeling studies by others indicate that the agricultural sector and regions of Southern California would be most affected by water scarcity resulting from climate change (CCCC

2006a; Kiparsky and Gleik 2003). The BARDP agencies are not directly concerned with the agricultural sector, which is mainly located in the Central Valley, but have water contracts with the same agencies: the DWR for the State Water Project (SWP) and the U.S. Bureau of Reclamation for the Central Valley Project (CVP).

Commercial and industrial water uses could increase as temperatures rise (DWR 2006a). Because of the concentration of these urban users in the Bay Area, additional sources of water beyond existing supplies could be needed to meet the increasing demand caused by climate change. Desalination could be an alternative to help meet this demand.

Because the BARDP desalination plant would be fed by sea, Bay, or Delta water, there would be no shortage of source water for desalination. Furthermore, although increased salinity in the source water could lead to greater energy demand by a desalination plant, the plant would not be inhibited and would still be able to carry out its intended function, which is to transform saltwater into drinking water supply. Therefore, desalination can be considered an adaptive response to climate change and may help reduce dependence on climate-sensitive sources of supply.

Project Implementation

A project implementation plan for the BARDP was developed based on the findings of this Feasibility Study and is described in **Section 9**. Although the agencies have not selected a final plant site, and the agencies reserve the right to revisit any of the previously investigated sites or other sites, they are pursuing a pilot program in the East Contra Costa site vicinity. Several desalination pilot programs have been or are being conducted along California's coast, and the Marin Municipal Water District desalination pilot program was completed in San Francisco Bay in 2006; therefore, the partner agencies are focusing their pilot program in the brackish waters of the Suisun Bay estuary. The results from the other studies may also be used to augment this desalination pilot program.

The pilot plant is proposed to be constructed at an existing CCWD pump station near Pittsburg, California, and draw water from the Suisun Bay estuary. A detailed site selection study would be performed to identify one or possibly two potential plant sites. The plant would provide the current data for this area of the North Bay/Delta estuary that are necessary for prudent evaluation of a full-scale regional desalination facility in the San Francisco Bay Area. The pilot program would also allow testing to support a project Environmental Impact Report (EIR) to ensure that the desalination facility would not adversely impact the Bay environment.

Following the pilot study, the agencies would conduct a detailed site selection study and identify a proposed site for the desalination facilities. The study would include hazardous waste and geotechnical investigations. The agencies would also continue to evaluate green technology alternatives and the technical feasibility of producing and distributing a new water source through their existing infrastructure. A site-specific preliminary site layout and conceptual engineering design would be prepared. The partner agencies would also determine and execute the appropriate organizational structure for implementing the BARDP. Environmental impact studies, permitting, and construction would follow. Table ES-6 provides a preliminary timeline for project implementation.

Table ES-6
Elements of Project Implementation Plan

Plan Element	Completion Date
Desalination Pilot Program	2009
Site Selection Study / Identify Proposed Project Site	2009
Evaluation of Green Technology Alternatives	2009
Technical Feasibility	2009
Preliminary Site Layout and Conceptual Engineering Design	2010
Environmental Impact Studies	2010
Environmental Permitting	2010
Project Design	2010
Project Construction	2012

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ACWD	Alameda County Water District
ADEIR	Administrative Draft EIR
Ag	Agriculture
agencies	Contra Costa Water District, East Bay Municipal Utility District, San Francisco Public Utilities Commission, and Santa Clara Valley Water District
Banks	Harvey O. Banks Pumping Plant
BARDP	Bay Area Regional Desalination Project
Bay-Delta	San Francisco Bay/Sacramento–San Joaquin River Delta
BCDC	Bay Conservation and Development Commission
BDPL	(San Francisco Public Utilities Commission) Bay Division Pipelines
BWRO	brackish water reverse osmosis
CCWD	Contra Costa Water District
CDFG	California Department of Fish and Game
CEC	California Energy Commission
CEQA	California Environmental Quality Act
CVP	Central Valley Project
DAF	dissolved air floatation
Delta	Sacramento–San Joaquin River Delta
DOC	dissolved organic carbon
DWR	California Department of Water Resources
EBMUD	East Bay Municipal Utility District
EIR	Environmental Impact Report
EIS	Environmental Impact Statement
EWA	(CALFED) Environmental Water Account
FEMA	Federal Emergency Management Agency
gfd	water throughput per square foot of membrane area per day
gpm/sf	gallon(s) per minute per square foot
HAA	haloacetic acid
IPCC	Intergovernmental Panel on Climate Change
JPA	Joint Powers Agreement
JPP	C.W. "Bill" Jones Pumping Plant
KWhr	kilowatt hour(s)

µg/L	microgram(s) per liter
µmhos/cm	micromhos per centimeter
mg/L	milligram(s) per liter
M&I	Municipal and Industrial
MCL	Maximum Contaminant Level
MF	microfiltration
mg/L	milligram(s) per liter
mgd	million gallon(s) per day
mm	millimeter(s)
MMWD	Marin Municipal Water District
MOU	Memorandum of Understanding
MPP	Multipurpose Pipeline
MW	megawatt(s)
NaOH	sodium hydroxide
NEPA	National Environmental Policy Act
NOAA Fisheries	(National Oceanographic and Atmospheric Administration) National Marine Fisheries Service
NOP	Notice of Preparation
NPDES	National Pollutant Discharge Elimination System
NTU	National turbidity unit(s)
O&M	operation and maintenance
Oceanside	Oceanside Waste Water Treatment Plant
ORP	oxidation reduction potential
PCB	polychlorinated biphenyls
psi	pound(s) per square inch
psu	practical salinity unit(s)
RO	reverse osmosis
RWQCB	Regional Water Quality Control Board
SCADA	Supervisory Control and Data Acquisition
SCVWD	Santa Clara Valley Water District
SDI	Silt Density Index
SFPUC	San Francisco Public Utilities Commission

SWP	State Water Project
SWRCB	State Water Resources Control Board
SWRO	seawater reverse osmosis
TDS	total dissolved solids
THM	trihalomethane
TOC	total organic carbon
TSS	total suspended solids
UF	ultrafiltration
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
VP	Visual Plumes
WPCP	Water Pollution Control Plant
WWTP	Waste Water Treatment Plant

The Bay Area's four largest water agencies, the Contra Costa Water District (CCWD), the East Bay Municipal Utility District (EBMUD), the San Francisco Public Utilities Commission (SFPUC), and the Santa Clara Valley Water District (SCVWD) (collectively referred to as "the agencies"), are jointly exploring the development of regional desalination facilities that would benefit the 5.4 million Bay Area residents and businesses served by these agencies. The Bay Area Regional Desalination Project (BARDP) may consist of one or more desalination facilities. The agencies' service area boundaries are shown in Figure 1-1.

1.1 GOALS AND OBJECTIVES

1.1.1 Project Goals and Objectives

The goal of the BARDP is to develop one or two desalination plants that will produce reliable potable water to help meet the drought and emergency needs[1] of all the participating agencies. The BARDP would also enable agencies to provide uninterrupted service while other major facilities such as treatment plants, water pipelines, and pump stations are temporarily out of service for maintenance or repair. Given the contiguous nature of their service areas, the agencies would leverage existing infrastructure to derive mutual benefits from the project. Depending on the location of the BARDP, each agency would either receive desalination product water or transfer water into its distribution system.

In addition to agency-specific water supply benefits, the BARDP is intended to provide broader regional benefits. In the event of an emergency, for example, the BARDP would provide the agencies with the flexibility to channel large volumes of supplemental water, to the extent it is supported by the existing infrastructure, where it is needed most using existing distribution networks. Furthermore, a regional project would reduce the relative costs of developing desalination as an alternative water supply option for each agency individually. Finally, by reducing the footprint of desalination facilities to serve the needs of multiple water agencies, a regional project could reduce the potential for adverse environmental impacts.

The agencies have undertaken this Feasibility Study to meet these goals and objectives and to help identify challenges, evaluate options, and plan the continued development of the BARDP. As such, this Feasibility Study lays the foundation for the planning, design and operation of the BARDP.

1.1.2 Feasibility Study Goals and Objectives

The goals and objectives of this Feasibility Study are to:

- Develop a process for evaluating the feasibility of regional collaboration for seawater/brackish water[2] desalination.

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[1] Drought is defined differently by each of the BARDP partner agencies but is generally defined as when water supplies drop below a predetermined level. Emergency needs may include water needs during a catastrophic event such as an earthquake or levee failure.
[2] Seawater is from the ocean and typically has salinity—the salt content of water as expressed in total dissolved solids (TDS)—of about 35,000 parts per million. Brackish water has higher salinity than freshwater but lower salinity than seawater, often as a result of mixing of the two waters as occurs in estuaries.

- Evaluate institutional options for the BARDP. Identify the mechanisms (such as a Memorandum of Understanding [MOU] or Joint Powers Authority) that can be implemented by multiple participants to own and operate a regional desalination project.
- Develop and implement a process by which various criteria relevant to desalination projects can be evaluated to select the optimal site(s). These criteria would include issues such as physical infrastructure, environmental issues, permitting, and cost. Apply this process to the BARDP sites and select a site or sites for detailed evaluation.
- Provide information about the costs and benefits of a centralized regional approach to desalination to the public, other water agencies, and environmental groups.
- Conduct a public, stakeholders, and agency outreach program.
- Provide a foundation for future project phases. Prepare a preliminary site layout for selected BARDP site(s) and a scope of work for environmental impact analysis of the proposed BARDP.
- Produce a template that can be replicated elsewhere in the state, potentially reducing adverse environmental and socioeconomic effects along the California coast.

In addition to these goals and objectives, this Feasibility Study includes a discussion of climate change and how the BARDP fits into the current thinking about potential climate change effects in California.

1.2 BARDP STUDY CHRONOLOGY

In 2003, the agencies entered into a MOU to explore the initial viability of the BARDP through a pre-feasibility analysis. The agencies initially considered the construction and operation of up to a 120 million gallon per day (mgd) desalination plant. In October 2003, the agencies completed a Phase 1 Pre-Feasibility Study that included a permit reconnaissance, an evaluation of desalinated water quality, and a siting study. The siting study included an assessment of site-specific feedwater quality and a review of permitting/water rights issues and environmental justice considerations. The study resulted in the short-listing of three of 22 potential sites considered. In June 2004, the agencies entered into a second (Phase 2) MOU to conduct preliminary environmental screening and an evaluation of conveyance options for the three short-listed sites. At this time, the agencies modified the projected capacity of the proposed regional desalination plant to 80 mgd. Nine operational scenarios involving the three top-ranked sites were developed based on a plant capacity of 80 mgd.

The agencies applied for a grant from the California Department of Water Resources (DWR) in January 2005 to conduct a Feasibility Study to further advance the development of the BARDP. The agencies were awarded the grant and initiated the Feasibility Study tasks, building on the work they had already completed during the two phases of the pre-feasibility study. The agencies assessed their individual needs for desalination water and determined that two agencies would ultimately need a total of 25 mgd during all years, while the other two agencies would need a total of 40 mgd during drought years only, requiring a total plant capacity of 65 mgd. Seven operational scenarios involving the three top-ranked sites were developed based on a plant capacity of 65 mgd, with 25 mgd needed every year and 65 mgd needed during drought years.

In November 2005, the agencies revisited their need for desalination water and determined that the cumulative needs of all four agencies would be the same amounts of water but during dry years only. Two of the seven operational scenarios were dropped, and the remaining five operational scenarios still included supplying 25 mgd during all years to reduce overall product water cost per acre-foot. The agencies initiated a market study analysis to identify other potential wet year customers for BARDP product water.

Recently the SFPUC increased its estimated need for desalination water from 20 mgd to 26 mgd, for a cumulative project need of 71 mgd. This estimate is consistent with the SFPUC's planning projections for 2030 and with its other planning documents. The operational scenarios and conveyance options have not been revised to reflect this increased capacity, but this Feasibility Study acknowledges this increased projected need.

1.3 DESCRIPTION OF PARTNER AGENCIES

1.3.1 Contra Costa Water District

CCWD serves approximately 510,000 people in north, central, and east Contra Costa County. CCWD acts as both a retail and wholesale water distributor, delivering treated drinking water directly to customers and both treated and untreated water to retail water agencies and major industries. Formed in 1936 to provide water for irrigation and industry, CCWD is now one of the larger urban water districts in California. CCWD provides water to the following wholesale customers:

- City of Antioch
- City of Brentwood
- Diablo Water District
- City of Martinez
- City of Pittsburg
- Golden State Water Company (Bay Point)

Table 1-1 presents CCWD's current (as of 2004) and projected population, water supply, and water demand. CCWD has sufficient existing supplies to meet demands in normal and single dry years through 2030. In a sequence of multiple dry years, CCWD projects having a deficit of up to 30 mgd by the 2030s (CCWD 2005).

CCWD has determined its desalination water need to be 15 mgd for drought years only.

Table 1-1
CCWD Current and Projected Population, Water Supply, and Demand

	Current[a]	Projected[a]				
		Normal Year		Single Dry Year		Multiple Dry Year (2032)[a,b]
	2004	2010	2030	2010	2030	Worst Case
Population[a]	507,823	536,258	649,265	536,258	649,265	649,265
Supply (mgd)[c]	187	214	224	174	199	169
Demand (mgd)	128	174	198	174	198	198
Difference (mgd)	59	40	26	0	1	-29

Source: Adapted from RMC and Jones & Stokes 2006
[a] As reported in CCWD's Urban Water Management Plan, December 2005.
[b] The worst-case scenario is the year with the largest water deficit from a multiple-dry-year scenario.
[c] mgd = million gallons per day. One mgd typically represents 1,120 acre-feet per year.

1.3.2 East Bay Municipal Utility District

Formed in 1923, EBMUD supplies water and provides wastewater treatment for approximately 1.3 million people in a 331-square-mile area that includes parts of Alameda and Contra Costa Counties. EBMUD has one of the largest conservation programs in California and was one of the first water utilities in the nation to develop a conservation supply master plan.

Table 1-2 presents EBMUD's current and projected population, water supply, and water demand. In dry years, shortages are expected by 2010. The worst-case scenario is the year with the largest water deficit from a multiple-dry-year scenario. The Multiple Dry Year column contains information for the worst-case multiple-dry-year scenario included in EBMUD's Urban Water Management Plan, 2005. The worst-case scenario was defined as the year in which the largest absolute water deficit would occur. In this case, the worst-case scenario occurs in Year 3 (2007) of Multiple Dry Water Years beginning in 2005. For a period of multiple dry years, EBMUD projects to have a deficit of up to 74 mgd (RMC and Jones & Stokes 2006).

EBMUD has determined its desalination water need to be 20 mgd for drought years only.

Table 1-2
EBMUD Current and Projected Population, Water Supply, and Demand

	Current[a]	Projected[a,b]				
		Normal Year		Single Dry Year		Multiple Dry Year (2007)[a,c]
	2004	2010	2030	2010	2030	Worst Case
Population[a]	1,338,000	1,380,000	1,598,000	1,380,000	1,598,000	1,354,800
Supply (mgd)[d]	>224	>225	>232	213	220	167
Demand (mgd)	224	225	232	225	232	241
Difference (mgd)	0	0	0	-12	-12	-74

Source: RMC and Jones & Stokes 2006
[a] As reported in EBMUD's Urban Water Management Plan, 2005 (in RMC and Jones & Stokes 2006). Population as reported in Table 1-2 of EBMUD's Urban Water Management Plan, 2005. The 2007 projected population was interpolated from projected populations for 2005 and 2010 that were reported in Table 1-2 of EBMUD's Urban Water Management Plan, 2005.
[b] Projected supply data includes dry-year supply deliveries from the Freeport Regional Water Project beginning in 2010. Without the Freeport Regional Water Project supply, 2020 deficiencies could be as high as 67 percent.
[c] The worst-case scenario is the year with the largest water deficit from a multiple-dry-year scenario. The Multiple Dry Year column contains information for the worst-case multiple-dry-year scenario included in EBMUD's Urban Water Management Plan, 2005. The worst-case scenario was defined as the year in which the largest absolute water deficit would occur. In this case, the worst-case scenario occurs in Year 3 (2007) of Multiple Dry Water Years beginning in 2005.
[d] mgd = million gallons per day. One mgd typically represents 1,120 acre-feet per year.

1.3.3 San Francisco Public Utilities Commission

The SFPUC owns and operates a regional system that provides and delivers water to a population of approximately 775,000 customers in San Francisco. The SFPUC also serves 28 wholesale customers in Santa Clara, Alameda, and San Mateo Counties, which provide water to an additional 1.65 million customers. Separately, the SFPUC provides wastewater service and municipal power to the City and County of San Francisco.

The SFPUC is currently implementing an extensive capital improvement program to repair, replace, and seismically upgrade the water system's aging infrastructure to ensure reliable delivery of its current and future water supply.

Table 1-3 presents the current and projected population, water supply, and water demand for the SFPUC's entire retail and wholesale water system. Currently, the SFPUC is unable to meet water demand during long-term dry periods. According to projections, the system-wide demand will exceed the supply in dry years beginning in 2030. The shortage will be up to 30 mgd in single dry years and up to 59 mgd in multiple dry years. For that reason, the SFPUC considers desalination as a potential alternative water supply to meet its increasing demand.

SFPUC has determined its maximum desalination water need to be 26 mgd for drought years only.

Table 1-3
SFPUC Current and Projected Population, Water Supply, and Demand

	Current[a]	Projected[a]				
		Normal Year		Single Dry Year		Multiple Dry Year (2029)[a,b]
	2004	2010	2030	2010	2030	Worst Case
Population[a]	2,486,216	2,550,087	2,804,829	2,550,087	2,804,829	2,742,873
Supply (mgd)[b]	267	277	300	277	270	234
Demand (mgd)	267	277	300	277	300	293
Difference (mgd)	0	0	0	0	-30	-59

Source: RMC and Jones & Stokes 2006
[a] As reported in 2005 Urban Water Management Plan for the City and County of San Francisco (in RMC and Jones & Stokes 2006).
[b] The worst-case scenario is the year with the largest water deficit during the SFPUC's 8.5-year design drought.
[c] mgd = million gallons per day. One mgd typically represents 1,120 acre-feet per year.

1.3.4 Santa Clara Valley Water District

SCVWD manages wholesale drinking water resources for Santa Clara County and provides stewardship for the county's watersheds, including its reservoirs, groundwater basins, and over 700 miles of streams. SCVWD encompasses all of the county's 1,300 square miles and serves the area's 15 cities, 1.7 million residents, and more than 200,000 commuters. SCVWD provides water to the following private and public water retailers:

- California Water Service Company
- Gilroy Community Services Department
- Great Oaks Water Company
- City of Milpitas Community Services
- City of Morgan Hill Public Works Department
- City of Mountain View Public Services Department
- San Jose Municipal Water System
- San Jose Water Company
- City of Santa Clara Water Department
- City of Sunnyvale Public Works Department

Table 1-4 presents SCVWD's current and projected population, water supply, and water demand. By 2020, demand will exceed supply in normal years, thus requiring additional supplies up to 26 mgd to meet demands through 2030. These new supplies may potentially include desalination. In dry years, SCVWD intends to use groundwater and other reserves to meet the demand. SCVWD does not predict shortages for single dry years through 2030.

Table 1-4
SCVWD Current and Projected Population, Water Supply, and Demand

	Current[a]	Projected[a,b]				
		Normal Year		Single Dry Year		Multiple Dry Year (2030)[a,c]
	2004	2010	2030	2010	2030	Worst Case
Population[a]	1,750,100	1,855,500	2,267,100	1,855,500	2,267,100	2,267,100
Supply (mgd)[d]	340	352	400	342	401	400[e]
Demand (mgd)	340	341	400	341	400	400
Difference (mgd)	0	11	0	1	1	0

Source: RMC and Jones & Stokes 2006
[a] As reported in SCVWD's Urban Water Management Plan, 2005 (in RMC and Jones & Stokes 2006).
[b] Demand after conservation savings reported.
[c] The worst-case scenario is the year with the largest water deficit.
[d] mgd = million gallons per day. One mgd typically represents 1,120 acre-feet per year.
[e] Includes "New Supplies–IWRP Framework" as identified in SCVWD's Urban Water Management Plan, 2005. **New supplies could include up to 8.9 mgd of desalination water.**

SCVWD has determined its desalination water need to be 10 mgd for drought years only.

1.4 RECENT BAY AREA DESALINATION STUDIES

Several investigations have been conducted regarding planned desalination facilities in the Bay Area between 2000 and 2006. These studies provide additional relevant information for the development of the BARDP and are summarized below.

1.4.1 Contra Costa Water District

In 1996, CCWD conducted a future water supply study (CCWD 1996). The study developed and screened resource alternatives in two separate rounds. A desalination plant at Mallard Slough was examined as part of the first round of alternatives. CCWD has consumptive water rights of 25 mgd from Mallard Slough. According to this study, a desalination plant at this location would produce 20 mgd. CCWD only uses water from Mallard Slough during the wet season (approximately 4 months of the year), when the water quality from the slough is at its best. Desalination of Mallard Slough feedwater would be beneficial to CCWD if it were used for water quality improvement.

The desalination at Mallard Slough alternative did not advance to the Round Two screening in the CCWD study due to high energy costs, brine disposal issues, reliability concerns, and high construction costs. However, it was recommended that the concept be revisited in periodic updates of the future water supply study (approximately every 5 years) to review how technology may have progressed to reduce construction and operating costs.

During the initial phase of the pre-feasibility study, CCWD recommended that the Mallard Slough site be added to the list of sites (see Section 2.1) considered by the agencies for a regional desalination facility.

1.4.2 East Bay Municipal Utility District

EBMUD conducted a fatal flaw analysis of operating a desalination facility at each of three sites east of Carquinez Strait (EBMUD 2003). The analysis examined the potential for constructing and operating a desalination plant at C&H Sugar Refinery, the Mirant Pittsburg Power Plant, and the Mirant Contra Costa Power Plant in Antioch. The sites were selected because each one already has intake and outfall structures that could also be used by a desalination plant. All three sites are relatively close to connections to the EBMUD distribution system. Consumptive water rights may have to be obtained to operate a desalination plant at any of the sites.

Feedwater obtained at the C&H Sugar Refinery site would be the most brackish of the three sites. Public perception issues could arise from obtaining feedwater at this location, although the outfall brine discharge is expected to be diluted immediately due to the depth of the channels and the strong current in that section of Carquinez Strait.

The analysis concluded that in concept, a desalination plant at any of the three sites would be feasible, although constraints would exist for each site. All three sites were recommended by EBMUD for inclusion in the list of sites considered by the agencies for a regional desalination facility (see Section 2.1).

1.4.3 San Francisco Public Utilities Commission

As part of the SFPUC Bay Division Pipelines (BDPL) *Hydraulic Upgrade Optioneering Phase I* study (SFPUC 2002), desalination was analyzed as a possible alternative to reinforcement of certain facilities in the system. The study analyzed a 120 mgd plant because a facility of that size would cover all eventualities except for peak day demand with the Irvington Tunnel (which transmits water through the East Bay Hills) out of service. The plant would operate under the following conditions:

- When the Irvington Tunnel is out of service for inspection, maintenance, or repair
- When the Harry Tracy Water Treatment Plant is out of service because of water quality issues or for repair (such as following an earthquake)
- When additional water supply is needed due to a drought

The analysis assumed the plant would operate at a minimum of 10 percent capacity on a continuous basis.

Three sites were considered for the plant location:

- Adjacent to the Dumbarton Bridge BDPL 1 & 2 and San Francisco Bay
- Adjacent to the Oceanside Waste Water Treatment Plant (WWTP) (the Oceanside site)
- Treasure Island

The study found that locating a plant near BDPL 1 & 2 would provide a short delivery into the transmission system. However, discharging the brine into the South Bay could cause significant environmental impacts. A plant adjacent to the Oceanside site or at Treasure Island would have fewer issues associated with brine disposal, but connecting the facilities to the transmission system would be more difficult.

The report recommended further investigation of regional desalination as a benefit to the SFPUC water system. SFPUC recommended the BDPL 1 & 2 site, the Oceanside site, and the Treasure Island site for inclusion in the nine sites that the agencies considered for a regional desalination facility (see Section 2.1). In subsequent analyses, the SFPUC has identified additional constraints at the Oceanside site, including available space (see Section 2.1.3).

1.4.4 Marin Municipal Water District

Although not part of this study, Marin Municipal Water District (MMWD) also is considering desalination. In 1989, the MMWD Water Supply Master Plan recommended that an additional 10,000 acre-feet of water per year be secured to meet supply shortfalls during droughts and to meet additional growth projected to occur within its service area. In 1990, MMWD embarked on a series of studies to develop plans and designs for various water supply facilities. That information was used as the basis for an Environmental Impact Report (EIR) that addressed environmental issues associated with two water supply options:

- A 10,000 acre-feet per year (approximately 9 mgd) desalination plant to be located on MMWD property at Pelican Way in San Rafael
- Establishment of an 8-mile pipeline from near Petaluma to Novato (the Sonoma-Marin Transmission Line) to convey Russian River water to be purchased from the Sonoma County Water Agency to MMWD's conveyance and distribution system

The EIR was certified, but the MMWD Board of Directors voted in July 1991 not to build a permanent plant. The Board instead selected the Sonoma-Marin Transmission Line option and placed an $80 million bond measure on the November 1991 ballot to fund the project. The bond measure was defeated. In November 1992, a subsequent bond measure for $37.5 million was passed to fund expansion of water recycling, conservation, and water imports.

In 2001, MMWD commissioned a new study of desalination as a water supply alternative (MMWD 2001). This report compared capital and operating costs of various desalination alternatives and reviewed and evaluated six different sites for desalination plants.

In 2003, MMWD updated the desalination project description, conducted a regulatory reconnaissance, performed an environmental screening of alternatives, and conducted an alternative energy study for the project (MMWD 2003).

From June 2005 through April 2006, MMWD operated a desalination pilot, enabling MMWD to conduct environmental studies, test equipment, refine operating costs, and demonstrate the technology to MMWD customers. MMWD will use the results of the pilot plant operations to refine the design requirements and costs of a full-scale desalination facility.

1.5 REPORT ORGANIZATION

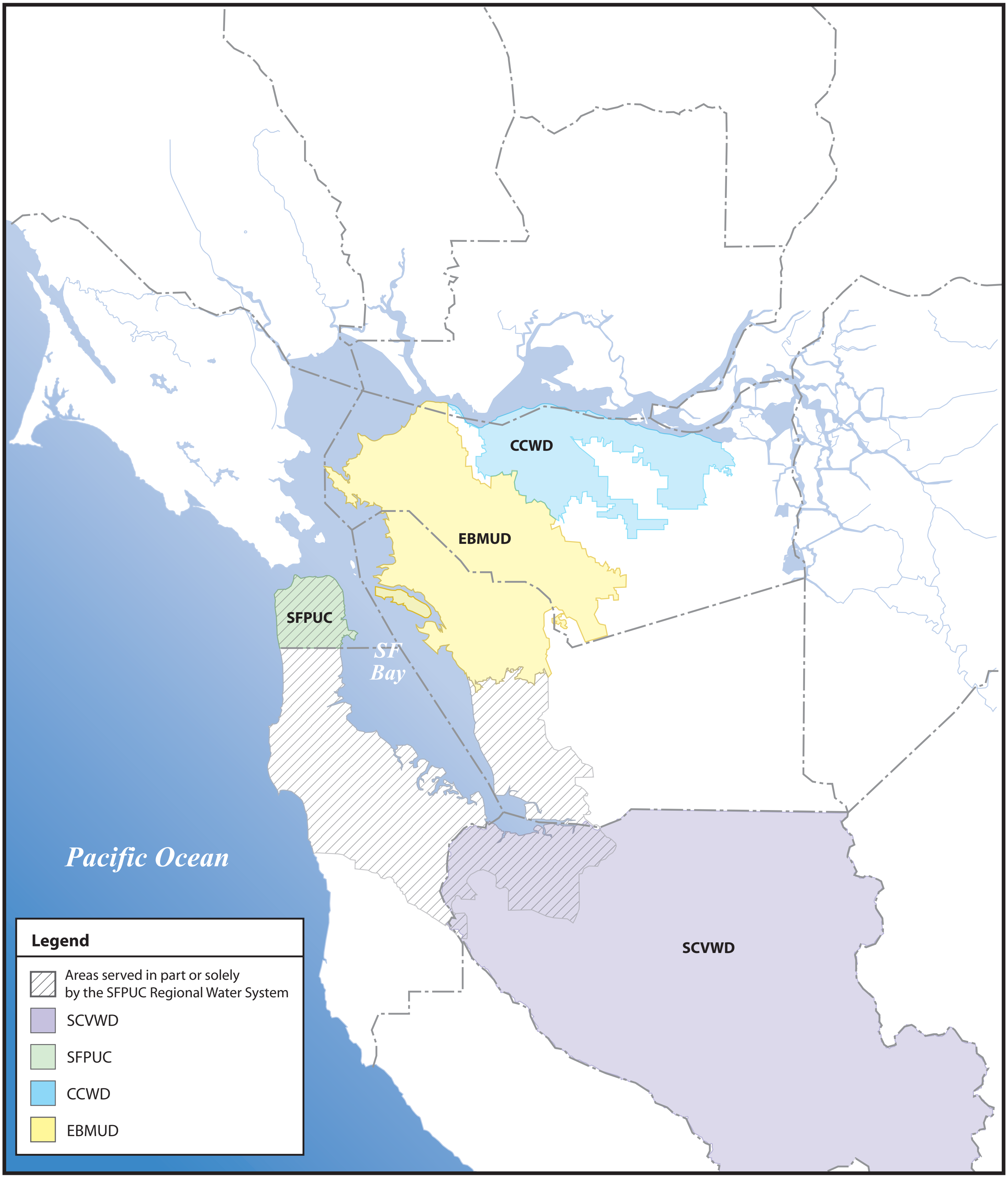
The remainder of this volume is organized as follows:

- **Section 2, Assessment of Site and Infrastructure Options,** summarizes the process and results of the site selection study, the findings of the BARDP conveyance options evaluation, and the development and ranking of operational scenarios.

- **Section 3, Plant Capacity and Operational Assessment,** identifies the optimum capacity and frequency of operation of a desalination plant based on individual agency needs.
- **Section 4, Preliminary Site Layout,** describes the desalination process and presents generic site layouts for two potential desalination plant configurations.
- **Section 5, Development of Institutional Agreement,** provides an overview of the types of agreements the agencies may consider and issues they may encounter in collectively setting up a desalination plant and subsequently delivering water through existing infrastructure.
- **Section 6, Market Analysis,** presents the results from an initial market assessment for water from the BARDP for other potential customers during wet years.
- **Section 7, Public Outreach,** describes the public outreach efforts that have been conducted as part of this Feasibility Study.
- **Section 8, Climate Change,** discusses current scientific thinking on climate change and places the BARDP in the context of potential changes to California's water supplies.
- **Section 9, Implementation Plan,** describes the recommended next steps for the BARDP.
- **Section 10, References,** lists the references used in preparing this Feasibility Study.

Volume II of this report, *Framework for a Regional Desalination Initiative,* discusses a framework that can be used to develop a regional desalination project in other areas of the state based on experience acquired during preparation of the BARDP Feasibility Study.

Section 1 Figures



Source: Adapted from BAIRWMP 2006

URS	26814534.14000 Bay Area Regional Desalination Project	Bay Area Water Agencies	Figure 1-1

This section describes the site selection process for the BARDP and presents the results of the site ranking evaluation. It also discusses the findings of the BARDP conveyance options evaluation. Project alternatives are then discussed along with the ranking of those alternatives. Feasibility-level cost estimates for the top five proposed operational scenarios are included in Appendix A.

2.1 SITE IDENTIFICATION

Twenty-two sites that represent a wide range of locations were initially identified as potential sites for BARDP plant facilities. Nine sites were eliminated due to potential environmental concerns or the potential lack of community acceptance for a single desalination facility that could meet agencies' needs. Evaluation criteria were developed to rank the remaining 13 sites for suitability for a regional desalination project.

The two Mirant power plant sites were ranked No. 1, the Oceanside site was ranked No. 2, and the Near Bay Bridge site was ranked No. 3. Since there was a tie for No. 1, it was agreed that the Mirant Pittsburg Plant site would be selected as No. 1 and the Mirant Contra Costa Plant site would be eliminated. The three sites represent a range of feedwater options: Bay/Delta water (Mirant Pittsburg Plant), Bay seawater (Near Bay Bridge), and ocean seawater (Oceanside).

The Mirant Pittsburg Plant site was subsequently renamed the East Contra Costa site, and its geographic location was broadened to include the portion of Contra Costa County bordering the Sacramento River/New York Slough/San Joaquin River from Mallard Slough east to Antioch. The East Contra Costa site location was generalized until more rigorous site selection analyses (e.g., hazardous waste site investigation, geotechnical investigation) can be performed. Similarly, the Oceanside site represents a generalized location on the western shore of the Peninsula.

The agencies reserve the right to revisit any of these sites, or other sites, in the future should their needs change or other partners join the project.

2.1.1 Initial Site Identification

Potential sites for a desalination plant were identified as a result of meetings with the agencies, previous Bay Area studies, review of related materials, and knowledge of local conditions. Sites were selected to leverage existing distribution infrastructure and supply water to all participating agencies. In the event of changes to the partnership, the appropriateness of sites would have to be re-evaluated.

The site selection process initially identified 22 sites that represent a wide range of potential locations. These sites are listed in Table 2-1. Some of the sites are labeled generically because a specific site had not been identified for the evaluation. For example, "Refineries" represents any one of the refineries along San Francisco Bay. If a "Refineries" site were selected, further analysis would be required to identify the specific refinery.

Table 2-1
Potential Desalination Plant Sites

No.	Site	Feedwater[1]	Service Area	Location
1	C&H Sugar Refinery	Bay Seawater	EBMUD	Crockett
2	Mirant Contra Costa Plant	Brackish water	CCWD	Antioch
3	Mirant Pittsburg Plant	Brackish water	CCWD	Pittsburg
4	Palo Alto Water Pollution Control Plant Site	Brackish water	SCVWD	Palo Alto
5	Pico Power Plant Site	Brackish water	SCVWD	Santa Clara
6	Los Esteros Power Plant Site	Brackish water	SCVWD	San Jose
7	Treasure Island Site	Bay Seawater	SFPUC	San Francisco
8	Oceanside	Seawater	SFPUC	San Francisco
9	Bay Division Pipelines 1&2 at Dumbarton Point	Bay Seawater	SFPUC	Newark
10	Near Bay Bridge	Bay Seawater	EBMUD	Oakland
11	Mallard Slough	Brackish water	CCWD	Pittsburg
12	San Francisco International Airport	Bay Seawater	SFPUC	San Mateo County
13	Barge-Mounted Plant	Bay Seawater	Any	Bay Area
14	Alameda Point	Bay Seawater	EBMUD	Alameda
15	Russell City Power Plant	Bay Seawater	EBMUD	Hayward
16	Oakland Airport	Bay Seawater	EBMUD	Oakland
17	"Refineries"	Bay Seawater	Any	Any of the Bay Area refineries
18	Southeast WWTP	Bay Seawater	SFPUC	San Francisco
19	Richmond-Sunset Water Pollution Control Plant	Seawater	SFPUC	San Francisco
20	Hunters Point Power Plant	Bay Seawater	SFPUC	San Francisco
21	Embarcadero Location	Bay Seawater	SFPUC	San Francisco
22	"Power Plant Site"	Bay Seawater	SFPUC	San Francisco

[1] "Seawater" is from the ocean and typically has salinity of about 35,000 parts per million of total dissolved solids (TDS). "Bay seawater" is from the Bay and can vary considerably in salinity because of tidal action. "Brackish water" is low-salinity water.

2.1.2 Initial Site Screening and Selection

An initial site screening was conducted that narrowed the 22 sites to 13 sites for further evaluation. The following sites were eliminated for reasons of potential environmental concerns or community acceptance for a single desalination facility that could meet agencies' needs:

- Alameda Point
- Russell City Power Plant
- Oakland Airport
- "Refineries"
- Southeast Wastewater Treatment Plant (WWTP)
- Richmond-Sunset Water Pollution Control Plant (WPCP)
- Hunters Point Power Plant
- Embarcadero Location

- "Power Plant Site"

Evaluation criteria were developed to rank the remaining 13 sites for suitability for a regional desalination project. The following criteria were developed using input from the agencies and a review of information from the California Department of Water Resources (DWR) Water Desalination Task Force (DWR 2003).

- **Feedwater Quality:** Source water quality issues that may affect product water quality, such as proximity of intake location to wastewater discharges, or potential seabed contamination
- **Water Cost:** Cost factors that will affect overall water costs, including
  - Power cost
  - Feedwater salinity
  - Existing agency infrastructure (distribution pipelines)
  - Operation with a high demand factor
  - Co-location with existing intake/discharge infrastructure (power plant, wastewater treatment plant)
- **Permitting:** Permit requirements to license a plant including
  - Water rights issues
  - Intake/brine discharge permit issues (intake/outfall ecological impacts, waste stream characterization, ecological impacts of brine disposal)
  - Land use compatibility
  - Hydrogeology
  - Public health
  - Energy use
- **Public Acceptance**: Public acceptance based upon such factors as
  - Environmental justice
  - Land use compatibility/visual impacts
  - Growth inducement issues
  - Demonstrated need
- **Grant Potential:** The best potential to receive grant funding. Important factors include
  - Innovative design features
  - Regional benefits
  - California Proposition 50 and other grant requirements
- **Regional Capability**: Production capacity to supply several agencies during droughts or emergencies through either
  - Interties (water transfer locations; several of the agencies have interties to the other agencies so they can directly transfer water)

- Other water transfers (water that an agency would normally receive is transferred to another agency; for example, a water transfer could occur in the Delta between CCWD and SCVWD)

2.1.3 Site Descriptions

The 13 sites selected for further evaluation are listed in Table 2-2, and their locations are shown on Figure 2-1. Background information on the sites is provided below. This information was used in the rating for each site.

Table 2-2
Sites Selected for Further Consideration

No.	Site	Feedwater	Service Area	Location
1	C&H Sugar Refinery	Bay Seawater	EBMUD	Crockett
2	Mirant Contra Costa Plant	Brackish water	CCWD	Antioch
3	Mirant Pittsburg Plant	Brackish water	CCWD	Pittsburg
4	Palo Alto Water Regional Pollution Control Plant Site	Brackish water	SCVWD	Palo Alto
5	Pico Power Plant Site	Brackish water	SCVWD	Santa Clara
6	Los Esteros Power Plant Site	Brackish water	SCVWD	San Jose
7	Treasure Island Site	Bay Seawater	SFPUC	San Francisco
8	Oceanside	Ocean Seawater	SFPUC	San Francisco
9	Bay Division Pipelines 1&2 at Dumbarton Point	Bay Seawater	SFPUC	Newark
10	Near Bay Bridge	Bay Seawater	EBMUD	Oakland
11	Mallard Slough	Brackish water	CCWD	Pittsburg
12	San Francisco International Airport	Bay Seawater	SFPUC	San Mateo County
13	Barge-Mounted Plant	Bay Seawater	Any	Bay Area

2.1.3.1 Alameda County

Two potential plant sites were identified in Alameda County:

- Adjacent to Bay Division Pipelines (BDPL) 1&2 at the Bay
- Near Bay Bridge

Adjacent to BDPL 1 & 2 at the Bay
A potential location was identified adjacent to South San Francisco Bay near the Dumbarton Bridge (Location 9, Figure 2-1) that would have a short intake pipeline to the desalination plant and would provide a short delivery into the transmission system. Water from the plant would be boosted into the BDPL and from there could be delivered to any South Bay and Peninsula customers. Intake pipelines could be located on the Bay shoreline, and saline feedwater would be obtained from the Bay.

Brine could be returned directly to the Bay, disposed of in available salt ponds, or transported elsewhere for disposal. Discharge of the brine from the plant into the South Bay may cause significant environmental impacts. Disposal to some other location is potentially expensive and would require long pipelines that in turn would impact the environment.

Near Bay Bridge
EBMUD provides wastewater treatment for parts of Alameda and Contra Costa Counties (Location 10, Figure 2-1). The wastewater system serves approximately 640,000 people along the east shore of San Francisco Bay. A desalination plant could potentially use the existing discharge line if an intake structure could be located to minimize any recirculation. As with the Treasure Island site, the intake could be located where there are strong currents and tidal flushing. The benefit of this location is that the brine could be blended with the wastewater discharge to reduce its impacts.

Wastewater flows to EBMUD's WWTP in Oakland near the eastern approach to the San Francisco–Oakland Bay Bridge. The treatment process includes primary treatment and secondary biological treatment. The wastewater treatment steps are prechlorination; screening; grit removal; primary sedimentation; secondary treatment using high-purity, oxygen-activated sludge; and final clarification. The treated effluent is then disinfected, dechlorinated, and discharged 1 mile off the East Bay shore through a deep-water outfall into San Francisco Bay. EBMUD provides secondary treatment for a maximum flow of 168 mgd. Primary treatment can be provided for up to 320 mgd. Storage basins provide plant capacity for a short-term hydraulic peak of 415 mgd. The average annual flow is currently 80 mgd, allowing capacity for seawater concentrate discharge.

