Desalination
Resource Management Strategy

Draft Memorandum

CALIFORNIA WATER PLAN UPDATE 2023

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Contents

1. Introduction

Desalination – the removal of naturally-occurring salt from water for beneficial use – occurred at 46 identified California facilities in 2020. The 46 facilities are shown in Figure 1 and presented more thoroughly in Appendix A. These facilities desalinate groundwater or surface water to meet both potable water supply and industrial needs and support California communities ranging from small remote locations to large urban populations. In general, desalination of water occurs where available water supplies are limited or where local supplies are too high in total dissolved solids (TDS, the amount of salts and other minerals present in the water) to be used without treatment.

Figure 1 Location of 2020 Desalination Facilities

The objective of the Desalination resource management strategy (RMS) is to present the current status of desalination in California, its projected future use, and its benefits and challenges. The discussion herein does not take a position for or against desalination. Desalination is a methodology to be considered and or implemented with other water supply and demand management approaches including conservation, potable and non-potable reuse, stormwater capture, and infrastructure improvements. This RMS does not rank other water supply approaches, nor does it prioritize them over desalination. The determination to implement desalination to support local or regional water supply resources is the decision of the local water suppliers, to be made after careful evaluation and consideration of alternatives and thorough public process.

The Desalination RMS discusses issues associated with removing naturally-occurring salts for subsequent potable or industrial beneficial use of the water. Treating water that is saline because of anthropogenic activities, such as remediation and wastewater treatment for reuse, may use common technologies or have similar challenges and benefits as presented in the Desalination RMS, but are discussed in other RMSs. These applications are discussed in other RMSs identified in Section 7.

The process of desalinating water can be complex and expensive but can also produce a high-quality and reliable water supply. Figure 2 shows the general approach to how water is desalinated.

- **Intake:** How the water is extracted from its source. The intake can be a screened pump from a surface water body, a groundwater well, or a slant well extracting seawater through the seabed.

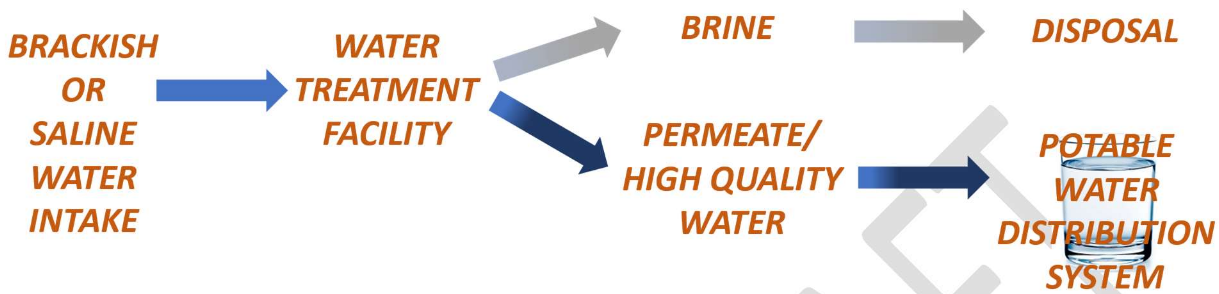
- **Treatment:** How salt is removed from the water extracted from its source. Treatment usually involves various processes including filtration and reverse osmosis and separates the intake water into permeate and brine.

- **Permeate:** The water from which the salts have been removed. This is drinking water and will have additional treatment or blending before being introduced into the local distribution system.

- **Brine:** High TDS liquid waste product. It is disposed through various methods, some of which include blending with discharged municipal wastewater, subsurface ocean diffusers, or evaporation.

Factors and challenges influencing these steps in the desalination process will be addressed in later sections of this RMS.

Figure 2 General Desalination Process



A key factor in discussing desalination is the source water salinity. Seawater has more salt in it by volume than brackish water. Removing salt from seawater takes more energy than removing salt from brackish water and also produces more brine. Salt that is removed during treatment remains in a concentrated brine at the end of the treatment process. Handling this brine is referred to as brine management. Both energy and brine management will be discussed further in Section 4.

This RMS discusses the status of water desalination in California, its challenges, and what water suppliers and researchers are considering for the future. It is focused on desalination of water for potable supply, although desalinated water is also used for industrial processes throughout the state and is discussed briefly later in this RMS. The role desalination plays in future water supply strategies to address climate change issues - described in the August 2022 document California's Water Supply Strategy, Adapting to a Hotter, Drier Future (WSS) - will also be discussed in Section 5.

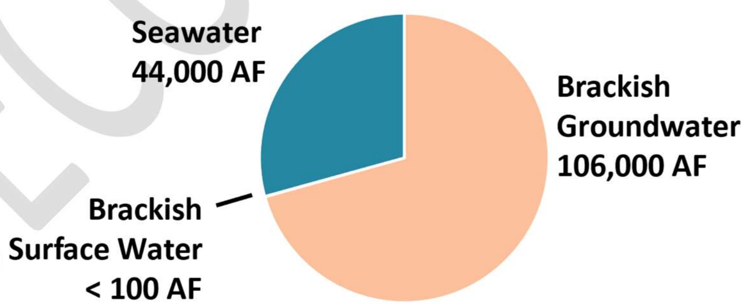
The previous version of this RMS, prepared in 2013, focused on desalination methods and approaches. The 2023 version focuses more on current issues and future objectives. The reader is referred to the 2013 version (see weblink in Section 9) for a thorough discussion of technologies, which currently are largely unchanged. However, improvements in efficiencies are being widely implemented and new research is ongoing, as discussed later in this RMS.

Types of Desalinated Source Waters

Both groundwater and surface water are desalinated in California for beneficial use (Figure 3). Source water characterization is irrespective of the method or methods used to collect the water to be treated.

- **Groundwater**: Groundwater desalination occurs when salts are removed from groundwater to meet state guidelines before it is delivered as potable water supply. The State Water Resource Control Board (SWRCB) has established the recommended secondary maximum contaminant level (SMCL) for TDS as 500 milligrams per liter (mg/L) with an upper SMCL of 1,000 mg/L. Most groundwater desalination in California occurs when TDS values are above 1,000 mg/L, but some occurs when the TDS of the source water is between 500 and 1,000 mg/L.
- **Surface Water**: Surface water desalination in California has traditionally been seawater desalination, although some small facilities in California's desert regions desalinate surface water from springs. Additionally, starting in 2021, two California communities are adding desalination treatment to address increasing salinity in the inland surface water supplies. In 2021 the City of Fort Bragg began desalinating water from its Noyo River intake because of seawater intrusion during high tide. In 2024, the City of Antioch will begin desalinating water from its San Joaquin River intake because of increasing saline bay water intrusion. By 2040, the percentage of brackish surface water is expected to be 1 to 2 percent of the state's total desalinated water supplies, versus the 2020 percentage of 5 thousandths of a percent shown in Figure 3.

Figure 3 2020 California Potable Desalinated Supplies by Source Water Type.



Distinguishing the type of source water for a desalination facility is important not only because the salinity of the inflow water drives the treatment process, but because the siting process for new facilities is significantly different for seawater facilities as compared to brackish surface water or groundwater facilities. New or expanded coastal facilities require compliance for intake and brine disposal with the current Ocean Plan (SWRCB 2019) prepared by the SWRCB and the Seawater Desalination

Siting and Streamlining Report (in preparation, SWRCB 2023). Coastal facilities also usually involve obtaining a Coastal Development Permit from the California Coastal Commission, as well as involvement with the Department of Fish and Wildlife and the State Lands Commission. These processes involve considerable agency and applicant coordination and development of supporting documentation, which can take multiple years to complete and require significant financial investment.

For coastal facilities, determining whether the source water is groundwater and surface water may not be immediately obvious. Source water intakes for coastal facilities may be vertical, collector, or slant wells that may partially or fully collect saline groundwater impacted by seawater intrusion. For this RMS, facilities with any type of well immediately adjacent to the coast that collect groundwater with a TDS comparable to seawater (greater than 30,000 mg/L) are considered seawater desalination facilities.

