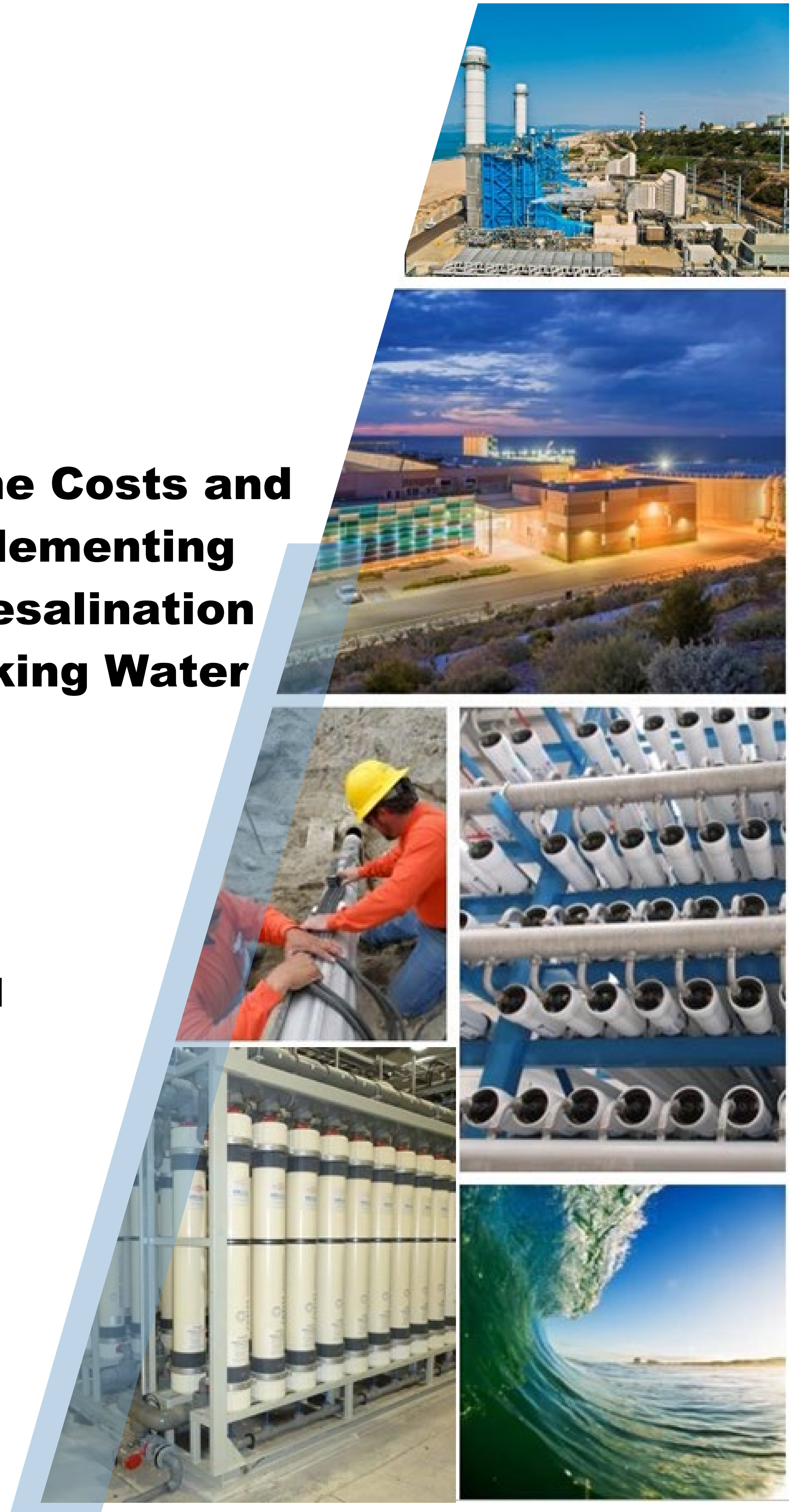
Evaluation of the Costs and Benefits of Implementing Ocean Water Desalination as a Local Drinking Water Supply



Chapter VI

Cost Benefit Analysis

West Basin Municipal Water District

Final Report
July 30, 2021

Submitted by

GHD

in association with

RAFTELIS

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1. Introduction

1.1 Scope and Purpose

Chapter VI of the *Evaluation of the Costs and Benefits of Implementing Ocean Water Desalination as a Local Drinking Water* (the Study) includes:

- Identification and analysis of benefits and costs attributed to the proposed Ocean Water Desalination Project (OWDP) including quantification where relevant.
- Analysis of affordability impacts with a focus on low-income households.
- The purpose of this report is to articulate the likely and significant benefits and costs of the OWDP project to assist the District's decision-makers in guiding development of the OWDP through its project delivery pathway.

The Study commenced in March 2019 and was completed in July 2021. It was undertaken in a five-stage process as covered in five Chapters of this Report (plus an Executive Summary):

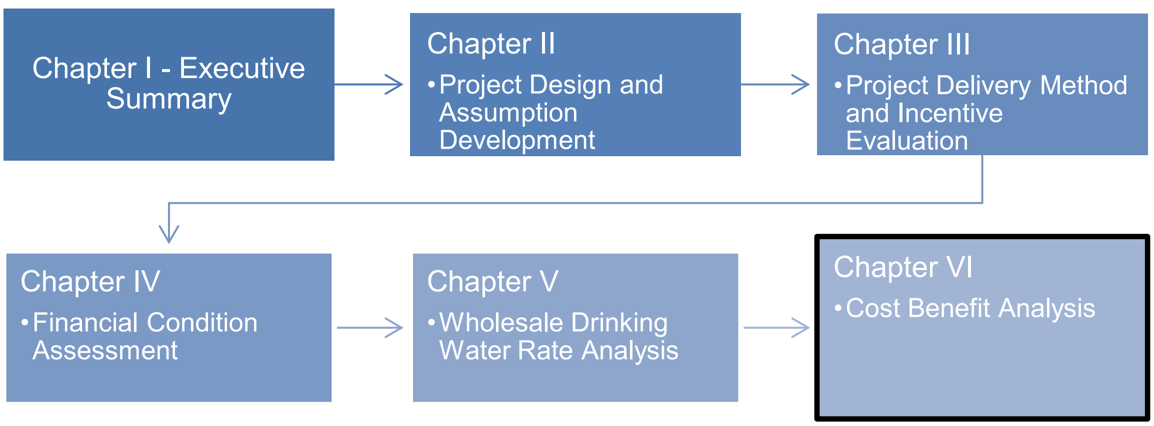

Figure VI-1 Structure of this Study: Evaluation of Cost and Benefits of Implementing Ocean Water Desalination as a Local Drinking Water Supply

The Chapter should be considered in the context of the detailed discussion included in the supporting Chapters as well as the assumptions, constraints and limitations of this Study.

1.2 Structure of this Report

This report includes:

- Section 2 – Description of the methodology used in this Cost-Benefit Analysis (CBA) including identification and shortlisting of impacts
- Section 3 – Discussion of water security benefits from the OWDP
- Section 4 – Discussion of water quality benefits and costs
- Section 5 – Discussion of economic stimulus benefits
- Section 6 – Discussion of organizational impacts
- Section 7 – Discussion of environmental & amenity impacts

- Section 8 – Discussion of financial impacts including affordability analysis for low-income households
- Section 9 – A summary of the key findings

1.3 Limitations, Exclusions and Assumptions

This Chapter contains analysis, modelling and discussion of possible impacts from the proposed OWDP.

- Assumptions used to discuss and estimate the magnitude of impacts (both costs and benefits) are included throughout this Chapter.
- The estimates, findings and conclusions presented in this report are a function of these assumptions, and should be viewed as such.
- Many of the benefits and costs discussed within this report will be influenced by decisions made by third-parties, or have inherent uncertainties in the likelihood and severity of their impact. For example, the magnitude of benefits the OWDP would have on regional water security is heavily influenced by the stance of regional water planning authorities such as Metropolitan Water District (MWD). The purpose of the discussion is to articulate the likely and significant benefits and costs to assist District decision-makers in guiding OWDP delivery. Actual benefits and costs from the OWDP may be different to those discussed in this Study. GHD does not guarantee any benefits or costs will be realized.

Limitations and Exclusions pertaining to the Study overall are included in Chapter I and apply here.

1.4 Reference Documents

In addition to the Reference Documents listed in Chapter I of this Study, the following documents are foundational to the discussion in this Chapter. Other references are noted using footnotes throughout the rest of this document.

- Seismic Resilience First Biennial Report (Report No. 1551), MWD, Feb 2018.
- Seismic Resilience Report 2020 Update (Report No. 1551-1), MWD, Feb 2020.
- West Basin Municipal Water District Drought Rationing Plan, 2015.
- MWD Drought Response Plan 1999.
- MWD Water Supply Allocation Plan (WSAP), 2014.
- West Basin Municipal Water District Annual Water Use Reports, 2016 to 2019.

2. Cost Benefit Analysis Methodology

2.1 Overview

The proposed OWDP is a major capital project and will have many impacts with varying characteristics. CBA is an established methodology for assessing the merits of an investment based on holistic consideration of all impacts from the project.

The term ‘impact’ is used to describe an outcome of the OWDP affecting the District, the community, the environment, or the economy surrounding it. Impacts may be positive (a ‘benefit’), or negative (a ‘cost’).

‘Impacts’ and ‘benefits’ / ‘costs’ are used interchangeably throughout this report.

The fundamental premise of CBA is that an investment is worth pursuing if the sum of all benefits is greater than the sum of all costs. The step-by-step approach to the CBA methodology used in this assessment is illustrated below.

Figure VI-2 Cost Benefit Analysis Step-by-Step Methodology

CBA attempts to capture the wide variety of benefits and costs from the project. Where suitable, impacts are quantitatively expressed in monetary terms and included as cashflow equivalents in the year in which they accrue. In this analysis, not all benefits and costs were able to be fully or partially quantified, and these are therefore discussed qualitatively. This is common in CBA applications. Importantly, an impact that is discussed qualitatively is not ‘less important’ than another that is quantified. Rather, the means of analysis is considered in the context of the amount of data and effort available, and the level of transparency offered by methods to quantify the impact.

The CBA is a type of economic analysis, meaning impacts (both benefits and costs) of the project are considered from a broad societal point of view, not just for the direct project proponent and involved parties.

2.2 Methodology

Some further information on the methodology of the CBA is provided below.

2.2.1 Project Configurations

Benefits and costs for project designs are compared against a base case. In this analysis the base case is the No-Project alternative.

The following OWDP project configurations are considered in this report:

- Current Project Design – DBOM project delivery method
- Current Project Design – PPP project delivery method
- Current Project Design – DBOM with 50% SRF funding project delivery method
- Subsurface Intake Design – DBOM project delivery method
- Subsurface Intake Design – PPP project delivery method
- Subsurface Intake Design – DBOM with 50% SRF funding project delivery method

2.2.2 Costs & Benefits Identification and Categorization (Steps 1 to 3)

Identification & Long-list

A longlist of potential benefits and costs from the OWDP was developed based on literature review, District input and GHD local and international experience with desalination projects. While the long-list is intended to be comprehensive, it was not an attempt to capture the whole universe of possible impacts – clearly immaterial or tenuous impacts were not included.

To structure the discussion, impacts were organized within a set of categories and subcategories, as summarized in Table VI-1.

Table VI-1 Categories of potential benefits and costs

Impact categories and subcategories	
Water Security	-
Water Quality	Salt and minerals
	Emerging contaminants
	Health impacts
	Other impacts
Environmental / Amenity	Land
	Air
	Marine
	Community
Economic Stimulus	-
Organizational Impacts	-
Financial	Project costs
	Affordability for customers

Shortlisting

To shortlist the impacts for further analysis, a multi-step screening analysis was performed, using three criteria:

i. Relevance to OWDP context – *is the impact relevant to the customers that the District serves?*

ii. Materiality – *is there potential for a sizable consequence?*

iii. Credibility – *has direct connection between desalinated water and impact been established*?

Each impact was qualitatively scored as High, Medium, Low (H, M & L) against each of the three criteria. The scores were developed based on the judgement of the consulting and District team, with the approach being to assess impacts relative to each other so as to facilitate effective shortlisting.

The flowchart below was used to determine which impacts were shortlisted, based on the assigned scores. Scoring combinations would result in the impact being shortlisted.

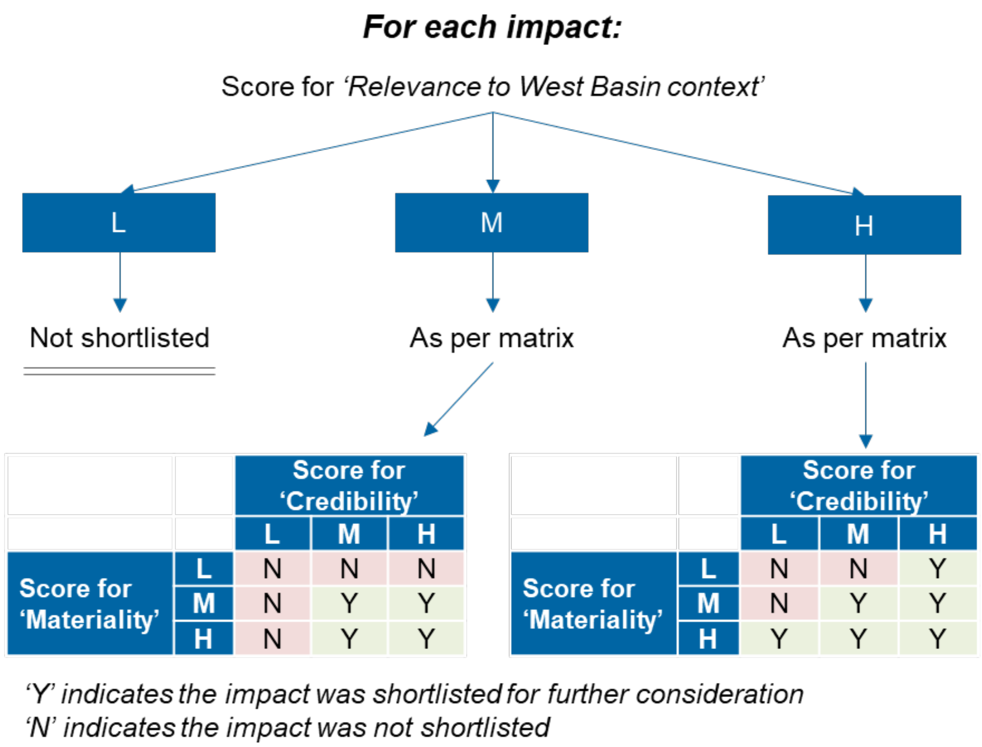

Figure VI-3 Flowchart of multi-step shortlisting process

Table VI-2 summarizes the long list and shortlisting results for OWDP impacts.

2.2.3 Analysis of Costs and Benefits (Steps 4 to 6)

Impacts which passed the shortlisting process were taken forward for further analysis and form the basis of the discussion in the remainder of this report.

Table VI-2 Longlist and screening of identified impacts

Impact	Group	Subgroup	Type	Materiality	Comment	Credibility	Comment	Relevance to OWDP context	Comment	Shortlisted?
Avoided direct costs to West Basin Municipal Water District (WBMWD or District) and other regional water retailers from potential long-term shortages of imported water supply from MWD	Water Security	-	Benefit	H	Major driver for rainfall-independent water supply sources.	H	Major driver for rainfall-independent water supply sources.	H	Major driver for rainfall-independent water supply sources.	Y
Avoided direct costs to the District and other regional water retailers from potential short-term shortages of imported water supply from MWD	Water Security	-	Benefit	H	Major driver for local supply project.	H	Major driver for local supply project.	H	Major driver for local project.	Y
Avoided amenity and cost impacts to households from water shortages	Water Security	-	Benefit	H	Major driver for rainfall-independent water supply sources.	M	Major driver for rainfall-independent water supply sources.	H	Major driver for rainfall-independent water supply sources.	Y
Avoided costs to minor industry and commercial enterprises from water shortages	Water Security	-	Benefit	H	Major driver for rainfall-independent water supply sources.	M	Major driver for rainfall-independent water supply sources.	H	Major driver for rainfall-independent water supply sources.	Y
Avoided costs to major industry from water shortages	Water Security	-	Benefit	H	Major driver for rainfall-independent water supply sources.	H	Major driver for rainfall-independent water supply sources.	M	Much of major industry in the District's service area is already connected to recycled water supply.	Y
Value of local control over water supply for the District	Water Security	-	Benefit	M	Major driver for local supply project.	M	Major driver for local supply project.	M	Major driver for local supply project.	Y
Avoided costs to agricultural producers from water shortages	Water Security	-	Benefit	H	Major driver for rainfall-independent water supply sources.	H	Often experience largest and earliest restrictions on water use during times of shortage.	L	Very little agriculture in the District's service area.	N
Household savings from reduced maintenance of appliances and hot water systems	Water Quality	Salt and Minerals	Benefit	M	Potential to be sizable.	M	Substantive global body of literature.	M	Large residential population served by the District and its Retail Agencies.	Y
Household savings from reduced use of POU treatment systems	Water Quality	Salt and Minerals	Benefit	M	Potential to be sizable.	M	Substantive global body of literature.	M	Large residential population but no recent data available on use of POU treatment systems in the District's service area.	Y
Savings to major industry from reduced pretreatment or other costs e.g. refineries	Water Quality	Salt and Minerals	Benefit	M	No data available on current costs or activities undertaken by major industry.	M	Many industrial applications have strict WQ requirements related to salts and minerals.	M	Large industrial customers but mostly served recycled water. Limited data available from the District.	Y
Savings to small industry and commercial from reduced pretreatment and maintenance of appliances	Water Quality	Salt and Minerals	Benefit	M	Potential to be sizable.	M	Substantive global body of literature.	H	Large commercial districts within service area.	Y
Household savings from reduced soap and detergent consumption	Water Quality	Salt and Minerals	Benefit	M	Potential to be sizable.	M	Substantive global body of literature.	M	Large residential and commercial population served by the District and its Retail Agencies.	Y

Impact	Group	Subgroup	Type	Materiality	Comment	Credibility	Comment	Relevance to OWDP context	Comment	Shortlisted?
Avoided treatment costs for Per- and polyfluoroalkyl substances (PFAS) removal	Water Quality	Emerging Contaminants	Benefit	H	Potentially very high given difficulties in treating for PFAS.	M	Reverse Osmosis (RO) process is one of the most effective technologies for eliminating PFAS.	M	Unpredictable as driven by dynamic regulatory environment and unclear whether an issue in imported water supplies.	Y
Avoided treatment costs for Personal Care and Pharmaceutical Products (PPCPs) removal	Water Quality	Emerging Contaminants	Benefit	H	Potentially very high given difficulties in treating for PPCPs.	M	RO process is one of the most effective technologies for eliminating PPCPs.	M	Unpredictable as driven by dynamic regulatory environment.	Y
Health benefits from reduced hardness resulting in reduced rates of atopic eczema in children	Water Quality	Health Impacts	Benefit	M	Potential to be sizable.	M	Several observational studies suggest that hard water is associated with the development of atopic dermatitis (AD).	M	Atopic eczema is prevalent throughout the US.	Y
Reduced dental cavities from fluoride and calcium addition	Water Quality	Health Impacts	Benefit	M	The sizable public health impacts of fluoride addition have been known for decades.	H	Established throughout the global literature.	H	Current practice in California is to add fluoride to drinking water supply.	Y
Reduced cardiovascular disease from optimal Magnesium concentrations	Water Quality	Health Impacts	Cost	H	Potential to be sizable.	M	Limited connections made in water quality literature related to desalination, but gaining increasing attention. Indirect effect with multiple steps and factors at play.	M	Not typically considered in desalination facility design or water quality studies, but growing body of literature.	Y
Impacts from boron in potable water supply on agriculture users	Water Quality	Other	Cost	M	Potential to be sizable.	M	Established throughout the global literature.	M	Very little agriculture in WB operating region, but can impact residential horticulture.	Y
Impacts from seawater algal blooms	Water Quality	Other	Cost	M	Potential to be sizable.	H	Known issue at Carlsbad Desalination Plant.	M	Studied by District in earlier investigations.	Y
Reduced scaling of household appliances	Water Quality	Salt and Minerals	Benefit	M	Potential to be sizable.	M	Substantive global body of literature.	H	Large residential population served by the District and its Retail Agencies.	Y
Household savings from reduced bottled water purchases	Water Quality	Salt and Minerals	Benefit	M	Potential to be sizable.	L	Less credible connections have been made since consumer preferences and other factors play big role in decisions around bottled water purchases.	L	Limited data available on bottled water purchases within service area.	N
Health benefits from reduced Endocrine Disrupting Chemicals (EDCs)	Water Quality	Emerging Contaminants	Benefit	M	Potential to be sizable.	L	Gaining increasing attention. Indirect effect with multiple factors at play.	L	Emerging area of research and interest but limited application to date in California.	N
Health benefits from reduced sugary beverage consumption	Water Quality	Health Impacts	Benefit	M	Potential to be sizable.	L	Limited connections made in water quality literature globally, but gaining increasing attention. Indirect effect with multiple steps and factors at play.	L	No data available on water quality impacts on purchases of non-water bottled beverages.	N
Health benefits from reduced Water disinfection by-product (DBPs)	Water Quality	Health Impacts	Benefit	L	The District and its Retail Agencies already meet DBP targets in delivered water so gains are likely to be small.	H	The RO process is very effective at removing organics that contribute to formation of DBPs. Reduction in DBPs seen after implementation of Carlsbad Desalination Facility.	M	The District and its Retail Agencies already meet DBP targets in delivered water so gains are likely to be small.	N

Impact	Group	Subgroup	Type	Materiality	Comment	Credibility	Comment	Relevance to OWDP context	Comment	Shortlisted?
Health benefits from reduced perchlorate	Water Quality	Health Impacts	Benefit	L	The District and its Retail Agencies already meet perchlorate targets in delivered water so gains are likely to be small.	H	The RO process is very effective at removing perchlorate.	M	The District and its Retail Agencies already meet perchlorate targets in delivered water so gains are likely to be small.	N
Health benefits from reduced arsenic	Water Quality	Health Impacts	Benefit	L	The District and its Retail Agencies already meet arsenic targets in delivered water so gains are likely to be small.	H	The RO process is very effective at removing arsenic.	M	Per the Water Replenishment District's 2013-2014 Regional Groundwater Monitoring Report, arsenic concentrations greater than the 10 µg/L MCL are detected in about a third of the Central Basin wells.	N
Health benefits from reduced uranium	Water Quality	Health Impacts	Benefit	L	The District and its Retail Agencies already meet uranium targets in delivered water so gains are likely to be small.	H	The RO process is very effective at removing uranium.	M	The District and its Retail Agencies already meet uranium targets in delivered water so gains are likely to be small.	N
Health benefits from reduced chromium-6	Water Quality	Health Impacts	Benefit	L	The District and its Retail Agencies already meet NDMA targets in delivered water so gains are likely to be small.	H	The RO process is very effective at removing NDMA.	M	The District and its Retail Agencies already meet NDMA targets in delivered water so gains are likely to be small.	N
Health benefits from reduced N-Nitrosodimethylamine (NDMA)	Water Quality	Health Impacts	Benefit	L	The District and Retail Agencies already meet DBP targets in delivered water so gains are likely to be small.	H	The RO process is very effective at removing organics that contribute to formation of DBPs. Reduction in DBPs seen after implementation of Carlsbad Desalination Facility.	M	The District and its Retail Agencies already meet DBP targets in delivered water so gains are likely to be small.	N
Increase agricultural yield due to reduced sodium adsorption ratio of water	Water Quality	Other	Benefit	M	Potential to be sizable.	M	Established throughout the global literature.	L	Very little agriculture in the District operating region.	N
Additional management and support staffing leading to overhead costs	Organizational Impact	-	Cost	M	Potential to be sizable, but dependent on project delivery method chosen.	H	Extra staffing will be directly linked to additional tasks needed to manage OWDP.	M	Needs to be considered by District decision-makers.	Y
Increased pipe corrosion in distribution system	Organizational Impact	-	Cost	M	Potential to be sizable.	L	Post treatment process is to be specifically designed to mitigate this risk.	M	Project not yet at the stage where post treatment design is developed to enough detail to analyze this meaningfully.	N
Reduced costs and land value recovery to District from decommissioning Brewer Desalter Facility	Organizational Impact	-	Benefit	M	Potential to be sizable.	M	Potential overlap in functionality given OWDP and desalter both produce desalted water. Potential opportunity for the District to cease its operations.	L	Limited appetite from the District to alter operation of the Brewer Desalter facility - it is owned by an external party, and uses different source water, amongst other reasons.	N
Impacts to downstream wastewater treatment and reclamation systems	Organizational Impact	-	Benefit	L	Uncertain magnitude of impact but due to large size of Hyperion Wastewater Plant, unlikely to be material (much of District service	M	Desalinated water has lower salt and mineral (and other) content than typical supply, potentially resulting in lower contaminant load on downstream wastewater infrastructure.	L	Project not yet at the stage where connection to feeder system and downstream flows to wastewater collection and treatment system have	N

