California Desalination Planning Handbook

Prepared for:
California Department of
Water Resources

Prepared by:
California State University, Sacramento
Center for Collaborative Policy

Acknowledgements and Foreword

The author acknowledges the key findings and major recommendations of the California Water Desalination Task Force as the basis for this California Desalination Planning Handbook. Appreciation is extended to its Chair, Co-Chairs and members. Their leadership, investigations, dialogue and problem solving paved the way for identifying the key elements that should be included in planning for and evaluating new desalination facilities in California. The names of the Task Force Chair, Co-Chairs and members can be found at the following Website address:

http://www.owue.water.ca.gov/recycle/desal/Docs/Desal_TF_Membership_List.pdf

The Task Force was primarily staffed and supported by the California Department of Water Resources (DWR), whose contributions are also thankfully acknowledged, in particular Chuck Keene, Dr. Fawzi Karajeh and Dr. Fethi BenJemaa. In addition to funding from DWR, the U.S. Bureau of Reclamation also provided funding to support the work of the Task Force.

As a follow-up to the work of the Task Force a one-day workshop was held at the University of California, Santa Barbara (UCSB) to review and comment on a draft framework for planning associated with desalination facilities. The workshop was attended by several Task Force members as well as many other individuals who expressed interest during the Task Force process. The workshop was co-sponsored by the Center for Collaborative Policy, California State University Sacramento and by UCSB under the leadership of Dr. Robert Wilkinson. The partnership with UCSB and input from workshop participants is greatly appreciated.

The invaluable contributions of the authors of the many working papers supporting the work of the Task Force are also gratefully recognized. Additionally, representatives of regulatory agencies with primary responsibilities for desalination related permits participated in a one-day workshop to identify roadblocks, differing approaches and ways to improve the permitting process. Their contribution is also thankfully acknowledged.

Finally, appreciation is extended to the many Task Force members who provided comments on earlier versions of the Handbook and helped shape its focus and content. Their expertise and willingness to invest time in advancing the dialogue and providing guidance on the applications of desalination in California is greatly appreciated.

This Planning Handbook was developed from all the sources described above under the leadership of DWR, especially Dr. Fawzi Karajeh, Chief, Recycling and Desalination Branch. Its contents, however, represent the integration of several independent sources of information in addition to those noted above, including reports on desalination by the Coastal Commission, the San Francisco Bay Conservation and Development Commission, the Monterey Bay National Marine Sanctuary, the Pacific Institute, Poseidon Resources Inc., among others.

The primary author of this report is Gregory Bourne, Managing Senior Mediator, Center for Collaborative Policy (CCP), California State University Sacramento, who also served as the independent mediator of the Task Force. Contributions to this Handbook from CCP colleagues include John Folk-Williams, Austin McInerny, Brian Davis and Tina Chen.

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Cover Photos:
Left photo: Gideon Litchfield
Center photo: Danielle Supercinski
Right photo: Gideon Litchfield

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Chapter 1

Background and Introduction

Desalination is receiving increased attention as a means for addressing the water supply challenges of California. Growing population, much of which is located in semi-arid regions of the state, and various other water demands pose increased pressure on existing water supplies. Much of California's water supply depends on snow accumulation in the winter, providing spring runoff that fills reservoirs and replenishes often depleted groundwater supplies. But in periods of drought, water supply shortages can be encountered throughout the state, particularly in the central valley and southern portion of the state.

All indications suggest the impacts of global warming will include a change in the timing of runoff and less snowfall. This will put more pressure on existing supplies, and exacerbate the impacts of drought. As the implications of global warming become clearer, more emphasis will likely be given to developing new sources of water supply to meet existing and projected demand. While conservation and recycling are recommended as the first course of action, other alternatives (such as desalination and increased surface and groundwater storage) are receiving increased attention.

While conservation and recycling are recommended as the first course of action, desalination is receiving increased attention as a new source of water supply.

In September 2002, AB 2717 was signed into law, designating the Department of Water Resources (DWR) to establish the California Desalination Task Force (Task Force) to "make recommendations related to potential opportunities for the use of seawater and brackish water desalination." The Task Force, through DWR, was to report to the legislature on potential opportunities for the use of seawater and brackish water desalination in California, impediments to the use of desalination

technology; and what role, if any, the State should play in furthering the use of desalination technology.

Subsequently, desalination has been highlighted in the California State Water Plan *(Reference: DWR; Chapter 9, #6)* as an alternative to be considered as part of a region's water supply portfolio. Likewise, Proposition 50 set aside funds to both test and construct desalination facilities as a source of water supply. These initiatives have added impetus to both brackish and seawater desalination as legitimate alternatives to consider in addressing water supply needs. Nonetheless, some remain concerned about the use and possible proliferation of desalination due to potential environmental impacts, energy consumption, greenhouse effects, environmental justice and other considerations. As such, the basis of these concerns will need to be addressed to gain broad support among various publics who believe some aspects of desalination have not yet been adequately addressed.

This Handbook builds on the report from the Task Force, which includes a list of key findings and major recommendations, submitted to the State Legislature in early 2004. (Chapter 9, #1 contains a link to the Task Force findings and recommendations.) The Task Force was comprised of a broad array of stakeholders who worked to develop consensus on the many recommendations developed. While consensus was not achieved on all points, the findings and recommendations highlighted were broadly supported by Task Force members.

Seawater and brackish groundwater desalination have been used in California for many years.

No claims of consensus are made for this Handbook. But every effort was made to build as closely as possible on the Task Force recommendations and to accurately describe both the opportunities and concerns associated with desalination. Furthermore, the Handbook is intended to outline a process to assist in: 1) determining the appropriate conditions, 2) addressing identified concerns, and 3) building public trust for desalination projects.

CURRENT STATUS OF DESALINATION IN CALIFORNIA

Seawater and brackish groundwater desalination processes are not new, and both have been used in California for many years. In the past, however, seawater desalination has been prohibitively expensive

in the United States. But with new, longer lasting and more efficient membranes, and lower energy demand of these membranes, the cost of desalinating seawater water, in particular, is becoming more competitive. With cost subsidies for desalination, in the context of higher costs of existing or most new supplies, desalination is being considered a more realistic option for new water supply compared to just a few years ago. Yet it is not without challenges, which will be highlighted in this Handbook.

As the end of the first decade of the 21st century approaches, the desalination landscape is ever changing. Numerous projects are being proposed up and down the California coast (seawater desalination), in San Francisco Bay (estuarine desalination), and inland areas (brackish groundwater desalination). Historically, however, other than several large inland brackish groundwater applications, most desalination facilities have involved relatively small production operations. Today, a new trend is emerging – the proposed development of much larger seawater facilities, in the range of 30-50 million gallons per day (mgd). This has added a new level of scrutiny being given to seawater desalination.

Numerous new desalination projects are being porposed in California.

The landscape was quite different just three to four years ago. At that point five water districts within the Santa Ana watershed operated four brackish groundwater desalters and two ion exchange facilities. These facilities were treating and recovering about 49,000 acre-feet per year (44 mgd) of impaired groundwater. By 2010 it is anticipated there will be about a dozen desalters and about eight ion exchange operations, increasing the amount of groundwater recovered to about 244,000 acre feet per year (218 mgd). While most brackish groundwater desalting has occurred in Southern California, other facilities exist throughout the Central Valley and Northern California. The Alameda County Water District, for example, operates a facility capable of providing 5 mgd of drinking water to consumers from brackish groundwater desalting.

Also three to four years ago there were sixteen, relatively small ocean desalination facilities in operation. These ranged from about 2 acre-feet per year (2000 gallons per day (gpd)) to about 672 acre-feet per year (600,000 gpd). But approximately twenty new ocean and estuarine desalination facilities have been identified in various stages of planning. Proposed facilities would range from about 6 acre-feet per year (5000 gpd) to about 56,000 acre-feet per year (50 mgd).

Based on recent information, there are currently more than 40 desalination facilities in various stages of operation or planning, which represents a doubling in the number of facilities in just a four to five year period of time. While estimates vary, desalination is projected to provide between 5% and 10% of California's water supply during the next two or three decades. The Pacific Institute (*Reference: Chapter 9, #8*) projects that if all the seawater desalination facilities currently proposed were built-out, seawater desalination alone would provide 6 % of California's year 2000 urban water demand. (This would approach the volume of desalinated water currently being provided by brackish groundwater desalination in California (350-400 mgd)).

These trends reinforce the need to undertake thorough planning processes, especially in this early period of potentially expanding larger seawater desalination facilities. For much of the public, as well as elected officials, desalination represents a new source of water supply. And while the potential benefits of desalination are clear, there are also uncertainties associated with these facilities and their impacts. This suggests the need for concerted public education efforts, as well as the development of sound planning and permitting practices to ensure these facilities prove to be environmentally and economically acceptable.

Current trends reinforce the need to undertake thorough planning processes, especially in developing larger seawater desalination facilities.

Since 2005, funding has been provided in California for desalination research, feasibility studies, pilot projects and construction of new facilities (Proposition 50, Chapter 6). A brief summary of these projects is included in Appendix B. Through two rounds of funding from Proposition 50, more than $45 million has been invested to support further development of this technology and its potential application in California. This includes funding for both inland and coastal brackish groundwater facilities, estuarine facilities and seawater facilities, looking at a range of potential innovations such as "beach well" applications for intake and discharge, improved filter technology and improved energy efficiency.

In several instances, pilot and demonstration projects are being conducted to evaluate new technology, assess the product water and appraise the feasibility of larger scale desalination projects. These in essence provide a basis for adaptive management, as pilot or demonstration projects provide an opportunity to more thoroughly examine the design variables intended for a full scale project. Pilot

or demonstration projects are being used extensively to ascertain the potential applications of desalination.

In recent years, several public agencies and organizations have examined the use of seawater and brackish groundwater desalination, with application to California, including the National Water Resources Institute, the American Water Works Association, the U.S. Bureau of Reclamation, the Monterey Bay National Marine Sanctuary (NOAA), the California Coastal Commission, the San Francisco Bay Conservation and Development Commission (BCDC), and the Pacific Institute. References to these works are included in the Handbook.

PURPOSE OF THE HANDBOOK

The primary purpose of this Handbook is to provide a planning framework for developing, where appropriate, economically and environmental acceptable seawater and brackish groundwater desalination facilities in California. The Handbook does not prescribe technical options, acknowledging numerous other resources available to assist in these areas. It suggests neither wholesale support for nor opposition to desalination. The planning framework proposed should prove helpful, however, for water resources engineers, local government and water resources planners, public officials making water resources decisions, staff of regulatory agencies and the various publics who have an interest in the potential applications of desalination.

The primary purpose of this Handbook is to provide a planning framework for developing, where appropriate, economically and environmental acceptable seawater and brackish groundwater desalination facilities in California.

The planning process outlined in this Handbook is intended to identify and address the siting, regulatory, technical, environmental and other issues which should be considered in determining whether and how to proceed with a desalination project. In some cases, a particular location, type of technology or other design consideration may limit the acceptability of a project due to economic, environmental or other issues. In other cases, modifications to initially proposed design parameters might be necessary to enhance project acceptability. In yet other cases, with thorough planning and early outreach, only minor revisions might be required for facility permitting. Any of these outcomes must be considered possible at the outset of a project. Especially in the early stages of expanding the use of desalination in California, flexibility in design and operational considerations will likely be necessary to build support for projects.

One of the common themes regularly repeated during the work of the Task Force, and a primary recommendation, is the need for early and ongoing interaction among sponsors of desalination facilities, relevant regulatory agencies, community members who will be served by facilities and groups with a stake in the outcome. This recommendation provides the foundation for the planning framework outlined.

Photo Coutesy of Tom Arthur

KEY ISSUES

The Task Force strongly encouraged a case-by-case evaluation of proposed desalination facilities due to the many site-specific variables to be considered. The Task Force suggested that desalination should neither be accepted nor rejected on a wholesale basis.

As the basis for a thorough planning process, this Handbook provides a brief overview of the key issues which have been raised pertaining to seawater and brackish groundwater desalination facilities. Additionally, the Handbook references numerous attachments intended to provide background on the various issues involved in siting, designing, permitting and operating desalination facilities, each of which affect the environmental and economic viability of specific desalination projects. If these key issues can be satisfactorily addressed in planning and designing a desalination facility, the likelihood of the facility being accepted by the public and permitted by regulatory agencies should be greatly enhanced.

At this stage in the development of desalination policies and projects in California, some of the issues identified have no definitive resolution. Another intended purpose of this Handbook is to identify key issues which will likely need to be addressed to the satisfaction

of the public or regulatory agencies, and bring more attention to these issues so they can be fully discussed and resolved, to the extent possible.

The Task Force strongly encouraged a case-by-case evaluation of proposed desalination facilities due to the many site-specific variables to be considered. The Task Force suggested that desalination should neither be accepted nor rejected on a wholesale basis. As such, the issues of greatest importance to regulatory agencies as well as local stakeholders need to be squarely addressed if desalination is to be broadly embraced as a new source of water supply. It is also true that with the speed at which new technologies and mitigation measures are being developed, some of the major issues now being identified may become less of a concern in the future. This suggests the need for ongoing monitoring of technological progress as well as those variables (such as energy costs) that can affect the feasibility of developing desalination facilities.