2.1.3.2 Contra Costa County

Several potential plant sites were identified in Contra Costa County. Three of the sites were previously analyzed in an EBMUD study as potential locations for a desalination plant (EBMUD 2003). The 2003 EBMUD study was a fatal flaw analysis for locating a 20 mgd desalination plant at any of these sites. In addition, there were indications that a 100 mgd facility could be located at the two power plant sites. The sites were selected because of the potential for co-locating a desalination plant along with an industrial facility in order to use existing infrastructure. The study reviewed the permitting and licensing issues and found no apparent fatal flaw regarding the co-location of a desalination plant at any of the locations. However, the study identified the unresolved issue of obtaining consumptive water rights. Further investigation would be required before proceeding with a desalination plant in these locations.

The three sites are:

- C&H Sugar Refinery
- Mirant Pittsburg Plant
- Mirant Contra Costa Plant (near Antioch)

In addition, a fourth site was identified at Mallard Slough. CCWD currently has 25 mgd of consumptive use water rights at this location.

C&H Sugar Refinery
The C&H Sugar Refinery (Location 1, Figure 2-1) is located in Crockett on Carquinez Strait in the San Francisco Bay–Delta region. The refinery has an intake near the shoreline that has a

maximum capacity of approximately 27 mgd, although it is probable that the capacity could be increased by installing a larger pump. The refinery site is within EBMUD boundaries, and distribution piping is already in place. Further study would be required to identify if the existing piping can accommodate the increased flow. It may be necessary to increase pipe sizes in this northern portion of EBMUD territory.

The referenced report (EBMUD 2003) showed that several environmental requirements need to be studied further. These include the intake structure, the existing National Pollutant Discharge Elimination System (NPDES) permit, and thermal and brine discharge issues.

A cogeneration facility exists on the C&H refinery site. Although a California Energy Commission (CEC) permit has been issued for the cogeneration facility, no permit is in place for the refinery. During the anticipated California Environmental Quality Act (CEQA) process, the CEC may choose to comment on the proposed project, but no permit should be required.

Limited land area is a consideration at the refinery. The State Lands Commission owns the property nearby below the existing Carquinez Bridge. The State Lands Commission would need to be contacted to determine if a lease or purchase agreement can be reached to obtain sufficient land for a desalination plant.

Mirant Pittsburg Plant Site

The Mirant Pittsburg Plant site (Location 3, Figure 2-1) near Pittsburg is within CCWD service area boundaries. The site is near a 2,060 megawatt (MW) power plant that has a permitted annual flow of 658 mgd. The site is relatively close to the EBMUD Mokelumne Aqueducts, the Contra Costa Canal, and the CCWD Multipurpose Pipeline (MPP), and the desalinated water could be mixed into either system where it would blend with other EBMUD or CCWD water and then be conveyed to treatment facilities before being pumped into the respective distribution systems. Approximately 2 miles of transmission pipe and a pumping plant would need to be constructed. The power plant has two shoreline intakes located approximately 2,000 feet west of New York Point. The water is used to cool the power plant condensers.

The site is approximately 1,080 acres. At this location, it was assumed that the desalination facility would be located on the power plant site, which is outside of the jurisdictional boundaries of the Bay Conservation and Development Commission (BCDC).

Mirant Contra Costa Plant Site

This 1,210 MW power plant (Location 2, Figure 2-1) is located near Antioch with a permitted average annual flow of 340 mgd. The power plant is within CCWD service area boundaries. The Contra Costa Power Plant site is relatively close to the EBMUD Mokelumne Aqueducts, the Contra Costa Canal, and the CCWD MPP, and desalinated water could be injected into either system where it would mix with other EBMUD water and then be conveyed to treatment facilities before being pumped into the respective distribution systems. Approximately 5 miles of transmission pipe and a pumping plant would need to be constructed. The power plant has one shoreline intake as well as an intake located in the San Joaquin River approximately 250 feet from the shoreline. Some water is drawn from the system for use within the plant. This water is treated with a clarifier followed by various modes of filtration (dual media, sand, and cartridge) and then is subject to RO and de-ionization prior to use.

The site is approximately 160 acres. It is probable that the desalination facility would be located outside of the boundaries of the BCDC. A larger facility would require further analysis to determine if sufficient area is available. The existing facility predates the CEC; however, Mirant obtained a certification from the CEC in May 2001 to construct a new 530 MW unit at the site. Conditions of Certification were issued, and the CEC has jurisdiction over the construction and operation of the new unit as well as any ancillary systems that need to be installed for that unit.

Mallard Slough

Mallard Slough (Location 11, Figure 2-1) is located on Suisun Bay near Bay Point. It is the farthest west of any domestic water supply intake in the Delta area. Due to its close proximity to San Francisco Bay, the salinity of the intake water varies widely and changes often depending on the tidal fluctuations and the quantity of fresh water flow through the Delta. Total dissolved solids (TDS) levels measured at the intake from 1997 to 2005 ranged from 70 milligrams per liter (mg/L) to 7,300 mg/L, with levels in June through December typically greater than 1,000 mg/L. Similar salinity variations exist at the Mirant Pittsburg Plant and Mirant Contra Costa Plant sites and the C&H Sugar Refinery. CCWD has 25 mgd of consumptive water rights for Mallard Slough and this water, when of acceptable salinity (lower chlorides), is used as part of the district's supply. The salinity levels are significantly higher than CCWD's goal of approximately 200 mg/L TDS. Due to the variably high TDS levels, CCWD uses the intake only seasonally when TDS levels are consistently low. Unfortunately, this is usually during winter and spring months when water demands within the service area are typically low.

CCWD's property at Mallard Slough is limited in size and could not accommodate a full-scale desalination plant. Land would have to be purchased to the south of CCWD's property to build a plant at this site.

2.1.3.3 San Francisco County

There are two potential plant sites in San Francisco County (SFPUC 2002):

- Oceanside
- Treasure Island location

Oceanside

This site (Location 8, Figure 2-1) is near the existing Oceanside WWTP but could be at any location on the western shore of the Peninsula within San Francisco. Seawater would be available as a feedwater source, and the brine discharge could be blended with the existing wastewater discharge. This site would have the highest salinity due to its ocean intake.

Modeling studies would be required to determine the impact of brine disposal into the ocean environment (as well as for the other sites). At this location, strong ocean currents and tidal flushing would aid in the disposal of the brine. Constructing the desalination plant close to the Oceanside WWTP would have the additional advantage of allowing the strongly saline treatment plant waste product to mix with the low-salinity treated wastewater from the wastewater plant. This would reduce the impact of both flows, as there are some potential advantages for mixing the denser brine with the low-salinity, less dense wastewater.

The SFPUC has identified significant limitations associated with this site. These include right-of-way issues, geotechnical and seismic issues, and availability of space. In addition, projects such as the potential expansion of the Oceanside WWTP and future recycled water facilities are competing for limited space at this location.

Product water distribution pipelines would need to be provided specifically for this water supply source, and hydraulic analyses would be needed to ascertain which customers could be provided with the desalinated water. The water could potentially be delivered to the two San Francisco Sunset area storage tanks (capacity of 89 million and 87 million gallons). Internal water transfers would allow this water to be distributed within San Francisco while exchanging water with other agencies.

Treasure Island Site

This location (Location 7, Figure 2-1) would place the plant in the Bay but in a location with strong currents and tidal flushing. As with the other locations, the true impact of a plant on this site could only be assessed after proper modeling. Limited power is available at the site, which would be a major limitation on the desalination plant size unless more power is provided.

As in the previous example, a transmission line would be required to feed water into the Peninsula transmission system and/or to Alameda County. The pipeline's vertical alignment would be along the Bay floor.

2.1.3.4 Santa Clara County

Two aquifer zones exist within the Santa Clara Basin. The division is formed by an extensive regional aquitard that occurs at depths ranging from about 100 feet near the forebay to about 150 to 250 feet in the interior portion of the basin and beneath San Francisco Bay. Several aquifer systems occur in the upper aquifer zone and are separated by aquitards that may be leaky or very tight. The lower aquifer zone occurs beneath the practically impermeable regional aquitard. From a basin utility standpoint, at present most of the pumped groundwater is from the lower aquifer zone, then pumped from the forebay. The upper zone aquifers are only used for local domestic or agricultural purposes and extraction for chemical contamination remediation projects. Little information exists on the production capacity for this aquifer but it is estimated to be less than 5 mgd at each of the following potential plant sites. This aquifer would be used as the source for desalinated water. Brackish groundwater is available at the sites. Desalination would be possible with likely brine discharge to the Bay.

Three potential sites for desalination facilities were identified in Santa Clara County:

- Pico Power Plant Site
- Los Esteros Power Plant Site
- Palo Alto Regional Water Quality Control Plant Site

Pico Power Plant Site

The Pico Power Project (Location 5, Figure 2-1) (since renamed the Donald Von Raesfeld Power Plant) is located at an existing Silicon Valley Power substation in an industrial area of Santa Clara. The power plant went into commercial operation in March 2005 and produces approximately 147 MW of power using two high-efficiency combustion turbines with added heat recovery steam generators (the latest combined-cycle generation technology).

The new power plant uses recycled water for its cooling tower and groundwater for other applications. The blow-down water is discharged to the existing sanitary sewer.

The desalination feedwater from this site would be brackish groundwater with a desalination plant capacity of less than 5 mgd.

Los Esteros Power Plant Site

The Los Esteros Power Plant (Location 6, Figure 2-1) is owned by Calpine and began commercial operation in 2003. The plant was built on 15 acres of a 55-acre site owned by Calpine near Milpitas. The power plant is fired by natural gas. Under a three-year DWR contract, Calpine will operate as many as 4,000 hours annually and will receive fixed annual capacity payments averaging $38.8 million. The power plant is surrounded by a large area of buffer land that is owned by the San Jose/Santa Clara Water Pollution Control Plant. Therefore, land could be available for a desalination plant.

The power plant uses recycled water for its cooling tower and discharges blow-down water to an existing sanitary sewer. This same sewer is a potential discharge method for the desalination facility as well, but this usage would require further study.

The desalination feedwater from this site would be brackish groundwater with a desalination plant capacity of less than 5 mgd.

Palo Alto Regional Water Quality Control Plant Site

The Palo Alto Regional Water Quality Control Plant (Location 4, Figure 2-1) is a regional wastewater treatment facility operated by the City of Palo Alto for East Palo Alto, Los Altos, Los Altos Hills, Mountain View, Palo Alto, and Stanford University. The plant is an advanced biological treatment facility that uses biological processes to remove unwanted organic material and toxins from wastewater. The plant’s treated effluent is discharged to the southern end of San Francisco Bay. The final treatment provides fine polishing filtration prior to discharge to the Bay.

The desalination feedwater from this site would be brackish groundwater with a desalination plant capacity of less than 5 mgd.

2.1.3.5 Other Locations

Two other locations were selected as potential sites:

- Barge-Mounted Plant
- San Francisco International Airport

Barge-Mounted Plant

Another approach to providing a regional facility is to use a barge-mounted desalination plant that would be mobile within the Bay (Location 13, Figure 2-1). The barge could be quickly relocated to an agency requiring water. Barge-mounted plants have been used in several locations in the Middle East. The first desalination plant at the Jubail Industrial Facility in Saudi Arabia was a 5 mgd barge-mounted plant. This plant contained both the desalination plant and a power plant so that it was completely self-contained. This concept offers several potential advantages:

- A barge-mounted plant would be quickly movable to a location for emergency or maintenance usage.
- An innovative concept is more likely to attract funding (e.g., an innovative desalination concept by Long Beach has attracted federal research and development funds).
- The cost could be shared with other communities that might also want to use the emergency water supply.
- A barge-mounted plant would provide maximum flexibility to meet the various agencies' objectives. Several barges could be combined at one location to provide maximum production for a major facilities outage.

Capacity is a limitation of barge-mounted systems, assuming that the barge would be located in San Francisco Bay. However, if in the future the agencies decide to investigate off-shore alternatives, larger-capacity sea vessel desalination systems could be evaluated.

San Francisco International Airport

San Francisco International Airport is administered by the City and County of San Francisco but is located in Burlingame, south of San Francisco (Location 12, Figure 2-1). This site is located near an existing high-voltage transmission line, a potential source of low-cost power. In addition, the site offers a potential for access to an existing outfall from the airport's WWTP.

2.1.4 Site Scoring and Ranking

The ranking procedure for potential plant site locations was as follows:

- Rating scores (shown below) were provided for each of the criteria.
- Sites were reviewed and rated by specialists knowledgeable about the specific criteria.
- The specialists conducted independent ratings.
- The independent ratings were reviewed and compared.
- Consensus was reached for a final scoring.

The sites were then ranked based on their rating scores as shown below.

Criteria	Rating
Ideal or best conceivable	5
Excellent	4
Good or above average	3
Fair or below average	2
Poor	1
Conditionally acceptable	0
Absolutely unacceptable	-1

The results of the scoring and ranking procedure are shown in Table 2-3. The results are listed in descending order by the final evaluated score. Appendix B provides the ratings for each location.

2.1.5 Findings

The two Mirant power plant sites were ranked No. 1 (Locations 2 and 3, Figure 2-1), the Oceanside site was ranked No. 2 (Location 8), and the Near Bay Bridge site was ranked No. 3 (Location 10). Since there was a tie for No. 1, it was agreed that the Mirant Pittsburg Plant site would be selected as No. 1 and the Mirant Contra Costa Plant site would be eliminated. The three sites represent a range of feedwater options: Bay/Delta water (Mirant Pittsburg Plant), Bay seawater (Near Bay Bridge), and ocean seawater (Oceanside).

The Mirant Pittsburg Plant site was subsequently renamed the East Contra Costa site, and its geographic location was broadened to include the portion of Contra Costa County bordering the Sacramento River/New York Slough/San Joaquin River from Mallard Slough east to Antioch. The East Contra Costa site location was generalized until more rigorous site selection analyses (e.g., hazardous waste site investigation, geotechnical investigation) can be performed. Similarly, the Oceanside site represents a generalized location on the western shore of the Peninsula.

It should be noted that the agencies reserve the right to revisit any of these sites, or other sites, in the future should their needs, objectives, or the partnership structure change.

Table 2-3
Site Scoring and Ranking Results

CRITERIA	Mirant Contra Costa Plant	Mirant Pittsburg Plant	Oceanside	Near Bay Bridge	Palo Alto Water Pollution Control Plant Site	Pico Power Plant Site	Los Esteros Power Plant Site	Treasure Island Site	Mallard Slough	San Francisco Airport	Barge Mounted Plant	BDPL 1&2 at Dumbarton Point	C&H Sugar
Feedwater Water Quality	3	3	3	3	4	4	4	4	3	3	3	3	3
Water Cost	4	4	2	2	5	5	5	1	4	2	3	2	2
Water Rights / Permitting Potential	3	3	2	2	3	3	3	3	3	2	1	2	1
Public Acceptance	2	2	3	3	1	1	1	4	2	2	4	1	3
Grant Potential	3	3	4	3	3	3	3	2	3	3	4	3	2
Regional Capability	4	4	3	4	1	1	1	4	1	3	2	4	2
Environmental	2	2	3	3	2	2	2	1	3	3	1	2	3
TOTAL SCORE	21	21	20	20	19	19	19	19	19	18	18	17	16
RANKING	1		2		3					4		5	6

2.2 CONVEYANCE OPTIONS EVALUATION

A conveyance evaluation was conducted in 2005 to estimate the amount of water that could be transferred among agencies depending on the location of the BARDP desalination facilities. The locations considered were East Contra Costa, Near Bay Bridge, and Oceanside. At the time, the individual agencies estimated their needs at 15 mgd for CCWD, 20 mgd for EBMUD, 20 mgd for the SFPUC, and 10 mgd for SCVWD during dry years. The cumulative needs were 65 mgd[1] for dry years only.

Five interties or water transfer locations were identified. Two dry year conveyance scenarios were developed for each plant location for a total of six scenarios. Three scenarios involve Delta water transfers between CCWD and SCVWD. All scenarios assume that sufficient flow capacity is available in transmission lines to convey BARDP desalination water. Transfers between the SFPUC and EBMUD are limited to 30 mgd due to the size of the EBMUD/SFPUC Emergency Intertie in Hayward. Transfers are limited to 40 mgd between the SFPUC and SCVWD due to limitations at the SFPUC/SCVWD Emergency Intertie in Milpitas. However, there is an opportunity for additional transfers between the SFPUC and SCVWD if deliveries to common customers are modified by agreement between the SFPUC and SCVWD. The current infrastructure would not limit the amount of water that could be transferred between EBMUD and CCWD and between CCWD and SCVWD as part of the BARDP. For the East Contra Costa and Near Bay Bridge sites, it is possible to share 65 mgd among the agencies without requiring a Delta water transfer. However, with a single 65 mgd plant at Oceanside, a water transfer in the Delta would be required to share the 65 mgd.

An emergency conveyance option was also developed for each plant location, with the underlying assumption that a single 65 mgd plant would be built at one of the three top-ranked locations. In most cases, supplying any agency with the total plant capacity of 65 mgd during an emergency would require Delta water transfers between CCWD and SCVWD. A desalination plant at East Contra Costa would require a Delta transfer in order for the SFPUC and SCVWD to collectively receive 65 mgd. With a plant at the Near Bay Bridge site, only EBMUD could receive 65 mgd without a Delta transfer. The same is true for the SFPUC with a plant at Oceanside.

2.2.1 Objectives

This section discusses the conveyance options evaluated for the BARDP. The objectives of this evaluation were to (1) determine the feasibility of water exchanges among the partner agencies through an initial assessment of the capacity of existing water transmission facilities and (2) identify any potential fatal flaws that would prevent the BARDP from meeting the needs of the participating agencies.

The preliminary siting study described in Section 2.1 resulted in the selection of three top-ranked potential plant sites: East Contra Costa, Near Bay Bridge, and Oceanside. Figure 2-2 shows the potential plant locations, existing transmission pipelines, and existing and potential interties.

[1] The SFPUC subsequently identified its dry year desalination water need as 26 mgd, which would bring the total dry year need to 71 mgd.

The conveyance options evaluation developed possible pathways for each of the four agencies to share/exchange water from a desalination plant at the three top-ranked sites by:

- Investigating possible water exchanges to fulfill the 65 mgd desalination capacity during dry years using the existing water transmission capabilities and
- Examining conveyance options in emergencies and identifying the maximum capacity of water exchanges between the agencies.

2.2.2 Approach and Assumptions

The approach used to evaluate conveyance options consisted of the following steps:

1. Identify interconnections/interties or other methods of sharing water among the agencies.
2. Identify major transmission lines near the potential plant sites that could be used to convey the water produced by the desalination plant. The existing conveyances would need to be large enough to convey the entire plant's production volume.
3. Develop a set of conveyance options using the information from Steps 1 and 2.

To develop the conveyance options, the following assumptions were made:

- The maximum capacity of the BARDP desalination plant would be 65 mgd.
- The agencies' water needs would be as follows: CCWD, 15 mgd; EBMUD, 20 mgd; SFPUC, 20 mgd; and SCVWD, 10 mgd.
- Existing conveyance facilities would be used except for the connection between the desalination plant and conveyance facility.
- Sufficient flow capacity would be available in transmission lines to convey BARDP desalination water for any conveyance option included in this evaluation. This assumption does not account for the current use of conveyance facilities. However, when the plant operates during dry years, there should be less water flowing in the water supply system and therefore more capacity in the existing pipelines. Hydraulic modeling would be needed to determine actual conveyance capacities between water systems.
- The agencies participating in the BARDP could modify operating procedures to facilitate the introduction of a new water supply from the desalination plant.
- The agencies would have the proper institutional agreements in place to share water using all identified interties.
- The agencies would have an agreement in place to exchange water in the Delta.
- Agencies would have the capacity to transfer desalination water during emergencies that are not related to dry years. This could require an agency that is not experiencing the emergency to change operations of portions of its water distribution system. During emergencies that affect only one agency, that agency may require up to 65 mgd of supplemental water (the full capacity of the plant).
- For a desalination plant constructed at Oceanside, EBMUD and CCWD would be limited to a combined total of 30 mgd by the EBMUD/SFPUC Emergency Intertie in Hayward. This

would be 5 mgd less than their combined demand of 35 mgd. The only way to meet the entire demand would be to include a transfer of water between SCVWD and CCWD in the Delta.

- The use of existing water infrastructure for conveyance has a significant cost. This cost was not considered in the selection of conveyance options.

This evaluation did not consider upgrading any existing interconnections because to do so would require significant new transmission capability. Hydraulic modeling would need to be performed at the point of entry for desalination water to refine the estimates for desalination plant sizing.

2.2.3 Interconnections Among Partner Agencies

The agencies can share water through the six existing systems listed in Table 2-4, the locations of which are shown in Figure 2-2.

Table 2-4
Summary of Agency Interconnections

Interconnection	Location (see Figure 2-2)	Capacity (mgd)	Description
CCWD/EBMUD Emergency Intertie	A1	20	Raw water transfer; bi-directional exchange
CCWD/EBMUD Emergency Intertie	A2	100	Raw water transfer; bi-directional exchange
CCWD/EBMUD Distribution Systems	B	15	Treated water; bi-directional exchange
CCWD/SCVWD Delta Diversions	C	> 65	Raw water transfer; would require approval from the U.S. Bureau of Reclamation
EBMUD/SFPUC Emergency Intertie	D	30	Treated water; bi-directional exchange
SFPUC/SCVWD Emergency Intertie	E	40	Treated water; bi-directional exchange

The following subsections describe the potential agency interconnections.

2.2.3.1 CCWD/EBMUD Emergency Interties (Locations A1 and A2)

EBMUD's Mokelumne Aqueducts pass through CCWD's service area and run parallel to the Contra Costa Canal from the CCWD Delta intakes to the City of Walnut Creek. A raw water transfer capability of about 20 mgd already exists near Lone Tree Way in Antioch (Location A1, Figure 2-2).

A new intertie is being constructed to connect the CCWD Los Vaqueros Pipeline and the EBMUD Mokelumne Aqueducts (Location A2, Figure 2-2) in Brentwood. The new intertie will allow transfer of 2.9 mgd of CCWD's CVP water supply from the Sacramento River at Freeport to improve CCWD water quality. The intertie will also function as an emergency connection between CCWD and EBMUD, enabling both agencies to share up to 100 mgd of raw water. Operation of the intertie is anticipated to begin in 2008.

2.2.3.2 CCWD/EBMUD Distribution Systems (Location B)

The EBMUD and CCWD distribution systems are located in t he same vicinity within the Cities of Walnut Creek and Pleasant Hill, with zone gates separating the systems (Location B, Figure 2-2). An emergency connection between EBMUD and CCWD is located on Boyd Road at Pleasant

Hill Road in Pleasant Hill. The intertie connects an existing 30-inch pipeline in EBMUD's system with a 24-inch pipeline in CCWD's system. The actual quantity of treated water that may be shared between the two systems has not been determined for this intertie; however, the intertie capacity was assumed to be approximately 15 mgd for the purpose of this evaluation.

An additional 8-inch emergency intertie between the two systems exists in the City of Martinez near Port Costa. As this intertie has very limited capacity, it was not considered in this evaluation.

2.2.3.3 CCWD/SCVWD Delta Diversions (Location C)

The CCWD Delta intakes for the Contra Costa Canal and the SCVWD South Bay Aqueduct are in close proximity (Location C, Figure 2-2). Therefore, CCWD and SCVWD could potentially exchange raw water. The feasibility of such a water exchange is difficult to assess because Delta water diversions carry institutional issues and are subject to historical water rights and constraints involving salinity and fisheries. However, water can be physically transferred at these diversion points through the Delta waterways. The capacity of the diversions would be roughly 200 mgd for the Contra Costa Canal and 287 mgd for the South Bay Aqueduct. For this evaluation, a maximum transfer capacity of 65 mgd was considered during drought years.

2.2.3.4 EBMUD/SFPUC Emergency Intertie (Location D)

A regional partnership among EBMUD, the SFPUC, and the City of Hayward was formed to construct new facilities to allow up to 30 mgd of treated water to be shared among these systems in the San Lorenzo/Hayward area (Location D, Figure 2-2). The project includes a new 30 mgd pump station at the City of Hayward Executive Airport near the intersection of Winton Avenue and Hesperian Boulevard. New pipeline, valving, and pump stations allow transfer of up to 30 mgd in either direction between the SFPUC and EBMUD.

Additional emergency interties may be possible in this area where the Alameda County Water District and the City of Hayward intertie with EBMUD to relieve up to an additional 30 mgd demand from the SFPUC system. However, water system modeling and modifications to institutional agreements would be required before the availability of additional capacity can be assumed.

2.2.3.5 SFPUC/SCVWD Emergency Intertie (Location E)

The SFPUC/SCVWD Emergency Intertie was constructed between the SFPUC and SCVWD in the vicinity of the City of Milpitas to transfer water between the two systems on BDPL 3&4 (Location E, Figure 2-2). The intertie is capable of pumping in either direction and has the water treatment capability to match the disinfection requirements of both systems. The SFPUC/SCVWD Emergency Intertie has a capacity of 40 mgd. Another option to transfer water from the SFPUC to SCVWD is through common customers. The SFPUC and SCVWD have eight common customers in Santa Clara County. With the appropriate institutional and operating agreements in place between the SFPUC and SCVWD and among the SFPUC, SCVWD, and the common customers, the SFPUC could deliver up to 10 mgd of additional supplies either directly to SCVWD through the intertie or to the common customers in Santa Clara County and offset the same quantity of SCVWD supplies, either during a water supply shortage or when conditions are met as specified in the institutional and/or operating agreements. Similarly, SCVWD could offset a portion of SFPUC supplies by meeting a portion of their demand through district supplies to common customers.

2.2.4 Evaluation and Findings

Conveyance options for each desalination plant site were evaluated in terms of their ability to fulfill the 65 mgd desalination capacity during dry years and to allow emergency water transfers using the maximum exchange capacity among the agencies. For dry years, two conveyance options were developed for each plant site: one with a Delta water transfer, and one without. The conveyance options during emergencies assume that 1) a single desalination plant would serve the project needs, 2) only one agency would experience an emergency at one time, and 3) the agency would require the maximum water supply, equal to the plant capacity. In the event that two or more agencies experience an emergency at the same time, operation would be somewhere between the dry year and emergency scenarios.

2.2.4.1 East Contra Costa Site

A desalination plant constructed at the East Contra Costa site would be near the EBMUD Mokelumne Aqueducts, the CCWD Contra Costa Canal, and the Multipurpose Pipeline (MPP). At the East Contra Costa site, water could be desalinated using one-pass or two-pass reverse osmosis (RO), with the cost implications discussed in Appendix A. The desalinated water would be either discharged into CCWD's MPP as treated water or into EBMUD's Mokelumne Aqueducts as raw water. The MPP capacity is 25 mgd. More desalinated water could be transferred to CCWD via the Contra Costa Canal as raw water with downstream treatment. Desalination water distributed through the Mokelumne Aqueducts would undergo downstream treatment.

Conveyance Options During Dry Years

East Contra Costa Option 1

Under this option, 50 mgd of desalinated water would be pumped into the EBMUD Mokelumne Aqueducts for downstream treatment and distribution to EBMUD, SCVWD, and the SFPUC. Fifteen mgd of desalinated would be provided to CCWD via the MPP. Of the 50 mgd taken by EBMUD, 30 mgd would be transferred to the SFPUC at the EBMUD/SFPUC Emergency Intertie (Location D, Figure 2-2), 10 mgd of which would go to SCVWD via the SFPUC/SCVWD Emergency Intertie (Location E, Figure 2-2), leaving 20 mgd for the SFPUC. Figure 2-3 illustrates this transfer option.

East Contra Costa Option 2

Under this option, CCWD would take 25 mgd of desalinated water into the MPP and EBMUD would take 40 mgd into the Mokelumne Aqueducts for downstream treatment. CCWD would transfer 10 mgd of raw water to SCVWD from the CCWD intakes to the South Bay Aqueduct (Location C, Figure 2-2). EBMUD would transfer 20 mgd of treated water to the SFPUC via the EBMUD/SFPUC Emergency Intertie (Location D, Figure 2-2). Figure 2-4 illustrates this transfer option.

Conveyance Options During Emergencies

The following options are available to each agency for emergency use of the desalinated water from a plant located at East Contra Costa.

CCWD

CCWD could take the entire 65 mgd desalination production into the Contra Costa Canal for downstream treatment and delivery. Alternatively, CCWD could take up to 25 mgd (the maximum pipeline capacity) of desalinated water via the MPP and the remaining 40 mgd via the Contra Costa Canal.

EBMUD

EBMUD could take the entire 65 mgd desalination production via the Mokelumne Aqueducts for downstream treatment and delivery.

SFPUC

A Delta transfer between CCWD and SCVWD would be required for the SFPUC to receive the full 65 mgd in an emergency. EBMUD would take 30 mgd of desalination water and transfer the same amount of treated water to the SFPUC using the EBMUD/SFPUC Emergency Intertie (Location D, Figure 2-2). CCWD would take 35 mgd of desalination water. CCWD and SCVWD would exchange an equal amount of water in the Delta (Location C, Figure 2-2). SCVWD would transfer 35 mgd to the SFPUC through the SFPUC/SCVWD Emergency Intertie (Location E, Figure 2-2).

SCVWD

EBMUD would take 30 mgd of desalination water and transfer 30 mgd of treated water to the SFPUC at the EBMUD/SFPUC Emergency Intertie (Location D, Figure 2-2). The SFPUC would transfer 30 mgd to SCVWD. Alternatively, CCWD would take up to 65 mgd and transfer between 35 and 65 mgd to SCVWD in the Delta (Location C, Figure 2-2). Without a Delta transfer, SCVWD has access to a maximum of 30 mgd.

2.2.4.2 Near Bay Bridge Site

If a desalination plant were constructed at the Near Bay Bridge site, then water produced by the facility would be available to offset localized demands in the central zone of EBMUD. The lower zones have an average daily demand of 20 to 50 mgd. A new pumping plant would need to be constructed to meet demand in a greater region of the EBMUD west-of-hills system. The pumping plant would convey water in reverse up the Central Aqueduct on 59th Avenue in Oakland to an elevation of more than 328 feet for broader distribution at the Claremont Tunnel. The new pumping plant and its facilities would require two new water delivery lines. One would connect to the lower pressure zones below the Genoa Rate Control Structure to serve a demand of 20 to 50 mgd. The second line would connect to the Central Aqueduct, which would be used to flow backward and deliver up to 45 mgd to Claremont Tunnel discharge headworks, where water would be available at the Sequoia and Wildcat Aqueducts for broader distribution.

Conveyance Options During Dry Years

Near Bay Bridge Option 1

EBMUD would receive the full 65 mgd capacity of the plant. Thirty mgd of EBMUD water would be conveyed through the EBMUD/SFPUC Emergency Intertie (Location D, Figure 2-2) to the SFPUC. The SFPUC would transfer 10 mgd to SCVWD by way of the SFPUC/SCVWD Emergency Intertie. Fifteen mgd could be transferred from EBMUD to CCWD through the emergency intertie on the Contra Costa Canal as a raw water transfer (Locations A1 or A2, Figure 2-2) or in Pleasant Hill as a treated water transfer (Location B, Figure 2-2). Figure 2-5 illustrates this transfer option.

Near Bay Bridge Option 2

EBMUD would receive the full 65 mgd capacity of the plant. Twenty mgd of EBMUD water would be conveyed to the SFPUC through the EBMUD/SFPUC Emergency Intertie (Location D, Figure 2-2). Twenty-five mgd would be transferred to CCWD. This water could be raw, treated water, or a combination of both (Locations A1, A2, and B, Figure 2-2). CCWD would transfer 10 mgd to SCVWD in the Delta (Location C, Figure 2-2). Figure 2-6 illustrates this transfer option.

Conveyance Options During Emergencies

The following options are available to each agency for emergency use of the desalinated water from a plant located at the Near Bay Bridge site.

CCWD

EBMUD could transfer up to 35 mgd to CCWD through the CCWD/EBMUD interties in Pleasant Hill (Location B, Figure 2-2) and Lone Tree Way (Location A1, Figure 2-2). EBMUD could transfer an additional 30 mgd to the SFPUC at the EBMUD/SFPUC Emergency Intertie (Location D, Figure 2-2), which could in turn transfer that capacity to SCVWD at the SFPUC/SCVWD Emergency Intertie (Location E, Figure 2-2). CCWD could obtain 30 mgd through a Delta transfer with SCVWD (Location C, Figure 2-2). Once the intertie between the Mokelumne Aqueducts and the Las Vaqueros Pipeline is completed, up to 65 mgd of water could be transferred between EBMUD and CCWD (Location A2, Figure 2-2).

EBMUD

EBMUD could take up to 65 mgd of desalinated water into its distribution system.

SFPUC

The SFPUC could receive 30 mgd of treated water through the EBMUD/SFPUC Emergency Intertie in Hayward (Location D, Figure 2-2). The remaining 35 mgd capacity would be obtained through a transfer from SCVWD, which would in turn receive a Delta transfer in that amount. CCWD would receive the 35 mgd from EBMUD through the CCWD/EBMUD interties in Pleasant Hill (Location B, Figure 2-2) and Lone Tree Way (Location A1, Figure 2-2). A Delta transfer between CCWD and SCVWD would be required for the SFPUC to receive the full 65 mgd in an emergency.

SCVWD

SCVWD could receive the entire 65 mgd capacity through a Delta transfer between CCWD and SCVWD (Location C, Figure 2-2). Alternatively, EBMUD would transfer 30 mgd of treated water to the SFPUC through the EBMUD/SFPUC Emergency Intertie (Location D, Figure 2-2). The SFPUC would transfer 30 mgd to SCVWD through the SFPUC/SCVWD Emergency Intertie (Location E, Figure 2-2). EBMUD would transfer an additional 35 mgd to CCWD through the CCWD/EBMUD interties in Pleasant Hill (Location B, Figure 2-2) and Lone Tree Way (Location A1, Figure 2-2). CCWD would transfer 35 mgd to SCVWD in the Delta (Location C, Figure 2-2).

2.2.4.3 Oceanside Site

A BARDP facility constructed in the vicinity of the Oceanside site could provide supplemental dry year or emergency water supply in the SFPUC service area. Water could be conveyed to the SFPUC upper zones including Sunset and Sutro Reservoirs, and a portion dropped to the lower zone to the University Mound Reservoir. Alternatives that include the possible use of the Lake Merced Pumping Plant for transferring water to Sutro Reservoir would need to be evaluated. The concept, for the purposes of this evaluation, would be to pump water from the BARDP to the Lake Merced Pumping Plant to maximize use of existing pumping capacity. Connection to these facilities would require construction of a new pipeline to connect into the existing system at Lake Merced at an elevation of 385 feet. The new pipeline would be designed to convey up to 65 mgd from the desalination plant to Sunset Reservoir. Some of this water would then drop to University Mound Reservoir for distribution into the lower zone. If a desalination facility is constructed at this site, most of the product water would be distributed to San Francisco customers. Approximately 5 mgd could be conveyed through University Mound Reservoir to Peninsula water customers.

Conveyance Options During Dry Years

Oceanside Option 1

Up to 10 mgd of treated water could be transferred to SCVWD through the SFPUC/SCVWD Emergency Intertie (Location E, Figure 2-2), and another 30 mgd (the maximum intertie capacity) could be transferred to EBMUD through the EBMUD/SFPUC Emergency Intertie (Location D, Figure 2-2). This would result in a net increase of 25 mgd (instead of 20 mgd) to the SFPUC if the plant operates at full capacity. Treated water would be transferred from EBMUD to CCWD via the CCWD/EBMUD emergency intertie in Pleasant Hill (Location B, Figure 2-2), or raw water would be transferred through the CCWD/EBMUD intertie at Lone Tree Way in Antioch (Location A1, Figure 2-2). Since EBMUD and CCWD would need a total of 35 mgd and only 30 mgd would be available, both demands could not be fully met. For that reason, this conveyance option cannot fulfill the 65 mgd desalination capacity without a Delta transfer due to the 30 mgd limitation (i.e., infrastructure constraint) of the EBMUD/SFPUC Emergency Intertie. To fully meet the demands of both agencies, an additional 5 mgd would need to be transferred from SCVWD to CCWD in the Delta. Figure 2-7 illustrates this transfer option.

Oceanside Option 2

SCVWD and CCWD could transfer water in the Delta. If SCVWD and CCWD transferred 15 mgd of raw water in the Delta (Location C, Figure 2-2), EBMUD could obtain its 20 mgd of treated water from the SFPUC via the EBMUD/SFPUC Emergency Intertie (Location D, Figure 2-2). The SFPUC would then need to increase its transfer to SCVWD via the SFPUC/SCVWD Emergency Intertie (Location E, Figure 2-2) by 15 mgd to 25 mgd to make up for the Delta transfer. This would result in the SFPUC’s net increase in water to 20 mgd. Figure 2-8 illustrates this transfer option.

Conveyance Options During Emergencies

The following options are available to each agency for emergency use of the desalinated water from a plant located at Oceanside.

CCWD

CCWD would have to receive water from both EBMUD and SCVWD to obtain 65 mgd (up to 30 mgd from EBMUD and the balance through a Delta transfer between CCWD and SCVWD). EBMUD could take 30 mgd through the EBMUD/SFPUC Emergency Intertie (Location D, Figure 2-2) with the SFPUC and transfer water to CCWD through the interties in Pleasant Hill or at Lone Tree Way (Locations A1 and B, Figure 2-2). SCVWD could take 35 mgd through the SFPUC/SCVWD Emergency Intertie (Location E, Figure 2-2) and transfer 35 mgd water with CCWD in the Delta.

EBMUD

EBMUD could take 30 mgd through the EBMUD/SFPUC Emergency Intertie (Location D, Figure 2-2). Additionally, in an extreme emergency, the SFPUC could transfer 35 mgd to SCVWD, which in turn could transfer the same amount to CCWD through a Delta transfer. CCWD could transfer up to 15 mgd of treated water through the intertie in Pleasant Hill and the remaining raw water to EBMUD through the Contra Costa Canal for downstream treatment.

SFPUC

The SFPUC could take the entire 65 mgd into its distribution system.

SCVWD

The SFPUC could take 40 mgd of desalination water and transfer that amount of water to SCVWD through the SFPUC/SCVWD Emergency Intertie (Location E, Figure 2-2). Additionally, the SFPUC would transfer 25 mgd to EBMUD, and EBMUD would transfer the same amount to CCWD. SCVWD would obtain 25 mgd from CCWD through a Delta transfer.

2.2.4.4 Summary of Conveyance Options

Figure 2-9 and Table 2-5 summarize the transfer options among the agencies that would fulfill the 65 mgd desalination capacity during dry years using existing water transmission facilities.

Figure 2-10 and Table 2-6 summarize the possible transfer options in emergencies and the maximum capacity of water exchanges among the agencies.

Table 2-5
Comparison of Conveyance Options During Dry Years

Desalination Plant Site	CCWD	EBMUD	SFPUC	SCVWD	Advantages/ Disadvantages
East Contra Costa	CCWD would take 15 mgd into the MPP or take 25 mgd into the MPP and transfer 10 mgd to SCVWD in the Delta.	EBMUD would receive between 40 and 50 mgd and send 20 or 30 mgd to SFPUC through the EBMUD/SFPUC Emergency Intertie.	SFPUC would receive 20 to 30 mgd through the EBMUD/SFPUC Emergency Intertie and would transfer 0 to 10 mgd to SCVWD through the SFPUC/SCVWD Emergency Intertie.	SCVWD would take 10 mgd through the SFPUC/SCVWD Emergency Intertie or through a Delta transfer with CCWD.	CCWD and EBMUD could take water directly from plant since the location is near major transmission facilities. Desalination water would be discharged into the EBMUD raw water system. CCWD could take up to 25 mgd of desalination water in its treated water system.
Near Bay Bridge	CCWD would receive 15 mgd of treated water from EBMUD through distribution system near Pleasant Hill or 15 mgd of raw water into Contra Costa Canal near Lone Tree Way. Alternatively, EBMUD would give CCWD 25 mgd, of which CCWD would transfer 10 mgd to SCVWD in the Delta.	EBMUD would take 65 mgd for local distribution and send 20 to 30 mgd through the EBMUD/SFPUC Emergency Intertie and 15 to 25 mgd to CCWD.	SFPUC would receive 20 to 30 mgd via the EBMUD/SFPUC Emergency Intertie and transfer 0 to 10 mgd to SCVWD.	SCVWD would take 10 mgd of treated water through the SFPUC/SCVWD Emergency Intertie or raw water through the Delta.	EBMUD would have a water source on the west side of Claremont Tunnel.
Oceanside	CCWD would receive 10 to 15 mgd of treated water from EBMUD through distribution system near Pleasant Hill, or 10 to 15 mgd of raw water into Contra Costa Canal near Lone Tree Way. Because of the 30 mgd limitation of the EBMUD/SFPUC intertie, EBMUD and CCWD cannot receive their full allotment without a Delta transfer. Alternatively, CCWD would receive 15 mgd from SCVWD through a Delta a transfer.	EBMUD would receive 20 to 30 mgd of treated water via the EBMUD/SFPUC Emergency Intertie and transfer 10 to 15 mgd of treated water to CCWD through distribution system near Pleasant Hill or raw water into Contra Costa Canal near Lone Tree Way.	SFPUC would take 65 mgd into its distribution system and transfer 20 to 30 mgd to EBMUD and 10 to 25 mgd to SCVWD.	SCVWD would take 10 to 25 mgd through SFPUC/SCVWD Emergency Intertie and transfer 0 to 15 mgd to CCWD in the Delta.	The site would provide additional reliability to the SFPUC by adding a water supply source on the west side of the Bay. It is not possible to supply EBMUD and CCWD with their full allotment without a Delta transfer because of the 30 mgd capacity of the EBMUD/SFPUC Emergency Intertie. The site would present challenges in connecting with the SFPUC distribution system.

