Salton Sea Independent Review Panel Feasibility Report

Independent Review Panel Feasibility Report

Evaluation of Water Importation Concepts for Long-Term Salton Sea Restoration

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Disclaimer

The views and opinions expressed in this Report and its appendices, including any interpretation of objectives or obligations of the state of California with regard to Salton Sea restoration, are solely those of the Independent Review Panel. They do not represent the official policy or position of the state of California.

The geotechnical section of the Report has been prepared in accordance with generally accepted civil engineering practice and makes no other warranties, either expressed or implied, as to the professional advice provided under the terms of our agreement and included in this analysis. This section is for informational purposes only in this feasibility study and should not be considered part of the contract documents or any type of design or inference of design.

The engineering opinions expressed in this Report represent an interpretation by the Panel and support team of the regulatory standards, the required material properties, and the general soil conditions based on available public information as per the planned approaches.

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Acronyms and Abbreviations

AF	acre-feet
AFY	acre Feet per Year
B	billion
bgs	below ground surface
BHP	brake horsepower
BoR	Bureau of Reclamation
CADFW	California Department of Fish and Wildlife
CADWR	California Department of Water Resources
CDFG	California Department of Fish and Game
CDPH	California Department of Public Health
CDWR	California Department of Water Resources
CEQ	Council on Environmental Quality
CEQA	California Environmental Quality Act
CFE	Federal Electricity Commission
CH_4	methane
CNIE	National Commission for Foreign Investment
CNRA	California Natural Resources Agency
CO_2	carbon dioxide
CO_2E	carbon dioxide equivalent
CPI	Consumer Price Index
cy	cubic yards
DWR	Department of Water Resources
EIR	Environmental Impact Report
EIS	Environmental Impact Statement
ESA	Ecological Society of America
FIL	Foreign Investment Review
ft	feet
ft/s	feet per second
GHGs	greenhouse gases
GWP	global warming potential
HGL	hydraulic grade line
IBWC	International Boundary and Water Commission
IID	Imperial Irrigation District
kWh	kilowatt hours

M	million
MAF	million acre-feet
MAFY	million acre-feet per year
MGD	million gallons per day
mg/l	milligrams per liter
mmol	millimole
msl	mean sea level
MW	megawatt
N_2O	nitrous oxide
NEPA	National Environmental Policy Act
NPDES	National Pollutant Discharge Elimination System
OBUs	omissions, biases, and uncertainties
OSHA	US Occupational Safety and Health Administration
Panel	Independent Review Panel
$PM_{2.5}$	particulate matter 2.5 microns or less in size
PM_{10}	particulate matter 10 microns or less in size
psi	pounds per square inch
QSA	Quantification Settlement Agreement
RFI	request for information
RNIE	Foreign Investment Registry
RO	reverse osmosis
SEN	Sistema Eléctrico Nacional
SEMARNAP	Secretariat of Environment, Natural Resources, and Fisheries
SSAM	Salton Sea Accounting Model
SSMP	Salton Sea Management Program
SWRCB	State Water Resources Control Board
TBD	to be determined
TBL	triple bottom line
TM	technical memorandum
US	United States
USD	US Dollars

Executive Summary

Introduction

This report is a product of the Independent Review Panel (Panel) evaluating long-term water importation solutions that were submitted in response to a request for information (RFI). The Panel was convened as part of Agreement # 4600014042 between the State of California Salton Sea Management Program (SSMP) and the University of California, Santa Cruz (Brent Haddad, Ph.D., Principal Investigator). This report is the third product of the Panel, after completion of the screening and fatal flaw reports.

In the review process, the Panel first screened submissions for compliance with the RFI (Screening Report). The Screening Report removed five responses from consideration due to non-conformance with the RFI, leaving thirteen. The Panel then examined these for fatal flaws (Fatal Flaw Report). The Fatal Flaw Report found that three responses did not have fatal flaws.

This report evaluates the feasibility of responses which were judged by the Panel to have no fatal flaws. Due to substantial similarities in the responses, such as drawing water from the north-western Sea of Cortez region and piping it to the Salton Sea, they were examined jointly in this Feasibility Report as a single water importation approach, the "Sea of Cortez Import Concept". As part of the research into long-term water importation solutions, the Panel evaluated other projects and ideas, including one that has been presented to the International Boundary and Water Commission (IBWC). This resulted in two additional concepts being included in this Feasibility Report: the "Sea of Cortez Exchange Concept" and the "Colorado River Voluntary Transfer Concept."

Summary of the Concepts Evaluated

Sea of Cortez Import Concept

The major components/facilities of this concept are as follows:

- Desalination at the Sea of Cortez
- Conveyance of desalinated water from the Sea of Cortez to the Salton Sea
- Additional desalination at the Salton Sea to further reduce salinity. Two sizes of remediation desalination facilities were evaluated. Scenario 1 includes a 13.5 million gallons per day (MGD); Scenario 2 includes a 100 MGD facility.

Sea of Cortez Exchange Concept

The major components/facilities of this concept are as follows:

- Desalination at the Sea of Cortez
- Conveyance of desalinated water from the Sea of Cortez to Mexico's Morelos Dam, located on the Colorado River
- In exchange for delivery of desalinated water to Morelos Dam, equivalent Colorado River water is provided to Salton Sea via the All-American Canal.
- Remediation desalination at the Salton Sea to further reduce salinity

Colorado River Voluntary Transfer Concept

The major components/facilities of this concept are as follows:

- Remediation desalination at the Salton Sea to reduce salinity
- Water is made available through voluntary fallowing in the Imperial Irrigation District (IID) service territory and transferred to the Salton Sea

Findings

The high-level analysis of the concepts evaluated found that all three concepts are technically feasible. However, the three concepts evaluated have differing environmental impacts, levels of uncertainty related to permitting, and likelihood of realizing project benefits. The three concepts also differ considerably in terms of cost.

Next Steps

The Panel will consider the results of the feasibility analysis and provide a comparative analysis, conclusions, and recommendations in its final deliverable, the Summary Report. The Summary Report will consist of an overview of the Panel's work and findings, followed by recommendations by the Panel for actions to be taken for restoration of the Salton Sea.

Section 1: Introduction

Executive Order N-10-19 calls for the California Natural Resources Agency (CNRA), the California Environmental Protection Agency, the California Department of Food and Agriculture, in consultation with the Department of Finance, to develop a Water Resilience Portfolio for the State of California. The final Portfolio contains a series of recommendations to improve California's ability to adaptively manage water resources. The Water Resiliency Portfolio specifies that the State of California will complete an independent feasibility analysis of water importation options for the Salton Sea. To facilitate this process, the California Department of Water Resources (DWR) procured the services of an independent third-party evaluation team – hereafter the Independent Review Panel (Panel).

Concurrently, the State Water Resources Control Board (SWRCB) adopted revised Order WRO 2002-0013. This order established a framework for Salton Sea Restoration and calls for the CNRA to develop a long-term plan for Salton Sea Restoration, which could include water importation. To this end, the CNRA issued a request for information (RFI), looking for concepts to improve the Salton Sea through water importation.

This report is a product of the Panel evaluating long-term water importation solutions that were submitted in response to the RFI. The Panel was convened as part of Agreement # 4600014042 between the State of California Salton Sea Management Program (SSMP) and the University of California, Santa Cruz (Brent Haddad, Ph.D., Principal Investigator). This report is the third product of the Panel, after completion of the screening and fatal flaw reports.

1.1 The Review Process

On two occasions, the SSMP (2017) and Panel (2021) issued a public RFI asking for water-importation-based approaches to restore the Salton Sea. A total of 18 concepts were received. They were reviewed by the Panel with the assistance of a research and analysis support team. The review process included the following steps:

- Screening of the 18 responses for compliance with RFI requirements (Screening Report)
- A fatal flaw analysis of the remaining submissions (Fatal Flaw Report)
- Detailed feasibility studies of the remaining responses (this report)
- A Summary Report with comparative analysis, conclusions and recommendations

As shown above, the Panel proceeded in their review of the RFI responses in two parts: screening and feasibility. The screening process itself was divided into two parts, the initial screening of submissions for compliance with the RFI (Screening Report), and an examination of submission for fatal flaws (Fatal Flaw Report). The Screening Report removed five responses from consideration due to non-conformance with the RFI, leaving 13 for the fatal flaw analysis. The Fatal Flaw Report served as the first substantive review of the remaining 13 responses. This report concludes the feasibility analysis of the three responses that were found to have no fatal flaws.

1.2 Purpose of this Report

This report evaluates the feasibility of responses which were judged by the Panel to have no fatal flaws. Due to substantial similarities in the three responses without fatal flaws, they were examined jointly in this Feasibility Report as a single water importation concept, the “Sea of Cortez Import Concept”. Research done related to long-term water importation solutions, identified other projects and actions that could benefit the Salton Sea and this resulted in two other concepts for inclusion in this Feasibility Report, the “Sea of Cortez Exchange Concept” and the “Colorado River Voluntary Transfer Concept.”

Section 2: Approach to Technical Analysis and Cost Assumptions

This section details the methodology used in the technical, economic, and benefits analysis.

2.1 Technical Analysis

2.1.1 Evaluating Feasibility of Planning and Permitting

To evaluate the feasibility of planning and permitting water importation project(s), the Panel reviewed the processes used to implement past binational water projects. In addition, the Panel undertook research to understand the resource trustee agencies and their permitting processes in both the US and Mexico.

The Panel did not engage with the agencies or governments listed in this section to evaluate feasibility of permitting under current political climates. Rather, the evaluation identified potential permitting requirements and conformance to established processes.

2.1.1.1 International Boundary and Water Commission

A project that will involve infrastructure that either: (a) crosses the US–Mexico international boundary, (b) includes infrastructure in both countries, or (c) affects the terms of treaties governing management of the Colorado River will require the involvement of the IBWC.

The U.S. and Mexico established the International Boundary Commission in 1889 to review and apply the rules of the various treaties and conventions that govern the management of the US-Mexico Border. Now known as the International Boundary and Water Commission (IBWC), its mission is to provide a framework to find binational solutions to issues related to boundary delineation, national ownership of waters, sanitation, water quality, and flood control in the border region. The Water Treaty of February 3, 1944, Article 24, expanded the jurisdiction of the IBWC:

> To initiate and carry on investigations and develop plans for the works which are to be constructed or established in accordance with the provision of this and other treaties or agreements in force between the two Governments dealing with boundaries and international waters; to determine, as to such works, their location, size, kind and characteristic specification; to estimate the cost of such works; and to recommend the division of such costs between the two Governments, the arrangements for the furnishing of the necessary funds, and the dates for the beginning of the works….

Coordination through the IBWC would involve a multi-step process, starting with project definition and approval, then development of an agreement on design and operation and maintenance costs, then construction and cost sharing, and finally startup and operations. Key to approval of a project through the IBWC is: (a) having a project that meets the objective of

IBWC Minute 323 to increase delivery and exchange of waters in a way to benefit both Mexico and the US, and (b) incorporating design features and mitigation that limit impacts to sensitive resources.

2.1.1.2 Cooperation with Trustee Agencies of Mexico

Several trustee agencies of Mexico are likely to be involved in a binational project, including any work involving US federal funds and commitments. Any project that could have an economic impact, any work that could affect sensitive habitats and sensitive species, and any work that could alter local land use and provision of public services is subject to negotiation with trustee agencies. Likely participants are described here, although other agencies could also participate.

Trustee agencies related to economic activity, foreign investments, and public–private partnerships include:

- Directorate General of Foreign Investment
- Ministry of the Economy
- Ministry of Finance and Public Credit
- The applicable state government (such as the State of Sonora Mexico or State of Baja California)

The mission of these agencies is to encourage investment in public services and economic development in Mexico with an emphasis on projects that have the greatest social benefit.

Trustee agencies related to protection of natural resources include:

- The Secretariat of the Environment, Natural Resources, and Fisheries (SEMARNAP). This department in turn has five decentralized departments:
    - National Water Commission
    - National Institute of Ecology
    - Federal Agency for the Protection of the Environment
    - National Institute of the Fishery
    - The Mexican Institute of Water Technology
- The applicable state government (such as the State of Sonora or State of Baja California)

These agencies seek to protect sensitive resources, such as maritime zones, fish and wildlife preserves, and forested lands within Mexico. These agencies also seek to ensure compliance with applicable laws governing appropriate construction methods, waste disposal, and air emissions.

Trustee agencies related to regulation of land use and protection of public services include the applicable Mexican state government and local municipalities as well as the Federal Electricity Commission (CFE) and Secretariat of Communication and Transportation. The mission of these agencies is to ensure that new development does not negatively impact or overburden existing public services.

2.1.1.3 Cooperation with Trustee Agencies of the United States

Like Mexico, the United States (US) has agencies that focus on regulation and protection of specific natural resources and of public services. Protection of natural resources would include both federal and state of California agencies, such as:

- US Fish and Wildlife Service
- California Department of Fish and Wildlife
- California Natural Resources Agency
- California Department of Water Resources
- State Water Resources Control Board (water rights)
- Colorado River Regional Water Quality Control Board (water quality)
- US Army Corps of Engineers (protection of navigation and wetlands)
- Imperial County Air Pollution Control District
- US Bureau of Reclamation (consistency with laws governing management of Colorado River water)
- National Marine Fisheries Service

These various agencies work to preserve environmental resources (water, wildlife, air quality) and generally have discretionary power to modify projects or require project mitigation to avoid significant negative impacts.

Agencies interested and focused on orderly development of lands and protection of public services would include:

- US Bureau of Reclamation (protection of agency-managed infrastructure)
- Imperial County (protection of land and roadways)
- California Department of Transportation
- US Navy (protection of Naval facilities)
- Bureau of Land Management (protection of lands owned/operated)
- Department of Defense (protection of lands owned/operated)
- Imperial Irrigation District (IID); protection of electrical infrastructure and lands owned/operated)
- Coachella Valley Water District

2.1.1.4 Need for Cooperation with Tribal Governments

Cooperation with tribal governments is an essential component of project success. The project team reviewed maps developed by the US Environmental Protection Agency and the State of California to identify tribal lands and tribal assets in and around the Salton Sea, Lower Colorado River, and Sea of Cortez. Lands of the following tribes were identified as being potentially affected:

- Agua Caliente Band of Cahuilla Indians

- Agustine Band of Cahuilla Mission Indians
- Barona Group of the Capitan Grande
- Cabazon Band of Mission Indians
- Cahuilla Band of Indians
- Campo Band of Diegueno Mission Indians
- Chemehuevi Tribe
- Cocopah Indian Tribe
- Diegueno Kwaaymii Laguna Band of Mission Indians
- Ewiiaapaayp Band of Kumeyaay Indians
- Fort Mojave Indian Tribe
- Iipay Nation of Santa Ysabel
- Inaja-Cosmit Band of Indians
- Jamul Indian Village
- Kumeyaay Tribe
- La Posta Band of Diegueno Mission Indians
- Los Coyotes Band of Cahuilla and Cupeño Indians
- Diegueno Kwaaymii Laguna Band of Mission Indians
- Manzanita Band of Kumeyaay Nation
- Mesa Grande Band of Diegueno Mission Indians
- Morongo Band of Mission Indians
- Quechan Tribe of the Fort Yuma Reservation
- Ramona Band of Cahuilla
- San Pasqual Band of Diegueno Mission Indians
- Santa Rosa Band of Cahuilla Indians
- Soboba Band of Luiseno Indians
- Sycuan Band of the Kumeyaay Nation
- Tohono O’odham Tribe
- Torres-Martinez Desert Cahuilla Indians
- Twenty-Nine Palms Band of Mission Indians
- Viejas Band of Kumeyaay Indians

Available information on tribes within Mexico was limited. Additional outreach should be conducted to include all potentially impacted tribes.

2.1.2 Evaluating Feasibility of Construction and Operation

This Feasibility Report has been prepared in accordance with generally accepted civil engineering practice and makes no other warranties, either expressed or implied, as to the professional advice provided and included in this study. These sections are for informational purposes only and should not be considered part of the contract documents or any type of design or inference of design.

2.1.2.1 Geotechnical Considerations

A geotechnical assessment was prepared to provide a general understanding of geotechnical issues. The geotechnical work performed for this study consists of data review and review of documents provided by others. No field work was performed during this feasibility study. The assessment attempts to provide for normal contingencies, but the possibility remains that unexpected conditions may be encountered during design and construction.

The basic physical layout and potential subsurface conditions likely to be encountered (based on literature reviewed) were used to identify the physical constraints and challenges associated with the proposed water importation concepts (Section 3). At this conceptual planning level, no final design plans/specifications or as-built drawings/reports were available for review at the time of this reporting. All geotechnical and geological information reviewed relates to available data collected in the general region of a given concept and is not considered to be within the exact known position of any structure or pipeline alignment or necessarily representative of current conditions.

Topics considered in the geotechnical review of each concept include earth materials likely to be encountered (including shrink/swell potential, corrosivity), geologic hazards (liquefaction, expansive soils, corrosive soils), seismic hazards, slope stability during excavation, the potential for groundwater or perched water to affect excavation, and the suitability of a site to support the structures proposed or the need to provide deep foundations.

2.1.2.2 Hydraulics

The hydraulic feasibility of a given concept was evaluated by mapping the anticipated project facilities, the estimated elevation, and then determining the required size of pumping facilities to achieve the needed lift. A pipeline velocity target of 6 feet per second (ft/s) was used as a basis to determine the diameter of the pipelines. The estimated pressures within pipelines were calculated and a pipe material suitable for the anticipated pressure selected for the cost estimate.

2.1.2.3 Other Construction Considerations

Utility Conflicts

Factors affecting the location of project facilities include the land requirements at the imported water source (Sea of Cortez) and the Salton Sea, and avoidance of sensitive environmental resources including protected areas. At the current level of study, the location of project facilities (treatment plants, tanks, pump stations) is not known in any detail. This Feasibility Report did not undertake special efforts (e.g., review of record drawings for electric, water, gas, petroleum, or other utilities) to examine the potential for utility conflicts.

Energy Requirements and Recovery

Energy demands for the pump stations were estimated using the known lift, volume, pump efficiency, and assumed operational parameters (e.g., operated continuously in all seasons). The project team estimated energy demands for the desalination facilities based on other similar (i.e., reverse osmosis [RO]) and like-sized facilities. Where information on a like-sized facility was not found, we scaled the energy requirements from existing information.

Once the project hydraulic profile was established, we contacted vendors to gather information on the acceptable technology for a given concept. We established the potential for energy recovery though informal discussions with vendors/manufacturers.

2.1.3 Evaluating Technical Performance

The Salton Sea Accounting Model (SSAM), a spreadsheet model, was used to estimate the Salton Sea average salinity, Salton Sea elevation and resulting Salton Sea surface area and exposed playa area under different imported water inputs. Descriptions of the SSAM can be found in the Fatal Flaw Report.

Benchmarks and targets for long-term Salton Sea restoration were largely developed as part of the fatal flaw analysis. Details about these benchmarks and targets can be found in the Fatal Flaw Report.

2.1.3.1 Water Quality

The Panel developed specific criteria against which to measure project performance. The water quality requirements were directly derived from the need to protect fish, birds, and invertebrates that live in or utilize the Salton Sea. As documented in Technical Memorandum (TM) 8.2, fish species that recently occupied the Salton Sea (e.g., tilapia, sailfin molly) can survive in water salinities between 45,000 milligrams per liter (mg/L) to 60,000 mg/L, dependent on temperature. These fish species' populations decline sharply at water salinities above 60,000 mg/L as their reproduction and survival rates are lowered. Very few fish can survive in waters with greater than 70,000 mg/L salinity, including tilapia. In addition, the invertebrates that serve as the base of the current Salton Sea food web (e.g., brine shrimp and brine flies) do not survive well at salinities above 70,000 mg/L. Without fish and invertebrates to supply a food source, migratory birds will not continue to utilize the Salton Sea during migration or breeding, or will stop over to feed during migration but fail to gain sufficient weight to continue their migration due to low foraging rates. Thus, the Panel considers a salinity level of greater than 70,000 mg/L as a threshold beyond which complete ecosystem collapse is likely. Water salinities lower than 70,000 mg/L are desirable as these conditions will progressively support a greater variety of fish and invertebrates, which then provide a seasonal food source for migrating and resident birds. The 2007 Programmatic Environmental Impact Report (EIR) identified a target salinity range of 20,000 – 40,000 mg/L for regions supporting fisheries (California Department of Water Resources 2007). While the Panel did not develop a set salinity target, achieving a salinity of 40,000 mg/L or lower would increase the potential biodiversity attainable at the Salton Sea. Therefore, technical performance of the various candidate concepts related to water quality will be based on the following:

- Achieves a salinity favorable to the widest range of fish and invertebrates that can then support a variety of birds, at a salinity less than 40,000 mg/L
- Achieves a salinity supportive of fish, birds, and invertebrates, with a salinity less than 60,000 mg/L
- Achieves a salinity favorable to a select group of fish and invertebrates that can then support a variety of birds, at a salinity of greater than 60,000 but less than 70,000 mg/L

Other water quality concerns in the Salton Sea include the presence of heavy metals, selenium, nutrients, and pesticides. Proposed remediation treatment at the Salton Sea will be evaluated for their performance removing these constituents.

2.1.3.2 Water Quantity

Salton Sea hydrology is controlled by complex interactions between agricultural management practices, hydrology, urban use, evaporation, surface water–groundwater interactions, and water policy. Inputs to the Salton Sea come from the Colorado River, precipitation, agricultural and wastewater runoff, stormwater, and the Alamo River, New River, and Whitewater River. However, these inputs have declined over time and evapotranspiration and evaporation now exceed the inputs, and hence the Salton Sea volume and surface area are shrinking. Evaporation is the largest share of the Salton Sea water budget, representing an annual loss of over 1.2 million acre-feet per year (MAFY).

The Panel did not set a specific benchmark for water input. Studies performed for the Salton Sea Ecosystem Restoration Final and Draft Programmatic EIR (2007) indicate that the shoreline water surface elevation needs to be at least –228 ft to –230 ft to allow connectivity to the existing shoreline land uses and facilities, including boat docks and canals that flow into the Salton Sea. This minimum shoreline surface elevation allows boats to continue to access the Salton Sea from the canals. This elevation range also would allow for gravity flow from the New River, Alamo River and IID canals into the Salton Sea. Water surface elevations greater than –228 ft can lead to flooding of the northern and eastern shorelines.

2.1.3.3 Playa Exposure

Decreasing inflows and declining water surface elevations are shrinking the surface area of the Salton Sea, exposing the shoreline soils, or playa. Windblown dust from the playa may have air quality effects in nearby and distant communities.

In the fatal flaw analysis, one of the Panel's criteria for responses was to reduce exposed playa and/or utilize dust control measures. Specifically, exposed playa area should be reduced to levels consistent with the exposed playa area prior to 2018, when mitigation inflows to the Salton Sea stopped as a part of the Quantification Settlement Agreement (QSA). To achieve this reduction in the exposed playa area, Salton Sea water level should be equivalent to the water level prior to 2018, corresponding to a water level of –237 ft. If playa exposure exceeds this 2018 benchmark, the Panel required that dust control measures must be employed to reduce the emissivity of acreage equivalent to the remaining exposed playa. As a part of the SSMP 10-Year Plan, dust mitigation on approximately 30,000 acres of playa is planned by 2028. Responses that do not meet the water level of –237 ft may be credited up to 30,000 acres of dust mitigation by SSMP planned activities. Feasibility for mitigating exposed playa beyond this water level was evaluated by the Panel based on existing dust mitigation projects.

2.2 Economic Analysis

2.2.1 Approach to Capital Cost Estimates

Costs were developed in 2022 US Dollars (USD) and should be considered conceptual as is appropriate for the level of design completed at this feasibility study stage. The range of accuracy of the estimate is consistent with an Association for the Advancement of Cost Engineering Class 5 conceptual estimate of –50% to +100%. Where possible, the Panel used general costing resources, such as RS Means, which utilizes aggregate costs from recent construction projects, to estimate project cost. Where general cost databases were insufficient, we reviewed recent bids for similar facilities. Where design had not proceeded enough to estimate specific equipment or quantities (e.g., such as treatment facilities and pump stations), costs from similarly sized facilities were scaled to provide an estimate of cost.

2.2.2 Easement and Land Acquisition Cost Assumptions

The project team performed a desktop review on recent land sales in Imperial County, California, Baja California, and Sonora, Mexico, to develop an average cost of land acquisition. However, this desktop study was not extensive enough to identify land attributes (proximity to public services, zoning, proximity to the Salton Sea) that may significantly affect land value. For the purposes of this Feasibility Report, land in Sonora Mexico, Baja California Mexico and Imperial County is assumed to be $16,000/acre (USD). Acquisition of an easement is assumed to be half the cost of land acquisition or $8,000/acre (USD).

2.2.3 Approach to Operations and Maintenance Costs

The project team developed operations costs from operations of similarly sized facilities or by scaling known costs from like facilities. Operational costs included energy, labor, and chemicals. Given the conceptual nature of design at this time, maintenance costs for a given facility were assumed to be a percentage of capital costs.

2.2.4 Cost Offsets

The only cost offset anticipated at this time is hydropower production. Product information from vendors was used to estimate hydropower and energy cost offsets.

2.2.5 Other Cost Assumptions

Water purchase cost is assumed to be the same as purchasing a like amount of water from a lower Colorado River retail agency, such as IID.

Studies, permitting, and preliminary design are assumed to be 15% of capital costs.

2.2.6 Life Cycle Costs

Life cycle cost is an approach that assesses the total cost of an asset over its life cycle including initial capital costs, maintenance costs, operating costs, and the asset's residual value at the end of its life. The life cycle cost assessment is an economic evaluation of an engineering project across its lifetime, which helps inform the best alternative when looking at a suite of alternatives based on the least cost.

For the purpose of life cycle costs in this Feasibility Report, the analysis assumed initial costs to include the cost of planning, permitting, construction, land acquisition, and easement acquisition. It is further assumed that the initial costs would be financed through the sale of bonds and that the bond repayment term will be 4% over 30 years. The base year for the analysis is 2022 with the various concepts assumed to be in operation until 2078. Operational and maintenance costs were assumed to begin after construction is complete and the year in which operations begin. Each project cost was summed up to create a total cost in current dollars. A discount rate of 4% was used for the calculation. For simplification, it was assumed that the residual value of the infrastructure after 2078 is $0.

2.3 Benefits Analysis

A cost–benefit analysis framework was used to calculate and describe project benefits that would occur if water importation concepts were implemented. This systematic approach identifies and measures the full suite of benefits that may result from water importation at the Salton Sea. Where possible, benefits were quantified and monetized over the life of the project.

Due to time and resource constraints, a primary economic valuation of the specific resource and region was not conducted. Instead, values that were available in the existing scientific literature were utilized. The quality and quantity of information varied across benefit categories. Benefits were quantified and monetized where possible and appropriate. A qualitative description of the benefits is provided where quantification and monetization were not possible. Detailed descriptions of the methodological approaches are provided within each benefit category below.

Table 2-1 provides a summary of the benefit categories included and whether they are monetized or described qualitatively.

Table 2-1: Other Benefits Anticipated from Water Importation Concepts

Benefit Category	Qualitatively Described or Monetized
Economic revitalization	**Monetized**
Tourism and Recreation	Monetized
Real estate development	Monetized
Property tax	Monetized
Property value	Monetized
Ecosystem service enhancements	Qualitatively Described
Air quality and human health improvements	Qualitatively Described
Water quality in the Mexicali region	Qualitatively Described

Annualized values that could be reasonably applied to the benefits of water importation were identified from published studies and the monetized values were converted to 2022 USD using the consumer price index (CPI)[1]. Present values of the benefits were calculated with the following inputs:

- Discount rate of 3% to account for the social time preference of money and estimate the stream of benefits to society.
- Benefits begin accruing after project implementation and ramp up linearly over a 10-year time frame.
- Annual benefits through the last year of analysis, 2078, included.

2.3.1 Economic Revitalization

Since its peak in the late 1950s and early 1960s, recreation and economic development around the Salton Sea has declined due to a variety of factors, including changes to water levels, bird and fish die-offs due to eutrophication and high salinity, and health threats of untreated water (Sheikh and Stern, 2021; Cohen, 2014). The water importation concepts have the potential to improve the area's overall aesthetics and increase recreation and tourism by creating/restoring habitat conducive to recreation (e.g., boating, fishing, birding) and related tourism. These benefits are likely to subsequently attract new development and spur economic growth. There are several real-world examples where restoration of degraded environmental conditions has led to economic revitalization of the surrounding communities (e.g., Delavan Lake, WI; Onondaga Lake, NY; *see* Tourism Economics, 2017).

[1] Dollar values updated to 2022 values using the Consumer Price Index (per https://www.bls.gov/data/inflation_calculator.htm)

To estimate the benefit of economic revitalization associated with the water importation concepts, we relied on a study done by Tourism Economics in which the authors analyzed the potential economic benefits of a hypothetical restoration scenario of the Salton Sea. The outcomes of the hypothetical scenario are likely to differ from the projected outcomes of the water importation concepts analyzed here. Nonetheless, transferring the values offers a conceptual estimate of the benefits of the importation concepts. The specific economic benefits included are:

- Tourism and recreation
- Real estate development and property tax impact
- Property value impact

The Tourism Economics (2017) study made the following assumptions:

- The sea is characterized as having (p. 33):
    - approximately 23,000 acres of lake surface area, where the perimeter lake is separated into water cells with areas up to 25 feet deep suitable for boating and 130 miles of shallow habitat along the existing shoreline;
    - approximately 18,000 acres of habitat areas with a total lake and wetland area of 41,000 acres.
- The community/surrounding area is characterized as (p. 32)
    - stable, vibrant and diverse lake and wetlands;
    - offer a range of natural habitats, attracting and sustaining a diverse base of wildlife, including birds and fish;
    - offer extensive areas for outdoor recreation, including substantial areas for boating, swimming, fishing, hiking, bicycling, and wildlife observation and education;
    - offer proximate areas for development of visitor facilities, including marinas, boat launches, campgrounds, RV facilities, restaurants, resorts, hotels, other accommodations, educational and interpretive facilities, and other visitor attractions; and,
    - be stable, in the sense that the water level, quality and related aspects would be controlled and supportive of wildlife, but also stable from a financial and regulatory perspective, with sufficient clarity on financial resources, responsibility, and commitments to provide a predictable setting for real estate development.

There is large uncertainty in predicting the characteristics of the Salton Sea and surrounding communities that will result from water importation. When comparing benefits to costs, note that none of the water importation concepts will result in the full benefits of the hypothetical scenario analyzed in Tourism Economics (2017). Rather, the importation concepts will provide the necessary first step for potential economic revitalization. For purposes of this analysis, the projected economic benefits estimated in Tourism Economics are used but with several caveats and additional scaling.

This analysis is composed of the following steps:

1. Gain an understanding of the baseline economic levels. The analysis assumed that economic levels under the no-importation scenario would be similar to levels experienced today.
2. Scale the values provided in Tourism Economics (2017) to account for the anticipated lower level of economic revitalization from the water importation concepts compared to the 2017 study's projected scenarios. The level of economic revitalization provided in Tourism Economics (2017) is based on several factors outside the scope of the water importation concepts (e.g., offer proximate areas for development of visitor facilities, including marinas, boat launches, campgrounds, RV facilities, restaurants, resorts, hotels, other accommodations, educational and interpretive facilities, and other visitor attractions). Without these, the benefits provided by the water importation concepts are likely to be lower than the benefits in Tourism Economics (2017). This underestimation is partially offset by the additional sea surface area resulting from the water importation concept, roughly 230,000 acres, vs. the 23,000 acres estimated in the Tourism Economics model, which was not based on water importation. Given the uncertainty in the expected characteristics of the Sea and surrounding communities, a range of scalars is applied. Specifically, quartile-scalars are applied to the inputs from the study: 25%, 50%, and 75%.
3. Conduct a value transfer and apply the scaled annual benefit values to the expected outcome under the water importation concepts, including applying the expected time frame and discount rates. The analysis assumed a linear increase in annual benefits for 10 years starting the year after the project is complete. A constant annual benefit into the future is also assumed.
4. The results of the analysis are presented as a range of potential benefits using the quartile scalars and discuss the potential impact on the proximate areas surrounding the Salton Sea.

2.3.2 Ecosystem Services

Environmental goods and services, such as habitat improvements to sustain local and migrating wildlife populations, are difficult to value first because there is no market price for them. These goods and services generate what is often referred to as "nonuse values" and require a "nonmarket valuation" approach to determine their economic value or benefit to society. These nonmarket valuation approaches typically involve primary data collection, such as through well-designed and executed primary research studies, such as valuation surveys. Moreover, they are difficult to value because of the complexities of the systems themselves. For example, at the Salton Sea, average salinity levels might suggest near-uninhabitability for fish and therefore fish-eating birds. However, zones near river inflows could have lower salinity enabling fish and birds to survive beyond what the average salinity suggests. A benefits estimation would be based on complex modeling of area salinity levels and their impacts on fish and bird populations. This leads to yet another issue – the high cost of undertaking an ecosystem benefits analysis means that they are rarely undertaken at a level of detail that addresses all the issues.

In the absence of specific, targeted studies, nonmarket values from available published studies could be applied to an unstudied site of interest. This valuation can be done using a more-rigorous "benefit transfer" approach or a less rigorous "value transfer" approach (Parson and Kealy, 1994).

To date there has been no primary research done (e.g., valuation surveys) to determine the value of ecosystem services provided by the Salton Sea. Due to time and resource constraints, primary research or a rigorous benefits transfer analysis were not possible. Instead, a study conducted by Schwabe and Baerenklau (2007) that reviewed the literature on nonmarket valuation studies for related ecosystems or habitats, was relied upon and a value transfer method utilized to gauge the plausible range of nonmarket or nonuse benefits provided to California residents by a restored and preserved Salton Sea. Schwabe and Baerenklau (2007) reviewed 23 studies. The most relevant of these included seven studies that evaluated the value of wetlands and wildlife in the San Joaquin Valley and three studies that evaluated the value of the Mono Lake ecosystem.

Based on value estimates from these 10 studies, Schwabe and Baerenklau (2007) reported a "conservative order of magnitude" estimate of the value of Salton Sea ecosystem services, that when applied to the Salton Sea, indicate values between $1.5 and $7.5 billion each year (escalated to 2022 USD using the CPI). There are several caveats to keep in mind when interpreting this finding.

- The studies relied on by Schwabe and Baerenklau (2007) are now up to 34 years old, and the social and demographic landscape is different than what it is today.
- While there are similarities between the Salton Sea and the San Joaquin Valley and Mono Lake, they are not the same ecosystem nor are the populations surrounding them the same.
- Schwabe and Baerenklau (2007) did not adjust for different time horizons over which services would be provided.

As stated in Schwabe and Baerenklau (2007), "these arguments should not be interpreted as justification for discounting or inflating the values… but they should be interpreted as strong motivation for treating the value transfers as suggestive estimates." They further state that the stated range of benefits is likely lower than the actual value given the uniqueness of the Salton Sea. Schwabe and Negris (2008) characterize some of the unique qualities of the Salton Sea that likely drive its nonuse value.