Key issues that need to be addressed in developing desalination projects include:

- The role of desalination in the overall water portfolio of a region, in light of the need to have comprehensive conservation and recycling programs in place
- Ecological impacts of impingement and entrainment associated with seawater intake
- Ecological impacts associated with brine and related discharges
- Siting related to habitat value, public access, energy and other infrastructure, visual and other aesthetic considerations
- Potential project impacts on population growth
- Energy consumption and costs
- Sources and costs of energy
- Possible co-location with power plants, wastewater treatment plants and other facilities with water intake or outfall structures
- Public health considerations
- Regulatory requirements
- Land use implications
- Secondary and cumulative impacts.

A thorough planning effort is needed to address each of these critical issues in sufficient detail to answer the many questions that will arise in the review and permitting process, and to enhance public support. The Handbook provides a planning framework for addressing each of these in detail, many of which encompass significant challenges which need to be addressed from the standpoint of either regulatory or public acceptability.

Another variable in discussions about desalination facilities is the distinction between inland, groundwater desalination facilities and ocean or estuarine facilities. Many of the key issues and concerns are quite different between the two (e.g., the ecological impacts of feedwater intakes from seawater or estuarine sources, pre-treatment requirements), while some are similar (e.g., the ecological impacts of brine/concentrate disposal, growth implications). Where these distinctions are important, an effort is made to identify them in this Handbook.

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WATER RESOURCES PLANNING

As noted earlier, desalination is now considered one of the many water supply and management options available to water resources planners as part of a water supply portfolio. Water resources planning for a specific area or region, however, is ultimately linked to the water resources needs identified. For example, water resources planning needs for a specific region may include increased water supply, improved water quality, reduction in groundwater withdrawals, drought reliability, habitat restoration, flood control, among others. The key then is matching the best water resources management strategy(s) with the specific need(s) identified. In some situations desalination might be a viable alternative; in other cases it might not.

Currently, water resources planning in California occurs at several levels, and any initiatives to use desalination as a water supply source should be considered in this context. At the local and regional level, either city and county water agencies, or special districts which have been established to provide water supply or flood control, typically work with local planning and land use officials to assess future water demand and water management needs. In urban areas, Urban Water Management Plans are required to assess water supply and quality conditions within that area. These

Plans must be in place to qualify for state funding opportunities. In both rural and urban areas, basin-wide Groundwater Management Plans are required to assess groundwater resources and their relationship to surface water resources (conjunctive use) if state funding is being sought.

More recently, Proposition 50, Chapter 8 (established through public referendum) provided guidelines for developing Integrated Regional Water Management Plans (IRWMP) as a means of encouraging regions to begin working more cooperatively to address water resources needs. Beginning in 2007, IRWMPs must be adopted by regional partners in order to receive state funding specifically earmarked for regional water management projects. The State Water Plan also recommends more regional approaches to water resources planning and management. Increasingly, emphasis is being given to conducting more comprehensive, region-wide planning as the basis for funding water resources projects throughout the state.

Desalination should be evaluated as one possible component of a larger water management portfolio.

The implications of this regional, cooperative approach to water resources planning are significant to desalination. Presumably, desalination will be considered in the broader context of regional water resources needs, as one of several possible water management strategies to meet those needs. It will be evaluated as one possible component of a larger water management portfolio, comparing and contrasting its costs and benefits with other components of the portfolio. As such, planning for desalination facilities should be considered in this broader context of water resources management.

Of particular importance, the Task Force recommended that water conservation be maximized prior to or as part of a larger strategy that might employ desalination, or other more energy intensive options. This recommendation is re-emphasized in the proposed planning process.

The Task Force recommended that water conservation be maximized prior to or as part of a larger strategy that might employ desalination.

As noted previously, Proposition 50, Chapter 6 is intended to support desalination more directly, as it was designed to explore and promote appropriate applications of desalination. So while numerous aspects of desalination projects will continue to be scrutinized, Proposition 50 has established desalination as a potential component of regional water management portfolios, assuming that environmental and economic concerns can be adequately addressed.

Desalination should be considered in the context of potential climate change and greenhouse emissions.

Desalination will also need to be considered in the context of statewide water resources issues. The impacts of drought not just in California but in the western third of the United States could have serious implications on water deliveries from the Colorado River to Southern California. Extensive water imports from Northern California to Southern California could be impacted by drought or emerging legal rulings and policies affecting pumping from the Sacramento-San Joaquin Delta. As threats to water reliability rise in various areas throughout the State, impetus exists to explore more localized sources with greater reliability, such as desalination.

Another emerging component of water resources planning in evaluating future water supply portfolios throughout the state is the impact of climate change. DWR has published a report highlighting the potential impacts associated with projected changes in climate (*Reference: DWR; Chapter 9, #9*). A key consideration related to desalination is the extent to which climate change impacts hydrological regimes in a manner that threatens water supply reliability. Environmental and energy costs and benefits with different supply/demand scenarios during drought and other periods may well influence the viability and desirability of desalination.

Other considerations associated with climate change are sea level rise and greenhouse emissions. In planning for coastal desalination facilities the potential impacts from a one meter rise in sea level rise, and perhaps more, during the next several decades needs to be evaluated. The state's recent initiatives to reduce greenhouse emissions will also need to be addressed, as water related energy use accounts for a significant proportion of the entire state's energy consumption (*Reference: Energy Commission; Chapter 9, #7*). Issues such as whether a particular desalination project will result in a net decrease in emissions due to energy use reductions associated with fewer water transfers and imports, or a net increase due to the energy demands associated with desalination will need to be addressed.

ANY new source of water supply undergoes scrutiny due to the many real and perceived issues associated with new supplies. This makes adequate planning even more important.

Any new source of water supply undergoes scrutiny due to the many real and perceived issues associated with new water supply. Developing new water supplies is typically complex, often controversial, requires extensive public education, involves multiple stakeholders (often with competing interests), and links to a broad array of other issues (such as land use, growth, etc.). In this context,

desalination will be scrutinized for its potential contribution to new water supplies, regardless of its specific technological, operational, economic, environmental and/or social impacts. This makes adequate planning even more important.

And as with any potential new source of water, various environmental and economic issues will need to be considered. It is likely that "trade-offs" will need to be made to address potential water supply shortages. These trade-offs could involve new ground water and surface storage options as well as wastewater recycling, importing water from distant locations, and other possible strategies. The environmental and economic issues associated with these different sources will need to be analyzed and compared as part of the process of determining the best strategies for meeting water resource management needs.

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Chapter 2

Overview of Potential Seawater and Brackish Groundwater Desalination Opportunities and Benefits

The Task Force highlighted both the potential benefits of and impediments to more widespread application of desalination. This chapter discusses the potential benefits of desalination, while the next chapter focuses on the potential impediments to more wide-scale use.

Numerous opportunities exist for recovering contaminated or polluted groundwater and generating new potable water supply by desalting brackish surface and groundwater, as well as seawater. These in essence serve primarily as "new" sources of potable water.

The various values and benefits associated with seawater and brackish groundwater desalination include:

- Providing additional water supply to meet existing and projected demands
- Reducing reliance on imported water supplies
- Enhancing water reliability (especially during drought)
- Restoring use of brackish or polluted groundwater
- Replacing water that can be used for sustaining or restoring river and stream ecosystems, and
- Improving potable water supplies in coastal areas impacted by saltwater intrusion.

In addition to the use of seawater, numerous opportunities exist for recovering contaminated or polluted groundwater and generating new potable water supply by desalting brackish surface and groundwater.

More specialized benefits, limited to specific situations, include:

- Reducing groundwater overdraft in coastal areas
- Providing improved water quality for disadvantaged communities
- Providing for additional groundwater storage (in coastal and inland areas dependent on groundwater)
- Improving compatibility with ambient salinity levels by mixing brine with freshwater-based (e.g., domestic wastewater) discharges to estuaries or the ocean.

While these potential benefits suggest the opportunities associated with desalination, it should be noted that, for many of these benefits to be realized, regulatory and other hurdles may need to be overcome, especially for seawater or estuarine desalination facilities.

1. Providing Additional Water Supply to Meet Existing and Projected Demand

Water reliability is an increasing concern to both the public and private sector throughout the state.

Many communities throughout California have limited water supplies, as well as limited options for "new" water. For areas experiencing or desiring the ability to support population growth, new development, or facing new housing requirements, the need for new water sources can become critical. Some communities have not been able to meet existing demand for several years as gradual growth has exceeded existing supplies of high quality potable water. While the entire array of new sources of water must be considered as part of the water supply portfolio, many communities are now looking to seawater or brackish groundwater desalination as a potentially viable option for meeting demand.

2. Reducing Reliance on Imported Water Supplies

Many communities, particularly in Southern California, are concerned about the potential ramifications of losing water currently being conveyed from outside their region. The potential exists for changing conditions over time to reduce the supplies of imported water. In the case of Southern California, this concern exists for long-term imports from both the Colorado River as well as the Sacramento/San Joaquin Delta. Likewise, some communities, regardless of the risk of losing imported supplies would like to

become more self-sufficient rather than relying solely or primarily on "external" sources of water. Both brackish groundwater and seawater desalination could provide a source of new "local" water as part of the larger water portfolio.

3. Enhancing Water Reliability

Water reliability is an increasing concern to both the public and businesses throughout the state. With each new period of drought, more concerns are raised about the impacts of a prolonged drought on water supply. Continued population growth in many areas makes this even more acute. As a potentially "drought resistant" supply of water, seawater desalination is increasingly being considered as a desirable option in coastal areas. Desalting brackish groundwater is already being utilized to improve water reliability for many inland communities.

4. Restoring Use of Brackish or Polluted Groundwater

Groundwater tainted by high nitrates and salts often goes untapped because it has little use, even for agricultural purposes. Certainly it would not be considered a source of drinking water without further treatment. Desalting this groundwater, however, along with ion exchange technology can restore such water to higher uses, including a drinking water source. With much lower energy costs than seawater desalination, brackish groundwater desalting represents an even more attractive source of water from a cost standpoint. This also results in more groundwater storage capacity from natural recharge sources.

5. Providing Water to Sustain or Restore Riparian Ecosystems

Some proposed desalination facilities are being considered for the expressed purpose of relieving the impacts of surface water withdrawals on sensitive aquatic ecosystems in riparian systems. With the increased demands placed on water supplies of all kinds, many aquatic ecosystems throughout the state are being threatened by reduced flows. Desalination potentially provides an opportunity to reduce the impacts on these freshwater aquatic ecosystems by reducing withdrawals, thereby allowing existing surface waters to sustain, or restore, the aquatic ecosystem. For this to be actualized, however, agreements must be enacted so that water being "replaced"

Nearly all new sources of water have economic, energy and environmental implications that must be compared to make wise resource management decisions.

by desalinated water is left instream and not diverted by withdrawals for other purposes or by other users.

6. Improving Potable Water Supply in Coastal Areas Impacted by Saltwater Intrusion

In some coastal areas utilizing groundwater for either agricultural or potable uses, groundwater overdraft can result in saltwater intrusion from seawater. In coastal areas this allows seawater to migrate inland creating high salt levels, creating potential public health risks where groundwater is used for potable purposes. Seawater desalination potentially offers direct replacement water, to provide potable water as well as reduce or even reverse saltwater intrusion. Brackish groundwater desalination could be used to solve the water quality issues but it would not resolve the overdraft issues.

Evaluating new sources of water supply will involve an analysis of trade offs.

While each of these represent possible opportunities for improved water resources management, including both ecosystem restoration and public health benefits, the use and role of desalination needs to be considered in the larger context of the overall water supply portfolio. Some trade-offs may well be necessary. For example, if reliability during times of drought is a major concern for a community, resolving this issue may involve a choice between increased surface storage and desalination, or recycling/reuse and desalination. Myriad issues will need to be addressed, however, related to economic, environmental and other impacts, before decisions can be made.

As identifying sources of new water supply becomes more and more challenging, and the sources more limited, water resources planning will require an analysis of trade-offs, perhaps in the form of cost-benefit analyses that include secondary and tertiary impacts. Nearly all new sources of water, except perhaps conservation, will have economic, energy and environmental implications that must be acknowledged and compared to make wise resource management decisions.

Chapter 3

Overview of Potential Seawater and Groundwater Desalination Challenges and Impediments

While seawater and brackish groundwater desalination offer promise as sources of reliable, drought-resistant, high-quality water supply, various challenges and possible impediments to their widespread use have been identified. Some are related specifically to desalination whereas others are related to nearly any attempts to generate new sources of water. Regardless, these need to be evaluated in the conceptual planning phase for a desalination facility to ensure they can be addressed to the satisfaction of local government officials, regulatory agencies and the public. This is especially relevant to ensuring environmental and economic acceptability.

Identified challenges and potential impediments associated with developing desalination facilities include:

- Ecological impacts associated primarily with seawater intakes
- Environmental and ecological impacts associated with brine discharge
- Economic and energy cost constraints
- Land use and siting impacts
- Cumulative impacts from increased numbers of desalination facilities, and
- Facility ownership.