Table 2-6
Comparison of Conveyance Options During Emergencies

	CCWD	EBMUD	SFPUC	SCVWD
East Contra Costa	CCWD would take 65 mgd into the Contra Costa Canal (raw water), or 25 mgd in the MPP (treated water) and the remaining 40 mgd in the Contra Costa Canal (raw water).	EBMUD would receive 65 mgd of desalination water into the Mokelumne Aqueducts.	EBMUD would take 30 mgd of desalination water and transfer 30 mgd of treated water to SFPUC through the EBMUD/SFPUC Emergency Intertie. CCWD would take 35 mgd of desalination water and transfer 35 mgd to SCVWD in the Delta. SCVWD would transfer 35 mgd of treated water to SFPUC.	EBMUD would take 30 mgd of desalination water and transfer 30 mgd of treated water to SFPUC through the EBMUD/SFPUC Emergency Intertie. SFPUC would transfer 30 mgd to SCVWD. Or, CCWD would take 0 to 65 mgd and transfer between 35 and 65 mgd to SCVWD in the Delta.
Near Bay Bridge	EBMUD would transfer 35 mgd of treated water to CCWD through distribution system near Pleasant Hill and raw water into Contra Costa Canal near Lone Tree Way. (If the emergency intertie between the Mokelumne Aqueducts and Los Vaqueros pipeline is available, then 65 mgd could be transferred.) SCVWD could transfer 30 mgd to CCWD in the Delta.	EBMUD would take 65 mgd into its distribution system.	SFPUC would receive 30 mgd through the EBMUD/SFPUC Emergency Intertie. EBMUD would transfer 35 mgd to CCWD, which would transfer the same amount to SCVWD in the Delta. SCVWD would transfer 35 mgd to SFPUC.	SFPUC would take 30 mgd through the EBMUD/SFPUC Emergency Intertie and transfer the same amount to SCVWD through the SFPUC/SCVWD Emergency Intertie. The remaining 35 mgd would come from a Delta transfer with CCWD. CCWD would receive 35 mgd from EBMUD. (If the emergency intertie between the Mokelumne Aqueducts and Los Vaqueros pipeline is available, then 65 mgd could be transferred between EBMUD and CCWD, which would transfer the same amount to SCVWD in the Delta.)
Oceanside	EBMUD could take 30 mgd through the EBMUD/SFPUC Emergency Intertie and transfer water to CCWD through the interties in Pleasant Hill or Lone Tree Way. SCVWD could take 35 mgd through the SFPUC/SCVWD Emergency Intertie and transfer 35 mgd to CCWD in the Delta.	EBMUD would receive 30 mgd of treated water via the EBMUD/SFPUC Emergency Intertie. SFPUC could transfer 35 mgd to SCVWD. CCWD and SCVWD could transfer 35 mgd in the Delta and CCWD could transfer 35 mgd to EBMUD.	SFPUC would take 65 mgd.	SCVWD could take 40 mgd through the SFPUC/SCVWD Emergency Intertie. EBMUD would take 25 mgd from the EBMUD/SFPUC Emergency Intertie and transfer it to CCWD. CCWD would transfer 25 mgd to SCVWD in the Delta.

2.2.5 Limitations

2.2.5.1 Capacity Issues

The primary limitation for sharing of water among agencies during dry years would be the EBMUD/SFPUC Emergency Intertie through Hayward, since it can only transfer a maximum of 30 mgd unless water is transferred in the Delta. This would meet the needs of the SFPUC and SCVWD when the water moves from EBMUD to the SFPUC but would not meet the needs of EBMUD and CCWD (35 mgd) when water moves from the SFPUC to EBMUD.

The East Contra Costa site is limited to about 25 to 30 mgd of treated water. This limitation is imposed by the capacity of the MPP, the closest conveyance facility for treated water. The East Contra Costa site is close to both the Contra Costa Canal and the Mokelumne Aqueducts. Both of these facilities have a large capacity for raw water.

2.2.5.2 Potential Water Quality Issues

This section compares the agencies' treated water quality and examines the water quality implications of blending water from various agencies. This analysis is for water quality only and does not consider the potential limitations of water rights on blending and transfer capabilities. Table 2-7 compares water quality parameters for treated water supplies from each agency. In general, water supplied by CCWD and SCVWD is of comparable quality and is representative of Delta water as a primary source of supply. Both EBMUD and the SFPUC transport water through long conveyance systems from the Sierras to the Bay Area and are, for the most part, very similar in quality. Upper San Leandro Reservoir is located near the EBMUD/SFPUC Emergency Intertie. If Upper San Leandro Reservoir provided water, it may be of a different quality because it is influenced by local runoff. The ultimate source of water that would be transferred would depend on conditions at the time of the transfer. Water could potentially come from either Upper San Leandro Reservoir or the Mokelumne Aqueducts.

Water from a desalination facility would be of high quality and low mineral and solids content. In general, desalinated water should have minimal impact on the water agencies, and, in many cases, the blended water would improve water quality overall. Desalinated water would require chemical adjustment for corrosion control when delivered to all water agencies.

Blending of waters from different sources has been known to impact the following aspects of the water quality delivered to the consumer:

- Taste and odor
- Variability of water, causing customers to notice the difference in quality
- Impacts on industrial users on process water treatment
- Corrosivity
- Disinfection
- Denitrification in distribution systems
- Precipitated particulate material

Table 2-7
Comparison of Water Quality Parameters from 2003 Annual Reports

Parameter	Units	MCL	CCWD	EBMUD	SFPUC	SCVWD
Chloride	mg/L	600	50	8	12	70
Total Dissolved Solids (TDS)	mg/L	1500	NR	102	99	250
Turbidity	NTU	5	0.11	0.05	1.58	0.05
Trihalomethanes (THMs)	µg/L	80	32.1	39	65.3	64
Haloacetic Acids (HAAs)	µg/L	60	8	20	19.5	24
Bromate	µg/L	10	ND	<5	NR	NR
Hardness	mg/L	None	85	130	51	109
Alkalinity	mg/L	None	72	116	49	80
Total Organic Carbon (TOC)	mg/L	None	NR	NR	2.8	1.95

Source: 2003 annual reports for CCWD, EBMUD, SFPUC, and SCVWD
µg/L = Micrograms per liter
MCL = Maximum Contaminant Level
mg/L = Milligrams per liter
ND = Not detected
NTU = National turbidity units
NR = Not reported

These water quality issues would be difficult to predict without blending studies. Table 2-8 summarizes the potential for water quality impacts from blending water from different agencies/sources.

Table 2-8
Potential for Water Quality Impacts Due to Blending

From/To	CCWD	EBMUD	SFPUC	SCVWD	Desalinated Water
CCWD	None	Possible Impacts	NA	None	None
EBMUD	None	None	Possible Impacts	NA	None
SFPUC	NA	None	None	None	None
SCVWD	NA	NA	Possible Impacts	None	None
Desalinated Water	None	None	None	None	None

NA = Not applicable
None = No likely impacts

A description of the possible impacts of blending waters between agencies is provided below.

- **CCWD to EBMUD –** If a treated water transfer is made to EBMUD, source water from the Delta may be noticeable to customers. The primary difference will be in the taste of the water since it can be dissimilar in mineral content.

- **EBMUD to CCWD –** If a desalination facility is built at the Near Bay Bridge site, EBMUD may transfer to CCWD.
- **EBMUD to SFPUC –** If water supplied by EBMUD is primarily from Upper San Leandro Reservoir, then the mineral, total organic carbon (TOC), and nutrient content, along with the potential for taste and odors, may be issues when delivering water to the SFPUC. Another possible issue is that SFPUC industrial customers are sensitive to water quality changes that impact industrial water treatment practices in Silicon Valley. Theses issues are of lesser concern if the primary source of water is the Orinda Water Treatment Plant. However, depending on the distribution decisions, part or all of 30 mgd could be used locally in Hayward and Alameda County Water District.
- **SFPUC to EBMUD –** The SFPUC can supply water to EBMUD without major impacts on water blending.
- **SFPUC to SCVWD –** The SFPUC already delivers water to SCVWD and to common customers without measurable impacts to date.
- **SCVWD to SFPUC –** If water supplied to the SFPUC is from the South Bay Aqueduct, then the mineral, TOC, and nutrient content, along with potential for taste and odors, may be issues when delivering water to the SFPUC. SFPUC industrial customers are sensitive to water quality changes that impact industrial water treatment practices in Silicon Valley.

2.2.6 Conclusions and Recommendations

Figures 2-9 and 2-10 and Tables 2-5 and 2-6 summarize the options evaluated. The evaluation produced the following general conclusions.

- The EBMUD/SFPUC Emergency Intertie has a capacity of 30 mgd, limiting the transfer between the northern agencies (EBMUD and CCWD) and southern agencies (SFPUC and SCVWD). For a plant built at the Oceanside site, the combined demand of 35 mgd for EBMUD and CCWD exceeds the capacity of the intertie. Therefore, part or all of CCWD demand would have to be met through a Delta transfer between CCWD and SCVWD.
- For the East Contra Costa and Near Bay Bridge sites, it is possible to share 65 mgd among the agencies without requiring a Delta water transfer. The SFPUC’s revised desalination water needs from 20 mgd to 26 mgd would affect the conveyance options by increasing the desalination plant capacity from 65 mgd to 71 mgd. Because the existing infrastructure at the EBMUD/SFPUC Emergency Intertie limits water transfers to 30 mgd, Delta transfers between CCWD and SCVWD would be required to distribute each agency’s allotment. This would apply to a single 71 mgd facility at any of the three sites.
- In most cases, supplying 65 mgd during emergencies to any agency not connected directly to the proposed desalination plant would require Delta transfers. With a plant at the East Contra Costa site, the SFPUC and SCVWD could not receive 65 mgd without a Delta transfer. With a plant at the Near Bay Bridge site, only EBMUD could receive 65 mgd without a Delta transfer. The same is true for SFPUC with a plant at Oceanside.
- Transferring water between agencies would have potential water quality impacts (Section 2.2.5.2).

- Development of a desalination plant at each of the three sites would require construction of interconnection pipelines and pump stations. A plant at the Near Bay Bridge or Oceanside site may require additional infrastructure.
- Memoranda of Understanding developed between the agencies for use of the existing interties would have to be revised to allow for transfer of water for the BARDP.

Blending studies should also be conducted for all of the water sources that could be exchanged to determine any potential limitations.

2.3 EVALUATION AND RANKING OF OPERATIONAL SCENARIOS

Seven operational scenarios were developed that consisted of combinations of different desalination plant capacities at the three top-ranked sites (East Contra Costa, Oceanside, and Near Bay Bridge). These operational scenarios were developed based on agency needs identified at the time of the evaluation, which included both dry year and wet year needs. The agencies identified their dry year needs as follows: CCWD, 15 mgd; EBMUD, 20 mgd; SFPUC, 20 mgd; and SCVWD, 10 mgd. CCWD and SCVWD both anticipated that their needs would extend to wet and normal years. Two of the seven operational scenarios were eliminated due to “fatal flaws,” resulting in five feasible scenarios.

The five feasible operational scenarios were then subjected to a formal evaluation process. The evaluation process accounted for both the individual and collective objectives and constraints of each BARDP agency. If the objectives and/or constraints of any agency participating in the BARDP change, or if there is a change in the makeup of the participating agencies, the operational scenarios may need to be reassessed, and this process would be triggered again.

Scenario 1 (“Single 65 mgd Facility at East Contra Costa”) ranked the highest. Scenario 3 (“40 mgd Plant at Near Bay Bridge and 25 mgd Plant at East Contra Costa”) had the second-highest score.

Although the sites were ranked based on the agencies’ views on and sensitivity to the criteria described in this section, no sites or scenarios were eliminated from future consideration through this analysis. Other scenarios could rank higher as agencies’ needs and priorities shift. Although the evaluation process was designed to be as objective as possible, the rating of individual issues and subissues was sometimes subjective, depending on the views of the individual or agency at that time (September 2005).

2.3.1 Scenario Development

A survey of water needs and an evaluation of conveyance options indicated that an estimated 65 mgd[1] of product water would be needed to meet the agencies’ dry year demands from the year 2010 to beyond the year 2030. Based on this estimate, seven operational scenarios consisting of combinations of different desalination plant capacities at the three top-ranked sites (East Contra Costa, Oceanside, and Near Bay Bridge) were developed.

To develop the scenarios, the following assumptions were made:

- The maximum capacity of the BARDP desalination plant would be 65 mgd.
- The agencies’ water needs during dry years would be as follows: CCWD, 15 mgd; EBMUD, 20 mgd; SFPUC, 20 mgd[2]; and SCVWD, 10 mgd.
- The agencies’ water needs during wet years would be as follows: CCWD, 15 mgd; and SCVWD, 10 mgd. CCWD and SCVWD revised their needs to dry years only during this evaluation, but the 25 mgd wet year production scenarios were retained in the analysis. As

[1] After this evaluation, the SFPUC identified its dry year desalination water need as 26 mgd (an average of 23 mgd over an 8.5-year design drought) to meet planning objectives and be consistent with other planning documents. This would bring the total dry year need to 71 mgd.

demonstrated in the cost evaluation (Appendix A), production during wet and normal years could substantially reduce acre-foot water costs. Therefore, this analysis assumed that third-party customers may be identified for wet and normal years (Section 6).

- Desalination water that would be conveyed through a raw water transmission line would be produced using one-pass RO. Desalination water that would be conveyed through a treated water transmission line would be produced using two-pass RO.
- Only 25 mgd of treated water conveyance (through the MPP) would be available at the East Contra Costa site.

The following criteria were used in developing the operational scenarios and associated conveyance options:

- Minimize the number of water exchanges needed to meet all agency demands
- Provide increased reliability for emergency use
- Minimize treating water more than once

Based on these criteria, the following seven scenarios were identified that would satisfy the agencies' demands:

- A single 65 mgd plant at East Contra Costa
- A single 65 mgd plant at Oceanside
- A single 65 mgd plant at Near Bay Bridge
- A 40 mgd plant at Oceanside and a 25 mgd plant at East Contra Costa
- A 40 mgd plant at Near Bay Bridge and a 25 mgd plant at East Contra Costa
- A 30 mgd plant at Oceanside and a 35 mgd plant at East Contra Costa
- A 45 mgd plant at East Contra Costa and a 20 mgd plant at Oceanside

Figures illustrating these seven scenarios are provided in Appendix C.

Under the proposed scenarios, the East Contra Costa site would require the fewest transfers to meet the agencies' water demands. As such, this site satisfies the first two criteria, and it was included in all scenarios with multiple plants.

Only one option with multiple plants was developed that included the Near Bay Bridge site. This is because locating both plants on the east side of the Bay would reduce flexibility of water transfers since EBMUD cannot directly transfer or exchange water with SCVWD.

After the initial seven scenarios were developed, they were analyzed for potential fatal flaws based on scenario feasibility. Two fatal-flaw criteria were identified: insufficient space to support a facility that could generate the target water yield, and inability of the participating agencies to exchange water due to institutional/legal constraints. Based on these criteria, two of the seven potential scenarios were considered to be infeasible. The 65 mgd plant at Oceanside scenario was found to be infeasible because of insufficient space for a facility of this size. The Near Bay Bridge 65 mgd plant scenario was determined to be infeasible because of institutional constraints on the exchange of water.

The five remaining scenarios (numbered 1 through 5) were considered to be feasible until further technical and operational studies are conducted and were further evaluated as described below. These scenarios are illustrated in Figure 2-11.

2.3.1.1 Scenario 1: East Contra Costa 65 mgd Plant

For the East Contra Costa 65 mgd Plant scenario (Figure 2-11), three options were developed for dry year operations. In Option A, CCWD would receive 15 mgd of one-pass RO water from the plant, and EBMUD would receive 50 mgd of one-pass water from the plant into the Mokelumne Aqueducts. EBMUD would then provide the SFPUC with 30 mgd of treated water through the EBMUD/SFPUC Emergency Intertie, and the SFPUC would in turn provide 10 mgd of treated water to SCVWD through the SFPUC/SCVWD Emergency Intertie or directly supply 10 mgd to SCVWD customers. If CCWD were the only agency that needed water, it could receive two-pass RO water through the MPP.

In Option B, CCWD would receive 45 mgd of one-pass water from the plant, and EBMUD would receive 20 mgd of one-pass water from the plant. CCWD would then provide 30 mgd of raw water to SCVWD through a Delta water transfer. SCVWD would provide 20 mgd of treated water to the SFPUC through the SFPUC/SCVWD Emergency Intertie.

In Option C, CCWD would receive 25 mgd of one-pass water from the plant, and EBMUD would receive 40 mgd of one-pass water from the plant. CCWD would then provide 10 mgd of raw water to SCVWD through a Delta water transfer. EBMUD would provide 20 mgd of treated water to the SFPUC through the EBMUD/SFPUC Emergency Intertie. If CCWD and SCVWD were the only agencies that needed water, then CCWD could receive 25 mgd of two-pass RO water through the MPP and then provide 10 mgd of raw water to SCVWD through a Delta transfer.

2.3.1.2 Scenario 2: Oceanside 40 mgd Plant/East Contra Costa 25 mgd Plant

Scenario 2 (Figure 2-11) would consist of a 25 mgd plant at East Contra Costa and a 40 mgd plant at Oceanside. Water at the East Contra Costa plant could be produced by either one-pass or two-pass RO depending on end-user needs. For example, desalination water conveyed through the MPP would be treated by two-pass RO, and desalination water conveyed through the Contra Costa Canal could be treated by one-pass RO. The East Contra Costa plant would operate to serve the needs of CCWD and SCVWD. CCWD would take 25 mgd (by either one- or two-pass RO, depending on the conveyance system used), and SCVWD would receive 10 mgd of raw water from CCWD through a Delta transfer.

Water from the Oceanside plant would be produced using two-pass RO, and the SFPUC would take the full plant capacity of 40 mgd of water into its distribution system. A transfer of 20 mgd would occur at the EBMUD/SFPUC Emergency Intertie to provide EBMUD with 20 mgd of treated water.

2.3.1.3 Scenario 3: Near Bay Bridge 40 mgd Plant/East Contra Costa 25 mgd Plant

The Near Bay Bridge 40 mgd Plant/East Contra Costa 25 mgd Plant (Figure 2-11) scenario is similar to Scenario 2 except the 40 mgd plant would be constructed at the Near Bay Bridge site. EBMUD would take 40 mgd of water into its East Bay distribution system and transfer 20 mgd of treated water through the EBMUD/SFPUC Emergency Intertie to the SFPUC. The East Contra Costa plant would operate as in Scenario 2.

2.3.1.4 Scenario 4: Oceanside 30 mgd Plant/East Contra Costa 35 mgd Plant Scenario

In the Oceanside 30 mgd Plant/East Contra Costa 35 mgd Plant scenario (Figure 2-11), two plants would be constructed, one to supply CCWD and EBMUD and one to supply SCVWD and the SFPUC. The scenario includes a 35 mgd plant at the East Contra Costa site and a 30 mgd plant at the Oceanside site. During dry/critically dry years, the East Contra Costa plant would operate to meet the demands of CCWD and EBMUD. Either CCWD would take all of the water and transfer 20 mgd of water to EBMUD (Option A), or CCWD would take only 15 mgd and 20 mgd could be added to the Mokelumne Aqueducts (Option B). Water at the East Contra Costa plant could be produced by either one-pass or two-pass RO, depending on end-user needs. For example, desalination water conveyed through the MPP would be treated by two-pass RO, and desalination water conveyed through the Contra Costa Canal could be treated by one-pass RO.

The Oceanside plant's 30 mgd production would go into the SFPUC's distribution system, and 10 mgd of treated water would be transferred to SCVWD through the SFPUC/SCVWD Intertie, or provided directly to common customers.

2.3.1.5 Scenario 5: East Contra Costa 45 mgd Plant/Oceanside 20 mgd Plant Scenario

In the East Contra Costa 45 mgd Plant/Oceanside 20 mgd Plant scenario (Figure 2-11), the East Contra Costa plant would provide the additional water for EBMUD, CCWD, and SCVWD since CCWD can transfer/exchange water with both of these agencies directly. For this scenario, a 45 mgd plant would be constructed at the East Contra Costa site and a 20 mgd plant would be constructed at the Oceanside site.

During dry/critically dry years, either CCWD would take the 45 mgd of water from the desalination plant as one-pass water and transfer water to SCVWD and EBMUD (Option A), or CCWD would take 25 mgd of the produced water into the Contra Costa Canal and EBMUD would take 20 mgd into the Mokelumne Aqueducts (Option B). In either case, SCVWD would receive 10 mgd of raw water from a Delta transfer. Water at the East Contra Costa plant could be produced by either one-pass or two-pass RO, depending on the end-user needs. For example, desalination water conveyed through the MPP would be treated by two-pass RO, and desalination water conveyed through the Contra Costa Canal could be treated by one-pass RO. If CCWD and SCVWD were the only agencies that needed water, CCWD could receive 25 mgd of two-pass RO water through the MPP and provide 10 mgd of raw water to SCVWD through a Delta transfer.

The Oceanside plant would serve the SFPUC's dry year needs.

2.3.2 Scenario Evaluation

Figure 2-12 is a flowchart that illustrates the key steps of the scenario evaluation process. This evaluation exercise accounted for both the individual and collective objectives and constraints of each agency. If the objectives and/or constraints of any agency participating in the BARDP change, or if there is a change in the makeup of the participating agencies, the scenarios may need to be reassessed and this process would be triggered again. Each of the steps shown in Figure 2-12 is described briefly below.

Although the evaluation process was designed to be as objective as possible, the rating of individual issues and subissues was sometimes subjective, depending on the views of the individual or agency. Such level of subjectivity is inherent in any multi-criteria evaluation process involving human judgment. Also, it should be noted that this evaluation process took place in September 2005. There was an awareness that the Delta smelt was a federally listed threatened species; however, issues regarding the recent decline of Delta smelt and other pelagic organisms were beginning to emerge but were not widely publicized in the popular media. Therefore, the recent pelagic organism decline was not considered in this evaluation.

2.3.2.1 Step 1. Define Issues and Subissues Relevant to the Evaluation of Scenarios

In individual consultation with each of the participating agencies, the project consultant team first defined the major issues relevant to evaluating the feasible scenarios and then defined relevant subissues within each issue. These issues and subissues were based on the factors that one or more of the agencies viewed as important in selecting a site, and formed the criteria by which the scenarios were ranked.

Table 2-9 shows the issues and subissues defined for the scenario evaluation process. The issues and subissues do not appear in any specific order.

Table 2-9
Relevant Issues Identified for the Evaluation of Scenarios

Issue	Subissue
Environmental Resource Protection	Visual sensitivity of plant location
	Potential impacts to land-based biology
	Potential impacts to water-based biology
	Potential impacts to historic resources
	Presence of sensitive noise receptors in the vicinity
	Potential impacts to recreational resources
	Potential impacts to agricultural lands
	High energy requirement for plant operation
Permitting	NPDES Permit
	BCDC Permit
	Coastal Development Permit
	Encroachment Permit
	Appropriative Water Rights Permit
Institutional/Legal	Need for multiple exchanges to allocate water to each agency
	Pipeline constraints due to type of water conveyed (raw or treated)
	Agencies give up higher-quality water in exchange for lower-quality water (non-desalination water only)
	Agencies serve as a “pass-through” with no net increase in water supply
Cost	Product water costs
Public Perception	Proximity of intake to wastewater outfall
Reliability	Plant susceptibility to natural hazards
	Water supply system reliability

2.3.2.2 Step 2. Rate Each Scenario on Each Subissue Within Every Issue

The agencies collectively rated each of the five scenarios for each subissue except cost using a rating scale of –2 to +2, with –2 representing the least desirable outcome and +2 representing the most desirable outcome. With the participation of the project consultant team as moderator, the agencies engaged in a group discussion to identify the pros and cons of each subissue for each scenario. Except for two subissues for which the responses were agency-specific (under the Institutional/Legal and Reliability categories, respectively[2]), the group reached consensus on the rating of each subissue for each scenario. The cost issues were not rated in the same manner because cost factors were developed as a separate task (see Appendix A). All agencies agreed that lowest cost would be rated most favorably.

Group rating results by issue are presented in Appendix C. Key discussion points associated with each issue area are summarized below.

Environmental Resource Protection

All scenarios that included the Oceanside site received a –2 rating for visual sensitivity. Although the Great Highway at this location is not a designated scenic resource, the agencies agreed that the area may be visually sensitive.

No historic resources are known to occur at any of the proposed locations, and no agricultural uses would be affected by the facility/facilities based on anticipated design features. Therefore, all of the scenarios rated similarly for these two environmental factors. Because project design would minimize noise generated at the proposed facility/facilities, each scenario rated the same relative to noise impacts.

The energy requirements for a desalination plant would vary substantially depending on the plant size and salinity levels. For these reasons, the energy requirements would be lower at scenarios including East Contra Costa than those including Near Bay Bridge or Oceanside. The ranking reflects the relative proportions of desalinated water production under each scenario.

Permitting

The two permits perceived as being the most difficult to obtain given the three potential locations were the NPDES permit and the appropriative water rights permit. The group agreed that the NPDES permit would be most difficult to obtain at the East Contra Costa location because there would be lower diffusive mixing between the discharged brine and the source water.

Appropriative water rights would be an issue of concern at the East Contra Costa site for all scenarios in which production would be greater than 25 mgd. For production of up to 25 mgd, existing CCWD water rights may be transferred or extended. For larger plants at this location, however, additional water rights would be required. Given the limited availability and large number of water users that depend on water from the Delta, it is anticipated that this permit could be difficult to obtain at the East Contra Costa site.

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[2] Ratings tables in this section that include Institutional/Legal and Reliability issues list ratings for those categories by agency (generically numbered 1, 2, 3, and 4, in no particular order).

Since this evaluation was conducted in September 2005, there has been increasing awareness and concern regarding the pelagic organism decline in the Delta.

Institutional/Legal

A single facility would present the maximum number of infrastructure challenges, as water would need to move through different pipelines so that agencies could effectively share more water. Therefore, the most challenging scenario from an institutional perspective would be Scenario 1.

Each agency had different views regarding the issue of water quality differences that would occur as a result of conveyance configurations under different scenarios. Therefore, the rating for this subissue reflected individual agency preferences. Neither the SFPUC nor EBMUD would be affected by any particular scenario. However, CCWD and SCVWD could receive higher-quality water in scenarios where their dependence on Delta water is reduced. SCVWD could receive SFPUC water freed up by the SFPUC in Scenarios 4 and 5. In Scenario 1, SCVWD would receive additional water from the Delta, which is consistent with their current Delta supply and is not of lower quality.

Cost

As part of the evaluation process, feasibility-level cost estimates for each of the three top-ranked sites and the five scenarios were developed. Table 2-10 presents feasibility-level capital cost estimates for each site and scenario as described in Appendix A. The capital costs are for the desalination facilities, intake, and concentrate disposal but do not include potential conveyance system improvements.

Table 2-11 presents the feasibility-level operation and maintenance (O&M) costs for each site and scenario as described in Appendix A. An on-stream factor of 95 percent was assumed for the plant operation. The operating costs do not include wheeling and post-treatment. These costs will differ for each agency. Desalination water conveyed using raw water conveyance facilities would require post-treatment. O&M costs were developed on an annual basis assuming that the plant operates every year.

Table 2-12 summarizes year 2007 product water costs for each site and scenario. The product water cost is the sum of the annual (amortized) capital cost plus annual O&M costs divided by the volume (acre-feet per year) of product water. The capital costs for each scenario were annualized to account for the interest rate (5.5 percent) and plant life (30 years). The cost estimates assume operation of the desalination facility during dry years only (that is, 1 out of 3 years. Note that the predicted frequency of use of the desalination facility for varying capacities was later refined. O&M costs for wet and dry years were developed. Wet year O&M costs assume that an offline desalination plant must sustain a reduced flow to maintain the integrity of the reverse osmosis membranes. Wet year O&M costs were assumed at 20 percent of the dry year O&M costs. For all dry years, the costs assume that the plant operates at full capacity. An annual inflation rate of 3 percent was applied to the O&M costs to estimate product water costs for 2007.

Table 2-10
Desalination Facility Feasibility-Level Capital Cost Estimates by Plant Site and Scenario
($, in Millions)

Project Cost Component	Scenario 1	Scenario 2		Scenario 3		Scenario 4		Scenario 5	
	East Contra Costa (65 mgd)	Oceanside (40 mgd)	East Contra Costa (25 mgd)	Near Bay Bridge (40 mgd)	East Contra Costa (25 mgd)	Oceanside (30 mgd)	East Contra Costa (35 mgd)	Oceanside (20 mgd)	East Contra Costa (45 mgd)
Desalination Facility and Intake Costs	**163.1**	**199.1**	**71.8**	**206.8**	**71.8**	**161.0**	**97.1**	**114.3**	**117.1**
Non-construction Costs (15% of Desalination Facility Cost) (incl. Planning, Permitting, Engineering & Administrative Costs)	24.5	29.9	10.8	31.0	10.8	24.1	14.6	17.1	17.6
Project Cost without Contingency	187.6	229.0	82.5	237.8	82.5	185.1	111.7	131.4	134.6
Contingency (25%)	46.9	57.2	20.6	59.4	20.6	46.3	27.9	32.9	33.7
Project Cost per site with Contingency (Rounded up)	**234.5**	**286.2**	**103.2**	**297.2**	**103.2**	**231.4**	**139.6**	**164.3**	**168.3**
Project Cost per Scenario with Contingency (Rounded up)	**234**	**389**		**400**		**371**		**333**	

Notes:
1. Costs reflect the estimation performed in November 2005. No inflation was applied to the costs.
2. No contractor mark-up was included to the construction cost estimate.

Table 2-11
Desalination Facility Feasibility-Level Operation and Maintenance Cost Estimates by Plant Site and Scenario ($, in Millions)

O&M Cost Items	Scenario 1	Scenario 2		Scenario 3		Scenario 4		Scenario 5	
	East Contra Costa (65 mgd)	Oceanside (40mgd)	East Contra Costa (25mgd)	Near Bay Bridge (40 mgd)	East Contra Costa (25 mgd)	Oceanside (30 mgd)	East Contra Costa (35 mgd)	Oceanside (20 mgd)	East Contra Costa (45 mgd)
Labor	1.3	1.0	0.5	1.0	0.5	0.7	0.7	0.5	1.0
Electrical	13.5	24.4	5.2	21.1	5.2	18.3	7.3	12.2	9.4
Membrane Replacement	1.8	3.6	0.8	3.5	0.8	2.7	1.0	1.8	1.3
Chemical Feed System	5.1	4.5	2.2	4.4	2.2	3.4	2.9	3.3	3.6
Miscellaneous Maintenance	3.3	4.0	1.4	4.1	1.4	3.2	1.9	2.3	2.3
O&M Cost per site	**25.0**	**37.4**	**10.1**	**34.1**	**10.1**	**28.2**	**13.8**	**20.1**	**17.6**
O&M Cost per Scenario	**25.0**	**47.5**		**44.2**		**42.1**		**37.7**	

Notes:
1. O&M costs assume an on-stream factor of 95 percent.
2. Costs reflect the estimation performed in November 2005. No inflation was applied to the costs.
3. Costs assume continuous operation (every year) of the desalination facilities.
4. Wheeling and post-treatment costs are not included.
5. Costs assume that full-capacity is needed in every dry years.

Table 2-12
Dry Year Product Water Costs by Plant Site and Scenario (Year 2007)

	Scenario	Year 2007 Product Water Cost ($/acre-foot)		
		East Contra Costa Site	Near Bay Bridge Site	Oceanside Site
1	Single 65 mgd Facility at East Contra Costa	1,237	-	-
2	40 mgd Facility at Oceanside and 25 mgd Facility at East Contra Costa	1,363	-	2,694
3	40 mgd Facility at Near Bay Bridge and 25 mgd Facility at East Contra Costa	1,363	2,633	-
4	30 mgd Facility at Oceanside and 35 mgd Facility at East Contra Costa	1,325	-	2,808
5	20 mgd Facility at Oceanside and 45 mgd Facility at East Contra Costa	1,271	-	2,994

Notes:
1. Product water costs reflect operation during dry years only. It was assumed that there would be 1 dry year for every 2 wet years.
2. Product water costs are for water leaving the desalination plant and do not include conveyance improvements, wheeling, and post-treatment. Wheeling and treatment costs will be different for each agency. For CCWD with the plant at East Contra Costa, product water cost will be for treated water.

Public Perception

The proximity of the proposed intake structure to an existing wastewater outfall would be the biggest issue at the Near Bay Bridge site, followed by the Oceanside site.

Reliability

A facility at Oceanside would be most vulnerable to natural disasters such as tsunamis. The other sites would be less vulnerable; however, any of the locations would be vulnerable to earthquakes.

On the issue of operational reliability, particularly during emergencies, agencies' views varied based on their proximity to the proposed site and the diversification the product water would add to their water supply portfolios. As all scenarios include an East Contra Costa site, which would provide water to CCWD, CCWD would stand to benefit equally from any scenario. For EBMUD, reliability would be greater under the scenario that includes the Near Bay Bridge site (Scenario 3) because if a seismic event were to disrupt Claremont Tunnel deliveries, the desalination facility could provide backup for the west-of-hills water system demands. Both the SFPUC and SCVWD would have a more reliable water supply basis from a plant located at Oceanside. The Oceanside site would provide a high degree of reliability for the SFPUC since the water supply point is located to the west of where the Bay Division Pipelines cross major faults. SCVWD viewed Scenario 4 as the most beneficial, as this scenario would afford it the greatest diversification of its water supply portfolio. Although Scenario 5 includes a desalination plant at Oceanside, its capacity would serve only the immediate identified need of the SFPUC, and therefore this scenario would not offer the same benefits as the other two scenarios that include Oceanside to SCVWD.

Current research on climate change in California indicates that some existing conventional water supply sources, such as water stored in the Sierra snowpack, may become less reliable in the future as a result of climate change (see Section 8).

2.3.2.3 Step 3. Assess Relative Values of Improving Different Subissues Within Each Issue ("Intra-Issue Evaluation")

Each participating agency was asked to independently assess relative values of improving different subissues within an issue from its least desirable level (i.e., –2) to its most desirable level (i.e., +2). To do this, each agency considered a hypothetical site, defined by the project consultant team, for which every subissue was at its least desirable level. The agencies were instructed to identify the subissue that they would improve to its most desirable level first, second, and so forth. Based on their prioritization, the agency gave each subissue a relative value on a scale of 0 to 10, with 10 representing the highest value and 0 representing no or little value. The results of this assessment, presented in Appendix C, provided the means to calibrate the relative weights of different subissues within each issue. Cost and public perception issues were not included in this step since they each had only one subissue.

2.3.2.4 Step 4. Assess Relative Values of Improving Different Issues ("Inter-Issue Evaluation")

Each participating agency was asked to independently assess relative values of improving different issues by improving a specific subissue within each issue. The agencies considered a hypothetical scenario for which one specific subissue within each issue was at its least desirable level while all other subissues remained neutral. Again, agencies independently assigned a relative value of 0 to 10 to show which subissue they would improve ahead of other subissues representing different issues. The results of this assessment, presented in Appendix C, provided the means to calibrate the relative weights of the different issues.

2.3.2.5 Step 5. Calculate an Overall Desirability Score of Each Scenario

Using the results of Steps 2, 3, and 4, the overall desirability score of each scenario was calculated using a scale of 0 to 100. For both group and individual ratings, a score of 100 would result if a scenario were rated as +2 on each subissue within every issue. Conversely, a score of 0 would result if a scenario were rated as –2 on each subissue within every issue.

2.3.2.6 Step 6. Perform Sensitivity Analysis

A sensitivity analysis was performed to analyze the impact of inter-agency differences on the ranking of the scenarios. The agencies were asked to assess the relative values of two scenarios each with the same average rating across the four agencies. The two scenarios were different with regard to inter-agency assessments. One scenario specified the same rating by each of the four agencies, while the other scenario specified the same rating by three agencies (which was higher than that for the first scenario), but a substantially lower rating by the fourth agency. Based on the relative values assessed by the agencies for these two scenarios (one emphasizing a lower rating but greater consistency and agreement among agencies and the second emphasizing a lesser degree of consensus, but greater appeal to some of the agencies), the project team defined two sensitivity analysis cases that represent two different views of the impact of inter-agency differences. For one case, the average score of a scenario was increased by a certain percentage if three of the agencies gave consistently higher ratings than the fourth agency. For the other case, the average score of a scenario was reduced by a certain percentage if there were substantial inter-agency differences.

The results of the sensitivity analysis provided an understanding of whether the ranking of the scenarios would be substantially altered if inter-agency differences were considered to have an impact on the overall desirability of a scenario. The results of the sensitivity analysis suggest that the relative ranking of the five scenarios would remain practically the same under different assumptions regarding inter-agency diversity of opinions. Therefore, a simple average of the values for the four agencies would be a robust criterion for ranking the scenarios.

2.3.2.7 Step 7. Rank Scenarios

The results of Steps 5 and 6 were used to rank the scenarios. Based on the analysis, all four agencies rated Scenario 1 (“Single 65 mgd Facility at East Contra Costa”) as the top-ranked scenario.

2.3.3 Findings

Table 2-13 shows the overall desirability score of each scenario under seven different cases. The first four cases show the scores of the four individual agencies.

The results in Table 2-13 show that Scenario 1 (“Single 65 mgd Facility at East Contra Costa”) consistently had the highest score for each of the seven cases. This scenario ranked the highest for each agency, including when the ranking was based on the average score of the four agencies. Therefore, Scenario 1 is recommended as the preferred scenario. Scenario 3 (“40 mgd Plant at Near Bay Bridge and 25 mgd Plant at East Contra Costa”) had the second-highest score. Scenario 3 may be considered as a backup to Scenario 1.

Although the sites were ranked based on the agencies’ views on and sensitivity to the criteria described in this section, no sites or scenarios were eliminated from future consideration through this analysis. Other scenarios could rank higher as agencies’ needs and priorities shift.