Impact	Group	Subgroup	Type	Materiality	Comment	Credibility	Comment	Relevance to OWDP context	Comment	Shortlisted?
					area lies within Hyperion catchment).		This has had noticeable impacts in other systems worldwide.		been developed to enough detail to analyze this meaningfully.	
Cost of desalinated water vs. imported water	Financial	Project Costs	Cost	H	Detailed modelling completed in this Study.	H	Detailed modelling completed in this Study.	H	This is a real cost incurred by the District and its customers to deliver the project.	Y
Increased cost of road maintenance in vicinity of plant	Financial	Project Costs	Cost	L	ESGS site is located in busy coastal region. Project-specific traffic likely to be minimal in scheme of total traffic.	M	Understanding baseline vs. project case may be difficult.	M	Relevant, as with all major operating facilities.	N
Affordability impacts to lower income residents	Financial	Affordability	Cost	M	Costs of OWDP will be passed on to Retail Agencies.	H	Direct link between OWDP and increase in rates can be established.	M	Affordability analysis to be undertaken.	Y
Fugitive emissions during construction	Environmental & Amenity	Air	Cost	M	As per Draft EIR, 'Significant and Unavoidable Impact'.	H	Established and discussed in EIR.	H	Established and discussed in EIR.	Y
Noise emissions during construction	Environmental & Amenity	Air	Cost	M	As per Draft EIR, 'Significant and Unavoidable Impact'.	H	Established and discussed in EIR.	H	Established and discussed in EIR.	Y
Amenity reduction due to light pollution / visual character / scenic resources	Environmental & Amenity	Community	Cost	L	As per Draft EIR, 'Less than Significant with Mitigation Incorporated'.	M	Established and discussed in EIR.	H	Established and discussed in EIR.	N
Traffic disruption due to truck & worker movements during construction and operation	Environmental & Amenity	Community	Cost	L	As per Draft EIR, 'Less than Significant with Mitigation Incorporated'.	M	Established and discussed in EIR.	H	Established and discussed in EIR.	N
Impacts to land-based biological resources incl. sensitive species, invasive weeds, bird nesting, species of concern (western snowy plover & blue butterfly) due to land disturbance during construction.	Environmental & Amenity	Land	Cost	L	As per Draft EIR, 'Less than Significant with Mitigation Incorporated'.	M	Established and discussed in EIR.	H	Established and discussed in EIR.	N
Impacts to cultural, archeological and paleontological resources due to land disturbance during construction.	Environmental & Amenity	Land	Cost	L	As per Draft EIR, 'Less than Significant with Mitigation Incorporated'.	M	Established and discussed in EIR.	H	Established and discussed in EIR.	N
Release of hazardous materials during construction or operation	Environmental & Amenity	Land	Cost	L	As per Draft EIR, 'Less than Significant with Mitigation Incorporated'.	M	Established and discussed in EIR.	H	Established and discussed in EIR.	N
Air pollutant production during construction	Environmental & Amenity	Air	Cost	L	As per Draft EIR, 'Less than Significant with Mitigation Incorporated'.	M	Established and discussed in EIR.	H	Established and discussed in EIR.	N
Greenhouse gas emissions	Environmental & Amenity	Air	Cost	M	As per Draft EIR, 'Less than Significant with Mitigation Incorporated'.	M	Established and discussed in EIR.	L	Project design allows for purchase of greenhouse gas offsets for project to be net carbon-neutral. Cost is already included in financial modelling.	N

Impact	Group	Subgroup	Type	Materiality	Comment	Credibility	Comment	Relevance to OWDP context	Comment	Shortlisted?
Impacts to marine biological resources incl. entrainment, underwater noise, invasive species	Environmental & Amenity	Marine	Cost	L	As per Draft EIR, 'Less than Significant with Mitigation Incorporated'.	M	Established and discussed in EIR.	H	Established and discussed in EIR.	N
Economic stimulus (regional output) from construction phase	Economic Stimulus	-	Benefit	H	Large project = large indirect and induced impacts	H	Flow on economic impacts widely analyzed.	H	Economic impact will occur within the District region.	Y
Economic stimulus (regional output) from operations phase	Economic Stimulus	-	Benefit	H	Large project = large indirect and induced impacts	H	Flow on economic impacts widely analyzed.	H	Economic impact will occur within the District region.	Y
Economic stimulus (employment) from construction phase	Economic Stimulus	-	Benefit	H	Large project = large indirect and induced impacts	H	Flow on economic impacts widely analyzed.	H	Economic impact will occur within the District region.	Y
Economic stimulus (employment) from operations phase	Economic Stimulus	-	Benefit	H	Large project = large indirect and induced impacts	H	Flow on economic impacts widely analyzed.	H	Economic impact will occur within the District region.	Y

3. Water Security

The shortlisted water security impacts discussed in this section are:

- Avoided direct costs to the District and other regional water retailers from potential long-term shortages of imported water supply from MWD.
- Avoided direct costs to the District and other regional water retailers from potential short-term shortages of imported water supply from MWD.
- Avoided amenity and cost impacts to households from water shortages.
- Avoided costs to minor industry and commercial enterprises from water shortages.
- Avoided costs to major industry from water shortages.
- Value of local control over water supply for the District.

3.1 Context

'Water security' refers to the ability of water agencies (in this case the District, its customer Retail Agencies and MWD) to maintain full service of potable water supply to households, commercial and industrial users. Water security can be thought of as the ability to withstand both long-term and short-term threats to water availability:

'Reliability' – long-term water supply capacity (i.e. drought-proofing)

- Changing hydrological conditions - climate change and severe droughts
- State Water Project limitations

'Resilience' – short-term water supply capacity (i.e. disaster-proofing)

- Facility failure
- Natural disasters – earthquake, fires
- Power outage

Better water security provides benefits by:

- Reducing the risk of economic consequences from total or partial water unavailability to industry, commercial enterprises and agriculture.
- Reducing the risk of amenity impacts and increased costs of water-based activities to residents and households.

No water supplier in Southern California is an isolated, independent entity unto itself, and most, to varying degrees, are dependent upon a regional system of water importation, storage, treatment, and distribution. However, water security can be improved for an individual entity through the development of local projects, which provides the ability to exercise greater local control over supply production and cost.

Note that the discussion contained herein does not contemplate long-term catastrophic total water shortage scenarios during which water is unavailable to meet basic human survival needs due to a lack of reliability or resilience. The consequences of such a situation would be extremely high, however it is deemed to be such low likelihood that it would not impact on decision-making for the OWDP. This is due to the ability of state, regional and federal agencies to mobilize to distribute essential water supplies in case of a catastrophic event.

We focus the analysis on scenarios of moderate to severe water restrictions which will mostly impact on amenity and outdoor uses of water by residents, and in the more severe scenarios could have adverse economic impacts on consumers and some landscape and water-reliant businesses.

3.2 Reliability

3.2.1 Regional Water Reliability Challenges

Since the early 1990's, supporting water reliability for Southern California has been a core driver of short and long-term water supply planning undertaken by the MWD, the District, and its Retail Agencies. Nevertheless, maintaining full water availability to the region has been a significant challenge.

Subsequent to the 1987-1992 drought which launched the region's drive to diversify water supplies, California has experienced two sustained and severe state-wide multi-year droughts in the past 15 years. These most recent prolonged droughts resulted in mandatory supply cutbacks and severe water use restrictions. The drought of 2008–2011 and the unprecedented 5-year statewide drought of 2012–2016 have demonstrated that imported water constraints are an ongoing and frequent occurrence. The severity of the most recent prolonged drought was illustrated through the unprecedented actions taken by Governor Brown in Emergency Proclamation B 21-13 in 2014, declaring a state of Drought Emergency, and in 2015 Executive Order B 29-15 that required municipal water agencies throughout California to reduce total water usage by 25 percent. The emergency was only rescinded in 2017, after an extremely wet winter in Northern California replenished many reservoirs.

Varying hydrology, future effects from climate change on surface water supplies, and the increased competition for decreasing supplies affect the long-term availability and reliability of imported water from northern California and the Colorado River Basin. Continued regulatory uncertainty surrounding exported water from the Sacramento Bay Delta will continue to contribute to long term water supply reliability challenges for the State Water Project (SWP) and further limit imported supply availability. Furthermore, recent droughts lowered groundwater reserves, even at the same time that groundwater use by the District's customers decreased notably (Figure VI-6 and Figure VI-7).

However, the end of the drought and expanded indirect potable reuse have improved the situation considerably. In 2014, the West Coast Basin water rights were subject to a groundwater adjudication amendment, which also contributed. As noted in the annual Engineering Survey and Report published by Water Replenishment District of Southern California (WRD) in 2020, "because of the current years [2019/20 Water Year] normal precipitation so far and WRD will continue to replenish with recycled water, the projected groundwater levels in the Central Basin and West Coast Basin (CBWCB) will be within historic ranges and the District anticipates that there will continue to be sufficient supplies of safe and reliable groundwater to meet the demands of the pumpers in our service area in the current and ensuing years."

Into the future, groundwater resources will contribute to regional reliability, but will continue to be impacted by a myriad of legal, water quality, and climate factors. That is why MWD's Integrated Resources Plan has supported its member agencies effort to create new rainfall-independent reliable supplies such as the District's OWDP as a means to improve future regional reliability.

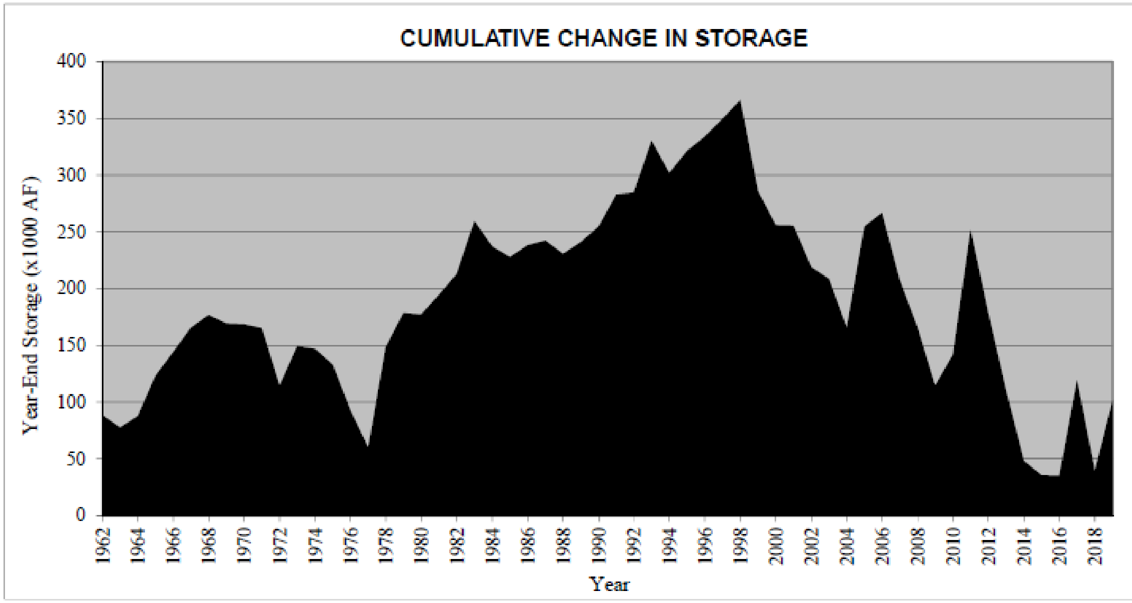

Figure VI-4 Year-end water storage in combined Central Basin and West Coast Basins. Source: Table 8 of Water Replenishment District (WRD) 2020 Engineering Survey and Report

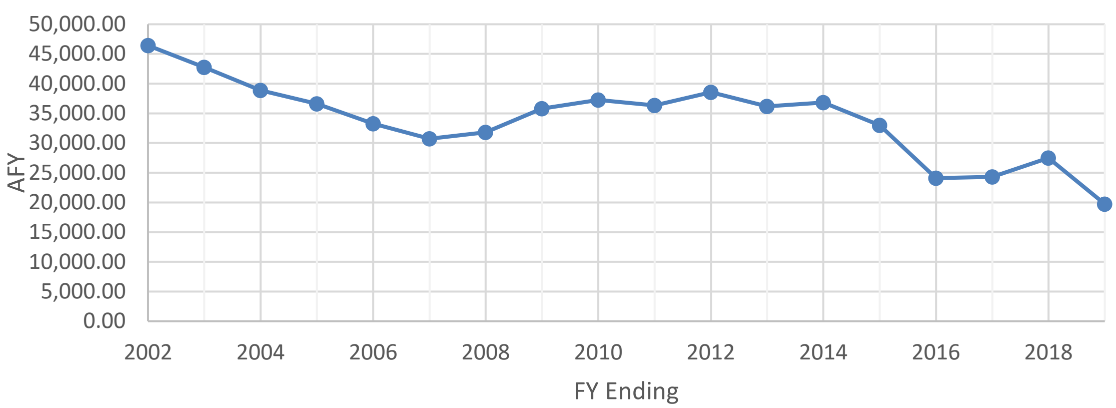

Figure VI-5 Historical groundwater pumping from inside District service area by retail customers only and pumping from Central Basin. Source: WBMWD Water Use Reports 2010-11 and 2018-19.

There is a very substantial body of literature and effort directed to analyzing and addressing the water security challenges to Southern California. This report has not included a comprehensive review of these aspects. Nevertheless, these challenges and the unprecedented imposition by the State of mandatory restrictions in 2015 reinforces the need for long-term reliability that reduces Southern California's dependence on imported water.

3.2.2 Water Reliability Benefits from the OWDP

The OWDP compared to most other local supply projects in the MWD service area is considered to provide a significant amount of local supply. Although it is unlikely to be a large enough individual supply source of potable water to, by itself, reduce future regional restriction levels enforced by MWD, it contributes to protecting and extending stored water and other supplies during an extended shortage.

The OWDP would be capable of creating 21,283 AFY of drought-proof water each year. MWD forecasts total imported water transactions sales of 1.4 to 1.8 MAF over the next 10 years[1], and had available supply of 1.7 MAF during the supply-constrained year of 2015. Thus, the OWDP would add supply ~1% of total MWD imported water. This is a relatively large contribution for a single local water supply project.

Importantly, the potable supply provided by the OWDP is fully hydrologically-independent and drought-proof by nature of relying on abundant seawater feed, providing reliability benefits.

As a local project, it also enhances resilience since it is shielded from natural disasters that occur regionally or disruptions to the imported water system that could occur elsewhere.

3.2.3 Water Reliability Planning

Key water planning documents in the context of the OWDP project are listed below, and the reader is referred to these documents for more detailed discussion:

- West Basin Municipal Water District UWMP 2015[2]
- West Basin Municipal Water District Drought Rationing Plan 2015
- MWD UWMP 2015
- MWD Drought Response Plan 1999
- MWD Water Supply Allocation Plan (WSAP) 2014

In broad summary, the current planning principles for water supply in Southern California are based on diversification of the region's water supply portfolio and continued efficient water use. This integrated resource planning process has recognized that only through a mix of imported and member agency local supplies along with aggressive implementation of water conservation can the MWD service area attain overall reliability of water supply.

The need for diversification and drought-resilient local supplies has been reinforced in recent years as MWD's service area has experienced two severe droughts resulting in water shortages to MWD and cutbacks in supplies to its member agencies including the District, during 2009-10 and 2015 (see Figure VI-6).

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[1] Proposed Biennial Budget for FYs 2020/21 and 2021/22, Water Rates and Charges for CYs 2021 and 2022, Ten-Year Forecast, and Applicability of S124.5 AV Tax Limit for FYs 2020/21 and 2021/22, MWD Finance and Insurance Committee, Item 8-1, April 13 2020.

[2] It is known that efforts are currently underway by the District and MWD to produce updated Urban Water Management Plans for 2020. These documents were not available at the time of this analysis and we have based our discussion on the information available in 2015 UWMPs.

The District's water supply portfolio reliability was analyzed as part of the UWMP 2015 development, with the following key findings:

- The District and its Retail Agencies can reliably meet its projected demand to 2040 in normal, wet and single dry-year conditions using its current potable supply sources (consisting of imported water and supplementary groundwater use by its Retail Agencies). Figure VI-8 summarizes the projected water demands to 2040. Therefore, the reliability benefit of a new desalination facility is minimal in years with normal, wet or single dry-year conditions.
- In multiple dry-year scenarios (i.e. drought conditions, defined as 3 or more years of reduced precipitation), additional rainfall-independent local supply is desirable due to the likelihood of restrictions on imported water availability. These restrictions manifest themselves through a Regional Shortage Level declaration by MWD, with an associated enforced reduction of imported water use consumption for that year. The percentage reduction in imported water consumption depends on the Regional Shortage Level declared, with higher Levels representing more drastic reductions.
- A repeat of the Regional Shortage Level 3 scenario was used for planning purposes by the District in its UWMP. Regional Shortage Level 3 involves 22.5% reduction in imported water consumption by the District and its customers. The reduction may be reduced to no less than 15%, depending on the amount of retail adjustments it can secure from MWD. It found that 21,500 AFY of local water supply will be needed in the future to ensure reliable supply, in this scenario.

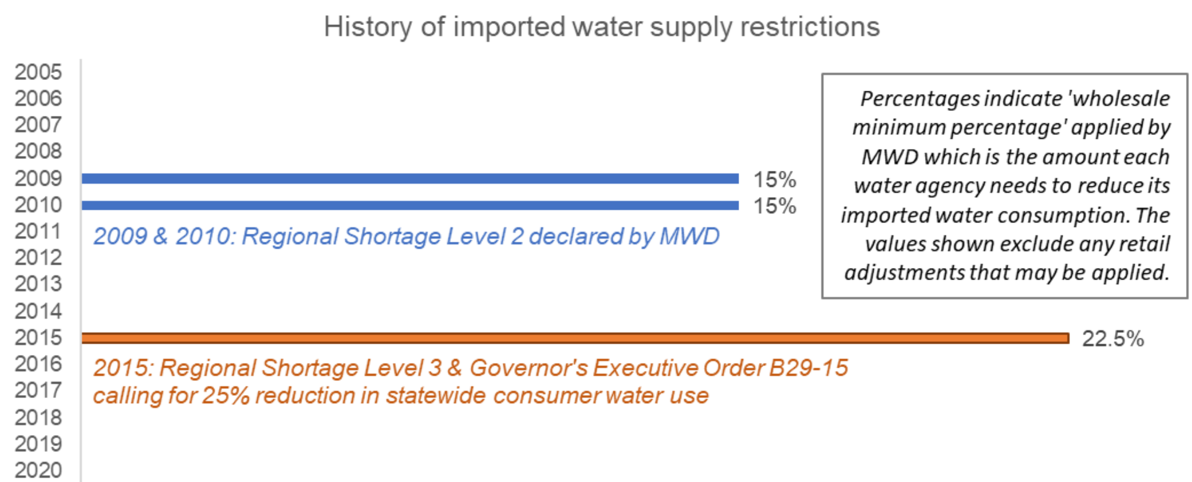


Figure VI-6 Summary of recent imported water supply restrictions imposed by MWD on retailers (including the District)

3.2.4 Regional Allocation Framework and Impact to the District

MWD's WSAP provides the formula for allocating available water supplies to member agencies during extreme imported water shortages which result in declaration of a Regional Shortage. The WSAP was developed in consideration of the principles and guidelines described in MWD's Water Supply and Drought Management Plan, with the objective of creating an equitable needs-based allocation which considers:

- Impact on retail consumers and regional economy
- Investments in local resources, including recycling and conservation.

- Population growth
- Changes and/or losses in local supplies
- Participation in MWD's non-firm (interruptible) programs
- Investment in MWD's facilities

The WSAP contains the detailed calculation method. In brief summary:

- An agency's baseline imported water demand (in AFY) is calculated based on the two most recent non-shortage years.
- An agency's allocation of imported water is reduced by a percentage based on the Regional Shortage Level declared by MWD.
- Retail impact adjustments are made to ensure that member agencies with high level of dependence on imported water do not experience disparate shortages. That is, an agency which is substantially or fully reliant on imported water, will not need to restrict its use by as much as other agencies.
- Through the process some other adjustments are made to account for population growth, new local supplies and conservation demand hardening.

The District uses the same calculation procedure to determine how imported water is allocated to its own Retail Agencies, to meet the District-level imported water reductions imposed on it by MWD.

The relevance of the allocation process is that the additional supply of potable water from the OWDP is 'shared' between the District and other region or regions as a whole. The following hypothetical example below in Figure VI-7 demonstrates the difference in water restriction outcomes for the District and the region, with and without the OWDP, with the water demand values shown based on the projections for 2035 (as per Figure VI-8).

Evidently, the OWDP would have a direct benefit to the District and its retail customers by increasing the availability of potable water during times of restrictions. In this hypothetical scenario, the District and its Retail Agencies have access to an additional 4,780 AFY than if the OWDP is not built. Furthermore, the District's reduced reliance on imported water has 'unlocked' an extra 16,450 AFY (= 21,230 minus 4,780 AFY) of potable water available to the region as additional water supply.

In the context of this CBA, it is critical to appreciate that the majority of the reliability benefits of the OWDP compared to the No-Project alternative accrue to the region as a whole, and a smaller portion of the desalinated water output will accrue directly to the District and its Retail Agencies as additional available water during times of region-wide water restrictions. This is the basic justification by MWD for its Local Resource Program (LRP) financial incentives.

Providing the OWDP is a partial 'insurance policy' to improve availability of water should drought conditions return in the future.

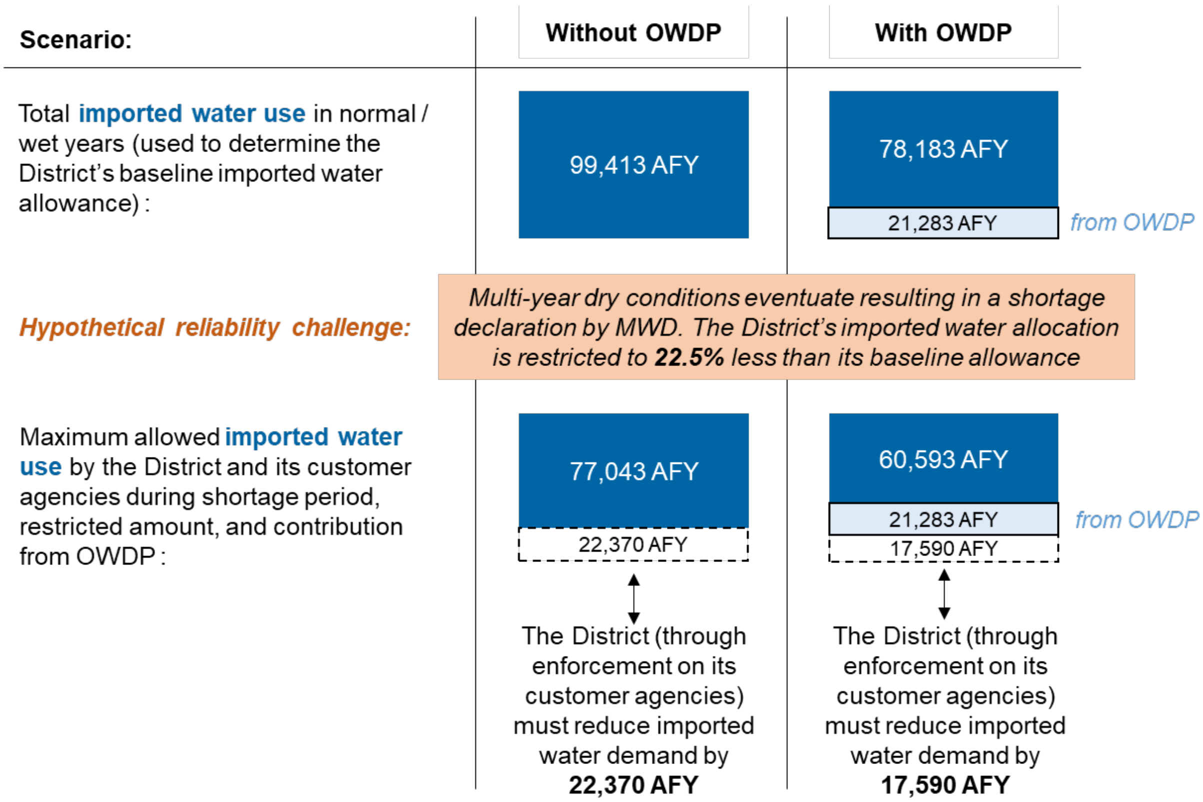
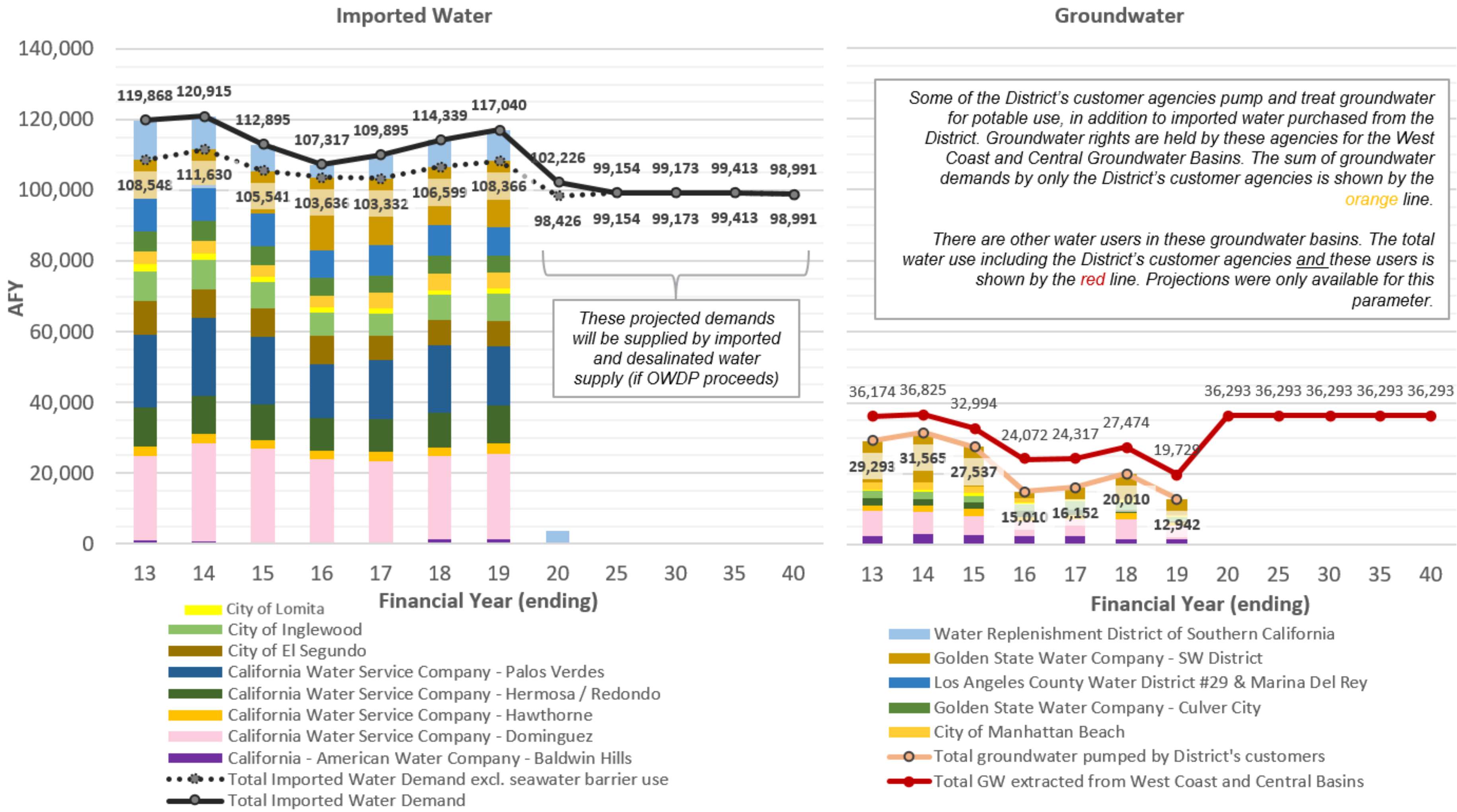


Figure VI-7 Illustrative example of water restrictions for the District during a regional shortage event, with and without the OWDP



Sources: *GHD analysis of historical data from West Basin Annual Water Use Reports; Projected data from West Basin 2015 UWMP and Final EIR*

Figure VI-8 Historical and projected water demands from District customers

3.3 Resilience Planning

3.3.1 Overview

Resilience of the District's water supply refers to its ability to maintain water supply capacity in response to an acute emergency event. MWD provides a more thorough description of the concept: *"'Resilience' is broadly defined as the ability of a system to absorb and rebound from shocks. The more resilient a system is, the smaller the impact will be that any given shock will have on the system, and the shorter the duration of recovery will be."*[3]

Emergency events could include facility failures, regional power outage, wildfires or earthquakes. In particular, seismic-induced damage from earthquakes is a major consideration for Southern California's water supply and MWD have led numerous studies in recent years to better understand and respond to this risk.