While these have been identified as potential substantive impediments, process impediments identified include:

While seawater and brackish groundwater desalination offer promise as sources of reliable, drought-resistant, high-quality water supply, various challenges and possible impediments to their widespread use have been identified.

- Lack of effective public involvement
- Lack of effective, ongoing interaction with permitting agencies
- Steep learning curve and limited capabilities to support developing large-scale desalination facilities.

As perceived by proponents of desalination facilities, another obstacle that currently exists but will likely diminish over time is that of regulatory uncertainty and differing requirements among regulatory agencies.

Four other issues add an additional layer of complexity in determining impediments and benefits from desalination facilities. These are seen as benefits from some perspectives and as impediments by others. As such, these require additional examination:

- Co-location of seawater desalination facilities with power plants using once-through cooling
- Potential impacts on growth
- Environmental justice impacts
- Risk reduction.

To meet regulatory requirements, the potential impacts of impingement and entrainment, and their mitigation, need to be addressed in designing a desalination facility.

POTENTIAL SUBSTANTIVE IMPEDIMENTS

1. Ecological Impacts Associated with Seawater Intakes

Perhaps the primary ecological concerns related to seawater and estuarine desalination facilities are impingement and entrainment of aquatic organisms associated with water intakes. Impingement refers to the impacts on organisms pulled against screens and other filter mechanisms at the source water intake point(s), and entrainment refers to the impacts of organisms which are pulled into the intakes. Impingement primarily affects fish and larger organisms that cannot be pulled through screens or filters, whereas entrainment primary affects smaller organisms (e.g., phytoplankton, zooplankton).

A variety of factors can influence the relative impacts of impingement and entrainment, such as water depth at the intake, velocity of water associated with the intake, location of the intake, type of intake, among others. Increasingly, measures are available

to significantly reduce the environmental and ecological impacts of feedwater intake (e.g., beach well versus open water intakes). The issue is whether these measures can be utilized in the context of desired facility capacity and location. To meet regulatory requirements, the potential impacts of impingement and entrainment need to be evaluated as part of the design considerations of a facility, and the appropriate mitigation measures need to be incorporated into the design and operational considerations of the facility.

2. Environmental and Ecological Impacts Associated with Brine Discharges.

The second major ecological concern associated with desalination facilities is the impact of the brine, or concentrate discharge. Unlike impingement and entrainment which are only relevant to seawater and estuarine facilities with open water intakes, brine discharge issues relate to both seawater and brackish groundwater desalination facilities. The primary issue is the impact on salinity levels near discharge points. Increased salinity levels can have deleterious effects on individual species as well as assemblages of species in proximity to these locations.

While changes in salinity, even small changes, can affect certain aquatic species, it is typically considered easier to mitigate these impacts than those of impingement and entrainment. Various design considerations are available (such as diffusers, mixing strategies, discharging into areas of low productivity) which can in many cases result in negligible impacts on ambient salinity levels. Nonetheless, due to the sensitivity of some species to increased salinity this is an issue which needs to be given adequate scrutiny in the design of desalination facilities to provide adequate ecological safeguards.

In some inland areas, the inability to properly dispose of the brine can limit the application of brackish groundwater desalination. Where this issue can be resolved, however, brackish groundwater desalination has few ecological barriers.

3. Economic and Energy Cost Constraints

The economic considerations of desalination facilities are complex, as noted in the Economics Working Paper Referenced in Chapter 9. Perhaps the major driver, however, due to the energy intensive

The cost of energy is a critical determinant to the viability of, in particular, seawater desalination on a large scale.

nature of desalination processes, is the cost of energy. This is a critical determinant to the viability of desalination on a large scale, especially for seawater desalination due to higher salinity levels and the concomitant increase in energy required (compared to brackish groundwater desalination). This is likely to change over time as more energy efficient desalination methods are developed and/or as the cost of energy decreases. But under current conditions, energy availability, costs and impacts will prove critical to the development of desalination facilities.

Energy costs are subject to fluctuation, as evidenced by the variation that occurred during and since the convening of the Task Force. In the 1990's, desalination was in the range of $2000 an acre-foot. Improved membranes and lower energy costs brought some estimates of seawater desalination earlier this decade to near $1000 per acre-foot. But a recent cost assessment of a desalination project in the San Francisco Bay area put costs in the range of $2000 to $3000 per acre-foot. Despite improvements in membrane efficiency, desalination costs largely remain subject to swings in energy costs. When planning the development of a desalination facility, potential impacts of energy cost fluctuations should be evaluated to the extent possible.

Numerous land use and siting issues associated with desalination facilities must be adequately addressed to meet regulatory requirements.

Other cost considerations, not to be underestimated, include infrastructure needs, source water pre-treatment costs, compatibility with other water supplies, potential subsidies and costs of alternative water sources. At the same time, economic analyses will also point to potential economic benefits such as the value of increased reliability of water supply, and potential reduction of and reliance on water imports from outside the region.

4. Land Use and Siting Impacts

Numerous land use and siting issues are associated with desalination facilities which must be adequately addressed to meet various regulatory requirements. Primarily these relate to public access, land use compatibility, recreation and tourism, environmental justice and wetland or upland habitat. Each of these is discussed in greater detail in the Planning and Siting Working Papers referenced in Chapter 9. Most of these concerns can typically be addressed through thorough planning and design considerations. Yet some locations will present greater challenges in meeting regulatory requirement and/or public acceptability.

5. Cumulative Impacts from Increased Numbers of Desalination Facilities

To date, cumulative impacts associated with desalination facilities have not been a critical issue. Concern exists, however, that with an increased number of new, and much larger, seawater desalination facilities cumulative impacts need to be considered in both planning and permitting these facilities. Monitoring, policy and regulatory issues need to be addressed, such as how to measure cumulative impacts, what potential restrictions to place on proximity and/or size of facilities, and how this is incorporated into permitting procedures. Many factors such as ocean or estuarine circulation patterns, facility capacity and design, and operational considerations will likely need to be addressed.

6. Ownership of Desalination Facility

An issue that may stand as an impediment in some circumstances is the ownership of the facility. Some agencies remain concerned about public water supplies being "owned" or controlled by private entities. As such, the nature of public-private partnerships associated with desalination facilities may impact the permitting process so will require assessment early in the planning stages to ensure that the ownership issue does not act as an impediment.

In the absence of effective approaches to educate and involve the public, elected officials and even some regulatory agencies, the recipe exists for resistance to new water supply projects.

POTENTIAL PROCESS IMPEDIMENTS

1. Lack of Effective Public Involvement

Water resources planning is a challenging public policy issue. Most "new" water supplies being considered today, perhaps with the exception of conservation, receive intense public scrutiny. Water resources planning links a complex web of issues including water supply, water quality, water reliability, watershed management, fisheries and aquatic habitats, water management strategies, land use, public access, ecological and environmental health, among others. Add to this the wide ranging views about new surface storage facilities, exporting and importing water, and the impacts of new water on growth.

It is relatively easy to understand then why much of the public and many elected officials lack an in-depth understanding of the issues

and/or have strong views about how to proceed. In the absence of effective approaches to educate and involve the public, elected officials and even some regulatory agencies, the recipe exists for significant resistance to new water projects. The lack of an effective public involvement program has already proved to be an impediment to developing several coastal desalination facilities. These impediments, however, can often be resolved by adequate planning and a genuine public engagement program.

2. Lack of Effective, Ongoing Interaction with Permitting Agencies

Federal, state and local permits are required to build and operate a desalination facility. These are the protections in place to protect the public and the environment, and to meet public trust obligations of public agencies. Permits are also intended to assist project proponents by ensuring design and operational considerations have been adequately planned.

Not surprisingly, the information required by the various agencies may differ in either content or format. This has created obstacles for some desalination project sponsors. Some have encountered situations where agencies were not clear about the level of detail necessary to meet informational and data requirements. In other cases, different staff members in the same agency have provided different guidance to project sponsors. In yet other cases, the same information has been requested by different agencies, but in different formats or different levels of detail. Each of these has resulted in delays and additional costs.

Regulatory agencies should be contacted early and often during the course of planning, designing and permitting a desalination facility.

On the other hand, some permitting challenges have been project-sponsor induced. One example is where a desalination project sponsor received clear direction about what would be acceptable, only to change the project and not re-confirm that the changes would still meet permitting requirements. This placed permitting agencies in the position of informing project sponsors later in the project (than necessary) that their project no longer met permitting requirements, and that additional information was necessary. This lack of ongoing communication led to additional work on the part of the sponsor, along with frustration and delays. It is acknowledged that there is a cost to maintaining these ongoing interactions and communications. But it is also clear that there is a cost associated with not doing so.

These dynamics are the basis for one of the primary recommendations from the Task Force and subsequent work group: contact regulatory agencies early and often during the course of planning, designing and permitting a desalination facility. Since another key recommendation in this Handbook is to incorporate feedback loops into the design and permitting processes, developing working relationships with permitting agencies should increase the efficiency of moving through the permitting process.

3. Steep learning curve and limited capabilities to support developing large-scale desalination facilities.

Early experience among some agencies looking to develop larger seawater desalination facilities suggests the learning curve for many involved in building these facilities is steep. Serious delays and constraints have been encountered in proceeding with even demonstration projects. This has resulted from challenges with equipment supplies, contractors and engineers, many of whom have limited or no experience with large desalination facilities and attendant issues. This current environment will presumably improve as more facilities of varying sizes and specifications are developed, but as of now acts as a potential impediment to the timely and cost effective implementation of even research and pilot projects.

Photo Coutesy of Roplant

ISSUES POTENTIALLY PERCEIVED AS EITHER A BENEFIT OR AN IMPEDIMENT

1. Co-Location with Other Facilities

Co-locating desalination facilities with other facilities presents both opportunities and challenges.

From the perspective of some, locating seawater desalination facilities with once-through cooling power plants is a natural linkage. The existing power plant intake and discharge structures provide pre-existing infrastructure. Power plant intake water volumes are much larger than needed for the desalination facility, so no additional water withdrawals are necessary. Assuming the desalination facility operates only when the power plant operates, the environmental and ecological impact of the facility then could be minimal since the desalination facility uses cooling water already in the power plant and the large discharge volumes provide dilution and mixing for the brine.

On the other hand, some are concerned with linking the two facilities, for a variety of reasons. One of the major concerns stems from opposition to once-through cooling power plants. Some believe siting desalination facilities with once-through cooling power plants might act to perpetuate these facilities when otherwise they might be phased-out. In addition, if the power plant ultimately is changed to a different cooling system, will the investment in the desalination facility either be lost or subject to significant increases? Likewise, if the once-through cooling system is eliminated, what impact will the intake volumes and brine discharge - of a stand-alone desalination facility - have in the absence of the large volumes of power plant intake and discharge? These are questions that need to be answered in the planning process. More detail associated with this issue can be found in the working paper series referenced in Chapter 9.

2. Growth Impacts

The growth implications of new water supplies is a critical component of the planning process.

The growth implications of new water can also be controversial. Some communities desire to limit growth and view additional water supply as a threat to no- or slow-growth preferences. They generally oppose the availability of new water sources that could open the door to unwanted or uncontrolled growth. Desalination resulting in "new" water supplies therefore could be considered a threat to these communities or regions.

But some communities are underserved at their current levels of development or desire at least some potential to grow. Communities with these circumstances or perspectives may prefer the potential availability of new water sources. Since estimated population growth in California must be distributed among communities, some may be put in the position of needing to acquire new supplies of water regardless of their views about growth. As such, these communities may support desalination as a means to meet these needs.

Growth issues are discussed in the Planning Working Paper referenced in Chapter 9.

3. Environmental Justice Impacts

Depending on the circumstances, desalination can either contribute to or alleviate environmental justice concerns.

One of the primary concerns of environmental justice communities and advocates is siting industrial facilities in or adjacent to low income or minority communities, especially if there is a history of this practice. From this perspective, desalination facilities could be considered an environmental justice issue depending on the location of the facility, the presence of other industrial facilities, the proximity of low income or minority communities and the extent of public health, access or other community impacts.

On the other hand, environmental justice communities are sometimes served by inadequate infrastructure and/or poor water supplies. For example, some low income communities in rural coastal areas, using groundwater for water supply, may encounter the impacts of either saltwater intrusion or agricultural impacts (nitrates). With no other source of water possible, desalination of ocean water or brackish groundwater could alleviate environmental justice concerns. So, it is possible that depending on the circumstances desalination can either contribute to or alleviate environmental justice concerns. This needs to be weighed seriously in the planning process, and environmental justice or disadvantaged communities need to be directly involved in the earliest stages of considering new facilities.

4. Risk Reduction

Risk trade-offs need to be evaluated.

One consideration in support of desalination is that it serves as insurance against drought and other potential disruptions in imported water supplies. For some desalination is conceived as a way to

reduce the risk of poor water quality from groundwater wells used for water supply. On the other hand, it may be more costly to provide water via desalination. This raises the concern that for some the cost of the water may overshadow the benefits from reduced risk. Others believe it may be worth the extra cost – insofar as desalination is more expensive than alternatives – if it acts to effectively reduce risk and enhance reliability. Cities and businesses which place a premium on reliability may believe any extra cost is well justified, while some residential users may feel that the added cost creates disproportionate impacts to them. Again, these potential tradeoffs need to be recognized and addressed in the planning process.