Table 2-13
Ranking Evaluation Results Summary

Scenario #	Values of Scenarios on a Scale of 0 to 100						
	Agency 1	**Agency 2**	**Agency 3**	**Agency 4**	**Average of Four Agency Values**	**Increase Value Based on Average of 3 Highest Agency Values**	**Reduce Value if Agency Diversity**
Scenario 1: Single 65 mgd Facility at East Contra Costa	69	64	63	55	62	63	54
Scenario 2: 40 mgd Plant at Oceanside and 25 mgd Plant at East Contra Costa	50	46	49	45	47	48	43
Scenario 3: 40 mgd Plant at Near Bay Bridge and 25 mgd Plant at East Contra Costa	60	60	56	45	55	56	50
Scenario 4: 30 mgd Plant at Oceanside and 35 mgd Plant at East Contra Costa	50	45	53	42	47	48	42
Scenario 5: 20 mgd Plant at Oceanside and 45 mgd Plant at East Contra Costa	52	43	46	41	46	46	40

Section 2 Figures

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NO.	SITE	NO.	SITE
1	C&H Sugar Refinery, Crockett	8	Oceanside, San Francisco
2	Mirant Contra Costa Plant, Antioch	9	BDPL 1 & 2 at Dumbarton Point
3	East Contra Costa, Pittsburg	10	Near Bay Bridge
4	Palo Alto Water Pollution Control Plant Site	11	Mallard Slough
5	Pico Power Plant Site, Santa Clara	12	San Francisco Airport
6	Los Esteros Power Plant Site, San Jose	13	Barge-Mounted Plant
7	Treasure Island Site, San Francisco		

URS

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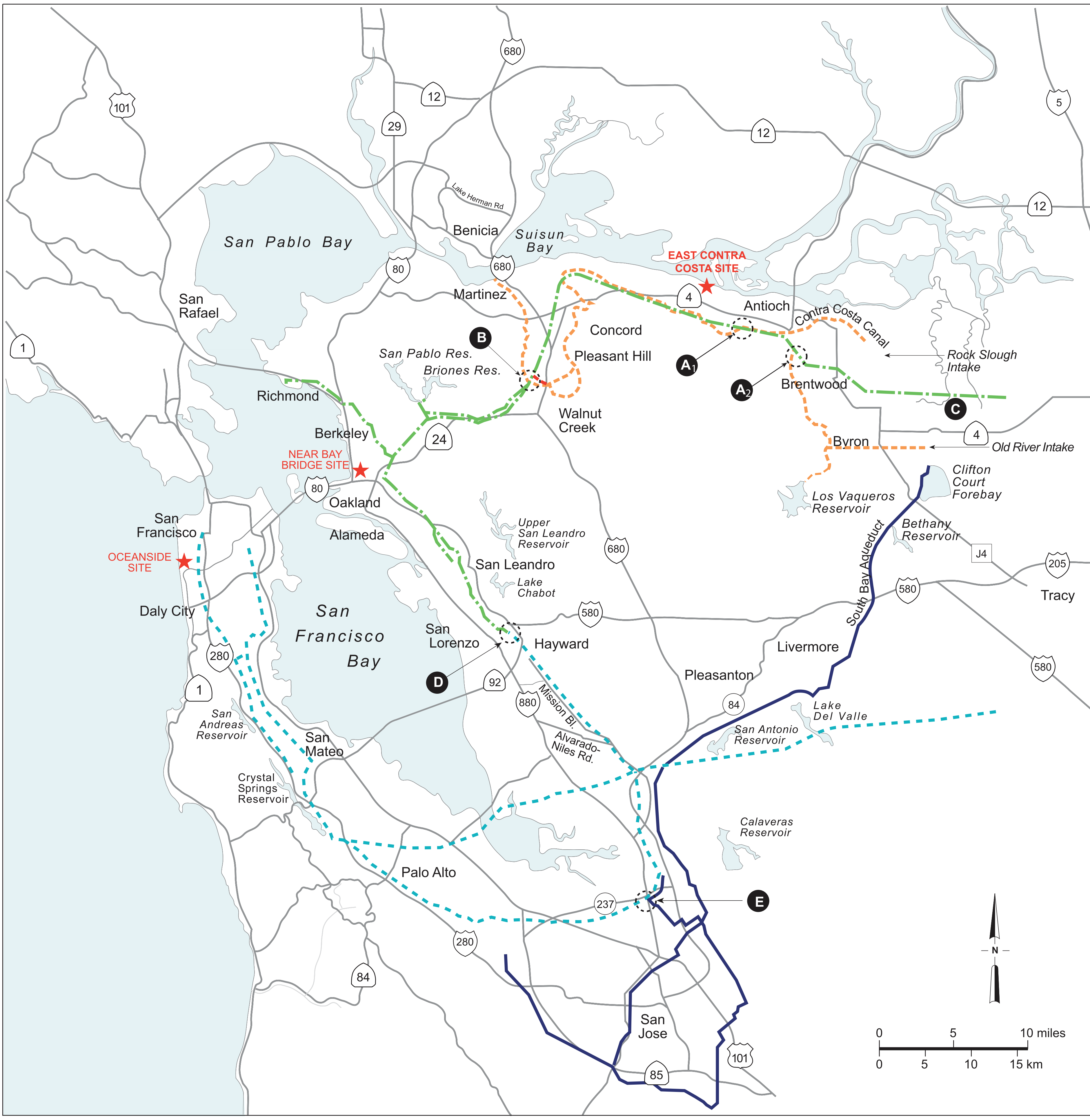
Bay Area Regional Desalination Project

Site Location Map

Figure 2-1



LEGEND

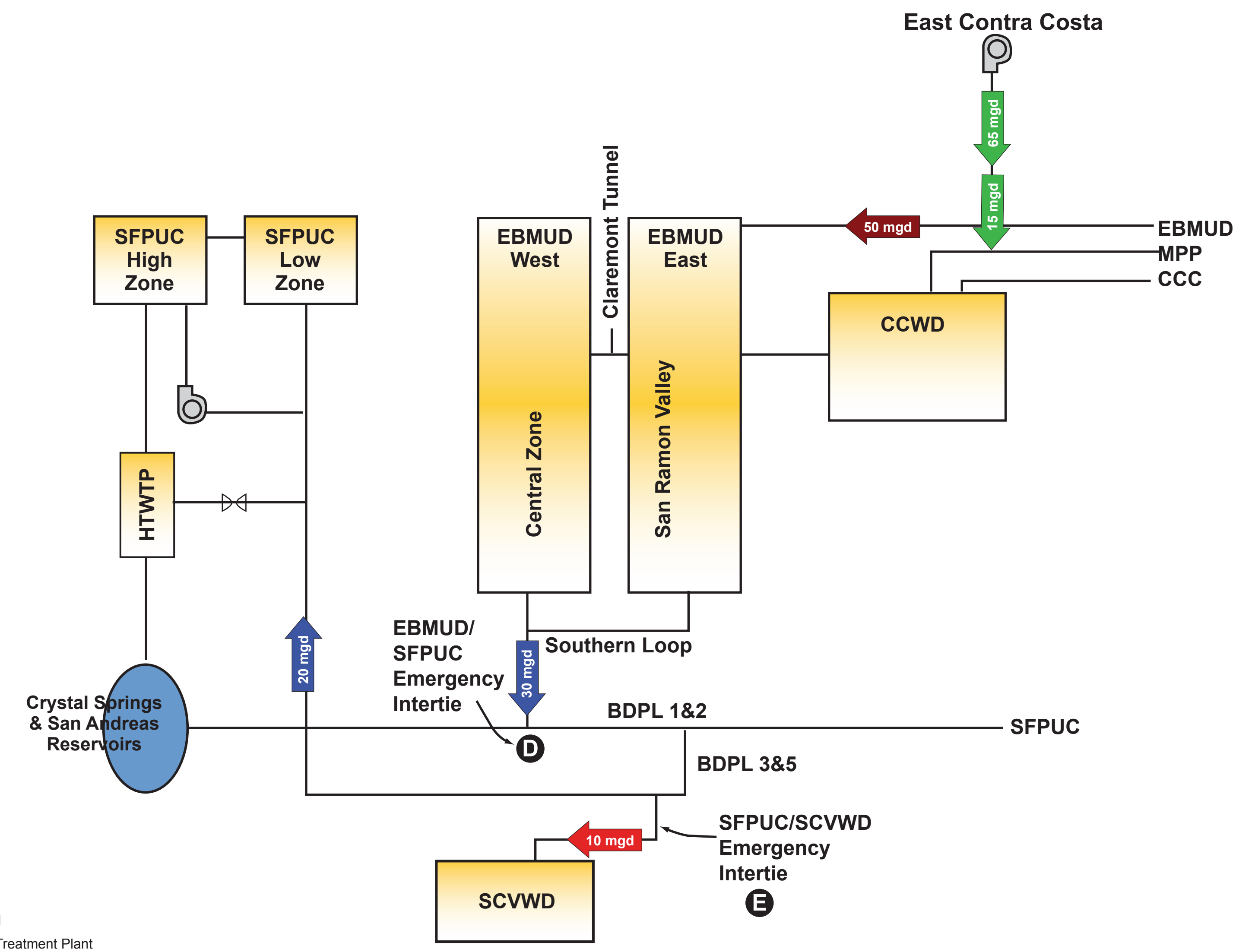
★ Top-Ranked Site Location

Transmission Lines

- SFPUC
- CCWD
- SCVWD
- EBMUD

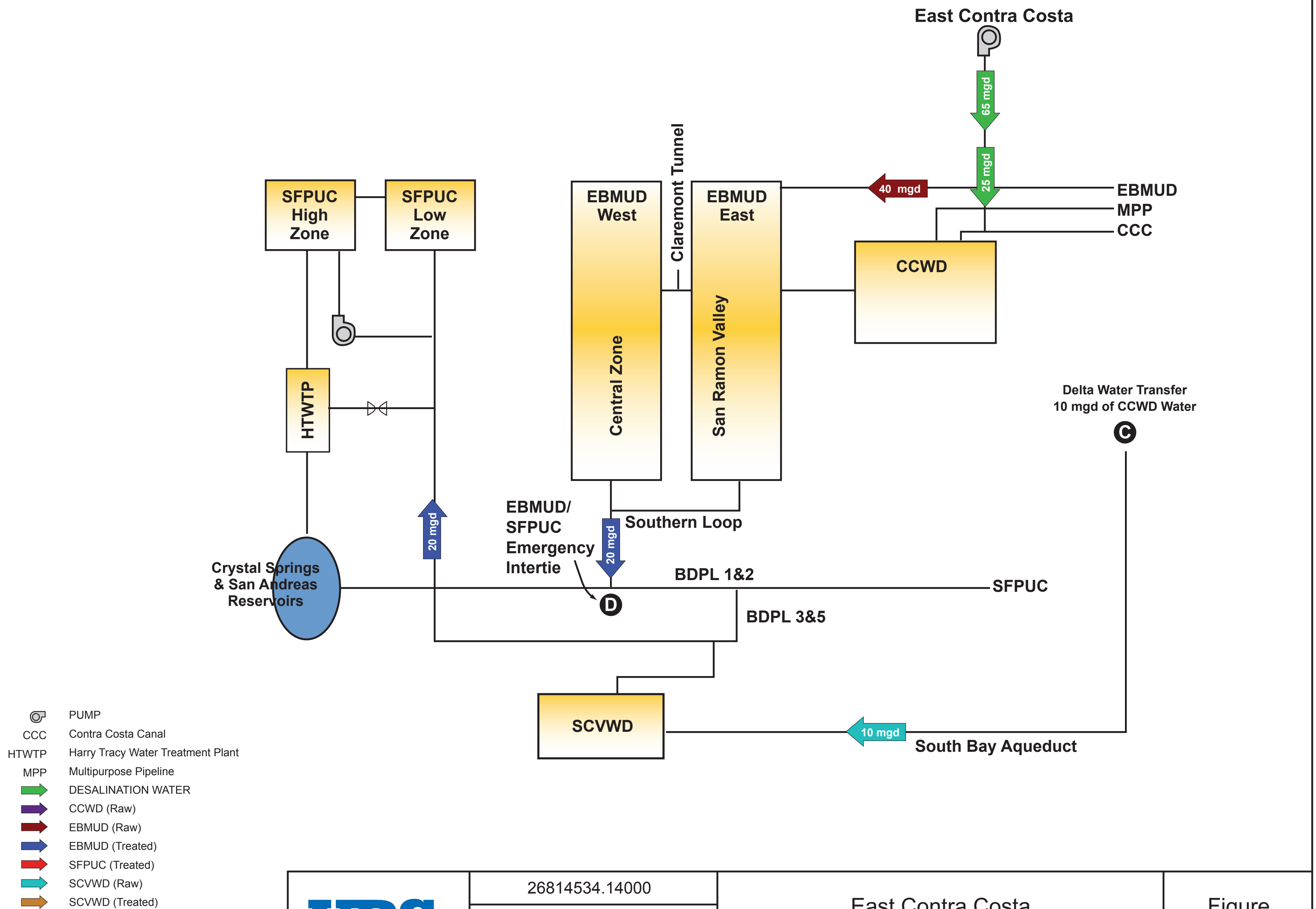
Water Transfer Location	Between	Capacity
A_1	CCWD/EBMUD	20 mgd (untreated)
A_2	CCWD/EBMUD	100 mgd (untreated)
B	CCWD/EBMUD	15 mgd (treated)
C	CCWD/SCVWD	>65 mgd (untreated)
D	EBMUD/SFPUC	30 mgd (treated)
E	SFPUC/SCVWD	40 mgd (treated)

URS	Project No. 26814534 Bay Area Regional Desalination Project	TRANSMISSION PIPELINE AND EXISTING/POTENTIAL WATER TRANSFER LOCATIONS	Figure 2-2

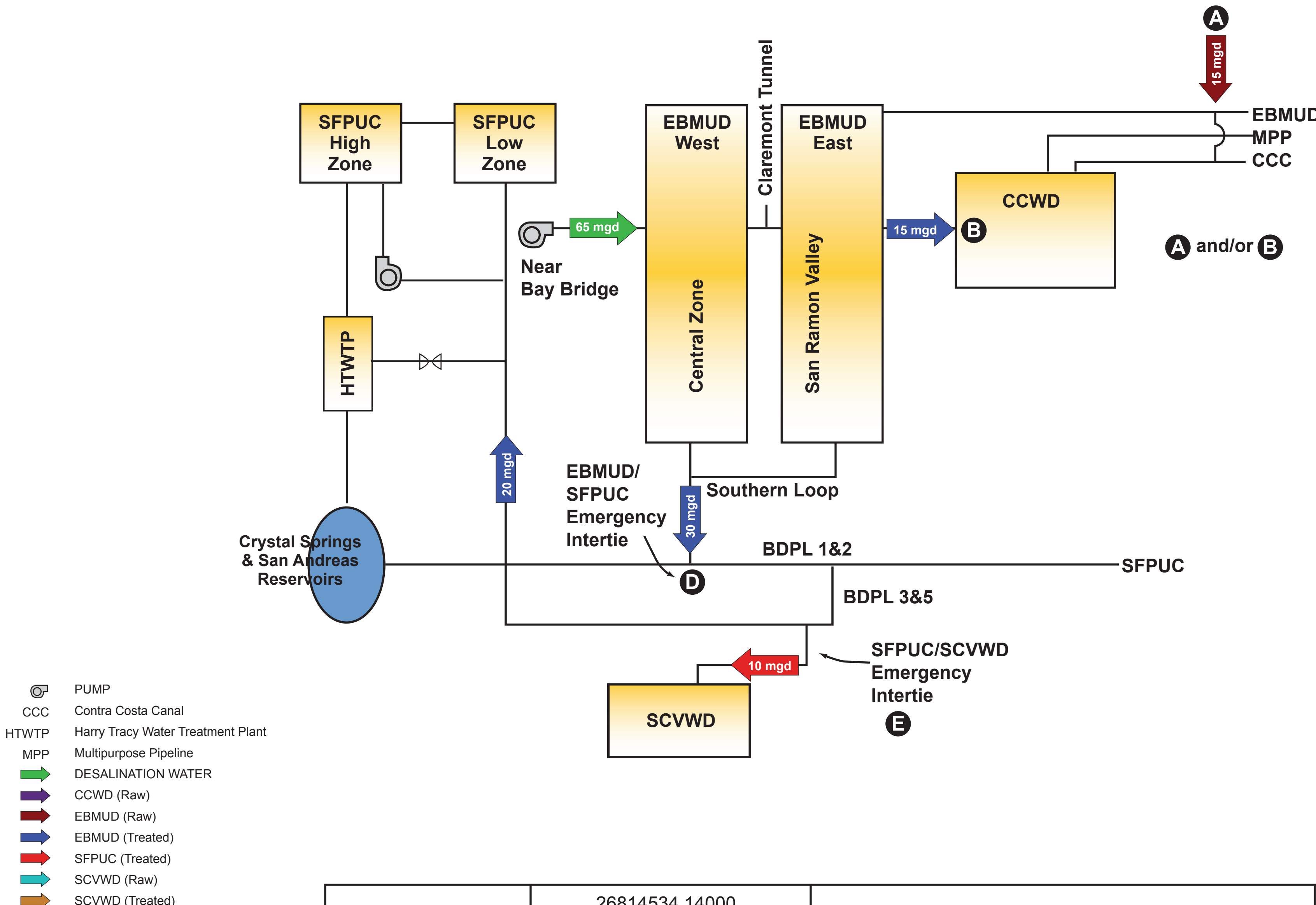


(pump symbol)	PUMP
CCC	Contra Costa Canal
HTWTP	Harry Tracy Water Treatment Plant
MPP	Multipurpose Pipeline
(green arrow)	DESALINATION WATER
(purple arrow)	CCWD (Raw)
(dark red arrow)	EBMUD (Raw)
(blue arrow)	EBMUD (Treated)
(red arrow)	SFPUC (Treated)
(teal arrow)	SCVWD (Raw)
(orange arrow)	SCVWD (Treated)

URS	26814534.14000 Bay Area Regional Desalination Project	East Contra Costa Dry Year Conveyance Option 1	Figure 2-3



URS	26814534.14000 Bay Area Regional Desalination Project	East Contra Costa Dry Year Conveyance Option 2	Figure 2-4



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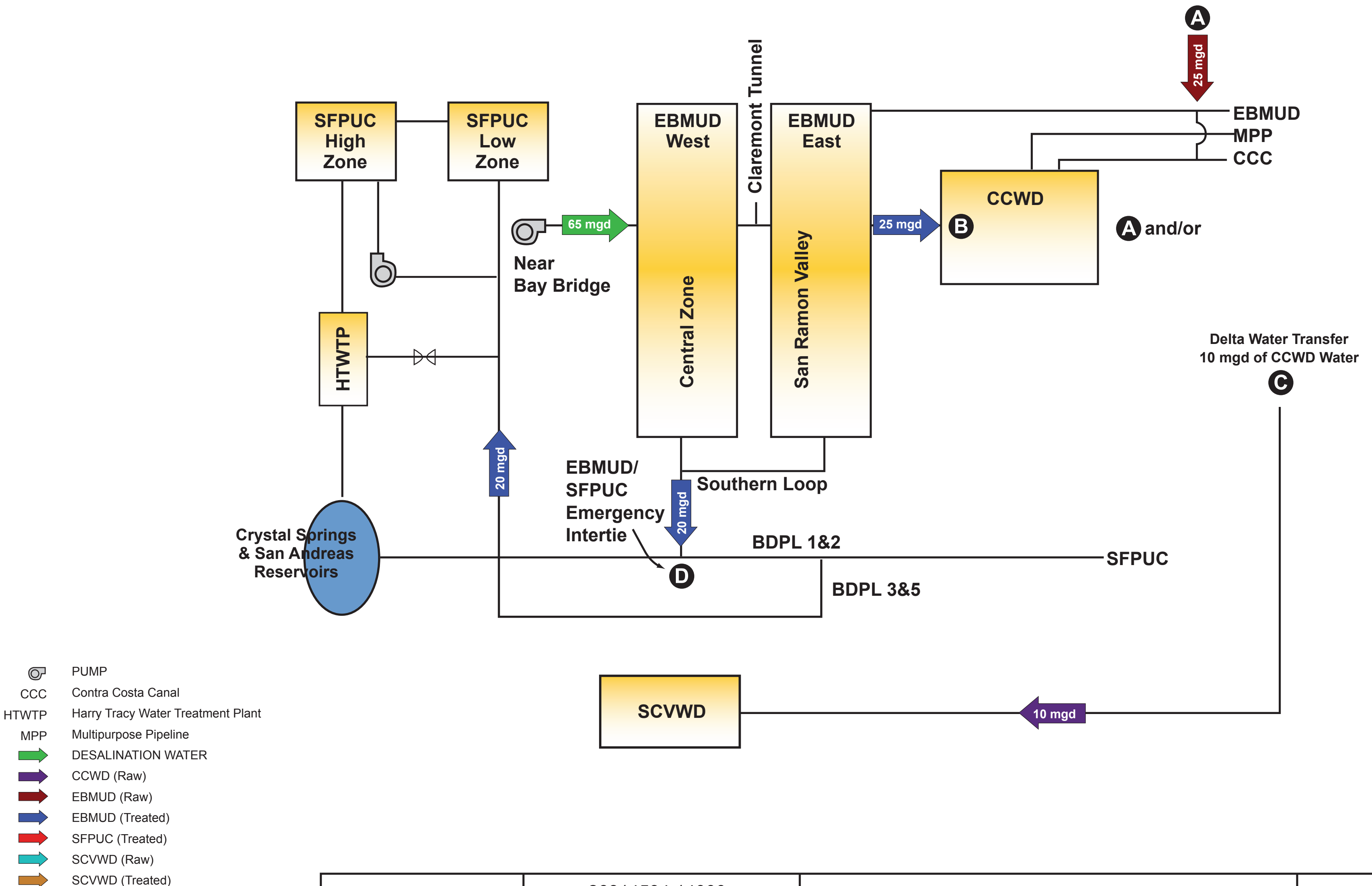
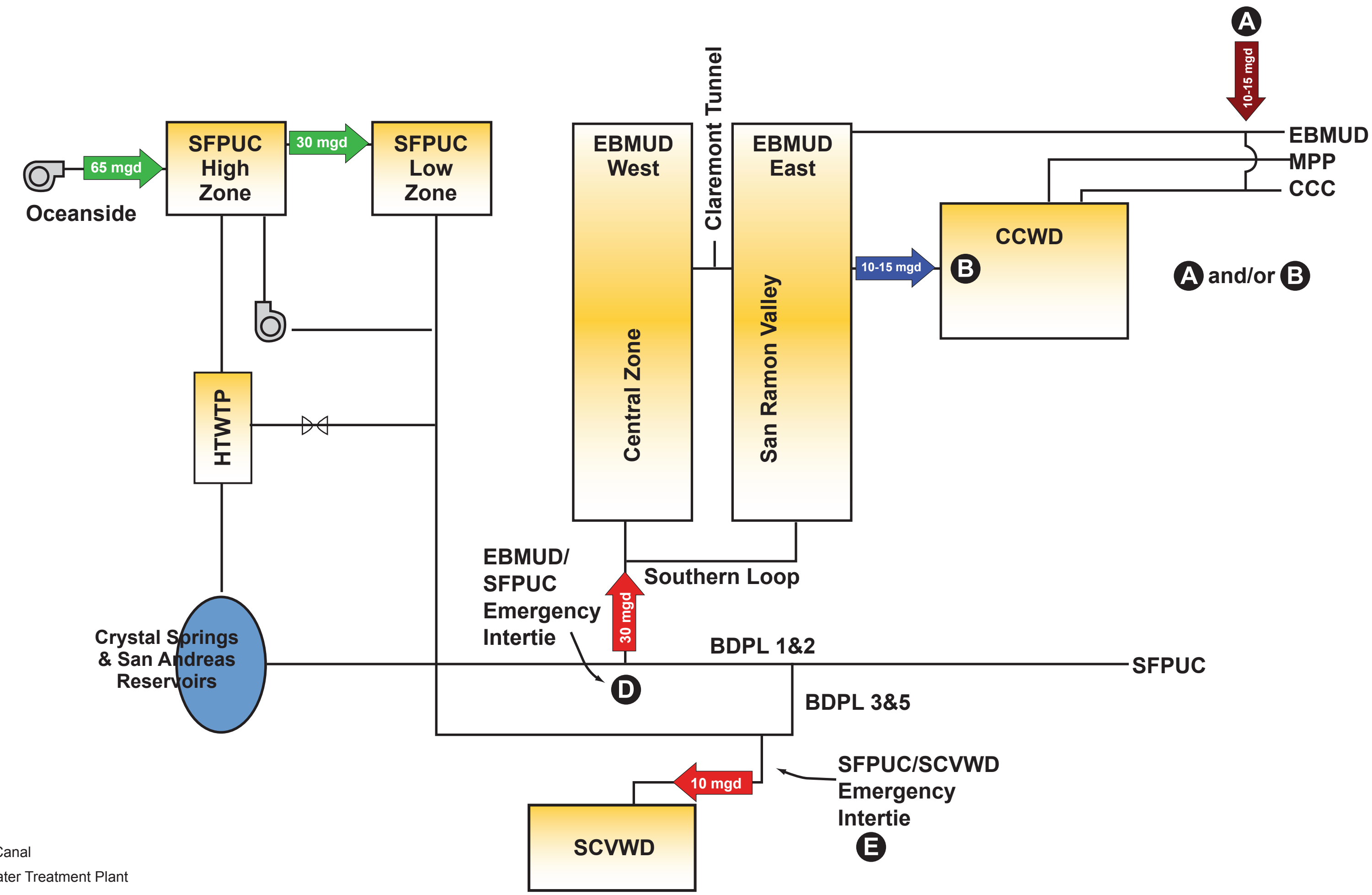
Bay Area Regional Desalination Project

Near Bay Bridge Site
Dry Year Conveyance Option 1

Figure 2-5

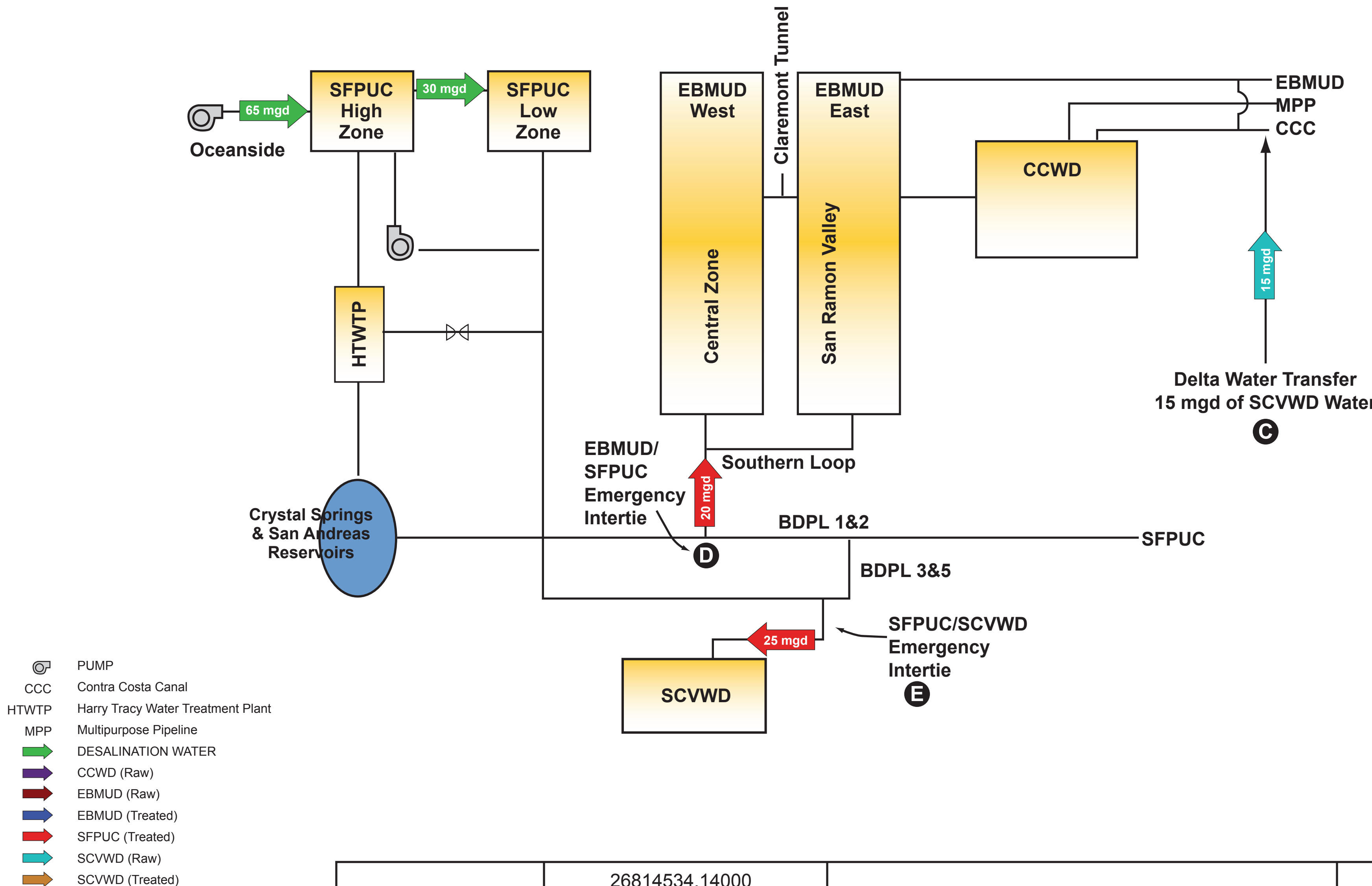


URS	26814534.14000 Bay Area Regional Desalination Project	Near Bay Bridge Site Dry Year Conveyance Option 2	Figure 2-6

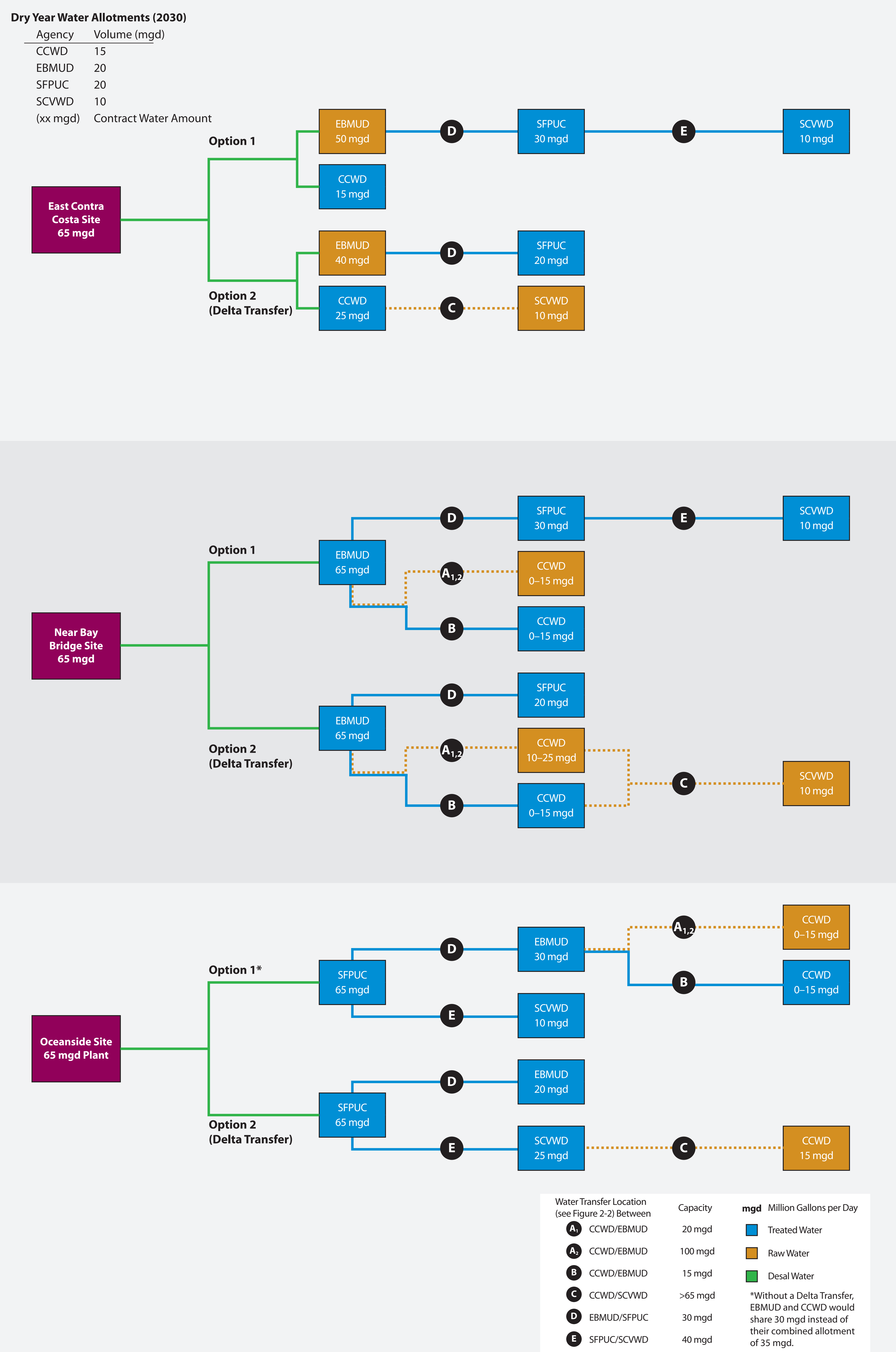


PUMP
CCC Contra Costa Canal
HTWTP Harry Tracy Water Treatment Plant
MPP Multipurpose Pipeline
DESALINATION WATER
CCWD (Raw)
EBMUD (Raw)
EBMUD (Treated)
SFPUC (Treated)
SCVWD (Raw)
SCVWD (Treated)

URS	26814534.14000 Bay Area Regional Desalination Project	Oceanside Site Dry Year Conveyance Option 1	Figure 2-7



URS	26814534.14000 Bay Area Regional Desalination Project	Oceanside Site Dry Year Conveyance Option 2	Figure 2-8



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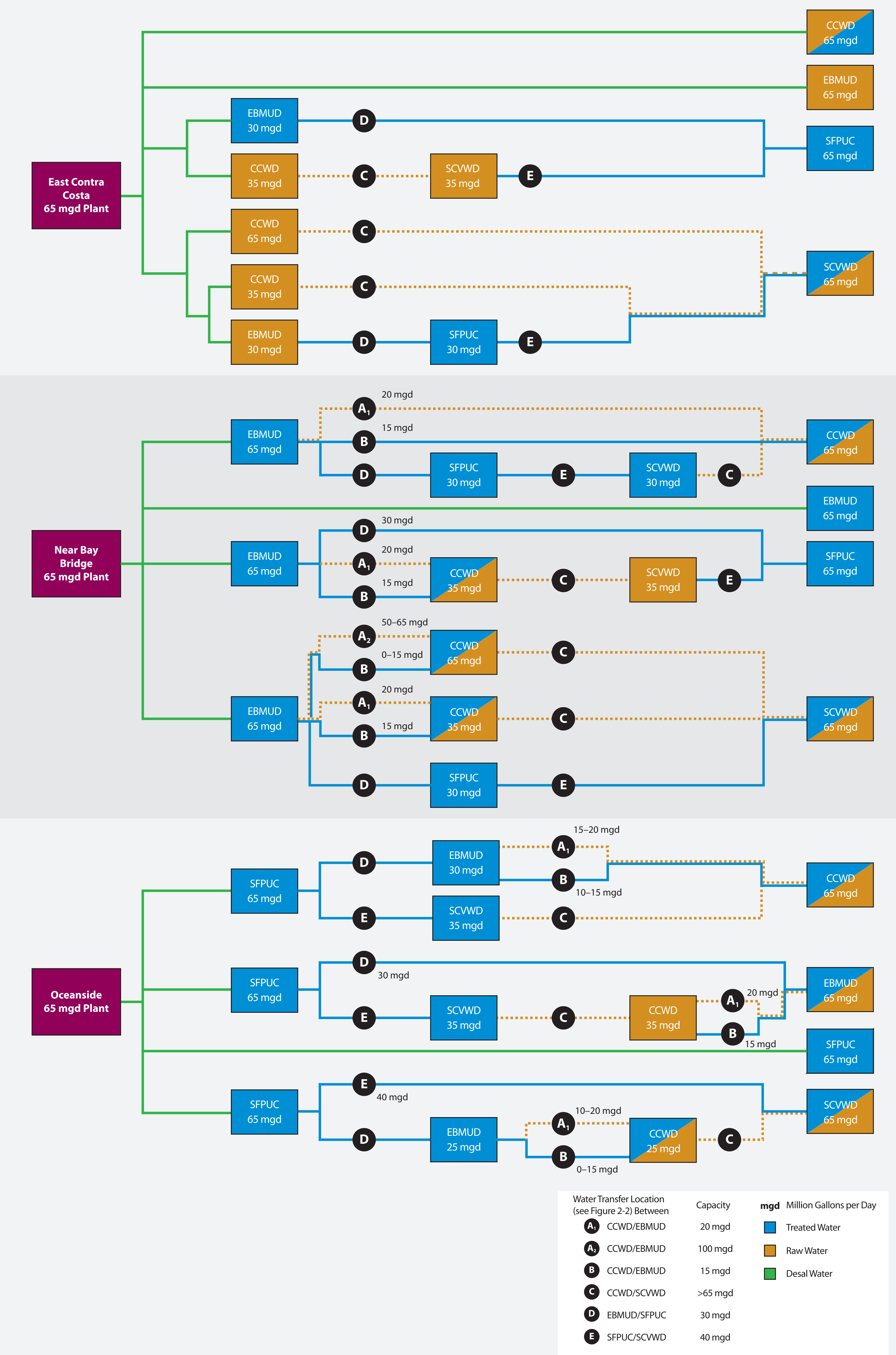
Bay Area Regional Desalination Project

DRY YEAR CONVEYANCE OPTIONS

FIGURE 2-9



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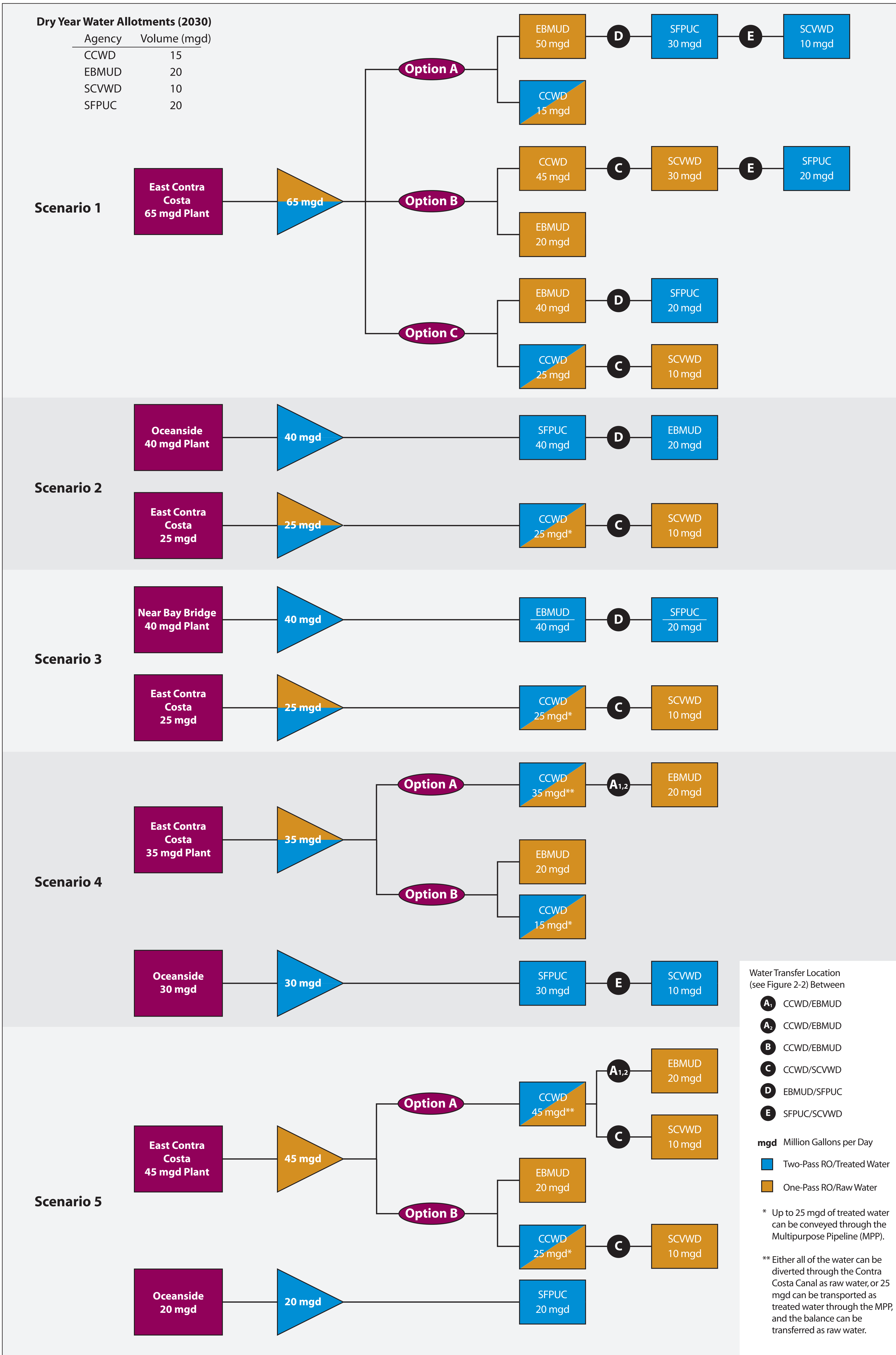
Bay Area Regional Desalination Project

EMERGENCY CONVEYANCE OPTIONS

FIGURE 2-10



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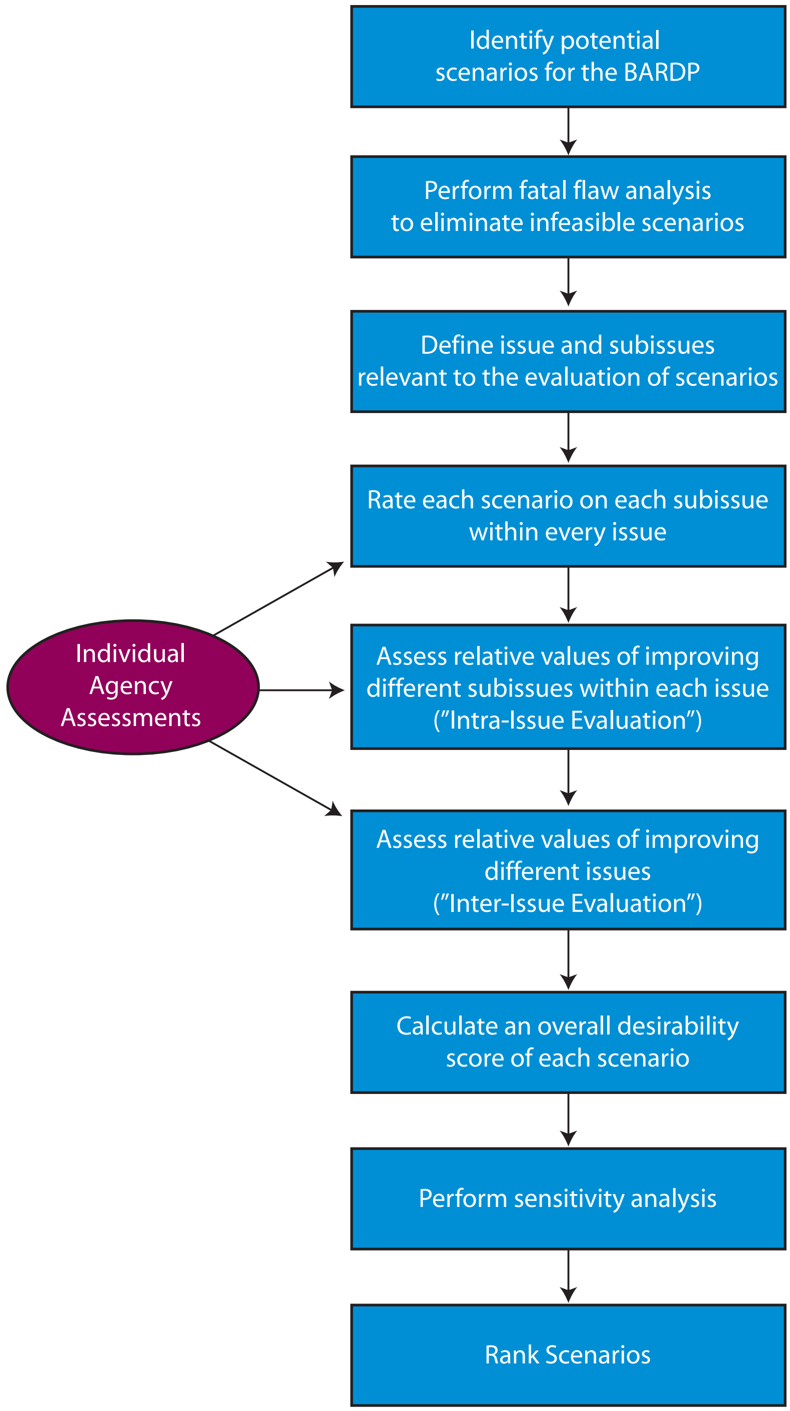
Bay Area Regional Desalination Project

PRODUCTION AND DISTRIBUTION SCENARIOS

FIGURE 2-11



URS	26814534.14000 Bay Area Regional Desalination Project	Flowchart of Scenario Evaluation Process	Figure 2-12

Assuming that desalination would serve as an alternative regional water supply during dry years and emergencies, an assessment was conducted to identify the optimum capacity and frequency of operation of a desalination plant based on individual agency needs. Each agency considered its projected demand, available alternative water sources, and its objectives for meeting demands. The assessment compared each agency's needs with the water supply record for the years 1920 to 2002 to identify years in which an additional reliable supply of water, if available, would have been used.