This section describes the benefits and costs of the OWDP on the region's resiliency, with a focus on seismic risk.

It is noted that in a regional emergency event that affects the entire southern California region, MWD would take the lead and activate its Emergency Operation Center (EOC). Therefore, the following discussion draws heavily from MWD's recent Seismic Resiliency Planning Reports[4]. The District's own resiliency measures will contribute an important, but subsidiary role to regional resilience.

3.3.2 Seismic Risk Context

Within Southern California, there are a number of known active faults with varying levels of activity that are capable of generating significant earthquakes and causing widespread damage to infrastructure, particularly large-scale imported water conveyance infrastructure such as the California Aqueduct (which provides State Water Project supply), the Colorado River Aqueduct or the Los Angeles Aqueduct. MWD in collaboration with The Department of Water Resources (DWR) and Los Angeles Department of Water and Power (LADWP) have extensively analyzed and quantified the seismic risks facing imported water supply. The Southern San Andreas Fault was identified as having the highest likelihood of a damaging earthquake, and could impact any of the major imported water aqueducts.

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[3] Seismic Resilience First Biennial Report (Report No. 1551), The Metropolitan Water District of Southern California, Feb 2018

[4] Footnote 3 and Seismic Resilience Report 2020 Update (Report No. 1551-1), The Metropolitan Water District of Southern California, Feb 2020.

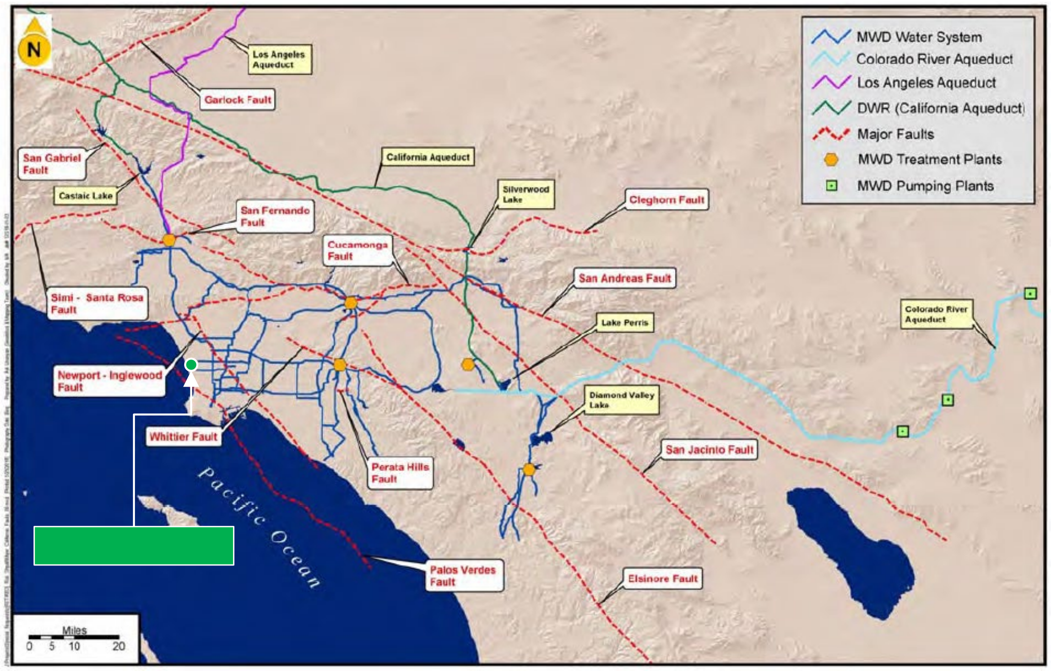

Figure VI-9 Major Earthquake Faults in Southern California (Source: Footnote 3)

In a catastrophic scenario of a large and poorly-located seismic event, it is conceivable that some or all imported water aqueducts could be damaged and be offline for an extended period. In such a situation, Southern California would not have access to imported water until repairs are completed.

Restoring water deliveries following earthquakes is crucial for fire suppression, for the general welfare of local residents (to meet basic sanitary and health needs), and for the regional economy that relies on imported water. As such, a highly resilient water supply that can limit temporary loss in capacity and minimize the period of disruption until full supply is re-established (refer Figure VI-10) has economic, health, safety and community benefits that are difficult to quantify but self-evidently extremely large.

Figure VI-10 Elements of resilience (Source: Footnote 3)

3.3.3 Regional Resilience Strategy and Benefits of OWDP

MWD's Seismic Resilience Strategy is a multi-faceted approach to prepare for and respond to seismic events. It involves close, formal coordination within the MWD and with other owners of imported water conveyance systems that cross the Southern San Andreas Fault. The Resilience Strategy components are shown below:

Figure VI-11 MWD Seismic Resiliency Strategy Components (Source: Footnote 3)

The development of the OWDP is most relevant to the Planning component of the Resilience Strategy, which includes the following three facets: diversified water supply portfolio, system flexibility, and emergency storage.

Diversified Water Supply Portfolio and System Flexibility

MWD Resiliency Strategy demonstrates that increased flexibility to draw upon a wide range of sources from an ever more diverse water supply portfolio results in greater resilience to the potential impacts of seismic events on Southern California's water supply infrastructure. First, the more a diversified supply portfolio can contribute to meeting baseline water demand, the more imported water MWD can divert into storage to prepare for droughts (as discussed in in Section 3.2.2 of this Chapter) or potential seismic events. Furthermore, system delivery flexibility is improved by having geographically and source-varied water supply sources. The flexibility improves the possibility and extent to which partial deliveries can be provided immediately following an emergency event. With reference to Figure VI-10, this contributes to resiliency by minimizing the 'loss of capacity' post-event.

The OWDP would provide benefits from both the perspectives of diversification and flexibility.

As per Figure VI-9, the proposed location is far from the Southern San Andreas fault. The likelihood of a major earthquake at the fault line closest to the OWDP, the Palos Verdes fault, is at least 5 times lower than the Southern San Andreas[5]. Therefore, the OWDP is at a lower and differentiated seismic risk than imported water supply, and further diversifies the risk since it uses a seawater source that is completely independent of the imported network.

Furthermore, the coastal location of the OWDP means treated desalinated water will be delivered into the MWD feeder system from the west (currently proposed directly into the Sepulveda Feeder line). Therefore, if imported water supply is lost, OWDP's location may provide flexibility to still maintain some supply in the system downstream of the Sepulveda Feeder, which would otherwise be isolated.

It is noted that the exact role the OWDP would play in a post-event recovery will be entirely dependent on the nature of the event and the extent of impacts to the regional water supply system. Furthermore, the integration of the OWDP with the MWD feeder system has not been fully developed at this stage of the project development. Nevertheless, the OWDP's differentiation of geography and source will only improve regional resilience.

It is also worth noting that from the District's perspective, the OWDP would contribute to its ability to meet its obligations to MWD, specifically §4503 (b) of the MWD Administrative Code which stipulates:

> *b) Each member agency shall have sufficient resources such as local reservoir storage, groundwater production capacity, system interconnections or alternate supply source to sustain:*
>
> *(1) A seven-day interruption in Metropolitan deliveries from raw and treated water distribution facilities based on average annual demands of the affected facility.*
>
> *(2) For service connections installed or modified after December 31, 2008 on raw water conveyance facilities, a seven-to twenty-one-day interruption in Metropolitan raw water deliveries based on average annual demand of the affected facility.*

The OWDP's localized, independent production capacity is approximately 20% of total average potable water demand in its service area, so the facility, if operating at full capacity could contribute ~20% of daily demand during a 7-day interruption period.

Emergency Storage

The other component of the planning component of the Resilience Strategy is emergency storage. MWD's emergency storage requirements are based on the potential of a major earthquake to cause damage that could render the imported water aqueducts[State Water Project (SWP), Colorado River Aqueduct (CRA), and Los Angeles Aqueduct (LAA)] out of service for six months. As a result, MWD has based its planning on a 100 percent reduction in these imported supplies for a period of six months.

Emergency storage is distributed among the available capacities of existing DWR and MWD surface reservoirs located on the coastal side of the San Andreas Fault.

The OWDP will not provide a substantial benefit from the perspective of emergency storage since the amount of treated water storage at the facility is minimal (equivalent to several hours of production) and

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[5] Likelihood of one or more Magnitude ≥ 6.7 earthquake over next 30 years, based on USGS Third California Earthquake Rupture Forecast (UCERF3); GHD analysis of Figure 2-1, Footnote 3

would therefore not make a meaningful contribution to MWD's 750,000 acre-feet target for the emergency storage program.

3.4 Measures of Value for Additional Water Security

3.4.1 Introduction

As discussed above, the OWDP would undoubtedly improve local and regional water security. However, providing a 'value' of the additional water security is a difficult and contentious exercise given that water is a fundamental input upon which almost all human, environmental and economic activities depend. It is commonly accepted that the prices of water provided by water agencies in most of the developed world are far lower than the true economic value of water – further complicating the ability to value the reliability of said supply. The definition of adequate water security also varies widely between users.

The approach adopted in this analysis was to review and document existing literature and primary sources of a contextually relevant context to the OWDP project. They are presented to provide decision-makers with a perspective on the potential range of water security benefit that may be derived through the OWDP.

3.4.2 Penalty Rates

In a WSAP enacted shortage allocation MWD enforces member agency allocations through a penalty rate structure, in which a levy on water consumption is imposed if a member agency exceeds its WSAP allocation. Penalty rates are in addition to the base rate of water purchased. These penalty rates apply only during times of regional shortage and water supply allocation.

The District has adopted the same penalty rate approach for its Retail Agencies [6].

Table VI-3 shows the ascending block structure and penalty rates applied.

Table VI-3 Allocation Penalty Rates

Usage Above Allocation	Penalty Rate (on top of imported water cost)
100 percent - 115 percent	$1,480/AF
Above 115 percent	$2,960/AF

Source: West Basin Municipal Water District Drought Rationing Plan (2015) and MWD UWMP (2015)

The penalty rate is calculated using an opportunity cost approach, where the rate is equivalent to the cost of saving the same amount of water through MWD's Turf Removal Program:

- Turf removal saves ~44 gallons per year per square foot for 10 years

[6] However, the levy is only applied if a Retail Agency exceeded its allocation under the DRP AND the District exceeded its allocation with Metropolitan under the WSAP. In such a case, the District's total penalty will be assessed to each Retail Agency that exceeded its DRP allocation on a pro-rata basis if the District as a whole exceeds its allocation under the WSAP.

- Turf removal program - $2/sq.ft = $1,480 AF
- Turf removal program - $4/sq.ft = $2,960 AF

The penalty rates levied by MWD are evidently high, in per acre foot (AF) terms. For example, the total MWD Full Service Treated Volumetric Rate plus MWD Readiness-to-Serve Charge in FY2019, totaled to just $1,148 per AF.

The high penalty rate supports their use as a deterrent for overuse of water during times of shortage and are supported by an opportunity cost / avoided infrastructure estimation basis that is indeed implemented by MWD.

The penalty rates could be interpreted as a reasonable upper-end valuation for additional reliability from an avoided infrastructure perspective – upper-end because less costly alternatives may exist, especially when centralized. However, such an analysis does not account for potential wide-scale and indirect economic impacts from water shortages, or the perspectives of individual customers toward water security.

3.4.3 Willingness to Pay and Consumer Surveys

Willingness-to-pay (WTP) studies have been used by economists in the water sector for decades to understand reliability and level-of-service tradeoffs. WTP studies use analytic techniques to quantify the amount of money a set of consumers is willing to give up or receive (willingness-to-accept) in exchange for a different level of service. There is an existing body of literature specifically investigating potable water customers' WTP to avoid water restrictions.

A range of WTP study methodologies have been developed and applied to water reliability issues including:

- Stated preference techniques, in which survey questions are used to ask individuals to make a choice, describe a behavior, or state directly what they would be willing to pay for specified changes in reliability. Contingent valuation and choice experiment studies are types of stated preference techniques. These studies are circumstance-specific and can be prone to poor repeatability depending on the way the study questionnaire is set up. Furthermore, they inherently involve providing a set of hypothetical scenarios to respondents, and therefore they cannot be said to observe actual behavior.
- Revealed preference and cost-based studies, in which market data is analyzed to infer consumer behavior and value attributes from actual behavior.

WTP studies are useful because they aggregate and derive a single monetary value for the wide range of financial and non-financial impacts that water restrictions may have on customers. It is important to interrogate the results of any WTP study in the context of its study population, methodology and questionnaire set-up.

In comparison, consumer surveys are commonly conducted by water agencies in California. Consumer surveys are valuable as they provide direct feedback from the population most affected by a water agency's decisions, and who fund the water agency. They are generally conducted more frequently and are useful for tracking changes in attitudes and perspectives of customers over time. Consumer surveys are not usually conducted with the same level of rigor as WTP academic literature, and WTP for water reliability is not usually the primary focus of a consumer survey.

The following discussion provides a summary of relevant WTP studies and consumer surveys from California since 1987. We have included brief commentary on the contextual relevance of each. The intention is to provide decision-makers with an understanding of the literature developed in this space. The truest indication of WTP for the OWDP would be to develop a WTP study and/or consumer survey specifically for the project, with customers located within the District's service area – this would update findings from the District's consumer survey conducted some years ago.

All values are expressed as 2019/20 dollars unless stated otherwise.

West Basin Municipal Water District Water Issues Survey, 2015[7]

The District conducted a survey of residents within its service area in September 2015, during the severe Californian drought. The survey found nearly half of households would support water rate increases to support, protect and increase local safe and reliable drought-proof drinking water supplies - the percentage who said they would be very willing to pay increases from 49% at $12/month to as much as 67% at $3/month (Figure VI-13).

Other interesting responses related to water security were:

- The District's customers were similarly concerned about water shortages but more concerned about the drought compared to statewide results (compared to statewide surveys conducted by FM3 for the Association of California Water Agencies). 79% of the District's customers were extremely or very seriously concerned about water shortages due to more frequent droughts.
- The District's customers' recognition of long-term water security challenges were similar or slightly higher than statewide results (see Figure VI-12).

Doheny Desalination Project, Orange County, California, 2020[8]

A recent public opinion survey conducted for the proposed Doheny Desalination Project in Dana Point, CA surveyed residents in the lead agency's (South Coast Water District) service area on various aspects of the project. The survey found 63% or more reported they would be willing to pay at least $15 per month on average to build the desalination project, and the percentage who said they would be very willing to pay increases from 29% at $15/month to as much as 58% at $5/month (Figure VI-13).

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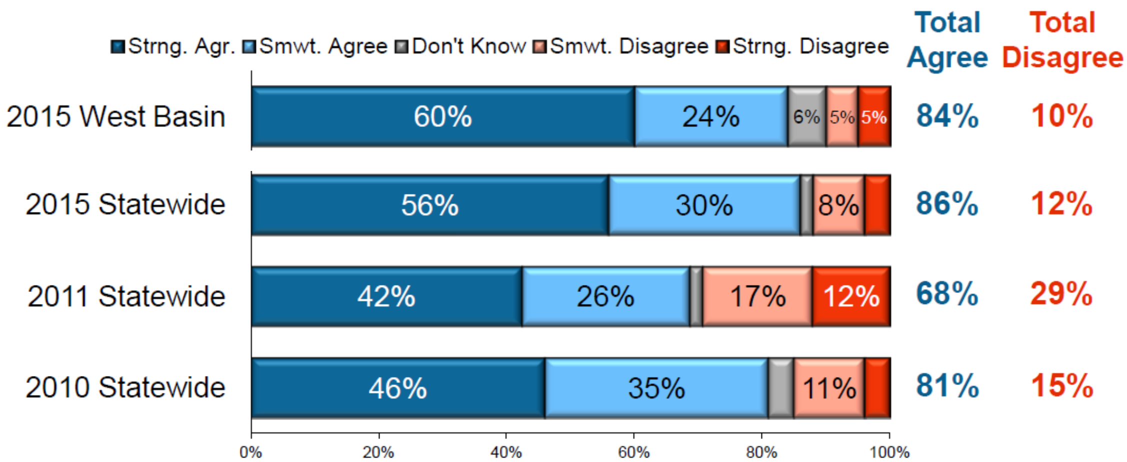
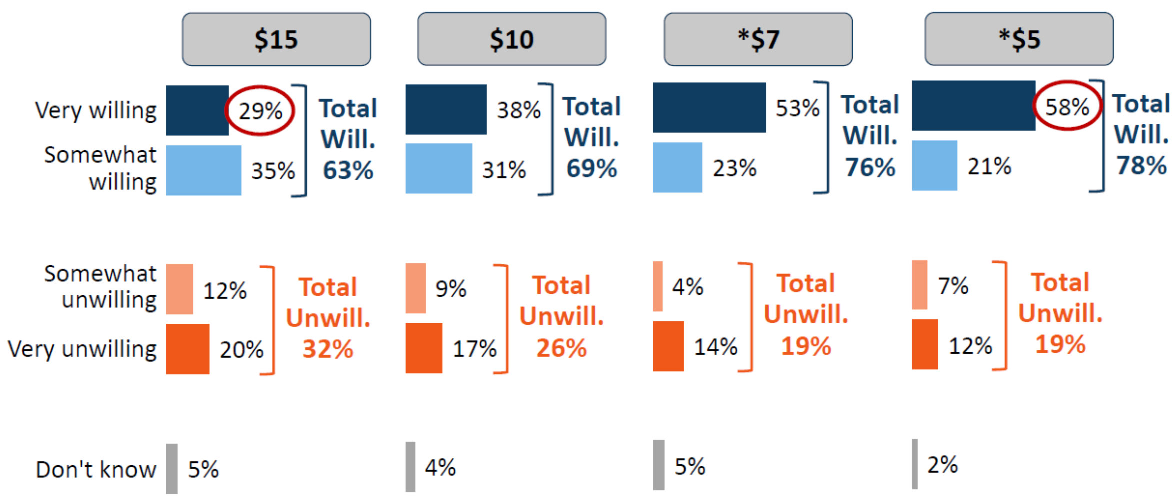
[7] West Basin Municipal Water District (WBMWD) Water Issues Survey, FM3 Research, Oct 2015

[8] South Coast Water District (SCWD) Issues Survey, FM3 Research, June 2020



Results in response to the statement: Even in times of normal rainfall, California still has an ongoing shortage of water

Figure VI-12 Results of public survey for WBMWD, 2015. Source: FM3 Research for WBMWD



*Survey question: Q. Suppose that building this desalination plant resulted in an additional cost of ____________ on the average household's monthly water bill. Would you be willing or unwilling to pay that amount? *Split Sample*

Figure VI-13 Results of WTP survey for the Doheny Desalination Project, 2020. Source: FM3 Research for South Coast Water District

San Diego County Water Authority, California, 2019[9]

SDCWA conducted a public opinion survey on a variety of topics in 2019. The study randomly sampled adults within the Authority's service area. The survey found that 45% of respondents would support an

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[9] Water Issues Survey Summary Report, True North Research for San Diego County Water Authority, Sep 2019 [link]

increase of $10 per month on their bill to fund priority water reliability projects, 50% would support a $7.50 monthly increase, and almost two-thirds (64%) would support an increase of $5 per month to fund water reliability projects. Other interesting responses related to water security were:

- 7% of respondents felt that the reliability of the supplies in both California and Southern California would improve over the next year. For San Diego County, the percentage was slightly higher at 10%. For each of the three geographies, respondents were close to evenly split between feeling that the supplies would stay about the same (California: 42%, Southern California: 40%, San Diego County 43%) or get worse (California: 41%, Southern California: 45%, San Diego County 40%).
- Just under half (48%) of respondents thought water supplies would be very or somewhat unreliable in San Diego County over the next 20 years.
- Among specific concerns offered about having an unreliable water supply in San Diego County, issues related to drought and not having enough supply was the most common response (32%), followed by concerns related to health, diseases, and contaminated water (23%), the cost of water and rate increases (21%), housing/population growth (10%), and climate change (9%).

It is important to note that this 2019 survey by SDCWA builds upon many years of outreach and education efforts on improving reliability. SDCWA consumers have seen first-hand the implementation of the Carlsbad Desalination Plant (CDP) which greatly improved the water security of the San Diego region, and subsequently impacted water bills. Therefore, responses to the 2019 survey may indicate attitudes and WTP for a water supply portfolio that already includes a large focus on reliability and many consumers believe may have been substantially solved by implementation of the CDP.

Attitudes to water supply reliability in the residential sector, WateReuse Research Foundation, 2013[10]

The WateReuse Research Foundation conducted stated preference surveys to estimate household WTP for water supply reliability, as represented by avoided future water use restrictions (e.g. limitations on outdoor watering). The study included participants from Austin, TX; Long Beach, Southern CA; Orlando, FL; San Francisco, northern CA; and one undisclosed location.

They found:

- The estimated WTP to avoid relatively severe (Stage 2) water use restrictions over a 20-year period ranged from $61 (Orlando, FL) to $111 per household per year (San Francisco).
- Residential customers tend to view low level (Stage 1) restrictions as an acceptable inconvenience and generally express a low WTP to avoid such shortages. However, San Francisco was an exception, with a WTP of $12 per household per year to avoid Stage 1 restrictions.
- Ocean desalination was ranked fourth and fifth amongst the ten water supply enhancement options in San Francisco and Long Beach respectively. Adding desalination was consistently preferred over importing

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[10] The Value of Water Supply Reliability in the Residential Sector, WateReuse Research Foundation for US Department of the Interior & Bureau of Reclamation, 2013 [link]

more freshwater from outside the region or transferring water from agriculture. Recycling, conservation and indirect potable reuse options were consistently ranked above desalination.

Older MWD Studies, 1987[11]

In 1987 MWD conducted one of the first stated preference studies related to water supply reliability, using contingent valuation studies. They found the following WTP for different frequency and shortfall amounts for households in northern and southern California:

- WTP to avoid 10-15% shortfall once in 5 years = $188 per household per year
- WTP to avoid 10-15% shortfall twice in 5 years = $347 per household per year
- WTP to avoid 30-35% shortfall once in 5 years = $259 per household per year
- WTP to avoid 30-35% shortfall twice in 5 years = $588 per household per year

California Water Utilities Agency Study, 1993[11]

California Water Utilities Agency conducted a stated preference study to determine household WTP to avoid water shortages of varying magnitude and frequency:

- WTP to avoid 20% shortfall once in 30 years = $200 per household per year
- WTP to avoid 50% shortfall once in 10 years = $354 per household per year

The study was undertaken for 10 water districts in California.

Orange County Groundwater Studies[11]

In 2002, California Recycled Water Task Force conducted a Groundwater Replenishment System Financial Study that estimated the value of drought-proofing (as associated with the Orange County Groundwater Replenishment System) to be $250 to $360/AF based on drought penalties and rate increases to customers.

East Bay Consumer Surplus, 1995[11]

A study using estimated price elasticities for residential customers in the San Francisco area East Bay Municipal Utility District estimated that a 25% reduction in potable water consumption was associated with a reduction in consumer surplus[12] between $72 to $322/AF.

3.4.4 Economic Losses

The District's Water Use Efficiency Report (2019)[13] demonstrated that commercial and institutional water use varies between its individual Retail Agencies, ranging from approximately 5% to 30% of total potable water

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[11] As described in WateReuse Research Foundation (see footnote 10).

[12] Consumer surplus is the difference between a consumer's willingness to pay and the amount they actually pay for a given quantity, or the total benefits minus the total costs of consumption.

[13] West Basin Municipal Water District Water Use Efficiency Data Study Fiscal Year 2018-2019, June 2019 [link]

use. Water use by the industrial sector is significantly more variable, ranging from 0% to 60% of total potable water use, depending on the Retail Agency.

The District has led numerous water efficiency programs to commercial and industrial water users (as well as households) as documented in the 2019 Water Use Efficiency Report. Substantial improvements to efficiency have been obtained, though there are areas to be targeted for further efficiency gains.