> The Salton Sea is ranked as the second highest birding area in the nation. Indeed, 90% of the North American population of eared grebes (*Podiceps nigricollis Heermann*), more than 80% of the entire western U.S. population of white pelicans (*Pelecanus erythrorhynchos Gmelin*), and nearly half of the U.S. population of Yuma clapper rails (*Rallus longirostris yumanensis Dickey*), an endangered subspecies, utilize this habitat. The Sea is one of the two nesting areas in the western U.S. for gull-billed terns (*Gelochelidon nilotica Bancroft*), a bird

> proposed for listing as a threatened species. From a fishery perspective, the Sea has supported eight species of fish, including the federally endangered desert pupfish (*C. macularius*).

To ground the Schwabe and Baerenklau (2007) estimates, the project team evaluated recent literature on the valuation of similar ecosystem services. Camacho et al. (2013) conducted a meta-analysis of wetland valuation estimates and provided value estimates for different types of ecosystem services including the monetized values reported in Camacho et al. (2013) for wetlands that provide water quality and biodiversity services. The values of annualized benefits of wetlands providing biodiversity and water quality are $40,000 and $120,000 per acre, respectively. To compare the estimated value of ecosystem services expected from water importation at the Salton Sea, the dollar-per-acre value of one of the mid-range studies used in Schwabe and Baerenklau (2007) that reflects the annualized benefit of habitat created/restored in the San Joaquin Valley could be used. This value is $75,000 per acre, which falls almost at the midpoint of the estimates reported in Camacho et al. (2013). While this ground-truthing does not eliminate the uncertainty contained in the estimated values of ecosystem services, it provides additional context related to the valuation of similar ecosystem services.

Quantified benefits are calculated as the difference between the outcome under a baseline scenario compared to the outcome under the scenario being analyzed (i.e., implementation of the "Concept"). In the case of ecosystem services, both outcomes are uncertain and numerous assumptions would have to be made to be quantify the difference between the two. Adding to the uncertainty is the low reliability of transferring dated environmental benefits estimates from other ecosystems to the Salton Sea ecosystem. Therefore, this analysis does not attempt to quantify and monetize the benefits of ecosystem services due to water importation. As an alternative to quantifying and monetizing the benefits, a qualitative estimate of the direction and relative magnitude of ecosystem service benefits of water importation is included.

2.3.3 Air Quality and Human Health

One of the largest concerns at the Salton Sea is the negative effect of increased playa exposure on air quality and human health due to the particulate matter, toxins, microbes, and allergens in the dust. The Salton Sea Task Force recently called the situation at the Salton Sea "a growing public health crisis as exposed shoreline exposes potentially toxic dust to local and regional communities" (Fogel et al., 2020, p. 13). Cohen (2014) estimated the public health costs of inaction in the billions of dollars.

The amount of benefit to human health of restoring the Salton Sea, while agreed to be positive, is not well understood and lacks consensus among scientists. Sheikh and Stern (2021) describe this lack of consensus:

> Some scientists support the premise that dust from exposed playa in the sea is the cause of respiratory illness in local communities… At the same time, some scientists assert that it is difficult to assess how increasing playa exposure is affecting air quality, because

monitoring data vary due to wind patterns and the location of monitoring sites relative to the sea. These scientists contend that air pollution in the region also may be caused by stirring up the surrounding desert and by other natural sources; they recommend more studies.

Lack of understanding of the baseline is another factor which limits the ability to measure the benefit to human health and the ability to quantify and monetize the benefits. Specifically,

- It is unknown how much playa would be exposed without water importation (i.e., the baseline condition).
- It is unknown how much of remaining exposed playa, after importation, might be effectively remediated and how much such remediation efforts might reduce the release of airborne particulate matter.
- It is unknown what the marginal impact of playa dust would be compared to the dust and air pollution from the surrounding desert. This same uncertainty about the marginal impact of dust pollution on human health exists in other parts of the world due to the "difficulty in isolating and measuring exposure to dust particles." (Ostro et al., 2021).

Quantified benefits are calculated as the difference between the outcome under a baseline scenario compared to the outcome under the water importation concept being analyzed. In the case of playa dust, both outcomes are uncertain and would require numerous assumptions to be able to calculate the quantified difference. Therefore, this analysis does not attempt to quantify and monetize the benefits that reduced playa dust will have on air quality and human health. As an alternative to quantifying and monetizing the benefits, we include a qualitative estimate of the direction and relative magnitude of air quality and human health benefits for water importation.

2.3.4 Omissions, Biases, and Uncertainty

Benefits analyses almost always require assumptions and caveats and often use methods that inject uncertainty. The most rigorous way to reduce the uncertainty is to conduct a primary study where all the unique qualities of the study site are included in the design and thus accounted for. Due to time and resource constraints, a primary study, which can take several months, was beyond the scope of this analysis. Instead, a benefits transfer approach was employed, which is best used to show order of magnitude estimates.

In addition to the uncertainty introduced via the analysis method, the outcomes of the analyzed scenarios have a great deal of uncertainty and rely on many factors other than water importation. For example, predicting how much economic development will occur at the Salton Sea with water importation is difficult. Water importation alone will not add critical infrastructure, and many factors contribute to economic development (e.g., prices of homes within commuting distance). Predicting the differences in benefits expected from varying quantities of water imported is even more difficult. Water importation may avoid the collapse of the Salton Sea ecosystem, but the benefits will be a range. Table 2-2 presents the key assumptions included in the analysis and the issues associated with the Salton Sea region, and how they may impact OBUs[2].

Table 2-2: Omissions, Biases, and Uncertainties

Assumption/Issue	Likely impact on benefits	Comment/Description
Uncertainty around outcomes of importation	U	There is a large amount of uncertainty in predicting the outcomes of the importation concepts and the associated benefits the outcomes will provide. This is in large part due to the complex interactions that include both ecological and economic conditions. It also is uncertain how the Salton Sea will be managed (e.g., different portions of the sea potentially being designed, remediated, and managed differently) and how such "within sea" management options might impact the overall benefits attributable to water importation.
Uncertainty around the "without importation" scenario	U	It is difficult to predict the baseline conditions that would result if importation does not occur. Since benefits are relative to the baseline, uncertainty about the baseline injects uncertainty into the benefit measures.
Exclusion of potential benefits to agriculture	+	Another study (Cohen, 2014) included the benefit to agriculture associated with restoring the Salton Sea.
Avoided cost of negative impacts to economic conditions in the Palm Springs region	+	The study we relied on for the economic revitalization benefits (Tourism Economic, 2017) included the benefit of avoiding negative impacts to the greater Palm Springs region. Given the uncertainty of the "without importation" scenario, we did not include those benefits in our analysis.

Note:

a. Indicating how addressing the assumption or overcoming the omission would probably impact the analysis, using the following key: + would likely increase net benefits; ++ would increase net benefits significantly; U direction of change in net benefit is uncertain; - would diminish net benefits; - - would diminish net benefits significantly.

[2] The assessment adopted the OBU approach from Stratus Consulting, 2009

Section 3: Concept Candidates

After the fatal flaw analysis of all submissions that passed the Screening Analysis, the Panel met for a two-day in-person meeting to continue its review of the RFI responses.

The first step of this process was to establish what the characteristics of the Salton Sea would be without a water importation project using the SSAM. The Panel acknowledges that its no-project scenario is a simplification. A significant amount of in-sea analysis has been, and continues to be, developed by the SSMP and the Long-Range Plan Committee including varying salinity zones, berm development to alter the shape and depth of the lake, and canal development (Salton Sea Summit, 2022). However, for comparative purposes the panel's no-project scenario provides insight on differences in sea level, playa exposure, and salinity under different water importation scenarios.

Next, the Panel continued its review of responses that passed the fatal flaw analysis. Components of these responses were reviewed and compared. Finally, the Panel discussed alternative concepts utilizing components of the responses, previous studies and practices, and projects implemented at the Salton Sea.

3.1 No-Project Baseline Scenario

This scenario is based upon the projected long-term average inflow of 717,000 AFY with no additional inflows from water importation projects. In this scenario, the Salton Sea water surface level declines until inflows match the estimated evaporation corresponding with the surface area and salinity of the Salton Sea. The below figures indicate the reduction of the water surface level and the increase in salinity of a no-project scenario. This baseline no-project scenario is provided for reference and as a comparison point to the evaluated water importation concept.

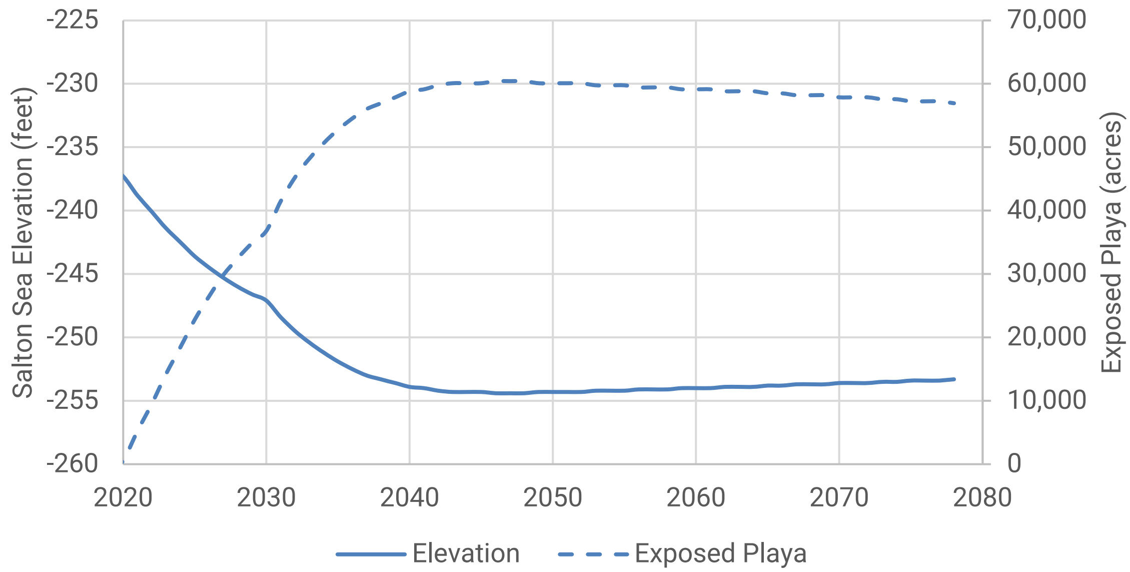


Figure 3-1: **Salton Sea elevation (solid) and resulting exposed playa relative to 2018 (dashed) projected under the no-project baseline scenario**

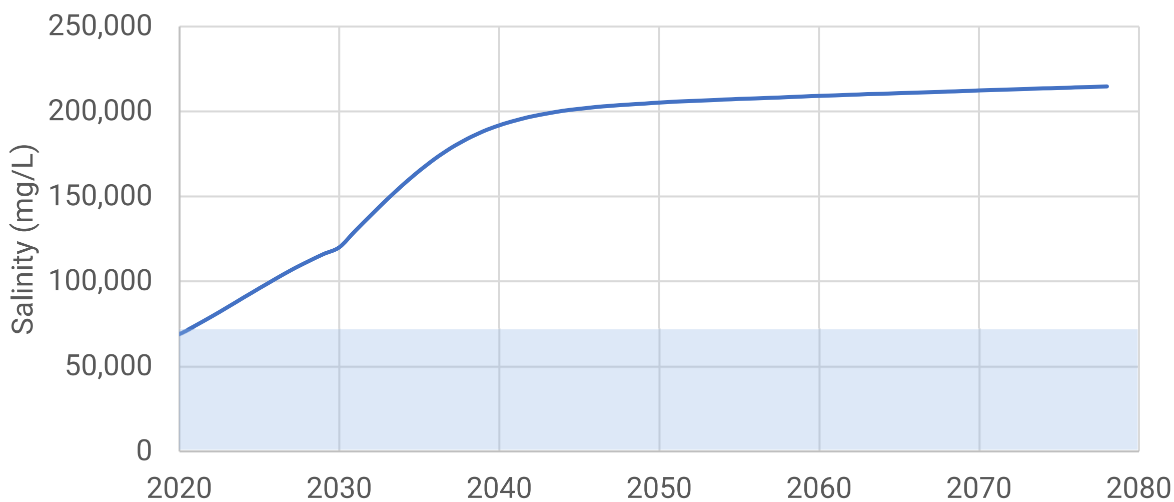


Figure 3-2: **Salton Sea average salinity under the No-Project Baseline Scenario.**

Blue shaded area represents the acceptable maximum salinity range identified in the Fatal Flaw Report

Modeling in SSAM for Figure 3-1 and Figure 3-2 used the assumptions presented in the Fatal Flaw Report.

3.2 Sea of Cortez Import Concept

After the screening and fatal flaw analysis of the 18 RFI responses, 3 responses were found to not have fatal flaws: R4, R9, and R10. The major components of the responses are shown in Table 3-1.

Due to the similarities of the major components of the responses, the Panel combined the three responses into a single Sea of Cortez Import Concept to be evaluated in the feasibility analysis, as described in the following sections. The purpose of this analysis is to develop information on the project-level feasibility. Where multiple approaches were proposed for a project component, a single approach was selected for feasibility analysis. This selection does not constitute an endorsement of a component as a preferred alternative; rather, alternative analyses should be completed at the detailed design phase when additional studies and evaluations can be pursued. Differences in cost implications between the proposed components are likely to be within the range of accuracy presented in the cost estimate.

Table 3-1: Components of Responses Passing the Fatal Flaw Analysis

Component	R4	R9	R10
Water Source	Sea of Cortez	Sea of Cortez	Sea of Cortez
Intake	Submerged	Tidal, sand filtered	Subsurface
Desalination - Sea of Cortez	RO	RO	RO
Brine Management- Sea of Cortez	Not specified	Salt recovery for sale; salinity gradient solar ponds	Brine Outfall
Conveyance	Pipeline	Pipeline and Canal	Pipeline
Delivery Point	Salton Sea	Salton Sea (R9A) Salton Sea via Mexicali (R9B) Mexicali, in exchange for Colorado River Water (R9C)	Salton Sea; option for desalinated water delivery to Mexico
Remediation Desalination at Salton Sea	RO; pumping of hypersaline water	RO	TBD as part of a salinity management plan

Component	R4	R9	R10
Brine Management-Salton Sea	Evaporation Ponds; Deep well injection	Salt recovery for sale; salinity gradient solar ponds	TBD; brine line to ocean outfall

Notes: RO = reverse osmosis
TBD = to be determined

3.2.1 Intake at the Sea of Cortez

Intakes for each of the three responses were located on the west coast of the Sea of Cortez north of San Felipe and south of the Biosphere Reserve core zone. Three different intake structures were proposed at the Sea of Cortez: submerged (R4), tidal sand-filtered (R9), and subsurface (R10). While tidal sand-filtered and subsurface intakes may be appropriate for the project, verifying the design criteria and suitability for the project would require additional geotechnical studies and infiltration evaluations. The feasibility analysis therefore used a submerged intake as no additional studies would be required to verify suitability for the project.

3.2.2 Desalination at the Sea of Cortez

To reduce the amount of salt imported into the Salton Sea basin along with the imported water, desalination at the Sea of Cortez was evaluated. The location of the desalination facility is assumed to be near the ocean intake north of San Felipe and south of the Biosphere Reserve core zone to reduce pumping costs and reduce the required distance for a brine outfall. This location was proposed in R9A, while R4 and R10 did not define a specific location for the facility. R9B proposed a desalination facility in the Cerro Prieto region of Mexico to utilize geothermal energy resources located there. While increasing the use of renewable energy sources is desirable, the additional pipeline and pumping required to deliver hundreds of millions of gallons of seawater to the desalination facility would be significant.

3.2.3 Brine Management- Sea of Cortez

Seawater RO facilities typically operate at a 50% recovery rate: for every gallon of desalinated water produced, a gallon of brine is produced. Brine produced at the seawater desalination facilities is typically discharged back into the ocean using diffusers to disperse the brine and limit environmental impact. Brine management via an outfall was proposed in R10. R9 uses a salt recovery facility to purify and dry salt for market sales as well as for use in solar salinity gradient ponds. Brine management at the Sea of Cortez was not specified in R4. While options for brine management and resource recovery should be explored, an outfall may still be required so that the desalination facility can operate in the event of any interruptions at the salt recovery facility. Therefore, the Sea of Cortez Import Concept includes an outfall to dispose of RO brine.

3.2.4 Conveyance

Responses R4, R9A, and R10 convey desalinated water from the Sea of Cortez to the Salton Sea. R4 and R10 use pipelines, while R9A uses a combination of canals and pipelines. The Sea of

Cortez Import Concept includes a pipeline to reduce potential water loss due to evaporation along the route. The planning-level alignments are shown in Figure 3-3:

The alignments proposed by R4 and R10 generally follow Highway 5 to the east of the Sierra de los Cucapah, while R9A travels west of the mountain range. This analysis uses an alignment to the east of the Sierra de los Cucapah due to easier access for construction, operations, and maintenance. Construction of a pipeline to the west of the mountains would likely require placement of an access road for construction, operations, and maintenance, and would likely come at a higher cost. An alignment on the east of the mountains, however, would likely require additional easements as more property lines would be crossed.

3.2.5 Delivery to the Salton Sea

Responses R4, R9A, and R10 convey desalinated water from the Sea of Cortez directly to the Salton Sea. R9B proposes delivery in Mexicali, with water flowing via the New and Alamo Rivers and existing canals as well as providing water for beneficial use in Mexico. R10 also contains provisions for additional water delivery to Mexicali prior to crossing the US-Mexico border. While delivery of desalinated water in Mexico provides a clear project benefit, the scope and scale of the water delivery in R10 is unknown. The decision as to how much water would be delivered to Mexico is critical as it impacts the size of the desalination facility at the Sea of Cortez, pipeline length and sizing, and other considerations. This feasibility analysis assumes 100% of the water delivery would be at the Salton Sea. However, opportunities to deliver desalinated water in Mexico should be explored in future project phases.

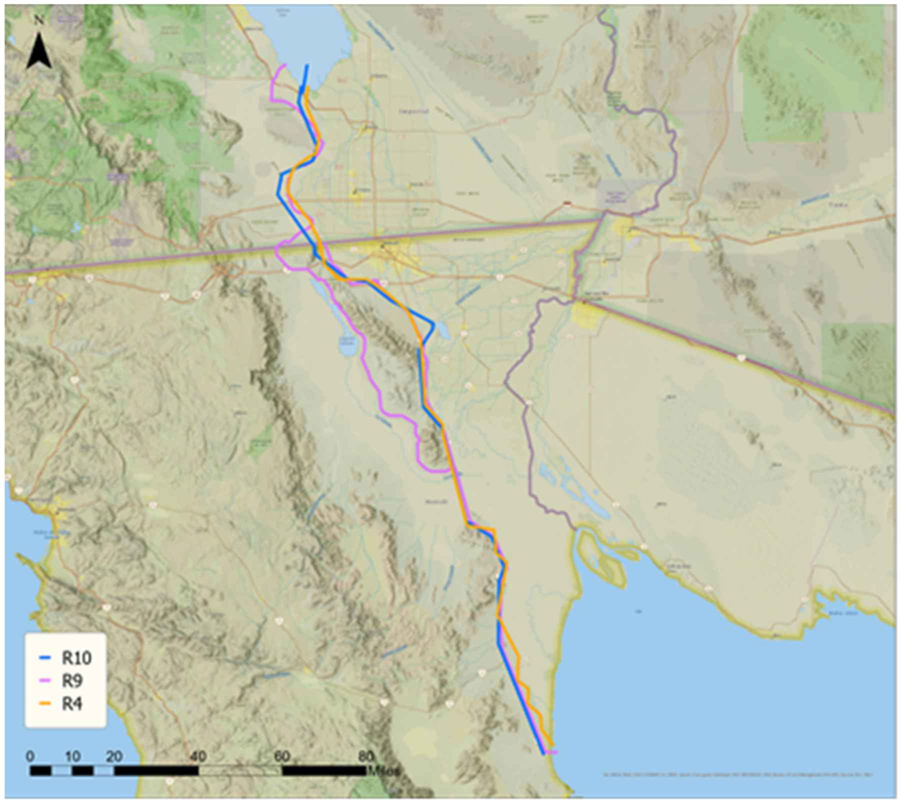


Figure 3-3: Proposed Alignments of the Responses Passing the Fatal Flaw Analysis

Response R9C consists of a water exchange with Mexico. Under R9C, 500,000 AFY of desalinated water would be delivered to Mexicali in exchange for Colorado River water transported via the Imperial Canal. While reducing the amount of infrastructure required to convey water from Mexicali to the Salton Sea, the scale of this water exchange (one third of Mexico's total Colorado River water allotment), is likely to impact instream flow on the Colorado River in Mexico significantly. Evaluating the impact of a water exchange on the Colorado River would require multiple years of seasonal flow data, including data on diversion points and flows. Seasonal variations in flows are important as desalinated water flows would likely be constant throughout the year. While options for water exchanges should be explored, this scenario requires estimation and modeling of future northern Mexico water conveyance and consumption patterns and is not included as a part of the feasibility analysis.

3.2.6 Salinity Reduction at the Salton Sea

Even with the desalination of imported water prior to delivery at the Salton Sea, additional salinity reduction at the Salton Sea is required to meet the salinity goals outlined in Section 2.1.3.1 due to the existing salt in the basin as well as the roughly 3.5 million tons of salt that enter the Salton Sea annually through existing inflows. Response R4 proposed a RO remediation desalination facility of approximately 13.5 MGD, while R9A included a facility approximately 100 MGD in capacity. R10 proposed development of a salinity management plan with no set strategy defined. With the remediation desalination facility, all the produced desalinated water would be returned to the Salton Sea. To evaluate the range of costs and benefits of the proposed desalination facilities, two sub-concepts were considered: (1) a 13.5 MGD remediation desalination facility, and (2) a 100 MGD remediation desalination facility at the Salton Sea. While operation of the facility can be adjusted based on observed conditions at the Salton Sea, for planning purposes the facility was assumed to operate at full capacity for the project duration (through 2078).

The evaluation assumes the use of RO for remediation desalination for salinity and cost estimation. Any technology selected should be tested at demonstration scale prior to implementation at the Salton Sea due to the unique and hypersaline conditions of the water. A constant recovery of 50% was assumed. The Panel acknowledges that at higher salinities, recovery will be reduced, and that recoveries may exceed 50% when salinity decreases below that of seawater.

3.2.7 Brine Management - Salton Sea

Both R4 and R9 include evaporation ponds as a part of the brine management strategy. R4 also includes the potential for brine disposal via deep well injection. A portion of the brine could potentially be disposed of via deep well injection into the geothermal reservoir in the area. This is an area for future study and beyond the scope of this analysis. Factors to consider include:

- Location of injection wells as to not impact the temperature of fluids at existing geothermal production wells
- Disposal capacity based on geothermal reservoir volume and existing and future water loss due to geothermal energy production activities
- Potential to blend desalination brine with geothermal return fluids without causing scaling or other impacts to existing geothermal operations
- Potential impacts to lithium concentrations in the geothermal reservoir and resulting lithium recovery potential

The feasibility analysis did not consider deep well injection due to the uncertainty of its suitability for the project. Deep well injection is an area for future study as brine disposal will be a key issue at the Salton Sea under many restoration scenarios.

R9 includes a suite of brine management techniques to separate and dry salt for market sale. While this strategy provides a promising alternative to disposal of salt in a landfill, whether a local market could accommodate the mass of salt generated at the proposed qualities is unclear. With salt being a low value commodity, most salt is used in the geographic region in which it is produced, as transportation costs quickly reduce the cost-effectiveness of the product. Future work should evaluate the proposed salt recovery facilities at a demonstration scale to establish the quality and marketability of recovered salt.

This evaluation only investigated evaporation ponds as a brine disposal method. However, grant funding should be made available to investigate technologies with the potential to optimize water recovery from brine and overall brine management, as this will be a critical component of any Salton Sea restoration strategy.

3.3 Sea of Cortez Exchange Concept

The submitted water importation concepts reviewed by the Panel largely involve importation of sufficient water to return the Salton Sea to water levels experienced in the mid-to-late 20th century. To provide the State a comparable, but contrasting option, the Panel investigated a water importation concept based on the IBWC Binational Desalination Facility Feasibility Study (Black & Veatch, 2020). The State of Arizona, California water agencies, and other parties have undertaken a study of building a desalination facility on the eastern side of the Sea of Cortez near Puerto Peñasco and piping water for potable use to Arizona as well as northern Mexico. The Panel investigated an expansion or add-on to this approach to benefit the Salton Sea, with the major components of the summarized in Table 3-2 and Figure 3-4:

Table 3-2: Components of the Sea of Cortez Exchange Concept

Component	Sea of Cortez Exchange Concept
Water Source	Sea of Cortez
Intake	Submerged
Desalination - Sea of Cortez	RO
Brine Management-Sea of Cortez	Brine Outfall
Conveyance	Pipeline
Delivery Point	Morelos Dam
Remediation Desalination at Salton Sea	RO
Brine Management- Salton Sea	Evaporation Ponds

Note: RO= reverse osmosis

Under this Sea of Cortez Exchange Concept, 100,000 AFY would be imported to the Salton Sea region via a water exchange with Mexico. 100,000 AFY is selected because, although twice the size of California's largest existing desalination facility (in Carlsbad), it is in the range of the Binational concept and would offset the water loss of a 100 MGD remediation desalination facility at the Salton Sea. It also results in manageable playa exposure and an eventual equilibrium sea size that can support environmental and tourism uses of the sea. The State of California and possibly other parties would help fund the construction of a new desalination facility on the northeast shore of the Sea of Cortez. The desalinated water would be delivered north to Mexico's Morelos Dam, where it would be blended with water in the Colorado River, for direct uses and instream flows in Mexico. It is also possible that desalinated water could be diverted prior to the Morelos Dam for alternative beneficial uses. A similar (but larger) exchange concept was discussed in RFI response R9.

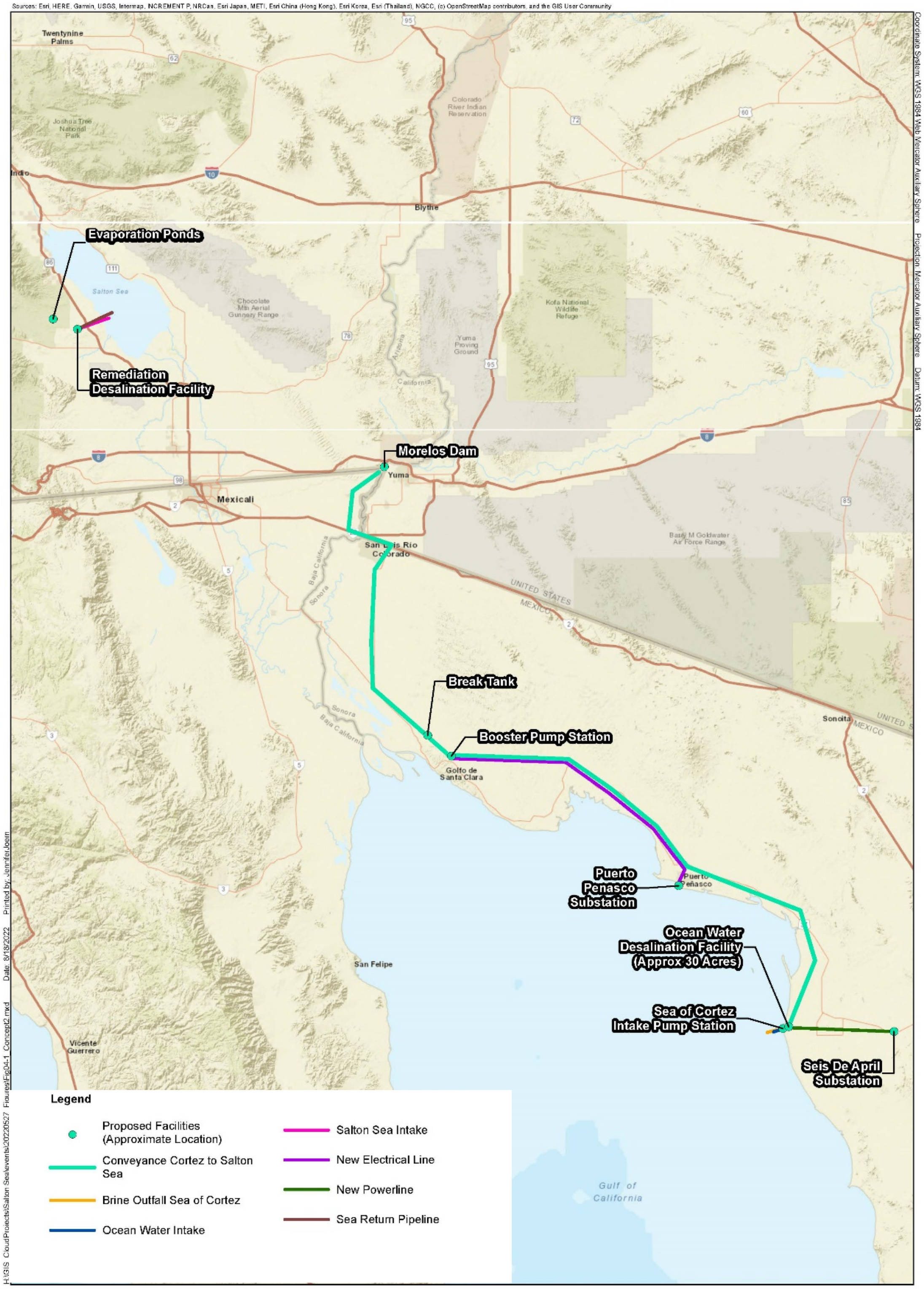


Figure 3-4: Components of the Sea of Cortez Exchange Concept

3.3.1 Intake at the Sea of Cortez

Intake for the Sea of Cortez Exchange Concept is assumed to be a submerged intake located on the east coast of the Sea of Cortez between Bahia San Jorge and Puerto Lobos, Sonora.

3.3.2 Desalination at the Sea of Cortez

To reduce the amount of salt imported into the Salton Sea basin along with the imported water, desalination at the Sea of Cortez was evaluated. The location of the desalination facility is assumed to be near the ocean intake to reduce pumping costs and reduce the required distance for a brine outfall.

3.3.3 Brine Management- Sea of Cortez

For the Sea of Cortez Exchange Concept, brine management is assumed to be via an outfall in the Sea of Cortez.

3.3.4 Conveyance

The proposed conveyance for the Sea of Cortez Exchange Concept is an approximately 230 mile, 70-inch steel pipe with cement mortar lining. The alignment generally follows Highway 3 from the intake and desalination facility to the San Luis Rio Colorado area before trending northerly generally parallel to Highway 2 before terminating near Morelos Dam. The planning-level alignment is shown in Figure 3-4.

3.3.5 Delivery to the Salton Sea

In the Sea of Cortez Exchange Concept, the desalinated water would be delivered at Mexico's Morelos Dam, where it would be blended with water in the Colorado River, for direct uses and instream flows in Mexico. In exchange, additional Salton Sea-bound water would be diverted from the Colorado River at Imperial Dam and delivered to the sea via the All-American Canal and other existing infrastructure and rivers.

3.3.6 Salinity Reduction at the Salton Sea

As discussed in Section 3.2.6, additional salinity reduction at the Salton Sea is required to meet the salinity goals. To reduce salinity at the Salton Sea, the Sea of Cortez Exchange Concept includes a 100 MGD remediation desalination facility at the Salton Sea. All the produced desalinated water would be returned to the Salton Sea. While operation of the facility can be adjusted based on observed conditions at the Salton Sea, for planning purposes the facility was assumed to operate at full capacity for the project duration (through 2078).

3.3.7 Brine Management - Salton Sea

Similar to the Sea of Cortez Import Concept, the Sea of Cortez Exchange Concept includes evaporation ponds as a brine disposal method.

3.4 Colorado River Water Voluntary Transfer Concept

Water from the Colorado River provides an opportunity to maintain Salton Sea levels while remediation desalination is implemented. For desalination of high salinity water, the ratio of water lost to water purified is roughly 1:1. Reallocating Colorado River water by using voluntary financial incentives, paired with remediation desalination, draws on the approach of voluntary, compensated fallowing of lands within IID's service territory in exchange for water deliveries to the Salton Sea. The region's recent experience with a voluntary fallowing program provides at least two lessons. One is the willingness and ability of farmers and IID to successfully implement such a program, and second is the implementation roadmap provided in Water Code § 1013, which could be a starting point for new negotiations.

By itself, water from voluntary fallowing could stabilize the sea's elevation, and paired with remediation desalination, it can eventually lead to a sustainable, living Salton Sea. The major components of this concept are shown in Table 3-3.

Table 3-3: Components of the Colorado River Water Voluntary Transfer Concept

Component	Colorado River Voluntary Transfer Concept
Water Source	Colorado River
Conveyance	Existing pipelines and canals
Delivery Point	Salton Sea
Remediation Desalination at Salton Sea	RO
Brine Management- Salton Sea	Evaporation Ponds

Note: RO= reverse osmosis

3.4.1 Salinity Reduction at the Salton Sea

Even with delivery of Colorado River water to the Salton Sea, additional salinity reduction at the Salton Sea is required to meet the salinity goals outlined in Section 2.1.3.1. For this reason, the Colorado River Water Voluntary Transfer Concept proposes a RO remediation desalination facility of approximately 100 MGD in capacity. With the remediation desalination facility, all the produced desalinated water would be returned to the Salton Sea. While operation of the facility can be adjusted based on observed conditions at the Salton Sea, for planning purposes the facility was assumed to operate at full capacity for the project duration (through 2078).

3.4.2 Brine Management - Salton Sea

The Colorado River Water Voluntary Transfer Concept assumes evaporation ponds as the brine management strategy.

Section 4: Feasibility of the Sea of Cortez Import Concept

4.1 Concept Description, Design and Engineering

The source of imported water for this concept is desalinated water from the Sea of Cortez, Mexico. Between 860,000 and 1 million AFY of water would be extracted from the Sea of Cortez, desalinated at an Ocean Water Desalination Facility on the western shore of the Sea of Cortez near San Felipe, Baja California Mexico. The product water from the desalination facility, approximately 430,000–540,000 AFY, would then be conveyed from the desalination facility to a location at the southwest edge of the Salton Sea. This water would be used to increase the Salton Sea elevation, decrease salinity, and decrease the amount of exposed playa. A second remediation desalination facility would remove salts and further decrease the salinity of the Salton Sea.