For the 83-year period analyzed, desalination water could have been used in 44 years (53 percent of the time), in amounts ranging from 10 mgd to the maximum predicted demand of 65 mgd.[1] In terms of capacity needed, a demand for 20 to 29 mgd occurred the most times during the analysis period (22 years), followed by 40 to 49 mgd (9 years) and 50 to 59 mgd (5 years). The analysis indicated that plant use would occur in "clusters" averaging 3.7 years followed by an average of 3 years of nonuse. The actual distribution of plant use was highly variable, with up to 11 consecutive years of use and up to 7 consecutive years of nonuse. Further, the plant would be used by one agency 52 percent of the time and by two agencies 30 percent of the time.

Based on these findings, risk and benefit-to-cost analyses were performed to determine the optimum plant capacity. The analyses identified an optimum plant capacity of approximately 40 mgd, which would have satisfied the agencies' water needs 61 percent of the time during the 1920 to 2002 period.

As discussed in Section 2, desalination would provide the partner agencies with an alternative regional water supply during dry years and emergencies. Potential desalination plant sites and conveyance options were evaluated and ranked based on an assumed total water demand of 65 mgd for the four agencies.[1] The next step was to examine how often a BARDP desalination plant would potentially be used and whether a plant capacity of 65 mgd or some lesser amount would be most practical to satisfy agency demands. This section describes the assessment conducted to identify the frequency of operation and optimum capacity of a plant based on individual agency needs.

3.1 APPROACH

Determining the optimum desalination plant capacity and frequency of operation requires analyzing how much desalination water is needed and when the water is needed.

The analysis was based on the individual needs of the partner agencies.[2] The agencies' water supply and demand characteristics vary greatly and are unique to each agency due to supply source, climate variations, population density, and types of users. Therefore, each agency evaluated its needs internally based on projected demand, available alternative water sources,

[1] The Feasibility Study was developed using a desalination need of 20 mgd for the SFPUC. As of November 2006, the SFPUC revised its desalination needs estimate from 20 mgd to 26 mgd, which is consistent with its other planning documents. As a result, the cumulative needs for all four agencies increased from 65 mgd to 71 mgd. Appendix D provides the latest revision of water needs estimates based on the November 2006 modifications to the SFPUC estimate.

[2] The CCWD, SFPUC, and SCVWD needs estimates were based on 2030 demand projections; the EBMUD estimate was based on 2020 demand projections.

and water supply objectives. The agencies identified both their annual desalination water needs for dry years and the criteria that would trigger such needs.

Next, by comparing these trigger criteria with the historic water supply record, the agencies identified the years in which an additional supply of water, if available, would have been used. The results of the historic review were extrapolated to cover the period from 1920 to 2002. For the purpose of this analysis, this approach assumes that the historic record will represent future hydrological conditions. In addition, it was assumed that if an agency needed water in a particular year, the agency would use its full allocation rather than a variable water supply based on actual need. By combining annual desalination water needs with needs criteria, a time series of total annual desalination supply (using the combined needs of the individual agencies) was developed and analyzed to determine the capacity and frequency of operation of the desalination plant.

By using the historical water supply record (1920–2002), this analysis does not account for potential climate change impacts, which are discussed in Section 8.

Finally, an optimization of the plant capacity (Appendix E) was performed based on two analyses: a risk criterion approach and a benefit-to-cost ratio approach.

3.2 ESTIMATE OF DESALINATION PLANT CAPACITY AND OPERATION

3.2.1 Desalination Needs Criteria

The needs criteria define the potential frequency of desalination plant operations. These criteria were developed assuming that desalination water would be used as supplemental supply during dry years only. Because emergencies cannot be predicted, emergency needs were not evaluated. As there are differences in demand and supply, each agency would use desalination water under somewhat different conditions. For example, not all agencies might consider a particular year dry. It was assumed that if an agency would have used desalination water in a particular year, that agency would have used its full allotment.

Table 3-1 summarizes each agency's needs criteria for determining when desalination supply would be used. As shown in the table, CCWD, EBMUD, and SCVWD would each use rationing before they would use desalination water. The SFPUC, on the other hand, would use desalination water before rationing, in some cases avoiding the need for rationing altogether. This difference in objectives is reflected in the number of times that agencies stated that they would have used desalination water based on the hydrological record analysis.

Table 3-1
Summary of Agency Criteria for Desalination Supply Use

Agency	Needs Criterion	Annual Desalination Water Needs
CCWD	According to CCWD staff, the district could potentially use desalination supply if projected 2030 demand could not be met with 15 percent rationing. CCWD indicated an average need for desalination supply of 15 mgd, if activated.	15 mgd
EBMUD	According to the EBMUD 2005 Urban Water Management Plan and feedback from agency staff, EBMUD would prepare a Drought Management Program and desalination supply would potentially be used in “moderate” (storage below 65 percent of total capacity) and “severe” droughts (storage reaches 50 percent of total capacity). EBMUD provided a time series of water needs based on its 2020 projection. EBMUD indicated an average need for desalination supply of 20 mgd.	20 mgd
SFPUC	The SFPUC has four levels of shortage—from Level 1 (initiate dry level supplies with no rationing) to Level 4 (supply is met with 20 percent rationing). The SFPUC indicated that it could potentially use desalination supply for any level of shortage, thereby avoiding a shortage in some years. The future demand for year 2030 is estimated at 300 mgd. The SFPUC indicated a demand for desalination supply of 20 mgd when needed.	20 mgd
SCVWD	For this analysis, it was assumed that SCVWD would consider activating desalination if yearly rainfall (based on San Jose precipitation data) was less than 70 percent of the yearly average (equivalent to less than 10 inches of precipitation) for two consecutive years. This 70 percent value was determined by comparing the historic water levels of SCVWD’s largest reservoirs to the precipitation data. This analysis indicated that it took at least 2 consecutive dry years to significantly lower the supply. To estimate long-term potential desalination needs, historic rainfall data from San Jose were used to approximate significant drought periods. SCVWD indicated an average need for desalination supply of 10 mgd if activated.	10 mgd

3.2.2 Desalination Supply Analysis

The results presented in this section were compiled from analyses performed by each agency. Only SCVWD’s yearly analysis was performed by the consultant based on the criteria described in Section 3.2.1. For the years 1996 through 2002, the San Joaquin Basin Index (an index categorizing the type of rainfall year based on river flow data) was used to evaluate the needs criteria for all agencies with the exception of SFPUC, which provided needs data based on modeling that assessed potential desalination needs over the 83-year period of record on a monthly basis. No dry years were identified for the period of 1996 through 2002.

Figure 3-1 illustrates the distribution of the total supply potentially needed for all agencies. The total desalination supply for a particular year is defined as the sum of the individual agencies’ needs for that year. The calculation assumes that the agencies would use their full allotment of desalination water every year it was needed.

Figure 3-1 Distribution of Desalination Supply Needed, 1920–2002

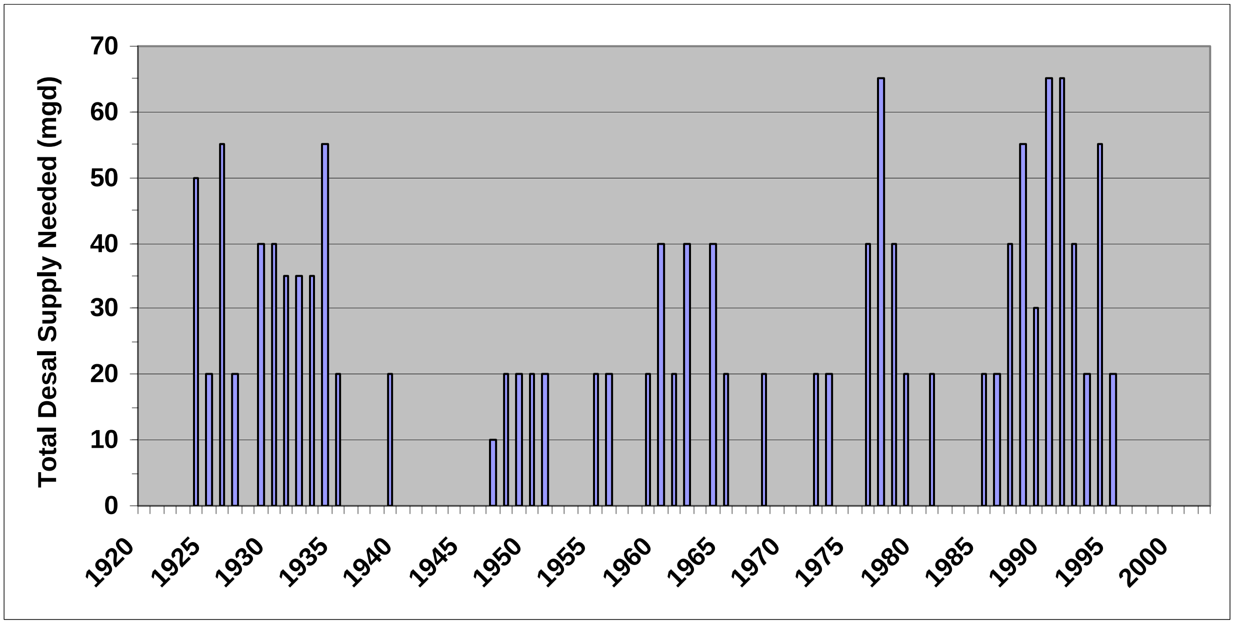


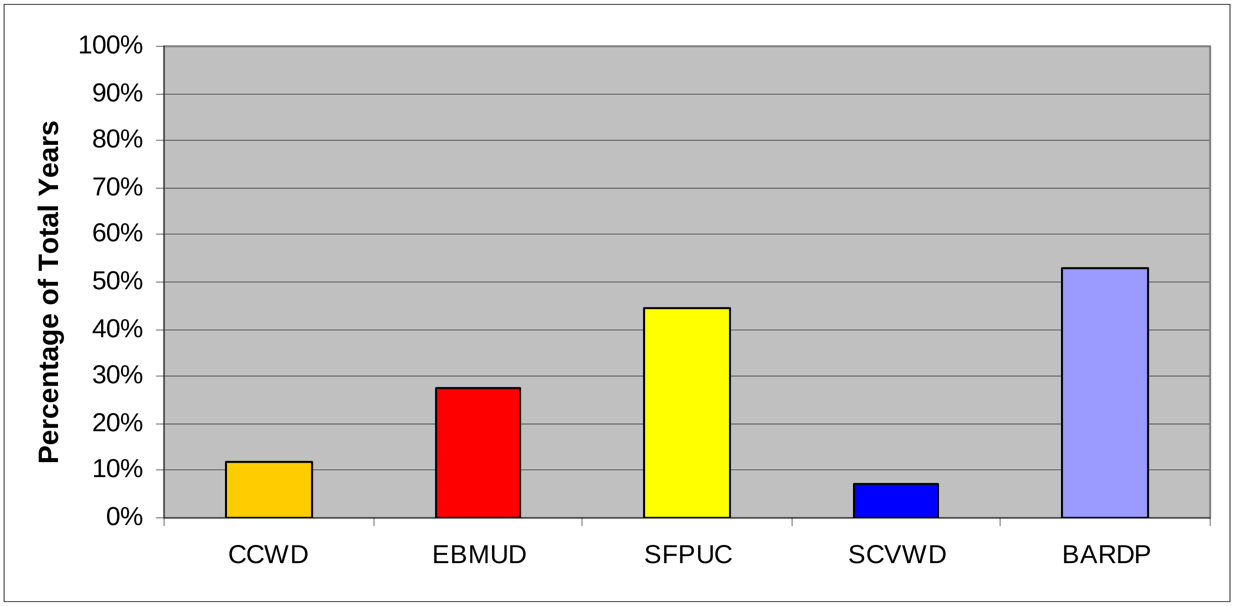
Table 3-2 and Figure 3-2 show the frequency of plant use from 1920 to 2002 based on the assumption that desalination product water would have been available to each agency as a water supply alternative. According to the analysis of needs and objectives of each agency, the BARDP desalination plant would have been used in 53 percent of the years (or 44 years). The SFPUC and EBMUD would have used desalination water the most frequently, in 45 percent and 28 percent of the years, respectively. This result reflects the SFPUC water supply objective of using desalination water before rationing.

Table 3-2
Summary of BARDP Desalination Plant Use, 1920–2002

Desalination Needs	CCWD	EBMUD	SFPUC	SCVWD	BARDP
Number of Years with Needs	10	23	37	6	44
Percent of Total Years with Needs	12%	28%	45%	7%	53%

Note: Based on CCWD, SFPUC, and SCVWD 2030 demand projections and EBMUD 2020 demand projections.

Figure 3-2 Needs for Desalination Water Supply, 1920–2002



Note: Based on CCWD, SFPUC, and SCVWD 2030 demand projections and EBMUD 2020 demand projections.

Table 3-3 quantifies the supplies that would have been needed for the 83-year period of 1920 to 2002. When desalination supply was needed, the plant would have operated 50 percent of the years to produce between 20 and 29 mgd, and 20 percent of the years to produce between 40 and 49 mgd.

Table 3-3
Distribution and Quantity of Annual Desalination Supply, 1920–2002

Total Annual Desalination Supply	Number of Years with Desalination Supply	Frequency of Desalination Supply (Percent of Years)	Frequency of Desalination Supply When Operating (Percent of Years with Desalination Supply)
0 mgd	39	47%	
10-19 mgd	1	1%	2%
20-29 mgd	22	27%	50%
30-39 mgd	4	5%	9%
40-49 mgd	9	11%	20%
50-59 mgd	5	6%	11%
> 60 mgd	3	4%	7%

Table 3-4 shows the agencies' plant usage patterns for the 83-year period of 1920 to 2002. The four agencies would have all needed desalination water in the same year for only 7 percent of the years of plant operation. During periods of operation, the plant would have supplied water to only one agency in 52 percent of the years and to two agencies in 30 percent of the years.

Table 3-4
Plant Usage by Agencies

No. of Agencies Using Desalination Plant	Number of Years of Operation	Percent of Years of Operation (when in use)
0	39	--
1	23	52%
2	13	30%
3	5	11%
4	3	7%

3.2.3 Findings

Although Table 3-2 and Figure 3-2 indicate that desalination supply could have been used 53 percent of the years over the 83-year period of record, it is important to note that the distribution of use would likely be in clusters of years. For example, the average length of time that the desalination plant would have been inactive is 3 years, and the average length of time that the plant would have been active is about 3.7 years. Therefore, the plant would not usually operate 1 out of every 2 years, as the 53 percent use rate would indicate, but would operate for several years at a time and then be inactive for several more years. Table 3-5 highlights some aspects of the analysis.

Table 3-5
Desalination Plant Operation Statistics, 1920–2002

Characteristic	Value
Maximum number of consecutive years using desalination	11
Maximum number of consecutive years not using desalination	7
Largest supply needed	65 mgd
Smallest supply needed	10 mgd
Average period of use	3.7 years
Average period of nonuse	3 years
Average supply needed if in use	32 mgd
Median supply needed if in use	20 mgd

Note: Based on CCWD, SFPUC, and SCVWD 2030 demand projections and EBMUD 2020 demand projections.

Although an 83-year period was used to assess the four agencies' needs for a desalination plant, the distribution of plant use throughout the period is extremely variable. In addition to the clustering of periods of plant use, there is extreme inconsistency over the longer term. For instance, in the 15-year period from 1920 to 1935, a desalination plant would have had a 69 percent use rate, while in the following 15-year period from 1936 to 1951, the use rate would have been only 38 percent (Figure 3-1).

3.2.4 Analysis of Optimal Plant Capacity

Two approaches were used to estimate the optimal plant capacity: a risk criterion approach and a benefit-to-cost ratio approach. Appendix E presents both analyses. The optimization was developed using the revised SFPUC desalination need of 26 mgd. As a result, the cumulative desalination needs for all four agencies increased from 65 mgd to 71 mgd.

The risk was defined as the probability of exceeding a specified gap between the cumulative water need in a dry year and the plant capacity. An estimate of that probability is the proportion of dry years in which the gap between the cumulative water need and the plant capacity would exceed a specified amount. Therefore, the analysis includes two components of risk: the risk of the desalination needs exceeding the plant capacity in a given year, and the risk of the needs exceeding the plant capacity too often. The risk analysis does not involve economics but rather serves as a tool to assist in policy decisions. For example, it can help define the plant capacity based on what is acceptable to the public and to the agencies. Therefore, if the maximum gap allowed in a dry year and the maximum probability of exceeding that gap are specified, a minimum plant capacity can be identified that meets both criteria. For example, if the maximum allowable gap is defined as 20 percent (that is, a shortage of 14.2 mgd) and the maximum percentage of dry years in which this gap is exceeded is defined as 10 percent (where a gap of more than 14.2 mgd would occur in no more than 10 percent of dry years), then the minimum plant capacity that would satisfy these two criteria would be 61 mgd.

The benefit-to-cost ratio approach involves economic analyses of the cost impact of water shortages in dry years and the plant capital costs. The approach identifies the optimal plant capacity by calculating the benefit-to-cost ratio. The "benefit" is the cost savings in future dry years from having a desalination plant of a certain capacity, and the "cost" is the capital cost of the desalination plant. The analysis identified an optimal plant capacity of approximately 40 mgd.

3.3 CONCLUSIONS

The following conclusions can be drawn from the plant capacity and operational assessment:

- The maximum desalination supply needed is 65 mgd, assuming that each agency takes no more and no less than its individual need during a dry year or a drought. For the 83 years analyzed, the maximum need (65 mgd) occurred three times. However, the analysis assumes that each agency would take its full allotment in dry years.
- The desalination plant would be used 52 percent of the time by only one agency and 30 percent of the time by two agencies.

- A smaller plant (less than 65 mgd) would not meet needs during the most critical droughts but would meet demand during moderate droughts when the need is less urgent.
- A 30 mgd plant capacity would meet the needs for desalination water 52 percent of the time.
- A 40 mgd plant capacity would meet the needs for desalination water 61 percent of the time.
- Plant use would occur in clusters; that is, there could be several sequential years of use followed by a long period of nonuse.

Based on these results and conclusions, an optimization of the desalination plant capacity was developed using a risk analysis and benefit-to-cost ratio analysis (Appendix E). The optimization analyses were developed using the revised SFPUC need of 26 mgd. The risk analysis shows that if the agencies are comfortable with accepting a level of risk of not meeting the demand in all dry years, the plant capacity could be reduced. The benefit-to-cost ratio analysis suggests that the optimal plant capacity would be approximately 40 mgd instead of equal to the revised cumulative needs of 71 mgd.

A preliminary design was developed to identify a practical process flow and associated components for a BARDP desalination plant based on the site, infrastructure, and operational options described in Sections 2 and 3. This section describes the desalination process and presents generic site layouts for two potential desalination plant configurations: a 20 mgd seawater reverse osmosis (SWRO) plant and a 65 mgd brackish water reverse osmosis (BWRO) plant. These configurations represent both the highest and lowest potential raw water salinity and the highest and lowest plant capacities considered in the various scenarios described in Sections 2 and 3. In addition, the 20 mgd SWRO plant was designed with a compact layout for a location where space is limited.

The RO desalination process used in the preliminary plant designs is described in terms of the equipment, facilities, and chemicals required to purify water to a quality that meets drinking water standards. Key equipment shown in the plant layout diagrams is illustrated with pictures and schematics to provide a clear overview of the desalination process flow.

Based on the assessment of site, infrastructure, and operational options described in Sections 2 and 3, a preliminary design was developed to identify a practical process flow and associated components for the proposed desalination plant(s). This section summarizes the various plant components and proposes facility layouts for two different feedwater types and plant capacities.

4.1 DESALINATION PROCESS OVERVIEW

4.1.1 Introduction

Desalination refers to any of several processes (such as reverse osmosis) that remove the excess salt and other minerals from water to obtain fresh water suitable for human consumption. This section describes the desalination process and presents generic site layouts for the proposed BARDP.

A site for the desalination plant has not yet been identified and could be any of the three top-ranked sites identified in Section 2.1. Two design options were chosen for preliminary design and layout:

- 20 mgd seawater reverse osmosis (SWRO) desalination plant, and
- 65 mgd brackish water reverse osmosis (BWRO) desalination plant.

These options were evaluated because they represent the highest and lowest potential raw water salinity as well as the highest and lowest plant capacities considered in the various scenarios described in Sections 2 and 3. A 20 mgd compact design layout for a space-constrained site was selected for the SWRO plant.

Technical drawings of both layouts are presented in Appendix F.

4.1.2 General Process Overview

For this preliminary design, the desalination process for the BARDP uses RO membranes to remove TDS from the seawater. RO membranes have pore sizes in the range of 0.0001 to 0.001

microns, which are small enough to remove most ions from the water. However, RO requires pretreatment of feedwater to protect the membranes from physical damage by particulates in the raw water, scaling (a process where ions such as barium and strontium that have a low saturation level precipitate on the membrane), or biofouling (caused by biological growth on the membrane). Ultrafiltration (UF) or microfiltration (MF) membranes were selected for pretreatment to the RO process for the following reasons:

- To provide a stable operation of the RO regardless of raw water turbidity,
- To reduce the number of RO units required (because the low-turbidity UF permeate allows for higher RO flux rates), and
- To reduce the total pretreatment chemical consumption.

UF membranes have larger pore sizes than RO membranes (in the range of 0.02 to 0.1 microns). UF membranes remove particulate matter in the molecular range such as colloidal silica, gelatins, precipitated molecules, viruses, bacteria, giardia, and cryptosporidium cysts. Due to the pore sizes, UF and MF membranes require 100- to 500-micron strainers upstream to protect them from physical damage. For this preliminary design, 100-micron self-cleaning strainers were selected, but the pore size could easily be increased depending on the source water and intake system.

The preliminary plant design consists of the following major process components:

- Raw water intake screening
- Raw water pumping
- Self-cleaning strainers
- Rapid mix/coagulation – inline induction mixers
- Flocculation
- UF submerged membranes (or MF under pressure—not shown in this preliminary design)
- RO membranes
- UF and RO membrane cleaning systems
- Sulfuric acid, sodium hydroxide, antiscalant, sodium bisulfite, and phosphate chemical feed systems
- Disinfection and chlorination
- Finished water storage/pumping

4.1.3 Typical Feedwater Chemistry

The chemical makeup of the feedwater to be purified affects the design of the pretreatment process, the RO process, and other components used in an RO desalination plant. Salinity, the salt content of water as expressed in total dissolved solids (TDS), is a key parameter to consider. To determine the highest and lowest potential raw water salinity that the 20 mgd SWRO plant and the 65 mgd BWRO plant would have to accommodate, water quality data for the Oceanside and East Contra Costa sites were used.

Feedwater composition varies substantially for the Oceanside and East Contra Costa sites, ranging from seawater with a TDS level of 35,000 mg/L at the Oceanside site to brackish water with 70 to 7,300 mg/L of TDS at the East Contra Costa site.

It must be noted that data for some important parameters in the design of an RO system, such as calcium, chloride, barium, strontium, turbidity, and silica, were not available for both sites.

Ocean water quality data for a limited number of parameters were provided for the Oceanside site. The data were collected below surface level at approximately 4 miles offshore. Default ocean water composition was used to estimate values for other parameters to assess raw water quality at the sites that would be using ocean water. Water quality data for the Oceanside site are presented in Table 4-1.

Raw water quality data for 1996 to 2000 for Mallard Slough near the East Contra Costa site were provided by the CCWD and are summarized in Table 4-2. The original data, presented in the form of five annual tables, presented monthly data and annual averages for each parameter without specifying the number of samples that were taken each month. Table 4-2 presents the maximum and minimum values found over the 5-year period as well as the 5-year average for each parameter.

Water quality data in Mallard Slough exhibit very high variability because of the wide range of Delta outflows and seawater intrusion during low Delta outflows. When outflows are high, brackish water is pushed back into San Pablo Bay, causing the water quality at Mallard Slough to be close to that of the Sacramento River.

High seasonal variability exists, and Delta water generally presents low salinity during the winter and higher salinity in the fall. TDS levels measured from 1997 to 2005 ranged from 70 mg/L to 7,300 mg/L, with levels in June through December typically greater than 1,000 mg/L.

Table 4-1
Water Quality Summary for the Oceanside Site (Based on Typical Seawater Composition)

Parameter	Unit	Concentration in Seawater
Sodium	mg/L	10,765
Potassium	mg/L	398
Calcium	mg/L	412
Magnesium	mg/L	1,275
Strontium	mg/L	7.9
Barium	mg/L	0.014
Lithium	mg/L	0.17
Silicon	mg/L	2.8
Aluminum	mg/L	$5.4x10^{-4}$
Iron	mg/L	$6x10^{-5}$
Manganese	mg/L	$3x10^{-5}$
Boron	mg/L	4.6
Chloride	mg/L	19,385
Sulfate	mg/L	900*
Bromide	mg/L	67
Ammonia**	mg/L	<0.05
Total Suspended Solids**	g/L	8.8
Oil and grease**	mg/L	<5
DOX	mg/L	7.95
Temperature**	Celsius	11.6
pH**	pH units	8.03
TDS	mg/L	35,000

Notes:

Typical seawater concentration estimated from Bruland (1983).

* Value is for sulfur

Table 4-2
Water Quality Summary for Mallard Slough, 1996–2000

Contaminant	Units	Maximum	Minimum	Average
Turbidity	NTU	146	4	24
Calcium	mg/L	276	4	35
Magnesium	mg/L	190	6	79
Sodium	mg/L	1,600	10	595
Chloride	mg/L	**3,100**	13	776
Potassium	mg/L	200	1	20
Sulfate	mg/L	420	10	152
Nitrate	mg/L	3.7	0.2	1.6
Phosphate	mg/L	3.4	<0.2	0.3
Silica	mg/L	23	13	17
Hardness	mg/L	**960**	36	**295**
pH	–	8.4	6.2	7.7
Alkalinity	mg/L	82	22	62
Conductivity	µmhos/cm	9,550	130	2,792
TDS	mg/L	**5,737**	70	2,138
Ammonia	mg/L	0.25	<0.1	0.1
TOC	mg/L	5.7	0.5	2.7

NTU = Nephelometric turbidity units
µmhos/cm = Micromhos per centimeter

4.1.4 20 mgd SWRO Process Flow Description

Technical Drawings 1 through 6 in Appendix F show a preliminary design of a compact 20 mgd desalination plant that could be constructed on a long, narrow site to minimize property costs. The building consists of three levels (including the basement) and is approximately 312 feet long by 60 feet wide (approximately 0.4 acre). The site is approximately 435 feet long by 120 feet wide (approximately 1.2 acre). The drawings illustrate the following:

- Drawing 1 shows the process flow schematic, including the number and size of each piece of equipment.
- Drawing 2 shows a preliminary site layout.
- Drawings 3 and 3A show two variations of the ground floor building layout. Drawing 3A shows a smaller flocculation system (8 minutes versus 10 minutes detention time) that allows the self-cleaning strainers to be installed on the first floor instead of the second floor.
- Drawing 4 and 4A show two variations of the basement layout that correspond with Drawings 3 and 3A.

- Drawings 5 and 5A show two variations of the second floor layout. Drawing 5A shows the second floor without the self-cleaning strainers.
- Drawing 6 shows a conceptual section through the building at the submerged UF tanks.

The process starts at the raw water intake system, which consists of submerged passive intake screens or collector wells near the beach that would supply water to the treatment plant with a minimal amount of solids and debris. This portion of the system is not shown to be on the desalination plant site. If collector wells were to be used, the raw water intake pumps would be part of the collector well and could be removed from the building layout to save space. Chlorine (or another oxidant) and acid can be injected in the raw water line as needed for process control. The raw water would typically be monitored for pressure, pH, oxidation-reduction potential (ORP), turbidity, conductivity, temperature, flow, and dissolved oxygen.

The raw water intake pumps push the water through the self-cleaning strainers and the rapid mix system where a chemical coagulant is added. The next process is flocculation in open tanks. Eight separate flocculation tanks are shown in Drawing 3, and six tanks are shown in Drawing 3A. The number of tanks required will be determined after pilot testing, as the number relates to the detention time needed for a floc of the appropriate size to form and depends on water quality and temperature. This is an important step in removing organics and color from the water.

The flow enters the UF membrane tanks through a gravity channel, and the permeate is drawn out by vacuum pumps. An air scour and backpulsing system is used to keep the membranes clean and extend the time between chemical cleanings. Sodium bisulfite must be added to remove any oxidizing agents prior to the flow reaching the RO membranes. The pretreated raw water would typically be monitored for chlorine residual, sodium bisulfite, pH, particulates, turbidity, conductivity, Silt Density Index (SDI) (at each membrane array), and ORP.

If chlorine is detected in the line upstream of the RO feed pumps, valves open and close to bypass the flow to the pretreated water dump to prevent damage to the membrane elements. Otherwise, the pretreated water is dosed with a liquid scale inhibitor (antiscalant) and then flows to the RO feed pumps, where the pressure is raised to the level required to drive the desalination process. An energy recovery turbine would be employed to recover the wasted energy in the concentrate flow stream and reduce electrical consumption. The permeate water would typically be monitored for pH (before and after sodium hydroxide injection), conductivity (before sodium hydroxide injection), pressure, and flow.

The RO permeate is very pure water and free of pathogens; however, it would be injected with chloramines to provide a residual in the distribution system. Next, sodium hydroxide is added for alkalinity and pH recovery and for corrosion control. An ortho-phosphate may be needed to help protect against corrosion and pitting of the pipes in the distribution system. The final step is to provide a minimum of 0.5 hours of detention time in a clearwell prior to entering the distribution system. Depending on the type of clearwell, the relative elevation, and proximity to the distribution system, high-service pumps may be required to deliver the final product. For this conceptual design, an elevated storage tank was assumed to take advantage of the pressure in the permeate and reduce energy consumption of high-service pumps, if needed. High-service pumps are not shown in the process flow schematic or preliminary site layouts. The clearwell storage tank(s) were assumed to be off-site for this preliminary design since the RO system can be designed to provide enough pressure in the permeate to "pump" it to another site for storage and/or high-service pumping. The finished water would typically be monitored for flow, pH (before and after sodium hydroxide injection), turbidity, chlorine residue, pressure, and conductivity.

4.1.4.1 Waste Streams

The following waste streams would be generated and a plan developed for their disposal:

- Backwash waste from the self-cleaning strainers, consisting of a high concentration of total suspended solids (TSS).
- UF retentate consisting of a high concentration of smaller species of TSS as well as viruses, bacteria, and other pathogens.
- RO concentrate consisting of a high concentration of TDS as well as some viruses, bacteria, and other pathogens.
- Clean-in-place chemicals for both UF and RO membranes, consisting of neutralized acids and bases.

4.1.4.2 Site Work

Asphalt or concrete pavement should be used for chemical delivery driveways, and concrete pavement should be used at chemical unloading locations. Curbing will be provided unless indicated otherwise. Disabled parking will be provided.

4.1.4.3 Controls/Security

The plant would be controlled by a sophisticated Supervisory Control and Data Acquisition (SCADA) system. This computer-controlled system would allow monitoring and control of unit processes from both a main control room and at local control stations. Exterior lighting would be provided as needed for safety and security purposes. Door switches and motion detectors would be installed where applicable.

4.1.5 65 mgd BWRO Process Flow Description

The 65 mgd BWRO system would be similar to the 20 mgd SWRO except that dissolved air floatation or other high-rate pretreatment process may be required due to water quality issues such as algae and higher levels of TOC. It was assumed that the BWRO plant site does not have the same space constraints as the SWRO plant site; therefore, the clearwell storage and high-service pumping system are assumed to be on the same site as the desalination plant.

The clearwell could be in the form of elevated storage tanks, standpipes, or buried concrete tanks. For this design, the clearwell was assumed to consist of standpipes with a total storage capacity of 10 million gallons, which is 3.69 hours of detention time. Actual system needs may require more storage for various reasons.

Also, due to the size of the plant, intermediate storage of the UF permeate was added to provide more flexibility and easier process control. However, this necessitates the use of 0.5 micron cartridge filters upstream of the RO membranes as a precautionary measure and an additional set of pumps to pump through the cartridge filters. Section 4.2 provides a more detailed description of the equipment components for the proposed desalination facility.

The 65 mgd BWRO plant is illustrated in the following technical drawings, which are included in Appendix F:

- Drawing 7 shows the process flow schematic detailing the number and size of each piece of equipment.
- Drawing 8 shows a preliminary site layout.
- Drawing 9 shows the raw water intake pump building.
- Drawing 10 shows the self-cleaning strainer building.
- Drawing 11 shows the flocculation and dissolved air floatation facilities.
- Drawing 12 shows the UF building.
- Drawing 12S shows a section of the UF system.
- Drawing 13 shows the RO treatment building.

Detailed layouts were not provided for the high-service pump building, administration building, or sludge-handling facilities (belt filter press building, sludge thickeners, and sludge storage pad).

4.2 DESALINATION FACILITY COMPONENTS

This section presents an overview of the components needed for the RO desalination process.

4.2.1 Raw Water Intake

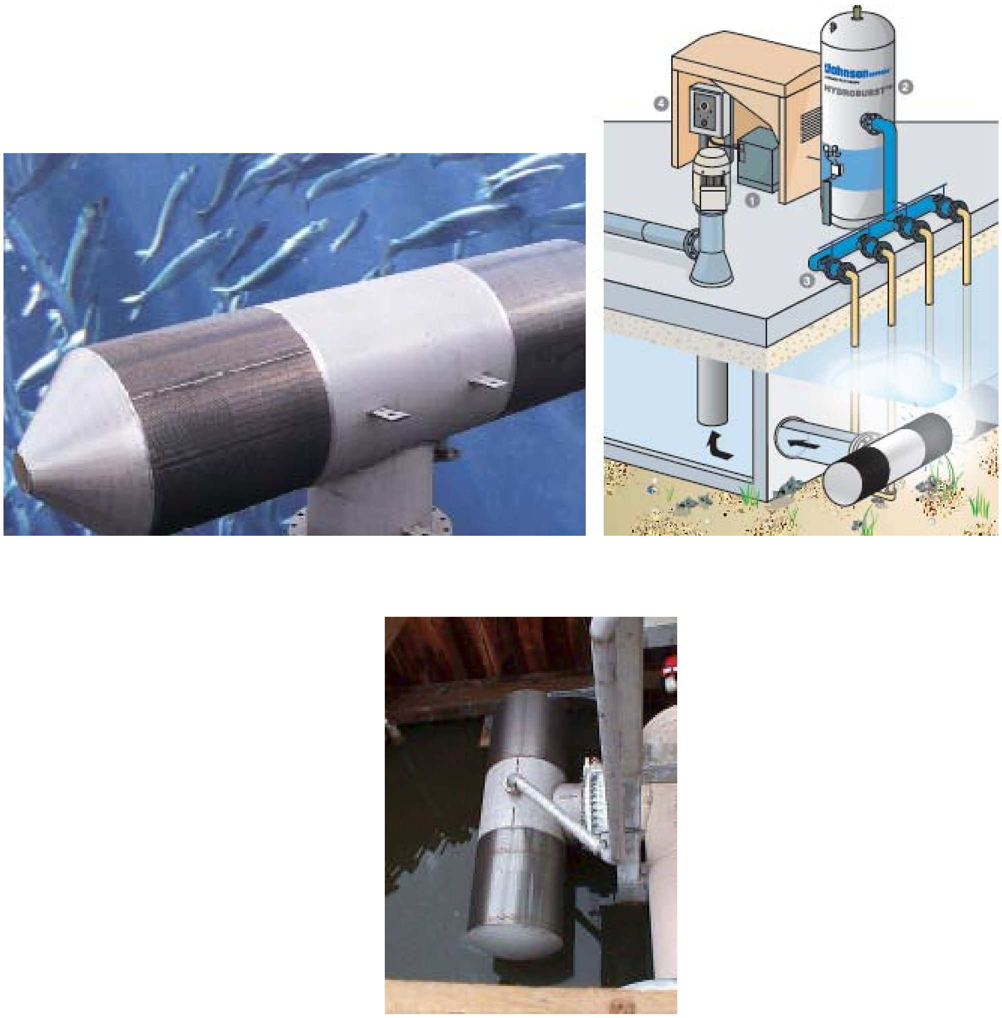
Many different types of screening devices are available for raw water intakes. The two best systems are the passive wedgewire/air backwash system and the beach collector well system because they do not collect screenings. Collection of the screenings would generate a waste stream that would require disposal in a landfill, by incineration, or as required by local authorities.

4.2.1.1 Passive Wedgewire Screen

Passive wedgewire screens could be used for the intake structure for both the SWRO and BWRO facilities. Examples of these screens are shown in Figure 4-1. The screen openings would be 3/32-inch or smaller to satisfy regulatory agency requirements. The screen diameter would likely be 48 inches with a 36-inch outlet. The screens would be fabricated from corrosion-resistant materials and would be designed to prevent biofouling. The screen length is typically 150 inches. A guide rail system for removing the screens would be provided. When clean, each screen can filter up to 6.9 mgd.

A compressed air backwash system would be provided for the screens. A compressed air system would be needed, including an air compressor, receiver, intake filter, and air dryer. A control system would be used to properly sequence the air backwash operation.

Figure 4-1 Passive Wedgewire Screens



Source: Johnson Screens and Cook Legacy. This product is presented as an example; equivalent products are acceptable.

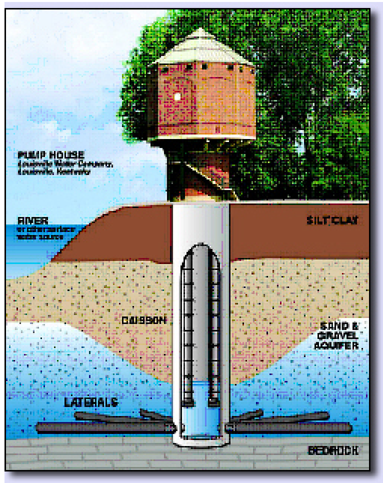
4.2.1.2 Collector Well System

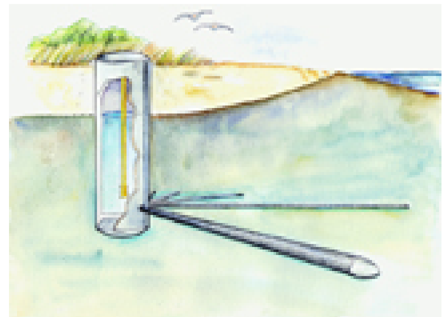
This system is designed to use the natural sand deposits along the coast to pre-filter the intake water. Sometimes referred to as Ranney wells, radial wells, or horizontal collector wells, these wells consists of large-diameter caissons (10 to 16 feet in diameter) with well screens extending outward in a radial direction from the caisson beneath the ocean or Bay. Figure 4-2 provides examples of collector wells.