In the context of the historic droughts experienced in the last 15 years and the continuing drive for water efficiency programs, many low-risk and high-yield actions to reduce water consumption in times of shortages have already been addressed.

Future water shortages can lead to high magnitude economic losses if commercial and industrial consumers have no option but to restrict operating activities in response to water restrictions.

As detailed in Burdack's 2011 analysis of water shortages and restrictions in Queensland, Australia, "When water usage is already efficient and there are no other ways to improve efficiency of businesses and industry (e.g. with water saving technology) then water restrictions always entail welfare losses and economical damages. The longer and higher restrictions are, the higher the welfare loss and damage. Additional disadvantages occur when businesses, under water restrictions, have economical activities outside the region and competitors in other regions are not restricted in their water consumption. The non-restricted business could underprice the restricted business which could result in a loss for the affected company. Consequently, there would be trade from unconstrained to constrained regions. Therefore, water restrictions also intervene into competitive market processes."[14]

The 2014-16 California drought resulted in very large economic losses to the State's agricultural sector, as that sector bore the majority of legislated restrictions, as well as responding to market forces for the price of water. A study by U.C. Davis researchers projected that the drought cost California's economy $2.7 billion in 2015 alone and will cost more than 18,000 jobs[15].

There is limited data available on economic losses to urban industry and businesses from water restrictions during that drought.

Nevertheless, it is evident that water restrictions resulting in cutbacks in production of urban industrial and commercial water users in the District's service area can quickly result in very large economic disruption and losses, though not currently quantified.

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[14] The Economic Impact of Water Restrictions on Water-Dependent Business in South East Queensland, Australia, D Burdack, University of Pottsdam (2011) [link]

[15] California's Drought Is Part of a Much Bigger Water Crisis. Here's What You Need to Know, Zamora, Lustgarten and Kirchner, ProPublica, June 2015 [link]

4. Water Quality

4.1 Overview

Desalinated water from the OWDP will have a different chemistry from the current supply of imported water and groundwater used by households and businesses in the District's service area.

The composition of treated desalinated water is dependent on:

- Constituents in the feedwater to the plant – seawater contains different constituents compared to groundwater and imported water sources;
- Filtration steps in the desalination process to remove constituents – the filtration steps in desalination performs very well at removing contaminants from final product water; and
- The type and amount of post-treatment chemicals used in the desalination process – because the filtration removes minerals from the seawater, it is necessary utilize chemicals after filtration to balance water quality.

Defining the water quality goals for desalination plants is context-specific and is based on a number of considerations:

- Ensuring safe potable water supply;
- Minimizing impacts to customers by avoiding large fluctuations in aesthetic parameters compared to existing sources in the distribution system;
- Minimizing impacts to the potable water distribution network such as corrosion or scaling of distribution pipes (note that impacts to the distribution network are covered separately in Section 6 of this report); and
- Economic and health impacts of various constituents.

The water quality goal will be outlined in the Treated Water Quality Specification included in the contract for design, construction and operation of the facility. In the context of this CBA, it is important to note that there has not yet been a detailed evaluation to model the filtration and post-treatment steps of the OWDP desalination process and the desalinated water quality goal has not been defined.

Therefore, this analysis has adopted many of the water quality principles adopted for the CDP, due to the similarities in the seawater feed and end users of the OWDP. A case study of water quality impacts from integration of the CDP is included in Section 4.5.2.

We have used broad assumptions suitable for the current level of development of the OWDP. These assumptions can be reviewed and refined as the project proceeds through its development pathway.

Literature sources and industry standards have been reviewed to understand global desalinated water quality impacts and to ensure these are captured in our analysis.

The comprehensive list of water quality impacts identified during the costs and benefits identification process is included in the Impact Longlist Table (Table VI-2, refer Section 2.2.2).

The shortlisted impacts are discussed in the subsections below, organized by their respective subcategories:

- Salt and minerals – Section 4.2
- Emerging contaminants – Section 4.3
- Health impacts – Section 4.4
- Other impacts – Section 4.5

4.2 Salt and Minerals

The shortlisted water quality impacts discussed in this section are:

- Household savings from reduced maintenance of appliances and hot water systems
- Household savings from reduced soap and detergent consumption
- Household savings from reduced use of Point-of-use (POU) treatment systems
- Savings to major industry from reduced pretreatment or other costs e.g. refineries
- Savings to small industry and commercial businesses from reduced pretreatment and maintenance of appliances

4.2.1 Current Composition and Desalinated Water Composition

Salinity, or total dissolved solids (TDS), commonly expressed in milligrams per liter (mg/L), is a measure of mineral salts dissolved in water. Typical constituents include calcium, magnesium, sodium, sulfate, and chloride.

Hardness is a component of TDS. It is a measure of specific dissolved salts, principally calcium and magnesium, which can leave deposits in plumbing systems and appliances. Hardness also inhibits the solubility of soap.

Table VI-4 shows how various levels of TDS and hardness are classified in potable supply in California. The State Water Resources Control Board's Division of Drinking Water (DDW), established a secondary drinking water standard for salinity, commonly expressed as TDS, with a recommended maximum contaminant level (MCL) of 500 mg/L and upper limit MCL of 1,000 mg/L.

Table VI-4 TDS and Hardness targets in California

TDS Range (mg/L)	TDS Range Description[1]	Hardness range (mg/L as $CaCO_3$)	Hardness Range Description[2]
< 500	Recommended max.	0-75	Soft
< 1000	Upper MCL.	75-150	Moderately Hard
<1500	Short term max.	150-300	Hard
		> 300	Very Hard

1. California Secondary Drinking Water Standards, California Code of Regulations, Title 22, Division 4, Chapter 15, Article 16

2. Salinity Management Study, Final Report, Metropolitan Water District of Southern California and US Bureau of Reclamation, 1999. Note that hardness is not a regulated constituent in the water supply and does not have an associated primary or secondary drinking water standard in California.

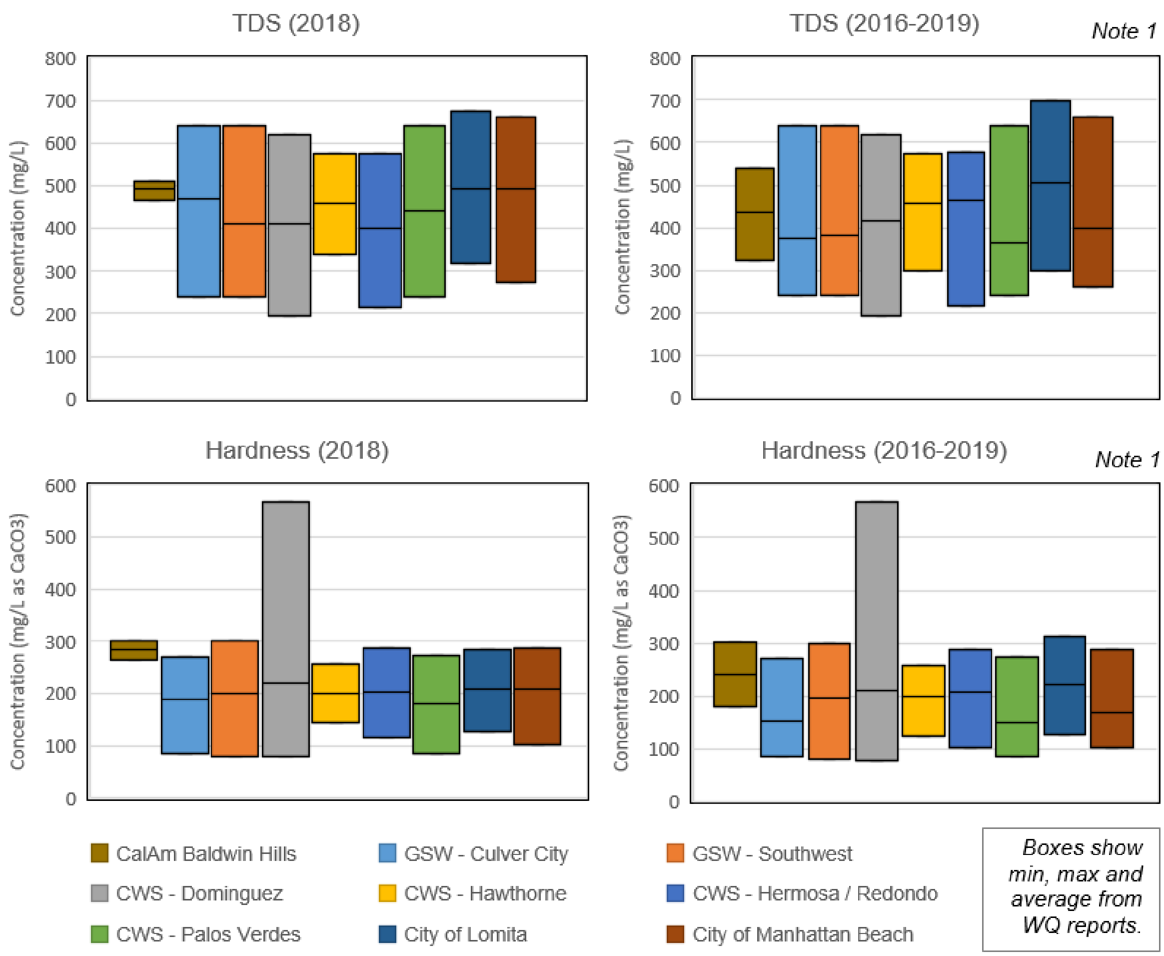
Figure VI-14 below illustrates recent salinity and hardness levels in potable water supplied to customers in the District's service area. Salinity and hardness in the current imported and groundwater supply sources are most sensitive to:

- The proportion of imported water sourced from the CRA relative to the SWP. The CRA has historically had salinity levels three times higher than supply from the SWP.
- The proportion of groundwater in total supply. Groundwater is typically higher in salinity and hardness.
- Hydrologic conditions such as prolonged droughts which can affect the composition of surface water sources drastically and rapidly, and groundwater more slowly.
- Seawater intrusion into aquifers.

Salinity levels in the potable supply within the District's service area have ranged between 200 and 700 mg/L in recent years, and hardness has typically ranged between 100 and 300 mg/L as $CaCO_3$. CWS-Dominguez reported a high maximum recorded hardness of 569 mg/L as CaCO3 in 2018 and this may be an outlier. In 2019 a maximum recorded of hardness of 285 mg/L was recorded.

Table VI-5 below summarizes three water quality scenario cases that were built to assess the impact of introducing desalinated water to the existing potable supply. The scenarios are purely indicative and are aligned to the minimum, average and maximum values from the historical data, as shown in Figure VI-14. Comparison to desalinated water output from the CDP is included in the table.

Desalinated water will provide potable supply of notably lower salt and mineral content than the existing imported and groundwater supply in the District's service area. This is standard for desalination facilities around the world.



Note 1: Data sourced from Annual Water Quality Reports published by each Retail Agency. Data was not available from some agencies for years 2016 and 2017.

Figure VI-14 Range and average of salinity (as total dissolved solids, TDS) and hardness in potable water supply for year 2018 and period 2016-19

Table VI-5 Salt and mineral comparison of existing supply scenarios within the District's Service Area and desalinated water

Scenario	Existing supply within District Service Area		Desalinated water from OWDP*	
	TDS (mg/L)	Hardness (mg/L as $CaCO_3$)	TDS (mg/L)	Hardness (mg/L as $CaCO_3$)
Low salt and mineral content	250	90		
'Typical' salt & mineral content	420	210	194	50
High salt and mineral content	650	320		

** Based on 2015 reported annual average water quality from the Carlsbad Desalination Facility Source: Otay Water District, Consumer Confidence Report, 2015.*

4.2.2 Impacts of Salt and Minerals

There is a sizable body of literature focused on the impacts to various water users from salt and minerals in water supply. Water users are generally classified as households (i.e. residents), major industries (i.e. major water users such as refineries, manufacturing, etc.), minor industry (i.e. commercial-scale businesses such as restaurants, offices, etc., and recreational or agricultural users. Different users face different impacts and varying tolerances for salt and minerals in water supply.

Relevant impacts identified for this analysis are outlined below:

Households and Residents

Salinity and hardness in water supply result in costs to households through:

- Maintenance of household appliances such as clothes washers, dish washers and water heaters, kettles, faucets and water pipes due to scaling. Higher salt and minerals result in higher annualized maintenance cost.
- Use of POU treatment systems within households to mitigate against effects of hardness and salinity. POU systems include household water softeners, under-sink filters and other household filters. Households incur costs to use such POU systems.
- Amount of detergent needed for cleaning and washing. Higher hardness results in higher detergent costs for households and businesses.

These impacts are relevant to the District's service area. Global estimations have been developed to quantify the annualized costs incurred by households from salt and minerals (refer Section 4.2.3 below).

Small Industry and Businesses

Similar to households, small to medium-sized businesses can feel the impacts of salt and hardness in water supply through:

- Maintenance and total usable life of appliances such as dish washers, water heaters, coffee machines, faucets and water pipes due to scaling. Higher salt and minerals result in higher annualized cost.
- Amount of detergent needed for cleaning and washing. Higher hardness results in higher detergent costs.

The type and magnitude of impacts to small industry are far more varied than to households due to the large variety of uses of potable water and differences in the sizes of businesses.

Major Industry

Generally, reducing salt and minerals in water supply is a positive for major industrial uses such as process feed, cooling towers, boiler feed, and other manufacturing needs. Often major industrial water customers will conduct their own pretreatment or incur other costs to meet their specific water quality requirements. Minimizing salt and mineral content is essential for optimal performance of boilers and cooling towers and is typically a large portion of industrial pretreatment costs.

It is noted that many of the largest refineries and manufacturers in the region have already been connected to the District's demineralized recycled water system, as summarized in Table VI-6 below.

This analysis conservatively assumes that such benefits are negligible. The impacts to major industrial customers could be reviewed further in the project development pathway, including detailed engagement with large water users to better understand their water quality requirements and if they currently pretreat potable water onsite.

Table VI-6 Major existing recycled water customers in FY2018

Existing Recycled Water Customer	Annual recycled water usage (AFY)
Andeavor Boiler Feed	3,694
Andeavor Cooling Towers	1,057
Chevron Cooling Towers	3,985
Chevron HP Boiler Feed	2,554
Chevron LP Boiler Feed	1,915
NRG Energy Inc. Boiler Feed	61
NRG Energy Inc.*	32
Torrance Refinery Boiler Feed	2,862
Torrance Refinery Cooling Towers	3,369
Major Industry Subtotal	19,529
Total recycled water sales FY18	*37,062*
Major industry as % of total recycled water sales	*53%*

Source: West Basin Municipal Water District Water Use Report - Fiscal Year 2017-2018.

Recreational & Agriculture

There is limited recreational and agricultural use of potable water in the District's service area and water quality impacts to these users are not considered further in this analysis.

4.2.3 Quantifying Salt and Mineral Benefits from Desalination

Literature References

Several procedures have been proposed by academics and government authorities for estimating the water quality benefits of reduced salt and minerals in potable water supply. GHD reviewed and applied several procedures to the introduction of desalinated water from the OWDP to the existing imported and groundwater supply. The procedures used in this analysis are sourced from:

- Salinity Management Study by MWD and US Bureau of Reclamation[16] *(referred to as 'MWD/USBR Procedure').* In this report it was estimated that a reduction in salinity concentrations of 100 mg/L in imported water supply could yield economic benefits of $146 million per year (escalated to 2019 dollars) within Metropolitan's service area.

[16] Salinity Management Study, Final Report, Metropolitan Water District of Southern California and US Bureau of Reclamation, 1999 (including supporting technical appendices)

- Journal papers by Rygaard, Arvin and Binning published between 2009-11 investigating indirect costs and benefits of adding desalination to existing water supplies in the context of the water supplies in Copenhagen, Denmark and Perth, Australia *(referred to as 'Rygaard Procedure')*[17].
- Investment Framework for Economics of Water Sensitive cities (INFFEWS) Value Tool developed by the Cooperative Research Centre for Water Sensitive Cities (CRC WSC) in Australia. The tool developed its valuation of salinity and mineral impacts based on a wide range of literature studies conducted in Australia from 2004 to 2014 *(referred to as 'INFFEWS Procedure')*[18].

Each procedure relates a change in the average salt and mineral content of water supply to a monetized estimate of the reduced household expenditure (in $/year or $/AF). These procedures are focused on the impact to households, and as such the analysis below does not include cover benefits to small industry, major industry, recreational or agricultural users.

Quantification Approach

Each of the estimation procedures from literature contains different assumptions, inclusions and exclusions. The reader is directed to these sources (as footnoted) for full detail. Table VI-7 below summarizes the impacts covered by each procedure

Clearly the different procedures have varied inclusions and produce thus produce varying estimates of the net benefits to residents from reduced salt and minerals. Nevertheless, the intention of this analysis is to present decision-makers with a representative range of the potential indirect water quality benefits from introducing desalinated water from the OWDP to the existing imported and groundwater supply, using established procedures.

The approach involved:

- Developing cost curves relating $/yr expenditure to water quality parameters (mg/L TDS and mg/L hardness (as $CaCO_3$)), based on estimates from the three procedures described above
- Estimating annual expenditure in the No-Project Alternative. Water quality parameters for the three scenarios shown in Table VI-5 above were used, to derive an average expenditure and low-to-high range.
- Estimating the change in TDS and hardness parameters after blending desalinated water at a 20-80 ratio.

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[17] M. Rygaard, E. Arvin, P.J. Binning, Indirect economic impacts in water supplies augmented with desalinated water, Water Sci. Technol. Water Supply. 10 (2010) 664–671. [link]

M. Rygaard, Desalinated water in urban water supplies - a systems approach to identify optimal drinking water composition, Technical University of Denmark, 2010 [link]

M. Rygaard, E. Arvin, P.J. Binning, The valuation of water quality: Effects of mixing different drinking water qualities, Water Res. 43 (2009) 1207–1218 [link]

M. Rygaard, E. Arvin, A. Bath, P.J. Binning, Designing water supplies: Optimizing drinking water composition for maximum economic benefit, Water Res. 45 (2011) 3712–3722 [link]

[18] Proprietary document for CRCWSC members – further information can be found at [link]

- Calculating the change in annal expenditure from the change in TDS and hardness, using the same cost curves.
- Expressing the value of the change in $/AF of desalinated water.

Results

The calculated net benefits from reduced salt and minerals in the potable supply are shown together in Table VI-7.

Evidently the size of the benefits is sensitive to the literature reference used, highlighting the uncertainty associated with analysis of such indirect benefits. The Rygaard and INFEWWS approaches result in notably larger expected benefits than the MWD/USBR procedure.

Nevertheless, the MWD/USBR procedure still demonstrates that the beneficial impacts to households from lower salt and mineral content in potable supply once desalinated approach have an additional non-market ‘value’ in the order of ~$90/AF from avoided maintenance and other costs.

This benefit may be several multiples higher according to the Rygaard and INFEWWS sources, which rely on more recent data, though different geographical contexts.

Table VI-7 Estimation of net benefits to residents from reduced salt and minerals in potable water supply, from addition of OWDP to existing imported and groundwater supply

Procedure:	MWD/USBR Procedure	Rygaard Procedure	INFEWWS Procedure

Procedure inclusions:	Impacts to residents from:
	• Reduced maintenance and prolonged life
	  o Galvanized water pipe
	  o Water heaters
	  o Faucets
	  o Garbage grinders
	  o Clothes washers
	  o Dishwashers
	• Reduced detergent / soap consumption
	• POU systems
	  o Water softeners
	  o Dispensed water & home filtration systems
		Impacts to residents from:
		• Reduced maintenance and prolonged life
		  o Clothes washers
		  o Water heaters
		• Reduced detergent / soap consumption
			Impacts to residents from:
			• Reduced maintenance and prolonged life
			  o Plumbing fixtures and fittings
			  o Hot water systems
			  o Water filters
			  o Water softeners

Est. benefits from reduced salinity and minerals[1]	**$90 per AF***	**$320 per AF***	**$280 per AF***
Sensitivity – Low existing salt and mineral content[2]	$20 per AF*	$80 per AF*	$70 per AF*
Sensitivity – High existing salt and mineral content[3]	$185 per AF*	$570 per AF*	$570 per AF*

** All expressed as $ per AF of desalinated water produced that is used by residents. All adjusted to 2019 USD. Average annual blend ratios used.*

1. Based on blending of OWDP desalinated water with ''Typical salt and mineral content' as defined in Table VI-5.

2. Based on blending OWDP desalinated water with 'Low salt and mineral content' as defined in Table VI-5

3. Based on blending OWDP desalinated water with 'High salt and mineral content' as defined in Table VI-5

4.3 Health Impacts

The shortlisted water quality impacts discussed in this section are:

- Reduced dental cavities from fluoride and calcium addition
- Health benefits from reduced hardness resulting in reduced rates of atopic eczema in children
- Reduced cardiovascular disease from optimal Magnesium concentrations

4.3.1 Dental Cavities

Addition of fluoride to potable water supply is standard practice around the developed world and is mandated in California by state law for all water suppliers with more than 10,000 service connections. It is known that provision of fluoride has benefits for dental health and reduces the incidence of dental caries and cavities.

MWD imported water is currently fluoridated. Groundwater supplied by the District's Retail Agencies have varying levels of naturally occurring fluoride. The CDP also conducts fluoridation during post-treatment.

In order to ensure that introduction of desalinated water from the OWDP maximizes dental health outcomes for the community, the desalinated water must be fluoridated during post treatment.

It has been identified that fluoridation has not been included to date in the design and cost estimates prepared for the OWDP.

GHD recommends that fluoride dosing to meet the recommended levels by the California State Water Resources Control Board's Division of Drinking should be added to the OWDP reference design in later stages of project development. This includes a target fluoride concentration of 0.7 mg/L and control range 0.6-1.2 mg/L.

The capital and operating costs of the fluoridation system are likely to be insubstantial relative to the overall project and will not impact the results of the CBA.

4.3.2 Atopic Eczema

There is some evidence suggest that water hardness can increase prevalence of atopic eczema, particularly in children. It is thought that increased hardness in water necessitates the use of additional soap during showering and lathering, and the use of soap can result in skin irritation contributing to eczema.

It may be hypothesized therefore that introduction of desalinated water to the potable supply system will contribute to lower incidence of atopic eczema since desalinated water is less hard than the existing supply. However, this is an area of emerging investigation with relatively little established literature. For this it was determined that establishing a direct link and attempting to quantify the value of this benefit is premature. Rygaard (see footnote 17) does provide a possible method for doing so.

4.3.3 Cardiovascular Disease

Of increasing interest is the contribution of magnesium in water supply to cardiovascular health outcomes. There is an increasing acknowledgement and body of literature from Israel (which supplies a large proportion of water through desalination) that low magnesium levels may be negatively impacting societal cardiovascular health[19].

Desalinated water provides very low amounts of magnesium (0.4 mg/L from Carlsbad). In comparison, current supply to customers in California Water Systems – Dominguez system averages 18 mg/L.

Rygaard (see footnote 17) proposes a quantification approach that estimates a very large societal cost from introducing desalinated water output, assuming a relationship of 2% reduction in risk of ischemic heart disease per extra mg magnesium consumed. The value includes hospitalization and medicinal costs of treating such disease.

However, this is a single data point and is not widely accepted yet. The complex nature of magnesium uptake phenomena makes any assessment of impacts uncertain. We note that there are no large-scale desalination facilities in the world that currently dose magnesium during post-treatment, with current practice focusing on calcium addition to reach acceptable hardness and scaling potential limits.

GHD recommends that post-treatment processes that increase the magnesium content of the treated water (to around the current drinking water supply levels (~20 mg/L) but at least > 10 mg/L) should be considered in next stages of project development. Cost implications and a deeper review of the potential benefits from health-related literature should be considered and balanced. This is an evolving area of scientific research and new literature should be identified.

4.4 Emerging Contaminants

The shortlisted water quality impacts discussed in this section are:

- Avoided treatment costs for PFAS removal
- Avoided treatment costs for Personal Care and Pharmaceutical Products (PPCPs) removal

4.4.1 PFAS

Per- and poly-fluoroalkyl substances (PFAS) encompass a diverse group of synthetic, anthropogenic substances that have been used extensively in a wide array of commercial and industrial applications due to their water and lipid resistance. PFAS do not easily break down, but instead persist in the environment and bioaccumulate up the food chain. PFAS have been found to accumulate in groundwater, which has increased concern for human exposure through contaminated potable water supplies. Environmentally persistent chemicals such as PFAS eventually reach the ocean in relatively short time by groundwater seepage and runoff

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[19] A. Tenne, D. Hoffman, E. Levi, Quantifying the actual benefits of large-scale seawater desalination in Israel, Desalin. Water Treat. 51 (2013) 26–37 [link]

R. Calderon, P. Hunter, Epidemiological Studies and the Association of Cardiovascular Disease Risks With Water Hardness, in: Calcium Magnes. Drink. Water Public Heal. Significance., WHO, Geneva, 2009: pp. 108–142.

A. Rosanoff, The high heart health value of drinking-water magnesium, Med. Hypotheses. 81 (2013) 1063–1065 [link]

R. Rylander, H. Bonevik, E. Rubenowitz, Magnesium and calcium in drinking water and cardiovascular mortality, Scand. J. Work. Environ. Heal. 17 (1991) 91–94 [link] through riverine systems. There is increasing concern that even very low doses of PFAS chemicals in drinking water may be linked to an increased risk of cancer, reproductive and immune system harm, liver or thyroid disease and other health problems.

Regulatory approaches to PFAS are evolving rapidly in the US and worldwide. California has put into place a response level of 10 parts per trillion (ppt) for perfluorooctanoic acid (PFOA) and 40 ppt for perfluorooctane sulfonate (PFOS), PFOA and PFOS are a subset of substances under the PFAS umbrella). Further, California has released notification levels for PFOA and PFOS at 5.1 ppt and 6.5 ppt, respectively[20].

It is known that the RO process included in seawater desalination is extremely effective at blocking passage of PFAS molecules into the final desalinated water stream – typical PFAS rejection by RO membranes has been established at greater than 99%[21].