Chapter 4

Guiding Principles for Developing Environmentally and Economically Acceptable Desalination Projects

Perhaps the keystone of the Task Force recommendations was that desalination facilities should neither be universally accepted nor rejected. Too many local and site specific variables exist to make universal pronouncements, policies or regulations in support of desalination. At the same time, the Task Force identified no imbedded "fatal flaws" that suggest universally prohibiting desalination. Therefore, each desalination facility needs to be evaluated based on numerous variables to determine the environmental and economic acceptability of a specific desalination facility.

Drawing on the work of the Task Force, ten guiding principles should be considered when developing a desalination project. Experiences in attempting to site coastal facilities in the recent past, in particular, have demonstrated the importance of these principles. Some of these incorporate standard engineering best practices, yet others address issues for which best practices have not yet been developed.

Drawing on the work of the Task Force, ten guiding principles should be considered when developing a desalination project.

Guiding principles for designing, evaluating and developing environmentally and economically acceptable desalination projects include:

Guiding Principle 1. Each project should be considered on its own merits.

The Task Force noted that while a proposed desalination facility might be acceptable in one location given design and operational considerations, cost variables and habitat issues,

it might not be acceptable in another location. As such, each project should be considered on its own merits. If and when the use of desalination (in particular seawater and estuarine) becomes more widespread, however, it will likely be necessary to ensure that proposed facilities are assessed for cumulative impacts as well when in close proximity to other facilities.

Guiding Principle 2. To the extent possible and practical, water conservation and water recycling measures should be in place before desalination facilities are pursued.

The Task Force acknowledged that to the extent possible, conservation and recycled water use measures should be maximized before desalination or other new sources of water are pursued. As identified by the State Water Plan, "new" water can be achieved through conservation for a much smaller investment than most other sources of new water. Where conservation has been maximized, desalination and other more costly sources of water then provide alternatives to be evaluated as part of the water resources portfolio to address identified needs.

Guiding Principle 3. Sponsoring agencies and facility owners should be determined early in the planning process.

In some cases to date, seawater desalination proponents have moved forward on projects without having solidified relationships with local project sponsors. This has created political challenges as well as raised questions of trust among local stakeholders. As larger desalination facilities are proposed, the potential impacts of the facility on the environment and community are also larger. Especially in these situations, establishing agreements early in the process to clarify who will serve as the local project sponsor(s) and/or owners is critical to the decision making process.

Guiding Principle 4. Permitting agencies should be engaged early (and often) in the planning process.

Permits are required to build and operate a desalination facility from a variety of local, state and federal agencies. As such, issues of coordination and consistency of data requests,

the scope of data required, and analysis and interpretation of data among these agencies are important. To address these issues most efficiently, sponsors and developers of proposed desalination facilities should identify and engage the appropriate permitting agencies early in the process. Otherwise, the potential increases for expending unnecessary time and energy, and perhaps even pursuing plans that are not viable. (Chapter 6 provides an overview of permitting processes.)

Guiding Principle 5. Key decision points should be identified (e.g., costs, environmental acceptability) to test the general feasibility of the project as early in the planning process as possible.

It is recommended that project proponents identify key decision points, in concert with regulatory review, to assess the viability of proceeding with desalination projects as initially envisioned. By identifying these key thresholds, more complete and cost-effective planning can be conducted. This is sometimes referred to as a "fatal flaw" analysis. It is important to know as early as possible if a project has characteristics that will create permitting challenges or raise intense scrutiny or opposition among the public or specific stakeholders.

Guiding Principle 6. The public should be engaged early in the planning process.

Also important to the planning process is engaging key stakeholders and the broader public early in the process of developing a desalination project. It is important to have the proposed project sufficiently developed so it can be accurately described, yet not so far along as to suggest that it is "set in stone." Effective public involvement rests not only on early involvement but also in creating an open and transparent process that allows meaningful public input on issues of environmental, economic and community importance

Guiding Principle 7. Environmental justice considerations should be addressed during desalination project planning.

The State of California has placed increased importance on addressing the concerns of environmental justice, or disadvantaged communities, associated with public works projects. In some instances, environmental justice concerns could act as a potential impediment to desalination projects, such as siting in an area of predominantly low-income or minority populations, where disproportionate exposure to adverse environmental impacts may occur. On the other hand, it has been noted in some instances environmental justice communities might benefit from a higher quality of potable drinking water that could result from a desalination project. These considerations should be evaluated in the process of planning a desalination project, in concert with community members to the extent possible.

Guiding Principle 8. The potential benefits of and impediments to a desalination project should be clearly identified and thoroughly addressed in a transparent manner.

Even as regulatory agencies and the public become more familiar with the issues surrounding desalination facilities, it will be important to identify and substantiate the benefits as well as demonstrate how potential impediments will be resolved. This information will typically be required and made public regardless as part of CEQA (California Environmental Quality Act) or other environmental reviews. As such, it is recommended that these issues be addressed early in the planning process to reduce uncertainty and reinforce trust in the project and its sponsors. Likewise, water supply, environmental and community benefits should accrue from any desalination project and should be demonstrable in the planning phases of the project.

Guiding Principle 9. Feedback loops should be incorporated into the planning and design processes to allow for revising the project as appropriate to meet permitting requirements and address public concerns.

Given their complex nature, and the range of possible

options, it is not uncommon for desalination projects (especially seawater desalination facilities) to be altered during the course of design, planning, public involvement and permitting. When such modifications are made, however, projects that might have received preliminary "approvals" should be re-submitted for review. Otherwise, additional delays could be encountered if regulatory agencies are presented with revisions they have not reviewed and which may not meet permitting requirements. It is recommended that when regulatory agencies are contacted in the early stages of project development that the project proponents establish a "review committee" of relevant regulatory agency personnel, with whom contact is maintained on a regular basis as the project proceeds.

Guiding Principle 10. The use of collaborative processes should be considered when uncertainty or opposition is potentially significant.

In some cases, particularly where there is a high degree of uncertainty and potential controversy about project benefits or impacts, collaborative decision-making or problem-solving processes may prove helpful. (Collaborative processes refer to open, transparent decision making processes that engage stakeholders in constructive negotiations and problem solving, often convened by an impartial third party.) Since some desalination projects may involve design or operational features which are initially opposed by key interest groups, it may be necessary to engage in collaborative processes to set the stage for the project, by building trust and developing a project that incorporates needed assurances. This may require slowing down the development process but might prevent delays later in the planning process that could threaten the outcome of the project. Collaborative processes might also include permitting agencies which must be assured that the proposed project will meet regulatory requirements.

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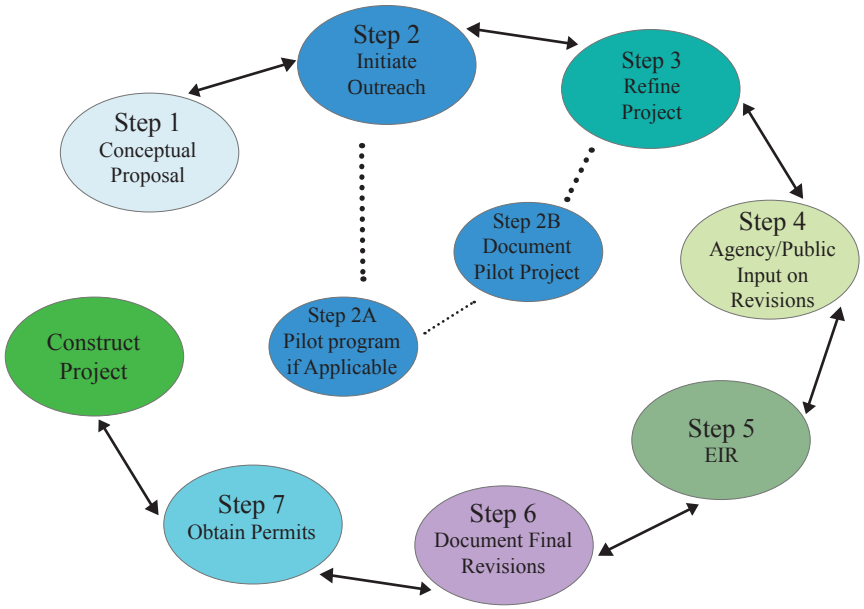
Chapter 5

Planning Framework for Desalination Projects

After completion of the Task Force's work, members of the Task Force and other parties interested in desalination throughout California were invited to participate in a workshop to develop a planning framework for developing desalination projects in California. Participants at this workshop helped identify the key components of a planning framework for desalination projects. Figure 5.1 provides a graphic representation of a seven-step planning process for desalination facilities that emerged from this workshop. This planning process incorporates and builds on the Guiding Principles identified in the previous chapter.



This planning process incorporates and builds on the Guiding Principles identified in the previous chapter.

The Conceptual Plan for a desalination facility should provide detail on at least 20 critical components.

It is important to highlight that this planning framework is not linear. As noted earlier, it is recommended that there be regular communication and regularly scheduled feedback loops among local sponsors, key stakeholders and publics, and regulatory agencies. While this may seem like an overly onerous or unnecessary step to some, in most cases it will result in more efficient permitting and public acceptance processes. It is acknowledged that other engineering design models will be employed in developing project plans, design specifications and feasibility analyses. This Handbook is intended to augment rather then supplant those models.

An early step in planning for a desalination facility is to clarify whether a pilot project will be conducted. Regardless, it is still valuable to follow the steps of developing a conceptual proposal as outlined below. This assists in designing the project, helps substantiates how information gained from the pilot project will be applied, and also helps in determining the feasibility of the project for which the pilot is being developed.

The steps for permitting pilot projects in many cases will be similar to a full-scale operation. Receiving a permit for a pilot project, however, may be significantly more straightforward than receiving a permit for the full-scale facility. As an example, the California Coastal Commission has approved permits for pilot projects while at the same time indicating the challenges a full-scale operation would likely face. In other words there is no reason to assume that because a permit is issued for a pilot that one will also be issued for the full-scale project. The pilot project may, however, pave the way for identifying how potential concerns can be addressed.

STEP 1
DEVELOP A CONCEPTUAL PROPOSAL

The conceptual proposal for a desalination project should address or incorporate the following components:

1) **Needs statement:** what are the water supply needs for the immediate area as well as the service area or region in which the desalination facility will operate?

2) **Asses the long-term reliability of existing water supply:** what is the long-term water reliability of existing supplies,

including environmental issues, climate change impacts, cost increases, etc. associated with existing supplies?

3) **Alternatives to desalination:** identify alternatives to desalination and their viability for meeting identified/ projected water resources needs (this ultimately substantiates the need/role for desalination).

4) **Role of desalination in the overall water portfolio for the region:** how will desalination complement conservation, recycling, reuse and other water supply strategies; what is the capacity for increasing water supply from these other sources?
5) **Relationship to other potential desalination projects:** identify if there are other existing or proposed desalination projects in or near the area of the proposed project; clarify the nature of the relationship (if any) including the potential for cumulative impacts.

6) **Decision pathway:** clarify the decision pathway, including "go-no go" criteria (e.g., such as permitting constraints, cost, etc.).

7) **Potential project sponsors, partners and owners:** identify project sponsors and partners, including water districts, municipalities, co-location partners, etc., including who will own and operate the facility.

8) **Project objectives:** what are the desired objectives for and anticipated outcomes from the project; to what extent, in what location and over what time frame, will the proposed project achieve the objectives identified for desalination?

9) **Proposed desalination technology(ies):** identify the preferred desalination technology given the project objectives, potential site conditions and constraints, etc.

10) **Possible locations for the facility, intakes, outfalls, etc.:** clearly identify the possible locations for the facility and infrastructure requirements associated with the project, especially indicating if co-location with a power plant, wastewater treatment or other facility is planned.

Step 1 Conceptual Proposal

Step 1 Conceptual Proposal

11) **Primary cost factors:** identify the major costs associated with the project, and potential constraints, given the proposed location and technology, environmental considerations, energy availability and costs, etc.

12) **Potential public and environmental benefits:** identify the potential for and extent of "demonstrable" public and environmental benefits from the project, including water supply reliability, improved water quality, etc.

13) **Potential environmental concerns:** identify the major environmental issues associated with the project and potential options for addressing those issues, including facility siting, facility operations (e.g., intake impacts (entrainment/impingement), discharge impacts, greenhouse impacts, etc.

14) **Key opportunities and constraints:** summarize the primary opportunities to be realized by the project and the potential constraints that might limit the feasibility of the project, including an analysis of the implications of and to global warming and greenhouse emissions.

15) **Potential economic costs and benefits**: summary the economic impacts of the proposed new facility, including comparative impacts associated with climate change, greenhouse emissions, etc. versus other potential alternatives.

16) **Preliminary "financing plan:"** identify preliminary plans for capitalizing the project as well as sustaining the ongoing operation of the facility.

17) **Key security considerations:** Homeland Security provisions now require provisions for security of water supplies; identify how this will be addressed and the potential impacts.

18) **Key permitting agencies:** identify the key permitting agencies and lead CEQA agency.