The caisson serves as the suction well or wet well for the raw water intake pumps and allows for periodic inspection and maintenance of the well screens (performed by trained divers). Because collector wells provide some natural filtering, the size of the openings in the self-cleaning strainers could possibly be increased from 100 microns to 300 or 500 microns.

Natural sand deposits that are too fine-grained could clog the screen; therefore, an artificial gravel pack would be installed around the screen. The screen can be constructed of stainless steel, plastic, steel alloy, or fiberglass, depending on the water chemistry.

Figure 4-2 Collector Wells





Source: Collector Wells International. This product is presented as an example; equivalent products are acceptable.

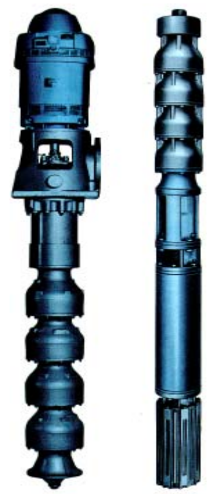
4.2.2 Intake Pumps

Because a site location has not yet been determined, it was assumed that the intake pumps would be located on the same site and, for the SWRO design, in the same building due to the footprint minimization requirements.

Vertical turbine centrifugal pumps were selected for this application for their high efficiency, small footprint, and simple piping arrangement. Figure 4-3 shows examples of vertical and submersible turbine pumps. The pump system can have multiple stages if needed. The motor is located on the first floor, and the pump (connected by a drive shaft) is located in the suction well below. The pump discharge is directed upward and perpendicular to the motor axis.

The same style of vertical turbine pumps could be used if a collector well system is selected. The pumps could either be housed in a separate building above the well, or submersible turbine pumps could be used if aesthetic reasons, flood issues, or other local codes prevent housing the pumps in a building.

Figure 4-3 Vertical Turbine Pump (left) and Submersible Turbine Pump (right)



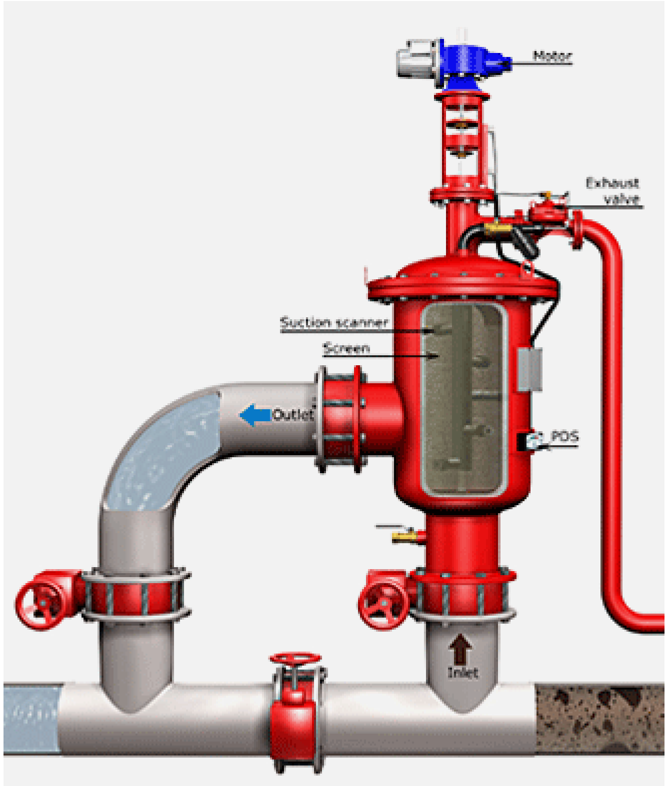
Source: Peerless. This product is presented as an example; equivalent products are acceptable.

4.2.3 Self-Cleaning Strainers

Self-cleaning strainers can be constructed of stainless steel or rubber-lined carbon steel (or cast iron). Rubber-lined carbon steel is recommended as an economical corrosion-resistant solution, and carbon steel would weigh less than cast iron. This is important because in the Oceanside preliminary design layout these units are located on the second floor. All internal elements, including the wire mesh screen, need to be made from corrosion-resistant materials.

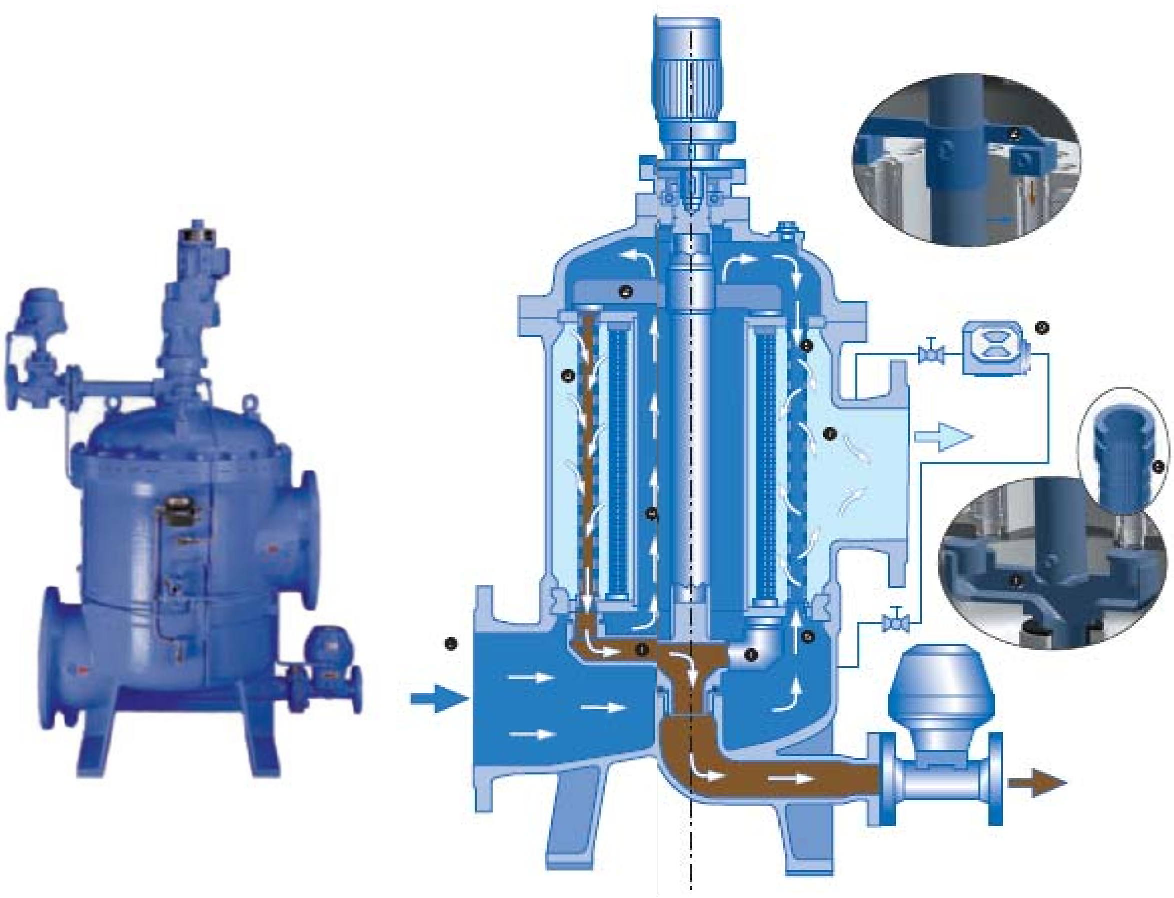
Backwashing can be controlled automatically by the differential pressure across the screens or continuously in small sections. Examples of self-cleaning strainers are illustrated in Figures 4-4 and 4-5.

Figure 4-4 Self-Cleaning Strainer Type I



Source: Amiad. This product is presented as an example; equivalent products are acceptable.

Figure 4-5 Self-Cleaning Strainer Type II



Source: Bollfilter. This product is presented as an example; equivalent products are acceptable.

4.2.4 Rapid Mix / Coagulation

Alum, ferric or ferrous chloride, and/or a polymer is added to water to form tiny sticky particles called floc that attract the dirt particles, which form larger particles that can be filtered out by the UF step that follows. The chemicals must be added and mixed quickly and be thoroughly dispersed to be effective, especially when using the UF membranes.

The type of mixer selected is referred to as an inline induction type, which is illustrated in Figure 4-6.

Figure 4-6 Inline Induction Mixer

Source: US Filter. This product is presented as an example; equivalent products are acceptable.

4.2.5 Flocculation / Dissolved Air Floatation

Flocculant settling refers to a dilute suspension of particles that coalesce, or flocculate, during the sedimentation operation. As coalescence or flocculation occurs, the particles increase in mass and settle at a faster rate. The amount of flocculation that occurs depends on the opportunity for contact, which varies with the overflow rate, the depth of the basin, the velocity gradients in the system, the concentration of particles, and the range of particle sizes. The effects of these variables can only be accomplished by pilot testing. Flocculation can take between 5 to 10 minutes when followed by UF. Longer detention times are required for conventional clarification/sedimentation processes.

For this preliminary design, two layouts were developed for the 20 mgd SWRO desalination plant. Layout 1 was designed using a detention time of approximately 10 minutes with 8 flocculators. Layout 2 was developed using a detention time of approximately 7 minutes, which resulted in 6 flocculators. A detention time of 5 minutes was used for the 65 mgd BWRO desalination plant at the East Contra Costa site. A typical vertical paddle flocculator is shown in Figure 4-7.

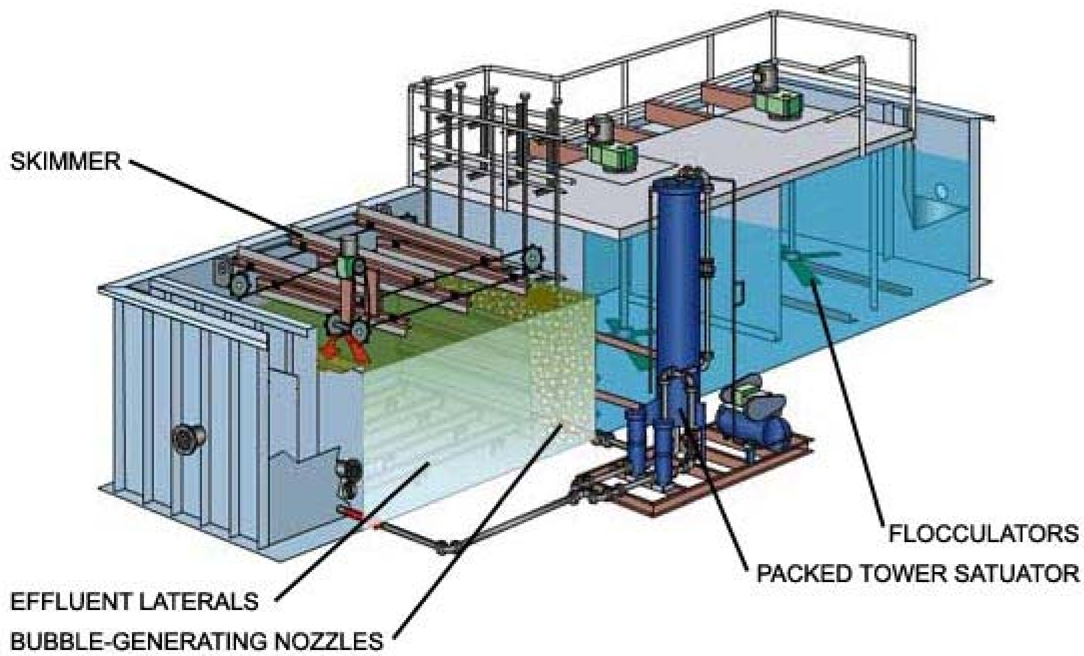
Figure 4-7 Typical Vertical Paddle Flocculator

Source: Amwell. This product is presented as an example; equivalent products are acceptable.

Depending on the outcome of the pilot testing, flocculation may not be sufficient; therefore, dissolved air floatation (DAF) may also be tested and used in the full-scale plant if needed. If large amounts of organics or algae are found in the ocean or Bay intake, then DAF may be required.

DAF systems dissolve air into water under pressure and then inject it into an open tank where the air is released into millions of tiny microbubbles approximately 30 to 100 microns in diameter, which then collide with and entrap the floc particles as they rise to the surface. The scum that accumulates at the surface is collected for disposal, and clear effluent water is removed from the bottom of the tank and flows by gravity into the submerged UF membrane tanks. The surface area required for DAF varies depending on the manufacturer and water quality. The requirements range from 4 gallons per minute per square foot (gpm/sf) to 20 gpm/sf. The preliminary design was based on a system by F.B. Leopold, at 20 gpm/sf. Figure 4-8 illustrates a typical DAF system.

Figure 4-8 Typical Vertical DAF Equipment



Source: Leopold. This product is presented as an example; equivalent products are acceptable.

The benefits of this DAF system are as follows:

- High loading rates (up to 20 gpm/sf)
- Reduced chemical consumption (formation of large, rapidly settling floc is not required, reducing cost)
- High sludge concentrations (dewatering can occur without additional thickening, eliminating expensive sludge thickeners)
- Rapid start-up (good-quality water can be produced within 45 minutes of start-up)
- Compact design (requires less space than conventional processes)

4.2.6 Ultrafiltration Submerged Membranes

UF membranes are the preferred pretreatment choice for RO systems. They produce reliable, superior-quality feedwater that ensures stable, long-term RO performance even if the quality of the raw water changes. Conventional pretreatment systems are typically complex, use large quantities of chemicals, and produce highly variable water quality. UF systems are compact, highly automated, and simple to maintain. In addition, UF systems use significantly fewer chemicals.

Possible UF membrane systems that could be used are Zenon's ZeeWeed 1000, Pall's Aria System, or an equivalent. The preliminary layouts provided in this report were developed using the Zenon system, which is the more compact of the two systems. Each system is described in the following sections.

4.2.6.1 ZeeWeed 1000

Typical treated water results are as follows:

- Turbidity < 0.1 nephelometric turbidity units (NTU)
- Bacteria > 4 log removal
- Giardia cysts > 4 log removal
- Cryptosporidium oocysts > 4 log removal
- Virus rejection > 4 log
- SDI < 2

The ZeeWeed 1000 UF membrane would:

- Supply high-quality feed water to the RO system regardless of raw water turbidity and ensures that the RO system continuously operates at peak performance
- Extend the life of the RO membranes and reduces maintenance and replacement frequency
- Increase the efficiency of the RO membranes, minimize RO system size, and reduce capital construction costs due to higher RO flux
- Lower chemical requirements for pretreatment and cleaning chemicals

Figure 4-9 illustrates the components of the Zenon UF modular cassette system.

Figure 4-9 Ultrafiltration System Type I

Source: Zenon. This product is presented as an example; equivalent products are acceptable.

In the ZeeWeed treatment process tanks, individual membrane modules are combined to form cassettes. Filtration is achieved by drawing water to the inside of the membrane fiber under low vacuum pressure. The treated water (permeate) is conveyed to the main permeate collection pipes. The unsupported ZeeWeed 1000 Series membrane use “Outside-In” flow through a hollow-fiber membrane that has nominal and absolute pore sizes of 0.02 and 0.1 microns, respectively. The flux rate for Zenon UF varies from 20 to 35 gfd (water throughput per square foot of membrane area per day).

The small pore size excludes particulate matter including solids, bacteria, pathogens and certain viruses. ZeeWeed 1000 series membranes are horizontally oriented within the membrane cassette and have a significantly higher module packing density. This membrane is being applied successfully in a variety of applications and demonstrates superior performance in applications with low solid feed water quality.

The membrane surface is kept clean though intermittent aeration and membrane back-pulsing. Diffused air is introduced from the bottom of the membrane module during back-pulsing and travels along the membrane surface, scouring solids away from the surface. At pre-set time intervals, the membranes are back-pulsed. This is accomplished by briefly reversing the flow of permeate through the membrane to remove any particles that may have obstructed the pores during membrane operation.

In addition to particulate (turbidity) and pathogen removal, ZeeWeed water treatment systems are effective at removing color, TOC, and dissolved organic carbon (DOC) when combined with coagulant addition. Ultrafiltration, with coagulant addition, combines immersed membrane technology with rapid mix, coagulation, and flocculation steps. The addition of coagulant allows for dissolved organic particles that would have otherwise passed through the membranes to be adsorbed onto and enmeshed in the floc. Unlike a conventional system, ZeeWeed membranes do not require clarification upstream of the membranes. Solids removal is accomplished in a single process tank containing the UF membranes. Coagulant is injected into the feedwater to allow the formation of pin-sized floc particles that only need to be larger than the membrane pores for removal by the membranes. Typical flocculation times are 5 to 10 minutes depending on the coagulant selected and source water quality and temperature. ZeeWeed membranes are compatible with a wide range of coagulants.

4.2.6.2 Pall Aria System

The Pall Aria system uses 0.1 micron rated polyvinylidine fluoride membranes to remove even the finest particles from the water. Unlike the ZeeWeed system, the Aria is not submerged in an open tank but rather enclosed in a pressure vessel as shown in Figure 4-10.

The Pall Aria system when used as a salt water pretreatment provides feedwater to the RO system with an SDI of approximately 1.5, a recovery rate of up to 50 percent for combined UF and RO, and a membrane flux of between 59 and 82 gfd. To maintain optimal performance, it is recommended that the system is cleaned in place monthly using sodium hydroxide and chlorine followed by acid. This Pall system is classified as MF instead of UF; however, UF sizes are also available. Even though the Aria system has higher flux rates, it may still require more space. This should be investigated during the piloting and detailed design phases.

Figure 4-10 Ultrafiltration System Type II

Source: Pall. This product is presented as an example; equivalent products are acceptable.

4.2.7 Reverse Osmosis Desalination

4.2.7.1 Purposes and Principles of Operation

The RO treatment system is a process for purifying water to a quality that meets drinking water standards. The system is designed to remove dissolved solids from the pretreated raw water for the purpose of desalination.

The RO design is based on a flux rate of 9 gfd with six standard 8-inch-diameter by 40-inch-long membrane elements, and a recovery rate of 50 percent. Newer, larger membrane elements are now available (18 inches in diameter by 61 inches long) that offer considerable space savings, which may be investigated further as the design progresses.

The arrays are arranged to operate in parallel, allowing the operator to remove one or several from service while the remaining arrays remain in service, allowing continuous operation of the treatment plant. The RO feed pumps pressurize the pretreated raw water to force the water through the membranes. The membranes separate the feedwater into two streams: permeate and concentrate. Permeate is water that has passed through the membranes and contains lower dissolved solids than the feedwater. Concentrate is water that does not pass through the membrane and therefore contains higher dissolved solids than the feedwater.

The concentrate will be returned to the ocean or Bay, far enough from the shore to provide sufficient dilution. The permeate will be chlorinated, stabilized with sodium hydroxide, and stored in the clearwells before being sent to the distribution system. Typical RO arrays for desalination are shown in Figure 4-11.

Figure 4-11 Typical Desalination RO Arrays

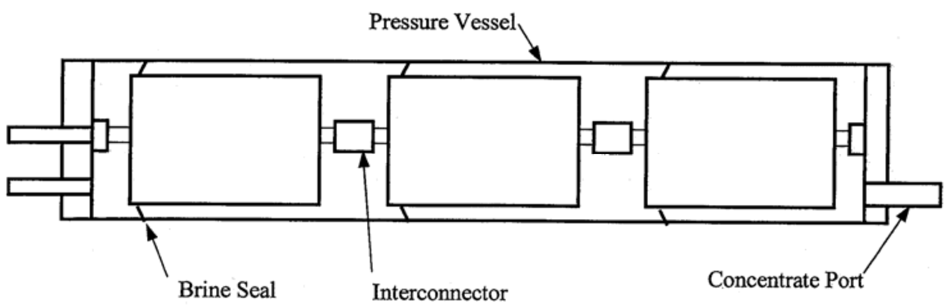
4.2.7.2 RO Array Components

A complete RO treatment system consists of pretreatment, chemical conditioning, the membrane array, post-treatment, and a cleaning system. An RO membrane array consists of the following components:

- Feed pump
- Pressure vessels
- Membrane elements
- Piping and valves
- Instrumentation and controls

Membrane elements are installed inside of pressure vessels as illustrated in Figure 4-12. Pressure vessels have permeate ports located at both ends, a feed port at one end, and a concentrate port at the other end. The permeate, concentrate, and feed piping are connected to their respective ports. Each pressure vessel contains six membrane elements connected in series. Pressurized water enters the pressure vessel through the feed port and flows through the channels between the spiral-wound "leaves" (sheets of membranes enclosing the permeate spacer to form a leak-free envelope) in each membrane element.

Figure 4-12 Cutaway of a Pressure Vessel with Three Membrane Elements



On the feed end of each element is a brine seal that forces the feedwater to enter the membrane element rather than passing around it. As feedwater flows through the first membrane element, part of it is converted to permeate. The water rejected by the first element becomes the feedwater for the second element and so on. As the feedwater flows from element to element, the dissolved solids in it become more and more concentrated.

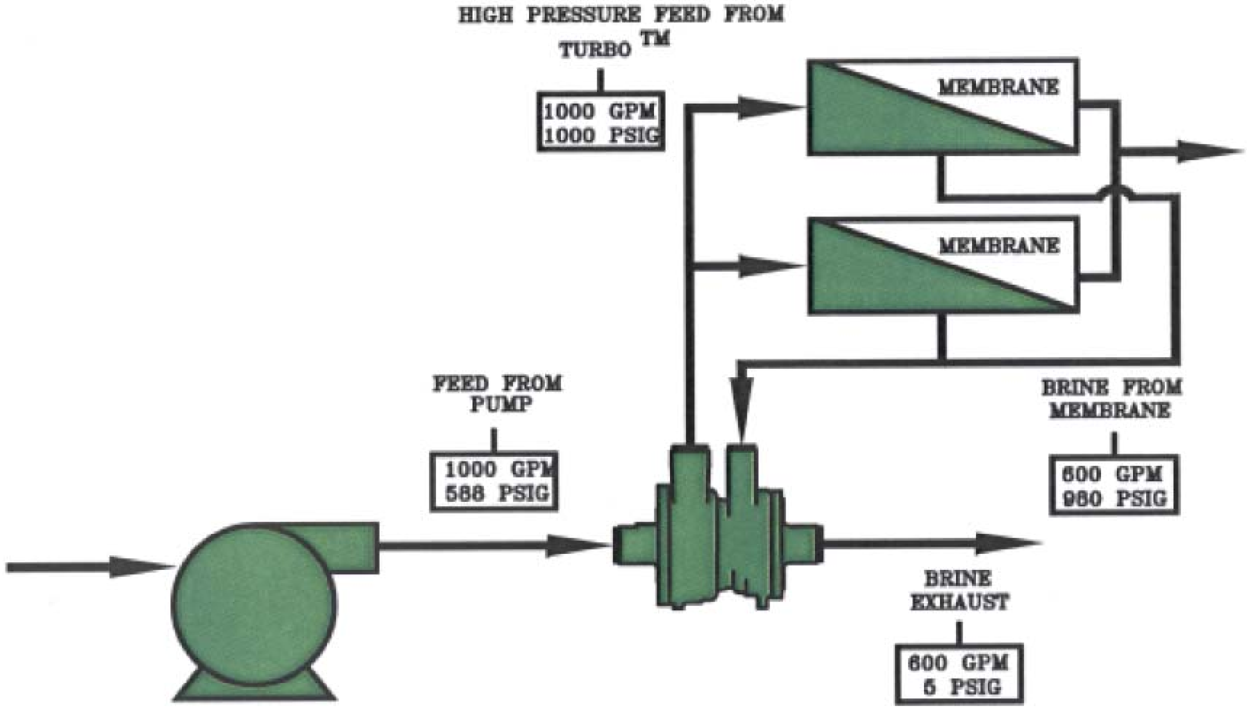
The permeate tubes of each element are connected to each other using interconnectors. The permeate tubes of the first and last elements are connected to the end ports of the pressure vessel. The permeate tube transports permeate from the pressure vessel. The permeate has the lowest salinity at the feed end and the highest salinity at the concentrate end. This is because the membrane only rejects a percentage of the feedwater TDS, and the feed salinity increases from element to element.

The concentrate valve installed on the concentrate manifold creates the necessary backpressure to force the feedwater through the membrane elements. The above principles apply to RO membrane operation regardless of the membrane array configuration.

4.2.7.3 Energy Recovery Turbines

Energy recovery turbines will be used on each RO skid pumping system to capture otherwise wasted energy in the concentrate (brine) flow stream. The RO membranes operate at high pressures (approximately 1,000 pounds per square inch [psi]) and the concentrate retains much of this pressure, which can be passed through a turbine to supplement the pressure for the feed pump. Figure 4-13 provides a schematic representation of an energy recovery system. The figure shows that the RO feed pump can be designed to deliver approximately 600 psi and the energy recovery turbine increases the pressure by an additional 400 psi to meet the required 1,000 psi feed pressure to the RO.

Figure 4-13 Flow Diagram for an Energy Recovery Turbine



Source: Pump Engineering, Inc. This product is presented as an example; equivalent products are acceptable.

4.2.8 Disinfection

The disinfection system would use chlorine as a primary disinfectant for pretreatment as needed, and for control of algae in raw water. The chlorine can be injected into the raw water upstream of the intake pumps and in the finished water (RO permeate).

In addition, the disinfection system would use chloramines to maintain a residual[1] in the distribution system. Chloramines are produced by combining chlorine and ammonia and have been used as a disinfectant since the 1930s. Chloramines are weaker disinfectants than chlorine but are more stable, thus extending disinfectant benefits throughout the distribution system. Utility companies in the San Francisco Bay Area use chloramines instead of chlorine for the following reasons:

- Chloramines are not as reactive as chlorine with organic material in water and produce substantially lower concentrations of disinfection byproducts in the distribution system. Some disinfection byproducts, such as the trihalomethanes (THMs) and haloacetic acids (HAAs), may have adverse health effects at high levels. These disinfection byproducts are closely regulated by the U.S. Environmental Protection Agency (USEPA). The USEPA

[1] In this context, a residual is the total amount of chlorine and/or chloramines remaining in water at the end of a specified contact period following disinfection. The residual is the measure of potential chlorine and/or chloramines disinfection.

recently reduced the allowable Maximum Contaminant Levels for total THMs to 80 micrograms per liter (µg/L) and now limit HAAs to 60 µg/L.

- Chloramines provide better protection against bacterial regrowth.
- Chloramines are effective in controlling biofilm, a slimy coating in pipes caused by bacteria that can cause corrosion of the water lines.
- Because chloramines do not tend to react with organic compounds, many systems will experience fewer taste and odor complaints than when using chlorine.

The preliminary design layout is based on a gas chlorine vacuum feed system, which is the most widely used disinfection system in the world. Other systems that can be investigated as the design progresses use sodium hypochlorite or calcium hypochlorite.

A chemical feed and storage system is provided for using aqua ammonia instead of anhydrous ammonia in gas form due to safety concerns. The chlorine system includes facilities for receiving, unloading, and storing one-ton chlorine containers and feeding equipment. The main components employed for delivering chlorine chemicals are container scales, an automatic switchover unit, ejectors, and vacuum feeding equipment.

Container-mounted vacuum regulators are used to reduce the pressurized chlorine gas withdrawn from the containers to a vacuum condition after the chlorine gas has exited the one-ton containers. Under vacuum conditions, chlorine gas is withdrawn from two one-ton containers that have been positioned on the chlorine scales adjacent to the chlorine manifold. The chlorine feed system is designed with one cylinder on either side of the automatic switchover unit. When one cylinder has been exhausted of chlorine gas, the automatic switchover unit senses a loss of vacuum from that side and automatically switches to the other cylinder in service. The chlorine gas flows under vacuum from the vacuum regulators on each container to the chlorinator units. The chlorinator units are used for regulating the quantity of chlorine gas that is delivered to the ejector units. The chlorine gas is drawn to the ejector by the vacuum that is created by the potable water flowing through the ejector unit. When the chlorine gas is blended with the potable water, a chlorine solution is formed. The pressurized potable water contains sufficient driving force to transport the chlorine solution to the injection points.

4.2.9 Chemicals

4.2.9.1 Sulfuric Acid

An acid is needed for three different purposes at the desalination facility:

- Conditioning the raw water to prevent calcium carbonate scale formation in the membrane treatment system
- Removing inorganic material that has accumulated on the surface of the membrane elements
- Lowering the pH of the water in the membrane cleaning tank to a level suitable for cleaning the membrane elements.

It was assumed that sulfuric acid would be used instead of hydrochloric acid because it creates less of an off-gassing problem.

The preliminary design includes facilities for receiving, unloading, and storing acid and feeding equipment. The main components employed for delivering the acid are chemical metering pumps and bulk storage and day tanks. Liquid sulfuric acid would be delivered to the facility by tanker truck and unloaded to the bulk storage tanks, located in the chemical storage area. Commercial-grade sulfuric acid is usually delivered as a 93 percent solution by weight.

Acid would be transferred from the bulk tanks to the day tank by gravity or with the use of transfer pumps. The day tank is sized to hold a one-day supply of chemicals, depending on the feed rate. The main components employed for delivering chlorine chemicals are container scales, an automatic switchover unit, ejectors, and vacuum feeding equipment.

4.2.9.2 Sodium Hydroxide

Sodium hydroxide is used for two different applications at the desalination facility. The chemical is used to raise the filtered water pH as a final conditioning step before the water leaves the plant for distribution. Increasing the pH in the chemically unbalanced filtered water produces a more stabilized finished water that can be delivered to the system. The stabilized finished water greatly increases the life of both the high-service pumps and the distribution mains.

Sodium hydroxide is also used to remove organic material that has accumulated on the surface of the membrane elements. The chemical is added to the membrane cleaning tank to raise the pH of the water to a level suitable for cleaning the membrane elements.

The main components employed for delivering the sodium hydroxide are chemical metering pumps and bulk storage and day tanks.

Liquid sodium hydroxide would be delivered to the facility by tanker truck and unloaded to the bulk storage tanks located in the chemical storage area. Commercial-grade sodium hydroxide is usually delivered as a 50 percent solution by weight. The solution weighs 12.76 pounds per gallon and contains 6.38 pounds of active sodium hydroxide per gallon. The freezing point of 50 percent sodium hydroxide solution is approximately 50 degrees Fahrenheit. This solution is usually heated prior to shipment to prevent crystallization.

4.2.9.3 Antiscalant

The antiscalant conditions the pretreated raw water for the RO process. The antiscalant is injected upstream of the RO feed pumps or cartridge filters (if used). The antiscalant inhibits the formation of carbonate and sulfate based scales on the membranes. The antiscalant keeps the dissolved compounds in the raw water in solution even when their normal solubility concentrations are exceeded. Without antiscalant, the membranes become fouled, resulting in a loss of permeate productivity and increased energy costs.

The main components employed for delivering the antiscalant are chemical metering pumps and bulk storage and day tanks.

4.2.9.4 Phosphate

The preliminary system design includes facilities for receiving, unloading, and storing phosphate and feeding equipment. The main components employed for delivering the phosphate are chemical metering pumps, storage tanks, and scales. Liquid phosphate is stored in the chemical storage area. The metering pumps are used to inject phosphate into the finished water.

The addition of phosphate promotes the stabilization of the treated water. Unstable water can lead to pipe corrosion or pipe scaling. The phosphate is blended in the finished water to control tubercular build-up on the inside wall of the distribution piping. The phosphate acts as a sequestering agent that prevents the scale-forming ions (calcium, magnesium, iron) from precipitating out of solution. If phosphate is not added to the finished water, the water could affect the efficiency of the high-service pumps and distribution piping by reducing the effective inside diameter of the pipes.

The partner agencies would enter into a series of *institutional agreements* to implement the BARDP. There are three general categories of agreements by which the agencies can define their roles, responsibilities, and legal obligations: the Joint Powers Agreement (JPA), the Memorandum of Understanding (MOU), and the standard contract. The type of agreement adopted will depend on key issues such as the structure for the ownership, operation, and maintenance of the facility. Based on the guiding structure for the principal agreement among the agencies, other issues may also require institutional arrangements including how the desalination water may be distributed and transferred among the agencies, how water banking may be used, and how capacity and pipeline constraints may be managed. These issues may be addressed within the principal agreement governing the BARDP, through modifications to existing agreements, through separate agreements, or through a combination of the above. The issues listed, in turn, will have important implications on cost, water delivery, conditions of use, and water quality. Once member agencies are in agreement on how the issues will be handled for the purposes of the BARDP, appropriate contractual mechanisms can be identified and executed.

5.1 INTRODUCTION

This section provides a brief overview of the types of agreements the agencies may consider in setting up a desalination plant and delivering water through existing infrastructure. Various considerations and issues are discussed that would likely be included in the agreements among the agencies. In addition, this section identifies the parties to individual agreements and the points in the water delivery structure, based on the site(s) selected for the BARDP, where agreements would be necessary.

The discussion in this section serves as a decision-making guide for managers as they consider the agreements that the agencies would have to enter into in order to implement the BARDP. This guide places the necessary agreements into the context of an inter-agency institutional framework. This discussion does not include legal advice or opinions, and it does not replace or otherwise advise any review of contractual agreements by the agencies' respective legal counsels.

5.2 TYPE OF AGREEMENTS

There are three basic types of agreements that the agencies may enter into for the implementation of the full-scale BARDP. Although other permutations may exist, the types of agreements listed below generally describe the categories of agreements that may be considered.

5.2.1 Joint Powers Agreement

A Joint Powers Agreement (JPA) is a legally binding way to link several public agencies to create a new entity that will share in fulfilling a specific and agreed-upon goal such as the BARDP. A JPA is a contract that is limited in authority to what each of the agencies is individually legally authorized to do. A JPA provides *flexibility* to meet goals, *protection* for local identity interests, and *opportunity* to meet agency needs. A JPA provides for the ability of agencies to share risks and costs without incurring direct liability to member agencies for other member financial obligations.

The JPA can be organized in many different ways, depending upon member preferences. A Governing Board can be established that sets the policy direction for the JPA. It is relatively simple to form since the statutory authority necessary to execute its functions already exists. The JPA would have public agency status and the ability to aggregate, finance, and/or own infrastructure. Thus, the JPA would own the facilities that are directly associated with the BARDP and are designed for exclusive use by the BARDP. Auxiliary facilities that may be used by the BARDP but are not designed for its exclusive use, such as pipelines and reservoirs, would continue to be owned by agencies that currently own them; the JPA would have rights to use those facilities for conveyance or water storage. The rights and obligations of the JPA would be established in the implementing agreement of the BARDP.

If a JPA is selected for the development of a BARDP, the agencies must consider that participation is limited to public entities. Potential private stakeholders would be excluded from the regional partnership.

5.2.2 Memorandum of Understanding

A Memorandum of Understanding (MOU) is an approved written agreement of a non-contractual, non-legally binding nature between two or more parties, in this case the four agencies, that documents an intent by all parties to cooperate in the BARDP project undertaking. An MOU will clarify relationships and responsibilities among the agencies but is characteristically general and non-binding in nature.

The work performed on the BARDP to date has been conducted through this type of agreement.

5.2.3 Standard Contract

A contract is a legally binding agreement among two or more parties that can be used to define relative benefits, obligations, and liability of the parties with respect to the proposed project. While a contract can define terms, conditions, and obligations as agreed to by the parties, it does not create a new entity for the purposes of ownership of the new facilities. The BARDP facilities would either be owned jointly pursuant to the contract or owned by one agency with terms of participation by other agencies defined by the contract. Private entities could be parties to a contract.

5.3 KEY ISSUES REQUIRING AGREEMENTS

As the BARDP is planned and structured, each of the agencies will have to consider and agree on a number of issues. Some of the key issues that will eventually drive the types of agreements that the agencies enter into are described below.

5.3.1 Facility Ownership, Operations, and Maintenance

There are three primary alternatives for ownership of the desalination facilities. The facilities could be owned by the agency in whose service area the facilities are located, with cost sharing and water sharing obligations defined by a binding contractual agreement among the agencies. In this case, one agency would likely have all management, O&M responsibilities, and discretion. The governing board of the agency that owns the facility would have the overall responsibility for the facilities, including residual benefits and risks of ownership if the agreement is terminated. It is possible that the agency owning the facility could be perceived as having a greater potential risk or benefit through ownership. Other participating agencies would receive water supply benefits and share in capital and O&M costs based on the terms of the agreement.

A second option would be joint responsibility of the facilities with benefits and obligations, including water supply and share of costs, defined by terms of an agreement among the agencies. The facilities would be most efficiently operated and maintained by the agency in whose service area the facilities are located. Protocols and procedures for O&M of the facilities would be subject to agreement by the agencies. The agreement would also have to provide for the governance of the facilities and the manner in which policy-level decisions would be made. The agreement should also provide for disposition of the facilities in the event that the agreement is terminated.

The third option would be the formation of a separate public entity (an Authority) through a JPA. The Authority would own the facilities, and the benefits and obligations of the member agencies would be defined by the JPA. The JPA would also identify infrastructure that it would use to convey or store water, but may not own, such as pipelines and reservoirs owned by the individual members of the JPA.

The Authority could hire its own employees to manage, operate, and maintain the facilities, or it could contract with one of the agencies or a third party for such services. One of the benefits of a JPA is that the member agencies can share the benefits of the facility as defined in the JPA while being at least partially insulated from some of the liabilities and risks of ownership. No agency would be perceived as having greater risks or benefits than those defined in the JPA. Responsibility for policy decisions and management would be shared by the Authority member agencies through the governance structure of the JPA.

The initial agreement that assigns the roles and responsibilities of the member agencies of the BARDP, regardless of the type selected, will serve as the project's implementing agreement (hereafter referred to as Master Agreement).

5.3.2 Water Supply Distribution

The agencies' existing distribution facilities do not have the capacity to directly deliver desalination plant product water to all of the member agencies at any of the sites under consideration. In each case, only one or two agencies would receive the water generated by the desalination plant, and that agency or agencies would then have the obligation of transferring water to other members, as defined in the Master Agreement. Due to limited interconnectivity options between agencies, transfers and/or exchanges would also take place between agencies that do not directly receive desalination water. As such, transfer or exchange agreements would be required to provide for the delivery of water from the agency receiving the BARDP product water to other agencies, and subsequently for other agencies exchanging water. Water transfers and exchanges between individual agencies may take the forms of standard contracts or MOUs. These agreements would likely modify or replace existing MOUs that govern emergency interties and other interconnections between agencies' water delivery systems.

The recipient of BARDP product water may or may not be party to agreements between other member agencies exchanging water, based on the roles and responsibilities assigned in the

Master Agreement. Figure 5-1 illustrates how the various agreements could enable the distribution of water supply benefits.

Key issues in each transfer/exchange agreement will include timing of deliveries, conditions and costs for use of existing connecting facilities, and possibly cost differentials related to different water quality and levels of treatment. The actual configuration of the relationships between agencies and the individual transfer or exchange agreements may vary depending on various other factors including water supply rights and entitlements of the member agencies, and capacity and design constraints of existing infrastructure such as conveyance and storage facilities. These constraints have been taken into account in Figure 5-1 and are described below.

5.3.3 Water Supply Rights and Entitlements

The agencies currently rely on various water sources to meet demand in their respective service areas. Each agency has water rights and entitlements attached to its current water supply. Modifications to the point of diversion, place of use, and purpose of use may potentially be required to exchange water between agencies. For example, the SFPUC has rights to the Tuolumne River. Modifications to the point of diversion to supply water to EBMUD would need to contemplate the rights of other water districts entitled to use Tuolumne River water. Similarly, Mokelumne River water and San Francisco Bay/Sacramento–San Joaquin River Delta (Bay-Delta) water also have water supply entitlements associated with them. Modifications may also be limited by the governing legislation. These restrictions would have to be considered in the water transfer/exchange agreement.

Water transfer/exchange agreements that affect the point of diversion, place of use, and purpose of use are typically subject to review and approval by the State Water Resources Control Board (SWRCB). Since the BARDP may need to establish the diversion rights for the facility (depending on the site location and transfer option selected), it would be reasonable to seek all necessary place of use change authorizations necessary to implement the transfer/exchange agreements at that time. In addition, it would probably be most efficient to deal with the water transfer and exchange issues from a regulatory perspective (i.e., compliance with CEQA, National Environmental Policy Act [NEPA], and Endangered Species Act guidelines) at the time the BARDP facilities are evaluated.

5.3.4 Water Banking

The agencies have identified mitigation for droughts, emergencies, and facility repair/maintenance as the goal of the BARDP. Needs and priorities of each agency may vary substantially during times of emergency. The impacts of a drought on water users, for example, will depend on the extent to which water uses can be maintained by drawing on stored water, and how the available water is allocated among potential users.