4.1.1 Major Facilities

Specific facilities of the Sea of Cortez Import Concept are described below, summarized in Table 4-1, and mapped in Figure 4-1:

Components:

- A 960 MGD **Ocean Water Intake** on the west side of the Sea of Cortez near San Felipe, Baja California. The intake will be a structure at least 40 feet below sea surface. The intake will be comprised of two 144 inch diameter pipelines of steel with polyurethane lining. The intake will include screens that will prevent entrainment and impingement of sea life, and will extend 1.9 miles offshore.
- 960 MGD **Sea of Cortez Intake Pump Station**, 51,100 brake horsepower (BHP).
- A RO **Ocean Water Desalination Facility**, located near the intake with a product water capacity of approximately 480 MGD. This facility will be located on a 75 acre site.
- A desalination **Brine Outfall, Sea of Cortez**, assumed to be co-located with the intake. The brine outfall would consist of one 144 inch pipeline, 3.4 miles in length. Proposed pipeline material would be steel with polyurethane lining.
- 480 MGD **Conveyance Pump Station**, 96,000 BHP.
- 5 mile new connection to 69kV or higher **Transmission Line** between the City of San Felipe and the Sea of Cortez Pump Station. The presence of the necessary electrical facilities with sufficient generation and transmission capacity serving San Felipe has not been confirmed but is assumed for the purposes of this analysis.
- Construction of an **Electrical Substation** at the Sea of Cortez Intake Pump Station to step down the voltage 13.8kV to feed distribution switchgear within the pump station facility.
- **Conveyance, Cortez to Salton Sea**. Approximately 190 miles of parallel 108 inch steel pipelines with polyurethane lining to transport desalinated ocean water to the Salton Sea. Water conveyance pipeline assumed to be installed via trenching.

- **Energy Recovery Turbines**, expected to be parallel Francis turbines near the discharge of the Salton Sea. The 108 inch parallel pipelines will connect to a header that distributes flow to these turbines. The discharge piping will run under the concrete structure and water will be discharged into the Salton Sea below the water surface. This energy recovery station could produce 29 Megawatts (MW) and has an expected efficiency of 87%.

Scenario 1 components:

- **Salton Sea Intake** for the remediation desalination facility located near the southwest corner of the Salton Sea. Assumed to be 36 inch diameter steel pipe with polyurethane lining extending 1.9 miles offshore.
- The 27 MGD, 1,350 BHP, **Salton Sea Pump Station**, will be used to move water from the Salton Sea to the Remediation Desalination Facility.
- 13.5 MGD RO **Remediation Desalination Facility** near the Salton Sea to further treat Salton Sea water.
- Desalinated water produced by the remediation desalination facility will be returned to the Salton Sea via a 26 inch, 3.4 mile-long **Salton Sea Return Pipeline.**
- Brine handling for remediation desalination facility via 3,000 acres of **Evaporation Ponds**. Assumed to be on the west side of the Salton Sea, outside of sensitive ecological areas.

Scenario 2 components:

- **Salton Sea Intake** facilities for the remediation desalination facility located near the southwest corner of the Salton Sea. Assumed to be 98 inch diameter steel pipe with polyurethane lining extending 1.9 miles into the Salton Sea.
- The 200 MGD, 25,000 BHP **Salton Sea Pump Station**, will be used to move water from the Salton Sea to the Remediation Desalination Facility.
- 100 MGD RO **Remediation Desalination Facility** near the Salton Sea to further treat Salton Sea water.
- Water produced by the remediation desalination facility will be returned to the Salton Sea via a 70 inch, 3.4 mile long **Salton Sea Return Pipeline.**
- Brine handling for remediation desalination facility via 22,000 acres of **Evaporation Ponds**. Assumed to be on the west side of the Salton Sea outside of sensitive ecological areas.

Table 4-1: Water Importation Facilities

Treatment Facilities	Flow Rate *(MGD)*	Assumed Recovery Rate	Brine Production		Product Water	
			MGD	*AFY*	*MGD*	*AFY*
Ocean Water Desalination Facility (Sea of Cortez)	960	50	480	430,000 to 540,000	480	430,000 to 540,000
Pump Station(s)	**Flow Rate** *(MGD)*	**Horsepower** *(BHP)*				
Sea of Cortez Intake Pump Station	960	51,100				
Conveyance Pump Station	480	96,000				
Pipelines	**Diameter** *(in)*	**Length** *(miles)*	**Count** *(each)*	**Material**	**Flow Rate Per Pipe** *(MGD)*	**Flow Velocity** *(ft/s)*
Ocean Water Intake Parallel Pipelines (Sea of Cortez Pump Station Intake)	144	1.9	2	Steel with Polyurethane Lining	parallel pipelines carrying 480 each	6.57
Brine Outfall Sea of Cortez	144	3.4	1	Steel with Polyurethane Lining	480	6.57
Conveyance, Cortez to Salton Sea	108	190	2	Steel with Polyurethane Lining	240	5.84
Electrical Facilities	**Capacity** (kV)	**Length** (miles)				
Transmission line San Felipe to Sea of Cortez Pump Station	69	5				
Electrical substation at the Sea of Cortez Pump Station	13.8					
Energy Recovery Turbines	**MW**	**Efficiency**	**kWh offset**			
Parallel Francis Turbines	29	87%	254,042,400			

Table 4-2: Facilities Unique to Scenario 1 (in addition to the facilities of Table 4-1)

Treatment Facilities	Flow Rate *(MGD)*	Assumed Recovery Rate	Brine Production		Product Water	
			MGD	*AFY*	*MGD*	*AFY*
Remediation Desal Facility (Salton Sea)	27	50	13.5	12,100 to 15,100	13.5	12,100 to 15,100
Pump Stations	**Flow Rate *(MGD)***	**Horsepower *(BHP)***				
Salton Sea Pump Station	27	1,350				
Pipelines	**Diameter** *(in)*	**Length** *(miles)*	**Count** *(each)*	**Material**	**Flow Rate Per Pipe** *(MGD)*	**Flow Velocity** *(ft/s)*
Salton Sea Intake	36	1.9	1	Steel with Polyurethane Lining	27	5.91
Salton Sea Return Pipeline	26	3.4	1	Steel with Polyurethane Lining	13.5	5.67
Brine Handling Pipeline	26	0	1	Steel with Polyurethane Lining	13.5	5.67
Other	**Acres**					
Evaporation Ponds	3,050					

Table 4-3: Facilities Unique to Scenario 2 (in addition to the facilities of Table 4-1)

Treatment Facilities	Flow Rate *(MGD)*	Assumed Recovery Rate	Brine Production		Product Water	
			MGD	*AFY*	*MGD*	*AFY*
Remediation Desal Facility (Salton Sea)	200	50	100	89,600 to 112,000	100	89,600 to 112,000
Pump Stations	**Flow Rate *(MGD)***	**Horsepower *(BHP)***				
Salton Sea Pump Station	200	25,000				
Pipelines	**Diameter** *(in)*	**Length** *(miles)*	**Count** *(each)*	**Material**	**Flow Rate Per Pipe** *(MGD)*	**Flow Velocity** *(ft/s)*
Salton Sea Intake	98	1.9	1	Steel with Polyurethane Lining	200	5.91
Sea Return Pipeline	70	3.4	1	Steel with Polyurethane Lining	100	5.79
Brine Handling Pipeline	70	9.25	1	Steel with Polyurethane Lining	100	5.79
Other	**Acres**					
Evaporation Ponds	22,000					

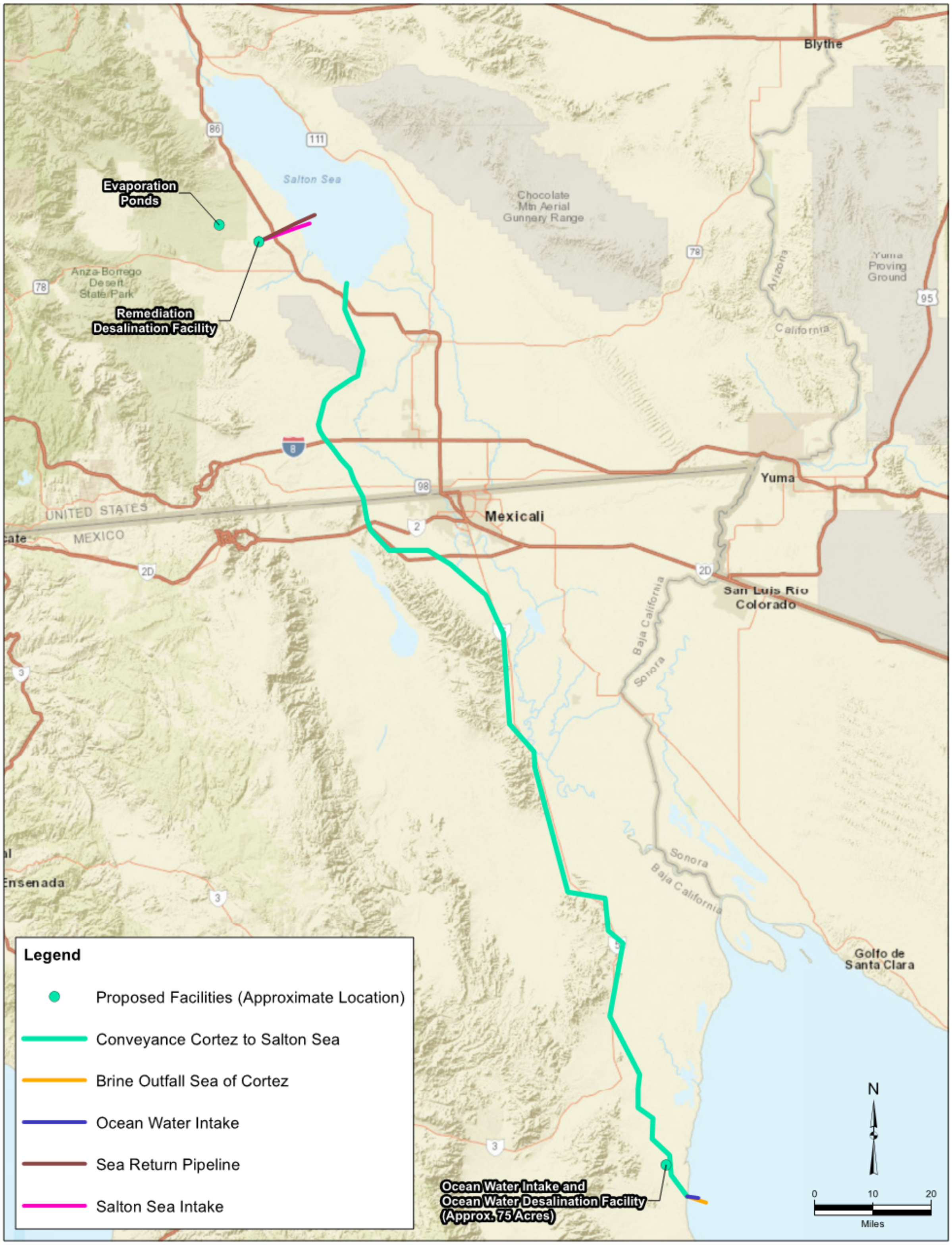


Figure 4-1: Major Facilities in the Sea of Cortez Import Concept

4.1.2 Hydraulics and Pumping Requirements

Key elevations for the hydraulic analysis of the intake and conveyance pump stations and the approximate hydraulic grade line (HGL) are presented in Figure 4-2 below. The total dynamic head of the 960 MGD Sea of Cortez Intake Pump Station and 480 MGD Conveyance Pump Station are estimated to be 243 ft and 912 ft, respectively. Based on the assumption that the pumps for these pump stations have an efficiency of 80%, the required BHP of the respective pump stations are 51,100 BHP and 96,000 BHP.

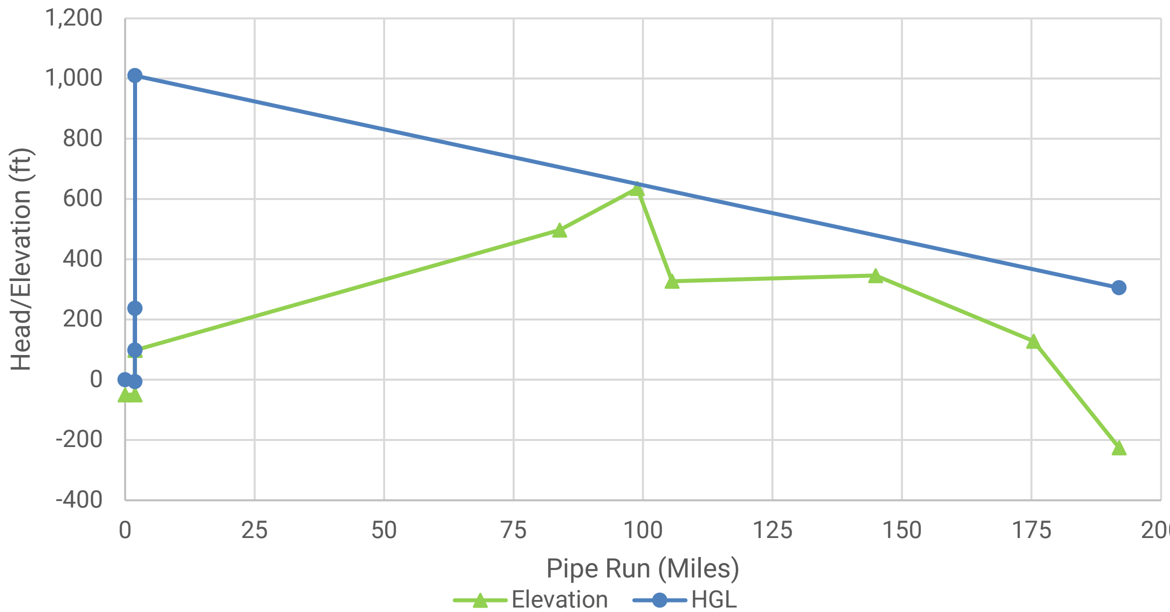


Figure 4-2: Elevation Profile and Hydraulic Grade Profile: Sea of Cortez to Salton Sea

Scenario 1 includes a 27 MGD Salton Sea Pump Station for the remediation desalination facility. The total dynamic head is estimated at 227 ft. Based on the assumption that the pumps for this pump station have an efficiency of 80%, the required BHP of the pump station is 1,350 BHP.

Scenario 2 includes a 200 MGD Salton Sea Pump Station for the remediation desalination facility. The total dynamic head is estimated at 570 ft. Based on the assumption that the pumps for this pump station have an efficiency of 80%, the required BHP of the pump station is 25,000 BHP.

4.1.3 Long-Term Operations, Including Energy Recovery

Annual operations and maintenance costs will consist of labor to run the treatment plants, maintenance labor for all facilities, treatment chemicals, and power for the pump stations and treatment facilities. These costs are summarized in Section 4.5 and Table 4-11 (Scenario 1) and Table 4-12 (Scenario 2). Operation of evaporation ponds will include removal and hauling of salts from the evaporation ponds associated with the remediation desalination plant. As the salinity of the Salton Sea changes, the amount of salt generation at the ponds will change, ranging from a low of 3 million tons per year up to 8 million tons for Scenario 1 and 6 million tons per year up to 59 million tons for Scenario 2.

The project has the potential for energy recovery. From the hydraulic profile developed for the project (Figure 4-2), water will discharge at approximately 230 pounds per square inch (psi) into the Salton Sea. This discharge pressure corresponds to approximately 530 ft of energy that can be partially recovered via an energy recovery station at the discharge location. Based on communication with Canyon Hydro, a manufacturer of hydroelectric systems, Francis turbines were selected for this application at the planning level. Multiple Francis turbines would be arranged in parallel, and the associated electrical equipment could be installed within a concrete structure at the shore of the Salton Sea. The 108 inch parallel pipelines would connect to a header that distributes flow to the turbines. The discharge piping would run under the concrete structure and water would be discharged into the Salton Sea below the water surface. This energy recovery station would produce 29 MW and has an efficiency of 87%.

4.2 Evaluating Feasibility of Planning and Permitting

4.2.1 Environmental and Permitting Considerations

This analysis assumed that a multi-national team would be used for the planning and design of the Sea of Cortez Import Concept. It also assumed that project execution and operation for facilities within Mexico would be undertaken by Mexican firms and/or governmental entities, with funding provided in total or in part by the State of California. The permits needed would be much more extensive if foreign entities constructed, owned, or operated the facilities within Mexico. The analysis assumed that construction and operation of facilities within the US would be undertaken by persons, firms, local and State governments that can legally perform work in California.

The necessary permits from Mexican authorities and US authorities take extensive effort and have an extended timeline. However, upon review of the laws and permits needed, there is no obvious reason the Sea of Cortez Import Concept could not be permitted so long as the following occur: (a) the project is structured in a way to meet the objective of IBWC Minute 323 (to increase delivery and exchange of waters in a way to benefit both Mexico and the US) and (b) appropriate project design and/or mitigation is put in place to limit impacts to sensitive resources. Table 4-4 and Table 4-5 provide general guidance about when in the process a particular permit activity should take place and provides an estimate of the timeline to acquire a permit.

4.2.1.1 Permits in Mexico

Table 4-4 summarizes the anticipated permits and permitting process for facilities and actions in Mexico. The timelines are based on experience on other projects; however, large multi-national, complex water projects are uncommon and no analogous projects provide history on the permitting process and probable timeline. The permitting timeline is therefore an area of significant uncertainty.

Table 4-4: Anticipated Permits Needed for Facilities in Mexico

Permit	Permit Triggers	Permit Timeframe
International Commission on Boundary and Waters	Projects that affect international (Mexico and US) rivers.	Multi-Step approval. 1. Project definition and approval. 2. Agreement on Design, O&M, and Costs 3. Construction and Cost Sharing 4. Operation and Maintenance Anticipated duration for permit activity – Ongoing from project conception to conclusion – approximately 15 to 20 years.
Law of Public–Private Partnerships of Public Services of the State of Sonora	When a private firm is seeking a public partner within Sonora to carry out an infrastructure project.	As part of project definition and approval. Anticipated duration for permit activity – 1 year.
Foreign Investment Registry (RNIE)	Required when foreign individuals or companies regularly engage in business acts in Mexico; or when Mexican companies have the participation, including through trusts, of foreign investment.	Following project definition, before significant investment in design, permitting, and land acquisition. Anticipated duration for permit activity – 90 days.
Foreign Investment Review (FIL) by the National Commission for Foreign Investment (CNIE)	When foreign investment may have significant impact on employment or when the work to be undertaken triggers other environmental reviews.	Following project definition, before significant investment in design, permitting, and land acquisition. Anticipated duration for permit activity – 90 days.
FIL by the Ministry of the Economy	When foreign investment may occur in a sector of the economy typically reserved for Mexican entities (such as land ownership).	Following project definition, before significant investment in design, permitting, and land acquisition. Anticipated duration for permit activity – 90 days.

Permit	Permit Triggers	Permit Timeframe
Environmental Impact Manifesto	Needed for activities that may have impacts: • wildlife management • federal natural protected areas • forest areas • hazardous wastes and national waters • high-risk industries • infrastructure development • mining operations • hydraulic projects • wetlands • coastal areas • natural protected areas • atmospheric emissions • noise • waste management • water discharge • drainage	Following preliminary design. Anticipated duration for permit activity – 3 years.
Environmental Impact Authorization per the General Law of Ecological Balance and Environmental Protection/Environmental Impact Assessment	Required for activities or works, including large-scale projects that involve hydraulic works, exploration and exploitation of precious substances, handling of hazardous wastes, activities in tidelands, work in natural protected areas.	Following preliminary design. Anticipated duration for permit activity – 3 years.
Risk Study	Needed by entities that intend to undertake activities that may cause real or potential significant negative environmental impact.	Obtained during design and needed before construction. Anticipated duration for permit activity – 3 years.
Authorization for Change in Land Use Forested Land	Construction in a forested area that results in removal of forest vegetation for non-forest activities.	As part of final design. Anticipated duration for permit activity – 1 year.
Municipal Comprehensive Environmental License	License for entities interested in carrying out work or activity that requires permits, license, authorization, or registration related to environmental matters.	Obtained during design and needed before construction. Anticipated duration for permit activity – 90 days.
Concession of Federal Maritime Land Use	The Federal Maritime Terrestrial Zone is the area of 20 meters adjacent to sea. To have access and use in this zone a concession is needed. Concessions are granted for a period of time, no more than twenty years. Concessions ban be renewed.	Obtained during design and needed before construction. Anticipated duration for permit activity – 1 year.
Law of Territorial Organization of the State of	For development of property within the State of Sonora.	Obtained during design and needed before construction.

Permit	Permit Triggers	Permit Timeframe
Sonora – Change of Land Use License		Anticipated duration for permit activity – 1 year.
Ministry of Infrastructure and Urban Development Regional Impact Opinion	For development of property that may have a significant impact on public services.	Obtained during design and needed before construction. Anticipated duration for permit activity – 1 year.
Wastewater Discharge Permit	Activities that will result in waste discharge of greater than 300 cubic meters a day.	Obtained during design and needed before construction. Anticipated duration for permit activity – 1 year.
Permit for Hydraulic Infrastructure Works	Projects that may affect the hydraulic or hydrological regime of a nationally owned river or which may affect lands with federal jurisdiction.	Obtained during design and needed before construction. Anticipated duration for permit activity – 1 year.
Concession for Use of Surface Waters	Projects that extract and use national waters such as rivers, reservoirs, and lakes.	Obtained during design and needed before construction. Anticipated duration for permit activity – 1 year.
Authorization to Connect to CFE Facilities	Needed for infrastructure works that will create facilities that will become connected to the CFE electrical supply.	Obtained during design and needed before construction. Anticipated duration for permit activity – 1 year.
Right of Way Permit Federal Highways and Toll Highways	Needed to use the right of way or surrounding areas for construction or easements (such as pipeline crossings).	Obtained as part of final design. Anticipated duration for permit activity – 1 year.
Construction Permit for Works in Federal Maritime Zone	Construction that will occur in the maritime beach, federal maritime land area or other areas reclaimed from the sea or projects that may modify coastal morphology.	Obtained as part of final design. Anticipated duration for permit activity – 1 year.
License for Breaking Pavement and Excavations Greater than 60 Centimeters	Performing work in the jurisdiction of a municipality that requires breaking of pavement.	Obtained immediately before pavement breaking. Anticipated duration for permit activity – 90 days.
Completion of Work, Conclusion of Building Permit	Upon conclusion of work subject to a Building Permit.	Upon completion of work subject to a Building Permit. Anticipated duration for permit activity – 90 days.

4.2.1.2 Permits in the US

Table 4-5 summarizes the anticipated permits for facilities within the US. These are viewed as the minimum times for each step in the absence of litigation. Because litigation can be reasonably anticipated for a project of this size and importance, a longer period before building begins can reasonably be anticipated.

Table 4-5: Anticipated Permits Needed for Facilities in the US

Permit	Permit Triggers	Permit Timeframe
IBWC	Projects that affect international (Mexico and US) rivers.	Multi-Step approval. 1. Project definition and approval. 2. Agreement on Design, O&M, and Costs 3. Construction and Cost Sharing 4. Operation and Maintenance Anticipated duration for permit activity – Ongoing from project conception to conclusion – approximately 15 to 20 years.
Review under the California Environmental Quality Act (CEQA) and National Environmental Policy Act	Projects receiving permits or funding from public agencies that may result in significant impacts to the environment.	Following preliminary design. Anticipated duration for permit activity – 3 years.
Agreement to modify Reclamation Colorado River Operations	Any needed modifications to the amount or location of how Reclamation delivers Colorado River Water.	Following preliminary design. Anticipated duration for permit activity – 3 years.
Federal Energy Regulatory Commission hydropower licensing	Non-federal hydropower projects located on navigable waterways or federal lands or connected to the interstate electric grid.	Following preliminary design. Anticipated duration for permit activity – 3 years.
SWRCB approval for water transfers	Water transfers within the State of California.	Following preliminary design. Anticipated duration for permit activity – 3 years.
Review and mitigation under the Endangered Species Act, Federal Incidental Take Permit	Projects requiring a federal permit, agreement, or receiving federal funding that may affect sensitive species.	Following preliminary design. Anticipated duration for permit activity – 3 years.
Review and mitigation under the California Endangered Species Act, State Incidental Take Permit	Projects requiring a permit, agreement, or receiving funding by a California public agency that may affect sensitive species.	Following preliminary design. Anticipated duration for permit activity – 3 years.

Permit	Permit Triggers	Permit Timeframe
IID Electrical Power Customer Application and Agreement	New construction that will receive power from the IID electrical utility.	As part of final design. Anticipated duration for activity – 1 year.
IID Generator Interconnection Agreement	New construction that will include interconnection of a generating facility to the IID transmission system.	As part of final design. Anticipated duration for activity – 1 year.
US Army Corps of Engineers Clean Water Action Section 404 Permit	Projects that may result in discharge of dredged or fill material into waters of the US.	As part of final design. Anticipated duration for activity – 1.5 years.
Colorado River Regional Water Quality Control Board Section 401 Permit	Projects that may result in discharge of dredged or fill material into waters of the US.	As part of final design. Anticipated duration for activity – 1.5 years.
California Department of Fish and Wildlife Fish and Game Code 1600 Permit	Projects that may substantially divert or obstruct the natural flow, or substantially change or use any material from the bed, channel, or bank of any river, stream, or lake.	As part of final design. Anticipated duration for activity – 1.5 years.
Right-of-Way Permit, Imperial County Transportation Department	Projects where new facilities or construction activities will encroach within, under or over County roadways.	As part of final design. Anticipated duration for activity – 1 years.
Right-of-Way Permit, IID	For facilities or construction activities that cross IID lands or encroach upon IID facilities or project sites	As part of final design. Anticipated duration for activity – 1 years.
Encroachment Permit Imperial County Public Works	For facilities or construction activities that encroach within County infrastructure such as storm drains.	As part of final design. Anticipated duration for activity – 1 years.
CalTrans Standard Encroachment Permit	Projects where new facilities or construction activities will encroach within, under or over State roadways.	As part of final design. Anticipated duration for activity – 1.5 years.

Permit	Permit Triggers	Permit Timeframe
Imperial County Development Permits (including General Plan Amendment, Zoning Change, Conditional Use Permit, Development Agreement, Grading Permit, Wastewater Permit, Fire Suppression Plan Permits, Mechanical Permits, Electrical Permits, Structural/Foundation Permits, Haul Route Plan Rule 310 Dust Control Plan & Rule 801 Compliance).	Projects that result in new construction or alterations to existing structures within the County.	As part of final design. Anticipated duration for activity – 1.5 years.
Imperial County Air Pollution Control District Dust Control Plan	New construction or building alteration within Imperial County.	At the end of final design. Anticipated duration for activity – 9 months.
Imperial County Air Pollution Control District Stationary Source Permit	Building, altering, replacing, or operating equipment or other contrivance which may cause the issuance of air contaminants.	At the end of final design. Anticipated duration for activity – 1.5 years.
Waste Discharge Permit for Brine Evaporation Ponds	Waste storage under Chapter 15.	At the end of final design. Anticipated duration for activity – 1.5 years.
National Pollutant Discharge Elimination System (NPDES) General Permit for Storm Water Discharges Associated with Construction and Land Disturbance Activities, and Treatment Plant outfall.	Construction disturbing 1 acre or more.	Immediately before construction. Anticipated duration for activity – 1 year.

Before the Federal Government or State of California can commit funding for construction, approve construction, or perform other actions that result in physical changes in the environment, an environmental review consistent with the California Environmental Quality Act (CEQA) and the National Environmental Policy Act (NEPA) will be necessary. These reviews are anticipated to include specialized studies comparing different project alternatives against a No Action alternative. Specialized studies related to Salton Sea bathymetry, water quality, biological resources of the Salton Sea, air quality (both during project construction and operation), as well as socioeconomic impacts and population growth inducement are likely as part of CEQA and NEPA review. These studies, along with preliminary design become the basis for many of the needed permits described in Table 4-5.

Case law related to NEPA indicates that the transboundary effects of a federal action must be analyzed. Council on Environmental Quality (CEQ) guidance states, “Agencies must analyze indirect effects, which are caused by the action, are later in time or farther removed in distance, but are still reasonably foreseeable. […] CEQ has determined that agencies must include analysis of reasonably foreseeable transboundary effects of proposed actions in their analysis of proposed actions in the United States." Executive Order 12114 requires Federal agencies to analyze in NEPA documents the significant impacts of proposed projects on the environment outside the US. For this reason, any NEPA review is likely to include analysis of impacts to imported water sources within Mexico, such as the Sea of Cortez, as well as impacts to the Biosphere Reserve of the Upper Gulf of California and the Colorado River Delta.

As part of the North American Agreement on Environmental Cooperation of 1993, the environmental side agreement to the North American Free Trade Agreement, the US, Canada, and Mexico started negotiations to develop a framework for transboundary environmental impact assessment. This framework was never officially adopted; instead, the US must prepare environmental reviews consistent with NEPA and Mexican authorities must undertake a separate review per that Country's Environmental Impact Assessment and Risk Assessment procedures. The reviews performed for one country are likely to inform the review and analysis undertaken by the neighboring country.

4.2.2 Flood Control

The Salton Sea is more than 200 ft below sea level. Surrounding towns such as Indio, Calexico, and associated farmland are also at or below sea level. For these reasons, there is concern about catastrophic flooding resulting from failure of project facilities. However, it is assumed that appropriate project design would introduce controls that would limit the potential for catastrophic flooding. Under the Sea of Cortez Import Concept, the intake at the Sea of Cortez would be approximately 50 ft below sea level. Considerable energy and pumping would be needed to move water to the highpoint in the conveyance pipeline, which would be at approximate elevation 635 ft mean sea level (msl). This significant pumping means there is ample opportunity to slow the movement of water toward the Salton Sea if needed in an emergency. Other design features such as pressure measurement and automated valving within the pipeline can be used to limit the length of pipeline and volume of water that could be released in the event of a pipeline rupture. Connections from the conveyance pipeline to existing storm drains, channels, and canals could be used to direct water released in an emergency.

Other actions that should be taken include using appropriate pipeline thicknesses and appropriate pipeline cover to minimize the chance that a third party could inadvertently damage the pipeline. Ongoing corrosion control would also reduce the risk of pipeline failure.

However, the risk of localized flooding cannot be eliminated and is generally limited to water stored in piped facilities. The project facilities would be moving 960 MGD into the Ocean Water Desalination Facility. A disruption in the intake pump station for a single hour could mean 40 million gallons of sea water would be released in an uncontrolled manner and would likely flow back towards the Sea of Cortez. The project facilities would be moving 480 MGD from the Sea of Cortez to the Salton Sea. If a mile of the conveyance pipeline suffered a rupture, more than 2.6 million gallons of desalinated water would be released in an uncontrolled manner. In Scenario 1, the Remediation Desalination Facility would extract 27 MGD from the Salton Sea, meaning a disruption of greater than an hour could mean approximately 1 million gallons of desalinated water would be released in an uncontrolled manner. However, berms and grading of the site would mean volumes of this size could likely be contained on site. In Scenario 2, the Remediation Desalination Facility would extract 200 MGD from the Salton Sea, meaning a disruption of greater than an hour could mean approximately 8.3 million gallons of desalinated water would be released in an uncontrolled manner, though with appropriate grading water could be retained on site.

4.2.3 Climate Change and Resiliency

4.2.3.1 Project Contribution to GHG Emissions

This analysis limits the project contribution to greenhouse gas (GHG) emissions to the energy used to power the various facilities. This analysis does not consider energy used to manufacture pipes, pumps, and other equipment, used during construction, used by laborers travelling to the work areas, or any population growth or other economic activity resulting from implementation of the project.

The GHG emissions for the project are dependent on the energy source used to power facilities. Mexico's National Electric System (Sistema Eléctrico Nacional or SEN) consists of nine interconnected regions. The Baja California system operates in the Western Interconnection of the US, overseen by the Western Electricity Coordinating Council (US International Trade Administration 2021). According to Mexico's National Electrical System Development Program, the total generation capacity as of April 2021 was 89,479 MW. Clean energy sources such as nuclear and high-efficiency co-generation account for 35.5% of power generation capacity with the remainder (64.5%) coming from conventional sources (conventional thermal, coal) (US International Trade Administration 2021).

Facilities operated within California (e.g., the remediation desalination plant) would most likely receive power from IID. IID's 2020 Power Content Label (the most recent available data) reports that renewable sources such as biomass, geothermal, hydroelectric, and solar make up 41% of the energy provided by the District. An additional 3.5% of the power comes from nuclear, and 5.8% from large hydroelectric generation. Natural gas and energy from unspecified sources of power (typically power purchased by IID on the open market) make up 49.7% of the power provided.

The primary GHGs that would be emitted during electricity generation for the proposed project are carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O). The heat absorption potential of a GHG is referred to as the "Global Warming Potential" (GWP). Each GHG has a GWP value based on the heat-absorption properties of the GHG relative to CO_2. This is commonly referred to as CO_2 equivalent (CO_2E). In Table 4-6, the estimated metric tons CO_2E per million kilowatt hour (kWh) is estimated for power delivered in Mexico and power delivered by IID.

Table 4-6: Carbon Dioxide Equivalents for Power Sources

Fuel Type	Life-Cycle CO_2E per million kWh[1]	Electricity Production by Source, Mexico (Percent of Total Generation)[2]	Electricity Production by Source, IID (Percent of Total Generation)[3,4]
Coal	820	0.05	0.01
Biomass - co-firing	740	0.10	0.01
Natural Gas	490	0.55	0.36
Biomass	130	0.05	0.10
Solar Photo Voltaic (utility)	48	0.05	0.15
Geothermal	38	0.00	0.14
Hydropower	24	0.10	0.15
Nuclear	12	0.04	0.05
Wind - Offshore	12	0.07	0.00
Wind - Onshore	11	0.00	0.02
Weighted CO_2E per million kWh		***396***	***217***

Notes:

1. CO_2E from Annex III of Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change.
2. BP Statistical Review of World Energy, Ember Global Electricity Review (2022).
3. IID 2020 Power Content Label. https://www.iid.com/energy/renewable-energy/power-content-label
4. A portion of IID electricity bought on open market. It is assumed these sources are consistent with California's 2020 Total System Electric Generation.

This analysis looks at the current sources used for electrical generation, rather than those that may be in place in years 2030, 2040, and beyond. This analysis likely overestimates GHG emissions as both the Mexican and IID energy sources have been trending to cleaner/lower emissions sources for electricity.

Table 4-7 shows the estimated annual CO_2E in metric tons for Scenario 1 and Table 4-8 provides the same data for Scenario 2.