Desalination in California

The volume of desalinated water produced for potable use in California during the 2020 calendar year was 150,000 acre-feet at 41 active facilities (Table A-1, including 40 dedicated potable facilities and potable water produced at Diablo Canyon). An acre-foot is 325,851 gallons, which is approximately enough water to supply two to three families of four for one year. Information on 2020 desalinated water use was obtained from 2020 Urban Water Management Plans (UWMP), electronic annual reporting to the SWRCB, and direct inquiries. This assessment of 2020 statewide desalinated water use only included centralized desalination facilities operated by a water supplier and did not include onsite treatment for individual residential or commercial buildings.

Desalination facilities in California are located in a wide range of communities. These include areas without reliable fresh water supplies with access to brackish or saline supplies, as well as island or isolated communities. In general, areas with desalination also are using recycled water, indicating that desalination can effectively be a component of a diversified water supply portfolio.

An unknown volume of water was produced by six (6) industrial facilities (Table A-2). The industrial volume is not included in the 2020 volume of statewide desalination because some of the industrial suppliers did not provide actual water volumes produced in that year and the 2010 quantified volume also did not include industrial production. Therefore, to facilitate the comparison of 2010 and 2020 desalination volumes, the 2020 volume focuses on potable supply. The potable use estimate is also considered a reasonably accurate number because of the strong response provided by the potable suppliers to DWR's inquiries.

The 2013 RMS identified approximately 80,000 acre-feet of desalinated water for potable use in 2010, which was the last time potable water produced by desalination was quantified. Between 2010 and 2020, desalination production in California for potable use has almost doubled. The rapid increase can be attributed to factors such as:

- Construction and start-up of the Claude "Bud" Lewis Carlsbad Desalination Plant, which delivers up to 50 million gallons per day (56,000 acre-feet per year) of desalinated seawater to the San Diego County Water Agency, Vallecitos Water District, and Carlsbad Municipal Water District.
- Construction or expansion of multiple groundwater desalination facilities, particularly in southern California.
- Improvement in efficiencies of desalination technologies, which has reduced the cost per unit of water.
- Increase in costs of traditional surface water supplies.
- Decrease in availability of inexpensive and reliable water supplies.
- Concern about reliability and availability of future water supplies.
- Increase in population leading to a greater demand for freshwater.
- Severe drought and snowpack decline in recent years leading to a shortage of freshwater resources.

Considering the third and fourth bullets - Improvement in efficiencies of desalination technologies and increase in costs of traditional surface water supplies – the cost of desalination is becoming more comparable with other water supplies and a viable solution for addressing water scarcity. Transporting water supplies over long distances, such as moving Colorado River or northern California water to southern California, requires power to move the water and evaporation during transport in open canals degrades water quality. Including these factors in alternatives evaluation can indicate desalinated water can be comparable to other water supply sources. These issues underscore the need for careful analyses and evaluation for desalination - and any water supply project - because treatment costs and comparisons can be very project specific.

Brackish Groundwater

Brackish groundwater is the source water for the majority of water desalinated in

California in 2020, although seawater is desalinated for both potable and industrial supplies at multiple sites along the coast. Figure A-1 shows the location of these existing facilities identified in Table A-1.

The majority of the facilities are located in the inland groundwater basins of southern California, serving large urban areas and rural communities. Brackish groundwater facilities may provide the sole source of water for smaller communities in desert areas. For larger communities closer to the coast, brackish groundwater may be one component of a water supply portfolio.

Industrial Uses of Desalinated Water

There are six identified locations (Figure A-1, Table A-2) where dedicated desalination facilities support a wide-variety of non-potable uses in the state. These facilities are:

- **San Francisco**. A 92 acre-feet per year (AFY) facility in San Francisco that uses groundwater collected from a dewatering facility at a BART station to support the City's heat production plant.
- **Santa Barbara County**. A 323 AFY facility in Santa Barbara County that produces steam to warm oil from offshore oil rigs to improve its movement in pipelines.
- **Monterey**. The Monterey Aquarium desalinates approximately 11,000 gallons per day (about 12 AFY) of its seawater intake for toilet flushing and life support equipment maintenance, which lessens the Aquarium's impact on local water supplies.
- **Moss Landing**. The Moss Landing power facility utilizes a seawater evaporator as a desalination plant to create ultra-high purity water for the steam turbines.
- **Diablo Canyon**. The desalination facility operating at the nuclear plant produces both potable and non-potable water.

Water is also desalinated on off-shore oil and gas platforms, probably for both potable and non-potable uses. These platforms have not been specifically identified for this RMS.

Projected Future Growth of Desalinated Water

Table 1 identifies the water suppliers that have indicated in their UWMPs that future water supplies will include desalinated water. This table includes three existing facilities (shown as inactive in Figures 1 and A-1) that were not operating in 2020 but that already are restarted or plan to be. The locations of these suppliers are shown in Figure 3.

The projects listed in Table 1 that have not begun construction have a higher, but not absolute, probability of being constructed before 2040. These projects are either identified in UWMPs or communicated to DWR that they are planned. Therefore, the water that these facilities are projected to produce is planned in future UWMP water supply and demand calculations. There are other projects that are in earlier phases of planning, but are not included in this RMS because there is less certainty of completion.

Figure 3 **Planned Desalination Project Through 2040**

Table 1 California Desalination Facilities Planned Between 2021 and 2040

Agency	Facility	County	Planned Year	Planned Type	Planned Capacity (acre-feet)	2023 Status and Comments
Marina Coast Water District	Marina Desalination Facility Expansion	Monterey	2030	Seawater	300	Restart of existing facility planned for 2024. Expansion in 2040
The Ranch at Live Oak	Desalination Facility	Ventura	2021	GW		Operating. Restart of existing facility
Beverly Hills, City of	Beverly Hills Desalter	Los Angeles	2022	GW	2,952 to 3,327	Operating. Restart of existing facility. Expansion in 2030.
Camarillo, City of	North Pleasant Valley Groundwater Desalter	Ventura	2022	GW	3,877	Operating
Eastern Municipal Water District	Perris II Desalter	Riverside	2022	GW	5,400	Operating
Fort Bragg, City of	Fort Bragg	Mendocino	2022	Surface water	2	Operating
Antioch, City of	Antioch	Contra Costa	2024	Surface water	3,000	In construction
California American Water--Monterey	Coastal Water Desalination Project (Cal-AM)	Monterey	2030	Seawater	6,252	Planned
Otay Water District	Rancho Del Rey Groundwater Well Project (Desalination)	San Diego	2035	GW	500	Planned
South Coast Water District (Et al.)	Doheny Ocean Desalination Project	Orange	2025	Seawater	5,600 to 16,802	Planned. Expansion in 2035.

Agency	Facility	County	Planned Year	Planned Type	Planned Capacity (acre-feet)	2023 Status and Comments
Ventura County Waterworks District No. 1	Moorpark Groundwater Desalter	Ventura	2030	GW	5,000	Planned
Thousand Oaks, City of	Los Robles Desalter	Ventura	2025	GW	500	Planned
Water Replenishment District	Regional Brackish Water Reclamation Program	Los Angeles	TBD	GW	TBD	Planned. Considered alternatives range from 12,500 to 20,000 AFY
Rainbow Municipal Water District	Rainbow MWD Desalination Facility	San Diego	2030	GW	2,000	Planned
Santa Barbara, City of	Charles Meyer Desalination Plant	Santa Barbara	2030	SW	5,000	Planned expansion of existing facility from 3125 to 5000 AFY
Catalina Island	Plants 1 and 2	Los Angeles	2025	SW	145	Currently expanding total capacity of Plants 1 and 2 from 186 to 331 AF

2. Benefits of Integrating Desalination into a Water Supply Portfolio

Desalination, at properly designed and sited facilities, has the benefit of providing a reliable supply to a local water supplier's water supply portfolio in locations where other water supply options are not readily available or where existing supplies are impacted by elevated salinity (i.e., TDS) levels. The benefits of desalination in these situations are discussed below. If adequate and sustainable water supplies are reliably available that do not require desalination, in most cases water suppliers will opt for non-desalinated supplies because of cost and other issues discussed in Section 4.