19) **Major stakeholders:** identify the major governmental and non-governmental agencies, organizations and interest groups which could be impacted by the project.

20) **Environmental justice:** identify the presence of environmental justice communities or issues in the sphere of influence of the project.

21) **Project Schedule:** identify the proposed tasks, activities and schedule anticipated for the project.

As a detailed environmental review of any large proposal will be required, it is recommended that early consideration be given to how CEQA, for example, will be conducted.

STEP 2
INITIATE AGENCY AND PUBLIC OUTREACH

Step 2 should begin concurrently with the later stages of drafting the conceptual plan. This is necessary as well if a pilot project is planned. At this stage of the process, the conceptual plan should be considered a "work in progress," until the opportunity for the initial stages of public and agency outreach have been conducted. To the extent possible, project sponsors should be open to modifications to their approach, project location, technology, design and other elements of their plan until the likelihood of local government acceptability and permitting feasibility can be anticipated. The planning and project development process should build-in regular feedback loops until the permitting process is complete.

If the project is a pilot project only, with little additional detail on the full-scale facility developed pending completion of the pilot, the following steps will likely be achieved with significantly less effort, as well as more efficiently. Other pilots, or demonstration projects, may be more a "test of concept," which will likely benefit from the more rigorous early analysis and agency and public interaction. This must be evaluated on a case by case basis.

1) **Overlap with Conceptual Plan development:** begin the initial steps of the permitting process as part of developing the conceptual proposal; compile a list of the information and formatting required by each permitting agency.

2) **Begin exploration of permitting requirements:** clarify formats among differing agencies, review timelines, etc., identifying staff and resource constraints.

Step 2 Initiate Outreach

3) **Introduce conceptual proposals to all permitting agencies:** identify the key contact person in each permitting agency; obtain early input on conceptual plan; clarify steps for meeting CEQA and all applicable regulatory review requirements (potentially including NEPA (National Environmental Policy Act)).

4) **Assess public perceptions and awareness:** identify the need for public education to address public concerns/perceptions, focusing on why desalination is being pursued, its potential impacts and benefits, its relationship to the overall water portfolio, etc.

5) **Develop a public involvement plan:** develop and begin implementation of a public involvement plan as soon as the conceptual plan is drafted.

6) **Identify the presence of or potential for environmental justice issues:** directly involve community-based organizations that can assist in identifying, clarifying and addressing potential issues.

7) **Identify potential project proponents and opponents:** identify groups that are, or are likely to, support or oppose the project, including elected officials, public groups, rate payers, competing agencies, etc.

8) **Clarify the aspects of the projects for which there is support, and those for which there is concern or opposition:** identify those components of the project that likely will need to be given further attention based on initial agency and public feedback; identify potential strategies to address concerns.

9) **Establish a "Permitting Review Committee:"** to provide feedback on the project during the course of its development, and the permitting process, identify a key staff member from each major permitting agency to participate on an ongoing ad hoc "Review Committee."

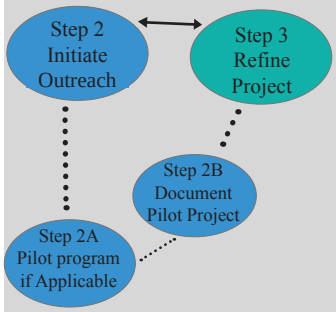
10) **Assess the need for explicit public or stakeholder support/affirmation:** identify whether tools such as an "Advisory Election" involving the local public are needed,

and/or whether a collaborative process among stakeholders would be helpful in developing an environmentally and economically acceptable project.

STEP 2A
DEVELOP PILOT PROJECT (If Applicable)

In the context of the conceptual design, this step involves identifying if a pilot project will be conducted. (Demonstration projects on a specific aspect of a potential desalination facility would proceed or be conducted in concert with developing the conceptual proposal.) If a pilot project is utilized, the planning process should include defining the objectives of the pilot project, project design, obtaining needed permits and a schedule for proceeding with the project (including construction, monitoring, evaluation, etc.).

It is recommended that public outreach also be conducted at this point to ensure an understanding of the project and minimize the opportunity for misconceptions about the project and its relationship to a potential full-scale project. Also, any environmental review activities associated with the pilot need to be identified and conducted. Pilot projects can either be pursued using state funds, or independently. Regardless, the key permitting agencies will need to be contacted. This provides an early opportunity to assess the likely permitting process for the full scale project as well.



STEP 2B
DEVELOP PILOT PROJECT RESULTS (If Applicable)

This step involves documenting the results of a pilot project, of particular use in testing a conceptual design or serving as the basis for the design of a proposed desalination facility. This step reinforces the value of documenting and sharing the information gained from monitoring and evaluation which is likely to serve as the basis for modifications and improvements to the initial conceptual design.

If a pilot project was conducted, the project should be documented and an analysis of the results prepared for both regulatory agency staff and eventually the public. This should include the potential implications to the full-scale project. Thereafter, proposed revisions in the design or other components of the full-scale project should

be identified and integrated into the over planning for the facility. This will be invaluable for agency and public review, to create a full understanding of the lessons learned and how the project will be improved based on the results.

STEP 3
INCORPORATE REVISIONS TO CONCEPTUAL DESIGN BASED ON AGENCY AND PUBLIC FEEDBACK (As Appropriate)

This step in the planning process involves revising and documenting revisions to the conceptual plan based on feedback received and information gained from Step 2 (and 2A and 2B if applicable). This is a critical aspect of the "feedback loop" built into the planning and decision making process. It provides the opportunity to demonstrate how agency and public feedback and information obtained has been addressed, as appropriate. To help achieve this objective, the following approach should be considered:

1) **Based on initial agency and public feedback, identify the elements of the conceptual proposal that may need revision**

2) **Identify options to those conceptual proposal elements for which revisions may be useful**

3) **Evaluate those options**

4) **Identify which options are feasible for further consideration**

5) **If major revisions are anticipated, engage regulatory agency staff to assess and provide feedback on potential revisions**

6) **Based on feedback from regulatory agency staff, engage key stakeholders or publics to obtain input on potential revisions**

7) **Make revisions to enhance the likelihood of permitting and public acceptance and proceed with remaining tasks to design and permit the project.**

STEP 4
OBTAIN AGENCY AND PUBLIC FEEDBACK ON PROJECT REVISIONS

After potential revisions have been incorporated into the conceptual plan for the project another round of agency and public review are recommended. Since in most cases public agencies and public trust issues will be involved, effective public engagement processes at each major milestone should help build community understanding of the need for the project, potential trade-offs and increased likelihood of public support. A public-friendly summary of potential revisions from initial agency and public input will help convey both the opportunities and potential constraints that will need to be addressed or mitigated if the project is pursued. Feedback and refinements should be anticipated through the permitting phases of the project.

STEP 5
INITIATE ENVIRONMENTAL REVIEW PROCESS

Desalination projects will require an environmental review process of some kind. Anticipating the necessity of conducting an environmental review under the California Environmental Quality Act (CEQA), the potential applications of CEQA to the project should be identified and evaluated early in the project. CEQA guidelines should be followed, and where appropriate, a sponsoring agency should be identified and agreed upon. If federal funding is involved, a NEPA process might also be required. This step involves initiating the environmental review process, which should be completed before final documentation on the project is prepared, pending potential modifications.

STEP 6
DOCUMENT FINAL PROJECT REVISIONS

This step addresses the key issues that will need to be clarified or resolved to obtain permits and respond to public interests in the project. It also should incorporate the production of the detailed technical, environmental, financial and planning issues necessary to support the permitting process. This step builds on the results from whatever environmental review processes have been conducted.

Documenting Final Project decisions should link directly to the Conceptual Plan.

Step 6
Document Final Project Revisions

A number of issues addressed in the Handbook have specific policy implications that have yet to be resolved by regulatory and policy agencies. These include preferences for specific types of desalination technologies, types of intakes (e.g., use of beach wells when feasible) and outfalls, growth impacts associated with desalination, acceptability of private ownership of desalination facilities, among others. This Handbook does not try to answer these policy issues but does try to identify some of the outstanding issues that should be addressed. The final documentation for the project will likely need to address these or other outstanding concerns.

While this step can begin during the environmental review process, it cannot be completed until the environmental review process(es) is(are) complete. Public outreach activities should be coordinated with those conducted for the environmental review process to the extent possible to build on previous public education and involvement activities, and to achieve efficiencies.

Critical components to clarify in this final stage of project documentation, if not already clarified, include:

1) **Project Sponsors and Partners**

2) **Ownership Issues**

   a. Public ownership
   b. Private ownership
   c. Public/Private ownership
   d. Domestic/International ownership issues

3) **Technical and Environmental Considerations,** including:

   a. Selected desalination technology(ies): identify the process and basis for determining the preferred technology

   b. Site location and operation: identify whether the facility will be a stand alone facility or co-located with a power plant and/or sewage treatment plant, and why that site was ultimately selected

c. Intake and discharge characteristics: such as type (e.g., beach well or open water intake), location, volumes, salinity levels and other critical water quality parameters in the vicinity of intakes and outfalls

d. Impact of water source supply and quality on operational considerations: such as specification of water supply pretreatment requirements; how issues associated with boron levels and other chemical constituents will be addressed

e. Characterization of infrastructure impacts: availability of existing conveyance structures or need to expand, etc.

f. Compatibility of desalinated water with existing distribution systems: compatibility of desalinated water with other water in the distribution system

g. Energy source and reliability: identify the source of energy, impacts on existing/available energy production, and reliability; if alternative energy sources will be used, note the differences in reliability and impacts compared to traditional supplies

h. Environmental impacts of intakes and discharges: identify the potential impacts of intakes and discharges associated with the proposed facility, the mitigation measures incorporated into the design and operational guidelines, and the impact of those mitigation measures on parameters such as habitat value, diversity, salinity and water quality, etc.

i. Environmental benefits: clarify the potential environmental and community benefits associated with facility (e.g., enhanced stream flows, improved public access), and measures employed to ensure those benefits

j. Cumulative impacts: identify the presence of other water intakes or discharges in the area and how they impact, and will be impacted by, the proposed

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project; include an analysis of cumulative ecological impacts, as well as impacts on infrastructure, energy consumption, etc.

k. Potential public health implications: what measures will be taken to ensure public health standards are met or exceeded, including protection of source water, including security provisions; identify any public health threats to source water that could impact permitting decisions

l. Monitoring program: identify the components of required or other monitoring programs, and associated work plans

m. How key permitting or public concerns were addressed or rectified: document how the key permitting or public concerns were resolved in the final design or operational considerations.

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4) **Local and Regional Planning Considerations,** including impacts on and implications of:

a. Existing and projected land use patterns
b. Agricultural resources
c. Biological resources
d. Cultural resources
e. Local hydrology
f. Recreation and Public Access
g. Utilities
h. Visual Resources
i. Proximity to needed infrastructure, including water supply conveyance
j. Growth (implications and clarity on differences between growth accommodation and inducement in CEQA)

5) **Financial Considerations,** including:

a. Document the final financial analysis, such as capital (construction) costs, costs for operational and maintenance aspects of the desalination process (including pretreatment), administrative

costs, monitoring program costs, infrastructure and conveyance costs, mitigation costs, final costs to end users.

b. Document the financial viability and security of the project, such as the cost of money (applicable interest rates on loans), cost of energy, availability of subsidies and other income streams to support the project, assurances that water supply operations will be sustainable, cost comparisons with feasible alternatives.

6) **Pilot Project Considerations:** If a pilot project was conducted, document the results and implications to the full-scale project.

A variety of engineering, economic and other quantitative tools exist to support detailed project planning, and are clearly not addressed by this Planning Handbook. These tools include computer models for forecasting supply and demand, as well as determining optimal treatment types and sizing of various modules within facilities. Another tool is the use of cost models. As an example, the Bureau of Reclamation has developed a model to evaluate the costs associated with various technical and energy desalination alternatives.

Other useful tools have also been developed, such as the Pacific Institute's method for assessing the value of water reliability. These models also allow testing of various alternatives and scenarios to narrow options for feasibility analysis. The use of these various tools, as well as Technical studies, data collection and data analysis should be highly transparent and integrated with the public involvement program.

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STEP 7
OBTAIN PERMITS

As this is not a linear planning framework, many of the tasks identified below should appropriately be included in previous steps, at least at a preliminary level of detail. Once final refinements in design have been made, based on permitting agency, public and other input, the process of obtaining permits continues until completed. This will require completion of all environmental

documents necessary to comply with CEQA (and NEPA as applicable).

The components of this final phase, which are largely a continuation of activities previously initiated, include:

- Finalize any remaining issues associated with obtaining permits, such as collecting and analyzing requested data, coordinating review timelines with regulatory agencies, completing any requested revisions in formatting or detail of required information, etc.
- Create checklist and timeline to guide project planners in finalizing design documents and meeting any remaining reporting requirements, as well as addressing any outstanding issues
- Identify required monitoring programs and design considerations
- Initiate pre-construction monitoring programs, as required or desired, before proceeding with the construction phase of the project
- Finalize proposed post project implementation evaluation processes
- Establish and initiate ongoing public involvement process, as necessary
- If adaptive management strategies are anticipated given the nature of the project, provide an adaptive management plan that indicates the objectives of the plan, how progress will be measured, decision points and processes, an indication of potential strategies that could be employed to meet project objectives, and how agency and public involvement will be incorporated.