Table 4-7: Estimated Annual CO_2E Emissions Water Importation Facilities Scenario 1

Facility	Annual Million kWh	CO_2E emissions per million kWh (metric tons)[1]	CO_2E (metric tons)
Facilities Using Electricity from Mexico			
Sea of Cortez Intake Pump Station	427	396	169,000
Ocean Water Desalination Facility	1,766	396	699,000
Conveyance Pump Station	805	396	319,000
Facilities Using Electricity from IID			
Salton Sea Pump Station	9	217	1,954
Remediation Desalination Facility	53	217	11,423
Energy Recovery Turbines	(254)	217	(55,158)
Total Annual CO_2E (metric tons, rounded)			**1,145,000**

Notes: 1. See Table 4-6

Table 4-8: Estimated Annual CO_2E Emissions Water Importation Facilities Scenario 2

Facility	Annual Million kWh	CO_2E emissions per million kWh (metric tons)[1]	CO_2E (metric tons)
Facilities Using Electricity from Mexico			
Sea of Cortez Intake Pump Station	427	396	169,000
Ocean Water Desalination Facility	1,766	396	699,000
Conveyance Pump Station	805	396	319,000
Facilities Using Electricity from IID			
Salton Sea Pump Station	163	217	35,447
Remediation Desalination Facility	442	217	95,881
Energy Recovery Turbines	(254)	217	(55,158)
Total Annual CO_2E (metric tons, rounded)			**1,263,000**

Notes: 1. See Table 4-6

4.2.3.2 Potential GHG Emissions without the Project

One benefit from restoring the Salton Sea would be to avoid the GHGs that may be released from the exposure of the playa. Public input on plans to restore the Salton Sea have highlighted concerns about enhanced fluxes of GHGs from the increasingly exposed playa. These concerns are well-founded. CO_2 and CH_4 fluxes are higher on dry compared to wetted lakes. In a meta-analysis, Marce et al. (2019) found that bodies of water produce 18 to 55 millimole (mmol) CO_2 m^{-2} day^{-1} whereas dry inland lakebeds may produce 4 to 1533 mmol CO_2 m^{-2} day^{-1}, although only 10 studies on dry inland lakes were available to draw from at time of publication. While considerably higher than bodies of water and having a high degree of variability, these emission rates are similar to estimates for soils, flowing rivers, and dry peatlands. Using the range of emissions from Marce et al., we can estimate the range of possible emissions from the playa in a no-project scenario where water is not imported, and the sea settles at an equilibrium level of

–261 ft. In this scenario, the playa would emit between 7,900 and 3 million metric tons of carbon per year in direct CO_2 emissions, which is a 6,300 to 2.4 million metric ton difference from 2018 levels. The high variability shows the need for a study of GHG emissions from the playa.

4.2.3.3 Project Resiliency

Rising temperatures and increasing extremes in precipitation (including longer periods of low precipitation) will lead to greater demands for water in the Salton Sea area and in Baja California while concurrently decreasing the amount of fresh water available. These conditions will be accompanied by increased sea level rise that is likely to affect the Sea of Cortez.

Risks to the Imported Water Source

The Sea of Cortez Import Concept relies on water from the Sea of Cortez. This water source is more resilient than a freshwater source such as the Colorado River. However, a concept that relies on exchanges or transfers of Colorado River water to achieve benefits may be imperiled by the ongoing Colorado River basin drought related to climate change.

Risks to Infrastructure

The Sea of Cortez Import Concept will require an intake within the Sea of Cortez and facilities in the near vicinity of the Sea of Cortez. Adequate planning and conservative design will be needed to confirm these facilities can function with ongoing sea level rise. The concept will also rely on an intake in the Salton Sea. As evaporation increases, freshwater runoff to the Salton Sea decreases, and the water levels in the Sea change, the intake for the remediation desalination facility may not function properly. Again, adequate planning and design could limit risks to this infrastructure. The conveyance pipeline between the ocean water desalination facility and Salton Sea will traverse several desert washes. More extreme rainfall events, though less frequent, could lead to scour and exposure of sections of the conveyance pipeline. Final pipeline alignment and pipe depth, as well as armoring of the pipeline could limit risk of stormflow damage to the pipeline.

4.2.4 Timeframe

4.2.4.1 Planning and Permitting Timeframe

Figure 4-3 below illustrates the anticipated planning and permitting timeframe needed for the Sea of Cortez Import Concept (both scenarios). As shown, this plan is estimated to need approximately 13 years to be ready to begin construction. This timeline does not account for the possibility of time-consuming legal challenges and litigation. To complete the design and obtain the necessary permits, each major facility would need its own separate design team, with the conveyance pipeline split into five separate packages with design of each pipeline segment taking place concurrently.

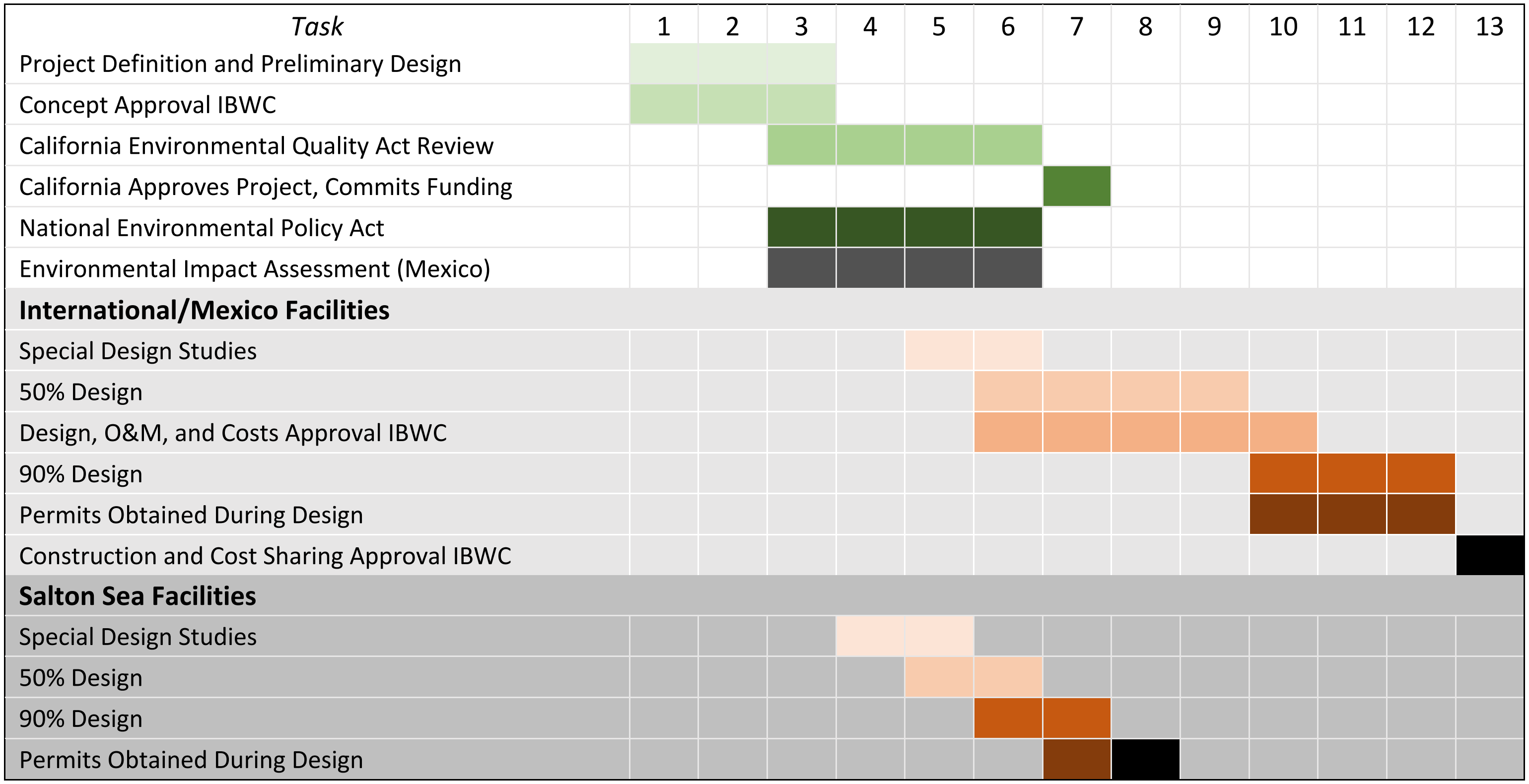


Figure 4-3: Estimated Permitting and Planning Timeframe

4.2.4.2 Construction Timeframe

Table 4-9 below provides information on the estimated timeframe for construction and startup of the needed infrastructure (both scenarios). The anticipated construction schedule is shown in Figure 4-4. As shown in Table 4-9 and Figure 4-4, the timeline needed for the Ocean Water Desalination Facility dominates the construction schedule. The overall construction schedule is anticipated to be nine years. The construction schedule in Table 4-9 and Figure 4-4 does not account for delays related to avoiding impacts to special status species (e.g., no construction during bird nesting season) nor are any constraints included on the amount of construction equipment usage or allowable ground disturbance to avoid excessive volumes of air quality emissions and dust generation during construction.

Table 4-9: Timeline Assumptions

Infrastructure Needed	Timeline Assumptions
960 MGD Ocean Water Intake	It is assumed the construction of the Ocean Water Intake will take place concurrent with construction of the Ocean Water Desalination Facility.
960 MGD Sea of Cortez Intake Pump Station	The timeline for construction of this large pump station was based on the timeframe for construction of the Harvey O. Banks Pumping Plant of the California State Water Project. The timeline for construction of that Banks Pumping Plant, and the Sea of Cortez Intake Pump Station are assumed to be six years. It is assumed that this pump station would be built concurrently with the Ocean Water Desalination Facility.
480 MGD Ocean Water Desalination Facility	If built, this would be the largest RO desalination facility in the world. Currently the largest RO facility under construction is the Taweelah facility in Abu Dhabi, United Arab Emirates. The Taweelah facility will be an approximately 200 MGD facility and has an anticipated construction schedule of 41 months (about 3.5 years). The largest existing constructed RO desalination facility is the Sorek Desalination Plant in Tel Aviv, Israel. It has a capacity of approximately 140 MGD and had a construction timeframe of approximately 30 months (about 2.5 years). Though it may be possible to build the desalination facility as separable, operable units all in concurrent construction, this is complicated by the need to have proper site access control and coordination. The analysis assumes construction of the 480 MGD facility will take approximately 100 months or approximately 8.5 years.
Brine Outfall Sea of Cortez	Construction of the Brine Outfall Sea of Cortez will take place concurrent with construction of the Ocean Water Desalination Facility.
480 MGD Conveyance Pump Station	Construction of the Conveyance Pump Station will take place concurrent with construction of the Ocean Water Desalination Facility.

Infrastructure Needed	Timeline Assumptions
Conveyance Cortez to Salton Sea	This consists of 190 miles of parallel 108 inch steel pipeline installed via trenching. It is assumed that this conveyance would be constructed concurrent with construction of the Ocean Water Desalination Facility. If multiple segments were constructed concurrently, it would be possible to complete the conveyance pipeline in the same timeframe as the Ocean Water Desalination Facility.
Specific to Scenario 1	
13.5 MGD Remediation Desalination Facility	No analogous surface water desalination facilities of this size were identified within California. However, similarly sized groundwater desalination facilities in California have had construction periods of 18 to 30 months. It is assumed this construction could be done independently of construction associated with water importation.
Salton Sea Intake	It is assumed this intake will be built concurrent with construction of the Remediation Desalination Facility and take between 5 to 10 months.
Sea Return Pipeline	It is assumed this return pipeline will be built concurrent with construction of the Remediation Desalination Facility and Salton Sea Intake pipeline and take between 10 to 20 months.
Evaporation ponds	No analogous evaporation ponds were identified within California. The construction timeframe needed for the evaporation ponds is based on the estimated time needed for excavation and would be approximately 15 months. It is assumed that the evaporation ponds could be built concurrent with the Remediation Desalination Facility.
Specific to Scenario 2	
100 MGD Remediation Desalination Facility	No analogous surface water desalination facilities of this size were identified within California. However, this construction schedule is assumed to be similar to that for the Sorek Desalination Plant, about 3 years. It is assumed this construction could be done independently of construction associated with water importation.
Salton Sea Intake	It is assumed this intake will be built concurrent with construction of the Remediation Desalination Facility and take between 16 and 24 months.
Sea Return Pipeline	It is assumed this return pipeline will be built concurrent with construction of the Remediation Desalination Facility and Salton Sea Intake pipeline and take between 16 and 24 months.
Evaporation ponds	No analogous evaporation ponds were identified within California. The construction timeframe needed for the evaporation ponds is based on the estimated time needed for excavation and is estimated to be 2 years. With multiple crews working it is assumed that the evaporation ponds could be built concurrent with the Remediation Desalination Facility.

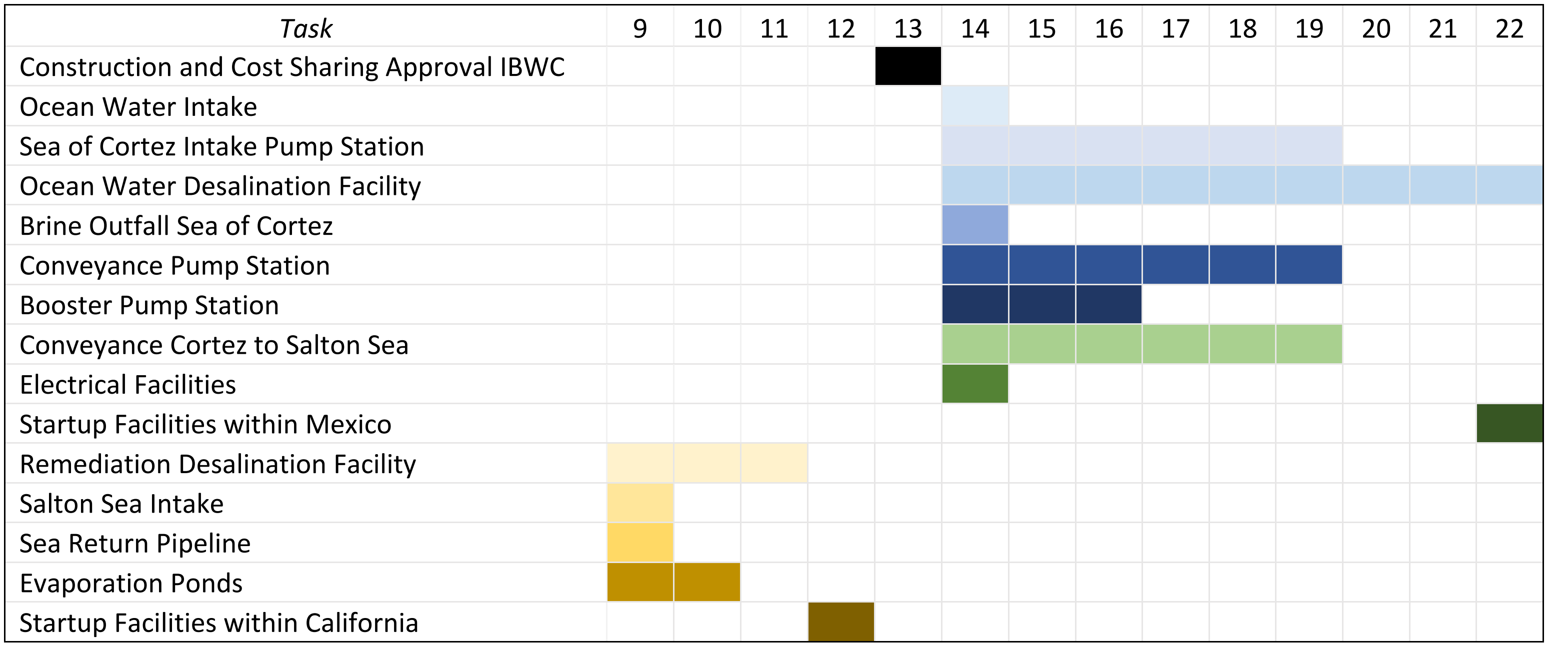


Figure 4-4: Estimated Construction and Startup Timeframe

4.2.4.3 Overall Implementation Timeframe

In total, it is estimated that planning activities will take approximately 13 years. Construction is anticipated to take approximately 9 years. In total, the project timeline, from permitting and design to construction completion, is estimated to take roughly 22 years.

4.3 Evaluating Feasibility of Construction and Operation

Several key construction and operational challenges are described below. While not insurmountable, these challenges add to the need for careful design, contribute to the project cost, and extend the timeline needed for implementation.

- The facilities will be in a seismically active area and areas prone to liquefaction. Due to the seismic risk, areas in proximity to the Gulf of California may require support on deep foundations;
- The facilities will be in areas with corrosive soils;
- Construction of the Conveyance: Cortez to Salton Sea will cross through hard rock areas and may require the use of blasting. Due to local ordinances and sensitive habitats, the use of a blasting program may be undesirable;
- The need for blasting as well as the depth and width of trenching for the Conveyance: Cortez to Salton Sea introduces worker safety issues;
- Project construction will generate large volumes of soil for disposal;
- Project construction will require skilled craft workers for an extended period, and may require travel of workers from other areas and/or establishment of temporary communities.
- Project operation will generate large quantities of brine salt that will need disposal;
- Project operation will require skilled workers who are not likely to be present in the current communities and will require recruitment/settlement of these workers from other areas.

4.3.1 Geotechnical

For the purposes of establishing a general understanding of geotechnical conditions around the proposed desalination plant(s) and along the proposed alignment of the conveyance pipeline, the support team, at the direction of the Panel, reviewed seven (7) separate geotechnical and geological referenced letters and reports regarding the soil and geologic conditions with the area between the Salton Sea (US) and San Felipe (Mexico) from 1984 to 2022. All references are listed below. The support team further reviewed available topographic and geologic maps as well as satellite images and photographs to further assess the proposed plant and pipeline alignment site conditions.

The historical documents reviewed as part of this assessment are listed below:

- US Department of the Interior Geologic Survey, Geotechnical Investigation of Liquefaction Sites, Imperial Valley, California, 1984

- Mueller, K and Rockwell, T., Late Quaternary Activity of the Laguna Salada fault in northern Baja California, Mexico, 1995
- Alles, David L., Geology of the Salton Trough, Western Washington University, November 28, 2011
- Wehncke, E., Ruben Lara-Lara, J., Alvarez-Borrego, S., Ezcurra, E., Conservation Science in Mexico's Northwest – Ecosystem Status and Trends in the Gulf of California, 2014
- Martin-Barajas, Arturo., The Geological Foundations of the Gulf of California region, December 2014
- Sanchez, Rosario, Rodriguez, Laura, Transboundary Aquifers between Baja California, Sonora and Chihuahua, Mexico, and California, Arizona and New Mexico, United States: Identification and Categorization, 2021
- Brusca, Richard C., A Brief Geologic History of Northwestern Mexico, 2022

The review of the previously completed reports and maps provided a general understanding of the subsurface conditions in the vicinity of the new desalination plant near San Felipe, Mexico and along the Conveyance: Cortez to Salton Sea by way of paralleling Highway 5 in Mexico to Mexicali before bypassing Mexicali to the west.

To more accurately reflect conditions that are likely to be encountered during the installation considered in this study, the support team focused on technical elements of the papers presented above while maintaining connectivity with other available information (from publicly available work in the US) where subsurface construction works were anticipated to be located in similar geologic areas.

No final design plans/specifications or as-built drawings/reports of any of the referenced projects were available for review. All geotechnical and geological information reviewed relates to data collected in the general region of the proposed project and is not considered to be within the exact known position of any structure or pipeline alignment.

4.3.1.1 Project Site Geology – San Felipe, Mexico to Salton Sea

The project site is located in the lower portion of the Salton Trough physiographic province. The Salton Trough is a topographic and geologic structural depression resulting from large scale regional faulting. The trough is bounded on the northeast by the San Andreas Fault and Chocolate Mountains and the southwest by the Peninsular Range and the San Jacinto Fault Zone. The Salton Trough represents the northward extension of the Gulf of California containing both marine and non-marine sediments deposited since the Miocene Geologic Age. Tectonic activity that formed the trough continues at a high rate as evidenced by deformed young sedimentary deposits and high levels of seismicity. As can be seen on the map below (Figure 4-5), the alignment (i.e., thick red line) passes through mostly alluvial and lacustrine sediments, as well as passing across several geologic faults from San Felipe, Mexico to the Salton Sea. There are two main geologic formations (moving from south to north):

- Lacustrine Deposits (from San Felipe to Laguna Salada Mexico);
- Alluvial Deposits and Laucustrine Deposits (from Laguna Salada to Salton Sea).

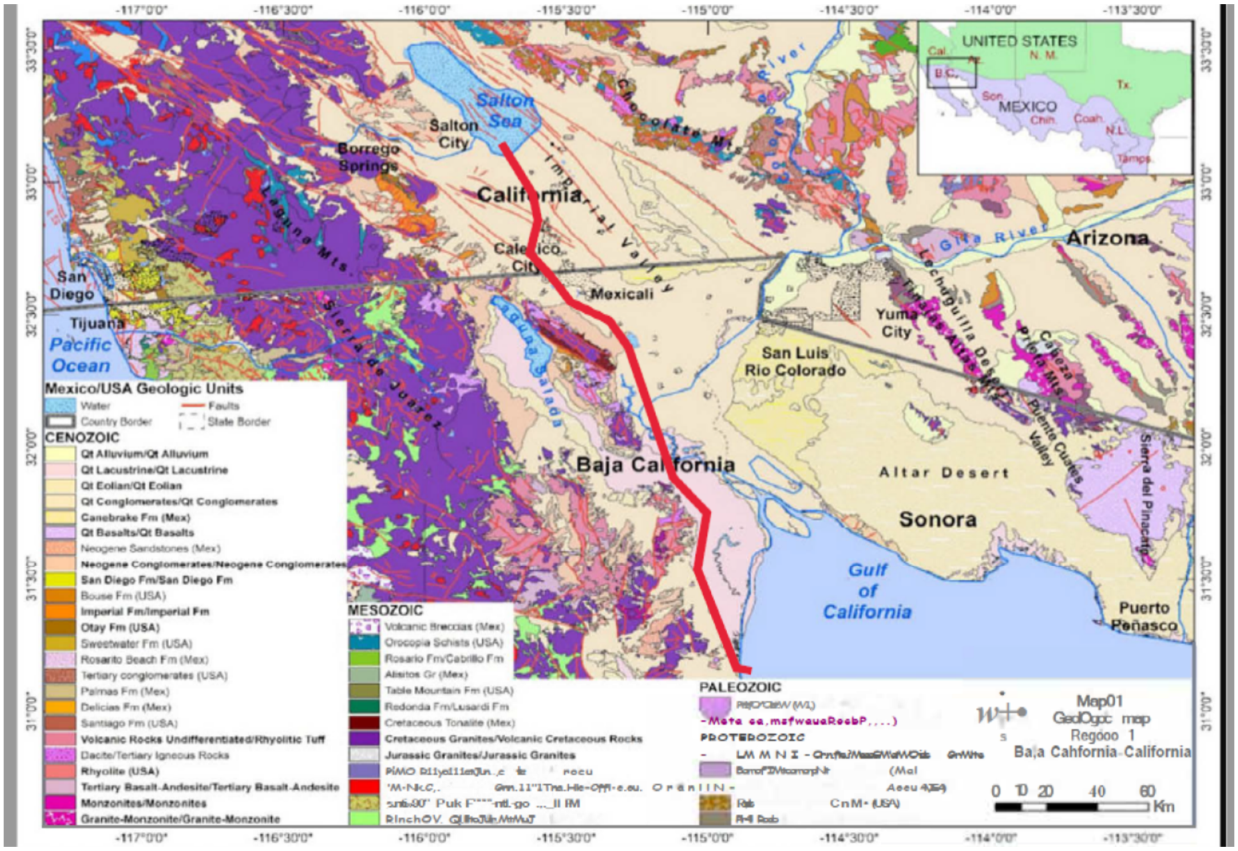


Figure 4-5: Approximate Conveyance Alignment on Mexico/USA Geologic Map

Lacustrine Deposits (Playa San Felipe) - Near San Felipe

The Valle San Felipe graben containing Playa San Felipe, a dry lakebed 19 kilometers (12 miles) long and 3.2 kilometers (2 miles wide), separates the high western mountains from three lower eastern mountain blocks. The southern equivalent of Valle San Felipe is known locally as Valle San Pedro or Valle Chico. The length of this combined structural depression is about 97 kilometers (60 miles). Magnetic and gravity surveys of the north end of this trough (Slyker, 1970) revealed a minimum of 2,450 meter^3 (8,000 ft) of sedimentary fill in the deeper part.

The Lacustrine deposits consist of interbedded lenticular and tabular silt, which are sand and clay that formed from lake deposits, and tend to be more stratified and can achieve greater compaction as more materials form overburden and drive particles into a denser arrangement. Older deposits of Miocene to Pleistocene non-marine and marine sediments were deposited during the intrusions of the Gulf of California.

The typical soil profile within this geologic unit consists of interbedded firm density silt and sand as well as stiff clays of varying expansiveness. Native clays may exhibit low to high shrink/swell potential. There is considerable variation of the soils in these types of geologic strata as the soils are formed from sediment and alluvium from mixed origin (Colorado River overflows and freshwater lake sediments).

Quaternary Age Deposits - Alluvial and Lacustrine Deposits (North of Laguna Salada to Salton Sea)

Clastic deposits of the Quaternary Age are found north of the Laguna Salada and the Imperial Valley in lower parts of slopes and in most open valleys. These Holocene era recent lake deposits include silt, clay, sand laid down in lakes and on their shores, alluvium (in stream valleys), fanglomerate, talus, and other locally derived materials that have been transported for short distances (from mountain slopes). Runoff sediments that drop out as alluvial fans are common. Depending on the depth of sediment stratification, surface materials tend to be loose, whereas underlying soils may be more compact due to overburden pressures from continued soil buildup over time.

Common features are a flat, sparse vegetation cover, fine sediment (clay, silt, and sand), and windy conditions. These features are similar to an aeolian type of environment, however, instead of wind moving soil particles, alluvial systems are created where particles move in a water filled environment and float over the surface until they settle due to a loss of velocity.

The Late Pleistocene to Holocene (recent) lake deposits are derived from periodic flooding of the Colorado River which intermittently formed a fresh-water lake (Lake Cahuilla). The Lacustrine deposits consist of interbedded lenticular and tabular silt, sand and clay which are formed from lake deposits. Lacustrine deposits tend to be more stratified and can achieve greater compaction as more materials form overburden and drive particles into a denser arrangement.

The typical soil profile within this geologic unit consists of interbedded firm density silt and sand as well as stiff clays of varying expansiveness. Native clays may exhibit low to high shrink/swell potential. There is considerable variation of the soils in these types of geologic strata as the soils are formed from sediment and alluvium from mixed origin (Colorado River overflows and fresh-water lake sediments).

4.3.1.2 Estimated/Anticipated Soil and Bedrock Conditions Along Conveyance Alignment

Based on assessments that were reviewed in the referenced materials, a general understanding of materials was developed for the linear extent of the conveyance alignment as summarized below (see Table 4-10). Based on the data, the following generalized subsurface strata underlie the Project Area to the depths as assumed from the literature.

Table 4-10: Anticipated Soil and Bedrock Conditions for the Sea of Cortez Import Concept

Sediment Type	Location	Characteristics
Lacustrine Deposits (Near San Felipe, Mexico)	From ground surface to likely depth of pipeline (i.e., about 18 ft bgs) At the Ocean Water Desalination Facility and along approximately 60 miles of pipeline alignment.	Brown and dark brown, silty clay (CL) and clay (CH) to clayey silt (ML) with varying amounts of sand and gravel, fine grained matrix with slight variations of coarse-grained particles, high corrosivity and shrink/swell potential, compact to very compact density
Alluvial sediments with interbedded lacustrine sediments (Salton Trough/Imperial Valley)	From ground surface to likely depth of pipeline (i.e., about 18 ft bgs) At Remediation Desalination Facility and along approximately 130 miles of pipeline alignment.	Light brown and brown, fine to coarse silty sand, (SM), silt (ML) and clay (CL) contains varying amounts of rock fragments to interbedded cemented sands and silts, some clay stringers; loose to medium dense, high corrosivity and shrink/swell potential where clay percentage is higher

4.3.1.3 Geological Hazards

Liquefaction

Liquefaction may be an issue in the alluvial materials where soils are saturated (i.e., in areas of higher groundwater). Liquefaction occurs in granular soils (e.g., like those in an aeolian formation setting) below the water table when those soils are subjected to vibrations such as those generated by earthquakes. Pore pressure increases as a result of the vibrations and allows the soil particles to rearrange, thus reducing in volume (i.e., resulting in settlement). The areas most prone to this issue are the Ocean Water Desalination Facility area near the Sea of Cortez coast and the pipeline alignments that are located close to water bodies. However, liquefaction is not isolated to only these areas. It could happen anywhere the groundwater is higher and loose density coarse-grained soils exist.

Expansive Soil

The soils in the Lacustrine and higher clay portion of the alignment within the alluvial materials are potentially prone to expansion (i.e., shrink/swell). Typically, these types of clay soils are considered sensitive to wetting and drying and have a volume change associated with those variations in moisture content. Site specific sampling and testing should be considered during the design phase along with potential mitigation measures provided by the geotechnical engineer.

Corrosive Soil

The Lacustrine and higher clay/silt portion alluvial soils are prone to be corrosive. Preventative measures that are specific to the systems to be constructed should be provided by the geotechnical engineer during the design phase. There are multiple methods of addressing corrosive soil conditions and those chosen should be specific to the materials to be used.

4.3.1.4 Seismic Hazards

The project site is primarily located in the Salton Trough (a seismically active area mapped in the Imperial Valley with numerous faults associated with the San Andreas system of faults). The entire northwest-trending province is characterized by a trend parallel to that of the San Andreas fault. While some conflict in this pattern exists in the northern end of the province, in the central part of the Imperial Valley there is a notable linearity and parallelism in the southernmost faults of the San Jacinto zone, which include the Superstition Mountains, Superstition Hills, and Imperial faults.

Although the primary San Andreas fault runs just east of the new plant and pipeline alignment, this very seismically active area still may affect the pipeline as the new alignment must cross several fault lines to reach the Salton Sea. A complete seismic analysis will be required at the time of initial design to accurately design the planned systems.

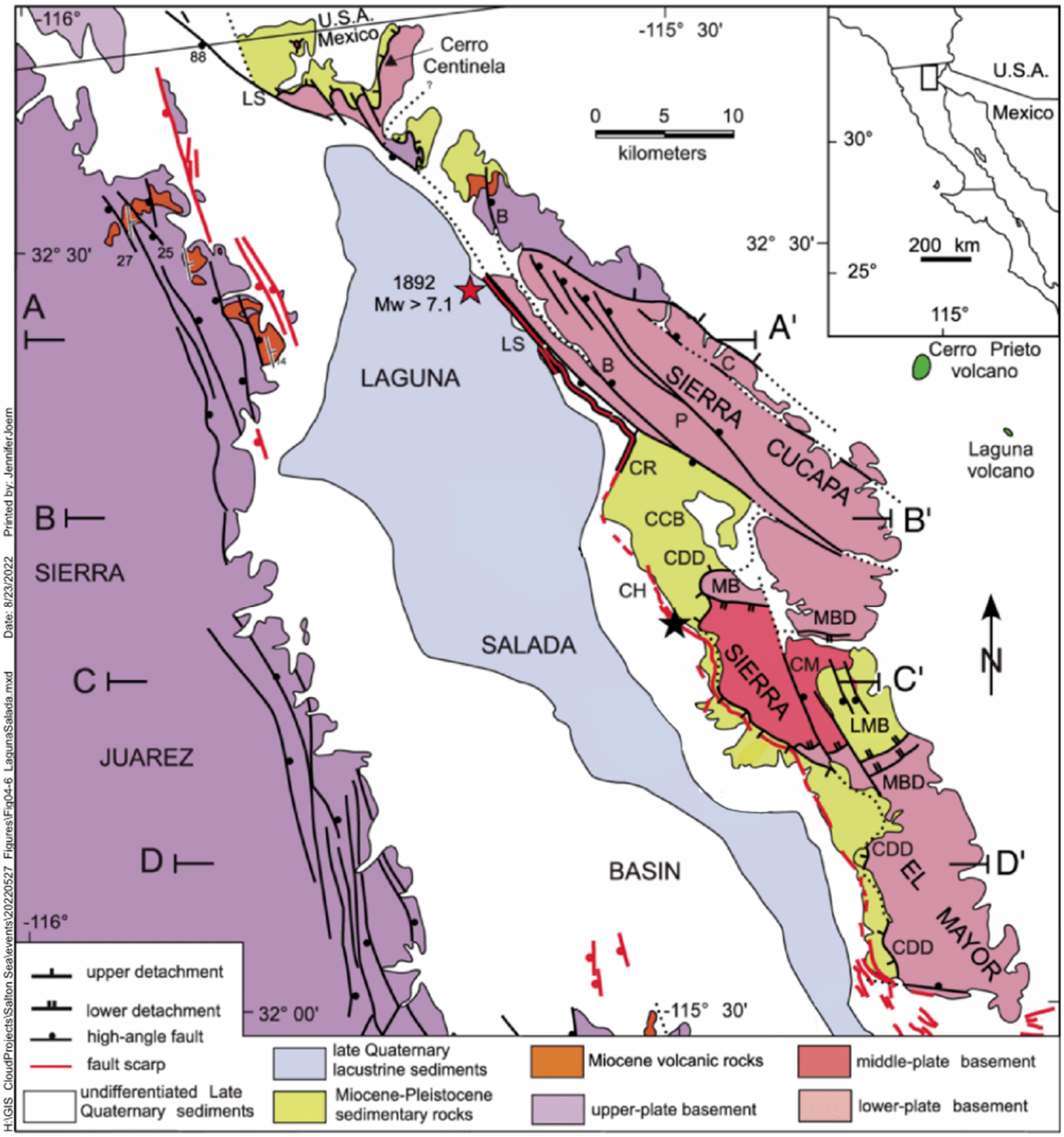
4.3.1.5 Geotechnical Engineering Construction Considerations

Excavation Characteristics

The review and assessment indicate that the project facilities are underlain by varying geologic formations and materials as indicated in the previous section. Excavation of the overburden soils are anticipated to encounter mostly silts and clays (in the Lacustrine section in the southern portion), and silts, clays, and sands in the northern alluvial portion of the alignment.

The proposed alignment appears to veer closely to the base of the eastern side adjoining mountain ranges shown on Figure 4-6. The area of interest is the El Mayor area to Sierra Cucapa area (see light pink area on Figure 4-6). Excavations within these mid-portions of the alignment (especially those areas near the base of the mountain ranges noted above) can generally be expected to be accomplished with heavy-duty excavation equipment and drilling equipment in good operating condition. Zones containing more resistant, less weathered rock should be anticipated, especially where the pipeline runs particularly close to the base of the mountain range. Excavation in such materials may necessitate heavy ripping, rock breaking, or coring.

Source: https://www.researchgate.net/figure/Schematic-geologic-map-of-the-Laguna-Salada-basin-which-is-a-half-graben-controlled-by_fig1_236272250



Schematic geologic map of the Laguna Salada basin, which is a half-graben controlled by the Laguna Salada and Cañada David faults along its eastern margin. Stars denote possible locations of major epicenters. Green map unit denotes Quaternary volcanoes located on the plate margin.

Figure 4-6: Geologic Map of Laguna Salada Region (Note: basement rock east of the basin)

Depending on the overall hardness of the underlying materials based on the results of any future geotechnical studies, establishing a pre-excavation blasting program in areas where harder materials are anticipated may be desirable to maintain a positive project schedule. Due to local ordinances and sensitive habitats, the use of a blasting program may be limited or restricted. Permitting requirements should be further investigated before assuming that blasting is allowed. Given the depth and likely width of the pipeline excavation work required, the consideration of a blasting program, if permitted, should be reassessed at the time of the geotechnical study of the final alignment.