Furthermore, ambient PFAS concentration in the ocean appear to be relatively low compared to groundwater levels. Most research to-date on PFAS accumulation in the ocean has focused on uptake in plankton and bioaccumulation in seafood. Ambient concentrations of PFAS in seawater along California's coast have not been reported on. In 2014a study found that total PFAS concentrations in the Pacific Ocean ranged from 0.3 to 2.5 ppt[22].

Construction of the OWDP may result in future savings to local and regional water suppliers, as the OWDP will likely offer a PFAS-free potable supply stream, and therefore reduce the associated (high) capital and operating costs to upgrade other water supply sources for PFAS removal.

Current guidance from MWD is that the two types of PFAS of greatest concern in the U.S. – PFOA and PFOS – have not been detected in MWD's imported or treated water supplies. MWD has recently detected in its supplies low levels of perfluorohexanoic acid (PFHxA), which is not acutely toxic or carcinogenic and is not currently regulated in California or at the federal level.

4.4.2 PPCPs

Pharmaceuticals and personal care products (PPCPs) are an emerging contaminant of concern. PPCPs are known to be present in surface water and drinking water around the world including the US at concentrations between ppt to parts per billion[23] because traditional wastewater treatment methods do not significantly remove PPCPs.

In 2007, MWD implemented a short-term monitoring program to determine the occurrence of PPCPs and other organic wastewater contaminants in MWD's treatment plant effluents and selected source water locations within

[20] https://www.waterboards.ca.gov/press_room/press_releases/2020/pr02062020_pfoa_pfos_response_levels.pdf

[21] Tang et al., Env. Sci. & Tech. 41, 6 (2007) [link]

[22] González-Gaya, Belén, et al. "Perfluoroalkylated Substances in the Global Tropical and Subtropical Surface Oceans." Environmental Science Technology, vol. 48, no. 22, 2014, pp. 13076–13084 [link]

[23] Y. Yang, Y.S. Ok, K.H. Kim, E.E. Kwon, Y.F. Tsang, Occurrences and removal of pharmaceuticals and personal care products (PPCPs) in drinking water and water/sewage treatment plants: A review, Sci. Total Environ. 596-597 (2017) 303–320 [link]

the Colorado River and SWP watersheds. Some PPCPs have been detected at very low ng/L levels. Currently, PPCP monitoring is conducted on an annual basis for MWD's source waters and treatment plants.

The impacts of PPCPs on human and ecological outcomes is still being studied. Currently, there is no evidence of human health risks from long-term exposure to the low concentrations (low ng/L; ppt) of PPCPs found in some drinking water. Furthermore, there are no regulatory requirements for removal PPCPs in drinking water, though some monitoring requirements are in place. USEPA included 13 PPCPs on the CCL3; however, currently there are no standardized analytical methods for these compounds.

Some attempts have been made to quantify the cost-benefit analysis of the removal of PPCPs from water streams[24], but given the health impacts have not been fully quantified yet and not all PPCPs have been studied, a clear quantitative evaluation is difficult. However, RO treatment is known to be one of the best available technologies for removal of PPCPs with it reported to remove 82% of neutral contaminants, 99% of ionic contaminants, and greater than 85% of most pharmaceuticals[25]. Furthermore, the presence of PPCPs in seawater is expected to be significantly lower than that of surface water due to dilution. Thus, desalinated water produced by seawater RO will have the lowest possible concentration of PPCPs.

Implementation of the OWDP will therefore provide the District and the region with a safe supply of potable water, and may reduce the extent of future investments needed in additional treatment to remove PPCPs, if there is a future change in future understanding of their impact, and associated regulations.

4.4.3 General comment on emerging contaminants

MWD specifically identified arsenic, disinfection byproducts, uranium, chromium-6, perchlorate, NDMA and nutrients (as well as PPCPs)[26] as its major regional concerns for water quality in their 2015 UWMP. RO treatment is very effective at removing all of these contaminants and the OWDP would offer an advanced treated supply of water due to the high level of treatment involved.

4.5 Other Potential Impacts

The shortlisted water quality impacts discussed in this section are:

- Impacts from boron in potable water supply on agriculture users
- Impacts from seawater algal blooms

[24] M. Molinos-Senante, R. Reif, M. Garrido-Baserba, F. Hernández-Sancho, F. Omil, M. Poch, R. Sala-Garrido, Economic valuation of environmental benefits of removing pharmaceutical and personal care products from WWTP effluents by ozonation, Sci. Total Environ. 461-462 (2013) 409–415 [link]

[25] Radjenović, J., M. Petrović, F. Ventura, and D. Barceló. 2008. "Rejection of Pharmaceuticals in Nanofiltration and Reverse Osmosis Membrane Drinking Water Treatment." Water Research 42 (14): 3601–3610 [link]

[26] These other contaminants were identified during the longlisting process but were screened out during shortlisting and did not receive detailed individual discussion in this report (refer Table VI-2).

4.5.1 Boron

Seawater contains boron at higher concentrations than typical surface and groundwater sources. Boron is one a few constituents that is not as simply removed through a conventional RO treatment process.

Elevated boron levels in the drinking water supply can pose agricultural and residential horticultural impacts as accumulation of boron from irrigation using water with a high concentration of boron can cause yellowing ('chlorosis') and leaf death. This was a key concern for the CDP as well as the proposed Huntingdon Beach Seawater Desalination plant which would supply potable water to nurseries and agricultural users (e.g. strawberry farmers) in its service area[27].

Human health considerations also exist for high levels of boron in drinking water, and the state of California maintains a health-based Notification Level of 1 mg/L for boron. The CDP included a treated water equality specification of average boron levels < 0.75 mg/L.

In 2014 the District completed an Ocean Water Desalination Water Quality (Integration Study[28]) for the OWDP, which assessed the feasibility of removing boron to a target level of < 0.5 mg/L in desalinated water. The report demonstrated that the boron target can be achieved by using a two-pass RO process: RO permeate from the lead elements in the first pass was blended with RO permeate from the second pass. The pH of the feed to the second pass is increased to provide more boron rejection.

A similar approach with careful process design was adopted for the CDP and resulted in desalinated water boron concentrations meeting the treated water quality specification.

The reference design to date for the OWDP includes provision of a second-pass RO system and can be carefully designed to ensure adequate boron removal through the desalination treatment process. Therefore, the risk of elevated boron can be adequately mitigated and is not expected to have any societal costs.

4.5.2 Algal Toxins and Red Tide

Harmful algal blooms (HAB's) often referred to as 'red tides' are a concern for desalination plants due to elevated biomass and toxic substances produced by some of these phytoplankton. In Southern California these include noxious substances and neurotoxins such as domoic acid, saxitoxins, okadaic acid and yessotoxin among others, which present human health impacts if not effectively and completely removed during treatment.

The District directly investigated HAB toxins in seawater during its bench studies, pilot studies in El Segundo and full-scale studies at Redondo Beach. These toxins were occasionally found present in ocean waters. The pilot studies demonstrated that these toxins were very effectively removed by RO treatment – some studies showing complete rejection.[29]

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[27] Trussell Technologies Technical Memorandum on Boron Mitigation for Seawater Desalination (Boron Removal Modeling), November 26, 2019 [link]

[28] Ocean Water Desalination Water Quality Integration Study, Final Report, Updated June 30, 2014, Hazen and Sawyer [link]

[29] Technical Memorandum Review of Proposed Water Quality Requirements for the Huntington Beach Desalter Prepared for Orange County Water District (OCWD), Trussell Technologies Inc., 2016.

Careful operation of the treatment process is required during severe red tide events. Californian severe red tide events (i.e. those which result in significant additional operational costs or even plant shutdown leading to lost revenue) are being seen in the range of once per three to five years at Carlsbad.

Early HAB detection is critical so that operational adjustments can be made and impacts to production minimized. The OWDP plant operator can adequately manage this risk through operational management, without compromising human health outcomes.

4.6 Case-Study: Carlsbad Desalination Plant (CDP)

The CDP in San Diego is a useful comparator for water quality cost-benefit tradeoffs given the similarities between the District's proposed OWDP and CDP. Located 100 miles away from the proposed OWDP site, the 50 MGD capacity CDP provides desalinated water to the SDCWA with the CDP desalinated water blended with imported treated water from MWD prior to distribution. The CDP desalinated water 7-10% of the overall annual treated water for SDCWA.

In 2018 a detailed study[30] was conducted of the water quality impacts of integrating CDP desalinated water with imported MWD water. In summary, the key findings were:

- *Positive impacts:* CDP water had lower levels of TDS (~20% lower), sodium, chloride, calcium, magnesium, alkalinity and hardness than imported MWD water. The lower TDS was received well by customers, and the lower calcium, magnesium and hardness led to reduced scale formations in pipes and appliances. The lower sodium levels in the water were also beneficial to farmers.
- *Limited to no impact:* CDP water blending had limited to no impact on nitrate levels, disinfection residual, disinfection byproducts.
- *Negative impact:* CDP water had higher Boron concentrations with seasonal temperature fluctuations (15-25°C) leading to fluctuations in membrane performance and hence water quality output, especially for Boron (varied by 2x) over the year. High boron adversely affects plants and agricultural output. Treated imported water had a boron concentration of 0.11-0.16 mg/L. In contrast, CDP water had Boron levels of 0.4 mg/L in the winter and 0.8 mg/L in the summer. Low levels of calcium and magnesium in desalinated seawater also lead to marginally higher fertilizer costs for farmers as well[31], a phenomenon noticed in Israel.

[30] B. Alspach, G. Imamura, Carlsbad Desalinated Seawater Integration Study, 2018

[31] U. Yermiyahu, A. Tal, A. Ben-Gal, A. Bar-Tal, Rethinking Desalinated Water Quality and Agriculture, Science (80-.). 318 (2007) 920–921

5. Economic Stimulus

The shortlisted economic stimulus impacts discussed in this section are:

- Economic stimulus (regional output) from construction phase
- Economic stimulus (regional output) from operations phase
- Economic stimulus (employment) from construction phase
- Economic stimulus (employment) from operations phase

5.1 Overview

As a major infrastructure project, the OWDP will affect its surrounding economy through three routes, defined in the economic literature as:

- **Direct impacts** – expenditure and employment involved in delivering the project (e.g. capital expenditure (CAPEX), operations expenditure (OPEX), employment of construction workers etc.).
- **Indirect impacts** – changes in sales, income or jobs in sectors that supply goods and services to the project (e.g. impacts on suppliers of maintenance equipment that will be used during the project operation).
- **Induced impacts** – increased economic activity within the region from household spending of the additional income generated by the project (e.g. the maintenance supplier now has more disposable income to spend on entertainment, groceries; similar reasoning for construction workers during the construction phase).

Direct impacts are known as primary effects. Indirect and induced impacts are known as secondary effects or ‘flow on impacts’.

Economic impact analysis is used to quantify the primary and secondary effects (collectively ‘economic stimulus’).

GHD conducted an economic impact analysis using the input-output (IO) economic multiplier methodology, based on IMPLAN data, to estimate economic stimulus that would result from the construction and operations of the OWDP.

5.2 Methodology

5.2.1 Input-Output Analysis and Economic Multipliers

IO analysis is a technique for representing an economy through the spending patterns between types of businesses as well as between businesses and consumers. The analysis captures all market transactions for consumption in a given period. The resulting mathematical representation allows analysis of the effect of a change in expenditure in one or more economic activities, on an entire economy, with all other factors held constant. IO analysis of an economy allows the derivation of economic multipliers, which are used to estimate secondary effects as a ratio to each additional dollar spent in another area of the economy.

IMPLAN is an IO model originally developed by the U.S. Forest Service that is now widely used for economic impact analysis throughout the United States. IMPLAN are widely used by industry and the public sector as a source of economic data for impact modelling in the USA. IMPLAN multipliers reflect a large set of data sources including: US Census, Bureau of Labor Statistics, County Business Patterns, Bureau of Economic Analysis and others.

The 2018 IMPLAN data model was used for the analysis, which was the latest data set available at the time.

5.2.2 Areas of Analysis

Economic impact analysis was performed for two regions:

- Primary Area = Los Angeles County
- Secondary Area = State of California

5.2.3 Stimulus Indicators

Two parameters were estimated during the economic impact analysis to characterize the level of economic stimulus:

- Change in output - Output represents the value of industry production, measured in 2019 USD.
- Employment – full-time/part-time annual average number of jobs. Note that this is the employment value reported by IMPLAN and is not strictly equivalent to Full-time Equivalents (FTE) as it does not account for the number of hours worked each day.

GHD did not estimate the expected fiscal impacts for county and state governments through increases in payroll taxes, property taxes, and sales taxes, though these are likely to be significant.

Economic stimulus impacts were analyzed separately for the construction-phase and operations-phase of the OWDP project.

Economic impacts are estimated relative to the No-Project alternative in which the OWDP is not built. Therefore, the economic impact results represent the incremental level of economic activity stimulated by the OWDP over and above the No-Project alternative.

5.3 Assumptions and Inputs – Construction Phase

To generate accurate results from the economic impact analysis, it is necessary to identify the portion of project expenditures that are directed to materials, equipment and consumables produced *within* the region of analysis.

For example, spending on construction materials sourced from outside of California, or imported from abroad, would not lead to the same indirect and induced impacts in California compared to materials sourced from within the State. Spending on such items is termed ‘leakage’ and should be excluded from the analysis.

Note that by definition in IMPLAN, labor and employment is based on where the job is located, not where an individual resides. Therefore, all expenditure on labor is included within the region of analysis.

The OWDP has not been developed to a stage where the origin of materials, equipment and consumables are fully known. For this analysis GHD’s Project Team conducted a workshop process for each capital and operating expenditure item, to classify them as:

For impacts to Los Angeles County:

- Fully-sourced from within County
- Partially-sourced from within County
- No sourcing from within County

For impacts to California:

- Fully-sourced from within CA
- Partially-sourced from within CA
- No sourcing from within CA

The cost of land acquisition was also removed from the capital cost, because within IMPLAN, land sales are considered to be asset transfers.

The resulting direct CAPEX assumptions, accounting for leakages, used in the economic impact analysis are shown in Table VI-8.

Table VI-8 Breakdown of capital expenditure by project design and region of analysis

	For LA County Impacts		For CA Impacts	
($ millions)	Current Project Design	Subsurface Intake Design	Current Project Design	Subsurface Intake Design
Total CAPEX estimate excl. land cost	$503	$731	$503	$731
CAPEX on labor*	**$126**	**$183**	**$126**	**$183**
CAPEX on materials and equipment	$378	$549	$378	$549
CAPEX on materials and equipment from within region of analysis	**$80**	**$133**	**$278**	**$450**
Leakage of expenditure on materials and equipment as %	*79%*	*76%*	*26%*	*18%*

** Assumed to be 25% of total CAPEX, based on similar projects in California*
All capital expenditures are totals over the three-year construction period. It is assumed that the expenditure is equally split across all three years. All values as 2019 USD.

All construction expenditure on materials, equipment and consumables within the region of analysis was classified as IMPLAN Industry 56 (Construction of other new nonresidential structures). All construction labor expenditure was classed as proprietor income.

5.4 Assumptions and Inputs – Operations Phase

To estimate the leakages from the local economy for OPEX items, default values from IMPLAN's Social Accounting Matrix were used. This accounts for the proportion of local demand for a given commodity that is met by local production. The relevant Social Accounting Matrices for LA County and California are contained in the IMPLAN model.

The table below summarizes the expenditures used to estimate economic impacts during operation of the OWDP, and the associated commodity types for each expenditure.

Table VI-9 Breakdown of operating expenditure by project design and commodity type

OPEX Item	Expenditure ($ mil per yr, 2019 USD)		Commodity Type (IMPLAN)
	Current Project Design	Subsurface Intake Design	
Annual Cost of Power	$8.75	$8.88	Electricity
Sludge Disposal	$0.21	$0.21	Waste management and remediation services
Chemicals	$0.75	$0.75	Other basic inorganic chemicals
Maintenance	$1.10	$1.10	Maintained and repaired nonresidential structures
Membrane & Cartridge Replacement	$0.80	$0.80	Maintained and repaired nonresidential structures
Other/ Misc.	$0.42	$0.42	Maintained and repaired nonresidential structures
NPDES Required Monitoring	$0.10	$0.10	Environmental and other technical consulting services
State Lands Lease	$0.20	$0.50	Environmental and other technical consulting services
Rehabilitation & Replacement	$4.30	$4.30	Maintained and repaired nonresidential structures
GHG Mitigation	$0.18	$0.18	Electricity
Biological Mitigation	$0.72	$0.74	Environmental and other technical consulting services

In addition to the commodity expenditures above, the EIR estimated that the OWDP would employ an anticipated 20 full-time personnel, with the facility being fully staffed 8 hours per day, 5 days per week, and partially staffed at other times. A direct employment assumption of 20 persons was used in the modelling.

5.5 Economic Impact Analysis Results

5.5.1 Construction Phase Impacts

Table VI-10 below summarizes the expected economic stimulus to LA County and California from construction of the OWDP.

With around $500 to $750 million of upfront investment (for the Current Project Design or the Subsurface Intake Design respectively), the three-year construction-period of the OWDP is likely to have a significant short-term stimulatory impact on the surrounding economy of LA County, as well as more broadly to California as a whole. This economic impact analysis using IMPLAN estimates that:

- The construction phase of the project will result in $249 to $395 million of additional output over three years within LA County (where the range depends on the project design evaluated). This includes $169 to $262 million of indirect and induced impacts from increased spending by local supporting businesses as well as increased household expenditure. This means local businesses and households will be positively affected due to the economic transactions and increased income associated with constructing the OWDP.

- It is estimated construction phase of the project will directly result in 291 to 484 jobs on average each year within LA County, as well as an additional 322 to 497 jobs from indirect and induced economic flow-on spending.
- These estimates may be conservative given that the economic impact assessment assumed a high proportion (~75 to 80%) of construction spending on the project will 'leak' from the local economy due to purchases made outside of LA County – that is, local economic stimulus could be even larger should the project proponent actively target the use of local suppliers.
- Construction of the OWDP will result in even larger changes to output and employment for the state of California as a whole.

Table VI-10 Economic Impact Analysis Results for OWDP - Construction Phase

	Output ($ millions, 2019 USD)[1]		Employment[2]	
	Primary effects	Secondary effects	Primary effects	Secondary effects
Current Project Design				
Within LA County	$80	$169	291	322
Within California	$278	$489	982	845
Subsurface Intake Design				
Within LA County	$133	$262	484	497
Within California	$450	$774	1593	1336

1. Economic output impacts are totals over the three years of construction.
2. Employment impacts are annual average number of jobs over each of the three years of construction.

5.5.2 Operations Phase Impacts

Table VI-11 below summarizes the expected economic stimulus to LA County and California from construction of the OWDP.

Ongoing operation of the facility over its 30-year operating life will stimulate the surrounding economy resulting in an estimated:

- ~ $28 million of total additional economic output within LA County including around $11 million in indirect and induced economic activity.
- A significant source of employment, directly supporting an estimated 61 to 64 jobs, including the 20 full time positions needed for staffing the facility. It is estimated an additional 53 to 64 jobs will be stimulated through indirect and induced economic activity within the County.
- Operation of the OWDP will result in even larger changes to output and employment for the state of California as a whole.

Table VI-11 Economic Impact Analysis Results for OWDP - Operations Phase

	Output ($ millions, 2019 USD)[1]		Employment[2]	
	Primary effects	Secondary effects	Primary effects	Secondary effects
Current Project Design				
Within LA County	$17.1	$10.9	61	53
Within California	$20.9	$17.2	69	81
Subsurface Intake Design				
Within LA County	$17.6	$11.2	64	65
Within California	$21.4	$17.6	72	84

1. Economic output impacts are annual output in each year of operation.
2. Employment impacts are annual average number of jobs over each year of operation.

6. Organizational Impacts

The shortlisted organizational impacts discussed in this section are:

- Additional management and support staffing leading to overhead costs
- Increased pipe corrosion in distribution system

6.1 Management and Overhead Staffing

Implementation of the OWDP will result in some organizational impacts to the District. In particular, the District will need to add additional management and supervision roles internally to effectively oversee the design, construction and long term, operation and maintenance of the OWDP.

The cost burden of additional management and overhead support roles during plant operation is not factored into the financial analysis for the OWDP. The financial analysis includes an operating expenditure allowance for onsite operational staff (as discussed in Section 5, around 20 FTE), but not additional management and overhead.

The extent of the additional management and overhead will depend on the project delivery model selected: the more responsibilities and risk that is transferred to the private sector, the fewer internal roles will be required at the District. The PPP delivery model will involve less additional management overhead than say the DBOM delivery model. (This is not to say that the level of oversight of the project is diminished through a particular model – rather it is whether the role and function sits within the District vs. being completed by the private-sector project partners).

At the minimum, in a PPP delivery model, the District will need to perform contract management functions in which it:

- Regularly reviews the performance of the private-sector project partners against performance criteria stipulated in the final OWDP operations contract (e.g. water quantities delivered, water quality, timeliness of reporting, safety record, etc.).
- Manages the amount of water ordered by the District from the OWDP.
- Oversees the payment of water availability and water usage fees to the private-sector project partners including any abatements of payments if performance criteria is not met.
- Negotiates with the private-sector project partners on unexpected costs or plant improvements for which the risk and/or cost is nor clearly delineated.
- Manages any residual risks which reside with the District.
- Manages or assists in easement access requests from developers and government agencies for OWDP easements.
- Conducts audits of the private-sector project partners.
- Liaises with the community and other stakeholders regarding ongoing operations.
- Manages and operates any assets for which it is the contractually-designated operator (e.g. there is an option for the District to take on operations of the treated water conveyance pipeline and pump station).

A case study for the roles and level of effort needed for such a contract management function is provided by the CDP. In that case, SDCWA fulfills the roles described above in house. Additionally, SDCWA owns, operates and maintains the desalinated water conveyance pipeline and has integrated that facility into its overall Operations and Maintenance (O&M) function. At SDCWA:

- 2 senior level engineers on a partial FTE basis oversee compliance with the Water Purchase Agreement by Poseidon and processing of monthly invoices. They also act as liaison with Poseidon on issues that touch upon the WPA.
- Partial FTE support from Operations & Maintenance staff interact with IDE, the contract operator at the CDP and Poseidon to coordinate orders and water deliveries on a daily basis or to address any operational or permit compliance issues that arise.
- Legal support from the General Counsel and outside specialized counsel assist in interpreting and amending the WPA as needed.
- Accounting support is required to process monthly invoices and prepare payment. Additionally, an outside financial consultant assists in addressing financial issues, added costs and capital modifications consistent with the WPA.

These costs are estimated to be in the order of $500,000 annually.

In a delivery model in which the District takes on additional responsibility and risk, the level of management overhead will be larger. The District's recycled water plant relies upon a contract operator and the District is familiar with the need for supplemental dedicated FTEs to support that contract. The District currently has around 50 full-time staff, of which approximately 20 are involved in day-to-day operation, upkeep and contract management of the District's recycled water portfolio.

The role of the District in a DBOM is to provide management oversight of the plant operation and to maintain the conveyance system itself or through another contract operations procurement. Because the District will continue to operate its non-potable recycled water facilities the question becomes whether any of these additional tasks can be absorbed by existing District staff that are qualified to conduct management oversight or integrated into existing administrative processes without additional staffing.

Because the OWDP will deliver potable water, which under California regulations requires a different and more stringent set of certifications reporting requirements, frequency, etc. compared to the District's existing recycled water portfolio. It is unlikely that existing district staff maintaining the non-potable distribution system has the proper certifications or can absorb the additional work associated with the potable conveyance pipelines. This results in a decision by the District as to the method it prefers to operate and maintain the pipelines that will distribute OWDP water to end users. It is beyond the scope of this report to determine the resource requirements for management and oversight of the District's recycled water system and the potential to integrate any of the OWDP management or maintenance responsibilities into the workload of existing staff. In discussions with District staff it appears very unlikely that the bulk of the new functions needed for the OWDP will be within latent workload capacity of existing staff – therefore it should be assumed by the District that new staff will be required.

Therefore, some additional roles that may need to be performed if a DBOM approach is utilized could be:

- Assignment of 1-2 FTE's to manage the operations contract and provide engineering support for potential capital modifications or to assist the contract operator in addressing treatment plant upsets.
- Partial to one full FTE to maintain the pipeline and liaise with plant contract operator.

- Integration into Finance department tasks related to liaising with grantors and debtors for repayment of municipal finance and the addition of that debt to its overall debt portfolio and maintaining debt service coverage requirements in its rate setting and reserve policies.
- Permit compliance activities will be overseen by the District and will require dedicated FTEs because in a DBOM structure the District is likely holder of all project related permits. The extent of involvement will depend on the project structure established.
- Partial FTE support from administrative functions to assist in purchasing and procurement for plant operations and fulfillment of District requirements for Small, Minority and Disadvantaged Business Enterprise participation.
- Accounting support for monthly invoicing and supply procurement.
- Additional Human Resources support to serve expansion of District staff.

For the purpose planning for and implementing the OWDP delivery steps, GHD suggests that decision-makers account for an additional management overhead of 5 to 10 FTE District personnel, depending on the final delivery model chosen.

6.2 Distribution System

The addition of a new OWDP potable water supply to the existing distribution systems operated by MWD and the District's Retail Agencies can have both positive and negative impacts on existing distribution assets.

While a more detailed investigation of how the OWDP will connect in to the existing potable water network will be required as the project progresses, the OWDP EIR outlines the current understanding – that desalinated water will be connected to one of the MWD feeder lines distribution system that delivers potable water to local area and regional supply feeders owned by MWD. The closest regional potable water feeder systems are MWD's West Basin Feeder and the West Coast Feeder. Both of these regional feeders are fed by the MWD Sepulveda Feeder.

To ensure that the final desalinated water from the OWDP is compatible with the existing MWD system, and the downstream Retail Agency distribution networks, desalinated ocean water is stabilized through post-treatment, to reintroduce minerals (calcium and alkalinity) before entering distribution systems. In recognition of the significance of post-treatment stabilization, the District partnered with MWD to prepare the 2014 Integration Study.