Step 7 Obtain Permits

The remaining steps of the process are associated with detailing design and engineering specifications, contracting, and other steps necessary to begin construction, tasks which go beyond the scope of a planning document

Chapter 6

Regulatory And Permitting Issues

The processes for obtaining permits to build and operate a desalination facility need to be fully understood in the planning and design phases of a desalination project. Issues such as the type, amount and formatting of information required can vary significantly. As such, these differences need to be fully understood.

Two helpful if not essential practices recommended in the conceptual planning phase of a desalination project are:

1) identifying all the permits that will be required, and
2) beginning a dialogue among the responsible public agencies.

As such, it is highly recommended that project sponsors identify all key agency staff who will be involved in permitting the project, and form a "Permitting Review Committee." This "Committee" would be comprised of a representative from each major regulatory agency who would interact with each other and the project sponsor as the project proceeds. This creates a line of communication that facilitates efficiencies in the timing of submitting permit applications, in the type and format of information required, and in reviewing changes to the project that occur during the planning and design phases of the project.

Project sponsors should identify key agency staff who will be involved in permitting the project, and form a "Permitting Review Committee" early in the process.

While some agencies might not have sufficient staffing to participate on a Permitting Review Committee, arguably, it is worth trying to establish such a group or at least work as closely as possible with permitting agency staff on an ongoing basis throughout the planning and design aspects of the project.

Appendix A identifies the agencies with desalination permitting authority and summarizes the major permits required to build and operate a coastal desalination facility.

PERMIT REVIEW AND APPROVAL PROCESS

The permit approval process is not straightforward. Some agencies wait for other agencies to review the permit before they will review or approve the permit. In coastal areas, an applicant will need to provide other local and state permits or preliminary approvals before their coastal development permit application is considered complete by the Coastal Commission. This generally results in the Commission's coastal development permit being the last of the local and state permits to be reviewed. However, all other permits are typically in place before the Department of Public Health can certify a facility that will be the source of drinking water. So it is important to determine early in the conceptual planning phase the permit review and approval process.

It is important for project sponsors and the various agencies involved to coordinate closely with each other and with interested publics.

Given the number of regulations involved in siting a desalination facility – a facility meant to provide drinking water, especially when located in a coastal area – the process will be subject to high public scrutiny. It will therefore be important for project sponsors and the various agencies involved to coordinate closely with each other and with interested publics. For the review process to be both effective and efficient there will likely need to be an open exchange of information among the various parties to allow issues of concern to be identified and resolved early in the process rather than later.

CALIFORNIA ENVIRONMENTAL QUALITY ACT (CEQA)

Desalination facilities will require comprehensive environmental review under CEQA, most likely through the Environmental Impact Report (EIR) process. With the number of agencies involved in desalination and the number of permits likely to be required, it is important to have a thorough and comprehensive CEQA review. Reviews for many permits, including coastal development permits, often require more detailed information than might be provided during CEQA; however, if agencies are involved in the CEQA review early and thoroughly, and much of the information they need is provided as part of that review, it may result in a more efficient and shorter decision-making process. The ecological impacts of

feedwater intakes and brine disposal are addressed through the CEQA and NEPA process, special designations along the coast and the SWRCB Ocean Plans. Growth and related land use and infrastructure issues, along with economic issues, are also addressed through CEQA.

AGENCIES WITH JURISDICTION

The following provides an overview of agencies, laws, and regulations that are most likely to be involved in reviewing desalination proposals, along with a brief description of how they are likely to be involved. Case law and new government regulations, however, should be explored to complete this list. Refer to Appendix A for a summary.

Local And Regional Permits

Each local jurisdiction has its own set of review, permit, and approval requirements. Facilities will be subject to local zoning requirements, land use ordinances, growth management objectives, and related policies, and will need to meet local requirements for public notice, public hearings, appeals and similar actions. Permits needed may also include grading permits, building permits, among others. Local or regional permits may be required from air pollution control agencies, water districts, local utilities, and city or county health departments.

Seawater and estuarine desalination facilities will need a coastal development permit from both the local jurisdiction, if it has a certified Local Coastal Program, as well as from the Coastal Commission. The local government's jurisdiction generally includes most upland areas near coastal waters and areas above the mean high tide line. Additionally, some desalination facilities will be located within the Coastal Commission's appeal jurisdiction. In these situations, a local jurisdiction's decision on a coastal development permit may be appealed to the Coastal Commission. The Coastal Commission may then review the appeal to determine whether the local decision conforms to the applicable policies of the Local Coastal Program.

Seawater and estuarine desalination facilities will need a coastal development permit from both the local jurisdiction, if it has a certified Local Coastal Program, as well as from the Coastal Commission.

State Permits:

Desalination facilities will likely require permits or approvals from the state agencies listed below. Unless otherwise noted, these approvals are generally required before the coastal development permit application to the Coastal Commission is considered complete.

Coastal Commission. The California Coastal Commission was established by voter initiative in 1972 (Proposition 20) and later made permanent by the Legislature through adoption of the **California Coastal Act of 1976**. The Coastal Commission, in partnership with coastal cities and counties, plans and regulates the use of land and water in the coastal zone.

Development activities, which are broadly defined by the Coastal Act to include (among others) construction of buildings, divisions of land, and activities that change the intensity of use of land or public access to coastal waters, generally require a coastal permit from either the Coastal Commission or the local government.

Activities that change the intensity or use of land, or public access to coastal waters, generally require a coastal permit from either the Coastal Commission or the local government.

State Lands Commission. The State Lands Commission manages most of the state's tidelands and lands lying under coastal waters. Desalination facilities proposing to place new intakes or outfalls on state tidelands, or to change existing intakes or outfalls, will generally be required to obtain a lease modification from the Commission.

In some coastal areas, the state has granted tidelands to a local jurisdiction. Coastal development permit applications to build structures in these areas will need to include a lease from the local jurisdiction. In these areas, the local jurisdiction's lease decision may be subject to review and approval by the State Lands Commission.

State Water Resources Control Board (SWRCB) and Regional Water Quality Control Boards (RWQCBs). The SWRCB is responsible for allocating water rights within California and establishing many of the state's water quality protection measures. Nine Regional Boards develop and enforce water quality objectives and implementation plans in particular regions of the state.

- ***Water Rights***: The SWRCB reviews and authorizes water rights in California, which are required for consumptive uses from enclosed water bodies within the state. Water rights are likely not needed for proposed desalination facilities using water from the open ocean, but may be needed by facilities proposing to use water from enclosed or semi-enclosed areas, such as bays or estuaries, or saline groundwater. Applicants and lead agencies should contact the State Board to determine whether a specific proposal will require a water right.

- ***Water Quality:*** The State Board and its nine Regional Boards share key responsibilities for implementing the state's water quality requirements, including permitting under the Clean Water Act. The Regional Boards are also responsible for Clean Water Act Section 316(b) requiring that "the location, design, construction and capacity of cooling water intake structures reflect the best technology available for minimizing adverse environmental impact." Under these provisions, extensive monitoring can be required to demonstrate that feedwater intakes from facilities do not cause unacceptable ecological impacts.

  The State Board establishes statewide standards, including the state's Ocean Plan, and hears appeals of Regional Board decisions. Each of the state's nine Regional Boards is responsible for water quality permitting within its region. Parts of six Regional Boards are located along the California Coast and would regulate the discharges of desalination facilities within their jurisdiction. The two most common RWQCB permits likely to be needed for a coastal desalination facility are a water quality certification and a discharge permit:

  - Section 401 Water Quality Certification: This permit is required when proposing to place fill in a water body. It is issued by the state in conjunction with a Section 404 permit from the U.S. Army Corps of Engineers (see below). "Fill" includes intake or outfall pipelines, beach wells, transmission lines, or other similar structures. Desalination facilities involving new intakes or outfalls or requiring

The SWRCB is responsible for allocating water rights within California and establishing many of the state's water quality protection measures.

modification of existing outfalls are likely to require a 401 water quality certification.

- National Pollutant Discharge Elimination System (NPDES) permit: allows pollutants to be discharged to waters of the U.S. Desalination facilities proposing a new outfall will likely need a new NPDES permit. For desalination facilities proposing to use existing outfalls at already-permitted facilities, such as power plants or wastewater treatment facilities, the RWQCB may choose to modify the existing permit or may require a new permit.

  NPDES permits almost exclusively regulate the discharge of pollutants from point sources, such as industrial effluent from an outfall pipe or stormwater from a municipal storm system. The primary exception applicable to coastal desalination facilities is that NPDES permits are also used to regulate intakes used by thermal power plants that use ocean water for cooling. An NPDES permit for these facilities must determine that these systems use the best technology available to minimize adverse impacts due to their location, design, construction, and capacity. Desalination facilities proposing to co-locate with these types of power plants may therefore be subject to NPDES requirements associated with their intakes.

For some project components the Coastal Commission may require some information not requested by a Regional Board, in part because the Coastal Act has different requirements.

Coordination between the Coastal Commission and the State/ Regional Boards: The Coastal Commission often works with the Regional Boards to coordinate review when there is shared jurisdiction of proposed projects. Although the State and Regional Boards operate primarily under the California Water Code while the Coastal Commission acts pursuant to the Coastal Act, there are several areas of shared responsibility and common requirements.

For some project components the Coastal Commission may require some information not requested by a Regional Board, in part because the Coastal Act has different requirements. The Coastal Act review is equivalent to CEQA, while the NPDES review process is exempt from CEQA. This is another reason that project applicants should request that the involved agencies identify the applicable

standards, necessary studies and likely requirements as early in the proposal process as possible, either during environmental review or even earlier during conceptual design or a proposed facility, to allow better coordination by all involved parties.

***Energy Commission*:** For desalination facilities proposing to locate at power plants, the Energy Commission is likely to review proposed changes to the power plant needed to accommodate the desalination facility. Some of those changes may require approval from the Energy Commission. The review may also evaluate the effects of the desalination facility on the power plant's operations, its effect, if any, on the local or regional transmission lines, and other aspects of the desalination facility's impact on energy use.

Department of Fish and Game: The Department requires a stream alteration permit for activities within inland waters and within some areas of bays and estuaries. It also reviews projects for potential impacts to listed species.

Public Utilities Commission (PUC): Desalination facilities may be subject to water rates established by the PUC. The PUC also establishes service areas for water districts, so water provided by a desalination facility may be subject to limits on where it can be sent and the price that may be set.

The permit from CDPH may be the final permit to be obtained in the permitting process.

Department of Public Health (CDPH): The Department has permitting responsibilities under the Safe Drinking Water Act. Equipment and processes used in desalination facilities will likely be subject to review and approval for use as drinking water. This review may include specific performance standards for construction and operation of a facility, evaluation of the integrity of equipment used at the facility, determining the required response by the facility operator to various problems, and other requirements. Their permit may be the final permit to be obtained in the permitting process.

Other: Other state permits may be required, depending on the facility location, from the state Departments of Parks and Recreation, Transportation, Boating and Waterways, and others.

Federal Permits

Coast Guard: Structures in navigable waters, such as intake and outfall pipelines, may require approval to ensure they do not

adversely affect navigation. The Coast Guard may also require buoys or markers to be maintained over the structures. The applicant may also be required to submit information about the structures to include on nautical charts.

U.S. Army Corps of Engineers: A desalination facility may require a Section 404 permit from the Corps if it involves placing fill in navigable waters, and a Section 10 permit if the proposal involves placing a structure in a navigable waterway.

National Marine Fisheries Service and/or U.S. Fish and Wildlife Service: Facilities may require review from these agencies for their potential effects on endangered, threatened, or other sensitive species. They may also require review for effects on protected marine mammals and migratory birds

Other: Other permits may also be required from the federal Bureau of Reclamation, Environmental Protection Agency, Mineral Management Service and others.

RELATIONSHIP OF PLANNING TO PERMITTING

Some project characteristics may make the planning, environmental review, and permitting processes more straightforward.

Designing a proposed project using the applicable regulatory requirements as design constraints may help complete the project successfully. The following list of characteristics includes those that will likely make the planning, environmental review, and permitting processes easier or more straightforward. These are based on feedback from permitting agencies and experiences of addressing these concerns.

As noted earlier, each facility should undergo a case-by-case review, but focusing on the following characteristics during the planning process may be beneficial. While not a complete list, under conditions where they are applicable, the following may affect the permitting process:

- Inland facilities or facilities away from the shoreline are typically easier to permit than coastal facilities.
- Subsurface seawater intakes are likely easier to permit than open-water intakes.
- Publicly-owned facilities are likely easier to permit than privately-owned.

- Facilities with known service areas are likely easier to permit than facilities with unknown or extensive service areas.
- Facilities that are part of a coordinated local or regional water portfolio are likely easier to permit than facilities proposed by a single, independent entity.
- Proposed desalination projects that have undertaken a thorough, transparent planning process will more likely be easier to permit than those which have not
- Early and ongoing coordination with permitting agencies and the public is likely to make the process easier than with little or no coordination.