Temporary Excavations and Shoring

The geotechnical consultant should evaluate the soil classifications and excavation performance in the field in accordance with the applicable regulations. Temporary excavations should be constructed in accordance with US and Mexican authorities' recommendations. For trenches or other excavations, requirements regarding personnel safety should be met using appropriate shoring (including trench boxes) or by laying back the slopes based on the soil types encountered. At a minimum, until otherwise assessed by a licensed geotechnical engineer, open cut excavations should consider sloping no less than 1H:1V and flatter sloping or temporary shoring may be necessary based on the presence of loose density soils. Due to varying levels of groundwater likely to occur at pumping and treatment facilities and along the alignment, temporary excavations that encounter seepage will likely require shoring. Excavations encountering seepage should be evaluated on a case-by-case basis. Presently, there is not enough site-specific information to determine the extent of temporary shoring.

In areas of loose density soils and/or the presence of groundwater seepage, a shoring system will likely be required to stabilize the excavation sidewalls during construction. Shoring systems are anticipated to be constructed through the upper loose density soils to the underlying firm soil/rock materials. The shoring system should be designed using the magnitude and distribution of lateral earth pressures to be determined at the time of final design for both braced shoring and cantilever shoring.

Remnants of less weathered/intact rock are anticipated to be encountered in the subsurface materials. Consequently, as noted earlier, these materials are anticipated to be difficult to excavate. The geotechnical engineer of record may want to consider the use of temporary shoring systems such as trench boxes, slide rail systems, etc.

The shoring discussions presented in this report are for preliminary feasibility purposes and the geotechnical engineer and contractor should evaluate design parameters by their own means and make appropriate considerations for their design. Most importantly, the contractor must take appropriate measures to protect workers. Occupational Safety and Health Administration (OSHA) requirements pertaining to worker safety should be observed.

Construction Dewatering

Where groundwater, seepage, and/or perched water conditions are encountered, dewatering measures during excavation operations should be prepared by the contractor’s engineer and reviewed by the design engineer. Considerations for construction dewatering should include anticipated drawdown, piping of soils, volume of pumping, potential for settlement, and groundwater discharge. Disposal of groundwater should be performed in accordance with stipulated guidelines of the overseeing government entity.

Groundwater levels may fluctuate with precipitation, irrigation of adjacent properties, and drainage. The groundwater levels discussed herein should not be interpreted to represent an accurate and/or specific condition within the desalination plant area and/or along the proposed pipeline alignment.

4.3.1.6 Foundations, Earthwork and Potential Costs

Without detailed information on the desalination plant sizing, the pipeline depth, and the pump station needs to convey the water over the 190 miles, the foundation and earthwork discussion must be kept to a general description of potential issues.

Foundations – Ocean Water Desalination Facility and Sea of Cortez Intake Pump Station

Due to the structural loads, the seismic activity, geologic formation in the vicinity and the proximity to the Gulf of California, most of the desalination facility is likely to require support on deep foundations. Shallow spread footings or mat foundations may be able to support some of the lightly loaded units (e.g., pump stations), depending on the final elevations, loads and structural tolerances. The final decision on the foundations to be used will be made by the geotechnical engineer of record based on specific data collected once the final design elements are better defined. Therefore, at this time, only order of magnitude cost ranges can be considered.

Earthwork – Ocean Water Desalination Facility and Sea of Cortez Intake Pump Station

This study assumed that cut/fill volumes for the Desalination Plant and associated Pump Stations are somewhat equal (although, typically a pump station produces more cut materials as the majority of the unit is below the ground surface and excess soils are generated as part of the construction). Regardless, the earthworks for the units presented above are very small in terms of total volume of earthwork necessary to complete the pipeline work.

Earthwork – Conveyance Cortez to Salton Sea (Parallel Water Lines)

This study assumed that the pipelines will be constructed as an open cut with 1V:1H side slopes to a design depth that provides 8 ft of soil cover over the pipes (in order to maintain consistent temperatures in the pipeline, will have 2 ft of pipe bedding due to the size of the pipes, and will be excavated with a minimum of 2 ft of clearance on each side of the pipe as well as provide a minimum separation of 5 ft between the pipelines. Therefore, for the conveyance pipeline, the total pipeline depth of excavation will be 19 ft below ground surface (bgs), will be 27 ft wide at the bottom of the trench and will be 65 ft wide at the ground surface.

Given the scenario provided above, it is estimated that up to approximately 32 cubic yards (cy) of soil will be required for removal per ft of pipeline (i.e., 171,000 cy/mile). The total pipeline length is 190 miles, therefore, up to about 32,500,000 cy of soil will need to be excavated. Costs for trench excavation of this magnitude would be at the lower end of the range (due to the volume of soils). It is estimated that a cost range of at least $5 to $10/cy would apply due to the remote work requirements, environmental conditions and the recent market price for fuel.

Use of temporary structural shoring can reduce the amount of earthwork required for movement, but there are costs for use of the temporary shoring measures (e.g., labor, equipment and time). The final geotechnical design work should focus on providing information necessary and select areas of the pipeline installation where shoring is most likely required.

Costs for removal of harder materials (e.g., hardpan, desert pavement, decomposed/weathered rock, bedrock) will be higher. Therefore, excavation of these materials using extraordinary means should be anticipated. This material will probably require removal by large track-hoe or ripper equipment. A pre-excavation blasting option, if allowed, (as mentioned above) should be considered in any project costing exercise as well.

4.3.1.7 General

The conclusions of this geotechnical section of this study are based on the review of documents provided by others. An effort has been made to account for a normal level of expected contingencies, but the possibility remains that unexpected conditions may be encountered during construction. Therefore, an allowance should be established to account for possible additional costs.

Following selection of a specific alignment concept, a phased geotechnical program should be implemented to better define the soils/bedrock likely to be encountered during installation to assess design requirements and costs for construction installation operations. This phased geotechnical approach should be considered as part of the step-by-step progressive process toward developing a final design that includes desalination plant site(s) selection, pipeline alignment and any other pertinent elements such as pump stations, intake/outfall pipe support systems and evaporation ponds.

4.3.2 Availability of Skilled Work Force

Project construction will generate a significant number of construction jobs. The length of construction (~9 years) means the construction workforce will need to be in the area for an extended time. The nearest metropolitan area with a significant work force from which Sea of Cortez desalination facility construction labor could be drawn is the Calexico-Mexicali metropolitan area. This metropolitan area is approximately 124 miles, an approximately 2.5-hour drive, from the proposed Sea of Cortez Intake Pump Station. Given this distance, it may be difficult to attract and retain the needed skilled workforce and it may be necessary to provide temporary facilities to house workers.

Following construction, operation of the ocean water desalination facility and associated pump station will require a skilled workforce of approximately 350 persons. It is unlikely that the necessary workforce currently resides in the San Felipe, Baja California area, and it will be necessary to attract these workers from a broad geographic area and/or set up appropriate training to prepare local workers for this employment opportunity.

The need for skilled workers both during construction and operation does not render the Sea of Cortez Import Concept infeasible; however, it adds an element of uncertainty and could delay construction and project startup.

4.4 Evaluating Technical Performance

4.4.1 Water Quality

As described in Section 2.1.3 the specific criteria against which to measure project performance related to water quality is:

- Achieves a salinity favorable to the widest range of fish and invertebrates that can then support a variety of birds, at a salinity less than 40,000 mg/L
- Achieves a salinity supportive of fish, birds, and invertebrates, with a salinity less than 60,000 mg/L
- Achieves a salinity favorable to a select group of fish and invertebrates that can then support a variety of birds, at a salinity of greater than 60,000 but less than 70,000 mg/L

Salinity modeling via SSAM was performed assuming water importation from the Sea of Cortez and: (1) no remediation desalination at the Salton Sea; (2) a 13.5 MGD remediation desalination facility treats Salton Sea Water (Scenario 1); and (3) a 100 MGD remediation desalination facility treats Salton Sea Water (Scenario 2). SSAM modeling was conducted as described in Section 2.1.3 of this Feasibility Report and the Fatal Flaw Report. Modeling included baseline scenarios (average baseflows of 717,000 AFY) and assuming a 10% increase in baseflows due to uncertainty in the long-term projected inflows to the Salton Sea. Modeled salinity represents an average salinity based on the salt and water balance.

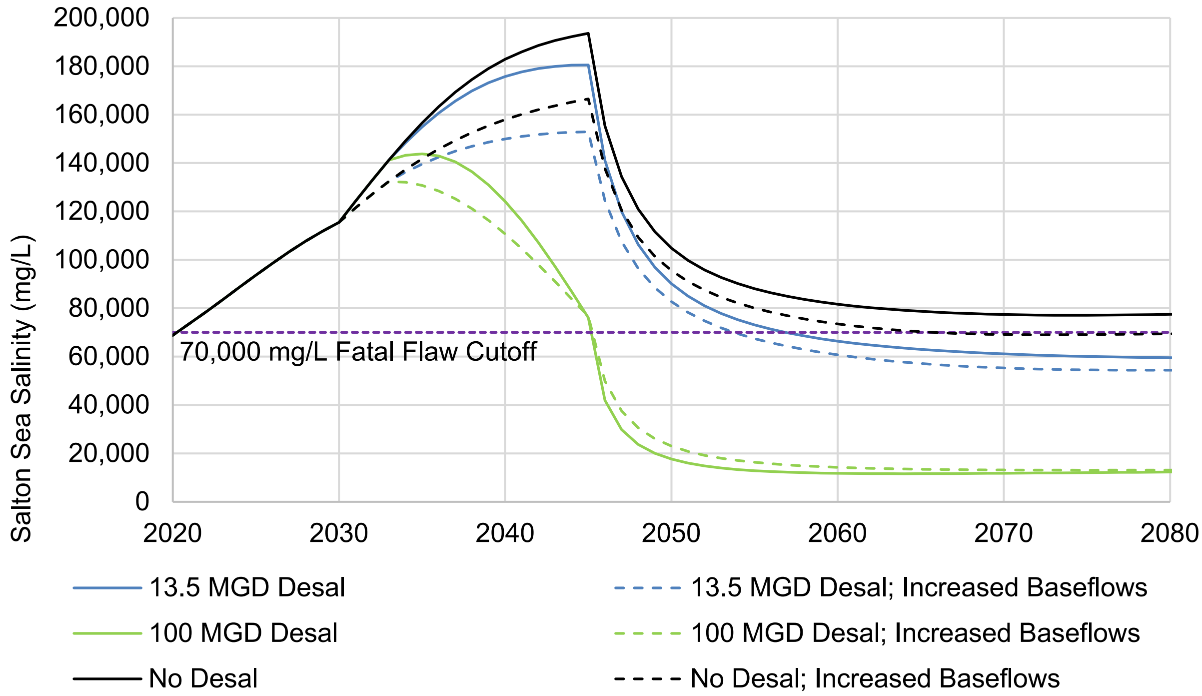


Figure 4-7: Projected Salton Sea average salinity with 540,000 AFY of water imported and no additional desalination (black), 13.5 MGD of desalination (blue), and 100 MGD of desalination (green) at the Salton Sea. The dashed lines indicate a 10% increase in baseflows.

Figure 4-7 shows that the 13.5 MGD facility in Scenario 1 provides a marginal benefit, reducing the average salinity from the baseline 69,000 – 77,000 mg/L with water importation but no desalination facility (black lines) to 59,000-64,000 mg/L with the desalination facility (blue lines; range incorporates uncertainty in baseflows). Modeling indicates that by year 2078, under Scenario 1, the Salton Sea salinity should be conducive to minimum ecological function. The 100 MGD facility in Scenario 2 provides additional salinity reduction to 21,000 – 22,000 mg/L (green lines). While there is not a defined salinity target below the 70,000 mg/L fatal flaw cutoff, Scenario 2 is likely to support higher aquatic biodiversity at the Salton Sea than Scenario 1 as the salinity will reach levels closer to that of seawater in an earlier timeframe.

Salt generation from the remediation desalination facilities discussed above is shown in Figure 4-8.

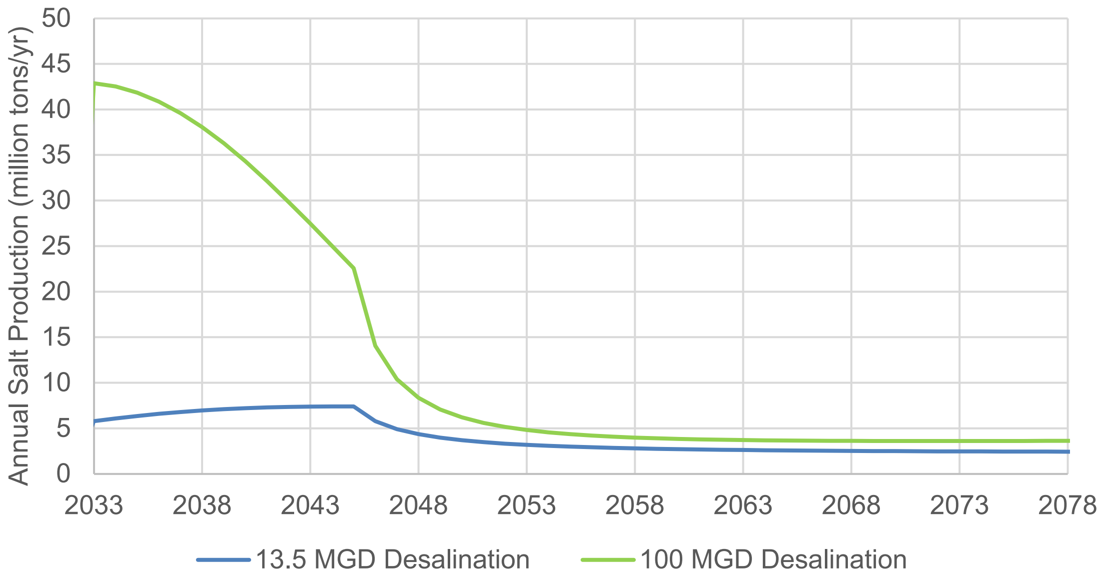


Figure 4-8: Projected annual salt production from proposed remediation desalination facilities with capacities of 13.5 MGD (blue), and 100 MGD (green) at the Salton Sea.

With potential salt production ranging from 2 million to 43 million tons per year, salt management at the Salton Sea from a remediation desalination plant will be a critical component of project success.

In addition to removal of salt, desalination of Salton Sea water is likely to reduce the concentrations of heavy metals, selenium, nutrients, and pesticides. Removal rates would be dependent on the remediation desalination facility intake location, effectiveness of mixing for both desalinated Salton Sea water and imported water, concentrations in existing inflows, and distribution of contaminants in the water column and sediments. While these factors prevent quantification of potential contaminant removal rates from the Salton Sea, increased desalination at the Salton Sea will decrease the overall concentrations of these contaminants.

4.4.2 Water Quantity

The Sea of Cortez Import Concept would import an annual quantity of between 430,000 to 540,000 AF, dependent on the recovery rate of the Ocean Water Desalination Plant and the percentage of time this desalination plant operates each year.

SSAM modeling projected the water surface elevation at the Salton Sea under Scenario 1 would recover to –233 to –229 ft msl, while Scenario 2 would reduce the elevation and is estimated to reach –239 to –235 ft msl due to the larger degree of water extraction for remediation desalination at the Salton Sea.

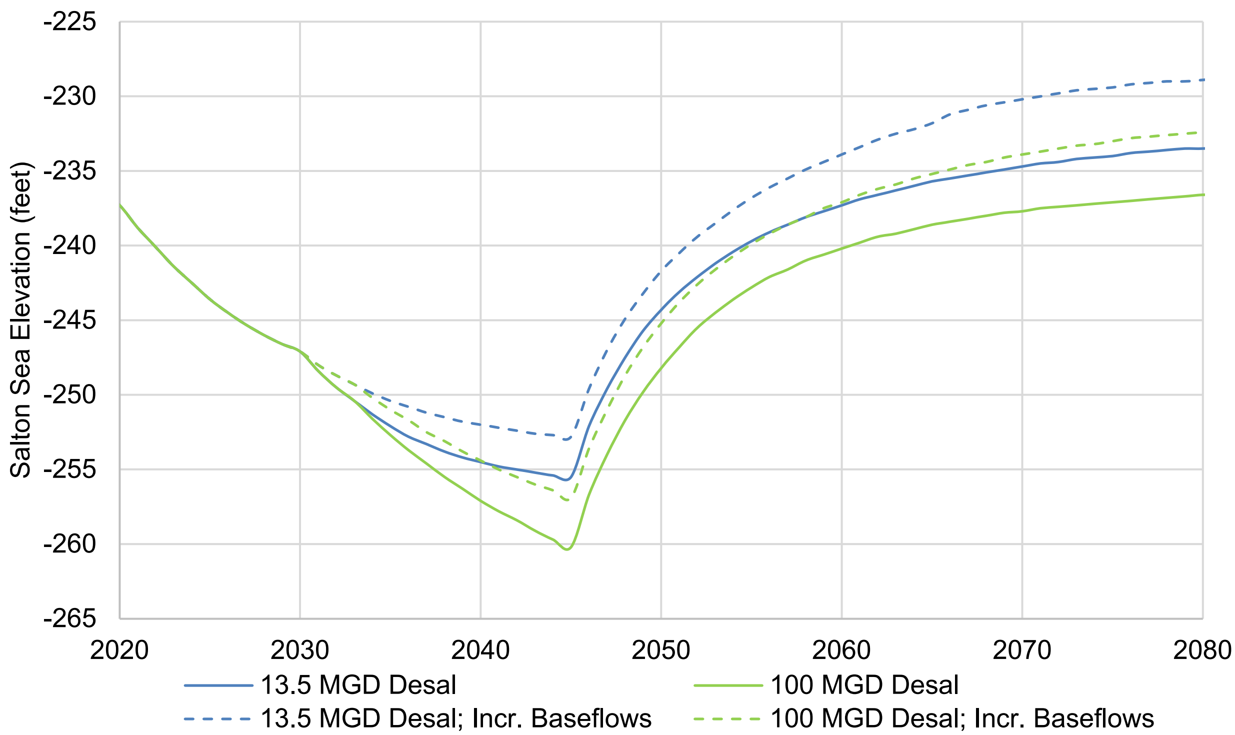


Figure 4-9: Projected Salton Sea elevation with 540,000 AFY of water imported under the Sea of Cortez Import Concepts Scenario 1 (blue) and Scenario 2 (green). The dashed lines indicate a 10% increase in baseflows.

4.4.3 Playa Exposure

As described in Section 2.1.3, a change in Salton Sea surface is assumed to have a direct correlation to a reduction in exposed playa and improved air quality. Scenario 1 is projected to result in a water surface elevation between −233 to −229 feet, meaning more of the playa would be covered by the sea than was covered in 2018 (when the Salton Sea elevation was approximately −237 feet). Scenario 2 is projected to result in a water surface elevation between −237 to −233 ft, meaning that exposed playa would be covered to the levels which occurred in 2018.

4.5 Project Cost Estimate

As described in Section 2.2, costs were developed in 2022 USD and should be considered conceptual, as is appropriate for the level of design completed at this stage. The range of accuracy of a Class 5 conceptual estimate is −50% to +100%. Subtotals in the tables below have been rounded to the nearest ten thousand dollars. Table 4-11 and Table 4-12 summarize the estimated capital costs, planning and permitting costs, and land acquisitions costs for Scenarios 1 and 2.

In addition to capital cost estimates and annual operation and maintenance (O&M) costs were developed. Annual O&M consists of labor costs to run the desalination plants, maintenance labor for all facilities, treatment chemicals, and power for the pump stations and desalination facilities. These costs are summarized in Table 4-13 and Table 4-14. Operation of evaporation ponds includes removal and hauling of salts from the evaporation ponds associated with the remediation desalination plant.

Finally, life cycle net present value costs were evaluated in Table 4-15 and Table 4-16. As described in Section 2.2, the net present value calculation considered the initial costs, operational costs, assumed financing costs, and assumed a discount rate. Net present value costs were also generated for just the importation components (no remediation desalination components at the Salton Sea) to generate a cost per AF of imported water for the Sea of Cortez Import Concept (assuming the project operates year 2045 to 2078). The cost of importation assuming 430,00-540,000 AFY of imported water for the project duration is $4,700–$5,900 per AF.

Table 4-11: Capital, Planning, Permitting, and Land Acquisition Costs – Sea of Cortez Import Concept Scenario 1

Cost Item	Unit	Unit Price ($)	Quantity	Total ($)
Ocean Water Intake, 144 inch parallel steel pipe with polyurethane lining	LF	17,424	20,100	350,222,000
Sea of Cortez Intake Pump Station, 960 MGD (total inflow)	BHP	10,250	51,100	523,775,000
Ocean Water Desalination Facility (RO), 480 MGD Product Water	LS	4,867,540,000	1	4,867,540,000
Brine Outfall, 144 inch steel pipe with polyurethane lining	LF	17,424	18,000	313,632,000
Conveyance Pump Station, 480 MGD	BHP	10,250	95,900	982,975,000
Conveyance Cortez to Salton Sea, parallel 108 inch steel pipeline with polyurethane lining	LF	13,068	2,006,400	26,219,635,000
Francis Turbines 29.6 MW	LS	9,710,000	1	9,710,000
Remediation Desalination Facility (RO), 13.5 MGD	LS	148,900,000	1	148,900,000
Salton Sea Pump Station, 27 MGD	BHP	10,250	1,342	13,756,000
Salton Sea Intake, 36 inch, steel pipe with polyurethane lining	LF	4,158	10,000	41,580,000
Sea Return Pipeline, 26 inch steel pipe with polyurethane lining	LF	3,003	18,000	54,054,000
High Voltage Electrical Line Connection (>69kV)	LF	300	26,400	7,920,000
Electrical Substation at Sea of Cortez Intake Pump Station (voltage step down 69kV to 13.8kV)	LS	42,000,000	1	42,000,000
Evaporation Ponds with liner and bird netting (3,000 acres)	LS	775,420,000	1	775,420,000
Subtotal				**$34,351,120,000**
Mobilization/Demobilization		@4%		1,374,045,000
Bonds and Insurance		@4%		1,374,045,000
Taxes		@8%		2,748,090,000
Overhead and Profit		@15%		5,152,668,000
Contingency		@30%		10,305,336,000
Subtotal Construction				**$55,305,300,000**
Studies, Permitting, Preliminary Engineering		@15%		5,152,668,000
Engineering/Design/CM		@15%		5,152,668,000
Subtotal Planning and Design				**$10,305,340,000**
Sea of Cortez Intake Pump Station and Desalination Site and Substation	Acre	16,000	75	1,200,000
Easement, conveyance pipeline within Mexico	Acre	8,000	1,474	11,792,000
Salton Sea Pump Station and Desalination Facility Site	Acre	16,000	2	32,000
Evaporation Ponds	Acre	16,000	3,050	48,800,000
Easement, conveyance pipeline within US	Acre	8,000	368	2,948,000
Subtotal Land and Easements				**$64,770,000**
Total Estimated Initial Costs				**$65,675,410,000**
Conceptual Cost Range (-50% to +100%)		**$32,837,710,000**	**to**	**$131,350,820,000**

Table 4-12: Capital, Planning, Permitting, and Land Acquisition Costs – Sea of Cortez Import Concept Scenario 2

Cost Item	Unit	Unit Price ($)	Quantity	Total ($)
Ocean Water Intake, 144 inch parallel steel pipe with polyurethane lining	LF	17,424	20,100	350,222,000
Sea of Cortez Intake Pump Station, 960 MGD	BHP	10,250	51,100	523,775,000
Ocean Water Desalination Facility (RO), 480 MGD Product Water	LS	4,867,540,000	1	4,867,540,000
Brine Outfall, 144 inch steel pipe with polyurethane lining	LF	17,424	18,000	313,632,000
Conveyance Pump Station, 480 MGD	BHP	10,250	95,900	982,975,000
Conveyance Cortez to Salton Sea, parallel 108 inch steel pipeline with polyurethane lining	LF	13,068	2,006,400	26,219,635,000
Francis Turbines	LS	9,710,000	1	9,710,000
Remediation Desalination Facility (RO), 100 MGD	LS	1,216,880,000	1	1,216,880,000
Salton Sea Pump Station, 200 MGD	BHP	10,250	25,000	256,250,000
Salton Sea Intake, 98 inch, steel pipe with polyurethane lining	LF	10,780	10,000	107,800,000
Sea Return Pipeline, 70 inch steel pipe with polyurethane lining	LF	8,855	18,000	159,390,000
High Voltage Electrical Line Connection (>69kV)	LF	300	26,400	7,920,000
Electrical Substation at Sea of Cortez Intake Pump Station (voltage step down 69kV to 13.8kV)	LS	42,000,000	1	42,000,000
Evaporation Ponds with liner and bird netting (22,000 acres)	LS	5,784,030,000	1	5,784,030,000
Subtotal				**$40,841,760,000**
Mobilization/Demobilization		@4%		1,633,670,000
Bonds and Insurance		@4%		1,633,670,000
Taxes		@8%		3,267,341,000
Overhead and Profit		@15%		6,126,264,000
Contingency		@30%		12,252,528,000
Subtotal Construction				**$ 65,755,230,000**
Studies, Permitting, Preliminary Engineering		@15%		6,126,264,000
Engineering/Design/CM		@15%		6,126,264,000
Subtotal Planning and Design				**$12,252,530,000**
Sea of Cortez Intake Pump Station and Desalination Site and Substation	Acre	16,000	75	1,200,000
Easement, conveyance pipeline within Mexico	Acre	8,000	1,474	11,792,000
Salton Sea Pump Station and Desalination Facility Site	Acre	16,000	15	240,000
Evaporation Ponds	Acre	16,000	22,000	352,000,000
Easement, conveyance pipeline within US	Acre	8,000	368	2,948,000
Subtotal Land and Easements				**$368,180,000**
Total Estimated Initial Costs				**$78,375,940,000**
Conceptual Cost Range (-50% to +100%)		**$39,187,970,000**	**to**	**$156,751,880,000**

Table 4-13: Annual O&M Costs – Sea of Cortez Import Concept Scenario 1

Item	Cost ($US)	*Notes*
Ocean Water Desalination Facility (480 MGD), Intake, and Outfall		
Power	286,158,000	1
Chemicals	76,730,000	2
Maintenance and Materials	9,010,000	2
Labor	85,571,000	3
Replacement	48,675,000	2
O&M Contingency	218,698,000	4
Subtotal	*724,840,000*	
Sea of Cortez Intake Pump Station		
Power	68,379,000	1
O&M (4% capital cost)	20,951,000	5
Subtotal	*89,330,000*	
Conveyance Pump Station		
Power	128,772,000	1
O&M (4% capital cost)	39,319,000	5
Subtotal	*168,090,000*	
Conveyance Cortez to Salton Sea		
O&M (1.5% capital cost)	393,295,000	6
Subtotal	*393,300,000*	
Energy Recovery Turbines		
O&M (4 % of capital costs)	388,000	5
Energy Recovered	(48,268,000)	7
Subtotal	*(47,880,000)*	
Remediation Desalination Facility (13.5 MGD) and Intake		
Power	9,996,000	7
Chemicals	1,644,000	8
Maintenance and Materials	680,000	8
Labor	3,272,000	9
Replacement	1,489,000	8
O&M Contingency	6,642,000	4
Subtotal	*23,720,000*	
Salton Sea Pump Station		
Power	1,710,000	7
O&M (4% capital cost)	550,000	5
Subtotal	*2,260,000*	
Evaporation Ponds		
O&M (36% of capital cost)	279,151,000	10
Subtotal	*279,150,000*	
Total	**1,632,810,000**	

1. $0.162/kWh Average cost, in USD, business price per kWh Mexico. Reported as of December 2021. https://www.globalpetrolprices.com/Mexico/electricity_prices
2. Estimated, scaled from 80 MGD RO plant.
3. Assumes 340 Full Time Equivalents at $121/hr
4. Assumed to be 10% of power, chemical, maintenance, and replacement costs.
5. Assumed to be 4% of capital costs.
6. Assumed to be 1.5% of capital costs.
7. $0.19/kWh. Average cost Pacific United States May 2022. Bureau of Labor Statistics www.bls.gov/regions/midwest/data/AverageEnergyPrices_SelectedAreas_Table.htm
8. Estimated, scaled from 15 MGD RO plant.
9. Assumes 13 Full Time Equivalents at $121/hr
10. Assumed to be 36% of capital costs, consistent with *Binational Study of Water Desalination Opportunities in the Sea of Cortez, TM2: Desalination Technologies and Brine Management Options.*

Table 4-14: Annual O&M Costs – Sea of Cortez Import Concept Scenario 2

Item	Cost ($US)	*Notes*
Ocean Water Desalination Facility (480 MGD), Intake, and Outfall		
Power	286,158,000	1
Chemicals	76,730,000	2
Maintenance and Materials	9,010,000	2
Labor	85,571,000	3
Replacement	48,675,000	2
O&M Contingency	218,698,000	4
Subtotal	*724,840,000*	
Sea of Cortez Intake Pump Station		
Power	68,379,000	1
O&M (4% capital cost)	20,951,000	5
Subtotal	*89,330,000*	
Conveyance Pump Station		
Power	128,772,000	1
O&M (4% capital cost)	39,319,000	5
Subtotal	*168,090,000*	
Conveyance Cortez to Salton Sea		
O&M (1.5% capital cost)	393,295,000	6
Subtotal	*393,300,000*	
Energy Recovery Turbines		
O&M (4 % of capital costs)	388,000	5
Energy Recovered	(48,268,000)	7
Subtotal	*(47,880,000)*	
Remediation Desalination Facility (100 MGD) and Intake		
Power	83,905,000	7
Chemicals	19,183,000	2
Maintenance and Materials	2,253,000	2
Labor	18,373,000	8
Replacement	12,169,000	2
O&M Contingency	55,911,000	4
Subtotal	*191,790,000*	
Salton Sea Pump Station		
Power	163,260,000	7
O&M (4% capital cost)	11,029,000	5
Subtotal	*174,290,000*	
Evaporation Ponds		
O&M (36% of capital cost)	2,082,251,000	9
Subtotal	*2,082,250,000*	
Total	**3,776,010,000**	

1. $0.162/kWh Average cost, in USD, business price per kWh Mexico. Reported as of December 2021. https://www.globalpetrolprices.com/Mexico/electricity_prices
2. Estimated, scaled from 80 MGD RO plant.
3. Assumes 340 Full Time Equivalents at $121/hr
4. Assumed to be 10% of power, chemical, maintenance, and replacement costs.
5. Assumed to be 4% of capital costs.
6. Assumed to be 1.5% of capital costs.
7. $0.19/kWh. Average cost Pacific United States May 2022. Bureau of Labor Statistics www.bls.gov/regions/midwest/data/AverageEnergyPrices_SelectedAreas_Table.htm
8. Assumes 73 Full Time Equivalents at $121/hr
9. Assumed to be 36% of capital costs, consistent with *Binational Study of Water Desalination Opportunities in the Sea of Cortez, TM2: Desalination Technologies and Brine Management Options*.

Table 4-15: Calculation of Net Present Value – Sea of Cortez Import Concept Scenario 1

Schedule Input			
Base Year:	2022	**Construction:**	Years 14–22
Study/Design/Approval:	Years 1– 13	**Project Operates:**	Years 23–56
Bond Repayment	Years 1 – 31		
Cost Input			
Initial Costs ($US)	$65.7B	**Annual Costs ($US)[1]:**	305M – 1.6B
Assumed Bond Rate:	4.00%	**Assumed Discount Rate:**	3.00%
Net Present Value Estimate 2078 (all costs)			
$92.5B			
Net Present Value Estimate 2078 (imported water only costs)			
$86.5B			
Present Value Per AF (imported water only costs, assumes 540,000 AFY import)			
$4,700			

1. Annual O&M costs will vary dependent on which facilities are operating.

Table 4-16: Calculation of Net Present Value – Sea of Cortez Import Concept Scenario 2

Schedule Input			
Base Year:	2022	**Construction:**	Years 14-22
Study/Design/Approval:	Years 1 – 13	**Project Operates:**	Years 23-56
Bond Repayment	Years 1 – 31		
Cost Input			
Initial Costs ($US)	78.4B	**Annual Costs ($US)[1]:**	2.4B – 3.8B
Assumed Bond Rate:	4.00%	**Assumed Discount Rate:**	3.00%
Net Present Value Estimate 2078 (all costs)			
$147.8B			
Net Present Value Estimate 2078 (import water only costs)			
$86.5B			
Value Per AF (import water only costs, assumes 540,000 AFY import)			
$4,700			

1. Annual O&M costs will vary dependent on which facilities are operating.

The initial costs presented above are higher than those presented in the RFI responses. R4 and R10 did not include costs for desalination of imported water or remediation desalination at the Salton Sea and ranged from $4.0B to $11.7B. R9 presented annual inflation-adjusted total capital costs of $16.4B. Costs presented in this report account for recent cost increases due to market conditions, electrical infrastructure, soft costs including mobilization/demobilization, bonds and insurance, taxes, contractor overhead and profit, contingency, studies, permitting, preliminary engineering, engineering design, and construction management, and land and easement acquisition costs. Costs presented in the responses may not have included some or all of these items.

There is potential to reduce the production of the remediation desalination facility once a desired Salton Sea salinity is reached, such as 40,000 mg/L as discussed in the Programmatic EIR (California Department of Water Resources 2007). To evaluate the impact on the project cost, a 50% reduction in O&M costs associated with the remediation desalination facility was investigated after the year 2047, with no change in capital costs. The resulting reduction in net present value was less than 9%, well within the range of uncertainty of the cost estimate.

4.6 Benefits Analysis

4.6.1 Economic Revitalization

This section provides a description and monetization of the economic revitalization benefits of Tourism and Recreation, Real Estate Development and Property Taxes, Property Value Impact. All dollar values are presented in 2022 USDs and were escalated using the CPI.

The economic revitalization benefits are likely to vary across the two scenarios, following the variation in both water quality and the timing of when benefits will start to be realized. Specifically, scenario 1 is expected to start providing benefits in 2055, while scenario 2 is expected to provide benefits a decade earlier in 2045. Scenario 1 is likely to have worse water quality which is likely to impact the economic revitalization benefits from less tourism and less desired property. To account for these differences, we use a different start year in the present value calculations and omit the high end (75th percentile) estimate for scenario 1.

4.6.1.1 Tourism and Recreation

Tourism Economics (2017) estimates that annual visitor spending under a revitalized Salton Sea scenario could be approximately $649 million. Applying quartile scalars, this results in a range of total present value benefits through 2078 (the timeframe of analysis) between $758 million (the low end of scenario 1) and $4.1 billion (the high end of scenario 2).

4.6.1.2 Real Estate Development and Property Taxes

Once the Salton Sea is revitalized and attracts more visitors, real estate development is likely to follow. As with all economic revitalization benefits, the amount of development expected in the proximate area is unpredictable. The analysis uses the estimate provided in Tourism Economics (2017): $255 million annual benefit to real estate development and $15 million annual benefit of associated property tax revenue increases. Applying the quartile scalars across the two scenarios, the result is a range of total present value benefits of real estate development between $298 million and $1.6 billion and a range of total present value benefits of property tax receipts between $18 million and $95 million.

4.6.1.3 Property Value Impact

As the Salton Sea is revitalized, the values of existing properties in the proximate area are expected to increase. The analysis used the estimate provided in Tourism Economics (2017) of $46 million annual benefit to property values. Applying the quartile scalars, the result is a range of total present value benefits between $54 million and $294 million.