Diversified Water Supply Portfolio

Water suppliers are diversifying water supply resources and developing alternative water sources such as desalinated water, recycled water, stormwater and gray water to augment traditional surface water and groundwater resources. They are also implementing demand management measures such as conservation and efficiency measures, as well as repairing or improving infrastructure. Having multiple sources of water provides water supply resiliency because of an uncertain water supply future. Changing climatic conditions are making existing water supplies less reliable and drought conditions more common. Diversifying water supplies usually incurs additional costs with the construction of additional infrastructure or development of water-sharing agreements. However, the ability to manage resources, such as reducing groundwater pumping when groundwater levels are declining, may outweigh the additional infrastructure costs. The ability to maintain a consistent supply for customers during drought and other periods of uncertainty by developing desalinated supplies may also be more cost-effective than obtaining water from external sources during drought periods because water costs rise significantly during droughts.

A regional or watershed approach to water supply diversification can also be beneficial, especially considering desalination. Two existing desalination facilities provide are regional providers of water. Both the Poseidon facility in Carlsbad and the City of Santa Barbara's facility support multiple water suppliers. It is expected that the soon-to-be-constructed South Coast Water District Doheny facility also will be a regional provider, as will the planned California American Monterey plant. This enables these desalination facilities to defray construction and operational costs and support regional water needs, but, if needed be balanced within the region if changing conditions warrant it.

Water supply diversification is being implemented both as a tool to seeks additional water supplies and to replace existing supplies to make sure that future supplies can support future needs. In the future, current water supplies may be unreliable, over-allocated, or unavailable. Diversification can both replace or provide additional supplies and desalination, where appropriate, may be evaluated as a feasible future option.

Water supply diversification can provide an additional benefit to the environment. With future water supply uncertainty, expected competition for water resources between the environment and water users may occur because of continued reliance on inland waterways for water supply. This could impact inland species which comprise a majority of the species listed under the Endangered Species Act. As water suppliers evaluate available water supply options, those that reduce dependence on inland waterways may be considered supportive of environmental sustainability. Desalination may be considered as an alternative, especially if approaches such as brackish or marine marsh enhancement can be developed.

Water Supply Reliability

Properly designed and sited desalination water treatment facilities provide unique reliability because they are generally sourced from consistent surface or groundwater supplies. They may also be less impacted by changing climatic conditions or droughts, especially if the source water is seawater. As climate change continues to impact weather patterns in California, there is potential for increased occurrence of extreme climatic conditions such as drought or wet-year flooding events. Because the infrastructure needed to capture extreme flood flows for water supply can be both cost-prohibitive and require large areas of land, investment in more cost-effective and consistent water supply approaches may provide options. Desalination is one reliable water supply, as are recycled water and gray water.

In communities implementing groundwater or seawater desalination, it is usually an effective baseline component of a diversified water supply portfolio. For both Santa Barbara and the City of San Diego desalinated seawater provides a baseline supply of approximately 15-25 and 10 percent, respectively, of their total water supplies. This enables both communities to use other diversified supply portfolios components to meet seasonal and annual water needs, as they are available. Both South Coast Water District and California American Monterey are expected to have similar approaches to operation of their planned facilities. Water suppliers desalinating groundwater also rely on these sources as a component of total supply. Most also have groundwater resources that are not desalinated, as well as recycled water and/or surface water supplies as part of their diversified water supply portfolios.

Operating desalinated resources as a baseline supply also provides water suppliers with a level of certainty as a local or regional supply. Local supplies can provide greater reliability when planning future water supply availability because they be more reliable than water supplies conveyed over long distances. They also may be less susceptible to climatic changes, political challenges, and natural impacts such as earthquakes, fires, or floods.

Human Right to Water

In California, the Human Right to Water means that "every human being has the right to safe, clean, affordable, and accessible water." This includes having sufficient supplies for direct consumption, cooking, and sanitary purposes. This right extends to all Californians, regardless of location or socioeconomics.

The right to water inherently implies reliability. In some more arid parts of the state, where local water conditions naturally contain high levels of salt, desalinated water may provide the only reliable option for water supply. As the state evaluates future water supply options considering changing climatic conditions, desalination could play a role in supporting the human right to water.

Two key components of the human right to water that directly apply to desalinated water are accessibility and affordability. Desalination has the potential to impact water rates. The accessibility of desalinated to disadvantaged communities and methods to shield disadvantaged households from the impact of potential rate increases has been discussed at hearings for planned desalination projects. As water suppliers evaluate water supply options, both of these issues should be included and documented in alternatives analysis, particularly with respect to supporting water supply needs for disadvantaged households, to develop implementable and successful methods.

Variable Water Sources for Other Uses

The advantage of a baseline sustainable water source enables a water supplier to manage its supplies. The water supplier may be able to use less expensive ones, as they are available, or enable surface water supplies to recharge groundwater during wet periods so that groundwater is available during droughts. It may also enable suppliers to utilize supplies in different distribution system zones to reduce pumping costs or enable water transfers to other water suppliers or users.

Beneficial Use of Low-quality Water

Desalination enables brackish or saline water, unusable as water supply because of salinity, to be used for potable supply. Other potential beneficial uses include water manufacturers operating in water-challenged areas of the state or agriculture.

Using either brackish water or seawater requires ensuring that the source water use complies with existing requirements. Use of brackish groundwater should adhere to groundwater management plans that comply with the Sustainable Groundwater Management Act (SGMA 2014) or basin adjudication allocations. Seawater desalination must comply the Ocean Plan (SWRCB 2019) requirements. Brackish surface water, unless it is within the jurisdiction of the Ocean Plan would need to comply with existing surface water rights.

Desalination reduces salinity in the water supplied to customers which can subsequently lower the salinity of treated wastewater. This reduces wastewater treatment costs to comply with discharge requirements and increases recycled water opportunities.

An additional benefit to using brackish groundwater is that the removal of brackish water can also act to remediate the groundwater basin. For example, the Regional Brackish Water Reclamation Program being planned by the Water Replenishment District and its regional partners plans to capture and treat saline groundwater from seawater intrusion that occurred in the 20th century and then was trapped in the basin when the seawater injection barriers were implemented. The trapped saline water adversely impacts the groundwater of several suppliers. By extracting and desalinating this water, the regional partners will have an additional water supply and in the future be able to recharge the basin with high-quality recycled water. The regional partnership helps defray the desalination costs among multiple agencies and supports local disadvantaged communities.

3. The Cost of Inaction and Investment Needs

As California looks to strengthen water supply reliability, developing water resources that can respond to changing conditions will be a key factor in meeting the state's future needs.

Changing Water Supplies

Groundwater and surface water were the water sources used by Californians in the 19th and 20th centuries to meet agricultural, industrial, and personal needs. But with more frequent and prolonged drought conditions in the late 20th century and then again early in the 21st century, coupled with larger population and aging infrastructure, water suppliers began to look at other potential sources of water to meet growing water demands. Options such as hauling icebergs and barging large 'pillows' of fresh water filled from northern rivers (the Columbia River and Alaska were often cited) were seen as stop-gap measures. However, as the realization that climate change was a global phenomenon with widespread impacts, water suppliers began to look for locally available resources. Recycled water is now a key component of many water suppliers' portfolios, particularly in southern California.