Water banking is a management tool that can supplement traditional reliance on surface water reservoirs. Water banks can facilitate voluntary water transfers to help mitigate the impacts of an emergency scenario by increasing water supplies for highly valued uses during water-shortage periods. In the case of the BARDP, because the agencies have identified that they would have dry year and emergency needs only, water banking could replace and/or augment the need for water transfers and exchanges during those periods. As such, provisions for water banking may be outlined within the implementing agreement for the BARDP.

A water bank can be involved to differing degrees in water exchange, as determined by the member agencies of the BARDP. If water supply from the desalination plant (assumed at 65 mgd for each site under consideration) exceeds the regular water needs identified by the agencies, excess water supply can be pooled and made available to third-party buyers. During times of water shortage for any of the agencies, banked water can be purchased by those members. The implementing BARDP agreement would establish the uses of the water bank and priorities of members over non-members. The agreement would also provide a ranking of values to prioritize water values during times when demand among agencies exceeds supply. Based on these values, the water bank would establish a cost structure for the sale or purchase of banked water.

In the implementing agreement of the BARDP, the following would have to be established in regard to water banks:

- Determine what rights can be banked.
- Establish the quantity of bankable water.
- Limit who can purchase or rent from the bank if necessary.
- Set contract terms and/or prices.
- Facilitate regulatory requirements.

To buy storage in a bank requires a substantial initial investment (millions of dollars), and the annual maintenance fee can be $7.00 to $8.00 per acre-foot. In addition, available water storage is very limited. Storage can be purchased from water agencies that have already purchased storage.

5.3.5 Water Capacity Constraints

As discussed in Section 2.2, there are physical limitations posed by the existing infrastructure. For example, the EBMUD/SFPUC Emergency Intertie in Hayward has a maximum carrying capacity of 30 mgd, and a treated water interconnection between EBMUD and CCWD has a capacity limit of between 10 and 15 mgd. As noted in Section 2.2, further hydraulic modeling is warranted to determine actual conveyance capacities among the agencies. In addition, each member agency will have to consider existing uses and available capacities in the individual water transfer/exchange agreements.

5.3.6 Pipeline Design Constraints

Pipeline design and current use dictates the exchange of raw or treated water and the direction of the water flow. These issues will also affect how agreements are established and the parties that can exchange water. The scenarios shown in Figure 5-1 consider these issues. For example, under the Alternative B scenario at the East Contra Costa site, SCVWD takes an additional 25 mgd of raw Bay-Delta water. Pipeline configurations necessitate that SCVWD provide 15 mgd of treated water to the SFPUC. Any cost differentials associated by the transfer that are dictated by pipeline infrastructure would have to be taken into account in the appropriate transfer/exchange agreements.

5.3.7 Other Considerations in Formulating Agreements

The agencies have identified the need for additional water during droughts and emergencies and the need for existing facilities to be taken out of service for maintenance and repairs as two key objectives of the BARDP. Contingencies that account for such situations, such as water banking, may be incorporated into the Master Agreement for the BARDP. The cost and distribution of water during times of emergency or drought, for example, should be clearly identified in the initial implementing document for the project. Responsibilities for water transfer should also be clearly assigned. Mechanisms for dispute resolution and termination of the BARDP should also be laid out in the Master Agreement. The Master Agreement should also clearly describe the "seniority" or first right of refusal each partner would be entitled to during situations that may require using the BARDP facilities.

5.4 KEY ISSUES FOR AN INTER-AGENCY INSTITUTIONAL FRAMEWORK

The agencies have a number of options, both for establishing the framework for the desalination facility or facilities, and for transferring and delivering water between individual water districts. The form that these agreements take (JPA, MOU, or contract for the BARDP implementation and transfer/exchange agreements for water distribution) will depend on the management decisions that guide the development of the project.

A range of issues including ownership, physical and regulatory constraints, and individual agency needs and priorities will have to be taken into consideration in the formulation, structuring, and implementation of agreements associated with the BARDP. These issues, in turn, will have important implications on cost, water delivery, conditions of use, and water quality. Once member agencies are in agreement on how the issues will be handled for the purposes of the BARDP, appropriate contractual mechanisms can be identified and executed.

The following summary of key principles and management decisions place the necessary agreements into the context of an inter-agency institutional framework.

I. Planning

Anticipated planning for the BARDP includes the following components:

a) Permitting, construction, and operation of a pilot plant(s).

b) Hydraulic modeling of the conveyance systems and blending studies.

c) Identification and evaluation of alternatives that mitigate or avoid potential adverse environmental impacts.

d) Final site(s) selection for the full-scale desalination plant.

e) Preparation and certification of an EIR.

f) Permit applications for the full-scale BARDP.

Key Principles:

1. Agencies agree to share costs for planning (as listed above).
2. Cost savings and overruns will be shared in proportion to costs incurred.

Key Management Decisions:

Considerations – Data collected from MMWD, San Diego, West Basin, etc. may be used to optimize the planning process.

1. Does each agency agree to continue to share planning-related costs related to perceived benefits, level of interest, etc.?
2. Will one, two, or three sites be selected for the pilot testing?
3. Which site(s) will be selected for pilot testing?

II. Governance

Key Principles:

1. Under a JPA or with individual agency ownership, the agencies would share costs in a manner that is commensurate with individual agency benefits from the project.
2. There would be a commitment to share costs of O&M based on quantities of water to be received by each agency.
3. There will be provisions for the addition and withdrawal of members in a manner that keeps members whole financially.

Key Management Decisions:

Considerations – Examples from local wastewater treatment plants may be useful as a model; for example, shared facilities used by North Bay Dischargers Association.

1. Will the BARDP facilities be owned jointly through a JPA, or individually by the agency in whose service area the plant(s) is located?
2. If a JPA is selected, should funding of the JPA be based on relative quantities of water received from the project, or should 50 percent of the costs be shared on an equal basis, and the remaining 50 percent shared on the basis of relative water amounts?
3. If individual ownership is selected, should a) the agency that owns the facilities have all management, operation, and maintenance responsibility, and primary responsibility for these costs (excluding O&M that can be shared); or b) the agencies be jointly responsible for cost, sharing all expenses associated with management, operation, and maintenance? (For efficiency, the agency in whose service area the facilities are located would still take the lead.)

III. Plant Design and Construction

Key Principles:

1. Agencies would share capital costs in a manner that is commensurate with individual agency benefits (capacity and water quality) from the project.
2. Assumption of design, technology, and construction risks will be factored into the agreement.
3. The owner of the BARDP will make final decisions and incur liabilities as defined by the governance agreement.

Key Management Decisions:

***Considerations* –** The preliminary design and cost estimate for the MMWD desalination project is available. Preliminary designs and cost estimates may also be available for desalination facilities proposed for Southern California.

1. Do agency managers agree that capital costs should be shared in a manner that is proportionate to the relative water benefits they receive?
2. Should design, technology, and construction risks be borne by the facility owner, or shared among agencies equally?

IV. Operation and Maintenance

Key Principles:

1. Facility staffing will be determined by ownership structure.
2. Baseline O&M costs may be shared proportionately among agencies. Each agency would incur the additional O&M costs needed to obtain water supply associated with the BARDP.
3. The owner will be responsible for renewing and maintaining permits.

Key Management Decisions:

1. Who will take responsibility for staffing the BARDP facilities (JPA-hired, member agency staff, or private contractors)?
2. Do agencies agree with the approach for the assignment of O&M costs above?

V. Water Distribution and Redistribution

Key Principles:

1. Share of cost for delivery of water to a designated point of delivery is relative to quantity and quality of water received from the project.
2. No one agency will be adversely affected by facilitating a transfer; the transferring agency will be made whole in costs and expenses by the agency receiving the benefit.
3. To the extent possible, water rights issues related to transfers and exchanges necessary to distribute the water to member agencies will be dealt with during the water rights proceedings for the BARDP facilities.
4. Provisions for water banking or marketing will be considered for production during wet and normal year operations, as appropriate.

Key Management Decisions:

***Considerations* –** SCVWD existing water banking agreement could be used as a model.

1. Should the point of delivery be a) exit from the treatment plant or any conveyance facilities owned and operated by the BARDP, or b) the point at which the receiving agency takes water into its distribution system? The selection can affect the assignment of cost responsibilities.

2. Should water banking and marketing be the responsibility of each individual agency (banking and subsequent delivery, or selling to third-party customers), or should the BARDP be responsible for arranging banking and marketing, and subsequent delivery to members? Banked water may also be marketed to others under terms and conditions defined by members, or water banking may be kept independent of the BARDP.
3. Determine water quality (treated vs. raw) and cost of additional treatment.

VI. Emergencies

Water conveyance contingency plans will be in place, which would take effect in the event of a natural or human-made emergency, prolonged drought, or other short- or long-term unanticipated disruption of water supply affecting one or more member agency.

Key Principles:

1. Water supply quantities to member agencies may change depending on the effect and nature of the water supply disruption.
2. The cost of changes in water conveyance necessary for the affected agency(s) to obtain water through the BARDP will be borne by that agency(s).
3. Member agencies that may or may not be affected by the emergency agree to convey water through their pipelines in order to facilitate efficient water supply to members.
4. Provisions will be made for non-member agencies facing emergencies to use BARDP facilities during emergency periods.

Key Management Decisions:

***Considerations* –** The 10 Bay Area counties are considering water deliveries as part of the Urban Area Security Initiative.

1. Do agencies agree with the contingency emergency actions outlined above?

VII Utilization of Excess Capacities / Unused Facilities

Key Principles:

1. Partner agencies that do not use their full capacities may enter into separate agreements with other agencies for using the excess capacities. These separate agreements will include the same terms and conditions of the BARDP agreement.

Key Management Decisions:

***Considerations* –** Data collected from MMWD, San Diego, West Basin, etc. may be used to optimize the planning process.

1. Do agencies agree with the principle stated above?

VIII Grants and Subsidies

Key Principles:

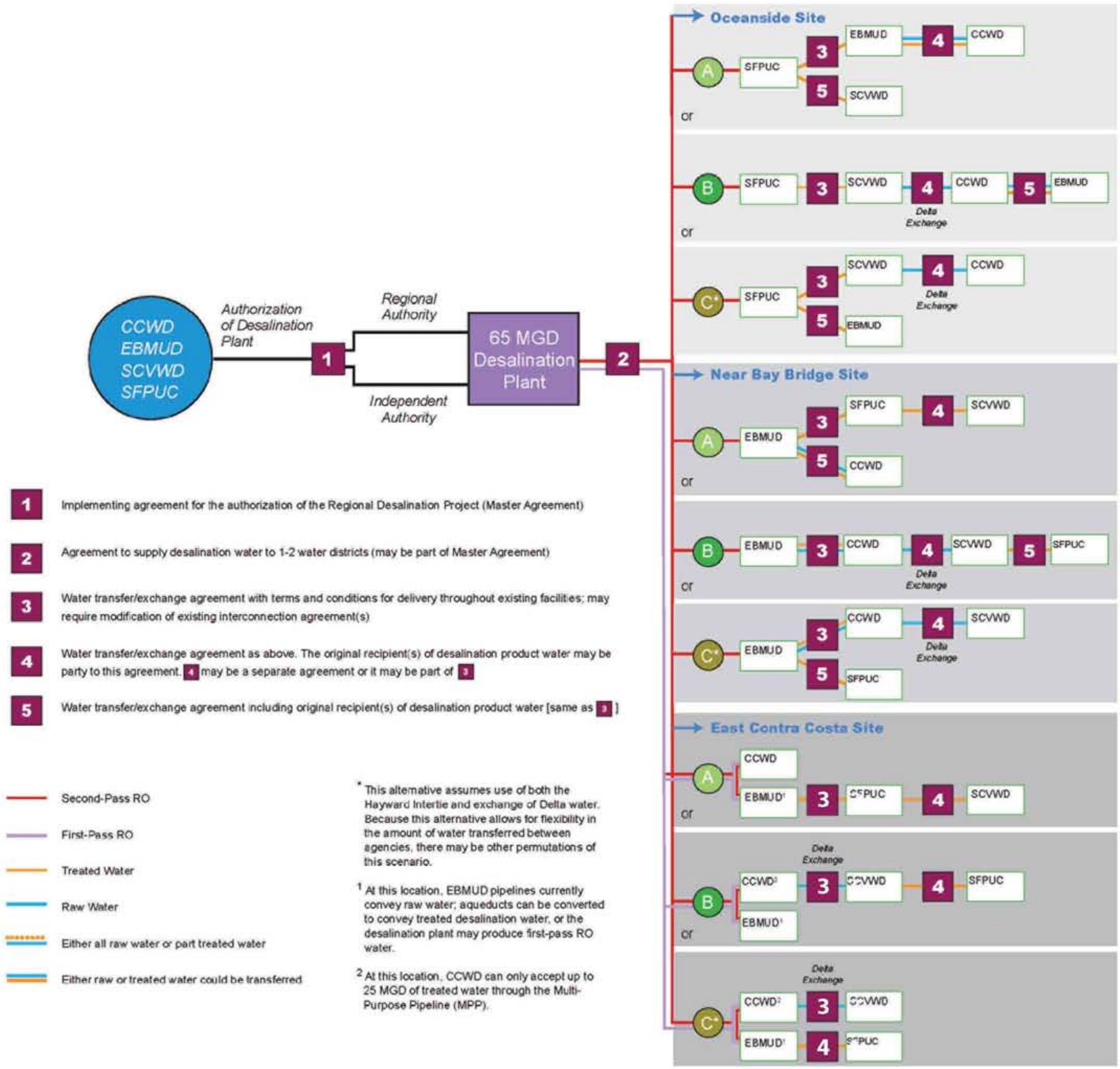
1. Partner agencies or the JPA responsible for the BARDP will pursue State and Federal funds for assisting in all stages of development. Any costs of the grant proposal applications will be shared in accordance with the cost-sharing agreement for that phase of the project (i.e. planning, design, construction, operation).

Key Management Decisions:

***Considerations* –** Continue existing lobbying efforts for the Water Resources Development Act.

1. Do agencies agree with these principles stated above?

Section 5 Figures



Source: BAIRWMP 2006

URS	26814534.14000 Bay Area Regional Desalination Project	Agreement Decision Flow Diagram	Figure 5-1

As described in Section 3, a BARDP desalination facility used for dry years and emergencies would likely operate in clusters of years and potentially experience consecutive years of nonuse. A plant that produces desalination water during wet years would be used more often, reduce unit water production costs, and address issues associated with intermittent operation. Therefore, the agencies sought to identify potential customers from the public and private sectors for collaboration on the BARDP. In addition, the agencies investigated selling water on the open market and to the CALFED Environmental Water Account (EWA).

Potential customers were identified and provided with a survey questionnaire, and follow-up meetings and telephone conversations were held to discuss the feasibility of using BARDP water during wet years. In general, it does not appear that the potential customers need water to meet supply shortages during wet years. Certain candidates stated that they would consider using BARDP water if the cost is economical, the water quality meets desired criteria, the plant is operational in time to suit the candidate's needs, and an economical water transport method can be provided.

The opportunity for the agencies to achieve premium prices for BARDP water on the open market would depend on the ability to structure a package that includes reliable conveyance and storage. Recent average prices for EWA water acquisitions have been substantially lower than the projected BARDP water cost. The EWA will expire on December 31, 2007, unless renewed; however, should a long-term EWA be adopted, it could become a long-term customer for the agencies.

The BARDP would operate during dry years and emergencies to provide the agencies with supplemental water in periods of drought, emergencies, and unplanned facility outages, as described in Section 3. Delivering water during wet years would increase use of the desalination plant, reduce product water cost, and address issues associated with intermittent operation. For that reason, the agencies sought to identify potential customers from the public and private sectors for collaboration on the BARDP. Long-term customers for desalination water during wet years would help to offset costs associated with constructing and operating the facilities. This section presents the results of an initial market assessment for desalination water during wet years.

6.1 APPROACH

The first step of the market assessment was to develop a list of the customers most likely to consider using water from the BARDP during wet years. The candidates were identified based on proximity to the potential facility location, potential needs for supplemental supply, and infrastructure and institutional framework. The list of private industrial and agency customers included the following:

- Zone 7 Water Agency
- PG&E/Mirant
- City of Pittsburg
- City of Antioch

- USS-Posco Industries
- Dow Chemical
- Calpine Corporation
- GWF Power Systems
- Alameda County Water District
- Marin Municipal Water District

A Customer Survey Questionnaire was developed for distribution to potential customers. This questionnaire inquired about customer water needs, interest in pursuing supply from the BARDP, and implementation issues such as:

- Water quantity
- Water quality
- Cost
- Transmission
- Delivery timing
- Delivery reliability/flexibility
- Contractual and institutional viability

A copy of the questionnaire is included in Appendix G.

Follow-up meetings and telephone conversations were held with potential customers to discuss the feasibility of using water from the BARDP during wet years. All of the collected information was compiled to determine whether it would be feasible to deliver water to each potential customer during wet years and whether a market exists for water during wet years in general.

In a parallel effort, the agencies also investigated selling water on the open market and to the CALFED Environmental Water Account (EWA). These two options were not part of the Customer Survey Questionnaire; instead, information about the options was gathered through multiple sources.

6.2 RESULTS OF AGENCY SURVEYS

Although Customer Survey Questionnaires were sent to the list of potential customers, most feedback on interest in water from the BARDP during wet years was obtained through meetings and telephone conversations. A summary of the feedback from the potential customers is provided below.

6.2.1 Zone 7 Water Agency

Zone 7 Water Agency is the Tri-Valley area's water wholesaler. The agency's service area borders EBMUD's southeastern boundary. Zone 7 manages the water supply, treats water to drinking water standards, and wholesales treated water to four local water retailers: California Water Service Company, the City of Livermore, the City of Pleasanton, and the Dublin–San

Ramon Services District. Zone 7 supplies 40,000 to 45,000 acre-feet of water annually. Zone 7 also sells untreated water directly to agricultural customers and manages flood control for the Tri-Valley area. Zone 7 was contacted by EBMUD, on behalf of the BARDP partnership, to explore whether it would be interested in wet year water supply from the desalination facilities. The following summarizes the information collected.

Zone 7's principal water supply facility is the State Water Project (SWP) California Aqueduct and South Bay Aqueduct. Most of the SWP costs are fixed costs; i.e., Zone 7 pays the charges regardless of the amount of water delivered. The only "variable" charge is for the energy cost to pump water from the Delta to the South Bay Aqueduct, which is approximately $25 to $30 per acre-foot. Zone 7's wholesale rate charged to the four major retailers for treated water is $591 per acre-foot for 2006.

The flexibility and reliability of Zone 7's water supply is based on access to two out-of-district water banking programs (Semitropic Water Storage District and Cawelo Water District), local groundwater basin storage, 12-month surface storage carry-over with the SWP system, and local runoff storage in Lake Del Valle. In June 2006, Zone 7 completed a groundwater banking/exchange program agreement with Cawelo Water District to store up to 120,000 acre-feet of water with a drought-year capacity of 10,000 acre-feet per year. According to the agreement, Zone 7 will need to deposit a net volume of 60,000 acre-feet to provide for a 6-year drought scenario at buildout (year 2030) demands.

Although current water supplies are safe and dependable, they do not fully meet all of the desired goals of Zone 7. Zone 7 initiated a Water Quality Management Program in 2003 and adopted a Salt Management Plan to reverse the salt build-up in the local groundwater basin. Projects such as wellhead demineralization are being implemented to achieve these goals. Zone 7 is interested in evaluating an economical project that can provide water quality benefits that are consistent with its goals. If the BARDP can economically provide a supplemental water supply that is better than its current water sources such as Delta water and/or groundwater supplies, then Zone 7 would be interested. Water quality improvements to TDS, hardness, taste and odor, and greater uniformity within the different regions would be of interest to Zone 7.

No direct interties exist between Zone 7 and any of the BARDP partner agencies. Water can be exchanged through institutional agreements with the South Bay Aqueduct contractors (SCVWD). Dublin–San Ramon Services District, which is a retail customer of Zone 7, has a small-capacity intertie (3 to 5 mgd) with EBMUD that could potentially be used for supplying treated water to Zone7 through EBMUD. There is also a potential link between Zone 7 and SFPUC via Lawrence Livermore National Laboratory/Sandia. Without constructing new facilities, the BARDP could use any one of these options to supply wet year water to Zone 7 for water quality improvement benefits. Additional studies are recommended for evaluating this option.

Zone 7 is not particularly interested in considering alternative sources to its existing water supplies. Zone 7 does not need a supplemental water supply source, although it is open to pursuing economical opportunities that increase its water supply flexibility and reliability and improve water quality and uniformity.

6.2.2 PG&E/Mirant

Mirant Corporation owns and operates two power plants in the BARDP vicinity, one in Antioch (Contra Costa Power Plant), and one in Pittsburg (Pittsburg Power Plant). PG&E has entered into discussions with Mirant to take over ownership of Unit 8 at the Contra Costa Power Plant. Unit 8 is an air-cooled facility and would not require process water. Mirant Corporation would not be interested in receiving water from the BARDP due to its need to control the quality of the water that enters the power plant boilers. For example, Mirant requires its process water to contain less than 5 mg/L of TDS; the finished RO water typically contains 100 to 300 mg/L. No follow-up was conducted after the initial contact because neither Mirant nor PG&E expressed an interest in BARDP water.

6.2.3 City of Pittsburg

The City of Pittsburg receives untreated water from CCWD. This water is treated at the city's own 32 mgd Pittsburg water treatment plant and distributed to its retail customers. Although the treatment plant has a hydraulic capacity of 32 mgd, it currently operates at an approximate average rate of 16 to 18 mgd. Pittsburg also supplements its CCWD supply with approximately 1,500 acre-feet per year from its municipal wells. As with other entities that depend on the Delta for water supply, water quality is an important issue for the city. The City of Pittsburg was identified for evaluation for potential wet year BARDP water use because of its location within CCWD and proximity to the East Contra Costa site. A plant at the East Contra Costa site would increase the flexibility and reduce the cost of delivering BARDP water to the city.

The City of Pittsburg, however, has stated that it would not be interested in receiving water from the BARDP because it has adequate capacity in its treatment plant to meet all future demands and because the cost of desalinated water would be higher than the city's current production cost.

6.2.4 City of Antioch

The City of Antioch receives both treated and untreated water from CCWD. Untreated water from CCWD is stored in the Municipal Reservoir. Antioch operates its own water treatment plant, where it treats water and distributes it to the residents of Antioch. In addition, CCWD sells some treated water to the City of Antioch. Although the city has water rights to 50 acre-feet per year of diversion directly from the San Joaquin River, it does not rely on this supply due to water quality limitations. As with other entities that depend on the Delta for water supply, water quality is an important issue for the City of Antioch. Similar to the City of Pittsburg, Antioch's location within the CCWD service area would increase the flexibility and reduce the cost of delivering BARDP water to this potential customer.

The City of Antioch would be interested in receiving water from the BARDP if it could be provided at a lower cost than the city currently pays for treated water. However, it is unlikely that the desalinated water would be a more cost-effective alternative.

6.2.5 USS-Posco Industries

USS-Posco has owned and operated a flat rolled steel processing facility on a 500-acre site in Pittsburg since 1909. The company currently uses river water, untreated canal water from CCWD, and potable supplies, depending on the type of application. USS-Posco has its own on-site filter plant and RO facility (11 mgd capacity) that it has maintained for decades and upgraded in 1989. The company also has its own NPDES permit. The temperature of the water must be controlled for some of the company’s processes, and other processes have stringent water quality requirements. USS-Posco stated that it is unlikely to be interested in receiving water from the BARDP because the company’s current sources of water are inexpensive and it has already invested heavily in its own facilities. USS-Posco reached its maximum production capacity during the 1960s, and production has since declined. As a result, the RO plant currently has an excess capacity of 6 to 7 mgd. USS-Posco expressed an interest in providing water from its RO plant to others potential users. No follow-up was conducted after the initial contact because USS-Posco expressed no interest in BARDP water.

6.2.6 Dow Chemical Company

Dow uses untreated canal water from CCWD and rainwater collected on-site as feedwater for its RO system, which produces boiler and process water. The system produced 0.5 mgd in the 1990s, but current demands are approximately 0.2 mgd. San Joaquin River water has been used as feedwater for Dow’s RO system, but it has not been as cost effective as using canal water. Treatment is more difficult in the summer due to higher salinity. Dow has a permit to discharge the brine directly to the river. Domestic water delivered by the City of Pittsburg is used for potable uses. Dow also has the ability to use river water and groundwater wells for fire suppression.

This facility currently manufactures 8 to 11 different products for agricultural uses (pesticides and herbicides that go to other sites), latex for paper products, and preservatives for cosmetics and paint. Depending upon production-related business decisions affecting other Dow locations, it is anticipated that in the next 5 to 10 years, the facility may not need boiler water and is unlikely to need water only in wet years. No follow-up was conducted after the initial contact because Dow expressed no interest in BARDP water.

6.2.7 Calpine Corporation

Calpine Corporation operates the following power plants in the BARDP vicinity:

- Pittsburg Power Plant, Pittsburg, CA
- Los Medanos Energy Center, Pittsburg, CA
- Delta Energy Center, Pittsburg, CA

Calpine acquired the Pittsburg Power Plant in 1998, began operations at the Los Medanos Energy Center in 2001, and began operations at the Delta Energy Center in 2002. The Delta Energy Center facility currently uses untreated canal water from CCWD for its boiler and recycled water from Delta Diablo Sanitation District for its cooling tower. The Los Medanos Energy Center plant uses recycled water for both processes. The third facility, Calpine Pittsburg Power Plant, is a cogeneration plant. Calpine owns and maintains an RO water treatment plant that is designed to accept steam produced at the Delta Energy Center as its energy source. The company has a mix of owned and leased equipment for the RO plant operations, has an NPDES permit, and discharges via Delta-Diablo Sanitation District’s outfall. Like the other power plants, Calpine has water quality requirements that are more stringent than or different from drinking water requirements. Additionally, BARDP water is unlikely to have a lower cost than Calpine's supplies because Calpine can take advantage of providing the energy for its own water treatment needs. No follow-up was conducted after the initial contact because Calpine expressed no interest in BARDP water.

6.2.8 GWF Power Systems

GWF Power Systems is an independent electrical power producer with power plants in Pittsburg and Antioch. GWF purchases untreated water from CCWD for the cooling tower supply for two plants in Pittsburg, and each facility currently uses about 320 acre-feet of water per year. GWF does not have an interest in receiving water from the BARDP, particularly for only wet year supply. Specific water quality requirements were not provided by GWF; however, in past studies that considered the potential use of recycled water, there was a concern that industry requirements may not be met. In discussions with GWF, it was also concluded that a considerable length of costly pipeline would be required to bring desalinated water to its facilities. No follow-up was conducted after the initial contact because GWF expressed no interest in BARDP water.

6.2.9 Marin Municipal Water District

MMWD has been considering desalination for over 15 years. The district recently completed a one-year desalination pilot plant program and an accompanying engineering report (MMWD 2007), and is in the process of preparing a Draft EIR on a full-scale desalination plant with a potential capacity of up to 15 mgd. MMWD has projected a need for additional water supplies. The engineering report (MMWD 2007) estimates a product water cost of $2,000 to $3,000 per acre-foot. Although the district is pursuing its own desalination project, it has expressed an interest in potentially becoming a customer of the BARDP. The district's main concern is the timing of the BARDP; that is, the BARDP facilities may not be online soon enough for MMWD's needs. Another concern is how to get water from the BARDP to the MMWD service area. As with the BARDP agencies, water would need to be transferred from one of the partner agencies (probably EBMUD) to MMWD. Transporting water from EBMUD to MMWD would require construction of a new pipeline either along (or under) the Bay bottom, or along the Richmond–San Rafael Bridge. Constructing a pipeline on the Richmond–San Rafael Bridge would require approval from Caltrans, which could be difficult to obtain. Constructing a pipeline along or under the Bay could be expensive. A cost assessment for a water transmission line between EBMUD and MMWD is necessary to further investigate this option.

6.2.10 Alameda County Water District

The Alameda County Water District (ACWD) provides water to 324,000 retail customers in the Cities of Fremont, Newark, and Union City. ACWD has several sources of supply: raw water from the SWP via the South Bay Aqueduct, treated supply from the SFPUC, local surface water from Del Valle Reservoir, fresh groundwater wells, and desalinated brackish groundwater. In addition to the plant that desalinates the brackish groundwater, ACWD operates two surface water treatment plants. Raw water from the SWP and Del Valle Reservoir are treated at these plants prior to distribution to customers. High-quality SFPUC water is blended with fresh groundwater of a higher hardness at a blending facility to produce water with an overall lower hardness. Over the recent ten-year period, approximately 27 percent of ACWD's supply has been met by the SWP, 19 percent has been met by SFPUC, and 54 percent has been met with local supplies (surface and groundwater).

While ACWD has adequate supplies to meet normal demands into the future, it anticipates shortages during single- and multiple-dry year scenarios. To increase the reliability of its water supply, ACWD participates in the Semitropic Groundwater Banking Program and has 150,000 acre-feet in the water bank. Because of its diverse water sources, ACWD has significant flexibility in managing its water resources to meet its demands.

ACWD evaluated the potential for using BARDP water during wet years and concluded that it does not anticipate the need to purchase additional wet year supplies. The district has completed its first-phase brackish groundwater desalination plant (5 mgd) and is currently moving forward with the Phase 2 expansion to 10 mgd. It is anticipated that ACWD's desalination project combined with other supplies will be sufficient to meet its wet year needs.

6.3 CALIFORNIA WATER MARKET

California's diverse mix of water uses, highly variable hydrology, and vast network of water conveyance and storage infrastructure supports a variety of water market opportunities. Water transfers and exchanges have become prominent in water planning and operations for many urban, agricultural, and environmental purposes. Opportunities to market BARDP water will depend primarily on the ability of the transferring agency to secure conveyance and storage capacity to make water available to potential buyers when they need it.

In California, three types of markets involve water: markets for short- or long-term use of water rights, storage of water, and conveyance of water. Aspects of these markets differ and interact. California's extensive water infrastructure network allows relatively widespread participation in water markets, yet the movement of large quantities of water from sellers to buyers is limited by the physical capacities of that network. Several agricultural districts in the San Joaquin Valley specialize in marketing water storage rights, allowing urban and agricultural districts to store water purchased during wet years for use in dry years. Other agricultural districts with surplus surface water specialize in the sale or lease of water rights, which fetch higher prices when purchasing agencies have a place to store such water or can secure reliable conveyance capacity. Conveyance is perhaps the most monopolized water resource in California, with only a few large aqueducts available for east-west or north-south transfers. Water transfer prices, costs, and risks are all highly affected by the price and institutional and physical availability of the water conveyance infrastructure. These factors contribute to the complexity and multilateral nature of water markets and related water capacity markets.

6.3.1 Capacity

A majority of the potential buyers are south of the Delta or in coastal areas that rely on pumping and conveyance capacity to move water from the Delta to locations where it can be stored or used. The two main conveyance systems that export water south from the Delta are the Central Valley Project (CVP) and the State Water Project (SWP). The major CVP system export area facilities include the C.W. "Bill" Jones Pumping Plant (JPP), the Delta-Mendota Canal, the San Luis Reservoir (shared with SWP), the O'Neill Forebay (shared with SWP) and the San Luis

Canal, which is a joint use facility with the California Aqueduct from O'Neill to Kettleman City. The major SWP facilities include the Harvey O. Banks Pumping Plant (Banks), the California Aqueduct, and San Luis Reservoir (shared with CVP).

The export pumping, conveyance, and storage capacity of both projects is committed first to projecting obligations and deliveries to water service contractors, so the ability to use either project to transfer water is generally limited and uncertain from year to year as well as within each year. Most transfers using either facility have been short-term transfers using pumping or conveyance capacity that happens to be available in the year the transfer is initiated. The SWP is more likely to have excess capacity at certain times of the year than the CVP.

The SWRCB regulates the place and purpose of use of California water rights, including CVP and SWP water. The marketing of any BARDP water would be subject to SWRCB approval whether accomplished through the direct delivery of BARDP water or through exchanges using CVP or SWP water. EBMUD, CCWD, and SCVWD are CVP contractors, and SCVWD is a SWP contractor. It is likely that any marketing of BARDP water would be facilitated through the use of exchanges using member agencies' CVP and/or SWP water.

6.3.2 Market Opportunities

Market opportunities for BARDP water may exist as agricultural (Ag), urban (referred to as Municipal & Industrial [M&I] in CVP contracts), and environmental. Market demand and price vary considerably by year type and the ability to purchase water as a firm supply. There is a demand for Ag water in all year types, but delivered cost is the controlling factor. Ag demand is limited in wetter years, and willingness to pay for water in wetter years is limited to around $100 per acre-foot delivered cost, including losses, conveyance costs, regulatory fees and other costs. Ag demand in drier years is higher and willingness to pay can increase to $300 per acre-foot or more on a spot market basis. As supplies become increasingly constrained and competition for limited supplies increases, Ag buyers may be willing to pay higher costs for firm supplies, but it is likely that urban buyers will always be willing to pay more than Ag buyers.

The demand for urban water supplies will continue to increase due to limited availability of current supplies to support growth and state laws that require demonstration of firm supplies for at least 25 years. Except in critically dry years, urban buyers are generally interested in purchasing reliable supplies either for sustained use or dry year protection. The latter generally involves a storage component. Buyers of urban supplies have shown a willingness to pay as much as $2,000 to $4,000 per acre-foot for the right to purchase water (equivalent to a capital cost) plus the actual cost of the water on an annual basis that may be several hundred dollars per acre-foot. Willingness to pay such prices is limited to supplies that are known to be very firm and reliable. The amounts that buyers are willing to pay on an annualized cost basis range from $200 to $300 per acre-foot up to $500 per acre-foot and possibly more, depending on the severity of demand. Since the availability of BARDP water for marketing will generally occur in normal to wetter years, the opportunity for BARDP member agencies to achieve premium prices for water produced during times when it exceeds their demands will depend on the ability to structure a package that includes reliable conveyance (likely through exchanges involving CVP or SWP water that would otherwise be pumped at JPP or Banks) and storage (likely in an existing or new groundwater banking facility in the San Joaquin Valley).

There may also be opportunities to market water for environmental purposes. The EWA was formed as part of the CALFED program to provide a supply of water that can be used for environmental purposes. Although the EWA is currently not authorized as a long-term program, it is likely to continue in some form. The EWA is operated by DWR and is currently purchasing water on an annual basis as well as trying to develop long-term assets. The market price paid for EWA water in the past has varied considerably but could be characterized as near the high end of the Ag market price or low end of the urban prices.

6.4 CALFED ENVIRONMENTAL WATER ACCOUNT

The EWA is a CALFED program developed to provide additional protection and recovery of Bay-Delta fisheries through environmentally beneficial changes in the operations of the SWP and CVP, at no uncompensated water cost to the projects' water users. The EWA is intended to increase existing regulatory provisions of water for fishery protection and restoration needs. This approach requires the acquisition of project water supply, called the "EWA assets," to increase streamflows and Delta outflows. EWA assets would also provide replacement water to compensate for reductions in deliveries caused by changes in project operations, such as reduction of export pumping, to protect fish.

Five state and federal agencies have responsibility for implementing the EWA: U.S. Fish and Wildlife Service (USFWS), National Oceanographic and Atmospheric Administration's National Marine Fisheries Service (NOAA Fisheries), U.S. Bureau of Reclamation, California Department of Fish and Game (CDFG), and DWR.

Beneficial changes in SWP and CVP operations could include changing the timing of some flow releases from storage and the timing of water exports from the Delta pumping plants to coincide with periods of greater or lesser vulnerability of various fish species to environmental conditions in the Delta. For example, the EWA might alter the timing of water diversions from the Delta and carry out water transfers to reduce fish entrainment at the pumps and provide migratory cues for specific anadromous fish species. The EWA program is designed to replace any regular water supply interrupted by the environmentally beneficial changes to SWP and CVP operations beyond the regulatory baseline. The timing of the protective actions and operational changes vary from year to year, depending on many factors such as hydrology and real-time monitoring that indicates fish presence at the pumps.

The EWA program obtains its water assets by acquiring, banking, transferring, or borrowing water and then arranging for its conveyance. Water is acquired substantially through voluntary purchases in the water transfer market and by developing additional assets over time. The EWA program also obtains water through operational flexibility of Delta facilities. Thus, the agencies could reduce their SWP and CVP water amounts by transferring them to EWA and instead use BARDP water. Table 6-1 presents EWA acquisitions from 2000 to 2005. The purchased water costs vary between $122 and $166 per acre-foot. This price is substantially lower than the projected BARDP water cost.

Table 6-1
CALFED Environmental Water Account Acquisitions, 2000–2005

Fiscal Year	Water Purchased (acre-feet)	Total Cost	Unit Cost ($/acre-foot)
2004-05	153,116	$21,915,360	$143
2003-04	155,000	$19,570,000	$126
2002-03	214,914	$30,967,620	$144
2001-02	239,543	$29,333,455	$122
2000-01	386,034	$64,423,008	$166

Source: http://www.watertransfers.water.ca.gov/water_trans/water_trans_index.cfm

Unless renewed by agreement, the EWA will expire on December 31, 2007. However, the U.S. Bureau of Reclamation, DWR, USFWS, NOAA Fisheries, and CDFG are currently analyzing a Long-Term EWA program. Should the Long-Term EWA be adopted, it is expected that it could become a long-term customer for the agencies.

6.5 CONCLUSIONS AND RECOMMENDATIONS

6.5.1 Conclusions

Based on the information collected to date, it does not appear that the potential customers need water to meet supply shortages during wet years. Therefore, they are generally not interested in purchasing water from the BARDP for supply reasons. Other reasons cited for lack of interest in water from the BARDP include the following.

- Customers have their own or are planning for their own desalination facility with adequate or excess supply.
- The BARDP may not be online in time to suit their needs.
- Additional infrastructure would be required to bring water to the customer, which would likely be costly.
- Industrial customers have the need to strictly control the quality of the water used for their processes.
- The projected cost of BARDP water may make purchasing that water uneconomical.

Some potential customers, such as Zone 7 Water Agency, City of Pittsburg, City of Antioch, and Calpine Corporation, did not expect the cost of water from the BARDP to be less than their current supply. The cost of water for Zone 7 Water Agency is $591 per acre-foot. Zone 7 would be interested in opportunities to use water from the BARDP if it is economical and can help improve Zone 7’s water quality. MMWD may be interested if the BARDP would be operational in time to suit the district’s needs and an economical way to transport the water to the district’s service area can be provided. The projected water cost for the MMWD desalination plant is between $2,000 and $3,000 per acre-foot.

Finding buyers on the California open market for wet years only would be difficult. However, the demand for urban water supplies will continue to increase, and urban buyers are generally interested in purchasing reliable supplies either for sustained use or dry year protection. The amounts that buyers are willing to pay on an annualized cost basis range from $200 to $300 per acre-foot up to $500 per acre-foot and possibly more, depending on the severity of demand, but this would be limited to supplies that are known to be firm and reliable. Therefore, the BARDP partner agencies would probably have to develop packages that are not limited to wet year supply and that include reliable conveyance and storage.

The CALFED EWA could be a potential buyer; however, unless renewed by agreement, the EWA will expire on December 31, 2007. The U.S. Bureau of Reclamation, DWR, USFWS, NOAA Fisheries, and CDFG are currently analyzing a Long-Term EWA program. In addition, EWA water needs tend to occur during dry years, and therefore EWA would have to secure enough storage for BARDP water.

6.5.2 Recommendations

Because some potential customers cited cost concerns with purchasing water from the BARDP, it would be beneficial to continue discussions with these customers to determine price thresholds at which they would purchase BARDP water. Based on the cost of water for Zone 7 ($591 per acre-foot) compared to recent BARDP product water estimates (shown in Table 6-2), there appears to be some opportunity with this customer. Offering water at a cost that does not include capital cost recovery or includes partial capital cost recovery may attract customers.

Table 6-2
Estimated BARDP Product Water Costs in 2007 ($/acre-foot)

Plant Site	Plant Capacity (mgd)	All Year Operation[1]		Dry Year Operation Only[2]
		Wet Year	Dry Year	
East Contra Costa	10	$ 559	$ 669	
	15			$ 1,363
	25			$ 1,325
	35			$ 1,271
	55			$ 1,237
Oceanside	20			$ 2,994
	30			$ 2,808
	40			$ 2,694
Near Bay Bridge	40			$ 2,633

Notes:
This cost estimate was developed in 2005. A 3 percent inflation factor was applied to obtain current and projected costs. Appendix A presents a detailed description of cost evaluation.
[1] The plant was assumed to operate at full capacity all years. The on-stream factor was assumed at 95 percent.
[2] The product water costs for dry years assumed a sequence of one dry year for every two wet years. Furthermore, it was assumed that an offline desalination plant must sustain a reduced flow to maintain the integrity of the RO membranes. For that reason, the wet year O&M costs were estimated at 20 percent of the dry year O&M costs.

More detailed discussions with Zone 7 Water Agency should be conducted with respect to its water quality goals. A review of Zone 7's Water Quality Management Program should be conducted to identify areas where the BARDP could help Zone 7 meet its desired water quality goals.