Table 4-17 summarizes the range of present value estimates of the potential benefits of economic revitalization.

Table 4-17: Monetized Benefits of Economic Revitalization for Water Importation Concepts

Benefit Category	Low (25% scalar)	Moderate (50% scalar)	High (75% scalar)
Water Importation Scenario 1			
Tourism and recreation	$758 M	$1.5 B	Not applicable[2]
Real estate development	$298 M	$596 M	
Property Tax	$18 M	$35 M	
Property value	$54 M	$108 M	
Total	**$1.1 B**	**$2.2 B**	
Water Importation Scenario 2			
Tourism and recreation	$1.4 B	$2.7 B	$4.1 B
Real estate development	$540 M	$1.1 B	$1.6 B
Property Tax	$32 M	$64 M	$95 M
Property value	$98 M	$196 M	$294 M
Total	**$2.1 B**	**$4.1 B**	**$6.1 B**

Notes: 1. Present Values over period 2022 through 2078 at 3% Discount Rate, 2022 USD
2.The high scenario was not included for scenario 1, as the economic revitalization benefits are expected to be lower due to worse water quality

4.6.1.4 Discussion

The present value estimates of economic revitalization are expected to vary across the two water importation scenarios and range from $1.1 B to $6.1 B. While the exact marginal benefit attributable to the importation concepts is highly uncertain, these values offer a range of benefits that can be used for comparison to the concept costs if the caveats and uncertainties are recognized and acknowledged.

Even under the best-case scenario, tourism and economic activity at the Salton Sea are unlikely to return to the levels seen in the late 1950s and early 1960s. Even so, several real-world examples show that restoration of a degraded resource can lead to economic revitalization of the proximity area. Successful economic revitalization of the proximate communities involves more than just restoring the natural resource. The economic revitalization also requires infrastructure such as new or improved roads and recreational facilities, which are not included in the cost estimates of the Sea of Cortez Import Concept. Thus, estimating the exact marginal benefit attributable from the importation project has a great deal of uncertainty. The contribution of the importation project to the economic revitalization of the Salton Sea area cannot be seen as a specific percentage of the total benefit, but rather a key first step in making the revitalization possible. In a no-project scenario, revitalization is unlikely to occur, but importation alone will not provide the full suite of benefits.

4.6.2 Ecosystem Services

Schwabe and Baerenklau (2007) applied a value transfer approach using similar valuation studies and estimated annualized benefits of $1.5 billion to $7.5 billion. However, there is too much uncertainty to robustly apply the values to the anticipated outcomes of water importation at the Salton Sea. This uncertainty includes:

1) The timing, type, and magnitude of the ecosystem services provided from water importation is unknown and cannot be reliably estimated without further research.
2) Whether the ecosystem services provided by the Salton Sea are similar enough to the ecosystems from which Schwabe and Baerenklau (2007) transferred their values to justify the methodology.
3) The long period of time between the original studies and now, and how nonmarket valuation can change over time as a result of changes to societal preferences.

Instead, a qualitative indicator of the direction and order of magnitude of the benefits is applied to each of the water importation scenarios. The first scenario is likely to provide fewer ecosystem services than the second due to worse water quality. While a monetized value of ecosystem services is not estimated, based on the literature available, it is plausible that the value of the benefits is in the range of billions of dollars.

In summary, the Schwabe and Baerenklau (2007) review of nonmarket valuations had several caveats and uncertainties in their analysis. Additionally, the study was conducted in 2007, when the conditions at the Salton Sea were different than today and different than the conditions expected after water importation.

4.6.3 Air Quality and Human Health

Existing literature indicates that reducing the size of the playa through water importation could have positive benefits to air quality and human health. For example, assuming equal emissivity of all exposed playa, Jones and Fleck (2020) connect playa exposure to airborne $PM_{2.5}$ particulate matter concentrations, and these concentrations to county-wide respiratory mortality rates in Imperial and San Bernardino Counties. They link a one-foot drop in lake level to a 0.28 ug/L $PM_{2.5}$ concentration increase and an increase in respiratory mortality of 1.4 to 15.6 people per year. However, as others note, a limitation is the use of county wide data, which includes cases in areas unaffected by the Salton Sea, increasing uncertainty. Recent research has found that playa emissivity varies by playa crust type (Imperial Irrigation District and Formation Environmental LLC, 2018; Buck et al, 2011). Additionally, 6 years of study by IID using the PI-SWERL technique has found that the desert contributes more than double the PM_{10} to the region on a weighted area average basis than the playa, and the desert occupies far more area than the playa. This means that at current playa exposure, the yearly dust contribution of the playa is ~1% of that of the surrounding desert (IID and Formation Environmental LLC, 2018, 2019, 2020, 2021, 2022). These results are somewhat at odds with the finding of Frie et al. (2017) that the playa contributes about 9% of PM_{10} as a daily average by mass. Other authors have examined landforms in the Salton Sea area to see which were the biggest emitters of PM_{10}. Sweeney et al. (2011) found that dry washes were the highest emitters of PM_{10}, followed by soft-crust playa types. King et al. (2011) found that soft-crust playa types were the highest emitters, pointing to the importance of mitigating dust emission in areas that are most emissive. We do not have data about the relative contribution to $PM_{2.5}$ of these areas. In addition to finding congruence about the current level of emissions from the playa and understanding their contribution to public health problems, it is important to understand the future of emissions from the sea. Parajuli et al. (2018) predicted that by 2030, overall PM_{10} levels in the region would increase by 11% and in smaller localities by 900%. It seems clear that reducing exposed playa area would yield benefits for the sea.

4.6.4 Summary of Benefits

Using the approach to estimating economic benefits detailed in Section 2.3, the total estimated present value of monetized benefits of the Sea of Cortez Import Concept range from $1.1 billion to $6.1 billion for the period from 2022 to 2078. An importation project is likely to provide additional benefits associated with ecological, air quality, and human health improvement that are included qualitatively but likely to be in the billions of dollars. Table 4-18 provides a summary of the benefits.

Table 4-18: Estimated Benefits of the Sea of Cortez Import Concept

Benefit Category	Scenario 1	Scenario 2
Economic Revitalization		
Tourism and recreation	$758 M – $1.5 B	$1.4 B - $4.1 B
Real estate development	$298 M - $596 M	$540 M - $1.6 B
Property Tax	$18 M – $35 M	$32 M - $95 M
Property value	$54 M - $108 M	$98 M - $294M
Total Monetized Benefits		
	$1.1 B - $2.2 B	**$2.1 B - $6.1 B**
Ecosystem Services[1]		
	+	++
Air Quality and Human Health[1]		
	++	++

Present Values over period 2022 through 2078, at 3% discount rate; 2022 USD
1. A qualitative indicator using the following key: + would likely increase benefits; ++ would likely increase benefits to a greater degree.

Section 5: Feasibility of the Sea of Cortez Exchange Concept

Section 4 contains the Panel evaluation of long-term water importation solutions that were submitted in response to the RFI. As part of the research into long-term water importation solutions, the Panel evaluated other projects and analyses that had been presented to the IBWC. One such project identified was the *Binational Study of Water Importation Opportunities in the Sea of Cortez, Minute 323 of the Desalination Work Group*, dated April 2020. Using the water importation element of that analysis, combined with useful features of some of the RFI responses (such as a remediation desalination plant at the Salton Sea) resulted in a concept herein referred to as the “Sea of Cortez Exchange Concept.” Though not specifically a RFI response, the Panel is providing the analysis found in this Section as it aids the overall understanding of the issues, challenges, benefits, and costs to water importation to improve the Salton Sea.

5.1 Concept Description, Design and Engineering

In the Sea of Cortez Concept, between 90,000 to 112,000 AFY of desalinated water would be moved from a desalination plant on the eastern shore of the Sea of Cortez approximately 11 miles south of the City of Jaquey, Baja California, Mexico to the Canal Alimentador Central which delivers water to the reservoir behind Morelos Dam on the Colorado River. Through agreement with Colorado River users, an equivalent amount of water, or in-lieu water, will be delivered via the All-American Canal to the Salton Sea. These water deliveries will be used to stabilize the Salton Sea elevation and decrease the amount of exposed playa. Additional legal analysis is required to determine whether such a transfer is possible and whether the transferred water could be used for sea restoration. A remediation desalination facility is proposed in this Concept, the purpose of which is to remove salts and further decrease the salinity of the Salton Sea.

5.1.1 Major Facilities

Specific facilities of this Concept are described below and summarized in Table 5-1 and mapped in Figure 3-4.

Components:

- 200 MGD **Ocean Water Intake** on the east side of the Sea of Cortez between Bahia San Jorge and Puerto Lobos, Sonora. This intake will need to accommodate approximately 200 MGD. Pipeline will be 98-inch diameter HDPE pipeline. Intake will be 3.4 miles in length, extending 1.9 miles offshore. Will involve submerged ocean water intake with velocity cap.
- 200 MGD **Sea of Cortez Intake Pump Station**, 9,000 BHP.

- An **Ocean Water Desalination Facility**, RO, located near the intake with a product water capacity of approximately 100 MGD. Assuming a 30 acre site.
- A desalination **Brine Outfall Sea of Cortez**, assumed to be co-located with intake. The brine outfall would consist of one, 91 inch pipeline 4.9 miles in length, extending 3.4 miles offshore. Proposed pipeline material would HDPE.
- 100 MGD **Conveyance Pump Station**, 26,900 BHP.
- **Conveyance Cortez to Salton Sea.** Approximately 230 miles of 70 inch steel pipe with cement mortar lining conveying up to 100 MGD product water from desalination plant to Morelos Dam. Water conveyance pipeline assumed to be installed via trenching.
- **Energy Recovery Turbines**, expected to be parallel Francis turbines near Morelos Dam. The 70 inch pipeline will connect to a header that distributes flow to these turbines. The discharge piping will run under the concrete structure and water will be discharged into the Canal Alimentador Central below water surface. This energy recovery station could produce 4030 hp and has an expected efficiency of 87%.
- 100 MGD **Booster Pump Station** 7,000 BHP located approximately 125 miles from Ocean Water Desalination Facility.
- 368,000 gallon 50 ft diameter **Break Tank** located immediately upstream of the Booster Pump Station. The break tank is assumed to be filled to a height of 20 ft with 100 MGD of inflow from the ocean intake pump station and 100 MGD of flow leaving the tank during normal operation. It is assumed that after two minutes of not receiving flow from the ocean intake pump station while 100 MGD of flow is leaving the tank, the water elevation within the tank reduces to a height of 10 ft, the assumed minimum submergence of the booster pumps. It is also assumed that the tank will overflow after one minute of having no flow out of the break tank while 100 MGD of flow is supplied to the tank.
- Construction of 5 electrical substations to serve the desalination plant and 2 pump stations. All co-located with pump stations or the ocean water desalination plant.
- 78 mile new connection to the existing National Transmission Network Electrical Service 115 KV transmission line.
- 27 mile new connection to the existing National Transmission Network Electrical Service 230 KV transmission line.
- **Salton Sea Intake** facilities for the remediation desalination facility located near the southwest corner of the Salton Sea. Assumed to be 98 inch diameter steel pipe with polyurethane lining extending 1.9 miles into the Salton Sea.
- The 200 MGD, 25,000 BHP **Salton Sea Pump Station**, will be used to move water from the Salton Sea to the Remediation Desalination Facility.
- 100 MGD RO **Remediation Desalination Facility** near the Salton Sea to further treat Salton Sea water.
- Water produced by the remediation desalination facility will be returned to the Salton Sea via a 70 inch, 3.4 mile long **Salton Sea Return Pipeline.**
- Brine handling for remediation desalination facility via 22,000 acres of **Evaporation Ponds**. Assumed to be on the west side of the Salton Sea outside of sensitive ecological areas. It is assumed that evaporation ponds could be used to cover playa that would otherwise be exposed as the sea declines, thereby decreasing the acreage of playa needing remediation.

Table 5-1: Sea of Cortez Exchange Concept, Water Importation Facilities

Treatment Facilities	Flow Rate *(MGD)*	Assumed Recovery Rate	Brine Production		Product Water	
			MGD	*AFY*	*MGD*	*AFY*
Ocean Water Desalination Facility (Sea of Cortez)	200	50	100	90,000 to 112,000	100	90,000 to 112,000
Remediation Desalination Facility (Salton Sea)	200	50	100	90,000 to 112,000	100	90,000 to 112,000
Pump Station(s)	**Flow Rate** *(MGD)*	**Horse Power** *(BHP)*				
Sea of Cortez Intake Pump Station	200	9,000				
Conveyance Pump Station	100	26,900				
Booster Pump Station	100	7,000				
Salton Sea Pump Station	200	25,000				
Pipeline	**Diameter** *(in)*	**Length** *(miles)*	**Count** *(each)*	**Material**	**Flow Rate Per Pipe** *(MGD)*	**Flow Velocity** *(ft/s)*
Sea of Cortez Pump Station Intake	98	3.4	1	HDPE	200	5.91
Desalination Facility Brine Discharge to Sea of Cortez	90.55	4.9	1	HDPE	100	3.46
Conveyance Cortez to Salton Sea (Desalination Facility to Booster Pump Station Tank)	70	125	1	Steel with Cement Mortar Lining	100	5.79
Conveyance Cortez to Salton Sea (Booster Pump Station to Morelos Dam)	70	105	1	Steel with Cement Mortar Lining	100	5.79
Salton Sea Intake	98	1.9	1	Steel with Polyurethane Lining	200	5.91
Sea Return Pipeline	70	3.4	1	Steel with Polyurethane Lining	100	5.79
Brine Handling Pipeline	70	9.25	1	Steel with Polyurethane Lining	100	5.79

Electrical Facility	Capacity (kV)	Length (miles)		
Transmission line Puerto Peñasco to substation near Ocean Water Desalination Facility	115	78		
Transmission line Seis de Abril Substation to substation near Ocean Water Desalination Facility	230	27		
Electrical substation near Ocean Water Desalination Facility to step down 115 kV to 34.5 kV				
Electrical substation near Ocean Water Desalination Facility to step down 230 kV to 34.5 kV				
Substation at Ocean Water Desalination Facility				
Substation at Sea of Cortez Intake Pump Station				
Substation at Booster Pump Station				
Other	**Capacity (Gallon)**	**Diameter (ft)**	**Height (ft)**	
Break Tank	368,000	50	25	
Energy Recovery Turbines	**Horse-power**	**Efficiency**	**kW/hr offset**	
Parallel Francis Turbines	4030	87%	6,657,600	
Other	**Acres**			
Evaporation Ponds	22,000			

5.1.2 Hydraulics and Pumping Requirements

Key elevations for the hydraulic analysis of the intake, conveyance, and booster pump stations and the approximate HGL are presented in Figure 5-1 below. The elevation that corresponds to break tank overflow was used to determine the horsepower of the conveyance pump station and the elevation that corresponds to the minimum booster pump submergence was used to determine the horsepower of the booster pump station. The total dynamic head of the 200 MGD Sea of Cortez Water Intake Pump Station, 100 MGD Conveyance Pump Station, and 100 MGD

Booster Pump Station are 205 ft, 1225 ft, and 319 ft, respectively. Based on the assumption that the pumps for these pump stations have an efficiency of 80%, the required BHP of the respective pump stations are 9,000 BHP, 26,900 BHP, and 7,000 BHP.

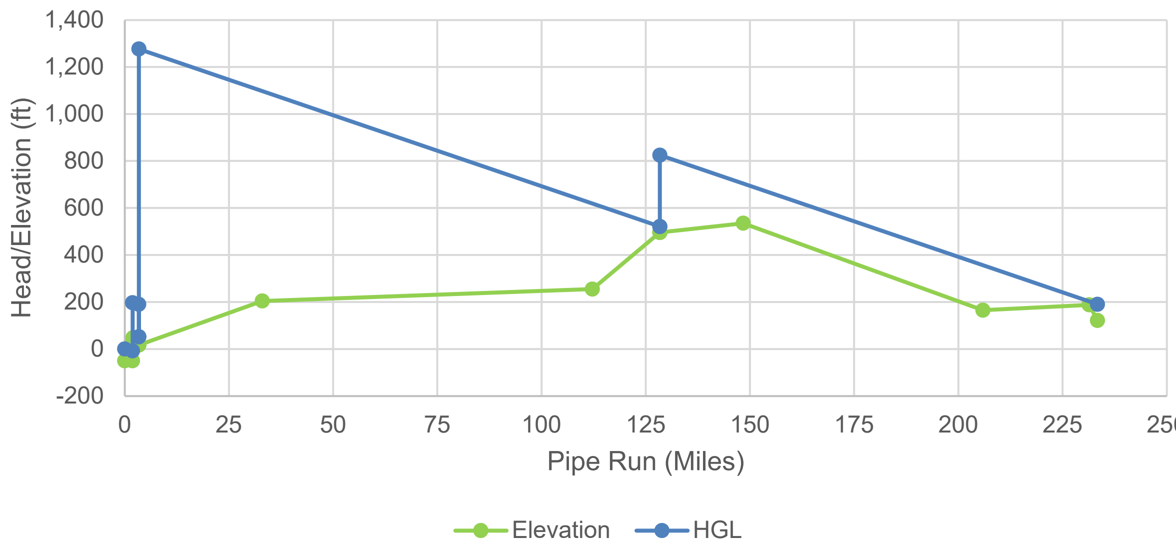


Figure 5-1: Elevation Profile and Hydraulic Grade Profile of the Sea of Cortez Exchange Concept Ocean Water Intake and Booster Pump Stations

The Sea of Cortez Exchange Concept includes a 200 MGD Salton Sea Pump Station for the remediation desalination facility. The total dynamic head is estimated at 570 ft. Based on the assumption that the pumps for this pump station have an efficiency of 80%, the required BHP of the pump station is 25,000 BHP.

5.1.3 Long-Term Operations, including Energy Recovery

Annual operations and maintenance will consist of labor costs to run the treatment plant, maintenance labor for all facilities, treatment chemicals, and power for the pump stations and treatment facility. These costs are summarized in Section 5.5 and Table 5-6. Operation of evaporation ponds will include removal and hauling of salts from the evaporation ponds associated with the remediation desalination plant. As the salinity of the Salton Sea changes, the amount of salt generation at the ponds will change, ranging from a low of 6 million tons a year up to 59 million tons.

The Sea of Cortez Exchange Concept has the potential for energy recovery. From the hydraulic profile put together for the project, water will discharge at approximately 30 psi at Morelos Dam because high points along the run of the 70 inch pipeline require additional energy to overcome. This discharge pressure corresponds to approximately 69 ft of energy that can be partially recovered via an energy recovery station at the discharge location. Based on coordination with Canyon Hydro, a manufacturer of hydroelectric systems, it was determined that Francis turbines will be suitable and most cost effective for this application. Multiple Francis turbines arranged in parallel and the associated electrical equipment will be installed within a concrete structure at the Morelos Dam. The 70 inch pipeline will connect to a header that distributes flow to these turbines. The discharge piping will run under the concrete structure and water will be discharged into the Canal Alimentador Central below water surface. This energy recovery station could produce 1033 hp and has an expected efficiency of 87%.

5.2 Evaluating Feasibility of Planning and Permitting

5.2.1 Environmental and Permitting Considerations

Similar to the Sea of Cortez Import Concept, this analysis assumed that a multi-national team would be used for the planning and design of the Sea of Cortez Exchange Concept. It also assumed that project execution and operation for facilities within Mexico would be undertaken by Mexican firms and/or governmental entities, with funding provided in total or in part by the State of California. The permits needed would be much more extensive if foreign entities constructed, owned, or operated the facilities within Mexico. The analysis assumed that construction and operation of facilities within the US would be undertaken by persons, firms, local and State governments that can legally perform work in California. For details on the permitting process in Mexico and the US, see Section 4.2.1 and Table 4-4 and Table 4-5.

The necessary permits from Mexican authorities and US authorities are expected to take extensive effort and have an extended timeline. However, upon review of the laws and permits needed, there is no obvious reason the Sea of Cortez Exchange Concept could not be permitted so long as the following occur: (a) the project is structured in a way to meet the objective of IBWC Minute 323 (to increase delivery and exchange of waters in a way to benefit both Mexico and the US) and (b) appropriate project design and/or mitigation is put in place to limit impacts to sensitive resources.

5.2.2 Flood Control

The intake at the Sea of Cortez would be approximately 50 feet below sea level. Considerable energy and pumping would be needed to move water to the highpoint in the conveyance pipeline which would be at approximately elevation 496 feet msl. This significant pumping means there is opportunity to suspend the movement of water toward the Salton Sea in an emergency. Valving can segment the pipeline into smaller volumes in the case of accidental release. Connections from the conveyance pipeline to existing storm drains, channels, and canals could be used to direct water released in an emergency. Other design features, such as appropriate pipeline thicknesses and appropriate pipeline cover and corrosion control also reduce the risk of pipeline failure.

Project features minimize but do not eliminate the risk of localized flooding. The project facilities would be moving 200 MGD into the Ocean Water Desalination Facility, a disruption in this facility for a single hour could mean 8.3 million gallons of sea water would be uncontrolled, but with berms and site grading could be used to minimize how much water could leave the site. The proposed Remediation Desalination Facility would extract 200 MGD from the Salton

Sea, meaning a disruption of greater than an hour could mean approximately 8.3 million gallons of desalinated water would be uncontrolled. The risk of catastrophic flooding could be reduced with appropriate site grading and berming to retain water on site and with grading to direct any water not retained on site back to the Salton Sea.

5.2.3 Climate Change and Resiliency

5.2.3.1 Project Contribution to GHG Emissions

Section 4.2.3.2 provides a discussion of potential GHG emissions without implementation of an imported water project. This section focuses on the potential contribution of the Sea of Cortez Exchange Concept to GHG emissions. This analysis is limited to the energy used to power the various facilities. This analysis does not consider energy used to manufacture pipes, pumps, and other equipment, used during construction, used by laborers travelling to the work areas, or any population growth or other economic activity resulting from implementation of the project.

As described in Section 4.2.3, the GHG emissions for the project are dependent on the energy source used to power facilities. Table 4-5 provides the estimated metric tons CO_2E per million kWh is estimated for power delivered in Mexico and power delivered by IID. Table 4-5, looks at the current sources used for electrical generation, rather than those that may be in place in years 2030, 2040, and beyond. This analysis likely overestimates GHG emissions as both the Mexican and IID energy sources have been trending to cleaner/lower emissions sources for electricity. Table 5-2 shows the estimated annual CO_2E in metric tons for the Sea of Cortez Exchange Concept.

Table 5-2: Estimated Annual CO_2E Emissions: Sea of Cortez Exchange Concept Facilities

Facility	Annual Million kWh	CO_2E emissions per million kWh (metric tons)[1]	CO_2E (metric tons)
Facilities Using Electricity from Mexico			
Sea of Cortez Intake Pump Station	166	396	65,910
Ocean Water Desalination Facility	442	396	174,875
Conveyance Pump Station	163	396	64,651
Booster Pump Station	43	396	16,996
Facilities Using Electricity from IID			
Salton Sea Pump Station	163	217	35,444
Remediation Desalination Facility	442	217	95,872
Energy Recovery Turbines	(7)	217	(1,445)
Total Annual CO_2E (metric tons, rounded)			**452,000**

Notes: 1. See Table 4-6

5.2.3.2 Project Resiliency

Rising temperatures and more extremes in precipitation (including longer periods of low precipitation) will lead to greater demands for water in the Salton Sea area and in Baja California while concurrently decreasing the amount of fresh water available. This will be accompanied by increased sea level rise that is likely to affect the Sea of Cortez.

Risks to the Imported Water Source

The Sea of Cortez Exchange Concept relies on water from the Sea of Cortez and the Colorado River. The Sea of Cortez as a source is more resilient than a freshwater source such as the Colorado River. However, because the concept relies on exchanges or transfers of Colorado River water to achieve benefits, those exchanges are imperiled by ongoing Colorado River basin drought related to climate change. In 2022 the largest reservoirs on the Colorado River dropped to historic lows and the US BoR ordered Colorado River states to reduce their total water use by 2 to 4 million AF, about a quarter of all usage. It is possible that the federal government will impose emergency cutbacks to California water use and this could limit water available for exchanges or transfers to the Salton Sea (Reclamation 2022).

Risks to Infrastructure

The Sea of Cortez Exchange Concept will require an intake within the Sea of Cortez and facilities in the near vicinity of the Sea of Cortez. Adequate planning and conservative design will be needed to confirm these facilities can function with ongoing sea level rise. The concept will also rely on an intake in the Salton Sea. As evaporation increases, freshwater runoff to the Salton Sea decreases, and the water levels in the Sea change, it is possible that the intake for the remediation desalination facility will not function properly. Again, adequate planning and design could limit risks to this infrastructure. The conveyance pipeline between the ocean water desalination facility and Salton Sea will traverse several desert washes. More extreme rainfall events, though less frequent, could lead to scour and exposure of sections of the conveyance pipeline. Final pipeline alignment and pipe depth, as well as armoring of the pipeline could limit risk of stormflow damage to the pipeline.

5.2.4 Timeframe

5.2.4.1 Planning and Permitting Timeframe

Figure 5-2 below illustrates the anticipated planning and permitting timeframe needed for the Sea of Cortez Exchange Concept. As shown, it is estimated that it will take approximately 13 years in the absence of litigation before this plan would be ready to begin construction. In order to complete the design and obtain the necessary permits, it is assumed that each major facility would have its own separate design team, with the conveyance pipeline split into five separate packages with design of each pipeline segment taking place concurrently.

5.2.4.2 Construction Timeframe

Table 5-3 below provides information on the estimated timeframe for construction and startup of the needed infrastructure for this concept. The anticipated construction schedule for this concept is shown in Figure 5-3. As shown in Table 5-3 and Figure 5-3, the construction schedule is dominated by the timeline needed for the Ocean Water Desalination Facility and Conveyance

Cortez to Salton Sea. The overall construction schedule is anticipated to be 5 years. The construction schedule in Table 5-4 and Figure 5-3 do not account for delays related to avoid impacts to special status species (e.g., no construction during bird nesting season) nor do they assume there is any constraints on the amount of construction equipment usage or allowable ground disturbance to avoid excessive volumes of air quality emissions and dust generation during construction.

5.2.4.3 Overall Implementation Timeframe

In total, in the absence of litigation, it is estimated that planning activities will take approximately 13 years. Construction is anticipated to take approximately 5 years. In total, the project timeline, from permitting and design to construction completion, is estimated to take roughly 18 years.

Table 5-3: Timeline Assumptions for the Sea of Cortez Exchange Concept

Infrastructure Needed	Timeline Assumptions
200 MGD Ocean Water Intake	It is assumed the construction of the Ocean Water Intake will take place concurrent with construction of the Ocean Water Desalination Facility.
200 MGD Sea of Cortez Intake Pump Station	It is assumed that this pump station would take approximately 18 months and be built concurrently with the Ocean Water Desalination Facility.
100 MGD Ocean Water Desalination Facility	The largest existing RO desalination facility is the Sorek Desalination Plant in Tel Aviv, Israel. It has a capacity of approximately 140 MGD and had a construction timeframe of approximately 30 months. For the purposes of this analysis, it is assumed that construction of a 100 MGD facility will take approximately 36 months or approximately 3 years.
Brine Outfall Sea of Cortez	It is assumed the construction of the Brine Outfall Sea of Cortez will take place concurrent with construction of the Ocean Water Desalination Facility.
Conveyance Cortez to Salton Sea	This consists of 230 miles of 70-inch steel pipeline installed via trenching. It is estimated pipeline construction will take approximately 4 years.
100 MGD Booster Pump Station	It is assumed the construction of the Booster Pump Station will take place concurrent with construction of the Ocean Water Desalination Facility.
100 MGD Remediation Desalination Facility	No analogous surface water desalination facilities of this size were identified within California. However, this construction schedule is assumed to be similar to that for the Sorek Desalination Plant, about 3 years. It is assumed this construction could be done concurrently with the Ocean Water Desalination Facility.
Salton Sea Intake	It is assumed this intake will be built concurrent with construction of the Remediation Desalination Facility and take between 16 and 24 months.

Infrastructure Needed	Timeline Assumptions
Sea Return Pipeline	It is assumed this return pipeline will be built concurrent with construction of the Remediation Desalination Facility and Salton Sea Intake pipeline and take between 16 and 24 months.
Evaporation ponds	No analogous evaporation ponds were identified within California. The construction timeframe needed for the evaporation ponds is based on the estimated time needed for excavation. With multiple crews working is assumed that the evaporation ponds could be built concurrent with the Remediation Desalination Facility.

5.3 Evaluating Feasibility of Construction and Operation

There are several construction and operational challenges for the Sea of Cortez Exchange Concept as described below. However, these challenges are not seen as insurmountable, but do add to the need for careful design, contribute to the project cost, and extend the timeline needed for implementation. As described below:

- The facilities will be in a seismically active area and areas prone to liquefaction. Due to the seismic risk, areas in proximity to the Gulf of California may require support on deep foundations;
- The facilities will be in areas with corrosive soils;
- Construction of the Conveyance: Cortez to Salton Sea will cross through hard rock areas and may require the use of blasting. Due to local ordinances and sensitive habitats, the use of a blasting program may be undesirable;
- The need for blasting as well as the depth and width of trenching for the Conveyance: Cortez to Salton Sea introduces worker safety issues;
- Project construction will generate large volumes of soil for disposal;
- Project construction will require skilled craft workers for an extended period of time, and this may require travel of workers from other areas and/or establishment of temporary communities.
- Project operation will generate large quantities of brine salt that will need disposal;
- Project operation will require skilled workers who are not likely to be present in the current communities and will require recruitment/settlement of these workers from other areas.

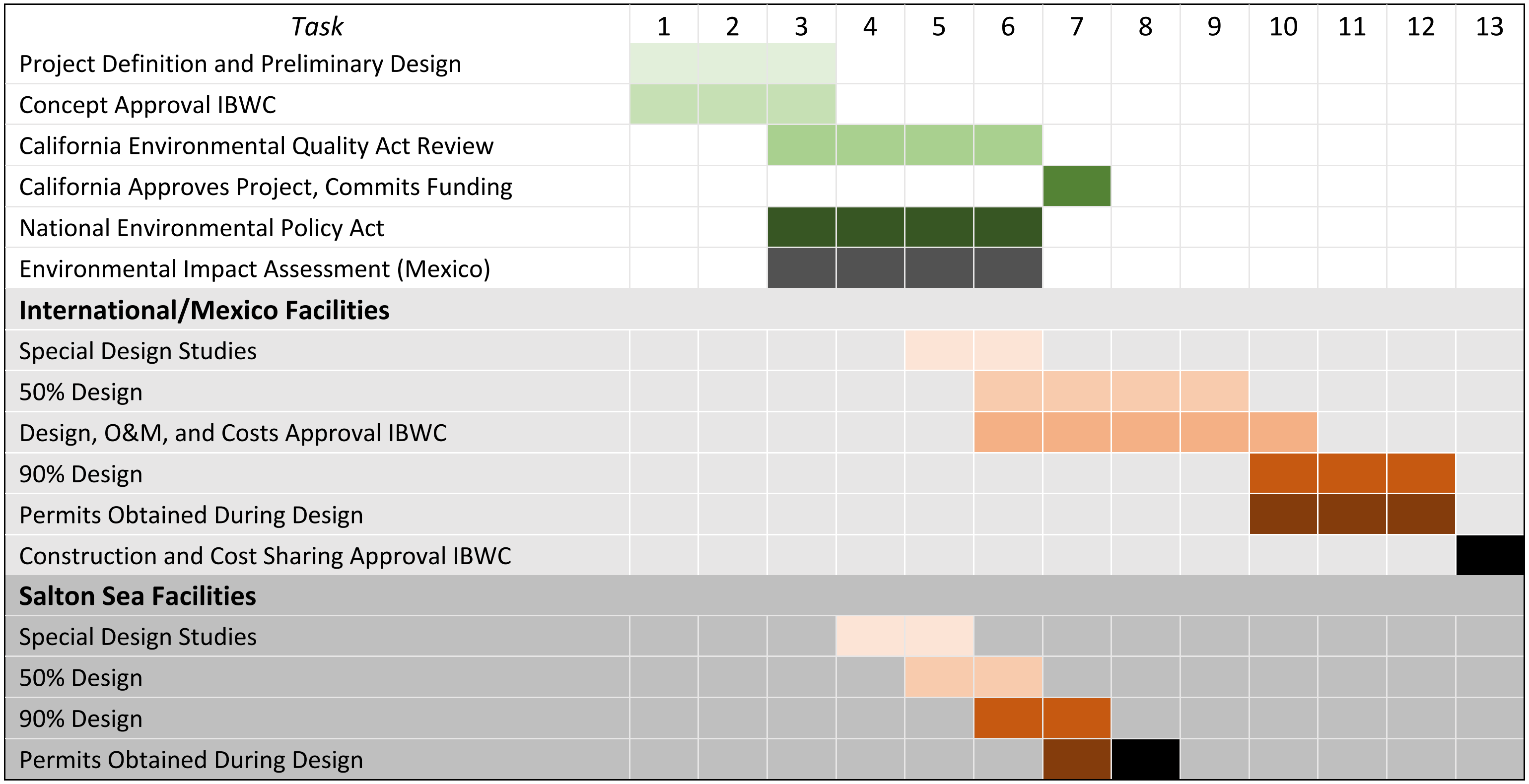


Figure 5-2: Estimated Permitting and Planning Timeframe: Sea of Cortez Exchange Concept

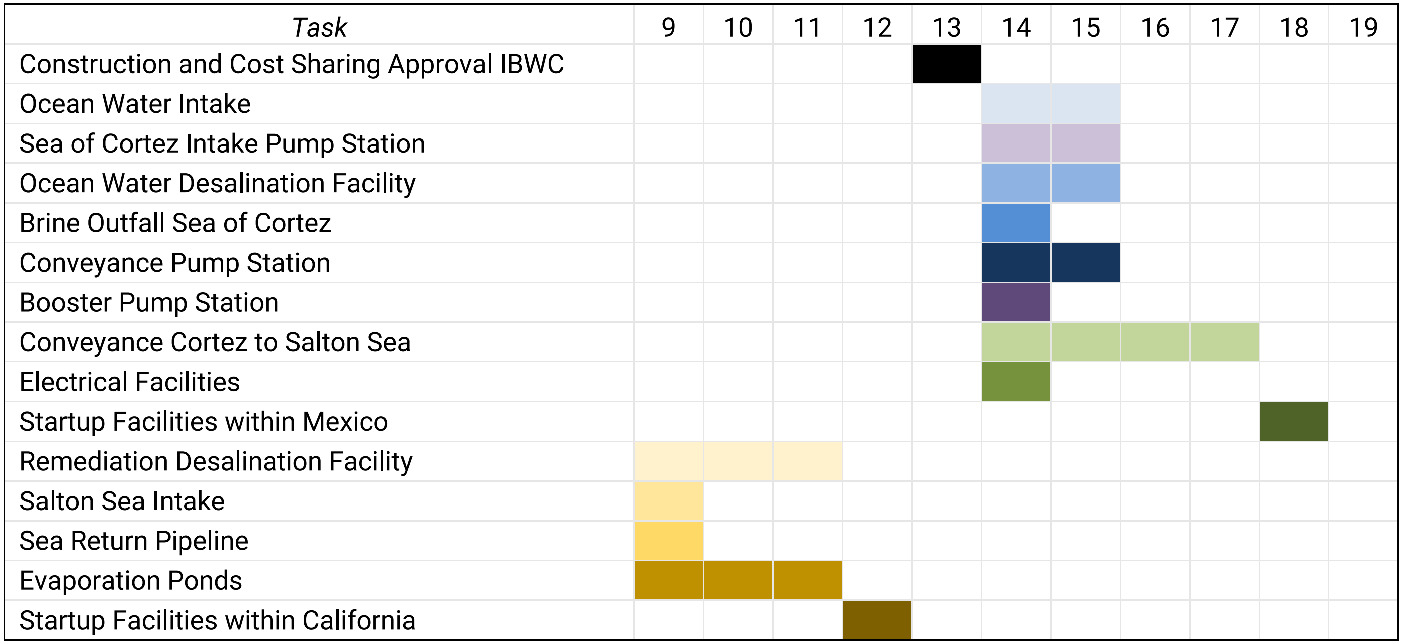


Figure 5-3: Estimated Construction Timeframe: Sea of Cortez Exchange Concept

5.3.1 Geotechnical

For the purposes of establishing a general understanding of geotechnical conditions around the proposed desalination plant(s) and along the proposed alignment of the conveyance pipeline, the support team, at the direction of the Panel, reviewed seven (5) separate geotechnical and geological referenced letters and reports regarding the soil and geologic conditions within the area between the Morelos Dam (US) and Puerto Lobos (Mexico) from 1984 to 2021.