David Sedlack, a University of California at Berkeley engineering professor, recently noted, "The water supplies of 2050 will be different from those of 2020." Although 2050 water supplies cannot be predicted exactly, it is expected that groundwater and surface water will no longer be the only sources of water suppliers utilize to meet future needs. For example, the 2023 Municipal Recycled Water RMS reports that municipal recycled water accounted for about 7 percent of the developed urban water supply statewide in 2020 and 13 percent in the greater Los Angeles/San Diego area, where recycled water use is highest. Local resources will become increasingly important to water suppliers as they seek to be able to meet customer needs with sources that they can rely on through their own efforts. This will also reduce the impact of evaporation and electrical consumption required to convey water over long-distances. To support long-term sustainability, suppliers will seek ways to reduce using water once and discharging it to locations where it cannot be reused.

The Cost of Inaction

California requires a secure water supply to support its population as well as its agricultural, commercial, and industrial needs. The state faces the risk of potential water supply insecurity if it does not begin to comprehensively and cohesively plan to develop the water supply resources for 2040 and beyond. Desalination, as well as other alternate water supplies such as recycled and gray water, can play a key role in providing a reliable water supply.

Developing reliable and sustainable long-term water supplies will require extensive planning and design. Key drivers supporting sustainability will be how water solutions interact with other resources, are protective of the environment, and identify multi-benefit approaches.

We are currently in the window of time (this RMS is being prepared in 2023) to be evaluating these options and developing plans. Implementation of long-term, sustainable solutions will require careful planning and consideration of impacts, which can take years or decades. These solutions will also require extensive local and regional coordination to support broad-scale connection and to avoid inter-regional divergence and must look at long-term changes versus annual variability.

Once appropriate plans are developed, design and construction of major infrastructure projects will also require time. This is true especially for desalination projects, which will be discussed further in Section 4. Because desalination, as well as other water projects, require longer lead times for implementation of a balanced project, this is the time for planning reasonable and sustainable projects. Crisis response runs the risk of developing inappropriate projects potentially with lasting negative impacts. This could result in wasting money, often at the expense of taxpayers.

Climate Change

Adaptation

Climate change has already begin impacting water resources in California and is expected to continue doing so. Our observational record over the last 100 years has indicated greater weather extremes, reduced snowpack, higher sea level, and changes in river flows. The warmer atmosphere the Earth is experiencing has brought increased temperatures and is impacting precipitation patterns. As a result, California is expected to fluctuate between extreme weather of droughts and flooding more frequently.

California's already inconsistent water years are expected to become more erratic in the future and desalination could help provide more consistent, reliable water supply in a more extreme climate. The adaptation strategy that desalination can provide will also help diversify water portfolios by expanding the local water supply. Expanding local water supplies has the potential to reduce water importation and lessen water demands pressures in other regions of California, particularly in constrained ecosystems such as the Delta which is vulnerable to degradation due to climate change and water supply demands. Additionally, water managers are encouraged to prepare an energy consumption and greenhouse gas (GHG) emissions assessment to inform their decisions on which water sources would be most sustainable.

Sea level rise is caused by warmer temperatures melting ice sheets and oceans absorbing heat creating thermal expansion. It will impact both the physical coastline and coastal aquifers. As sea level rises, the coastline moves inland causing saltwater to intrude into existing groundwater basins adjacent to the coastline. Saltwater intrusion reduces the amount of fresh water in coastal groundwater basins and can impact water suppliers that use coastal aquifers for water supply. Desalination may be used to supplement the loss of capacity in coastal aquifers and restore coastal water supplies.

Mitigation

The 'greenhouse effect' refers to certain gases in the Earth's atmosphere that trap heat like a blanket and effectively warm the planet. Increasing emissions of these gases through human activities are thickening this blanket and causing global warming. The biggest contributor of human-caused emissions is the burning of fossil fuels for energy and transportation. Reducing these human activities is essential for halting climate change and avoiding the most severe global impacts.

The energy demand associated with desalination is quite high, as mentioned previously in this document. Energy is not only needed for water treatment, but also for brine management including conveyance. Producing energy from fossil fuels for the purposes of desalination will increase GHG emissions and further advance global warming. Therefore, although desalination may provide a climate-resilient and robust water supply, the operation of desalination facilities has the potential to counteract GHG reduction goals if fossil fuel powered plants are used as the primary source of energy.

If energy for desalination facilities is produced through renewable sources, then GHG emissions would be avoided. Renewable energy sources are a potential mitigation opportunity for the future but is currently not the dominant energy source. In the recent future however sources of renewable energy are expected to drastically increase due to California's recent carbon neutrality goals, including Governor Gavin Newsom's California Climate Commitment of building a 100% clean energy grid by

2045, including interim goals. The conversion of energy production to renewable sources would make operating a desalination facility from fossil-free energy an actual possibility in the future.

Competition for renewable energy may increase because there will be greater demand for this energy source which may make building desalination plants more difficult in the future. Therefore, there is a need to explore new technologies that will lower the energy demands for desalination to better balance renewable energy production. Additionally, other mitigation measures that can be coupled with sustainable energy sources involve reducing energy consumption by increasing operation and process efficiencies within the facilities.

Investment Needs

Infrastructure

Diverse water supply portfolios will require additional infrastructure investment at both the state and local levels. As indicated above, changing future climatic conditions are expected to result in more frequent fluctuations between droughts and extreme wet years. This could mean that additional infrastructure is needed to support multiple approaches to supporting water supply to account for both wet and dry periods. For example, infrastructure could be needed to increase groundwater recharge during wet years and desalination for sustainable water supplies. Modifications may also be needed to existing infrastructure for coastal desalination facilities to move water from lower coastal areas higher into the distribution system.

Both planning and creative solutions are needed now to make appropriate infrastructure investment. Decisions as to what components are included in a diversified water portfolio – and if desalination is included – will be decided by local and regional water suppliers, their customers, and local stakeholders.

Research

Inclusion of desalination into more California water supply portfolios will require advances in things like reducing energy consumption, increasing longevity of system components, and developing methodologies to optimize operational efficiency and brine management. Research is ongoing into each of these areas throughout the world. Currently, the State of California is partnering with the National Alliance for Water Innovation (NAWI), a 5-year research program supported by the U.S. Department of Energy (DOE) in partnership with the California Department of Water Resources (DWR), the California State Water Resources Control Board (SWRCB), and other partners to lead and foster the research in these areas. NAWI has an existing contract with the DOE to act as its Energy-Water Desalination Hub coordinator to conduct research to lower the cost and energy of desalination and DWR is providing $16 million of funds beginning in 2021 to NAWI to coordinate and fund research projects in these key areas. These research projects will advance desalination technology and make desalination a competitive water supply source.

NAWI is focusing research to advance technologies to enable desalination to be cost-competitive, easily implementable, and energy-efficient. Currently, work is focusing both on improving treatment and brine management, because these are the two most energy-intensive aspects of removing salt from water. Several ongoing projects are evaluating approaches to harvesting minerals from brine and process improvement to reduce scaling, a common issue with reverse osmosis.

The NAWI research effort is already seeing benefits for California agencies with desalination and reverse osmosis facilities. Existing desalters currently are partnering with researchers to evaluate methods of improving technologies and addressing real-world challenges. These partnership opportunities occur for both early-stage research and pilot stage applications and will increase as NAWI broadens its funding opportunities. Participation in these projects directly benefits California water suppliers by enabling early access to innovations and helping to lead in the identification and solutions to difficulties, as well as supporting communities in need.

Emerging Technologies

Several innovative desalination approaches are being pilot tested or emerging as noteworthy approaches.

Several approaches to wave-energy desalination will be pilot-tested in California in 2024. These facilities are located offshore and generally use reverse osmosis technology. The energy generated by wave motion powers the treatment process. Brine can be immediately returned to the ocean and desalinated water is conveyed to shore.

Desalination at deeper ocean depths is another interesting technology. It proposes to use the higher pressure deeper in the water column to more efficiently desalinate water. Again, brine is returned immediately to the ocean and desalinated water is conveyed to shore.

Testing of these technologies will help determine whether they can be developed at commercial scale to support California's water supply needs. In addition to these direct treatment technologies, there is also ongoing work into beneficial linkage of desalination to green hydrogen production and carbon sequestration.