Additional studies are needed to determine if a water transmission line can be economically developed to connect the EBMUD system to MMWD. Based on the cost of desalination water for MMWD ($2,000 to $3,000 per acre-foot) compared to recent BARDP product water estimates (Table 6-2), there appears to be some opportunity with MMWD. The estimates presented in Table 6-2 do not include wheeling costs through the EBMUD system. The timing of BARDP operation needs to be determined in regard to whether it could meet MMWD's needs.

The agencies have conducted a number of outreach efforts to inform and solicit input from the public, regulatory agencies, and stakeholder groups about the BARDP. Outreach methods have included a project website, presentations to interest groups, public forums, and contact with regulatory agencies. The agencies have been compiling and considering questions and comments received during the outreach process. The public outreach will be continued into subsequent project steps.

7.1 INTRODUCTION

This section describes the efforts that the agencies have conducted to inform the public, regulatory agencies, and stakeholder groups about the BARDP and the comments and questions received as a result of public outreach.

7.2 FEASIBILITY STUDY PUBLIC OUTREACH

As part of the Feasibility Study, the agencies conducted a number of efforts to inform the public about the BARDP and provide opportunities to give input. The agencies are reviewing public comments and questions gathered during this process and will take the input into consideration as they determine next steps. During 2006, key activities during the Feasibility Study included:

- Preparation of informational materials, including a project website, fact sheet, and letter to stakeholders
- Presentations to interest groups (six)
- Public forums (two)
- Regulatory agency outreach
- Response to public inquiries and comments

7.2.1 Informational Materials

The agencies developed the following informational materials to educate the public on the BARDP.

7.2.1.1 Website

The project website, www.RegionalDesal.com, has served as the main repository of public information during the feasibility study. The website includes a "What's New" section on the home page that is updated approximately monthly and announces public meetings and current activities. Other information describes the project, including goals and benefits, current status, next steps, and funding and costs. A number of documents are available for download, including background reports, public notice materials, a public outreach calendar, and the project fact sheet. Links to media articles and related websites are also provided. Between the website's launch date of September 15, 2006, and March 1, 2007, the website was viewed approximately 3,500 times. Viewers can also submit questions and comments through the website (info@RegionalDesal.com).

7.2.1.2 Fact Sheet

In addition to the website, the agencies created a fact sheet that summarizes project information (see Appendix H). The agencies mailed the fact sheet to the project's stakeholder contact list (developed from the agencies stakeholders lists), provided it at public meetings, and posted it on the website.

7.2.1.3 Activity Calendar

The agencies created an activity calendar for the public that lists past and upcoming public outreach activities. The calendar is available on the website.

7.2.2 Interest Group Briefings

The agencies created a PowerPoint presentation that is updated and tailored to each organization's level of knowledge and interest, as needed. In 2006, the following presentations and briefings were conducted:

- January 18, 2006
  Presentation at the California Association of Sanitation Agencies in Burlingame, CA, entitled "Overview of Regional Desalination Project"
- April 25, 2006
  Presentation at the California-Nevada American Water Works Association Spring Conference in Burlingame, CA, entitled "Bay Area Regional Desalination"
- May 12, 2006
  Presentation at Desalination Seminar by The Seminar Group in Santa Barbara, CA, entitled "Discussion of the Bay Area Regional Desalination Project"
- August 15, 2006
  Presentation at the Contra Costa Council meeting in Walnut Creek, CA
- September 12, 2006
  Presentation at the 21st Annual Water Reuse Symposium in Hollywood, CA, entitled "Decision Management Systems for Regional Desalination Initiatives"
- September 21, 2006
  Presentation at CCWD's Operations and Engineering Board Committee Meeting, Concord, CA

In addition, SFPUC conducted a series of presentations to interested organizations about proposed options for supplementing the current water supply, including desalination and the proposed BARDP.

7.2.3 Public Forums

The agencies conducted two public forums in October 2006: a public open house and a presentation to the Bay Area Water Forum.

7.2.3.1 Public Open House

The agencies held a public open house on October 11, 2006, from 7 p.m. to 8:30 p.m. at the SCVWD Board Room in San Jose. Public notice of the open house was issued through the following means:

- Newspaper ads in the *San Jose Mercury News* and the *San Francisco Examiner*
- Media release to TV, radio, and newspapers including:

ABC	*Campbell Express*	*Morgan Hill Times*
ABC-7	*Campbell Reporter*	*Mountain View Voice*
KPIX	*Cupertino Courier*	*Palo Alto Daily News*
KRON	Empire Broadcasting	*Palo Alto Weekly*
KSBW	*Gilroy Dispatch*	*San Jose Mercury News*
KSTS	*India West*	*Santa Teresa Times*
NBC-11	*La Oferta Review*	*Silicon Valley Community Newspapers*
ACWA News	*Los Altos Town Crier*	*Sing Tao Daily*
Almaden Times	*Los Gatos Daily News*	Sing Tao Radio
Bay City News	*Milpitas Post*	*Sunnyvale Sun*

- Newspaper article in the *San Jose Mercury News* on October 11, 2006, entitled "Water District Meeting to Present Desalination Plans"
- Invitation letters to environmental stakeholders (approximately 45 contacts)
- Notice on the project website (www.RegionalDesal.com)

Notification materials for the open house are included in Appendix H.

The Chairman of the SCVWD Board of Directors and SCVWD staff provided opening remarks. Information on the BARDP was relayed through a series of exhibit boards (included in Appendix H), as well as a video on desalination, fact sheets, and background reports. The exhibit boards included information on the desalination process, project background, a map of potential desalination site alternatives, project costs, schedule, and environmental and other challenges. Project staff helped to explain the exhibits and answer questions. Members of the public, staff and students from San Jose State University, and representatives from consulting agencies attended. Comments and input were summarized from written comment cards and discussion among project staff and attendees.

7.2.3.2 Bay Area Water Forum

The agencies gave a presentation to the Bay Area Water Forum, an organization of local water agencies and other regulatory agencies, on Monday, October 30, 2006, at the Elihu Harris State Office Building in Oakland. The presentation was announced on the project website as well as through the Bay Area Water Forum's notification procedures. Forty representatives from various water-related agencies and interest groups attended the presentation, including various water districts, DWR, SWRCB, Association of Bay Area Governments, Bay Area Council, and Bay Area League of Women Voters.

7.2.3.3 Regulatory Agencies

The San Francisco District of the U.S. Army Corp of Engineers (USACE) holds a monthly interagency meeting on the second Wednesday of every month for upcoming projects. On November 8, 2006, representatives from the BARDP agencies made a presentation at the interagency meeting to inform the regulatory agencies about the project, work performed to date on the project, and to receive feedback regarding future permitting issues. The following regulatory agencies were represented at the meeting:

- USACE
- National Oceanographic and Atmospheric Administration's National Marine Fisheries Service (NOAA Fisheries)
- U.S. Environmental Protection Agency
- California Department of Fish and Game
- California Department of Health Services
- Bay Conservation and Development Commission

The BARDP agencies gave a presentation about the proposed project and a dialogue ensued regarding the important regulatory issues associated with the project. The regulatory agencies made the following comments during the meeting:

- If the BARDP would be collocating with another facility and using its existing intake structure, that structure would need to be improved to minimize impingement and entrainment impacts.
- The BARDP partner agencies should be thinking of mitigation options now
- The regulatory agencies thought that the East Contra Costa site would have the most environmental issues.
- Delta smelt is a federal listed threatened species that is being considered for listing as endangered. Concerns related to this species would be a big issue at the East Contra Costa site.
- If a pilot plant is constructed the regulatory agencies would like to see toxicity testing performed on the brine and/or brine/effluent mix (if a shared existing outfall is used) and see how that analysis would be scaled up to apply to a full-scale desalination facility.
- The regulatory agencies would like to see a literature review of national and international studies on the effects of brine discharge.
- Could desalination be used as a means for allowing increases in river flows for environmental purposes?

7.3 KEY PUBLIC COMMENTS AND QUESTIONS

The following are key themes among the comments received to date from the public through briefings, e-mails, and other means.

General

- How does desalination work? What is the process used to develop desalinated water?
- What other public outreach efforts are taking place for the project?

Technology

- Have the participating agencies looked at desalination technologies in countries with more advanced capabilities and experience in this field?
- Will the BARDP agencies be testing multiple technologies in the pilot, or just one? What will be tested?

Environmental Issues

- Desalination plants in other areas have closed due to environmental impacts.
- What happens to the brine that is created through the desalination process?
- Brine discharge and environmental impacts, especially in the Delta, are a concern.
- Have the participating agencies looked at finding a use for the brine?
- Impingement and entrainment and its negative impact on marine life, specifically fish, is a concern.
- What are the thresholds for determining acceptable levels of impacts to marine life?
- What are the energy requirements for desalination? High energy consumption is a concern.
- Will lower energy-consuming technology or renewable energy usage be considered?
- It is commendable that participating agencies are looking at renewable energy.

Cost

- What are the differences in cost among the sites under evaluation?
- Why are the energy costs so variable among the sites?
- What are the different costs for dry years versus wet years?

Pilot Plant Site Alternatives

- What was the process for ranking sites during the pre-feasibility phase? How long will it take to choose the pilot plant site?
- Where in East Contra Costa would the pilot plant be?
- Was a pilot plant at the Alviso aqueduct considered, where there is a wastewater outfall?
- Was a pilot plant in the South Bay refuge considered? The South Bay needs saltier water, so it could benefit from the discharge.

Water Supply

- Will water rights need to be acquired for the pilot plant? If so, will this pose difficulties for some of the sites?
- It is commendable that participating agencies are looking ahead at how to fulfill future water supply needs.
- Will the plant run constantly, even during wet years?
- What percent of the combined agencies' water usage will the proposed desalination plant produce?

7.4 CONCLUSIONS AND RECOMMENDATIONS

Public interest in the BARDP was high. The public outreach will be continued into subsequent project steps. The website will be maintained and updated. Information collected during the pilot program and future project phases will help the agencies respond to comments and questions from the public and regulatory agencies.

California, with its complex water supply system, will be vulnerable to changes in water supply and demand related to climate change. The three general areas of impact from climate change—increases in temperature, precipitation, and sea level—are multifaceted, interrelated, and likely to affect California's water supply, demand, and system planning. This section provides an overview of potential climate-related changes such as flooding and extreme weather, salt water intrusion, and degraded water quality, and investigates the role of desalination technologies and programs such as the BARDP in California's water future. As climate change alters local hydrology and affects the resilience and variability of the existing water supply, desalination systems can provide a buffer, but they are not without cost and feasibility issues, energy and emissions considerations, and potential climate change–related implementation concerns.

8.1 INTRODUCTION

As acknowledgement of global climate change increases in the international community, scientists, government entities, and water agencies are attempting to assess the effects of climate change on water resources and develop strategies to address its long-term impacts. California, with its complex water supply system, will be particularly vulnerable to changes in water supply and demand related to climate change. Section 3 describes the assessment conducted to identify the optimum capacity and frequency of operation of a desalination plant based on the historic hydrology for 1920 through 2002. The assessment assumes that the historic record will represent future hydrological conditions. However, changes in the global climate are likely to affect the future hydrologic record. The purposes of this section are to provide an overview of those potential changes and to investigate the role of desalination technologies and programs such as the BARDP in California's water future. Although this section does not present additional analysis or studies specific to the BARDP, it presents a review of the existing literature pertaining to climate change in California and, when possible, to climate change as it could affect the BARDP. This section does not necessarily reflect the positions or policies of the partner agencies, which are currently developing individual policies regarding climate change. However, the information in this section reflects the efforts of various state agencies, most notably the Department of Water Resources (DWR). The climate change policies of the partner agencies would likely be developed with the aim of being consistent with state policies and goals.

Consensus on the definition of climate change has been difficult to achieve, but climate change can be broadly defined as variations in the global climate or regional climates over extended periods of time (Pielke 2004). Climate change can be anthropogenic (a result of human activity) or natural (Pielke 2004). Efforts to investigate the potential effects of climate change on California's water resources have been ongoing since the early 1980s (Kiparsky and Gleik 2003). In 2005, Governor Arnold Schwarzenegger issued an Executive Order establishing greenhouse gas emissions reduction goals and requiring the California Environmental Protection Agency to regularly report on the state's progress toward reaching the goals. On September 27, 2006, the Governor signed Assembly Bill 32, the Global Warming Solutions Act, which would cap California's greenhouse gas emissions at 1990 levels by 2020. Additional legislative actions taken by the State of California have established various programs and action teams to further investigate the effects of climate change.

State efforts to forecast the impacts of climate change represent only a small part of the multitude of global emissions scenarios and climate models that have been developed worldwide. The wide range of scenarios and models that exist reflects the degree of uncertainty inherent in this field of study. However, the projections set forth by the Intergovernmental Panel on Climate Change (IPCC), a joint effort of the World Meteorological Organization and the United Nations Environment Program, are reviewed by hundreds of scientific experts around the world, and are therefore among the most highly-regarded climate change projections. The IPCC released the first part of their Fourth Assessment Report on February 1, 2007, entitled “Climate Change 2007: The Physical Science Basis.” This document assesses the current scientific knowledge of the natural and human drivers of climate change, observed changes in climate, the ability of science to attribute changes to different causes, and projections for future climate change. Some projections that have been developed for the State of California are based on IPCC projections (CCCC 2006b; DWR 2006a). It should be noted that the uncertainties in climate change and temperature projections increase as global projections are scaled down to a regional level (DWR 2006a). Nonetheless, state and international research indicates that climate change could potentially affect California’s water resources in the following ways.

- Statewide average temperatures are expected to rise between 3 and 10.5 degrees Fahrenheit through the year 2099 (CCCC 2006b). Water demand from domestic, agricultural, commercial, and industrial users increases with temperature. Rising temperatures, potentially compounded by decreases in precipitation, could also severely reduce spring snowpack, increasing the risk of summer water shortages (CCCC 2006b). A rapidly melting snowpack could result in flooding and flows that exceed storage capacity (Kiparsky and Gleik 2003).
- Precipitation projections disagree as to whether climate change will lead to more or less rainfall, and some projections show little change in total annual precipitation in California (CCCC 2006b; Kiparsky and Gleik 2003). However, historical trends between 1966 and 1998 show that precipitation is increasing (DWR 2006a). Increased rainfall could result in flooding and flows that exceed storage capacity (Kiparsky and Gleik 2003).
- The sea level along California’s coast has risen about 7 inches over the past century and is expected to rise an additional 22 to 35 inches by the end of this century (CCCC 2006b). In San Francisco Bay, the level is projected to rise 6.5 inches between 2000 and 2030 (Martin 2007). Sea level rise can increase the potential for seawater intrusion into the San Francisco Bay, the Sacramento–San Joaquin River Delta (the Delta), and coastal groundwater aquifers, which would increase the salinity of those waters (CCCC 2006b; DWR 2006a).

These three general areas of effect are multifaceted and highly interrelated. Water agencies around the state have began to consider the implications of these effects on the reliability and safety of water systems, and professional water organizations have begun urging managers and planners to integrate climate change into long-term planning (Kiparsky and Gleik 2003).

Increases in temperature, precipitation, and sea level and their potential repercussions on California’s water supply, demand, and system planning are discussed in more detail below.

8.2 POTENTIAL EFFECTS ON REGIONAL WATER RESOURCES

8.2.1 Flooding and Extreme Weather Events

Climate change could exacerbate flooding by increasing the frequency and intensity of extreme weather events (Cooley et al. 2006; Kiparsky and Gleik 2003). The effect of climate change on extreme weather is one of the least well-understood categories of impacts. Scientific modeling has predicted various levels of increased storminess, but whether or not storms are predicted to occur more frequently, increased storm intensity is consistently forecast (Kiparsky and Gleik 2003). Modeling results indicate that the frequency of El Niño events could increase (Kiparsky and Gleik 2003). In addition, intense La Niña events and stronger interannual variability could occur, meaning that year-to-year variations may become more extreme under enhanced warming conditions (Kiparsky and Gleik 2003).

Increased flows and flooding resulting from rapidly melting snowpack and/or increased rainfall would add pressure on levees and other flood control structures, thus increasing the risk of structural failure (Kiparsky and Gleik 2003). If levees in the Delta were to fail, the fresh water capacity of the Delta would be reduced by saltwater intrusion from the Bay, thereby disrupting a major current water supply.

Several state programs have been established to address growing concerns related to the Delta's aging levee system. CALFED's Delta Vision is intended to identify a strategy for managing the Delta as a sustainable ecosystem. It is composed of an independent Blue Ribbon Task Force, appointed by the Governor, that will be responsible for recommending future actions to achieve a sustainable Delta (CALFED 2007). The Department of Water Resources (DWR) is developing a strategic initiative called FloodSAFE to improve flood protection for the people of California (DWR 2006b). This initiative would help to minimize flood risks and the consequences of floods.

Changes in precipitation variability could also increase the frequency of droughts (DWR 2006a). During seasons that are already dry, runoff will decrease further because of a decline in snowpack and accelerated spring snowmelt (Kiparsky and Gleik 2003).

8.2.2 Sea Level Rise

Warming of the climate on a global scale has and will continue to warm sea temperatures, causing glaciers to melt and water to expand, ultimately leading to rising sea levels. The worldwide average sea level has risen about 0.3 to 0.6 feet over the past century and is projected to rise 0.3 to 2.9 feet by the year 2100 (DWR 2006a). As previously stated, in San Francisco Bay, the level is projected to rise 6.5 inches between 2000 and 2030 (Martin 2007). Further inland, sea level rise diminishes and is much smaller in the Delta compared to the coast (Duffy 2006). There is evidence that the coast of Northern California is experiencing a slow uplift, or increase in elevation (DWR 2006a). Coastal areas that are undergoing uplift will tend to experience a slower sea level rise than the worldwide average or sea levels that appear to be declining or not changing compared to worldwide trends. It could be argued that uplifting land will lessen the effect of sea level rise in the Bay Area, but due to the uncertainties in climate change predictions, more research is necessary.

Sea level rise increases the potential for seawater intrusion into the Bay and Delta as well as coastal aquifers, thus leading to increased salinity of Bay and Delta waters (CCCC 2006b; DWR 2006a). The low-lying marshes and estuaries of the Delta are particularly susceptible to the influx of saltwater as a result of sea level rise. Under natural conditions, fresh water in coastal aquifers flows toward the ocean, keeping saline ocean water from moving inland. However, the increased pressure of ocean water exerted against water-bearing deposits hinders the flow of fresh water outward, making less fresh water available to the surface.

Sea level rise can also increase the potential for intrusion of seawater into coastal groundwater basins through the inundation of areas that were formerly above sea level (DWR 2006a). Furthermore, if groundwater pumping exceeds the rate of natural recharge, ocean water may move inland (DWR 2006a; Kiparsky and Gleik 2003). Many groundwater basins along California’s coast are susceptible to seawater intrusion or to the intrusion of brackish water from bays and estuaries. Seawater intrusion into groundwater has occurred in some areas around San Francisco Bay and the Delta (DWR 2006a). As saline groundwater is released to the surface, the salinity of the ambient surface water increases.

8.2.3 Raw Water Quality

Increases in temperature and changes in flows due to extreme weather or droughts could affect water quality in different ways. Decreased stream flows during periods of low precipitation can exacerbate water temperature rise, increase the concentration of pollutants, increase the time required for contaminants to flow out of water bodies, and increase salinity (Kiparsky and Gleik 2003). During dry seasons when snowmelt is low, decreased surface water volumes can increase sedimentation, concentrate pollutants, and reduce non-point source runoff (Kiparsky and Gleik 2003). Increased water flows can dilute point source pollutants, increase loadings from non-point source pollutants, decrease chemical reactions in streams and lakes, reduce the flushing time for contaminants, and increase export of pollutants to coastal wetlands and deltas (Kiparsky and Gleik 2003).

Indirect effects of climate change on source water quality include reduced dissolved oxygen levels, increased chloride mass loadings, and increased particulate matter from extreme weather- and flood-induced erosion (DWR 2006a; Kiparsky and Gleik 2003). Another indirect effect is increased water salinity (see Section 8.2.2).

8.3 POTENTIAL EFFECTS ON WATER DEMAND AND SUPPLY

Rising temperatures related to climate change would both increase water demand and reduce the reliability of existing water supplies by degrading water quality and decreasing the amount of stored water. The anticipated effects of climate change on water demand and supply are described below.

8.3.1 Water Demand

Of the water demand factors that could be directly affected by climate change, potential changes in evapotranspiration,[1] agricultural practices, and environmental water demand (water for fisheries and habitat) might be the most significant for California (DWR 2006a; Kiparsky and Gleik 2003). Modeling results indicate that the agricultural sector, the state's largest single user of water, and regions of Southern California would experience the greatest water scarcity resulting from climate change (CCCC 2006a; Kiparsky and Gleik 2003).

Domestic water demand typically increases with temperature. Increased domestic water demand could occur due to the use of water for cooling, more frequent laundering and bathing, increased drinking water requirements for humans and pets, increased landscape irrigation, and recreational water uses (DWR 2006a; Kiparsky and Gleik 2003).

Commercial and industrial water uses could also increase as temperatures rise (DWR 2006a).

8.3.2 Surface Water Supply

Climate change could affect existing surface water supplies and infrastructure, which may have already grown unreliable in recent decades due to aging facilities. As stated in Section 8.2.2, fresh water in the Delta could be subject to saltwater intrusion, and rising temperatures, potentially compounded by decreases in precipitation, could severely reduce spring snowpack, increasing the risk of summer water shortages (CCCC 2006b). Filling winter reservoir flood control space during late spring and early summer could be difficult with reduced spring snowmelt, thus potentially reducing the amount of surface water available during the dry season (Kiparsky and Gleik 2003). On the other hand, the wet season could yield increasingly high flows that potentially exceed the design capacity of the existing reservoir system. The reservoirs may be unable to store all of these flows for irrigation, power, and urban uses during the dry season (Martin 2007).

8.3.3 Groundwater Supply

As described in Section 8.2.2, rising sea level as a result of climate change could increase the potential for seawater intrusion into coastal groundwater aquifers. As the demand for water supply grows, groundwater pumping is likely to increase. However, increased groundwater pumping could exacerbate seawater intrusion beyond the effect of sea level rise, further degrading groundwater quality (DWR 2006a; Kiparsky and Gleik 2003).

Groundwater recharge could also be affected by climate change (Kiparsky and Gleik 2003). Additional winter runoff could occur at a time when some groundwater basins, particularly those in Northern California, are either being recharged at their maximum capacity or are already full (Kiparsky and Gleik 2003). Conversely, reductions in spring runoff and higher evapotranspiration rates could reduce the amount of water available for recharge in the spring (Kiparsky and Gleik 2003).

[1] Evapotranspiration is the process in which water is transferred from the earth's surface to the atmosphere through the *evaporation* of liquid or ice and the *transpiration* of water from plants. Plants transpire, or secrete, water through pores in their leaves.

8.4 POTENTIAL ROLE OF DESALINATION AS AN ALTERNATIVE WATER SUPPLY

Because climate change could decrease the reliability of traditional surface water and groundwater supplies, technological innovation could play a significant role in determining California's future water supply (DWR 2006a). One such innovation is seawater or brackish water desalination. As climate change alters local hydrology and affects the resilience and variability of the existing water supply, a reliable supply of high-quality water from desalination systems that are independent of hydrologic conditions can provide a buffer against this variability (Cooley et al. 2006). The following describes the general cost issues related to desalination, energy and emissions considerations, and potential implementation issues related to climate change.

8.4.1 Cost Issues

Desalination technology is relatively expensive and energy-intensive, although the unit cost has fallen in recent years (DWR 2006a). It is unclear whether the cost of desalination could decline enough to become economically competitive with other available and emerging sources of water supply. However, if the cost of desalination continues to fall and the potential impacts of climate change continue to threaten existing water supplies, desalination could become a more viable option for the future. More improvements in desalination technologies, which could be implemented throughout the lifetime of a desalination plant, could reduce costs and energy requirements. In the meantime, the potential for implementing desalination is generally greater in wealthy coastal communities, where residents may be willing to pay to invest in a more reliable water supply in the face of climate change (CCCC 2006a; Martin 2007).

8.4.2 Energy Consumption and Greenhouse Gas Emissions

The water sector in California is a major user of power in the state, accounting for an estimated 19 percent of total electricity consumption and 32 percent of natural gas consumption in 2001 (CEC 2005). Historically, desalination has been the most energy-intensive source of water. A life cycle assessment of three water supply sources—desalination, importation, and recycling—in the San Francisco Bay Area showed that desalination demands two to five times more energy and generates two to 18 times more greenhouse gas emissions than the other two water supplies (Stokes and Horvath 2005). In recent years, improvements in membrane technology and advances in energy recovery systems have decreased energy requirements for desalination. Studies conducted for the MMWD desalination facility found that the energy required to desalinate water for one household in the service area was only slightly higher than that required to operate a 75-watt lightbulb (MMWD 2007).

Extensive development of desalination facilities can exacerbate the effects of climate change by increasing fossil fuel demand and, consequently, greenhouse gas emissions (Cooley et al. 2006). The Pacific Institute (Cooley et al. 2006) recommends that plans for desalination must explicitly describe the energy implications of the facility and how these impacts fit into regional efforts or requirements to reduce greenhouse gas emissions or meet regional, state, or federal clean air requirements.

If the proposed desalination plant could be powered by alternative energy, its greenhouse gas impacts could be reduced. Photovoltaics and wind turbines are powering several desalination facilities around the world (Cooley et al. 2006). Another alternative is to integrate a desalination system with an existing power plant. The advantages of a joint desalination and power plant include utilizing discarded thermal energy from the power plant (known as co-generation), lowering electricity costs due to off-peak use, and avoiding power grid transmission costs (Cooley et al. 2006). In addition, co-locating a desalination plant and a power plant would save electricity that would otherwise be lost over long transmission lines. Building on an existing power plant site may prevent impacts at more pristine or controversial locations. Co-location could offer substantial energy, economic, and environmental advantages.

A desalination plant would be located within or in closer proximity to its service areas than existing water supply sources. This could potentially affect the energy needed to pump water to customers.

8.4.3 Implementation Issues Related to Climate Change

Desalination would provide a viable water supply option when major water supplies are disrupted by saltwater intrusion due to sea level rise or Delta levee failures. Likewise, desalination would provide a reliable water supply in years of decreased runoff since it would derive its raw water from the sea or Bay. However, certain effects of climate change could present issues in implementing desalination technology.

A desalination plant could be vulnerable to storm surges and severe high tides caused by extreme weather events depending on its location (Kiparsky and Gleik 2003). Sea level rises would be much smaller in the Delta than at the coast (Duffy 2006), but over the expected lifetime of a desalination plant, sea levels could rise by as much as a foot or more (Cooley et al. 2006). A BARDP desalination plant constructed at Oceanside would be affected by sea level rise more than a plant at the Near Bay Bridge or East Contra Costa sites, though Bay and Delta water levels at these locations would also increase. Inundation could occur at all three of the top-ranked potential sites, but to a lesser extent at Near Bay Bridge or East Contra Costa. The intake and outfall structures of a desalination plant are also affected by sea level rise because the designs of such structures are partly dictated by their positions in the water column (Cooley et al. 2006). For that reason, sea level rise has the potential to affect both desalination plant design and operation and should be evaluated before plant construction and operation.

Seawater intrusion into groundwater has occurred in some areas around San Francisco Bay and the Delta (DWR 2006a). As saline groundwater is released to the surface, the salinity of the ambient surface water increases. This could potentially cause the waters of the Bay and the Delta to become even more saline, which would require more energy for the reverse osmosis (RO) desalination process. The energy requirements for RO depend directly on the concentration of salts in the source water and, to a lesser extent, on the temperature of the source water. As a result, energy consumption and product water cost increase with source water salinity (Cooley et al. 2006).

Climate change could increase seawater (or Bay or Delta water) temperature (DWR 2006a; Kiparsky and Gleik 2003). An increase of Delta water temperature could also be exacerbated by decreased surface flows, as described above. Higher water temperature may actually benefit desalination by increasing water permeability, which facilitates RO. Less energy would be required to push the feedwater through the RO membranes. However, the energy savings may be negligible compared to the energy required for an RO system.

Climate change could affect raw (or source) water quality, thereby changing the raw water characteristics that a desalination plant is designed to handle. Because the desalination plant would operate primarily during dry years when flows are low, raw water would likely be more polluted (primarily point source pollutants) and saline than current conditions. Lower summer flows could reduce dissolved oxygen concentrations, which may not have a notable effect on desalination processes. Seawater intrusion leads to increased chloride mass loadings at raw water intakes, which may affect desalination plant source water and the subsequent desalination processes. Increase in particulate matter could require more rigorous pre-treatment and energy. It is unclear what other water quality problems will arise due to climate change, but in general, lower summer flows could reduce the dilution of pollutants (Kiparsky and Gleik 2003). The performance of a desalination plant using existing technologies could be sensitive to increased pollution in the source water.

8.5 FINDINGS

Modeling studies by others indicate that the agricultural sector and regions of Southern California would be most affected by water scarcity resulting from climate change (CCCC 2006a; Kiparsky and Gleik 2003). The BARDP agencies are not directly concerned with the agricultural sector, which is mainly located in the Central Valley, but have water contracts with the same agencies: the DWR for the State Water Project (SWP) and the U.S. Bureau of Reclamation for the Central Valley Project (CVP).

Commercial and industrial water uses could also increase as temperatures rise (DWR 2006a). Because of the concentration of these urban users in the Bay Area, additional sources of water beyond existing supplies could be needed to meet the increasing demand caused by climate change. Desalination could be an alternative to help meet this demand.

Because the BARDP desalination plant would be fed by sea, Bay, or Delta water, there would be no shortage of source water for desalination. Furthermore, although increased salinity in the source water could lead to greater energy demand by a desalination plant, the plant would not be inhibited and would still be able to carry out its intended function, which is to transform saltwater into drinking water supply. Therefore, desalination can be considered an adaptive response to climate change and may help reduce dependence on climate-sensitive sources of supply.

A project implementation plan for the BARDP was developed based on the findings of this Feasibility Study. Although the agencies have not selected a final plant site, and the agencies reserve the right to revisit any of the previously investigated sites or other sites, they are pursuing a pilot program in the East Contra Costa site vicinity. Following the pilot study, the agencies would conduct a detailed site selection study and identify a proposed site for the desalination facilities. Hazardous waste and geotechnical investigations would be performed. The agencies would also continue to evaluate green technology alternatives and the technical feasibility of producing and distributing a new water source through their existing infrastructure. A site-specific preliminary site layout would be prepared and conceptual engineering design would be performed. The partner agencies would also need to determine and execute the appropriate organizational structure for implementing the BARDP. Environmental impact studies of the proposed project would be conducted, and environmental permitting would be initiated. After completion of the environmental review and permitting process, the BARDP desalination plant would be designed and constructed.

9.1 INTRODUCTION

This section describes the following steps necessary to implement the BARDP:

- Desalination pilot program
- Site selection study / identify proposed project site
- Preliminary site layout and conceptual engineering design
- Environmental impact studies/ environmental permitting
- BARDP organizational structure determination
- Project design and construction
- Schedule

9.2 DESALINATION PILOT PROGRAM

The partner agencies are planning to conduct a pilot program to further develop desalination as a regional water supply. Although the agencies have not selected the East Contra Costa site as the final plant site, and the agencies reserve the right to revisit any of the previously investigated sites or other sites, they are pursuing a pilot program in the East Contra Costa site vicinity. Several desalination pilot programs have been or are being conducted along California's coast (e.g., Long Beach, West Basin, and Carlsbad), and the MMWD desalination pilot program was completed in San Francisco Bay in 2006; therefore, the partner agencies are focusing their pilot program in the brackish waters of the Suisun Bay estuary. The results from the other studies may also be used to augment this desalination pilot program.

The pilot plant is proposed to be constructed at an existing CCWD pump station near Pittsburg, California, and draw water from the Suisun Bay estuary. The plant would provide the current data for this area of the North Bay/Delta estuary that are necessary for prudent evaluation of a full-scale regional desalination facility in the San Francisco Bay Area. The pilot program would also allow testing to support a project Environmental Impact Report (EIR) to ensure that the desalination facility would not adversely impact the Bay environment. The desalination pilot program would have the following objectives:

- Test technologies to minimize adverse environmental impacts from entrainment of aquatic organisms in the intake source water.
- Evaluate pressurized and submerged microfiltration pretreatment and determine the preferred pretreatment process for the source water.
- Test technologies and methods to maximize the overall efficiency of the desalination process.
- Demonstrate that the desalination process can reliably treat the variable Suisun Bay source water to equal or better than state and federal safe drinking water standards.
- Conduct testing of the brine discharge to ensure that the discharge would not adversely impact the Bay environment.
- Conduct testing of pretreatment residuals and develop design criteria for full-scale plant residuals handling to ensure acceptance of these residuals by a common landfill.
- Conduct a public outreach program to inform the public about the desalination process and the overall project through tours, presentations, educational materials, and taste tests.
- Develop design criteria and capital and operating costs for a full-scale desalination facility with an ultimate capacity of 65 mgd of drinking water production.

9.3 SITE SELECTION STUDY / IDENTIFY PROPOSED PROJECT SITE

The partner agencies conducted a site identification and ranking study in which two Mirant power plant sites were ranked as No. 1, the Oceanside site was ranked as No. 2, and the Near Bay Bridge site was ranked as No. 3 (see Section 2.1). Since there was a tie for No. 1, it was agreed that the Mirant Pittsburg Plant site would be selected as No. 1 and the Mirant Contra Costa Plant site would be eliminated. The three sites represent a mix of locations and feedwater types—Bay/Delta water (Mirant Pittsburg Plant), Bay seawater (Near Bay Bridge), and ocean seawater (Oceanside).

The Mirant Pittsburg Plant site was subsequently renamed the East Contra Costa site, and its geographic location was broadened to include the portion of Contra Costa County bordering the Sacramento River/New York Slough/San Joaquin River from Mallard Slough east to Antioch. A detailed site selection study would be performed to identify one or possibly two potential sites. These sites would then be subject to hazardous waste and geotechnical investigations as described below.

The agencies reserve the right to revisit any of these sites, or other sites, in the future should their needs change or other partners join the project.

9.3.1 Hazardous Waste Investigation

This task would determine if any known hazardous waste contamination exists at the site(s). If necessary, the services of an environmental data research firm would be retained to perform a regulatory database search for the location; this information may be available through the partner agencies. The results of the search for properties within the study area that are listed on federal, state, and local environmental databases would be presented in a report. A description of each database would be provided. The results of the database search would include the following:

- Addresses of known underground storage tank (UST) sites
- Addresses of landfills
- Hazardous waste generation, treatment, storage and/or disposal facilities
- Subsurface contamination known to be present in the study areas

9.3.2 Geotechnical Investigation

This task would use existing published information to evaluate the geological conditions at the site(s). The investigation would focus on soil conditions and seismic considerations that may dictate elements of the design, such as the use of in-ground concrete clarifiers versus above-ground steel clarifier tanks and ancillary equipment. Locations that would require special foundation work such as deep piles to support heavy structures would be identified. In addition, risks associated with seismic shaking from events along proximate faults, seismic-related ground failure, and impacts from expansive soils and/or soil liquefaction due to development at each of the alternative sites would be evaluated. Understanding these risks is particularly important if the facility will be used for emergency water supply.

Potential issues associated with low slope stability (landslides) would be identified. Attention would be given to the possibility that existing potentially adverse conditions in and around the potential sites may be exacerbated by project implementation.

Existing data, such as the seismic hazards section of the relevant General Plans, would be reviewed and evaluated. Background research would include a review of published geology maps, soil maps, landslide and active fault maps, and other relevant data published by the U.S. Geological Survey and the California Division of Mines and Geology.

9.4 EVALUATION OF GREEN TECHNOLOGY ALTERNATIVES

Evaluation of “green” technology alternatives is an ongoing process of identifying and evaluating alternatives that avoid or mitigate for potential adverse environmental impacts associated with the proposed BARDP facility. Alternatives include membrane technologies, energy alternatives, aquatic filter barrier technologies, and other systems and technologies that may reduce potential impacts.

9.5 TECHNICAL FEASIBILITY

Technical feasibility studies would include analyses required to demonstrate that product water can be produced and distributed to benefit all of the partner agencies. Some of these studies would expand on issues that were addressed in a preliminary fashion in this Feasibility Study. Such studies would include, but not be limited to, hydraulic modeling to determine if additional water supplies from a different source location could be accommodated through the agencies’ existing infrastructure, and blending studies to evaluate compatibility of adding new water sources to existing supplies.

9.6 PRELIMINARY SITE LAYOUT/CONCEPTUAL ENGINEERING

Based on information obtained from the desalination pilot program and other published studies and operating desalination systems, recommendations would be made for the treatment processes and operating parameters for a full-scale BARDP desalination facility. These recommendations would result in a site-specific preliminary site layout and preliminary engineering design in sufficient detail to allow for environmental impact analyses.

Because the full capacity of the desalination facility would be required for dry periods (low-rainfall years) and droughts, the pretreatment systems design approach would be based on meeting the required capacity under worst-case dry period source water conditions.

The overall treatment process for a full-scale desalination facility would likely include the following major components:

- Intake system
- Pretreatment system
- First-pass SWRO system
- Second-pass SWRO system
- Post-treatment and disinfection system
- Solids residuals handling system
- Brine discharge system
- Ancillary support systems

The full-scale desalination facility would likely include the following major site buildings or process areas:

- Operations and maintenance building
- Chemical storage area
- Pretreatment process area/basins
- First-pass SWRO and second-pass RO building
- Post-treatment process area and finished water disinfection tanks
- Solids residuals handling basins and dewatering building

9.7 ENVIRONMENTAL IMPACT STUDIES/ENVIRONMENTAL PERMITTING

Construction and operation of the plant would require compliance with the California Environmental Policy Act (CEQA) along with several other environmental laws, rules, and regulations. An EIR and related technical reports would have to be prepared. The technical reports would be prepared to both support the EIR and to support obtaining various permits and approvals associated with the BARDP. One of the agencies would perform the role of the lead CEQA agency. If the partner agencies form a Joint Powers Authority (see Section 9.8) prior to environmental permitting, then the Authority would be the lead agency. If federal funds are used to construct the facility, or a federal permit is required, then construction and operation of the plant would require compliance with the National Environmental Policy Act (NEPA). The type of environmental document required under NEPA will depend on the type of permit required and which agency would be the federal lead agency. In any case, a joint environmental document could be prepared to satisfy both CEQA and NEPA. A detailed scope of work for conducting environmental impact studies for the BARDP is provided in Appendix I. This scope would need to be revised and/or further tailored once the specific project site and project configuration has been identified.

Major permits or approvals that would likely be required for the BARDP include:

- NPDES Permit from the San Francisco RWQCB
- Section 401 Water Quality Certification from the San Francisco RWQCB
- Section 404 Permit from the USACE
- Permit from the BCDC
- Consultation with the USFWS and NOAA Fisheries in accordance with Section 7 of the Federal Endangered Species Act
- Consultation with CDFG through the Federal Endangered Species Act Section 7 consultation process for state-listed threatened or endangered species
- Permit from the State Lands Commission if a portion of the project is on state land

Information gathered from the environmental impact analyses and technical studies discussed above would be used in these permit applications.

9.8 ORGANIZATIONAL STRUCTURE FOR FULL-SCALE BARDP

There are three primary alternatives for ownership of the desalination facilities:

- The facilities could be owned by the agency in whose service area the facilities are located.
- Ownership of the facilities could be the joint responsibility of the agencies, with benefits and obligations, including water supply and share of costs, defined by terms of an agreement among the agencies
- A separate public entity (an Authority) could be formed through a JPA to own the facilities.

At any point after the pilot plant study and final site selection, the partner agencies would determine which type of organizational structure would be best for the BARDP and then implement that structure.

9.9 PROJECT DESIGN AND CONSTRUCTION

Project design would be an iterative process that begins with the scale-up analysis from the desalination pilot program, continues with preliminary engineering design for environmental impact studies and permitting, and ends with final design and construction specifications. Environmental impact analysis, permitting, and coordination with resource agencies would all contribute to the project design. It is the agencies’ intent to create a “green” desalination project by reducing energy consumption as much as feasible, using renewable forms of energy, and minimizing the environmental footprint of the project. These factors would also significantly affect the project design.

After the final design has been completed, the agencies would then solicit construction bids, select a contractor, and construct the project.

9.10 SCHEDULE

Estimated completion dates for the elements of project implementation are shown below.

Table 9-1
Elements of Project Implementation Plan

Plan Element	Completion Date
Desalination Pilot Program	2009
Site Selection Study / Identify Proposed Project Site	2009
Evaluation of Green Technology Alternatives	2009
Technical Feasibility	2009
Preliminary Site Layout and Conceptual Engineering Design	2010
Environmental Impact Studies	2010
Environmental Permitting	2010
Project Design	2010
Project Construction	2012

9.11 RECOMMENDATIONS

The following actions are recommended to better identify how the BARDP can serve climate change–related water supply needs and provide a model for an energy-efficient desalination facility:

- Develop more quantitative information about the impacts of climate change on water supply to more accurately estimate/evaluate the need for desalination water, and
- Evaluate the potential energy savings from co-location, use of energy-efficient equipment, and implementation of energy recovery measures.

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