All references are listed below. The support team further reviewed available topographic and geologic maps as well as satellite images and photographs to further assess the proposed plant and pipeline alignment site conditions.

The historical documents reviewed as part of this assessment are listed below:

- United States Department of the Interior Geologic Survey, Geotechnical Investigation of Liquefaction Sites, Imperial Valley, California, 1984
- Mueller, K and Rockwell, T., Late Quaternary Activity of the Laguna Salada fault in northern Baja California, Mexico, 1995
- Lancaster, Nicolas., Origin of Gran Desierto Sand Sea, Sonora, Mexico, Evidence for Dune Morphology and Sediments, January 1995
- Alles, David L., Geology of the Salton Trough, Western Washington University, November 28, 2011
- Sanchez, Rosario, Rodriguez, Laura, Transboundary Aquifers between Baja California, Sonora and Chihuahua, Mexico, and California, Arizona and New Mexico, United States: Identification and Categorization, 2021

The review of the previously completed reports and maps provided a general understanding of the subsurface conditions in the vicinity of the new desalination plant north of Puerto Lobos, Mexico and along the new 70 inch diameter pipeline alignment to the Morelos Dam at the US/Mexico border.

To more accurately reflect conditions that are likely to be encountered during the installation of the Sea of Cortez Exchange Concept, the support team focused on technical elements of the papers and reports presented above while maintaining connectivity with other available information (from publicly available work in the US available) where subsurface construction works were anticipated to be located in similar geologic areas.

It should be noted that no final design plans/specifications or as-built drawings/reports of any of the referenced projects were available for review at the time of this reporting. All geotechnical and geological information reviewed relates to data collected in the general region of the proposed project and is not considered to be within the exact known position of any structure or pipeline alignment.

5.3.1.1 Geologic Conditions – Puerto Lobos, Mexico to Morelos Dam, US/Mexico

The project site is located in the lower portion of the Salton Trough physiographic province. The Salton Trough is a topographic and geologic structural depression resulting from large scale regional faulting. The trough is bounded on the northeast by the San Andreas Fault and Chocolate Mountains and the southwest by the Peninsular Range and the San Jacinto Fault Zone. The Salton Trough represents the northward extension of the Gulf of California containing both marine and non-marine sediments deposited since the Miocene Geologic Age. Tectonic activity that formed the trough continues at a high rate as evidenced by deformed young sedimentary deposits and high levels of seismicity. As can be seen on Figure 5-4 below, the alignment (i.e., thick red line) passes through several geologic formations from Puerto Lobos, Mexico to the Morelos Dam. There are three main geologic formations (moving from south to north):

- Eolian (Aeolian) Formation (The Sonora Desert and Reserva de la Biofera El Pinacate);
- Canebrake Formation (near the base of the Sonora Mesa); and
- Alluvial Deposits and Laucustrine Deposits (near the USA/Mexico Border).

Eolian (Aeolian) Formation (The Sonora Desert and Reserva de la Biofera El Pinacate)

Aeolian landforms are shaped by the wind and create a number of distinct features, through both erosion and deposition of sediment, including:

- Sand Dunes
- Erosional Depressions
- Loess Deposits
- Desert Pavement

Common features of these environments are a sparse or nonexistent vegetation cover, a supply of fine sediment (clay, silt, and sand), and strong winds. Aeolian processes are responsible for the emission and/or mobilization of dust and the formation of areas of sand dunes. They largely depend on other geologic agents, such as rivers, glaciers, and waves, to supply sediment for transport.

In the Sonoran Desert, windblown particles may either creep (roll) across the surface until they settle due to a loss of velocity; hop from point to point; or be suspended entirely in the air (fine particle dust). Once sediment transport begins, it continues via gravity and momentum.

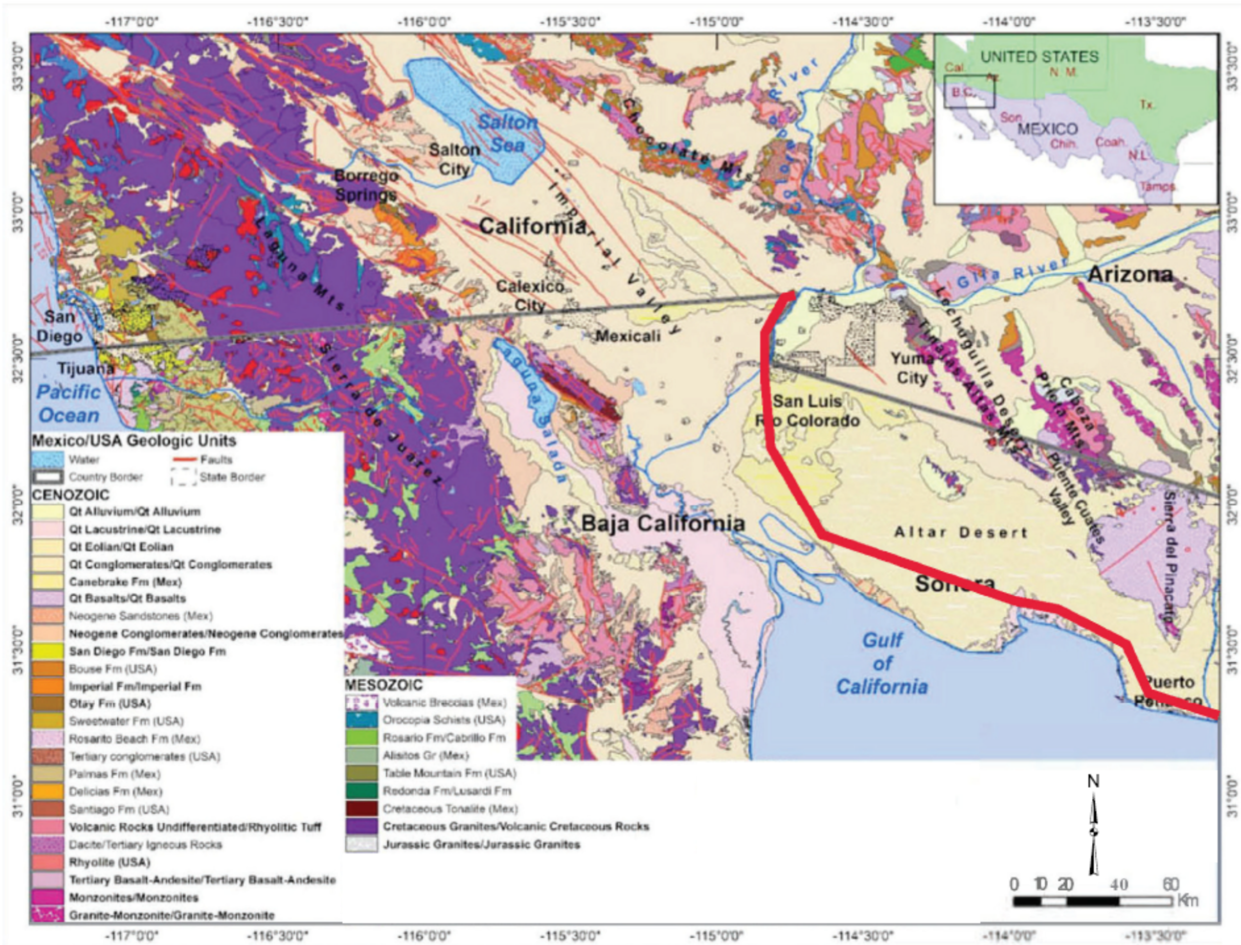


Figure 5-4: Approximate Alignment of Sea of Cortez Exchange Concept on Mexico/USA Geologic Map

Depositional landforms (e.g., dunes) are created where sand drops out and creates a condition where the wind traps the particles that ultimately provides adequate gravitational resistance to further movement. These depositional areas tend to be slightly thicker than erosional areas and are loose near the surface to a few meters below the surface.

Erosional landforms grow when more sediment is removed from an area faster than it is deposited. They are widespread in hardened, wind-swept surfaces. These erosional areas tend to have slightly thinner soil profiles than depositional areas and are loose immediately near the surface, however, the thin veneer of soil is underlain by generally hard cemented sand and rock (e.g., an erosional depression).

Canebrake Formation (part of the Palm Spring Group) - near the base of the Sonora Mesa

The Palm Spring sediments consist of dark brown sandstones, siltstones and claystones, with coarse grained linear gradational contact with the Canebrake Formation. Canebrake conglomerate is coarse marginal conglomerate facies of Palm Spring formation. Thin stringers of pebble conglomerate interfinger with the western part of the exposure and commonly gravitate into typical Canebrake sediments, but also present as lenses entirely within the Palm Spring formation. It should be noted that the Palm Spring formation is intensely folded, therefore, the heterogeneity of the sediments (as indicated herein) should be anticipated along most surficial linear paths (i.e., excavations in a linear alignment within this stratum are highly likely to vary from sandstone to siltstone to conglomerate to sandstone, etc.).

It is anticipated that the weathered materials at the immediate surface will be mostly coarse-grained and of medium to loose density. Extending deeper into the subsurface soil profile will likely encounter less weather dense soil layers and decomposed rock. Conglomerate bedrock tends to vary from soft to hard, depending on the degree of weathering and the breakdown of the cementation between the particles within the sedimentary rock structure.

Quaternary Age Deposits - Alluvial and Lacustrine Deposits (part of the Imperial Valley) - near the Mexico/USA Border

Clastic deposits of Quaternary Age are found in the Imperial Valley in lower parts of slopes and in most open valleys. These Holocene era recent lake deposits include silt, clay, sand laid down in lakes and on their shores, alluvium (in stream valleys) and fanglomerate, talus and other locally derived materials that have been transported for short distances (from mountain slopes). Run off sediments that drop out as alluvial fans are common. Depending on the depth of sediment stratification, surface materials tend to be loose, whereas underlying soils may be more compact due to overburden pressures from continued soil buildup over time.

Common features are a flat, sparse vegetation cover, fine sediment (clay, silt, and sand), and windy conditions. Similar to an aeolian type of environment, however, instead of wind moving soil particles, alluvial systems are created where particles move in a water filled environment and float over the surface until they settle due to a loss of velocity.

The Late Pleistocene to Holocene (recent) lake deposits are derived from periodic flooding of the Colorado River which intermittently formed a freshwater lake (Lake Cahuilla). The Lacustrine deposits consist of interbedded lenticular and tabular silt, sand and clay which are formed from lake deposits and tend to be more stratified and can achieve greater compaction as more materials form overburden and drive particles into a denser arrangement. Older deposits of Miocene to Pleistocene non-marine and marine sediments deposited during the intrusions of the Gulf of California.

The typical soil profile within this geologic unit consists of interbedded firm density silt and sand as well as stiff clays of varying expansiveness. Native clays may exhibit low to high shrink/swell potential. There is considerable variation of the soils in these types of geologic strata as the soils are formed from sediment and alluvium from mixed origin (Colorado River overflows and fresh-water lake sediments).

Estimated/Anticipated Soil and Bedrock Conditions along Conveyance Alignment

Based on assessments that were reviewed in the referenced materials, a general understanding of materials was developed for the linear extent of the Sea of Cortez Exchange Concept alignment as summarized below. Based on the data, the following generalized subsurface strata underlie the Sea of Cortez Exchange Concept project area to the depths as assumed from the literature.

Table 5-4: Anticipated Soil and Bedrock Conditions for the Sea of Cortez Exchange Concept

Sediment Type	Location	Characteristics
Eolian (Aeolin) Formation Sand (Sonoran Desert)	From ground surface to likely depth of pipeline (i.e., about 10 ft bgs) At Desalination Plant and along approximately 175 miles of pipeline alignment.	Light brown and brown, fine to coarse silty sand, (SM) contains varying amounts of sandstone rock fragments to interbedded cemented sands and sandstone; loose to medium dense at deeper thicker sand profile portions (depositional dunes), medium dense to dense at thinner soil profile sections (erosional depressions).
Canebrake Formation (Palm Springs Group) Conglomerate Rock	From ground surface to likely depth of pipeline (i.e., about 10 ft bgs) Along approximately 40 miles of pipeline alignment.	Brown and gray, conglomerate weathered rock/conglomerate bedrock, medium to coarse grained matrix, possibly loose density in highly weathered zones near the surface; compact to very compact density at depth (Note: Depending on soil overburden depth, harder/intact bedrock may be encountered within anticipated excavation depth).
Alluvial and Lacustrine Deposits (Imperial Valley Formation) near Mexico/USA Border	From ground surface to likely depth of pipeline (i.e., about 10 ft bgs) Along approximately 35 miles of pipeline alignment.	Brown and dark brown, silty clay (CL) and clay (CH) to clayey silt (ML) with varying amounts of sand and gravel, fine grained matrix with slight variations of coarse-grained particles, high corrosivity and shrink/swell potential, compact to very compact density

5.3.1.2 Geological Hazards

Liquefaction

Liquefaction may be an issue where soils are saturated (i.e., in areas of higher groundwater). Liquefaction occurs in granular soils (e.g., like those in an aeolian formation setting) below the water table when those soils are subjected to vibrations such as those vibrations generated by earthquakes. Pore pressure increases as a result of the vibrations and allows the soil particles to rearrange, thus tending to reduce in volume (i.e., resulting in settlement). The area most likely for this issue would be the new desalination plant area near the coast with the Gulf of California and the pipeline alignment that sets up close to water bodies. However, liquefaction is not isolated to only these areas. It could happen anywhere the groundwater is higher and loose density coarse-grained soils exist.

Expansive Soil

The soils in the Lacustrine portion of the alignment are potentially prone to expansion (i.e., shrink/swell). Typically, these types of clay soils are considered sensitive to wetting and drying and have a volume change associated with those variations in moisture content. Site specific sampling and testing should be considered during the design phase along with potential mitigation measures provided by the geotechnical engineer.

Corrosive Soil

The Lacustrine soils are prone to be corrosive. Preventative measures should be provided by the geotechnical engineer during the design phase that are specific to the systems to be constructed. There are multiple methods of addressing corrosive soil conditions and those chosen should be specific to the materials to be used.

Seismic Hazards

The project site is primarily located in the Salton Trough (a seismically active area mapped in the Imperial Valley with numerous faults associated with the San Andreas system of faults). The entire northwest-trending province is characterized by a trend parallel to that of the San Andreas fault. While some conflict in this pattern exists in the northern end of the province, in the central part of the Imperial Valley there is a notable linearity and parallelism in the southernmost faults of the San Jacinto zone, which include the Superstition Mountains, Superstition Hills, and Imperial faults.

Although the primary San Andreas fault runs just west of the new plant and pipeline alignment, this does not alleviate the pipeline from the effects of this very seismically active area. A complete seismic analysis will be required at the time of initial design to accurately design the planned systems.

5.3.1.3 Geotechnical Engineering Considerations

Excavation Characteristics

The result of review and assessment indicates that the project site is underlain by varying geologic formations and materials as indicated in the previous section. Excavation of the overburden soils are anticipated to encounter mostly sand (in the Aeolian and Canebrake sections in southern and mid portions of the alignment) and mostly silts and clays (in the Lacustrine section in the north portion). Additionally, excavations within southern and mid-portions of the alignment (especially those areas of erosional depressions) can generally be expected to be accomplished with heavy-duty excavation equipment and drilling equipment in good operating condition. However, zones containing more resistant, less weathered rock should be anticipated. Excavation in such materials may necessitate heavy ripping, rock breaking, or coring.

Depending on the overall hardness of the underlying materials based on the results of any future geotechnical studies, it may be desirable to establish a pre-excavation blasting program in areas where harder materials are anticipated in order to maintain a positive project schedule. However, given the narrow pipeline to be installed, these recommendations should be reassessed at the time of the geotechnical study of the final alignment. Additionally, due to local ordinances and sensitive habitats, the use of a blasting program may be limited/restricted, therefore, this should be further vetted as part of any future permitting assessment to be performed before it is assumed that blasting is allowed.

Temporary Excavations

The soil classifications and excavation performance should be evaluated in the field by the geotechnical consultant in accordance with the applicable regulations. Temporary excavations should be constructed in accordance with applicable recommendations. For trenches or other excavations, requirements regarding personnel safety should be met using appropriate shoring (including trench boxes) or by laying back the slopes based on the soil types encountered. At a minimum, until otherwise assessed by a licensed geotechnical engineer, open cut excavations should consider sloping no less than 1H:1V and flatter sloping or temporary shoring may be necessary based on the presence of loose density soils. Due to likely varying levels of groundwater along the alignment, temporary excavations that encounter seepage will likely require shoring. Excavations encountering seepage should be evaluated on a case-by-case basis. Presently, there is not enough information to determine the approximate length of pipeline excavation that may require shoring.

Shoring

In areas loose density soils and/or the presence of groundwater seepage, a shoring system will likely be required to stabilize the excavation sidewalls during construction. Shoring systems are anticipated to be constructed through the upper loose density soils to the underlying firm soil/rock materials. The shoring system should be designed using the magnitude and distribution of lateral earth pressures to be determined at the time of final design for both braced shoring and cantilever shoring.

Remnants of less weathered/intact rock are anticipated to be encountered in the subsurface materials. Consequently, as noted earlier, these materials are anticipated to be difficult to excavate. Use of temporary shoring systems such as trench boxes, slide rail systems, etc. may be considered, however, the use and final recommendation of these types of systems is a decision by the geotechnical engineer of record.

The shoring discussions presented in this report are for preliminary feasibility purposes and the geotechnical engineer and contractor should evaluate design parameters by their own means and make appropriate considerations for their design. Most importantly, the contractor must take appropriate measures to protect workers. OSHA requirements pertaining to worker safety should be observed.

Construction Dewatering

Where groundwater, seepage, and/or perched water conditions are encountered, dewatering measures during excavation operations should be prepared by the contractor's engineer and reviewed by the design engineer. Considerations for construction dewatering should include anticipated drawdown, piping of soils, volume of pumping, potential for settlement, and groundwater discharge. Disposal of groundwater should be performed in accordance with stipulated guidelines of the overseeing government entity.

Groundwater levels may fluctuate with precipitation, irrigation of adjacent properties, drainage, etc. The groundwater levels discussed herein should not be interpreted to represent an accurate and/or specific condition within the desalination plant area and/or along the proposed pipeline alignment.

5.3.1.4 Foundations, Earthwork and Potential Costs

Without detailed information on the desalination plant sizing and the pipeline depth and pump station needs to convey the water over the 230 miles, the foundation and earthwork discussion must be kept to a general description of potential issues.

Foundations – Desalination Plant and Pump Stations

It's likely that the structural loads, the seismic activity, geologic formation in the vicinity and the proximity to the Gulf of California may likely require the majority of the desalination facility to be supported on deep foundations. Some of the lightly loaded units (e.g., pump stations) may likely be able to be supported on shallow spread footings or mat foundations, depending on the final elevations, loads and structural tolerances. The final decision on the foundations to be used will be made by the geotechnical engineer of record based on specific data collected once the final design elements are better defined. Therefore, at this time, only order of magnitude cost ranges can be considered.

Earthwork – Desalination Plant and Pump Stations

For the purposes of this writeup, it has been assumed that cut/fill volumes for the Desalination Plant and associated Pump Stations are somewhat equal (although, typically pump stations produce more cut materials as the majority of the unit is below the ground surface and excess soils are generated as part of the construction). Regardless, the earthworks for the units presented above are very small in terms of total volume of earthwork necessary to complete the pipeline work.

Earthwork – Main Single 70 inch Diameter Waterline

For the purposes of this writeup, it has been assumed that the pipeline will be constructed as an open cut with 1V:1H side slopes to a design depth that provides 8 ft of soil cover over the pipe (in order to maintain consistent temperatures in the pipeline, will have 1 ft of pipe bedding and will be excavated with a minimum of 2 ft of clearance on each side of the pipe. Therefore, the total pipeline depth of excavation will be 16 ft bgs, will be 8 ft wide at the bottom of the trench and will be 48 ft wide at the ground surface.

Given the scenario provided above, it is estimated that up to approximately 14.2 cy of soil will be required for removal per ft of pipeline (i.e., about 75, 100 cy/mile). The total pipeline length is 230 miles, therefore, up to about 17,271,000 cy of soil will need to be excavated.

Note: Use of temporary structural shoring can reduce the amount of earthwork required for movement, however, there are costs for use of the temporary shoring measures (e.g., labor, equipment and time). The final geotechnical design work should focus on providing information necessary select areas of the pipeline installation where shoring is most likely potentially required.

It should be further noted that costs for removal of harder materials (e.g., hardpan, desert pavement, decomposed/weathered rock, bedrock) will be higher. Therefore, excavation of these materials using extraordinary means should be anticipated. This material will probably require removal by large track-hoe or ripper equipment. Note that a pre-excavation blasting option, if allowed, should be considered in any project costing exercise as well.

5.3.1.5 General

The conclusions of this geotechnical section are based on the review of documents provided by others. An attempt has been made to provide for normal contingencies, but the possibility remains that unexpected conditions may be encountered during construction. An allowance should be established to account for possible additional costs.

This section has been prepared in accordance with generally accepted civil engineering practice and makes no other warranties, either expressed or implied, as to the professional advice provided under the terms of our agreement and included in this memo. This section is for informational purposes only and should not be considered part of the contract documents or any type of design or inference of design. The opinions expressed in this memo are those of the professional geotechnical engineer and represent an interpretation of the regulatory standards, the required material properties, and the general soil conditions based on available public information as per the planned approaches.

Following selection of a specific alignment concept, a phased geotechnical program should be implemented to better define the soils/bedrock likely to be encountered during installation to assess design requirements and costs for construction installation operations. This phased geotechnical approach should be considered as part of the step-by-step progressive process toward developing a final design that includes desalination plant site(s) selection, pipeline alignment and any other pertinent elements such as pump stations, intake/outfall pipe support systems and evaporation ponds.

5.3.2 Availability of Skilled Work Force

Project construction will generate a significant number of construction jobs. The length of construction (~9 years) means the construction workforce will need to be in the area for an extended time. Similar to the Sea of Cortez Import Concept, it may be difficult to attract and retain the needed skilled workforce and it may be necessary to provide temporary facilities to house workers.

Following construction, operation of the ocean water desalination facility and associated pump station will require a skilled workforce of approximately 73 persons. This work force would be in addition to workers needed for the IBWC desalination facility. It is unlikely that the necessary workforce currently resides in the area, and it will be necessary to attract these workers from a broad geographic area and/or set up appropriate training to prepare local workers for this employment opportunity.

The need for skilled workers both during construction and operation does not render the Sea of Cortez Exchange Concept infeasible; however, it adds an element of uncertainty and could delay construction and project startup.

5.4 Evaluating Technical Performance

5.4.1 Water Quality

As described in the Feasibility Report, the specific criteria against which to measure project performance related to water quality is:

- Achieves a salinity favorable to the widest range of fish and invertebrates that can then support a variety of birds, at a salinity less than 40,000 mg/L
- Achieves a salinity supportive of fish, birds, and invertebrates, with a salinity less than 60,000 mg/L

- Achieves a salinity favorable to a select group of fish and invertebrates that can then support a variety of birds, at a salinity of greater than 60,000 but less than 70,000 mg/L

Salinity modeling via SSAM was performed assuming: (1) no remediation desalination and (2) a 100 MGD remediation desalination to treat Salton Sea Water. Modeling included baseline scenarios and assuming a 10% increase in baseflows due to uncertainty in the long-term projected inflows to the Salton Sea. Modeled salinity represents an average salinity based on the salt and water balance.

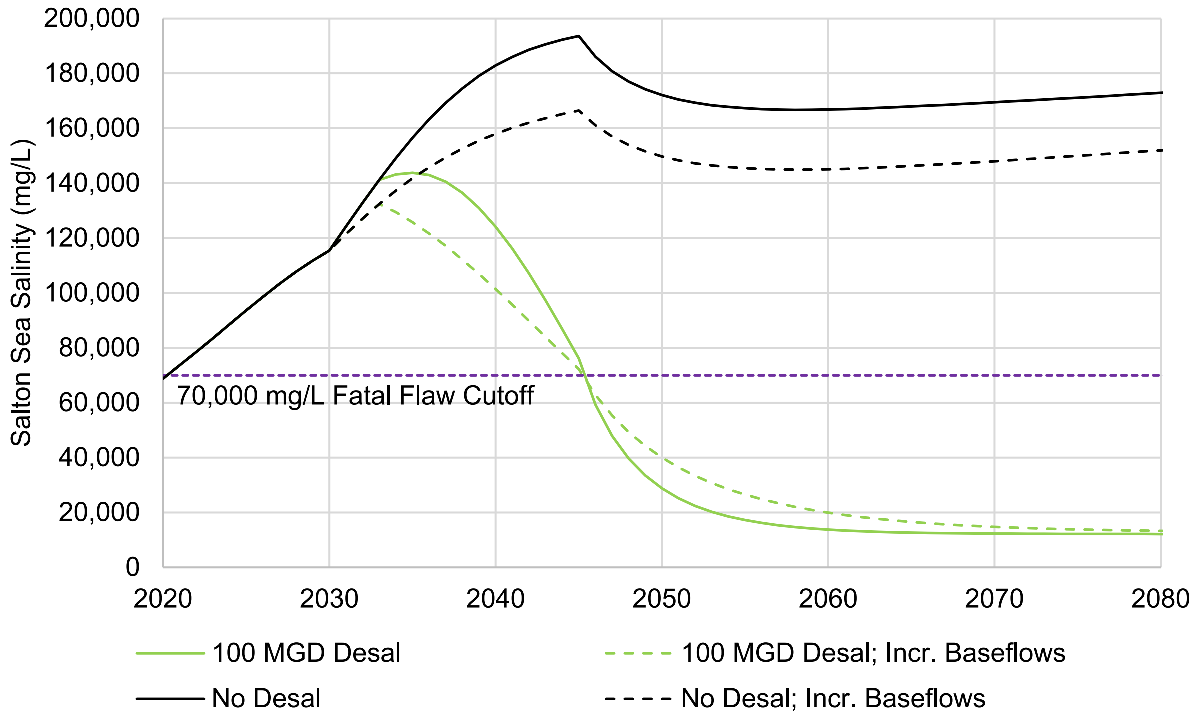


Figure 5-5: Projected Salton Sea average salinity with 100,000 AFY of desalinated water imported and no additional desalination (black) and 100 MGD of desalination (blue) at the Salton Sea. The dashed lines indicate a 10% increase in baseflows.

Figure 5-5 shows that the 100 MGD facility provides salinity reduction below 70,000 mg/L in as early as 2045 and declining to less than 40,000 mg/L by 2048. With decades of hypersaline conditions, concerted efforts will be required to reintroduce species and restore the ecosystem once it is conducive to minimum ecological function again.

Salt generation from the remediation desalination facility discussed above is shown in Figure 5-6:

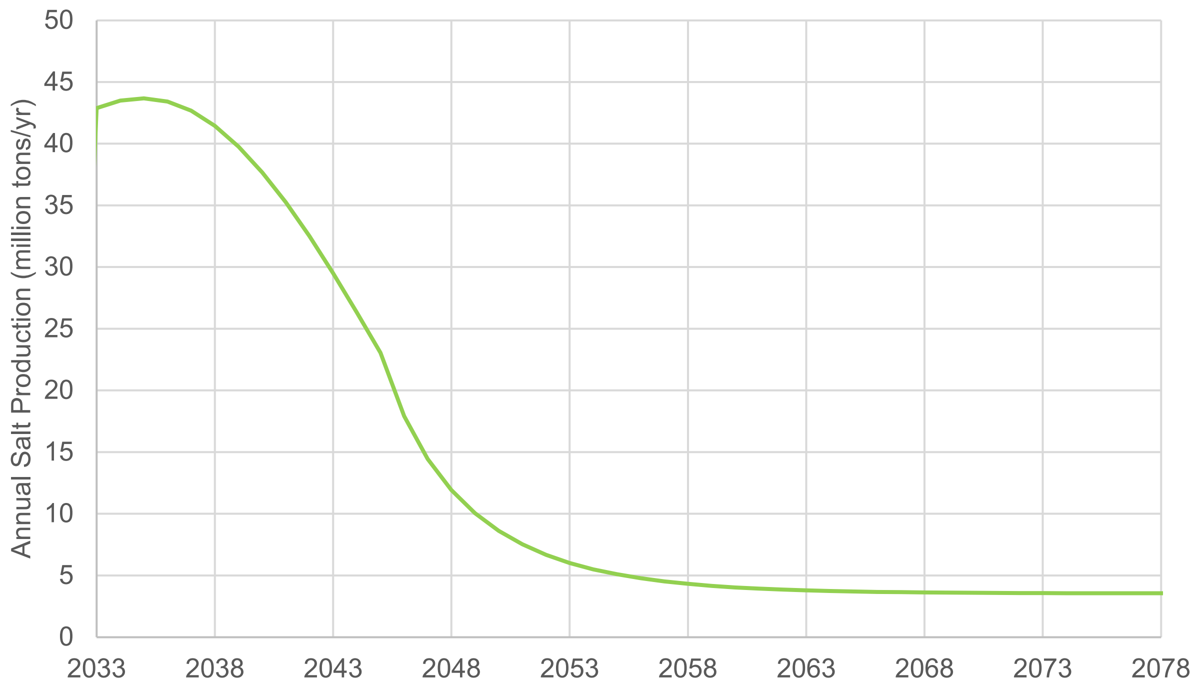


Figure 5-6: Projected annual salt production from proposed remediation desalination facility of 100 MGD at the Salton Sea.

With potential salt production ranging from 4 million to 44 million tons per year, salt management will be a critical component of project success.

In addition to removal of salt, desalination of Salton Sea water is likely to reduce the concentrations of heavy metals, selenium, nutrients, and pesticides. Removal rates would be dependent on the remediation desalination facility intake location, effectiveness of mixing for both desalinated Salton Sea water and imported water, concentrations in existing inflows, and distribution of contaminants in the water column and sediments. While these factors prevent quantification of potential contaminant removal rates from the Salton Sea, increased desalination at the Salton Sea will decrease the overall concentrations of these contaminants.

5.4.2 Water Quantity

The Sea of Cortez Exchange Concept will import an annual quantity of between 90,000 to 112,000 AF, dependent on the recovery rate of the Ocean Water Desalination Plant and the time the percent of time the desalination plant operates each year.

SSAM modeling projected that with this concept, the water surface elevation at the Salton Sea would continue to decline to -255 to -261 ft msl.

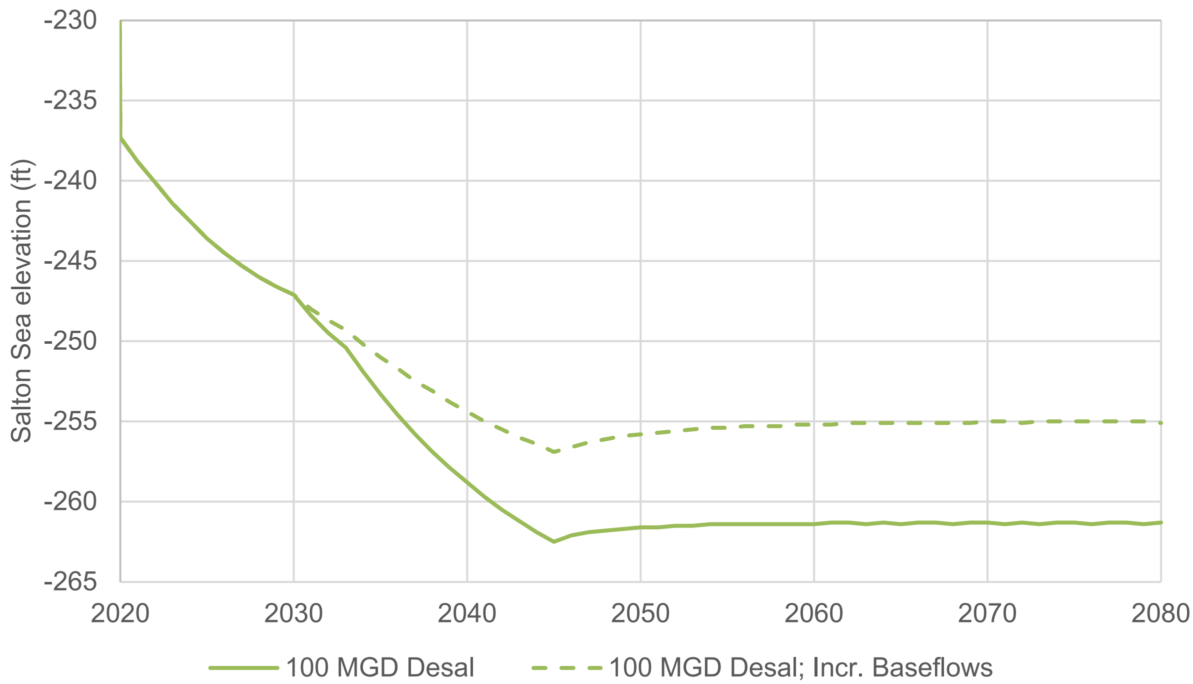


Figure 5-7: Projected Salton Sea elevation with 100,000 AFY of water imported under the Sea of Cortez Exchange Concept (blue). The dashed lines indicate a 10% increase in baseflows.

5.4.3 Playa Exposure

A decrease in Salton Sea elevation has a direct correlation to playa exposure and a decrease in air quality. The Sea of Cortez Exchange Concept could result in 63,000 to 85,000 acres of additional exposed playa, beyond that occurring in 2018. The acreage of playa exposure could be offset by the 30,000 acres of playa remediation proposed as part of the SSMP. It could be further reduced by placing the approximately 22,500 acres of evaporation ponds needed in a manner to reduce the surface area of exposed playa. This would leave roughly 30,000 acres of playa that would need to be remediated to return conditions to that approximating 2018. The costs of the Sea of Cortez Exchange Concept include costs needed to remediate approximately 30,000 acres of playa.