The Integration Study's objective was to analyze potential impacts of introducing low TDS desalinated ocean water into drinking water distribution systems that had previously been exposed to MWD water and/or groundwater sources. In addition, the Integration Study analyzed disinfectant residual stability and disinfection by-product formation at both pilot-scale and bench-scale.

The Integration Study found that adding stabilized desalinated product water into a range of representative potable water distribution system materials did not negatively impact water quality, cause corrosion, or result in a significant loss of disinfectant residuals. This study demonstrated that stabilized desalinated water can be successfully integrated into the existing MWD potable water distribution system without any adverse effects.

Nevertheless, careful design and management of the post treatment process is needed to fully mitigate against adverse impacts to the distribution network, and should be regarded closely by decision-makers moving forward with the OWDP.

Close consultation with MWD is needed since there will be a contractual agreement with MWD which include water quality parameters, for feeding the potable supply to MWD's existing supply network. Post-treatment will be a performance requirement of the Plant contract operator since the District will be liable to MWD for any water quality violations and has to pass the risk to the contractor. How the distribution pipes are maintained and who maintains them also will also be considered.

7. Environmental & Amenity

The shortlisted environmental and amenity impacts discussed in this section are:

- Fugitive dust emissions during construction
- Noise emissions during construction

7.1 Existing Work and Purpose of this Review

The District has completed its preparation of an EIR pursuant to the California Environmental Quality Act (CEQA) Guidelines to evaluate the potential environmental impacts associated with implementing the OWDP. The EIR assumed the Current Project Design. In summary, the process completed to date has been:

- Notice of Preparation (NOP) of an EIR was prepared and circulated for review to applicable local, state, and federal agencies and the public. The NOP was distributed on August 31, 2015, with a 45-day public review period concluding on October 15, 2015.
  - A public scoping meeting was held on September 30, 2015 at the Edward C. Little Water Recycling Facility.
  - Three additional outreach meetings were held: one for the environmental community on September 29, 2015; one for neighboring El Porto community residents within 300 feet of the proposed ocean water desalination facility site on September 29, 2015; and one for agencies and interested parties on September 30, 2015.
- The Notice of Availability (NOA) of the Draft EIR was posted on March 27, 2018, with the Los Angeles County Clerk-Recorder and filed with the Office of Planning and Research. Copies of the EIR for government agencies and interested parties were made available through several routes.
- The public review period was extended by the District, from the initial 60 days to a total public review period of 91 days, beyond the legal obligation of 45 days under CEQA requirements. The public comment period concluded on June 25, 2018.
  - During the Draft EIR public review period, the District held two public meetings, on April 25, 2018, and May 12, 2018, to provide Project information and receive public comments on the Draft EIR.
- The Final EIR was released on October 23, 2019 allowing a 25-day public review period.
- A public Special Board of Directors Meeting was held on November 18, 2019.
  - During the meeting, the Board of Directors certified the Final EIR and approved the North Site Project subject to conditions, authorizing staff to continue evaluating the conditions, adopting Findings of Fact, a State of Overriding Considerations and a Mitigation Monitoring and Reporting Program (MMRP). The conditions to be met are:
  - Securing the relevant permits from responsible and trustee agencies;
  - Development of cost estimates consistent with current Engineering News-Record construction cost indices;
  - Development and approval of a financial evaluation and plan;
  - Completion of a cost and benefit analysis of implementing the Project as a drinking water supply in the District's service area; and

– Development and approval of design and project delivery documents.

- The Notice of Determination (NOD) pursuant to Section 15094 of the CEQA Guidelines with the Office of Planning and Research and the Los Angeles County Clerk was filed on November 21, 2019.

Current District efforts are focused on evaluating those conditions. The EIR analyzed the Project's short- and long-term effects, direct and indirect impacts, and cumulative impacts associated with other past, present, and reasonably foreseeable future projects. The EIR's focus is on the changes in the environment that would result from project development. Where potentially significant impacts were identified, the EIR specified mitigation measures that are required to be adopted as part of Project approval to avoid or minimize the significance of impacts resulting from the Project. In addition, the EIR is the primary reference document in the formulation and implementation of the Project's Mitigation Monitoring and Reporting Program.

Given the extensive work completed to date in the EIR process, the intent of this environmental and amenity review section is to highlight and reiterate the impacts for which the level of significance is expected to be 'significant'. The reader is directed to the EIR for discussion of all environmental and amenity impacts from the OWDP, including the mitigation measures that will be incorporated into the project delivery to reduce the significance of impact to 'insignificant', or none.

7.2 Air

7.2.1 Construction-related Air Emissions

The EIR identifies that Fugitive Emissions during Construction (Impact AQ 5.2-2 & 5.2-3; Air Quality Standards) will have 'Significant and Unavoidable Impact'.

This appears to be due to emissions of NOx exceeding South Coast Air Quality Management District (SCAQMD) Construction thresholds as identified by CalEEMod modeling. In fact, Mitigation Measure AQ-1 specifically addresses fugitive dust emissions and maintaining compliance with SCAQMD Rules 403 by implementing dust suppression techniques required under Rule 402.

- SCAQMD Rule 402 – Nuisance: This rule states that a person shall not discharge from any source whatsoever such quantities of air contaminants or other material which cause injury, detriment, nuisance, or annoyance to any considerable number of persons or to the public, or which endanger the comfort, repose, health or safety of any such persons or the public, or which cause, or have a natural tendency to cause, injury or damage to business or property.

- SCAQMD Rule 403 – Fugitive Dust: This rule requires projects to prevent, reduce or mitigate fugitive dust emissions from a site. Rule 403 restricts visible fugitive dust to the project property line, restricts the net PM10 emissions to less than 50 micrograms per cubic meter (µg/m3) and restricts the tracking out of bulk materials onto public roads. Additionally, projects must utilize one or more of the best available control measures (identified in the tables within the rule). Mitigation measures may include adding freeboard to haul vehicles, covering loose material on haul vehicles, watering, using chemical stabilizers and/or ceasing all activities. Finally, a contingency plan may be required if so determined by the USEPA.

Daily regional emissions during construction were forecasted by assuming conservative construction activities (i.e., assuming all construction occurs at the earliest feasible date) and applying the mobile source and fugitive dust emissions factors. The emissions were estimated using the CalEEMod (Version 2016.3.2) software, an emissions inventory software program recommended by the SCAQMD for all land-based emissions. CalEEMod is based on outputs from OFFROAD and EMFAC, which are emissions estimation models developed by California

Air Resources Board (CARB) and used to calculate emissions from construction activities, including on-and off-road vehicles. Default CalEEMod inputs were used for the modeling where Project specific details were not available. These values were then applied to the construction phasing assumptions used in the criteria pollutant analysis to generate criteria pollutant emissions values for each construction activity.

Marine based emissions estimates were calculated outside of CalEEMod and were based on USEPA emissions factors for marine vessels. Detailed construction equipment lists, construction scheduling, and emissions calculations were provided in Appendix 3 of the EIR as well as Section 11, Refinements to the Project Description of the EIR.

Construction phases are anticipated to overlap to some degree as detailed in Appendix 3 of the EIR. Emissions from these activities are estimated by construction phase. The maximum daily emissions are predicted values for the worst-case day and do not necessarily represent the emissions that would occur for every day of Project construction. The maximum daily emissions were compared to the SCAQMD daily thresholds of significance.

The modelling found that without mitigation, construction activities on the OWDP would occasionally lead to exceedance of SCAQMD Construction thresholds for NOx during three of the six years analyzed. Without mitigation, daily peak loads of NOx generated from construction would range from 1.69x to 5.19x of the construction thresholds, during those three years.

Further, the modelling showed that by incorporating mitigation measures, the impact could be reduced. With mitigation, construction activities on the OWDP would occasionally lead to exceedance of SCAQMD Construction thresholds for NOx during two of the six years analyzed, with daily peak loads of NOx generated from construction ranging from 1.8x to 3.4x of the construction thresholds, during those two years.

The mitigation measures suggested were:

AQ-1: Prior to construction, the District shall confirm that the Grading Plan, Building Plans, and specifications stipulate that, in compliance with SCAQMD Rule 403, excessive fugitive dust emissions shall be controlled by regular watering or other dust prevention measures, as specified in the SCAQMD's Rules and Regulations. In addition, SCAQMD Rule 402 requires implementation of the following dust suppression techniques to prevent fugitive dust from creating a nuisance off-site and reduce construction-related fugitive dust impacts on nearby sensitive receptors:

- All active portions of the construction site shall be watered twice daily during daily construction activities, or as needed during wet weather, and when dust is observed migrating from the Project site to prevent excessive amounts of dust.
- Pave or apply water three times daily during daily construction activities or apply non-toxic soil stabilizers on all unpaved access roads, parking areas, and staging areas, during dry weather. More frequent watering shall occur if dust is observed migrating from the site during site disturbance.
- During dry weather, any on site stockpiles of debris, dirt, or other dusty material with five percent or greater silt contrast shall be enclosed, covered, watered twice daily, or non-toxic soil binders shall be applied.
- All grading and excavation operations shall be suspended when wind speeds exceed 25 miles per hour.
- Disturbed areas shall be replaced with ground cover or paved immediately after construction if completed in the affected area.
- Track-out devices such as gravel bed track-out aprons (3 inches deep, 25 feet long, 12 feet wide per lane and edged by rock berm or row of stakes) shall be installed to reduce mud/dirt track-out from unpaved truck exit

routes. Alternatively, a wheel washer shall be used at truck exit routes. On-site vehicle speed shall be limited to 15 miles per hour.

- All material transported off-site shall be either sufficiently watered or securely covered to prevent excessive amounts of dust before departing the job site.
- Reroute construction trucks away from congested streets or sensitive receptor areas. Trucks associated with soil-hauling activities shall avoid residential streets and utilize designated truck routes to the extent feasible.

AQ-2: During construction, all trucks that are to haul excavated or graded material on site shall comply with State Vehicle Code Section 23114 (Spilling Loads on Highways), with special attention to Sections 23114(b)(F), (e)(4) as amended, regarding the prevention of such material spilling onto public streets and roads. Before grading, the District shall indicate on the applicable Grading Plan, Building Plans, and specifications how operations subject to these requirements will comply.

AQ-3: Prior to construction, the construction contractor shall provide evidence that the following measures will be implemented during construction:

- Provide temporary traffic controls such as a flag person, during all phases of construction to maintain smooth traffic flow.
- Provide dedicated turn lanes for movement of construction trucks and equipment on- and off-site.
- Improve traffic flow by signal synchronization, and ensure that all vehicles and equipment will be properly tuned and maintained according to manufacturers' specifications.
- Require the use of electricity from power poles rather than temporary diesel or gasoline powered generators, as feasible.
- Require the use of 2010 and newer diesel haul trucks (e.g., material delivery trucks and soil import/export) and if the lead agency determines that 2010 model year or newer diesel trucks cannot be obtained the lead agency shall use trucks that meet USEPA 2007 model year NO_X emissions requirements. Additionally, consider other measures such as incentives, phase-in schedules for clean trucks, etc. during the construction period.
- During Project construction, all internal combustion engines/construction equipment (including tug boats but excluding crew and bio-survey boats) operating on the Project site shall meet Tier 4 CARB/USEPA emission standards. If not already supplied with a factory equipped diesel particulate filter, all off-road diesel-powered construction equipment shall be outfitted with BACT devices certified by CARB. Any emissions control device used by the contractor shall achieve emission reductions that are no less than what could be achieved by a Level 3 diesel emissions control strategy for a similarly sized engine as defined by CARB regulations. In addition, construction equipment shall incorporate, where feasible, emissions savings technology such as hybrid drives and specific fuel economy standards. In the event that all off-road diesel-powered construction equipment cannot meet the Tier 4 engine certification, the applicant shall use alternative measures, which include, but would not be limited to, reduction in the number and/or horsepower rating of construction equipment, limiting the number of daily construction haul truck trips to and from the proposed Project, using cleaner vehicle fuel, and/or limiting the number of individual construction Project phases occurring simultaneously. The effectiveness of alternative measures must be demonstrated through future study with written findings supported by substantial evidence that is approved by the lead agency before use.

Therefore, implementation of Mitigation Measures AQ-1 through AQ-3 would lessen construction-related impacts by requiring compliance with fugitive dust emissions regulations and incorporating USEPA Tier 4 construction equipment. However, according to the modelling completed in the EIR, generation of NOx emissions exceeding SCAQMD Construction thresholds is expected for a portion of the construction period.

7.2.2 Construction-related Noise

The EIR identifies that Noise Emissions during Construction (Impact NOI 5.12; Noise Exposure) will have 'Significant and Unavoidable Impact'.

Noise from construction activities is generated by two primary sources: (1) the noise related to active construction equipment and (2) the transport of workers, materials, and equipment to construction sites. These noise sources can be a nuisance to local residents and businesses or unbearable to sensitive receptors.

Construction of the OWDP treatment facility will occur within the existing ESGS site, with the nearest noise-sensitive receptors (residential uses) located approximately 130 feet from the South Site.

The greatest construction-related noise impacts would typically occur during the initial site preparation/grading/excavation, which can create the highest levels of noise. Grading and construction would occur along the existing berm, at the southern edge of the property north of 45th Street. Construction activities would cause increased noise in the immediate site vicinity and along access routes to and from the site due to movement of equipment and workers. Construction would be temporary and limited to the hours of 7 AM to 6 PM.

Construction activities, including sheet pile driving, would occur approximately 130 feet north of the nearest residences within the city of Manhattan Beach. At this distance, maximum noise levels from pile driving would be approximately 93 decibels (dB). Pile driving if necessary, may occur for approximately 3 months. Both El Segundo's and Manhattan Beach's noise ordinances exempt reasonable daytime construction noise. As is typical for construction activities, construction noise would exceed the operational exterior noise standards for residential uses. The ESGS North Site is further away (770 feet) from the closest sensitive receptors to the south and at this distance sheet pile driving noise would be reduced to 77 dBA. As such, impacts at the ESGS North Site would be substantially lower than the ESGS South Site.

Implementation of Mitigation Measures NOI-1 through NOI-3 would lessen construction noise and ensure that impacts at sensitive receptors would be minimized. Mitigation Measure NOI-1 requires that construction equipment be equipped with properly operating and maintained mufflers and other state-required noise attenuation devices. Mitigation Measure NOI-2 requires that the District provide a qualified "Noise Disturbance Coordinator" to respond to local complaints, should they arise. Mitigation Measure NOI-3 would require the District to investigate pile installation methods other than percussive pile driving and implement the alternative method if feasible.

OWDP desalinated water conveyance components construction would primarily occur within roadway right-of-way (ROW). Pipeline construction would generally occur in a linear fashion, and therefore would not be confined to one location for an extended period of time. Noise generation would occur adjacent to any given property for no more than a few weeks to a month as the linear pipeline is installed within the public ROW. Adherence to the applicable requirements and compliance with Mitigation Measures NOI-1 and NOI-2 would minimize construction noise impacts at nearby sensitive receptors.

The proposed mitigation measures are, in full:

NOI-1: Prior to construction, the District shall ensure that the contractor specifications stipulate that:

- All construction equipment, fixed or mobile, is equipped with properly operating and maintained mufflers and other state-required noise attenuation devices.
- When feasible, construction haul routes shall avoid noise-sensitive uses (e.g., residences, convalescent homes).
- During construction, stationary construction equipment shall be placed such that emitted noise is directed away from the nearest noise-sensitive receptors.
- Construction activities that generate noise shall not take place outside of the allowable hours specified by ESMC Section 7-2-10 (allows construction between the hours of 7:00 AM and 6:00 PM Monday through Saturday) for conveyance pipeline installation, and Manhattan Beach Municipal Code Section 5.48.060 (allows construction between 7:30 AM and 6:00 PM Monday through Friday, and from 9:00 AM to 6:00 PM on Saturdays) for noise-generating activities to be taken place at the ESGS sites and offshore. Construction shall be prohibited on Sundays and federal holidays.

NOI-2: Throughout Project construction and operation, the District shall document, investigate, evaluate, and attempt to resolve all Project-related noise complaints as soon as possible.

- The District shall establish and disseminate a 24/7 hotline telephone number for use by the public to report any undesirable Project noise conditions. If the telephone number is not staffed 24 hours per day, the District shall include an automatic answering feature with date and time stamp recording to answer calls when the phone is unattended.
- The District shall designate a Noise Disturbance Coordinator during construction and permanently once the facility is operational. The Noise Disturbance Coordinator shall assist in resolving noise complaints to minimize impacts while maintaining the objectives of the construction and operation of the facility. The Noise Disturbance Coordinator shall report all noise complaints to the District program manager.
- For construction noise complaints received outside of the construction hours and days allowed as described by Mitigation Measure NOI-1, the Noise Disturbance Coordinator shall take immediate steps to determine whether Project construction is causing the noise and, if so, to reduce the noise level of that activity or take other appropriate action to remedy the complaint as quickly as possible.
- For construction activities near local residences, the Noise Disturbance Coordinator shall have the authority to require the installation of a temporary noise barrier to reduce noise impacts to the closest sensitive receptors. The noise barriers shall be tall enough to effectively block sight-lines of the construction to the closest residences. The contractor shall install noise barriers as directed by the Noise Disturbance Coordinator to minimize construction noise and resolve noise complaints.
- Deliveries to the treatment facility normally shall not occur before 7:00 AM or after 10:00 PM on weekdays or between 9:00 AM and 6:00 PM on Saturdays, and are not allowed on Sundays. Oversized loads and other heavy-duty vehicles would primarily get to and from the site using main traffic conduits such as Vista Del Mar and Imperial Hwy except for special circumstances to minimize traffic load in residential areas. If for reasons of critical operational needs these hours must be violated, the District shall notify adjacent residences of the unusual circumstance at least 2 days in advance.
- On-site activities outside of enclosures shall not result in noise standard exceedances identified in the local noise ordinances.

NOI-3: The District shall determine the feasibility of using construction methods that avoid percussive pile driving. Other methods of pile installation such as vibratory or drilling shall be investigated during development of final designs and implemented if feasible.

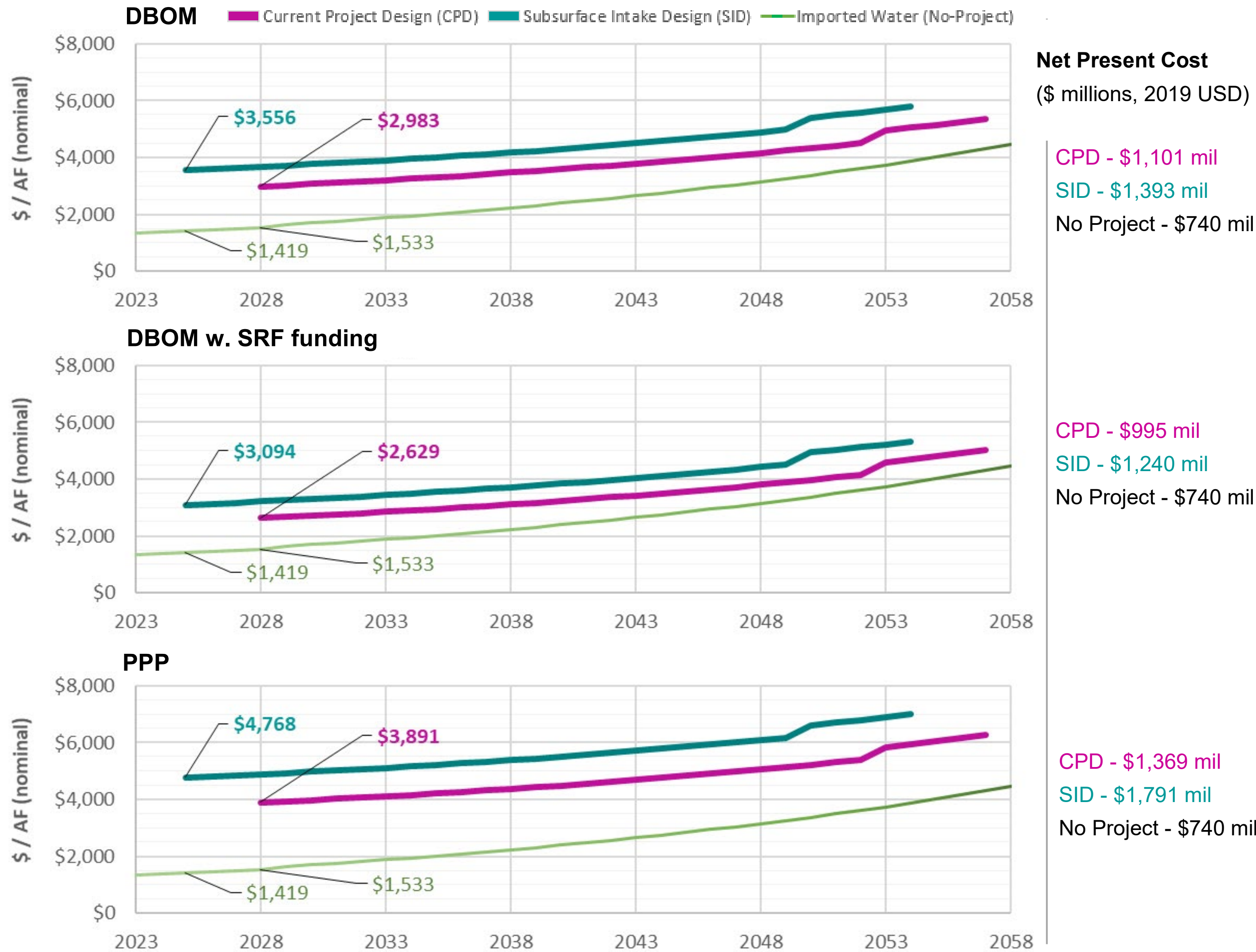
However, despite implementation of all feasible mitigation, and despite the fact that construction is exempt from the local noise ordinances, given the duration of construction and proximity to noise-sensitive receptors, and given the City of El Segundo's and City of Manhattan Beach's noise standards for residential uses would be exceeded for an extended duration, construction of the Project is considered significant and unavoidable.

8. Financial

8.1 Project Costs

Detailed financial models were developed to estimate the yearly cash flows incurred by the District to construct and operate the OWDP over the project timeframe. This is discussed in detail in Chapter III and Figure VI-15 below summarizes the estimated cost of water for the shortlisted delivery models. Key findings were:

- OWDP Current Project Design is considerably more attractive than Subsurface Intake Design on a financial basis, driven by its significantly lower capital cost (~30% reduction) and results in whole-of-life cost savings of approximately $300 to $450 million on a Net Present Cost (NPC) basis, depending on the delivery model.
- The choice of project delivery model to deliver the OWDP has a significant impact on the overall OWDP financial outcomes. This is due to the impact of different financing methods on the weighted average interest rate applied to capital repayments. As the level of private financing increases, the weighted average interest rate also increases due to additional returns expected by the private equity partners and debt lenders. The analysis estimates that fully privately financed delivery models (DBFOM-100% or PPP) result in an increased whole-of-life cost of ~$300 million to $350 million on an NPC basis compared to wholly municipally-funded delivery models (DBB or DBOM).
- Minimizing power price and power consumption is extremely important to reduce the costs of the OWDP project. Design decisions impacting power consumption, commercial negotiations with the District’s contractor and the regional grid power provider, and the potential for alternative power sources should be scrutinized closely.
- The MWD LRP rebate should be aggressively pursued during project development and offers around $90 million in subsidy value, on an NPC basis. Rebate Option A (Sliding scale $340 per acre-foot of water produced from the OWDP facility, for the first 25 years of plant operation) appears to be the best option on a whole-of-life basis. However, if the District prioritizes lower costs of desalinated water *early* in OWDP operation, then Option B (Sliding scale $475 per acre-foot of water produced from the OWDP facility, for the first 15 years of plant operation) would be most attractive.
- The District can reduce its risk exposure by using a project delivery model with higher levels of private sector involvement. However, the risk analysis performed in this work demonstrates the benefits of risk transfer **do not** appear to outweigh the additional costs of private financing. That is, the risk premium charged by the private sector does not appear to be worth the value of the risk transfer to the District.
- The DBOM delivery method offers the lowest risk-adjusted cost for the project, on both an NPC basis and cost of water over time. The PPP delivery model offers the maximum risk transfer away from the District.
- Below-market interest rate public funding sources such as the DWSRF or Water Infrastructure Finance Innovation Act (WIFIA) should be aggressively pursued during project development to minimize project debt service cost. These funding sources will be generally more accessible when the project is owned by the District, as a public agency, due to restrictions on availability when the project is owned by a private sector entity. The analysis performed a sensitivity scenario where half the project cost is funded by a DWSRF loan, and estimates whole-of-life cost savings of ~$100 million on NPC basis. This equates to a substantially lower cost of desalinated water of at least $300/AF at the start of plant operation.



*Note: the step change in cost of water profile in 2053 (*Current Project Design*) and 2050 (*Subsurface Intake Design*) is due to expiration of the MWD LRP rebate. The LRP option included in this analysis offers $340 / AF rebate for the first 25 years of plant operation.*
Note – the cost of water estimates in this figure differ slightly from those shown in Chapter III, because additional municipal finance costs were factored in after the completion of that task, as described in Chapter IV. The cost of water values here supersede the figures shown in Chapter III.

Figure VI-15 Cost of Water (nominal $/AF) and Net Present Cost (NPC, $ millions, 2019 dollars) of OWDP for Different Delivery Models

In Chapter IV, it was shown that although the cost of desalinated water is higher than imported water, the overall impact to Retail Agencies is relatively smaller, because desalinated water will make up approximately 20% of the total potable supply and a 'blended' wholesale rate combining desalinated water and imported water will be charged.

The Financial Condition Assessment detailed in Chapter IV showed the following results (Table VI-12 for the blended rate impact, which will be passed through to Retail Agencies.