4. Barriers to Implementing Desalination

Implementation of a desalination project, similar to most water supply projects, involves extensive evaluation, planning, and coordination. There are potential negative impacts that can be associated with desalination. Studies may be necessary to assess the potential for impacts.

The first two subsections of Section 4 (Demonstrated Need, Costs and Challenges) address the types of potential barriers to implementing desalination projects that can impact desalination projects using any type of source water. Issues, barriers, and potential impacts that apply only to seawater desalination projects are presented in the third subsection (Seawater Desalination), followed by the last subsection which addresses issues specific to groundwater desalination (Groundwater Desalination).

The following discussions provide general statements of the issues and are not intended to be in-depth discussion of the issues. Most desalination projects have a unique set of issues and potential impacts, and it is well beyond the scope of this RMS to attempt to go into detail about any of them. Links to key topics and documents are included in Section 9.

Demonstrated Need

The initial step for any desalination project – or any water supply project - is whether additional water supply is needed to meet present or expected future demands. California water suppliers that prepare an UWMP every five years are required to include supply and demand assessments considering a variety of scenarios. The required scenarios include normal conditions, short and long-term drought (defined as up to 5 years), and emergency outages. Future projects needed to meet water needs (often referred to as 'demands') are to be included in the UWMP. A water supplier will then use this as the basis for determining if a desalination is needed and would then begin the process of siting a permitting a facility. This effort enables water suppliers to document potential future shortage and identify water supply alternatives, such as those shown in Table 3.

The SWRCB is currently preparing its Seawater Desalination Siting and Streamlining Report, which is to identify ways in which the seawater desalination permitting process can be streamlined. One of the identified streamlining approaches is for the project proponent to identify, at the beginning of the permitting process, the water supply need for the project. This could include incorporating information from the UWMP.

Linking water supply planning in the UWMPs to desalination permitting could expedite the permitting process because UWMPs are public documents certified by the water supplier. It would also support early identification of prospective desalination projects in UWMPs, which would also facilitate public outreach and identification of potential environmental or environmental justice issues. It also supports development of well-integrated desalination projects and attempts to avoid emergency projects that may respond to unforeseen circumstances but could result in water is more costly and less efficient projects.

As part of the siting and permitting of any desalination facility in California, each of the issues identified below, applicable to the source water and/or location, will need to be addressed and documented for the appropriate regulatory agency.

Costs and Challenges

This subsection addresses the issues applying to any type of desalination project using both groundwater and surface water as source water.

Energy

The most commonly implemented method for desalinating water in California is reverse osmosis, a technology that also can be used to clean wastewater for subsequent beneficial reuse and to remove contaminants from water. Reverse osmosis forces water through a finely perforated membrane to capture most dissolved constituents and let the water flow through. This process is relatively energy-intensive because it occurs at higher pressures. So, in general, the saltier or contaminated the source water being treated, the higher the energy requirements of the desalination facility.

The higher energy use of reverse osmosis makes the operation of a desalination facility vulnerable to energy cost fluctuations which creates an uncertainty in planning long-term operational costs and comparing it to other water supply options. Depending on the source of energy used, desalination may result in the production of GHG emissions. These issues both can have negative impacts on the sustainability of desalination and on environmental considerations.

It should be noted that legislation passed in 2022 establishes 2045 goals of reducing

GHG emissions by 85 percent and achieving carbon neutrality. Therefore, with energy supplies increasingly originating from carbon neutral resources over the next two decades to reach the 2045 goal, the GHG emission issue associated with desalination may be reduced.

Between now and 2045, energy uncertainties can be offset by developing green energy sources that can support desalination energy demands. This may include solar or wind facilities in combination with energy storage facilities such as pumped hydro or other storage options facilitating renewable energy or zero-carbon resources. Santa Barbara is implementing such a plan. Santa Barbara also works with the local energy supplier to lower energy use during peak energy demand days. As discussed in Section 3, innovative technologies area being tested and research is ongoing to lower desalination energy demands.

One area of needed work is comparing the energy demands and GHG production of desalination to other water supply issues. For example, comparing local desalination to water conveyance over hundreds of miles or desalination to direct potable reuse of wastewater. This information will help water suppliers make informed decisions regarding water supply portfolio options.

Brine Management

When salts, minerals, or contaminants are removed from water during desalination, the removed constituents are not destroyed. As shown schematically in Figure 1, during desalination the salts removed from the water remain as a brine, a highly saline liquid. The concentration of salt in seawater is approximately 35,000 mg/L (3.5 percent salt by weight of water or 35 grams per liter). So, every 1,000 gallons of seawater contains about 292 pounds of salt. How the salt or brine produced during desalination is disposed is a major component of desalination and the permitting and siting process.

Brine management requires energy to convey the brine for disposal or to potentially beneficially use it may be for marshland or mineral recovery. Brine management or disposal is also usually expensive and requires consideration of environmental impacts. Therefore, it is a component of desalination which often requires careful planning and evaluation.

Brine disposal can be accomplished by various approaches.

- **Evaporation.** In arid regions, evaporation is an option, but this requires extensive land area, can have negative air quality impacts, and entails collection and disposal of the dried salts.

- **Brine Line.** Brine also can be collected by a separate wastewater system referred to as a brine line. A brine line conveys brine to a coastal discharge point

- **Comingled with Treated Wastewater.** Brine can be comingled with wastewater to discharged to an ocean outfall. Occasionally, brine can be discharged to a sanitary sewer where it mixes with domestic and industrial wastewater prior to wastewater treatment.

- **Diffusers.** Brine diffusers are usually associated with seawater desalination and will be discussed below in Seawater Desalination.

There is also work looking at using brine to support development of coastal wetlands. Research is also being conducted to see if treatment wetland methods can support brine management and the effectiveness of lowering fresh water recovery rates to reduce brine concentration. As mentioned in Section 3, research is also ongoing to identify technologies by which materials can be removed from brine to provide economic benefit.

Environmental Justice

Desalination plants can be considered industrial facilities. Locations should not disproportionally impact underserved communities. For example, if a proposed facility is within or adjacent to legacy industrial sites, it may represent a continuing disproportionate burden to nearly communities of concern.

Facility operational impacts could include air quality or noise, how the desalinated water is dispersed within the distribution system, or traffic increase associated with the facility. Involvement of community representatives during project planning and development is an important component to inclusion of environmental justice issues into the project.

As discussed earlier, it is also important to identify approaches to reduce the economic impact of higher treatment costs on disadvantaged communities. Approaches would be determined with discussions with impacted communities as part of early project outreach. Documentation of this outreach and approach may need to be included during subsequent permitting and environmental documentation.

Section 9 includes a link to the California Coastal Commission's Environmental Justice website. The site includes discussion of the Environmental Justice Policy, which may provide useful information, especially for considering coastal desalination facilities.

Tribal Considerations

Tribal considerations are key required components of desalination project planning and development to make sure that they are taken into account, responded to, and documented. Early and sustained involvement of tribal leaders and communities will safeguard inclusion during project development.

Treatment

Operation of a desalination facility as part of a water supply portfolio may include additional considerations such as whether desalinated water is chemically compatible with other water sources, if they are blended within the distribution system, or if plant operators require higher classification or different training. These considerations are in addition to the energy demand and environmental issues already discussed and are consistent with other projects implementing water supplies from multiple sources.

The desalination process itself is a complex issue. There are several methods and technologies that can be used to desalinate water, but as previously mentioned, reverse osmosis is the most common approach in California (Figure 4). Reverse osmosis can be implemented as a component of a treatment process operated by the water supplier or, for very small applications, it can be implemented as a self-contained package facility maintained by a commercial third party.

Figure 4 **Reverse Osmosis**

Seawater and Coastal Issues

Locating seawater desalination projects involves multiple coastal issues that do not apply to other desalination projects, as discussed below.