Existing permitting processes are in place to protect the public trust, local communities, residents and business in service areas, and environmental resources. Clearly, however, some technological and/or operational options proposed for desalination facilities can make the permitting process relatively easier or more difficult, as can the extent and effectiveness of planning and agency/public engagement.

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Chapter 7

Recent Trends And Advances

This chapter is intended to "ground truth" many of the observations and guidelines presented in the Handbook. The first section provides a series of perspectives from those directly involved with the development of desalination facilities during the period since the California Desalination Task Force convened. The second section provides a summary of the various projects funded by Proposition 50, Chapter 6 during 2005 and 2006, as an indication of where the state believes resources can best be applied to support, where appropriate, the development of economically and environmentally viable desalination facilities. The third section identifies some of the outstanding issues which will require additional attention as interest in the expanded use of desalination continues.

PERSPECTIVES ON RECENT DESALINATION PROPOSALS IN CALIFORNIA

Currently, more than 25 desalination projects are in various stages of planning throughout the State. The following summary provides actual quotes on the issues, opportunities and challenges associated with these and other desalination facilities. While not inclusive of all perspectives identified, it represents a cross-section of comments and perspectives by those who support as well as those who question or oppose the use of desalination. The facilities have not been identified, however, as the focus is on highlighting the issues and perspectives of various publics involved with desalination initiatives. Their incorporation into this Handbook is for instructive purposes, to help advance the dialogue in recognition of a wide range of perspectives. They are not intended to represent the views of DWR or the authors.

While not all inclusive, this summary represents a cross-section of comments and perspectives by those who support as well as those who question or oppose the use of desalination.

Ownership:

- "The potential for private ownership of desalination facilities have stirred concerns among some public officials and advocacy groups who worry that a public resource (drinking water) will be exploited for private profit and sold to the highest bidder."

- "Some proponents warn that multinational companies could try to use international trade agreements to get around local and state environmental regulation."

- "When monetary profit is the primary motive underlying the ownership and provision of water services, it is not unreasonable to expect that water conservation, water reclamation [recycling], water quality (and) minimization of growth-inducing effects ... will be compromised."

- "Private water utilities have operated in California since its infancy and today provide about a fifth of the state's drinking water. In an era of government budget cuts and monster deficits, it makes sense for private investors to shoulder the financial risks of getting new technology up and running."

- "We need to get creative. I don't think you can say [that] because it's private, it's bad. If we're meeting [quality and quantity] specifications for the life of a contract, it doesn't matter how you get the water there."

- "If [a private corporation] is going to venture their capital and we agree to buy water at a certain rate and define what the rules of the game are, I don't see the risk."

- "Competing desalination projects, public sentiment and the varying water needs of the county have made it clear that any desalination plant needs to be publicly owned and operated as a collaboration between various agencies and jurisdictions."

Economics and Cost:

- "Despite a drop in desalination costs over the last decade, desalinated seawater remains at least twice as expensive as conventional water supplies in Southern California. Ten years

ago, it cost about $2,000 an acre-foot to produce water by desalination. Today, the price is [about half that, depending on prevailing energy costs]."

- "It's a valid technology and, certainly, one of the biggest obstacles is energy [costs]."

- "The details of the county's program, including who would benefit and who will pay, have not yet been sorted through."

- "A lingering dispute over water rates has apparently become the latest threat to …….. dreams of turning ocean water into drinking water."

Environmental Impacts:

- "[The plant's] operation won't worsen the ecological threat. Proposed seawater-to-drinking-water plants are necessary to support population growth and development over 20 to 30 years."

- "Super-salty leftover water from the filtering process, called brine, could be blended with fresh water or treated wastewater before being piped back into the ocean in a complex diffusion system designed to minimize impact on marine species and habitat."

- "Environmentalists say that by setting up shop at power stations, desalination plant operators will continue to use the vintage pipes rather than investing in new technology that might be less harmful to marine life. There are too many unanswered questions about marine life mortality."

- "Recent studies of Northern California power plants show that their intakes have a significant impact on local marine populations. We know that [marine organisms are] killed, and at what rate, but beyond that — what is the long term effect to the rest of the ecosystem? We don't have a clue. We've never looked at that."

Growth Issues:

- "The prospect of runaway growth is especially worrying [to some] in central California, where places …… are nearly pristine, absent strip malls and acres of track homes, in part because of the lack of water."

- "The plant's capacity is so small that it doesn't present the growth-inducement problems that environmentalists fear in the larger plants."

- "[Concerns exist that] the plants will promote population growth by creating another water source, ……."

- "The water treatment plant can't produce enough clean drinking water to keep up with the population growth. The Water District has to replace that water."

- "Would expanded supply lead to expanded population growth in areas that are already facing population growth? Are we meeting existing supply needs, or are we going to facilitate growth?"

Regulatory Issues:

- "My main concern is every single agency under the sun has a piece of the review process, making it a bureaucratic nightmare. It would be great if they could find a way to consolidate that process."

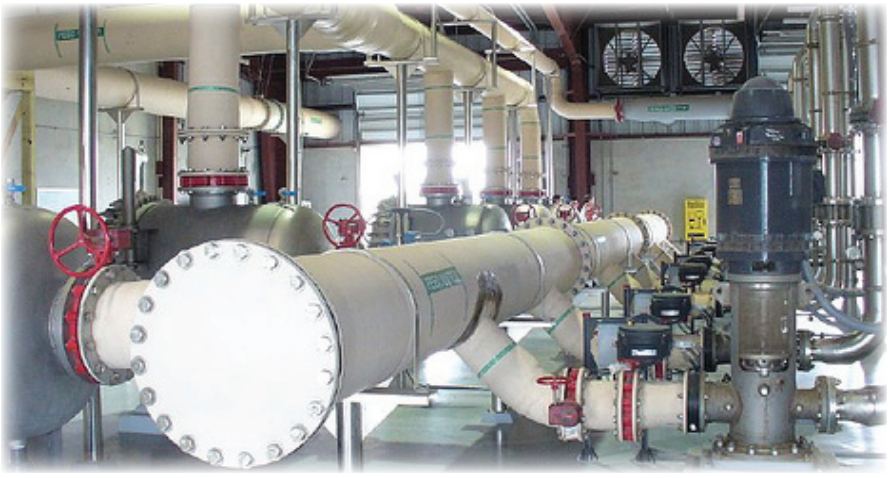

Photo Coutesy of Danielle Supercinski

RECENT PROPOSITION 50, CHAPTER 6 FUNDING TO SUPPORT DESALINATION RESEARCH, PILOT PROJECTS AND CAPITAL EXPENDITURES

Proposition 50, Chapter 6 has now provided two rounds of funding to address various issues associated with desalination in California. In addition to providing funding to build full-scale projects, funding has been provided to support both research and pilot projects intended to explore innovative approaches to desalination. See Appendix B for a summary of representative desalination projects funded by Proposition 50.

As noted from Appendix B, many initiatives are focused on retrieving brackish groundwater, in inland areas in particular. Attention is also being given to the treatment and conveyance of the brine discharge generated. Numerous projects are focusing on the next generation of desalination technologies and membranes, and approaches to reducing energy costs. Several initiatives are addressing ways to reduce potential environmental impacts, such as using subsurface rather than open ocean intakes. Approaches for supporting regional cooperation in developing and operating desalination facilities are also of interest. Several projects are focusing on economic analyses and how to make desalination more economically attractive. Projects include seawater desalination up and down the coast, estuarine and brackish groundwater desalination in the San Francisco Bay region, and brackish groundwater desalination in the central valley, the Los Angeles Basin and the Mojave Desert.

These are important initiatives, as they address some of the major concerns often expressed by both those who support desalination and those who question its use. Improved economic analyses, lower cost and more energy efficient desalination processes, and reduced environmental impacts are all seen as critical to more widespread use of desalination.

Numerous pilot and demonstration projects are focusing on the next generation of desalination technologies and membranes, and approaches to reducing energy costs.

EMERGING AND OUTSTANDING POLICY ISSUES

Several policy issues require additional attention as indicated by the views of permitting agencies, regional and local governments and water districts, and various interest groups. In some cases paradoxes have been observed, in others the lack of clear direction.

It is important to ensure public education and outreach processes are genuine efforts to enhance public understanding of desalination processes and project need.

Several outstanding issues are associated with the potential co-location of seawater or estuarine desalination facilities with power plants using once-through cooling.

The following examples suggest the kinds of issues on which further clarification, communication and coordination is needed in planning a desalination facility:

1) **Public Education and Outreach.** In one instance, the PUC disallowed costs for "public education and outreach" associated with planning and development of a desalination facility. The PUC ruled that many of the costs associated with outreach efforts were in fact "advocacy" rather than actual "public education and outreach." This suggests the importance of ensuring public education and outreach efforts are genuine efforts to enhance public understanding of desalination processes and project need.

   Perhaps more fundamental is ensuring "public input," so that individuals and public interest groups have an opportunity for their views to be heard and appropriately addressed. This can be challenging in situations where local government and/or water district officials believe that desalination is an essential component of the water supply portfolio, yet the broader public does not share that view. Under these circumstances the tendency is often to rely on "lobbying" to move a project through rather than working through the causes for concern. In the absence of effectively addressing these concerns or differences, however, several desalination projects have been the subject of added scrutiny and criticism.

2) **Co-Location.** Proponents of a proposed seawater desalination facility to be co-located with a "once-through-cooling" power plant were informed that the power plant would likely be moved and the cooling system changed to "dry-cooling" within the next few years. This raises several challenging issues. What types of design and operational modifications will be required for the desalination facility? How will the permitting process be affected in light of losing the benefits provided by the power plant (e.g., little or no net increase in water intakes, dilution of brine with power plant discharge)? How will permitting agencies view water intakes from a desalination facility alone (although much lower than the power plant)?

   Additionally, a ruling by the 2nd Circuit Court early in 2007

in essence requires power plants to reduce their impingement and entrainment impacts directly as opposed to offsets or mitigation through habitat restoration, fish planting, etc. This also has potential planning implications for desalination facilities considering linkages with once-through cooling plants.

This ruling also resulted in U.S. EPA rescinding their existing rule and returning to "best professional judgment" to make decisions about once-through cooling facilities. This is similar to the basis for decision making in California. In response to the potential for inconsistencies, however, the State Water Resources Control Board is developing a new policy regarding once-through cooling operations which is likely to have implications to desalination facilities considering co-location.

3) **Project Sponsorship.** At least two recently proposed desalination projects have been impacted by lack of clarity on which public entity(ies) will sponsor the project. This reinforces the value in having project sponsors, or applicable public-private partnerships, identified and established early in the process of planning a desalination facility. As the dynamics associated with these types of uncertainty unfold, the local governments or water districts involved expend resources competing with each other rather than working together. This results in parallel efforts and an expenditure of potentially significant resources. Time delays associated with these uncertainties can also have significant financial implications. The issue of public versus private ownership of desalination facilities is also associated with who sponsors, operates and "owns" the desalination facility.

How sustainability of desalination facilities is ensured, especially when private entities are involved, is an issue requiring greater attention.

4) **Sustainability and Reliability.** The issue of sustainability of the potable water supply has been raised when private ownership of facilities is involved. Some believe provisions should be put in place to ensure the viability of the facility should the owner/developer no longer be able to provide the service, especially when the facility is providing part of the public's potable water supply. The second aspect of this issue is reliability and continuity during emergency situations. This could include addressing Homeland Security provisions,

as well as addressing circumstances in the event of an earthquake or other natural disaster. Provisions to address these concerns should be addressed in the design and permitting process.

Several lawsuits have been filed or threatened related to recent seawater desalination proposals. Issues of concern include potentially damaging environmental or ecological impacts, quality of environmental studies, co-location with once-through cooling power plants and rate increases. These are examples of issues that must be effectively addressed in the planning and design processes, with adequate assurances provided, to build public trust that seawater desalination facilities can be environmentally and economically viable.

Chapter 8

Conclusions

There is not just "one way" to pursue the development of desalination facilities. In the same vein that each desalination project needs to be considered on its own merits, this Handbook provides just one possible approach to help ascertain the environmental and economic acceptability of a desalination project, and should be applied accordingly. This Handbook attempts to provide, however, a holistic approach to desalination planning that can be useful to the process of developing, reviewing, evaluating and permitting potential desalination projects.

As more and more is learned about the implications of expanded use of desalination, mitigation measures and improvements in desalination technology, planning and permitting processes will perhaps become more focused and efficient. But at this stage of developing desalination (especially seawater desalination) as a supplemental source of water supply in California, attention must be given to ensuring desalination planning – in both perception and fact – is addressing the key concerns raised and is building a strong foundation for sound decision-making.

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Chapter 9

References And Linkages To Related Information Sources

This chapter provides references and linkages to information that helped shape the recommendations of the Task Force. It also contains references to selected documents that have been developed since the Task Force completed its work that could be useful in the planning process for and review of potential desalination facilities.

The Water Recycling and Desalination Branch, California Department of Water Resources (DWR), is a valuable resource as well with a wealth of information on desalination in California. The Branch also is responsible for state funding of desalination projects. Many resources related to desalination in California can be found on its website: http://www.owue.water.ca.gov/recycle/.

The following reports are recommended for further information.