Table VI-12 Summary of Blended Cost Under Various Desalination Scenarios (Source: Vol. IV)

Desal Scenarios	Year	Blended Rate w/ Desal	MWD Rate	Desal Premium (%)	Desal Premium ($)
	First year of OWDP operation. Costs shown to right are for this year only	*Cost per AF of potable water sold to Retail Agencies*	*Cost per AF of imported water*	*% difference in blended rate and MWD rate*	*$ difference in blended rate and MWD rate*
DBOM Current Project Design	FYE 2028	$1,826	$1,501	22%	$326
DBOM Subsurface Intake Design	FYE 2025	$1,841	$1,368	35%	$473
PPP Current Project Design	FYE 2028	$1,985	$1,501	32%	$484
PPP Subsurface Intake Design	FYE 2025	$2,057	$1,368	50%	$689
DBOM w. SRF Current Project Design	FYE 2028	$1,729	$1,501	15%	$229
DBOM w. SRF Subsurface Intake Design	FYE 2025	$1,718	$1,368	26%	$350

8.2 Affordability Analysis

To assess how the cost of desalinated water from the OWDP could impact on household customers served by its member Retail Agencies, Raftelis conducted an affordability analysis.

8.2.1 Scenarios

The following two scenarios represent the lowest and highest cost OWDP scenarios being considered in this CBA. For simplicity in development and reporting results, the affordability analysis was developed for these two scenarios only, representing the “bookends” within which all other design and delivery model scenarios would fall:

- Lowest cost = Current Project Design, DBOM with SRF
- Highest cost = Subsurface Intake Design, PPP

8.2.2 Data Sources

The following data sources were utilized in the preparation of this affordability analysis:

- U.S. Census Bureau Geographical Data, including census tracts overlaid on top of a service area shapefile provided by the District.

- U.S. Census Bureau Socioeconomic Characteristics for each retail agency receiving water from the District, including information on income levels, occupancy, poverty, unemployment, etc.
- Retail Agency Website and/or Utility Billing Services as of June 29, 2020, which were referenced to determine local retail agency water rates, including fixed and variable costs and surcharges.

Table VI-13 shows the current average monthly minimum water bills for each of the District's eleven retail customer agencies, which assumes a meter size of 5/8" x 3/4" and minimum average monthly water use of 10 hundred cubic feet (ccf) representing indoor use only.

Table VI-13 Indicative average monthly minimum monthly water bill for District Retail Agencies without OWDP

Monthly Charge	El Segundo	Inglewood	Lomita	Manhattan Beach	LA County Waterworks
Fixed	$11.95	$15.11	$25.16	$20.23	$39.88
Variable	$28.20	$38.20	$47.90	$47.54	$71.10
Surcharges	$0	$0	$0	$0	$12.03
Monthly Bill	**$40.15**	**$53.31**	**$73.06**	**$67.77**	**$123.01**

Monthly Charge	CA American Water	CA Water Palos Verdes	CA Water Hermosa/Redondo	CA Water Hawthorne	CA Water Dominguez	GS Water
Fixed	$10.53	$21.17	$12.05	$19.15	$17.29	$17.01
Variable	$36.69	$47.56	$45.68	$46.65	$36.10	$43.36
Surcharges	$16.47	$0	$0	$0	$0	$0
Monthly Bill	**$63.69**	**$68.73**	**$57.73**	**$65.80**	**$53.39**	**$60.37**

8.2.3 Affordability Parameters

In order to develop an affordability analysis, the concept of "affordability" must first be defined. Affordability is a challenging concept that is open to interpretation. Three different definitions, or parameters, for residential water affordability are outlined below. Two of these parameters were used in assessing affordability for both the DBOM and PPP scenarios.

- **Affordability Parameter 1:** The Environmental Protection Agency (EPA) defines an affordable water threshold as a percent of Median Household Income (MHI). Specifically, the EPA states that water bills should remain under 2.5% of MHI for an area to be deemed affordable.
- **Affordability Parameter 2:** Another definition of affordability is that defined by Manuel P. Teodoro in his 2019 article, *Water and Sewer Affordability in the United States, 2019.*[32] The article notes that those at the lower end of the lowest quintile of income may qualify for income assistance programs, and that it is those making an income above these assistance levels at the threshold of the lowest quintile of income (20th percentile of income), who have very limited financial resources but remain ineligible for assistance, that should be targeted to ensure affordability.

[32] Working Paper, *Water and Sewer Affordability in the United States, 2019*, by Manuel P. Teodoro and Robin Saywitz, Texas A&M University, November 2019.

– For this reason, a combined water and sewer bill should remain below the 10% threshold of the lowest quintile of income, as defined by local Census Bureau information on MHI. To measure this, the MHI of the lowest one-fifth of the population is used, a number that will differ among Retail Agencies. For example, the lowest quintile of income in Palos Verdes is $64,340, while that for Lomita nearby is $32,611. In order to be considered affordable under this scenario, annual water and sewer bills would remain below 10% of these amounts for each retail area.

– It is challenging to include sewer costs accurately as some households may be on septic, some may be charged for only collection costs (with treatment separately charged on the property tax roll), and some may be charged on the property tax roll. As a result, this metric was adjusted to 5% (not 10%) to reflect the portion of costs related to water service only.

- **Affordability Parameter 3 (excluded):** Finally, a third definition of water affordability is to examine the number of hours worked at minimum wage in order to pay for the combined monthly water and sewer cost.[33] For the purposes of this analysis, a minimum wage of $15 per hour, as effective July 1, 2020 in Los Angeles County, was used. Results of this affordability parameter may vary due to differences in water bill methodology and rates. This metric is challenging to use and has been excluded from this analysis for the following reasons:

  – Varying costs for sewer bills within the District's service area make the appropriate allocation of 8 hours between water and sewer costs challenging.

  – The household size and number of people contributing to household income is unknown.

  – The number of hours worked at the minimum wage is unknown for each person as well as for the household.

8.2.4 Assumptions in Affordability Analysis

Desalinated Water Production

For all scenarios, desalinated water production is estimated at 21,283 acre-feet per year (AFY). Total District water demand is estimated at 99,173 AFY. This was the estimated total imported water demand in 2030 per Figure VI-8. Dividing estimated desalinated water production by total demand results in an estimated desalinated water share of 20.27% of District supply as shown here:

$$\textit{Desalinated Water Supply as \% of District Demand} \quad \frac{21{,}283\ AFY}{99{,}173\ AFY} = 21\%$$

In summary, desalinated water production is assumed to provide approximately 21% of total District water demand. This percentage of desalinated water supply has been applied to the calculations for each Retail Agency below.

Cost of Water – Current Project Design, DBOM with SRF Scenario

The lower end cost AF is $2,629 under the Current Project Design, DBOM with SRF scenario for the first year of OWDP operation (refer Chapter IV for detail). The per AF cost of desalinated water for the Current Project Design, DBOM with SRF scenario is converted to a per ccf (one hundred cubic feet) cost. The result is a desalinated water cost of $6.04 per ccf for the Current Project Design, DBOM with SRF scenario.

[33] Teodoro, *Water and Sewer Affordability in the United States*.

The incremental cost of desalinated water is the difference between the current MWD rates and the desalinated water cost.

The MWD rate is $1,078 per AF of water. The MWD Readiness-to-Serve (RTS) charge is $90 per AF. Added together, total MWD cost per acre foot is $1,168.

Dividing this cost per acre foot by the 435.6 conversion factor into ccf results in a total MWD cost per ccf of $2.6814. Subtracting this amount from the total desalinated water cost of $6.04 per ccf results in an incremental desalinated water rate of $3.35 per ccf as shown in Table VI-14.

Table VI-14 Current Project Design DBOM w. SRF Incremental Desalinated Water Cost

DBOM Scenario	MWD Rates
MWD Commodity Charge ($/AF)	$1,078.00
MWD RTS ($/AF)	$90.00
Total MWD Cost ($/AF)	$1,168.00
Conversion Factor (AF to ccf)	435.6
Total MWD Cost ($/ccf)	$2.6814
Incremental Desal Rate ($/ccf)	$6.0354 - $2.6814 ≈ **$3.35**

Desal Sensitivity Analysis – Subsurface Intake Design PPP Scenario

Using the same methodology as above, the upper end cost per AF of desalinated water is $4,768 under the Subsurface Intake Design PPP scenario for the first year of OWDP operation (refer Chapter IV for detail). The per AF cost of desalinated water for the Subsurface Intake Design PPP scenario is converted to a per ccf cost. The result is a desalinated water cost of $10.95 per ccf for the Subsurface Intake Design PPP scenario. The incremental cost of desalinated water is the difference between the current MWD rates and the desalinated water cost.

Subtracting the MWD cost from the total desalinated water cost of $10.9458 per ccf results in an incremental desalinated water rate of $8.26 per ccf as shown in Table VI-15.

Table VI-15 Subsurface Intake Design PPP Incremental Desalinated Water Cost

PPP Scenario	MWD Rates
MWD Commodity Charge ($/AF)	$1,078.00
MWD RTS ($/AF)	$90.00
Total MWD Cost ($/AF)	$1,168.00
Conversion Factor (AF to ccf)	435.6
Total MWD Cost ($/ccf)	$2.6814
Incremental Desal Rate ($/ccf)	$10.9458 - $2.6814 ≈ **$8.26**

Desal Cost Analysis Using 5-Year Average Water Supply Mix

After determining the incremental desalinated water cost for both the DBOM and PPP scenarios, we can use that to calculate the financial impact of desalination on each of the District's Retail Agencies.

Each Retail Agency receives imported water (water purchased from the District), groundwater, or some combination of the two. The share of District demand that represents desalinated water is approximately 21%, as calculated previously. The financial impact of desalination is equal to the percentage of imported water each Agency receives multiplied by the desalinated water percentage of demand.

Table VI-16 below shows the five-year average water supply mix for each of the Retail Agencies.

Table VI-16 Five-Year Average Water Supply Mix for District Retail Agencies

Water Supply Mix	El Segundo	Inglewood	Lomita	Manhattan Beach	LA County Waterworks	
Imported	100%	78%	73%	77%	100%	
Groundwater	0%	22%	27%	23%	0%	
Water Supply Mix	**CA American Water**	**CA Water Palos Verdes**	**CA Water Hermosa/Redondo**	**CA Water Hawthorne**	**CA Water Dominguez**	**GS Water**
Imported	21%	100%	86%	61%	83%	74%
Groundwater	79%	0%	14%	39%	17%	26%

Based on the supply mix for each Agency, the incremental cost of desalinated water as calculated in Table VI-14 and Table VI-15 can be applied to the imported water supply portion for each Agency using the prior assumption of 21% of imported water supply from desalinated water.

Table VI-17 shows the resulting desalinated water bill impacts for each Retail Agency using the cost impacts of $3.35/ccf for Current Project Design DBOM w. SRF and $8.26 per ccf for Subsurface Intake Design PPP.

For example, the estimated desalinated water bill impact for El Segundo under the Current Project Design DBOM w. SRF scenario is calculated as follows:

$40.15 (current water bill in Table VI-13)

+ 10 ccf x $3.35/ccf (incremental desalinated water cost)

x 100% (proportion of imported water supply)

x 21% (proportion of imported water served by desalinated water)
= $46.95

Table VI-17 Estimated Desalinated Water Bill Impacts for District Retail Agencies

Monthly Bill	El Segundo	Inglewood	Lomita	Manhattan Beach	LA County Waterworks	
Current Project Design DBOM w. SRF	$46.95	$58.59	$78.01	$73.02	$129.81	
Subsurface Intake Design PPP	$56.92	$66.34	$85.27	$80.72	$139.78	
Monthly Bill	**CA American Water**	**CA Water Palos Verdes**	**CA Water Hermosa/Redondo**	**CA Water Hawthorne**	**CA Water Dominguez**	**GS Water**
Current Project Design DBOM w. SRF	$65.12	$75.53	$63.60	$69.95	$59.01	$65.37
Subsurface Intake Design PPP	$67.21	$85.49	$72.19	$76.03	$67.24	$72.70

8.2.5 Heat Map Comparisons

In order to visualize affordability, heat maps showing relative affordability for the two affordability parameters above were created for the District's Retail Agencies. For each of the parameters, both the less expensive Current Project Design DBOM w. SRF scenario at a cost of $2,629 per AF and the more expensive Subsurface Intake Design PPP scenario at a cost of $4,768 per AF were analyzed.

The heat maps use the following gradient guide:

- Green: the water bill has a low impact on affordability
- Yellow: the water bill has a mid-range impact on affordability
- Red: the water bill has a high impact on affordability

A map of the District's service area, showing each retail customer in a different color, is provided in Figure VI-16.

Figure VI-16 District Service Area and Retail Agencies

In developing the affordability analysis, it should be noted that Retail Agency service areas and census tracts do not align perfectly. While creating the service area maps and resulting analyses, each census tract was matched to a single service provider, even though there are situations where two or more Retail Agencies have customers within a single census tract. The approach to address this was that the service provider that made up the majority of the census tract by area was assigned the entirety of the tract, per the Figure above.

Affordability Parameter 1: Percent of MHI

The annual water bill for each of the Retail Agencies as a percentage of MHI (Affordability Parameter 1), without adding desalinated water costs is shown in Figure VI-17. Yellow indicates the 2% threshold from Parameter 1. Most Agencies remain in the affordable range as defined by Parameter 1.

Adding in the incremental cost of desalinated water to the annual water bill, we arrive at the heat maps below. Figure VI-18 shows the annual water bill as a percentage of MHI under the Current Project Design DBOM w. SRF Scenario, while Figure VI-19 shows the water bill as a percentage of MHI under the Subsurface Intake Design PPP Scenario.

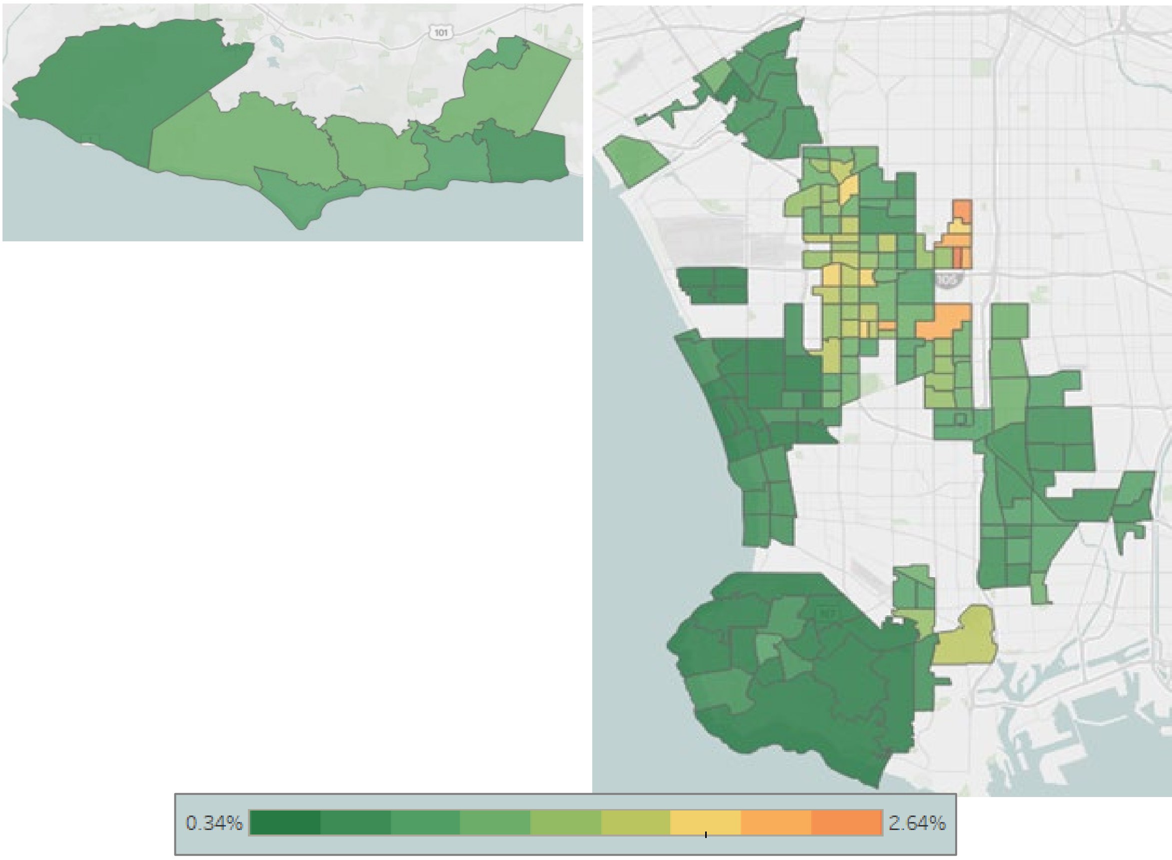


Figure VI-17 Annual Bill without Desalinated Water (Parameter 1)

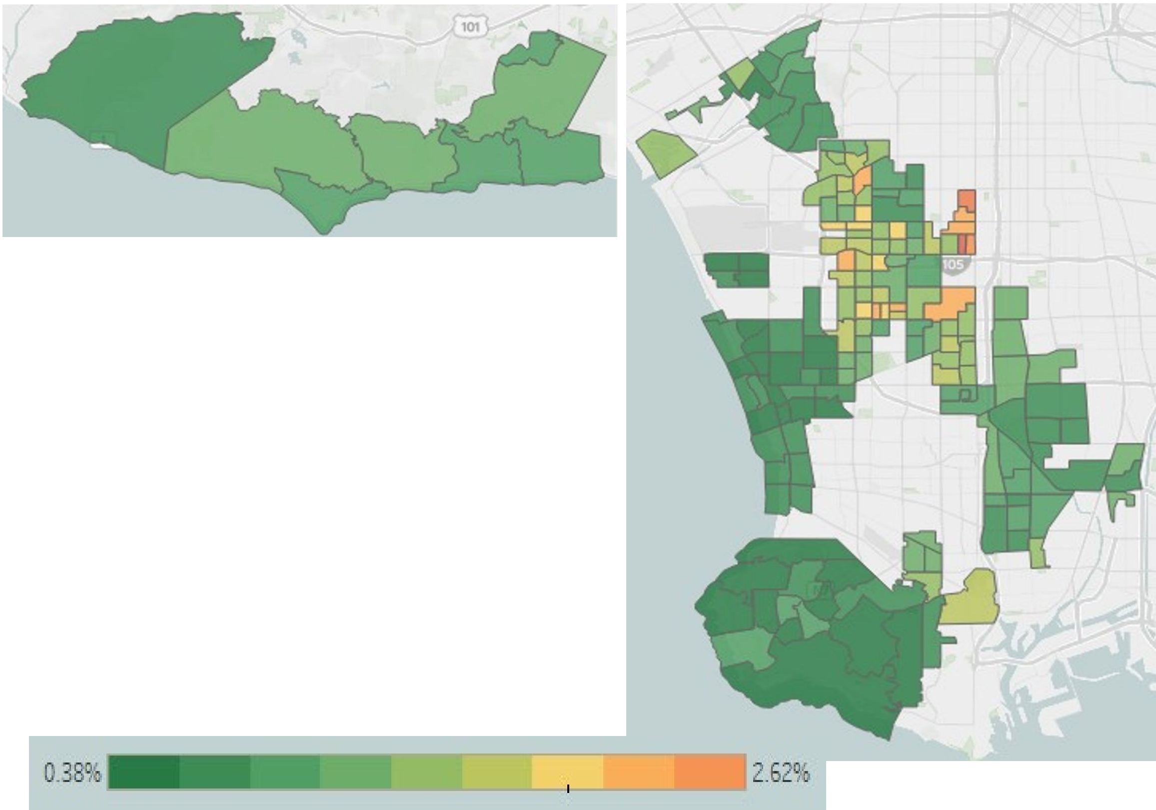


Figure VI-18: Annual Bill with Desalinated Water (Parameter 1, Current Project Design DBOM w. SRF)

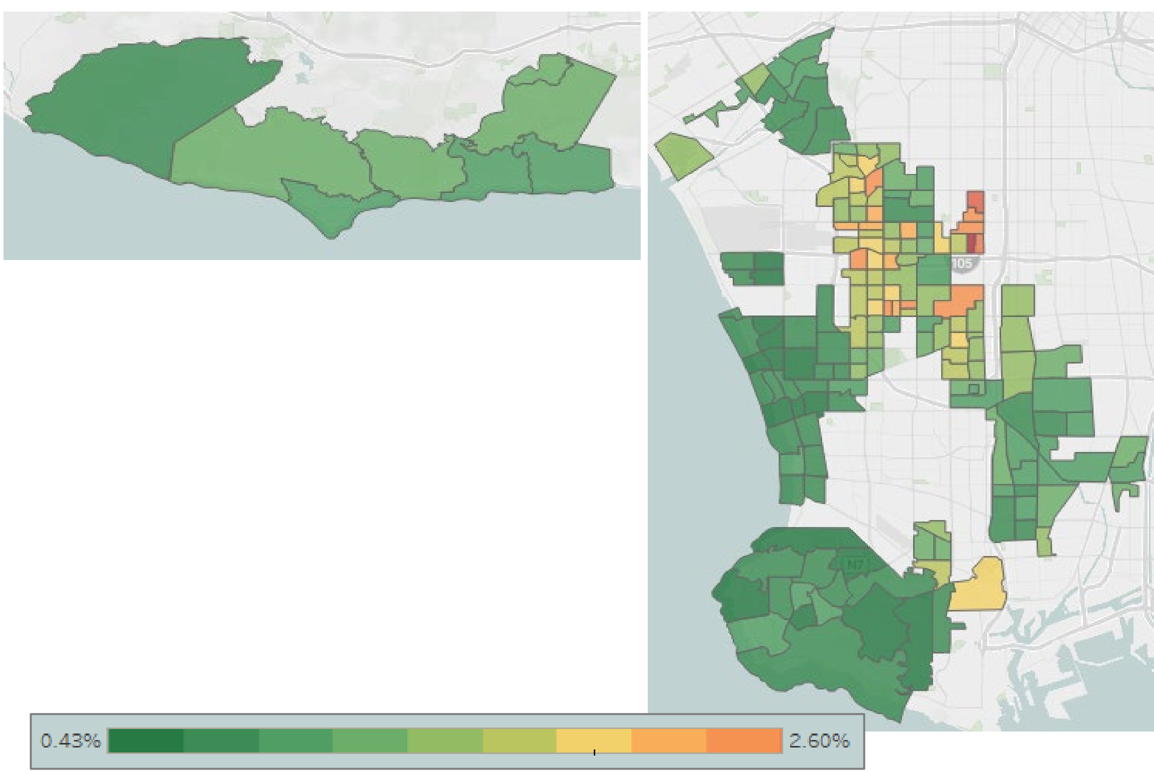


Figure VI-19: Annual Bill with Desalinated Water (Parameter 1, Subsurface Intake Design PPP Scenario)

The results of the affordability analysis under Parameter 1 are as follows:

- The average increase across Retail Agencies using the water annual bill as percentage of MHI is 0.18%.
- The highest impact occurs in California Water Hawthorne, which has an MHI of $55,673 per year and a bill increasing from 1.42% to 1.64% of MHI on average.
- A mid-range impact can be seen for LA County Waterworks, which has an MHI of $149,451 per year and a bill increase going from 0.99% to 1.12% on average.
- The lowest impact to the bill can be seen in the City of Manhattan Beach, with an MHI of $159,237 per year and a bill increase from 0.51% to 0.61% on average.

Parameter 1, utilizing the EPA threshold, states that affordability is defined as when the annual water bill remains below 2.5% of MHI. The highest impact, occurring in Hawthorne, is equal to 1.64% of that area's MHI. Based on this information, the definition of affordability under Parameter 1 has been met for desalinated water for all Retail Agencies.

A review of the impacts on provider census tracts is shown in Table VI-18 below, which illustrates the percentage of tracts that do not meet the affordability threshold. Golden State Water shows the largest impact under Subsurface Intake Design PPP Scenario, with 18% of the service area not meeting the affordability threshold.

Table VI-18 Tract Level Analysis (% of MHI) – Percent of Tracts

Change in Affordability		Status Quo	Current Project Design DBOM w. SRF	Subsurface Intake Design PPP
	Total # of Census Tracts	% of Service Area that do not meet affordability threshold	% of Service Area that do not meet affordability threshold	% of Service Area that do not meet affordability threshold
CA Water Hawthorne	21	0%	0%	5%
City of Lomita	6	0%	0%	0%
Golden State Water	34	3%	9%	18%
LA County Waterworks	9	0%	0%	0%
City of Inglewood	28	0%	0%	0%
CA Water Dominguez	23	0%	0%	0%
CA Water Palos Verdes	15	0%	0%	0%
CA Water Hermosa/Redondo	18	0%	0%	0%
City of Manhattan Beach	8	0%	0%	0%
CA American Water	3	0%	0%	0%
City of El Segundo	4	0%	0%	0%

A review of the impacts on provider census tracts is shown in Table VI-19 below, which illustrates the number of tracts that do not meet the affordability threshold. Golden State Water shows the largest impact under Subsurface Intake Design PPP scenario, with 6 of 34 tracts not meeting the affordability threshold.

Table VI-19 Tract Level Analysis (% of MHI) – Number of Tracts

Change in Affordability		Status Quo	Current Project Design DBOM w. SRF	Subsurface Intake Design PPP
	Total # of Census Tracts	No. of Tracts That Do Not Meet Affordability Threshold	No. of Tracts That Do Not Meet Affordability Threshold	No. of Tracts That Do Not Meet Affordability Threshold
CA Water Hawthorne	21	0	0	1
City of Lomita	6	0	0	0
Golden State Water	34	1	3	6
LA County Waterworks	9	0	0	0
City of Inglewood	28	0	0	0
CA Water Dominguez	23	0	0	0
CA Water Palos Verdes	15	0	0	0
CA Water Hermosa/Redondo	18	0	0	0
City of Manhattan Beach	8	0	0	0
CA American Water	3	0	0	0
City of El Segundo	4	0	0	0

Affordability Parameter 2: Bill as Percentage of 20th Percentile of Income

The District's service area was mapped using the annual bill as a percentage of the 20th percentile of income under current rates and without desalinated water costs as shown in Figure VI-20. Yellow indicates the 4% threshold from Parameter 2. All Agencies remain in the affordable range based on Parameter 2.