Alignment with California Ocean Plan

The Water Quality Control Plan for Ocean Waters of California (Ocean Plan) identifies standards to be enacted to protect the water quality of the Pacific Ocean along California's coastline. Requirements and preferred alternatives for both ocean discharges and intakes are identified in the Ocean Plan. California Water Code and Ocean Plan Desalination Provisions require seawater desalination facilities to use the best available site, design, technology, and mitigation measures to minimize intake mortality of all forms of marine life.

Adherence to the Ocean Plan is a fundamental requirement of siting or expanding seawater desalination facilities. As it pertains to coastal desalination facilities, the Ocean Plan indicates that, where feasible:

- Subsurface intakes are the preferred intake method for coastal marine desalination facilities, unless the RWQCB determines them to be infeasible, and
- Comingling brine with wastewater discharge is the preferred technology for brine discharge to minimize intake and mortality of marine life.

These key coastal seawater desalination requirements have been developed by the SWRCB to be protective of the marine environment.

The Ocean Plan is periodically updated to address changing issues. It is planned to be updated in 2024 to include actions identified in the Seawater Desalination Siting and Streamlining Report, after it is finalized. Therefore, specific requirements for siting or expanding coastal seawater desalination should be reviewed in the Ocean Plan at the website address provided in Section 9.

Permitting and Regulatory Considerations

Multiple permits are required to site most coastal infrastructure projects, including desalination treatment facilities, intakes, and infrastructure on the coast. These permits require extensive coordination with regulatory agencies and may entail conducting studies and assessments related to potential project impacts. These permits involve, but are not limited to, coordination and applications to the applicable regional water quality control board (RWQCB), the California Coastal Commission, State Lands Commission, Fish and Wildlife, and various federal agencies. Each project is different, so there is no definitive list of project permits that are required. Approved California Environmental Quality Act (CEQA) documentation is also required.

Permitting addresses issues such as environmental and habitat impacts both during construction and operation, future sea level rise considerations, methodology and impacts related to brine discharge, and intake approach. Permitting often takes years and involves complex timing because some permits have a limited term and if other aspects of the permitting process are delayed, already obtained permits may expire. Sequencing permits correctly may also be an issue if obtaining one permits requires another permit to already have been obtained.

Siting and Mitigation Reports are currently being prepared to identify approaches to streamlining the permitting process and in fulfillment of implementation actions identified in the Water Supply Strategy. Options being considered include concurrent permit application submittal to facilitate interagency coordination and consideration of common issues.

Mitigation

Mitigation measures offset harm that may occur as the result of the construction or operation of the desalination facility. Mitigation of adverse impacts is required as part of environmental documentation preparation or being granted a permit. It may involve avoiding a potentially harmful action, minimizing the impact or effect of the action, or developing an offsetting or compensatory action to balance for an unavoidable impact. Specific mitigations are negotiated between the permitting agency and applicant and may involve input or coordination with impacted or interested parties.

Siting Criteria

Specific siting criteria for coastal desalination have not been concisely documented because each proposed facility and location involve different considerations and raise unique sets of issues or permitting requirements. There are specific considerations that must occur, such as the Coastal Commissions requirement that sea level rise be considered when siting any component associated with a desalination occurring within its jurisdiction. However, not all criteria under the specific guidance of individual state and federal agencies are clearly defined. This includes assessment and documentation of environmental and habitat impacts. It is the responsibility of the water supplier seeking to site a sea water desalination facility to know the specific siting criteria for the planned facility and this may lead to permitting uncertainties and delays. [Note: additional language could be from the Draft Siting and Streamlining Plan may be added here after the document is finalized.]

Brine Discharge

The Ocean Plan (2019) identifies two technologies for brine disposal to the ocean. The “preferred technology for minimizing intake and mortality of all forms of marine life resulting from brine discharge is to comingle brine with wastewater (e.g., agricultural, municipal, industrial, power plant cooling water, etc.) that would otherwise be discharged to the ocean” to minimize “intake and mortality of all forms of marine life”. The Ocean Plan also indicates that multiport diffusers are “the next best method for disposing of brine" when it can't be diluted with wastewater. Multiport diffusers are submerged mechanisms that disperse brine to mix it with the receiving water to dilute brine impacts. The Ocean Plan also allows a project proponent to identify other brine methodologies if it can be demonstrated that the method provides a "comparable level of intake and mortality of all forms of marine life".

Hazards

Permitting agencies are responsible for identifying practices or structures that could cause physical or environmental hazards and to then require changes or mitigations as a coastal desalination facility is planned and permitted. The Coastal Commission, State Lands Commission, and RWQCBs each require consideration of various hazards when issuing their respective permits. Hazards could include adverse water or air quality associated with brine disposal, obstructions from coastal well sites, or coastal hazards associated with sea level rise, erosion, or tsunamis. Additionally, CEQA requires applicants to identify geologic and hydrologic hazards within proposed projects. However, the hazards analyses required by CEQA and each state agency are slightly different.

Public Access Limitations

A key issue for coastal desalination facilities is the potential for these facilities to obstruct, limit, or restrict coastal access. This is an issue that the Coastal Commission considers when it reviews applications for the Coastal Development Permits it issues.

Groundwater Issues

The primary issues unique to groundwater desalination projects relate to the groundwater basin. If a basin is adjudicated, the inflow to the basin may have to align with the groundwater allotment to the water supplier. This is not the case in all adjudicated basin, which may consider saline water extraction not applicable to allocations. If a groundwater basin has a Groundwater Sustainability Plan (GSP), whether approved or not, groundwater extracted for a desalination facility should be compliant with the GSP or coordinated with the Groundwater Sustainability Agency. If a groundwater basin is neither adjudicated nor has a GSP, the desalination project still needs to be protective of the safe yield or existing users in the groundwater basin and avoid adverse groundwater impacts.

Groundwater desalination usually occurs within inland groundwater basins. Brine disposal is often challenging for these projects. Brine lines can be expensive and discharge to conventional wastewater treatment facilities can adversely affect wastewater treatment or effluent quality relative to reuse opportunities.

5. Desalination and the Water Resilience Portfolio

California's Water Supply Strategy, Adapting to a Hotter, Drier Future (WSS) was issued in August 2022. The WSS provides specific actions and goals to support developing new water supplies and managing existing ones to prepare for changing climatic conditions. The WSS clarifies and accelerates actions in the Water Resilience Portfolio (WRP, 2020), which is considered to be the state's master plan for water, because climate-related impacts are already evident.

The WRP identified the following actions related to desalination:

6. Consider use of desalination technology where it is cost effective and environmentally appropriate.

> 6.1 Consider new desalination projects according to existing state criteria including the Water Board's Ocean Plan and the Coastal Act.
>
> 6.2 Team with federal and academic partners to develop desalination technologies that treat a variety of water types for various uses, with a goal of enabling manufacturing of energy efficient desalination technologies in the U.S. at a lower cost, same or better quality, and reduced environmental impact than non-traditional water sources.

The WSS then identified goals for increasing desalination in the state, as well as specific implementation steps:

1.2 Expand brackish groundwater desalination production by 28,000 acre-feet per year by 2030 and 84,000 acre-feet per year by 2040 and help guide location of seawater desalination projects where they are cost effective and environmentally appropriate.

Implementation Steps:

- By January 1, 2024, the Department of Water Resources (DWR) and the State Water Board, in coordination with local agencies, will identify the brackish desalination projects that have the potential to be operational by 2030 and by no later than 2040. The State will consider investing in grants to local agencies for planning and building desalination projects.

- By January 1, 2024, the State Water Board will review groundwater basins impaired by salts and nutrients and determine the volume of water available for brackish groundwater desalination.

- As the State's representative on the U.S. Department of Energy's five-year, $100 million desalination innovation hub, DWR will continue to guide research investments towards technological breakthroughs that solve California desalination challenges.