1. Water Desalination: Key Findings and Major Recommendations. The primary product from the Task Force, chaired by DWR, was a report citing key findings, followed by major recommendations based on the key findings. This document served as the report from the Task Force to the State Legislature required by AB 2717, and serves as the foundation for this Handbook. This report must be viewed, however, in the context of the rapidly changing environment of numerous new studies associated with proposals to develop desalination facilities, advances in research and technology, emerging policies associated with climate change and greenhouse emissions, lessons learned from pilot projects, among other recent sources of information relevant to the use of desalination technologies in California.

The electronic link to the Final Task Force report (10/2003) is:

http://www.owue.water.ca.gov/recycle/desal/Docs/Findings-Recommendations.pdf

2. Task Force Working Papers. The Task Force commissioned several working papers, prepared by experts on the selected topics, to advance understanding of desalination and its potential implications to California. Some papers have been updated since the Task Force completed its work. Others have not been updated. They remain useful, however, by identifying the key issues associated with the selected topics. These are intended as additional information for those seeking more in-depth understanding of critical desalination issues.

Issues addressed by these working papers are:

Siting Issues
Intake and Feedwater Issues
Concentrate/Brine Management Issues
Technology Overview
Energy Issues
Economics Issues
Planning and Growth Issues
Public Health Issues
Co-Location Issues
Regulatory and Permitting Issues
Local Government Perspectives
Wholesale Energy Issues
Subsidies
Beach Wells
Feedwater and Concentrate Management Alternatives
Unit Costs

The electronic link to these Working Papers (2003-2004) is:

http://www.owue.water.ca.gov/recycle/desal/Docs/IssuePapers.htm

3. Coastal Commission Report on Desalination. The Coastal Commission is one of the key regulatory agencies with permitting responsibilities for potential coastal and seawater desalination projects and facilities. Serving as one of the Task Force Co-Chairs,

the Coastal Commission followed the Task Force's report with its own, tailored more to its responsibilities and views of coastal and seawater desalination. This report was published in March 2004.

The electronic link to the Coastal Commission's report (03/2004) on desalination is:

http://www.coastal.ca.gov/energy/14a-3-2004-desalination.pdf

4. Bureau of Reclamation Desalination Initiatives. The Bureau of Reclamation has long been involved with desalination technologies and their application in the United States. They have generated numerous publications related to desalination technology especially.

The electronic link to their Website is:

http://www.usbr.gov/pmts/water/desalination/index.html

5. Association of Monterey Bay Area Governments (AMBAG) Monterey Bay Regional Desalination Feasibility Study. This report, prepared in conjunction with the Monterey Bay National Marine Sanctuary (MBNMS), highlights critical considerations for desalination in Monterey Bay. It provides a framework for planning and assessing potential desalination facilities specifically in Monterey Bay, yet with broader application as a planning framework for other areas. It considers desalination in the context of an overall water management portfolio and provides guidance on habitat-based siting criteria.

The electronic link to the AMBAG/MBNMS (11/2006) report on desalination is:

http://www.ambag.org/publications/reports/Desal%2006/AMBAG_FINAL_Desal_Study.pdf

6. California Water Plan. The California Water Plan, prepared by DWR, identifies desalination as one element to be considered in the development of a diversified state water resources portfolio. The Plan considers all potential elements of water resources portfolio and how desalination might contribute under appropriate conditions to providing water supply in California.

The electronic link to the most recent California Water Plan (01/2008) is:

http://www.waterplan.water.ca.gov/

7. California's Water-Energy Relationship. This report, prepared by the California Energy Commission in 2005, discusses the scope and extent of impacts of water resources related activities on energy use, including desalination.

The electronic link to this November, 2005 report is:

http://www.energy.ca.gov/2005publications/CEC-700-2005-011/CEC-700-2005-011-SF.PDF

8. Desalination, With a Grain of Salt: A California Perspective. This report was prepared by the Pacific Institute. It provides an overview of desalination activities in California, and also addresses potential opportunities and constraints associated with seawater desalination in particular. The report provides prescriptions about how to ensure adequate planning of desalination facilities, and for determining the appropriate conditions for desalination.

The electronic link to this June, 2006 report is:

http://www.pacinst.org/reports/desalination/index.htm

9. Progress on Incorporating Climate Change into Management of California's Water Resources. This report, prepared by DWR, documents the potential impacts of global climate change on water resources management in California. It documents anticipated changes in precipitation and runoff patterns that could significantly impact water supplies throughout the state of California.

The general Website for issues related to climate change is:

http://www.water.ca.gov/climatechange/

The electronic link to the July, 2006 report is:

http://www.water.ca.gov/climatechange/docs/DWRClimateChangeJuly06.pdf#pagemode=bookmarks&page=1

10. Other Potential Reports of Interest. Many other desalination handbooks, environmental impact reports and technical reports have recently been developed. The American Water Works Association (AWWA), World Health Organization, San Francisco Bay Conservation and Development Commission (BCDC), Poseidon Resources Inc., as well as several California cities that are working on desalination projects have contributed to the recent literature on desalination. Likewise, several Environmental Impact Reports have been conducted which add to an understanding of the key issues associated with desalination.

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Appendix A

Permits/Approvals Likely for a Coastal Desalination Facility

AGENCY	PERMIT OR APPROVAL	APPLICATIONS
FEDERAL		
U.S. Coast Guard	Consultation with Corps	
National Marine Fisheries Service	Endangered Species Act, Section 7 consultation	For federal permits that may affect endangered species
National Oceanic and Atmospheric Administration	Permits and/or consultation Endangered Species Act,	For projects in national marine sanctuaries
U.S. Fish & Wildlife Service	Section 7 consultation	For federal permits that may affect endangered species
Monterey Bay National Marine Sanctuary	Permit	Intakes from and discharges into Bay
STATE		
Coastal Commission	Coastal Development Permit Consistency with Coastal Zone Management Program	• For projects affecting coastal waters • For projects requiring federal permits and approvals
Department of Public Health	State Safe Drinking Water Act Federal Surface Water Treatment Rule	
Department of Parks & Recreation	Department of Parks & Recreation	
Department of Transportation	Encroachment permit	For utilities crossing state highways

AGENCY	PERMIT OR APPROVAL	APPLICATIONS
STATE CONTINUED:		
Department of Water Resources	Approval for use of state water conveyance facilities	
Public Utilities Commission	Regulates water services, rates, and service areas	
State Lands Commission	Land Use Lease	
State Water Resources Control Board / Regional Water Quality Control Boards	Water quality certification NPDES permit	
San Francisco Bay Conservation and Development Commission		Authorities similar to Coastal Commission for San Francisco Bay
LOCAL AND REGIONAL:		
City or County / Local utilities / Water Management Districts	These will vary by local jurisdiction and may include building permits, health department certifications, operation permits, or other types of approvals	

Appendix B

Proposition 50, Chapter 6 Representative Desalination Project Funding

CONSTRUCTION PROJECTS	
PROJECT SPONSOR/ LOCATION	**PROJECT DESCRIPTION**
Marin Municipal Water District	Construction of 10 million gallon per day (MGD) facility, with intake from San Rafael Bay
Inland Empire Agency	Expansion of the Chino II Desalter, adding 4,400 acre-feet per year (AFY) of treated groundwater to the potable water supply
Alameda County Water District	Expansion of the brackish groundwater desalination facility already in operation, doubling the capacity from five to 10 MGD of potable drinking water
East Bay Municipal Utility District	Construction of a Low Energy Application of Desalination (LEAD) facility to produce 1.5 MGD of potable water supply from cooling water used for a food processing plant on the Carquinez Strait.
Sand City	Construction of a 300 AFY reverse osmosis desalination facility to produce potable water for residential, commercial and industrial development
City of Oxnard	Construct a brackish groundwater desalter and blending station
Irvine Ranch Water District	Irvine Desalter Project and South Irvine Brine Line

PILOT PROJECTS	
PROJECT SPONSOR/ LOCATION	**PROJECT DESCRIPTION**
City of Long Beach	Demonstrate the potential of an innovative submerged intake and discharge system, utilizing beach sand to meet pretreatment requirements (2005) and determine how to best integrate desalinated seawater into existing conveyance systems networks (2006)
Coachella Valley Water District	Demonstrate the viability of an innovative brackish groundwater desalination technology, including low-energy, solar still technology and potential options for brine disposal
Eastern Municipal Water District	Test the feasibility of implementing innovative approaches to treating brine from a groundwater desalination facility, where the groundwater is characterized by high TDS, silica and other constituents
West Basin Municipal Water District	Demonstrate the applicability and costs of various technologies to pre-treat and desalinate Pacific Ocean seawater

PILOT PROJECTS (Cont.)	
PROJECT SPONSOR/ LOCATION	**PROJECT DESCRIPTION**
City of Santa Cruz	Test technology innovations and optimize operation of the Santa Cruz desalination facility
City of San Diego	Demonstrate the ability to successfully desalinate groundwater from the San Pasqual aquifer
Los Angeles Department of Water and Power	Assess the feasibility of developing a seawater desalination facility at the Scattergood Generating Station in Playa Del Rey
Affordable Desalination Collaboration	Test new technologies and membranes to optimize and reduce energy costs associated with reverse osmosis
East Bay Municipal Utility District	Building on previous feasibility studies, utilize a pilot project to test the operation and maintenance of a joint desalination facility in San Francisco Bay
U.S. Bureau of Reclamation	Pilot to demonstrate the use of Vertical Tube Evaporation Geothermal desalination, applied to brackish groundwater and Salton Sea water
Municipal Water District of Orange County	Test slant "beach wells" for an extended period to assess cost and pretreatment effectiveness
City of Avalon	In parallel with the existing desalination facility on Catalina Island, test a skid mounted seawater reverse osmosis (large diameter) system with reduced energy consumption
Indian Wells Valley Water District	Pilot to assess production of 3,000 AFY of potable water from brackish groundwater in the northern Mojave Desert
City of Camarillo	Test different desalination technologies and membranes for brackish groundwater desalination in the North Pleasant Valley Groundwater Basin

FEASIBILITY STUDIES	
PROJECT SPONSOR/ LOCATION	**PROJECT DESCRIPTION**
Western Municipal District	Evaluate expansion of the Arlington groundwater desalter in Riverside County
Bay Area Regional Desalination Partnership	Assessment of processes to support regional collaboration on desalination projects
Montara Water and Sanitary District	Feasibility study of brackish water desalination in San Mateo County and beach wells for feedwater intake
Association of Monterey Bay Governments	Devise a regional framework for planning for desalination in the Monterey Bay area
West Basin Municipal Water District	Research the feasibility of a 40 MGD desalination facility in Santa Monica Bay
San Diego County Water Authority	Feasibility study for seawater desalination at the San Onofre Nuclear Generating Station (2005) and a regional concentrate (brine) conveyance facility in southern San Diego County (2006)
City of San Diego	Assess the feasibility of developing a 6,000 AFY desalination facility using the San Diego Formation Aquifer

FEASIBILITY STUDIES	
PROJECT SPONSOR/ LOCATION	**PROJECT DESCRIPTION**
San Benito County Water District	Assess the feasibility of a groundwater desalination facility in the Pajaro River watershed
City of Arroyo Grande	Feasibility of a desalination facility to serve the southern portion of San Luis Obispo County
Sweetwater Authority	Feasibility of a brackish groundwater desalination facility in the Otay River Basin
City of Oxnard	Feasibility of expanding Blending Station No.3 brackish groundwater desalination facility

RESEARCH PROJECTS	
PROJECT SPONSOR/ LOCATION	**PROJECT DESCRIPTION**
City of Long Beach	Ultraviolet light and chlorine dioxide seawater pretreatment for bio-growth control and pathogen inactivation
UCLA	Test new technologies for producing potable water from brackish water (2005) and advancing monitoring, optimization and control technologies associated with reverse osmosis desalination (2006)
Calleguas Municipal Water District	Evaluate two treatment technologies to remove metals at low concentrations from brine
UC Santa Cruz	Develop an analytical tool for conducting a full social cost accounting-based assessment of the benefits and costs of proposed desalination projects in California
Municipal Water District of Orange County	Evaluate the feasibility of horizontal well technology in alluvial marine aquifers for ocean feedwater supply and pretreatment
Lawrence Livermore National Laboratory	Test a new desalination technology on a laboratory scale - Electrostatic Ion Pumping (2005) and approaches to desalination using carbon nanotube membranes (2006)
Joint Water Reuse and Desalination Task Force	Identify, prioritize and implement desalination research and development projects that would have the greatest impact on desalination issues in California
Montara Water and Sanitary District	Evaluate subsurface intake filter technology associated with a proposed seawater desalination facility
Sweetwater Authority	Determine if solar distillation loops can be used to produce potable water from brackish concentrate discharge using ambient solar energy
West Basin Municipal Water District	Monitoring program to assess impacts of stormwater, marine phytoplankton and biotoxin production on a seawater desalination facility and its product water
Colorado School of Mines	Develop and investigate the value of a hybrid membrane system for pre- and post-treatment associated with brackish or seawater desalination to reduce energy expenditure and environmental impacts
U.S. Bureau of Reclamation	Develop chlorine resistant reverse osmosis membranes