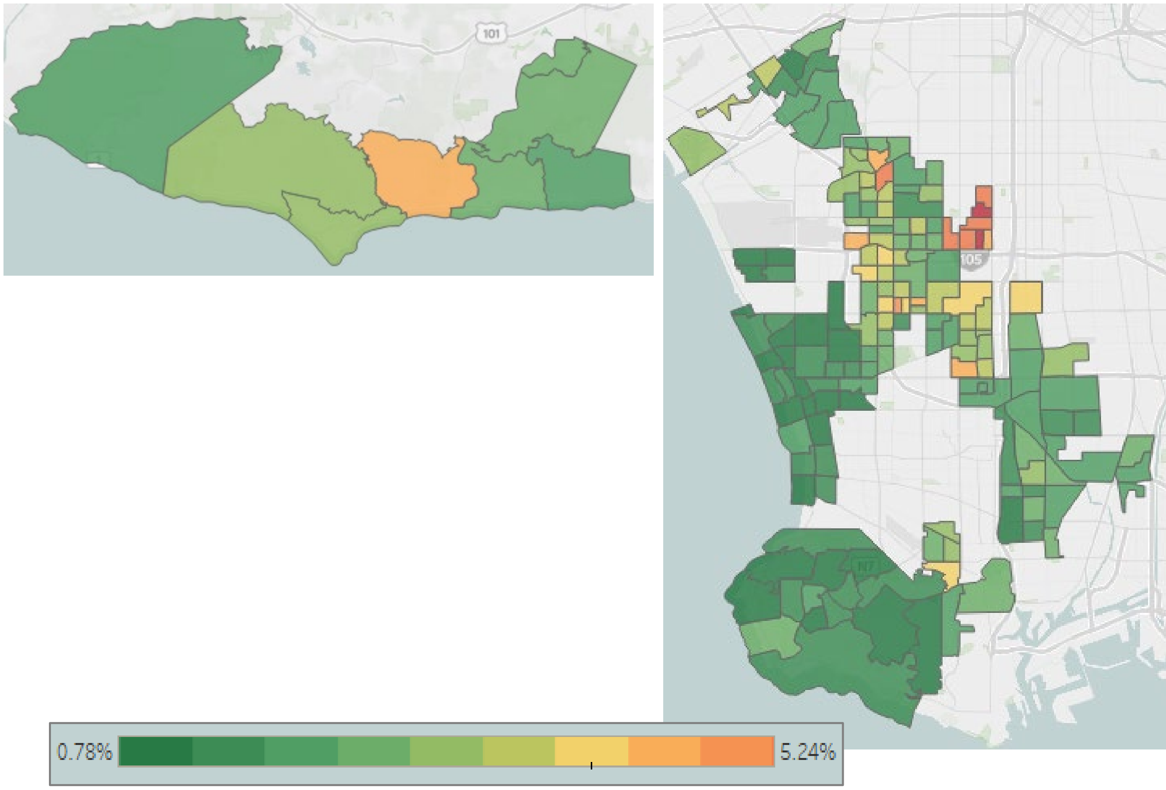


Figure VI-20 Annual Bill without Desalinated Water (Parameter 2)

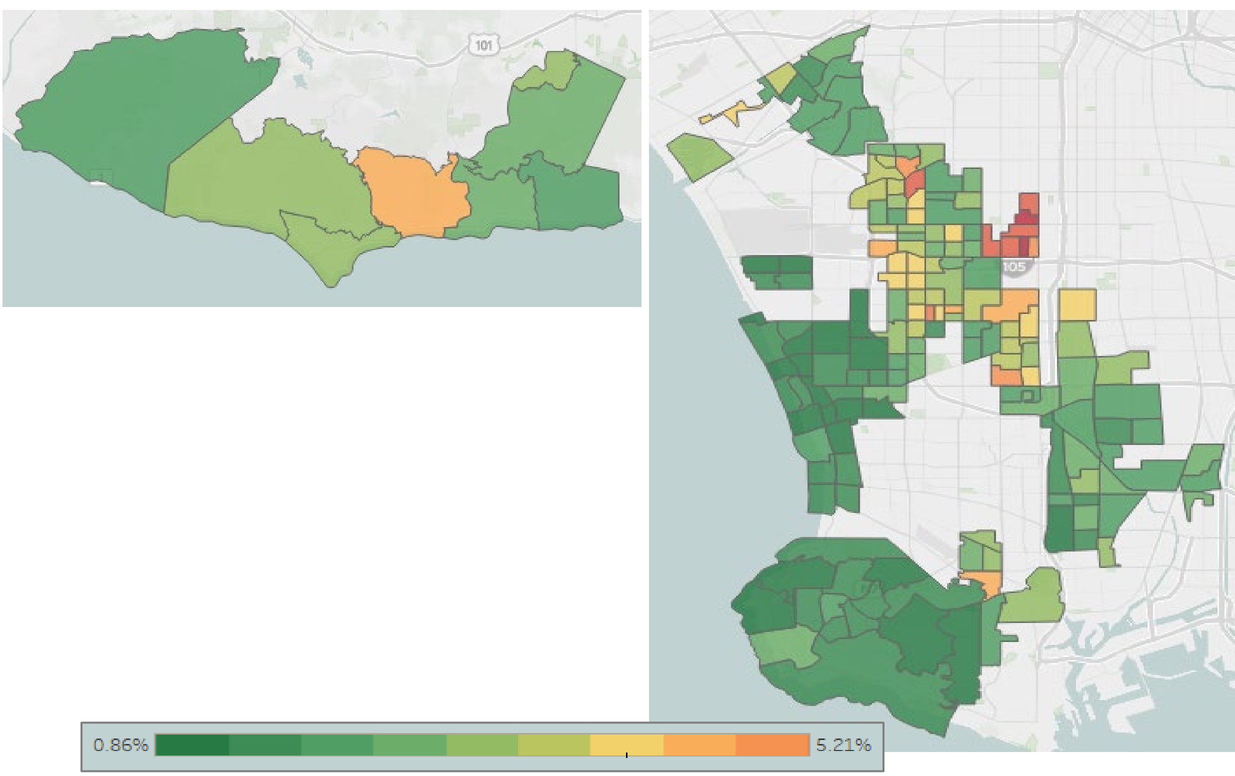


Figure VI-21 Annual Bill with Desalinated Water (Parameter 2, Current Project Design DBOM w. SRF Scenario)

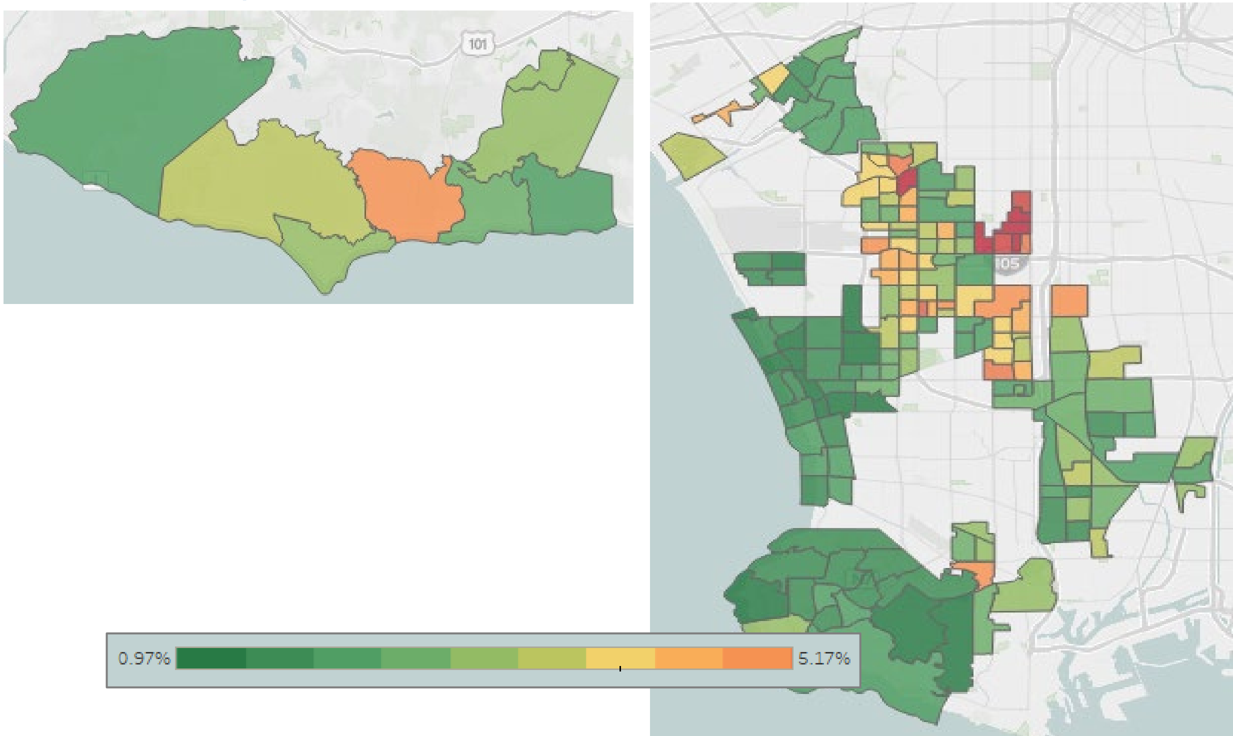


Figure VI-22 Annual Bill with Desalinated Water (Parameter 2, Subsurface Intake Design PPP Scenario)

Adding in the incremental cost of desalinated water to the annual water bill, we arrive at the heat maps below. Figure VI-21 shows the annual water bill as a percentage of 20th percentile of income under the DBOM Scenario, while Figure VI-22 shows the water bill as a percentage of 20th percentile of income under the PPP Scenario.

The results of the affordability analysis under Parameter 2 are as follows:

- The average increase across Retail Agencies using the water annual bill as percentage of 20th percentile of income is 0.40%.
- The highest impact occurs in the California Water Hawthorne has a 20th percentile of income of $27,156 per year and a bill increase going from 2.91% to 3.36% of the lowest quintile of income on average.
- A mid-range impact can be seen for LA County Waterworks, which has a 20th percentile of income of $57,126 per year and a bill increase going from 2.58% to 2.94% of the lowest quintile of income on average.
- The lowest impact to the bill can be seen in the City of Manhattan Beach, with a 20th percentile of income of $68,291 per year and a bill increase from 1.19% to 1.42% of the lowest quintile of income on average.

Parameter 2 states that affordability is defined when water bills are at 5% of the 20th percentile of income. Based on this information, the definition of affordability under Parameter 2 has been met for desalinated water for all Retail Agencies.

A review of the impacts on provider census tracts is shown in Table VI-20 below, which illustrates the percentage of tracts that do not meet the affordability threshold as a percentage of lowest quintile. Golden State Water shows the largest impact under Subsurface Intake Design PPP Scenario, with 26% of the service area not meeting the affordability threshold.

Table VI-20 Tract Level Analysis (% of Lowest Quintile) – Percent of Tracts

Change in Affordability		Status Quo	Current Project Design DBOM w. SRF	Subsurface Intake Design PPP
	Total # of Census Tracts	% of Service Area that do not meet affordability threshold	% of Service Area that do not meet affordability threshold	% of Service Area that do not meet affordability threshold
CA Water Hawthorne	21	5%	5%	5%
City of Lomita	6	0%	0%	0%
Golden State Water	34	18%	21%	26%
LA County Waterworks	9	0%	0%	0%
City of Inglewood	28	4%	4%	7%
CA Water Dominguez	23	0%	0%	0%
CA Water Palos Verdes	15	0%	0%	0%
CA Water Hermosa/Redondo	18	0%	0%	0%
City of Manhattan Beach	8	0%	0%	0%
CA American Water	3	0%	0%	0%
City of El Segundo	4	0%	0%	0%

A review of the impacts on provider census tracts is shown in

Table VI-21 below, which illustrates the number of tracts that do not meet the affordability threshold as a percentage of lowest quintile. Golden State Water shows the largest impact under Subsurface Intake Design PPP Scenario, with 9 of 34 tracts not meeting the affordability threshold.

Table VI-21 Tract Level Analysis (% of Lowest Quintile) – Number of Tracts

Change in Affordability		Status Quo	Current Project Design DBOM w. SRF	Subsurface Intake Design PPP
	Total # of Census Tracts	No. of Tracts That Do Not Meet Affordability Threshold	No. of Tracts That Do Not Meet Affordability Threshold	No. of Tracts That Do Not Meet Affordability Threshold
CA Water Hawthorne	21	1	1	1
City of Lomita	6	0	0	0
Golden State Water	34	6	7	9
LA County Waterworks	9	0	0	0
City of Inglewood	28	1	1	2
CA Water Dominguez	23	0	0	0
CA Water Palos Verdes	15	0	0	0
CA Water Hermosa/Redondo	18	0	0	0
City of Manhattan Beach	8	0	0	0
CA American Water	3	0	0	0
City of El Segundo	4	0	0	0

8.2.6 Summary of Results

Based on the analysis of two affordability parameters across both the Current Project Design DBOM w. SRF and Subsurface Intake Design PPP scenarios, the additional costs of desalinated water do not appear to impact affordability for customers based upon the criterion developed and reviewed in this Chapter. With one exception, the District's Retail Agencies remained within threshold levels for both affordability parameters.

It is important to note this analysis looks at the incremental cost of desalinated water using current costs, without considering future changes. The District could potentially bring the OWDP online between 2025 and 2030. It is challenging to forecast retail rates and income over the next 10 years; rates have historically increased by 6% per year but this can change due to external factors such as legislation, weather, etc. Given current income trends for the District, the lower percentile of MHI as expressed in this analysis is not expected to increase and, in fact, may even decrease over the next 10 years.

The definition of affordability is, of course, subject to interpretation. The criteria developed and used in this review as measures of affordability are not comprehensive and the issue of affordability is subject to debate. However, an analysis based upon the current environment shows that, while more expensive than current water provisions, desalinated water remains affordable for almost all Retail Agency customers based on the criteria we examined in this study.

9. Summary of Outcomes

This CBA exercise has reviewed the potential impacts from implementing the OWDP project. This exercise took a broad approach to assessing the Project, by reviewing indirect impacts to a large set of stakeholders.

At this time there are six OWDP concepts that have been shortlisted as the most promising: three delivery models (DBOM, DBOM with SRF funding & PPP), each with two technical Project Designs (the Current Project Design and the Subsurface Intake Design).

The key outcomes and findings below are organized around the two project scenarios with the highest and lowest cost of desalinated water, namely:

- Current Project Design delivered using a DBOM delivery model and 50% SRF funding – lowest cost
- Subsurface Intake Design delivered using a PPP delivery model

The impacts are considered relative to the No-Project alternative where the OWDP is not developed.

Table VI-22 Summary of Cost Benefit Analysis for OWDP

Impacts	Parameter	Current Project Design DBOM with SRF	Subsurface Intake Design PPP
Cost of desalinated water Desalinated water is higher cost than MWD imported water. This cost will be passed on to Retail Agencies using a single blended rate that captures the District's average potable water cost from both imported water and desalinated water.	Cost of desalinated water in first year of OWDP operation	\$2,629/AF (approx. + \$1,100/AF compared to No-Project) the Current Project Design has significantly lower capital cost due to reuse of existing ocean water intake and brine discharge assets. The SRF loan offers less expensive financing with a large reduction on the cost of water.	\$4,768/AF (approx. + \$3,400/AF compared to No-Project) Subsurface Intake Design has much higher capital cost but is preferred under OPA regulations. Facility commences operation ~ 3 years earlier than the Current Project Design due to assumed shorter permitting pathway. Note the Subsurface Intake Design was found to be **technically infeasible** during the EIR development and is presented here as a cost comparison for the Current Project Design.
	District's overall blended rate of potable water in first year of OWDP operation	\$1,729/AF (+ \$228/AF compared to No-Project)	\$2,057/AF (+ \$689/AF compared to No-Project)
	Net present cost, 30-year operating	+\$0.23 billion relative to No-Project	+\$1.05 billion relative to No-Project

<table>
<thead>
<tr><th>Impacts</th><th>Parameter</th><th>Current Project Design
DBOM with SRF</th><th>Subsurface Intake Design
PPP</th></tr>
</thead>
<tbody>
<tr><td></td><td>timeframe
(as 2019 dollars)</td><td></td><td></td></tr>
<tr><td rowspan="2">Affordability

Affordability impacts to households (with a focus on low-income residents) was assessed against two commonly used affordability parameters.

Results can be dependent on the size of region chosen for analysis – i.e. median household incomes are different for whole retail customer areas or the individual census tracts within. There are ~169 census tracts within the District’s service area.</td><td>Parameter 1 - Water bill as percentage of Median Household Income (<2.5% target)</td><td>Affordability definition is met for all Retail Agencies.

At census-tract level, additional 2 census tracts will not meet affordability target (all within Golden State Water customer area), relative to No-Project.</td><td>Affordability definition is met for all Retail Agencies. At census-tract level, additional 6 census tracts will not meet affordability target (within Golden State Water and Cal American Water Hawthorne customer areas), relative to No-Project.</td></tr>
<tr><td>Parameter 2 - Water bill as percentage of Household Income for lowest 20% income quintile (<5% target).</td><td>Affordability definition is met for all Retail Agencies.

At census-tract level, additional 1 census tracts will not meet affordability target (within Golden State Water customer area), relative to No-Project.</td><td>Affordability definition is met for all Retail Agencies.

At census-tract level, additional 4 census tracts will not meet affordability target (within Golden State Water and City of Inglewood customer areas), relative to No-Project.</td></tr>
<tr><td>Risk transfer</td><td colspan="3">Different delivery models enable the District to transfer different levels of risk to the private sector contractor/s. The value-for-money analysis conducted in this study indicated the benefits of risk transfer from greater private sector involvement do not appear to outweigh the additional risk premium costs that will be charged. DBOM delivery model appears to offer the best value for money over PPP, as well as enabling better access to public grants.</td></tr>
<tr><td>Water Reliability – long-term drought proofing and avoiding shortages</td><td colspan="3">Desalinated water is drought-proof and partially diversifies the District’s supply portfolio away from imported water. If a future multiple dry-year event leads to Regional Shortage declaration by MWD, the local OWDP supply will reduce the amount of cutbacks the District must enforce on its Retail Agencies. For example, if a Regional Shortage Level 3 was declared (as was in 2015), the District and its customers would have access to an additional ~4,800 AFY of potable water.

In addition, the drought proof supply would ‘unlock’ an extra ~16,500 AFY of potable water available to the MWD imported water region as a whole. The economic and social benefits of this additional water supply was not quantified in this study, however some relevant data points for consideration are:</td></tr>
</tbody>
</table>

Impacts	Parameter	Current Project Design DBOM with SRF	Subsurface Intake Design PPP
	• The value of avoided penalty rates for exceeding water consumption limits during Regional Shortage cutbacks, as dictated by the MWD Water Shortage Allocation Plan and the District's Water District Drought Rationing Plan (2015). Under the current frameworks, the value of this water is $1,480 to $2,960 per AF. • Willingness-to-pay and consumer surveys in Southern California that provide a basis for understanding household's perception of the value of increased reliability. Numerous studies have shown a perceived value in the order of hundreds of dollars per household, per year, for improved reliability, including the District's own Water Issues Survey in 2015. • There is limited California-specific data available on economic losses to urban industry and businesses from water restrictions during historical drought cutbacks, but experience from adverse impacts to California's agricultural sector during 2015 as well as global case studies, demonstrates that additional water availability can have immense benefits during the time where it enables economic activity to occur where it would be otherwise unable.		
Water Resiliency – seismic risk	Resilient water supply is one that has better ability to absorb and rebound from a supply shock. The proposed OWDP location is far south from the Southern San Andreas fault. The likelihood of a major earthquake at the fault line closest to the OWDP, the Palos Verdes fault, is at least 5 times lower than the Southern San Andreas. Therefore, the OWDP is at a lower and differentiated seismic risk than imported water supply, and further diversifies the risk since it uses a seawater source that is completely independent of the imported network. The diversification improves the possibility and extent to which partial deliveries can be provided immediately following an emergency event.		
Water Quality – salt and minerals Reduced salt and mineral content in desalinated water can result in avoided maintenance and household costs for appliances and point-of-use treatment systems	Amortized value of benefits to households from reduced salt and mineral content.	$90 to $320/AF of desalinated water production – *Depends on which estimation approach is used.* Value of benefits are higher or lower depending on the baseline water conditions assumed – benefits could be as high $570/AF if blended desalinated water is compared to times of annual maximum salt and mineral content in the District's service area.	
Water Quality - other	The reverse-osmosis treatment process included in the OWDP design is extremely robust at removing contaminants in water. Literature review indicated that there may be potential benefits to customer health, benefits from removal of emerging contaminants which may have regulatory limits in the future (e.g. PFAS/PPCPs). There may also be costs related to cardiovascular disease, algal toxins and horticulture (from boron), though these risks can be adequately mitigated with careful process design.		

Impacts	Parameter	Current Project Design DBOM with SRF	Subsurface Intake Design PPP
Economic stimulus Direct, indirect and induced economic activity will be generated from delivery of a large infrastructure project such as the OWDP, with positive effects on regional employment and supply chain.	Gross Regional Product during construction phase	$249 million within LA County and $767 million within California	$395 million within LA County and $1,224 million within California
	Gross Regional Product during operations phase	$28 million per year within LA County and $38 million per year within California	$29 million per year within LA County and $39 million per year within California
	Employment during construction phase	613 job-years within LA County and 1827 job-years within California	981 job-years within LA County and 2929 job-years within California
	Employment during operations phase	114 job-years within LA County and 150 job-years within California	129 job-years within LA County and 156 job-years within California
Management and Overhead Staffing The District will need to add and restructure management and supervision roles internally to effectively manage the OWDP once operational. As a potable water supplier, the District will be subject to more stringent set of reporting requirements (relative to its existing recycled water portfolio).		District will need to perform ongoing contract management and supervision functions. These engineering, operations, legal, finance, compliance activities may require an additional 7 to 10 FTE.	District will need to perform Water Purchase Agreement compliance monitoring (technical and legal), accounting and invoicing review and O&M interface with plant operators. These activities may require an additional 5 to 7 FTE.
Environmental and Amenity	Environmental and amenity issues were considered extensively during development of the OWDP EIR. The EIR was based on the Current Project Design.	The only impacts identified in the EIR as 'significant and unavoidable' were for construction-related air emissions and noise. Both impacts were assessed to be 'less than significant impact with mitigation' during operation.	The Subsurface Intake Design was not included in EIR. However, the land-based works are essentially the same as the Current Project Design. Marine works in the Subsurface Intake Design include the OPA preferred approaches for SSI, so may have similar or less impact over the long term

10. Glossary

Abbreviation	Meaning	Abbreviation	Meaning
@Risk	@Risk modelling software developed by Palisade Corporation	NDMA	Nitrosodimenthylamine
AF	Acre-foot	NPC	Net Present Cost
AFY	Acre-Feet per Year	NPV	Net Present Value
CAP	Continuous Application Program	NOA	Notice of Availability
CAPEX	Capital Expenditure	NOP	Notice of Preparation
CARB	California Air Resources Board	O&M	Operations and Maintenance
CBA	Cost Benefit Analysis	OWDP	Ocean Water Desalination Project
CDP	Carlsbad Desalination Plant	OPEX	Operations Expenditure
CEQA	California Environmental Quality Act	PAB	Private Activity Bonds
CRA	Colorado River Aqueduct	PCC	Public Contract Code
CRCWSC	Cooperative Research Center for Water Sensitive Cities	PFAS	Poly-fluoroalkyl Substances
CWSRF	Clean Water State Revolving Fund	PFHxA	Perfluorhexanoic Acid
DBB	Design-Bid-Build	PFOA	Perfluorooctanoic Acid
DBFOM	Design-Build-Finance-Operate-Maintain	PFOS	Perfluorooctane Sulfonate
DBOM	Design-Build-Operate-Maintain	POU	Point-of-use
DDW	Division of Drinking Water	PPCPs	Pharmaceuticals and personal care products
(the) District	West Basin Municipal Water District	PPP	Public-Private Partnership (also P3)
DWSRF	Drinking Water State Revolving Fund	PPT	Parts per Trillion
DWR	Department of Water Resources	R&R	Rehab and Replacement
EIFD	Enhanced Infrastructure Financing Districts	RDA	Redevelopment Agencies
EIR	Environmental Impact Report	RO	Reverse Osmosis
EPA	Environmental Protection Agency	ROW	Right-of-way
ESGS	El Segundo Generating Site	RPS	Renewables Portfolio Standard
FTE	Full-time Equivalents	SCAQMD	South Coast Air Quality Management District
GHG	Greenhouse Gas	SCE	Southern California Edison
GO	General Obligation (Bonds)	SDCWA	San Diego County Water Authority
HAB	Harmful Algal Blooms	SPV	Special Purpose Vehicle
INFFEWS	Investment Framework for Economics of Water Sensitive Cities	SRF	(Drinking Water) State Revolving Fund
IO	Input-Output	SWP	State Water Project
IRR	Internal Rate of Return	TDS	Total Dissolved Solids
kWh	Kilowatt Hour	TMs	Task Memorandums
LADWP	Los Angeles Department of Water and Power	UWMP	Urban Water Management Plan
LRP	Local Resources Program (a rebate program by MWD)	VfM	Value-for-Money
MCL	Maximum Contaminant Level	WBMWD	West Basin Municipal Water District
MGD (or mgd)	Million Gallons per Day	WIFIA	Water Infrastructure Finance Innovation Act
MG/L	Milligrams per liter	WIIN Act	Water Infrastructure Improvements for the Nation Act
MMRP	Mitigation Monitoring and Reporting Program	WPA	Water Purchase Agreement
MT/yr	Metric Tonnes per Year	WSAP	Water Supply Allocation Plan
MWD	Metropolitan Water District of Southern California	WTP	Willingness-to-pay
NAD Bank	North American Development Bank	WRD	Water Replenishment District

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