- The State will help streamline and expedite permitting to provide better clarity and certainty to further desalination projects. To this end, by June 30, 2023, the State Water Board, Coastal Commission, DWR and other State entities (e.g. State Lands Commission) will develop criteria for siting of desalination facilities along the coast and recommend new standards to facilitate approval.

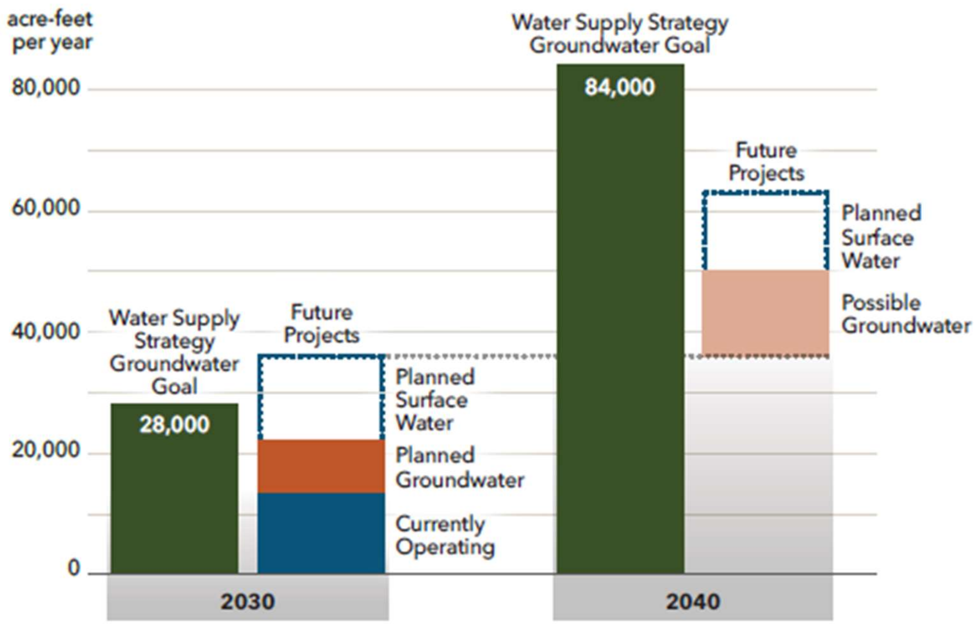
- Within the following year, these agencies will identify potential available mitigation sites to facilitate the expedited approval of desalination facilities. The State Water Board will consider amendments to the Desalination Policy in its Ocean Plan to streamline permits that meet the recommended siting and design standards for projects located in the identified priority areas.

Projected Desalination Production

Looking to the future, many water suppliers are planning to include desalinated water as part of their water supply portfolio and others are planning to expand existing production. Numerous other water suppliers are evaluating including desalination as part of future supplies, as discussed in Section 1. California's Water Supply Strategy: Adapting to a Hotter, Drier Future (Water Supply Strategy, 2022) identifies goals to increase desalinated water supplies by 28,000 AF by 2030 and 84,000 AF by 2040.

Reviewing the 2020 UWMPs, as well as conversations with suppliers conducted during the 2020 survey of suppliers with existing desalination facilities, an additional 37,000 acre-feet of desalinated water supplies, over 2020 use, are planned by 2030. This includes both brackish groundwater and surface water projects. If these projects are constructed as planned, this will meet the 2030 Water Supply Strategy goal for additional desalinated water, if surface water desalination is included (Figure 5).

Figure 5 Identified Future Desalination Compared to WSS Goals



For 2040 estimates, although the existing planning documents haven't identified the full goal of an additional 84,000 AF, multiple agencies that are not currently desalinating water are considering it. Also, given that the amount of water desalinated in California increased from approximately 80,000 AF in 2010 to 150,000 AF in 2020, almost doubling in just 10 years, it is expected that the 2040 Water Supply Strategies also will be met.

Implementing the WSS

The WSS identified multiple steps to be implemented by various state agencies. Each of these steps are underway and are expected to be completed by their required deadlines.

6. Recommendations

The following recommendations are made to support desalination in California and implement the steps identified in the WSS:

1. DWR proposes to increase interaction with regional leaders, water agencies, and community groups to support better education of desalination, implementation of the Water Supply Strategies, and integration of alternative water supply strategies into California's water supplies.
2. DWR proposes to assess methods to optimize continued integration of desalination. This assessment would include: evaluating efficiencies of large regional facilities or smaller dispersed facilities; optimal approaches for desalination to support rural communities; assessing how energy demands impact water options, including conveyance; and how can energy efficiency, brine management, and treatment support be maintained. This assessment also would include reviewing how existing agencies are implementing desalination and provide guidance for other agencies considering implementing desalination and reviewing the costs for water movement and comparing them to desalination costs.
3. DWR and SWRCB will continue to work closely with the National Alliance for Water Innovation to support research to improve energy efficiency, brine management and valorization, and cost-effective desalination technologies to support agriculture and industry etc. through both technical interaction and financial support in support of supporting and improving implementation of desalination in California.
4. In coordination with Municipal Recycled Water RMS Recommendation #5 (Assess what the potential costs are for advanced treated water for direct potable reuse. Identify GHG emissions for comparison to SWP and Colorado River conveyance and desalination), collect information from existing desalination facilities of various sizes and types and compare desalination costs and GHG emissions and compare them to projected direct potable reuse. parameters.
5. Identify if there are issues to be included in the proposed 2024 Ocean Plan Amendments that may be needed to address possible offshore desalination facilities.

7. Related Resource Management Strategies

The following RMSs have linkages to desalinated water. These RMSs may not directly mention desalination, but there are common issues.

- **Agricultural Water Use Efficiency.** Desalination is technologies are being considered for supporting agricultural water demands and treatment of agricultural water.
- **Groundwater and Aquifer Remediation.** Desalination is linked to this RMS in two ways. First, methodologies used to desalinate water may be similar to those used to remove chemical and biological contaminants in water. Second, saltwater intrusion may impact groundwater conditions, requiring treatment prior to potable or industrial use.
- **Municipal Recycled Water.** Like municipal recycled water, desalinated water is considered an alternate water supply. Both water types can incorporate similar treatment methods. Some opponents of desalinated water consider that recycled water opportunities should be fully implemented before a water supplier implements desalination. Direct potable reuse is also be proposed for implementation in California. Comparison of costs and environmental impacts for both direct potable reuse and desalination will be important to understand and compare to enable water suppliers to make informed water supply decisions.
- **Outreach and Engagement.** Introduction of desalinated water as a local water supply resource requires extensive public outreach and education regarding its uses, as well as addressing environmental issues and potential rate impacts.
- **Salt and Salinity Management.** Desalination is closely linked to the occurrence of saline water in groundwater basins, as well as the potential impact of brine management on salinity of the underlying groundwater basin.
- **Urban Water Use Efficiency.** Improvements in urban water use efficiency may delay or offset the need for desalination facilities.

8. References

David Sedlack comment, personal communication, February 2023

9. Useful Web Links

ADA accessibility requires that electronic documents incorporate "meaningful web links." For example, when including in the body text the title of another published document, the title itself is hyperlinked to the source of that document. Under "Useful Web Links," the full title of the document (not linked) is followed by its URL. This allows audience members who are reading the document (say, this RMS) in printed form to access the other document by typing its URL into a browser. Another advantage of employing such a section is that it keeps URLs out of body text; they are quite unwieldy in body text, often creating exaggerated line breaks and otherwise making reading more difficult.

California Coastal Commission Environmental Justice Policy
https://www.coastal.ca.gov/env-justice/

California Ocean Plan
https://www.waterboards.ca.gov/water_issues/programs/ocean/docs/oceanplan2019.pdf

California Water Plan Update 2018
https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/California-Water-Plan/Docs/Update2018/Final/California-Water-Plan-Update-2018.pdf

Water Resilience Portfolio (2020 and 2021)
https://resources.ca.gov/Initiatives/Building-Water-Resilience/portfolio

California's Water Supply Strategy Adapting to a Hotter, Drier Strategy (2022)
(https://resources.ca.gov/-/media/CNRA-Website/Files/Initiatives/Water-Resilience/CA-Water-Supply-Strategy.pdf)

Desalination RMS 2013, California Water Plan, Volume 3 - Resource Management Strategies, Desalination (Brackish and Sea Water) Desalination – Brackish and Sea Water (Resource Management Strategy) – California Water Library (cawaterlibrary.net) https://resources.ca.gov/-/media/DWR-Website/Web-Pages/Programs/California-Water-Plan/Docs/RMS/2016/09_Desalination_July2016.pdf). Please note that the year shown in the link is 2016 because the document was updated for accessibility.

Sustainable Groundwater Management Act. The program is discussed here:

https://water.ca.gov/Programs/Groundwater-Management/SGMA-Groundwater-Management and the legislative language is accessible at this link: https://leginfo.legislature.ca.gov/faces/codes_displaySection.xhtml?lawCode=WAT&sectionNum=10720.&highlight=true&keyword=Sustainable%20Groundwater%20Management%20Act

Appendix A. 2020 Desalination Facilities

The locations where desalination occurred in 2020 are shown on Figure A-1 and summarized in tables A-1 and A-2

Figure A-1 Locations Where Desalination is Occurring in 2020

Table A-1 California Potable Desalination Facilities (2020)

Number in Figure A-1	Agency	Facility	County	Capacity (acre-feet)	2020 Production Groundwater (acre-feet)	2020 Production Surface Water (acre-feet)
1	Zone 7 Water Agency	Mocho Groundwater Demineralization Plant	Alameda	6.1 mgd	1,850	
2	Alameda County Water District	Newark Desalination Facility	Alameda	13,451	8,680	
3	California American Water-Monterey	Sand City Desalination Project	Monterey	300		213
4	Marina Coast Water District	Marina Desalination Facility Expansion	Monterey	1		inactive
5	California Department of Corrections and Rehabilitation	Salinas Valley State Prison Reverse Osmosis Water Treatment Plant	Monterey	-	319	
6	National Park Service	Stovepipe Wells	Inyo	-	17	
7	National Park Service	Cow Creek/Nevares Wells	Inyo	-	78	
8	National Park Service	Furnace Creek	Inyo			
9	Morro Bay, City of	Morro Bay Desalination Facility (Groundwater Unit)	San Luis Obispo	581	61	
10	Morro Bay, City of	Morro Bay Desalination Facility (Seawater Unit)	San Luis Obispo	-		inactive
11	Santa Barbara, City of	Charles Meyer Desalination Plant	Santa Barbara	3,125		2,763

Number in Figure A-1	Agency	Facility	County	Capacity (acre-feet)	2020 Production Groundwater (acre-feet)	2020 Production Surface Water (acre-feet)
12	Oxnard, City of	GREAT Program Groundwater Desalination Facility (Blending Station No. 1)	Ventura	8,400	3,093	
13	Camrosa Water District	Round Mountain Water Treatment Plant	Ventura	1,121	566	
14	Port Hueneme, City of	Port Hueneme Water Agency Desalter/Brackish Water Reclamation Demonstration Facility	Ventura	4,484	2,128	
15	The Ranch at Live Oak	Desalination Facility	Ventura	-	inactive	
16	U.S. Navy/ Port Hueneme	San Nicolas Island Desalination Facility	Ventura	45		19
17	Southern California Edison	Santa Catalina Island Desalination Facility	Los Angeles	-		200
18	Paradise Ranch Mobile Home Park	Paradise Ranch Mobile Home Park (MHP) RO Unit	Los Angeles	-	10	
19	Beverly Hills, City of	Beverly Hills Desalter	Los Angeles	2,600	inactive	
20	Cal Pomona Dept of Water Ops	Cal Pomona WTP	Los Angeles	549	86	
21	West Basin Municipal Water District (CWS Dominguez)	C. Marvin Brewer Desalter	Los Angeles	-	438	

Number in Figure A-1	**Agency**	**Facility**	**County**	**Capacity (acre-feet)**	**2020 Production Groundwater (acre-feet)**	**2020 Production Surface Water (acre-feet)**
22	Torrance/WRD	Robert W. Goldsworthy Desalter Facility	Los Angeles	4,000	2,710	
45	Santa Monica, City of	Arcadia Water Treatment Plant	Los Angeles	11,300	366*	
23	Caltrans	Caltrans/CHP Nipton Headquarters	San Bernardino	-	<1	
24	U.S. Army	Fort Irwin	San Bernardino	2,190	1,531	
25	National Park Service	Zzyzyx	San Bernardino	-	<1	
26	Caltrans	C.V. Kane Reverse Osmosis Unit	San Bernardino	-	1	
27	Caltrans	Beechers Corner Maintenance Station	San Bernardino	-	<1	
28	San Bernardino County	Calico Ghost Town	San Bernardino	-	29	
29	Caltrans	Cajon Maintenance Station	San Bernardino	-	<1	
30	Chino Desalter Authority/Inland Empire Utilities Agency	Chino Desalter II	San Bernardino	36,989	23,669	
31	Chino Desalter Authority/Inland Empire Utilities Agency	Chino Desalter I	San Bernardino	15,917	15,493	

Number in Figure A-1	Agency	Facility	County	Capacity (acre-feet)	2020 Production Groundwater (acre-feet)	2020 Production Surface Water (acre-feet)
32	Tustin, City of	Tustin 17th Street Desalter Treatment Plant	Orange	3,363	2,843	
33	Irvine Ranch Water District	Wells 21 and 22 Desalter	Orange	6,400	2,295	
34	Irvine Ranch Water District	Irvine PotableTreatment Plant	Orange	5,600	2,861	
35	San Juan Capistrano, City of	San Juan Capistrano Groundwater Recovery Plant (Desalter)	Orange	5,761	1,701	
36	South Coast Water District	South Coast Water District Groundwater Recovery System (GRF - Groundwater Recovery Facility)	Orange	1,121	844	
37	Western Municipal Water District of Riverside	Arlington Basin Groundwater Desalter Project	Riverside	-	4,814	
38	City of Corona	Temescal Basin Desalter	Riverside	11,209	10,835	
39	Caltrans	Desert Center Maintenance Station	Riverside	-	<1	
40	Eastern Municipal Water District	Menifee Basin Desalter	Riverside	3,360	9,565	
41	Eastern Municipal Water District	Perris I Desalter	Riverside	7,500	-	

Number in Figure A-1	Agency	Facility	County	Capacity (acre-feet)	2020 Production Groundwater (acre-feet)	2020 Production Surface Water (acre-feet)
42	Oceanside, City of	Oceanside Mission Basin Brackish Groundwater Desalter	San Diego	7,130	2,302	
43	San Diego County Water Authority	Carlsbad Seawater Desalination Facility	San Diego	-		40,780
44	Sweetwater Authority	Richard A. Reynolds (Lower Sweetwater) Groundwater Desalination Facility	San Diego	8,800	7,161	
				Total	**105,982**	**43,975**

Note:

* The bulk of the treatment capacity of the water treated at the Arcadia WTP is remediated groundwater.

Table A-2 California Non-potable Desalination Facilities (2020)

Number in Figure A-1	Agency	Facility	County	Estimated Capacity (acre-feet)	Source Water	Comments
A	San Francisco Public Utilities	Energy Center San Francisco	San Francisco	92	GW	Water from Powell Street BART Station
B	DYNERGY	Moss Landing	Monterey		Seawater	Evaporative system
C	Monterey Bay Aquarium	Monterey Bay Aquarium Desalination Facility	Monterey		Seawater	
D	PGE	Diablo Canyon	San Luis Obispo	708	Seawater	
E	Chevron	Gaviota	Santa Barbara	323	Seawater	
F	USBR	Demonstration Project	Fresno		Surface	Produced water is comingled with brine and returned to source so no net water production

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