5.5 Project Cost Estimate

As detailed in Section 2.2 accuracy of a Class 5 conceptual estimate is -50% to +100%. Subtotals in the tables below have been rounded to the nearest ten thousand dollars. Table 5-5 summarizes the estimated capital costs, planning and permitting costs, and land acquisitions cost.

In addition to capital cost estimates and annual operation and maintenance (O&M) costs were developed. Annual O&M consists of labor costs to run the desalination plants, maintenance labor for all facilities, treatment chemicals, and power for the pump stations and desalination facilities. These costs are summarized in Table 5-6. Operation of evaporation ponds include removal and hauling of salts from the evaporation ponds associated with the remediation desalination plant.

Finally, life cycle net present value costs were evaluated in Table 5-7. As described in Section 2.1.9, the calculation considered the initial costs, operational costs, assumed financing costs, and assumed a discount rate. Net present value costs were also generated for just the importation components (no remediation desalination components at the Salton Sea) to generate a cost per AF of imported water for the Sea of Cortez Exchange Concept (assuming the project operates year 2045 to 2078). The cost of importation assuming 90,000 to 112,000 AFY of imported water for the project duration is $9,000-$11,300.

Table 5-5: Capital, Planning, Permitting, and Land Acquisition Costs: Sea of Cortez Exchange Concept

Cost Item	Unit	Unit Price ($)	Quantity	Total ($)
Ocean Water Intake, 98-inch HDPE	LF	12,936	10,030	129,748,000
Sea of Cortez Intake Pump Station, 200 MGD	BHP	10,250	9,000	92,250,000
Ocean Water Desalination Facility (RO), 100 MGD Product Water	LS	1,216,880,000	1	1,216,880,000
Brine Outfall, 90.55-inch HDPE	LF	10,957	18,000	197,226,000
Conveyance Pump Station	BHP	10,250	26,900	275,725,000
Conveyance Cortez to Salton Sea, 70-inch steel pipeline with polyurethane lining	LF	9,625	1,320,000	12,705,000,000
Francis Turbines 760kW	LS	2,465,000	1	2,465,000
Booster Pump Station, 100 MGD	BHP	10,250	7,000	71,750,000
Break Tank, 358 Thousand Gallon, 50' diameter	Gallon	5	368,000	1,840,000
Salton Sea Pump Station, 200 MGD	BHP	10,250	25,000	256,250,000
Salton Sea Intake, 98-inch, steel pipe with polyurethane lining	LF	10,780	10,000	107,800,000
Remediation Desalination Facility (RO), 100 MGD	LS	1,216,880,000	1	1,216,880,000
Sea Return Pipeline, 70-inch steel pipe with polyurethane lining	LF	8,855	18,000	159,390,000
Brine Discharge Pipeline, 70-inch steel with polyurethane lining	LF	8,855	48,840	432,478,000
High Voltage System Treatment and Conveyance	LS	194,530,000	1	194,530,000
Playa Remediation Costs	Acre	25,000	30,000	750,000,000
Evaporation Ponds with liner and bird netting (22,000 acres)	LS	5,784,030,000	1	5,784,030,000
Subtotal				**$ 23,594,240,000**
Mobilization/Demobilization		@4%		943,770,000
Bonds and Insurance		@4%		943,770,000
Taxes		@8%		1,887,539,000
Overhead and Profit		@15%		3,539,136,000
Contingency		@30%		7,078,272,000
Subtotal Construction				**$ 37,986,730,000**
Studies, Permitting, Preliminary Engineering		@15%		3,539,136,000
Engineering/Design/CM		@15%		3,539,136,000
Subtotal Planning and Design				**$ 7,078,270,000**
Sea of Cortez Water Intake Pump Station and Desalination Site and Substation	Acre	16,000	30	480,000
Easement, conveyance pipeline within Mexico	Acre	8,000	2,230	17,842,000
Break Tank Site	Acre	16,000	1	8,000
Salton Sea Pump Station and Desalination Facility Site	Acre	16,000	15	240,000
Evaporation Ponds	Acre	16,000	22,000	352,000,000
Subtotal Land and Easements				**$ 370,570,000**
Total Estimated Initial Costs				**$ 45,435,570,000**
Conceptual Cost Range (-50% to +100%)		**$ 22,717,790,000**	**to**	**$ 90,871,140,000**

Table 5-6: Annual O&M Costs: Sea of Cortez Exchange Concept

Item	Cost ($US)	*Notes*
Ocean Water Desalination Facility (100 MGD), Intake, and Outfall		
Power	83,905,000	1
Chemicals	19,183,000	2
Maintenance and Materials	2,253,000	2
Labor	18,373,000	3
Replacement	12,169,000	2
O&M Contingency	55,911,000	4
Subtotal	*191,790,000*	
Sea of Cortez Intake Pump Station		
Power	12,614,000	1
O&M (4% capital cost)	3,690,000	5
Subtotal	*16,300,000*	
Conveyance Pump Station		
Power	163,260,000	1
O&M (4% capital cost)	11,029,000	5
Subtotal	*174,290,000*	
Conveyance Cortez to Salton Sea		
O&M (1.5% capital cost)	190,575,000	6
Subtotal	*190,580,000*	
Energy Recovery Turbines		
O&M (4 % of capital costs)	99,000	5
Energy Recovered, 6,657,600 kWh@$0.19/kWh	(1,265,000)	
Subtotal	*(1,170,000)*	
Booster Pump Station		
Power	6,953,000	1
O&M (4% capital cost)	2,870,000	5
Subtotal	*9,820,000*	
Break Tank		
O&M (4% capital cost)	70,000	5
Subtotal	*70,000*	
Remediation Desalination Facility (100 MGD) and Intake		
Power	83,905,000	7
Chemicals	19,183,000	2
Maintenance and Materials	2,253,000	2
Labor	18,373,000	3
Replacement	12,169,000	2
O&M Contingency	55,911,000	4
Subtotal	*191,790,000*	
Salton Sea Pump Station		
Power	163,260,000	1
O&M (4% capital cost)	11,029,000	5
Subtotal	*174,290,000*	

Evaporation Ponds		
O&M (36% of capital cost)	2,082,250,000	8
Subtotal	*2,082,250,000*	
Total	**$ 3,030,010,000**	

1. $0.162/kWh Average cost, in USD, business price per kWh Mexico. Reported as of December 2021. https://www.globalpetrolprices.com/Mexico/electricity_prices
2. Estimated, scaled from 80 MGD RO plant.
3. Assumes 73 Full Time Equivalents at $121/hr
4. Assumed to be 10% of power, chemical, maintenance, and replacement costs.
5. Assumed to be 4% of capital costs.
6. Assumed to be 1.5% of capital costs.
7. $0.19/kWh. Average cost Pacific United States May 2022. Bureau of Labor Statistics www.bls.gov/regions/midwest/data/AverageEnergyPrices_SelectedAreas_Table.htm
8. Assumed to be 36% of capital costs, consistent with *Binational Study of Water Desalination Opportunities in the Sea of Cortez, TM2: Desalination Technologies and Brine Management Options.*

Table 5-7: Calculation of Net Present Value: Sea of Cortez Exchange Concept

Schedule Input			
Base Year:	2022	**Construction:**	Years 14-18
Study/Design/Approval:	Years 1-13	**Project Operates:**	Years 19-56
Bond Repayment	Years 1 - 31		
Cost Input			
Initial Costs ($US)	$45.4B	**Annual Costs ($US)[1]:**	2.4B – 3.0B
Assumed Bond Rate:	4.00%	**Assumed Discount Rate:**	3.00%
Net Present Value Estimate 2078 (all costs)			
$102.1 B			
Net Present Value Estimate 2078 (imported water only costs)			
$38.5 B			
Present Value Per AF (imported water only costs, assumes 112,000 AFY import)			
$9,000			

1. Annual O&M costs will vary dependent on which facilities are operating.

There is potential to reduce the production of the remediation desalination facility once a desired Salton Sea salinity is reached, such as 40,000 mg/L as discussed in the Programmatic EIR (California Department of Water Resources 2007). To evaluate the impact on the project cost, a 50% reduction in O&M costs associated with the remediation desalination facility was investigated after the year 2048, with no change in capital costs. The resulting reduction in net present value was up to 12%, a significant potential savings, but well within the range of uncertainty of the cost estimate.

5.6 Benefits Analysis

Section 4.6 above includes a discussion on the economic revitalization, ecosystem services, air quality and human health benefits that could occur with implementation of water importation concepts. The analysis in Section 4.6 specific to the second water importation scenario is applicable to the Water Exchange Concept.

Table 5-8: Estimated Benefits of the Sea of Cortez Exchange Concept

	Benefit Range	
Benefit Category	*Low*	*High*
Economic Revitalization		
Tourism and recreation	$1.4 B	$4.1 B
Real estate development	$540 M	$1.6 B
Property Tax	$32 M	$95 M
Property value	$98 M	$294 M
Total Monetized Benefits		
	$2.1 B	**$6.1 B**
Ecosystem Services[1]		
	++	++
Air Quality and Human Health[1]		
	++	++

Present Values over period 2022 through 2078, at 3% discount rate; 2022 USD
1. A qualitative indicator using the following key: + would likely increase benefits; ++ would likely increase benefits to a greater degree.

Section 6: Feasibility of the Colorado River Voluntary Transfer Concept

6.1 Concept Description, Design and Engineering

In the Colorado River Voluntary Transfer Concept, enough land would be voluntarily fallowed using financial incentives provided by the State of California to result in a net additional input of 100,000 AFY to the Salton Sea. Water from voluntary transfers could stabilize the sea's elevation, and paired with remediation desalination, the Salton Sea salinity levels would be reduced.

6.1.1 Major Facilities

Specific facilities of this Concept are described below and summarized in Table 6-1.

Components:

- **Salton Sea Intake** facilities for the remediation desalination facility located near the southwest corner of the Salton Sea. Assumed to be 98-inch diameter steel pipe with polyurethane lining extending 1.9 miles into the Salton Sea.
- The 200 MGD, 25,000 BHP **Salton Sea Pump Station**, will be used to move water from the Salton Sea to the Remediation Desalination Facility.
- 100 MGD RO **Remediation Desalination Facility** near the Salton Sea to treat Salton Sea water.
- Water produced by the remediation desalination facility will be returned to the Salton Sea via a 70 inch, 3.4 mile long **Salton Sea Return Pipeline.**
- Brine handling for remediation desalination facility via 22,000 acres of **Evaporation Ponds**. Assumed to be on the west side of the Salton Sea outside of sensitive ecological areas. It is assumed that evaporation ponds could be used to cover playa that would otherwise be exposed as the sea declines, thereby decreasing the acreage of playa needing remediation.

Table 6-1: Colorado River Voluntary Transfer Concept, Water Importation Facilities

Treatment Facilities	Flow Rate (MGD)	Assumed Recovery Rate	Brine Production		Product Water	
			MGD	AFY	MGD	AFY
Remediation Desalination Facility (Salton Sea)	200	50	100	90,000 to 112,000	100	90,000 to 112,000
Pump Station(s)	**Flow Rate** *(MGD)*	**Horse Power** *(BHP)*				
Salton Sea Pump Station	200	25,000				
Pipeline	**Diameter** *(in)*	**Length** *(miles)*	**Count** *(each)*	**Material**	**Flow Rate Per Pipe** *(MGD)*	**Flow Velocity** *(ft/s)*
Salton Sea Intake	98	1.9	1	Steel with Polyurethane Lining	200	5.91
Sea Return Pipeline	70	3.4	1	Steel with Polyurethane Lining	100	5.79
Brine Handling Pipeline	70	9.25	1	Steel with Polyurethane Lining	100	5.79
Other	**Acres**					
Evaporation Ponds	22,000					

6.1.2 Hydraulics and Pumping Requirements

All facilities for this Concept will be located at the Salton Sea and extensive conveyance pipelines are not considered. For this reason, detailed hydraulic modeling was not performed for this Concept.

6.1.3 Long-Term Operations, including Energy Recovery

Annual operations and maintenance will consist of providing incentives/purchasing water from fallowed properties, labor costs to run the remediation desalination plant, maintenance labor for all facilities, treatment chemicals, and power. These costs are summarized in Section 6.5 and Table 6-7. Operation of evaporation ponds will include removal and hauling of salts from the evaporation ponds associated with the remediation desalination plant. As the salinity of the Salton Sea changes, the amount of salt generation at the ponds will change, ranging from a low of 6 million tons a year up to 59 million tons.

6.2 Evaluating Feasibility of Planning and Permitting

6.2.1 Environmental and Permitting Considerations

This analysis assumes that under this Concept all water imported and all construction and all operation would solely occur within the US. Its further assumes that the voluntary transfer program would be conducted in a manner that would not necessitate any revisions to treaties or agreements with Mexico, and that IID has sufficient pre-1914 perfected water rights that could legally be allowed to provide water to the Salton Sea. The analysis assumes that construction and operation of facilities within the US would be undertaken by persons, firms, and local and State governments that can legally perform work in California.

Table 6-2 summarizes the anticipated permits needed for the Colorado River Voluntary Transfer program. Beyond permitting, the program would also need approval from the IID board, which would be one of the core participants in project development and implementation.

Table 6-2: Anticipated Permits Needed for Colorado River Voluntary Transfers

Permit	Permit Triggers	Permit Timeframe
Review under the California Environmental Quality Act and National Environmental Policy Act	Projects receiving permits or funding from public agencies that may result in significant impacts to the environment.	Following preliminary design. Anticipated duration for permit activity – 3 years.
Agreement to modify Reclamation Colorado River Operations	Any needed modifications to the amount or location of how Reclamation delivers Colorado River Water.	Following preliminary design. Anticipated duration for permit activity – 3 years.
Federal Energy Regulatory Commission hydropower licensing	Non-federal hydropower projects located on navigable waterways or federal lands or connected to the interstate electric grid.	Following preliminary design. Anticipated duration for permit activity – 3 years.
SWRCB approval for water transfers	Water transfers within the State of California.	Following preliminary design. Anticipated duration for permit activity – 3 years.
Review and mitigation under the Endangered Species Act, Federal Incidental Take Permit	Projects requiring a federal permit, agreement, or receiving federal funding that may affect sensitive species.	Following preliminary design. Anticipated duration for permit activity – 3 years.
Review and mitigation under the California Endangered Species Act, State Incidental Take Permit	Projects requiring a permit, agreement, or receiving funding by a California public agency that may affect sensitive species.	Following preliminary design. Anticipated duration for permit activity – 3 years.
IID Electrical Power Customer Application and Agreement	New construction that will receive power from the IID electrical utility.	As part of final design. Anticipated duration for activity – 1 year.
IID Generator Interconnection Agreement	New construction that will include interconnection of a generating facility to the IID transmission system.	As part of final design. Anticipated duration for activity – 1 year.
US Army Corps of Engineers Clean Water Action Section 404 Permit	Projects that may result in discharge of dredged or fill material into waters of the US.	As part of final design.

Permit	Permit Triggers	Permit Timeframe
		Anticipated duration for activity – 1.5 years.
Colorado River Regional Water Quality Control Board Section 401 Permit	Projects that may result in discharge of dredged or fill material into waters of the US.	As part of final design. Anticipated duration for activity – 1.5 years.
California Department of Fish and Wildlife Fish and Game Code 1600 Permit	Projects that may substantially divert or obstruct the natural flow, or substantially change or use any material from the bed, channel, or bank of any river, stream, or lake.	As part of final design. Anticipated duration for activity – 1.5 years.
Right-of-Way Permit, Imperial County Transportation Department	Projects where new facilities or construction activities will encroach within, under or over County roadways.	As part of final design. Anticipated duration for activity – 1 years.
Right-of-Way Permit, IID	For facilities or construction activities that cross IID lands or encroach upon IID facilities or project sites	As part of final design. Anticipated duration for activity – 1 years.
Encroachment Permit Imperial County Public Works	For facilities or construction activities that encroach within County infrastructure such as storm drains.	As part of final design. Anticipated duration for activity – 1 years.
CalTrans Standard Encroachment Permit	Projects where new facilities or construction activities will encroach within, under or over State roadways.	As part of final design. Anticipated duration for activity – 1.5 years.
Imperial County Development Permits (including General Plan Amendment, Zoning Change, Conditional Use Permit, Development Agreement, Grading Permit, Wastewater Permit, Fire Suppression Plan Permits, Mechanical Permits, Electrical Permits, Structural/Foundation Permits, Haul Route Plan Rule 310 Dust Control Plan & Rule 801 Compliance). [1]	Projects that result in new construction or alterations to existing structures within the County.	As part of final design. Anticipated duration for activity – 1.5 years.
Imperial County Air Pollution Control District Dust Control Plan	New construction or building alteration within Imperial County.	At the end of final design. Anticipated duration for activity – 9 months.
Imperial County Air Pollution Control District Stationary Source Permit	Building, altering, replacing, or operating equipment or other contrivance which may cause the issuance of air contaminants.	At the end of final design. Anticipated duration for activity – 1.5 years.

Permit	Permit Triggers	Permit Timeframe
Waste Discharge Permit for Brine Evaporation Ponds	Waste storage under Chapter 15.	At the end of final design. Anticipated duration for activity – 1.5 years.
National Pollutant Discharge Elimination System (NPDES) General Permit for Storm Water Discharges Associated with Construction and Land Disturbance Activities	Construction disturbing 1 acre or more.	Immediately before construction. Anticipated duration for activity – 1 year.

1. If the state constructs the facility, it will not need a county conditional use permit.

As described earlier, it will be necessary for federal entities and the State of California to perform reviews under NEPA and CEQA before committing to a particular action that could result in physical changes to the environment. The analysis performed for NEPA and CEQA will inform the various permits in Table 6-2.

6.2.2 Flood Control

Project features can minimize but do not eliminate the risk of localized flooding. The proposed Remediation Desalination Facility would extract 200 MGD from the Salton Sea, meaning a disruption of greater than an hour could mean approximately 8.3 million gallons of desalinated water would be released and uncontrolled. The risk of catastrophic flooding could be reduced with appropriate site grading and berming to retain water on site and with grading to direct any water not retained on site back to the Salton Sea.

6.2.3 Climate Change and Resiliency

6.2.3.1 Project Contribution to GHG Emissions

Section 4.2.3 provides a discussion of potential GHG emissions without implementation of an imported water project. This section focuses on the potential contribution of the Colorado River Water via Voluntary Fallowing to GHG emissions. This analysis is limited to the energy used to power the various facilities. This analysis does not consider energy used to manufacture pipes, pumps, and other equipment, used during construction, used by laborers travelling to the work areas, or any population growth or other economic activity resulting from implementation of the project.

As described in Section 4.2.3, the GHG emissions for the project are dependent on the energy source used to power facilities. Table 4-5 provides the estimated metric tons CO_2E per million kWh for power delivered by IID. Table 4-5, looks at the current sources used for electrical generation, rather than those that may be in place in years 2030, 2040, and beyond. This analysis likely overestimates GHG emissions as IID energy sources have been trending to cleaner/lower emissions sources for electricity. Table 6-3 shows the estimated annual CO_2E in metric tons for the Colorado River Water via Voluntary Fallowing.

Table 6-3: Estimated Annual CO_2E Emissions Colorado River Water via Voluntary Fallowing

Facility	Annual Million kWh	CO_2E emissions per million kWh (metric tons)[1]	CO_2E (metric tons)
Facilities Using Electricity from IID			
Salton Sea Pump Station	163	217	35,444
Remediation Desalination Facility	442	217	95,872
Total Annual CO_2E (metric tons, rounded)			**131,000**

Notes: 1. See Table 4-6

6.2.3.2 Project Resiliency

Rising temperatures and more extremes in precipitation (including longer periods of low precipitation) will lead to greater demands for water in the Salton Sea area while concurrently decreasing the amount of fresh water available.

Risks to the Imported Water Source

This Concept relies on exchanges or transfers of Colorado River water to achieve benefits, those exchanges are imperiled by ongoing Colorado River basin drought related to climate change. In 2022 the largest reservoirs on the Colorado River dropped to historic lows and the US BoR ordered Colorado River states to reduce their total water use by 2 to 4 million AF, about a quarter of all usage. It is possible that the federal government will impose emergency cutbacks to California water use and this could limit water available for transfers to the Salton Sea (Reclamation 2022).

Risks to Infrastructure

The concept will require an intake within the Salton Sea. As evaporation increases, freshwater runoff to the Salton Sea decreases, and the water levels in the Sea change, it is possible that the intake for the remediation desalination facility will not function properly. Again, adequate planning and design could limit risks to this infrastructure.

6.2.4 Timeframe

6.2.4.1 Planning and Permitting Timeframe

Figure 6-1 below illustrates the anticipated planning and permitting timeframe needed for the Colorado River Water via Voluntary Fallowing. As shown, it's estimated that it will take approximately 5 years before this plan would be ready to begin implementation of transfers and 8 years before construction of the remediation desalination facility is likely.

6.2.4.2 Construction and Implementation Timeframe

Table 6-4 below provides information on the estimated timeframe for implementation and construction and startup needed for this concept, in the absence of litigation. It is estimated that voluntary fallowing and related transfers to the Salton Sea could begin within 5 years;

construction of the remediation desalination plant is assumed to be complete within 11 years. The construction schedule in Figure 6-2 does not account for delays related to avoid impacts to special status species (e.g., no construction during bird nesting season) nor do they assume there is any constraints on the amount of construction equipment usage or allowable ground disturbance to avoid excessive volumes of air quality emissions and dust generation during construction.

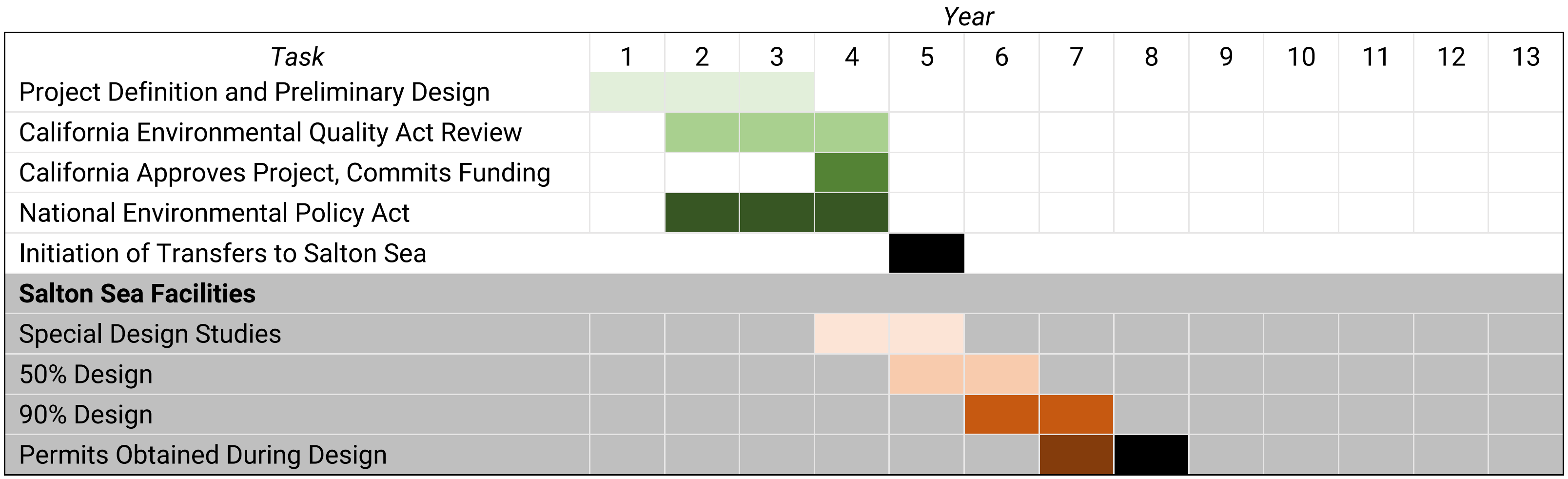


Figure 6-1: Estimated Permitting and Planning Timeframe Colorado River Water via Voluntary Fallowing

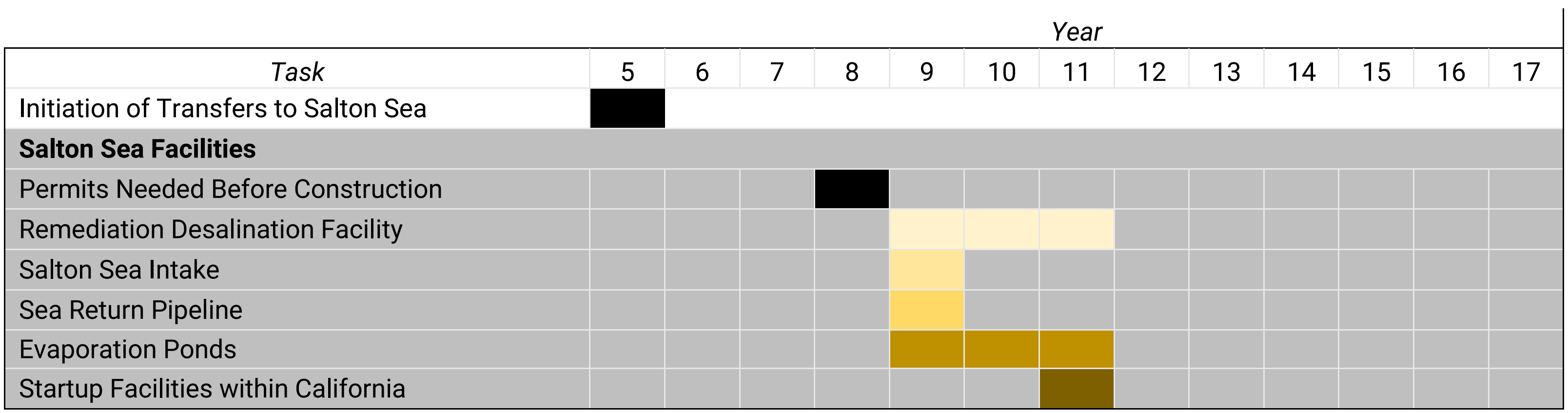


Figure 6-2: Estimated Construction Timeframe Colorado River Water via Voluntary Fallowing

Table 6-4: Timeline Assumptions for the Colorado River Water via Voluntary Fallowing

Infrastructure Needed	Timeline Assumptions
100 MGD Remediation Desalination Facility	No analogous surface water desalination facilities of this size were identified within California. However, this construction schedule is assumed to be similar to that for the Sorek Desalination Plant, about 3 years.
Salton Sea Intake	It is assumed this intake will be built concurrent with construction of the Remediation Desalination Facility and take between 16 and 24 months.
Sea Return Pipeline	It is assumed this return pipeline will be built concurrent with construction of the Remediation Desalination Facility and Salton Sea Intake pipeline and take between 16 and 24 months.
Evaporation ponds	No analogous evaporation ponds were identified within California. The construction timeframe needed for the evaporation ponds is based on the estimated time needed for excavation. With multiple crews working is assumed that the evaporation ponds could be built concurrent with the Remediation Desalination Facility.

6.2.4.3 Overall Implementation Timeframe

In total, assuming no litigation, it is estimated that planning activities will take approximately 5 years, with transfers to the Salton Sea beginning in year 5. Construction of the remediation desalination facility is anticipated to take approximately 3 years. In total, the project timeline, from permitting and design to construction completion, is estimated to take roughly 11 years.

6.3 Evaluating Feasibility of Construction and Operation

There are some construction and operational challenges for the Colorado River Water via Voluntary Fallowing as described below. However, these challenges are not seen as insurmountable, but do add to the need for careful design, contribute to the project cost, and extend the timeline needed for implementation. As described below:

- Project construction will require skilled craft workers for an extended period of time, and this may require travel of workers from other areas and/or establishment of temporary communities.
- Project operation will generate large quantities of brine salt that will need disposal;

6.3.1 Geotechnical

For the purposes of establishing a general understanding of geotechnical conditions around the proposed remediation desalination plant, the support team, at the direction of the Panel, reviewed geotechnical and geological referenced letters and reports regarding the soil and geologic conditions with the area of the Salton Sea. The support team further reviewed available topographic and geologic maps as well as satellite images and photographs to further assess the proposed remediation desalination plant.

No final design plans/specifications or as-built drawings/reports of any of the proposed concept were available for review. All geotechnical and geological information reviewed relates to data collected in the general region of the proposed project and is not considered to be within the exact known position of any structure.

6.3.1.1 Project Site Geology - Salton Sea

Like the other concepts, the project site is located in the Salton Trough physiographic province, primarily within Alluvial and Lacustrine deposits. The reader is directed to Section 4.3.1.1 for a discussion on site geology. Table 6-5 below summarizes the anticipated soil and bedrock conditions for the Colorado River Voluntary Transfer Concept.

Table 6-5: Anticipated Soil and Bedrock Conditions for the Colorado River Voluntary Transfer Concept

Sediment Type	Location	Characteristics
Alluvial sediments with interbedded lacustrine sediments (Salton Trough/Imperial Valley)	From ground surface to likely depth of pipeline (i.e., about 18 ft bgs) At Remediation Desalination Facility	Light brown and brown, fine to coarse silty sand, (SM), silt (ML) and clay (CL) contains varying amounts of rock fragments to interbedded cemented sands and silts, some clay stringers; loose to medium dense, high corrosivity and shrink/swell potential where clay percentage is higher

6.3.1.2 Geological Hazards

Expansive Soil

The soils in the Lacustrine and higher clay portion within the alluvial materials are potentially prone to expansion (i.e., shrink/swell). Typically, these types of clay soils are considered sensitive to wetting and drying and have a volume change associated with those variations in moisture content. Site specific sampling and testing should be considered during the design phase along with potential mitigation measures provided by the geotechnical engineer.

Corrosive Soil

The Lacustrine and higher clay/silt alluvial soils are prone to be corrosive. Preventative measures that are specific to the systems to be constructed should be provided by the geotechnical engineer during the design phase. There are multiple methods of addressing corrosive soil conditions and those chosen should be specific to the materials to be used.

6.3.1.3 Seismic Hazards

Like the other concepts, the project site located in the seismically active Salton Trough. A complete seismic analysis will be required at the time of initial design to accurately design the planned systems.

6.3.1.4 Geotechnical Engineering Construction Considerations

Excavation Characteristics

The review and assessment indicate that the project facilities are underlain by varying geologic formations and materials as indicated in the previous section. Excavation of the overburden soils are anticipated to encounter mostly silts, clays, and sands.

Temporary Excavations and Shoring

The geotechnical consultant should evaluate the soil classifications and excavation performance in the field in accordance with the applicable regulations. Temporary excavations should be constructed in accordance with US authorities' recommendations. For trenches or other excavations, requirements regarding personnel safety should be met using appropriate shoring (including trench boxes) or by laying back the slopes based on the soil types encountered. At a minimum, until otherwise assessed by a licensed geotechnical engineer, open cut excavations should consider sloping no less than 1H:1V and flatter sloping or temporary shoring may be necessary based on the presence of loose density soils. Due to varying levels of groundwater likely to occur at the remediation desalination facility temporary excavations that encounter seepage will likely require shoring. Excavations encountering seepage should be evaluated on a case-by-case basis. Presently, there is not enough site-specific information to determine the extent of temporary shoring.

In areas of loose density soils and/or the presence of groundwater seepage, a shoring system will likely be required to stabilize the excavation sidewalls during construction. Shoring systems are anticipated to be constructed through the upper loose density soils to the underlying firm soil/rock materials. The shoring system should be designed using the magnitude and distribution of lateral earth pressures to be determined at the time of final design for both braced shoring and cantilever shoring.

Remnants of less weathered/intact rock are anticipated to be encountered in the subsurface materials. Consequently, as noted earlier, these materials are anticipated to be difficult to excavate. The geotechnical engineer of record may want to consider the use of temporary shoring systems such as trench boxes, slide rail systems, etc.

The shoring discussions presented in this report are for preliminary feasibility purposes and the geotechnical engineer and contractor should evaluate design parameters by their own means and make appropriate considerations for their design. Most importantly, the contractor must take appropriate measures to protect workers. Occupational Safety and Health Administration (OSHA) requirements pertaining to worker safety should be observed.

Construction Dewatering

Where groundwater, seepage, and/or perched water conditions are encountered, dewatering measures during excavation operations should be prepared by the contractor's engineer and reviewed by the design engineer. Considerations for construction dewatering should include anticipated drawdown, piping of soils, volume of pumping, potential for settlement, and groundwater discharge. Disposal of groundwater should be performed in accordance with stipulated guidelines of the overseeing government entity.

Groundwater levels may fluctuate with precipitation, irrigation of adjacent properties, and drainage. The groundwater levels discussed herein should not be interpreted to represent an accurate and/or specific condition within the remediation desalination plant area.

6.3.1.5 General

The conclusions of this geotechnical section of this study are based on the review of documents provided by others. Following selection of a general site location, a phased geotechnical program should be implemented to better define the soils/bedrock likely to be encountered during installation to assess design requirements and costs for construction installation operations. This phased geotechnical approach should be considered as part of the step-by-step progressive process toward developing a final design that includes desalination plant site selection and related pipeline alignments, intake/outfall pipe support systems and evaporation ponds.

6.3.2 Availability of Skilled Work Force

Project construction will generate a significant number of construction jobs. The length of construction (~3 years) means the construction workforce will need to be in the area for an extended time. There are a few metropolitan areas in the surrounding vicinity from which construction workers could be drawn, including Riverside, Temecula, and the greater San Diego region, all roughly 100 miles distant. Given this distance, it may be difficult to attract and retain the needed skilled workforce and it may be necessary to provide temporary facilities to house construction workers.

Following construction, operation of the remediation desalination facility and associated pump station will require a skilled workforce of approximately 73 persons. It is unlikely that the necessary workforce currently resides in the Salton Sea area, and it will be necessary to attract these workers from a broad geographic area and/or set up appropriate training to prepare workers for this employment opportunity.

The need for skilled workers both during construction and operation does not render the Concept infeasible; however, it adds an element of uncertainty and could delay construction and project startup.

6.4 Evaluating Technical Performance

6.4.1 Water Quality

As described in Section 2.1.3 the specific criteria against which to measure project performance related to water quality is the salinity achieved by the project and whether or not this salinity is supportive of fish, birds, and invertebrates:

- Achieves a salinity favorable to the widest range of fish and invertebrates that can then support a variety of birds, at a salinity less than 40,000 mg/L
- Achieves a salinity supportive of fish, birds, and invertebrates, with a salinity less than 60,000 mg/L
- Achieves a salinity favorable to a select group of fish and invertebrates that can then support a variety of birds, at a salinity of greater than 60,000 but less than 70,000 mg/L

Salinity modeling via SSAM was performed assuming: (1) no remediation desalination and (2) a 100 MGD remediation desalination to treat Salton Sea Water. Modeling included baseline scenarios and assuming a 10% increase in baseflows due to uncertainty in the long-term projected inflows to the Salton Sea. Modeled salinity represents an average salinity based on the salt and water balance.

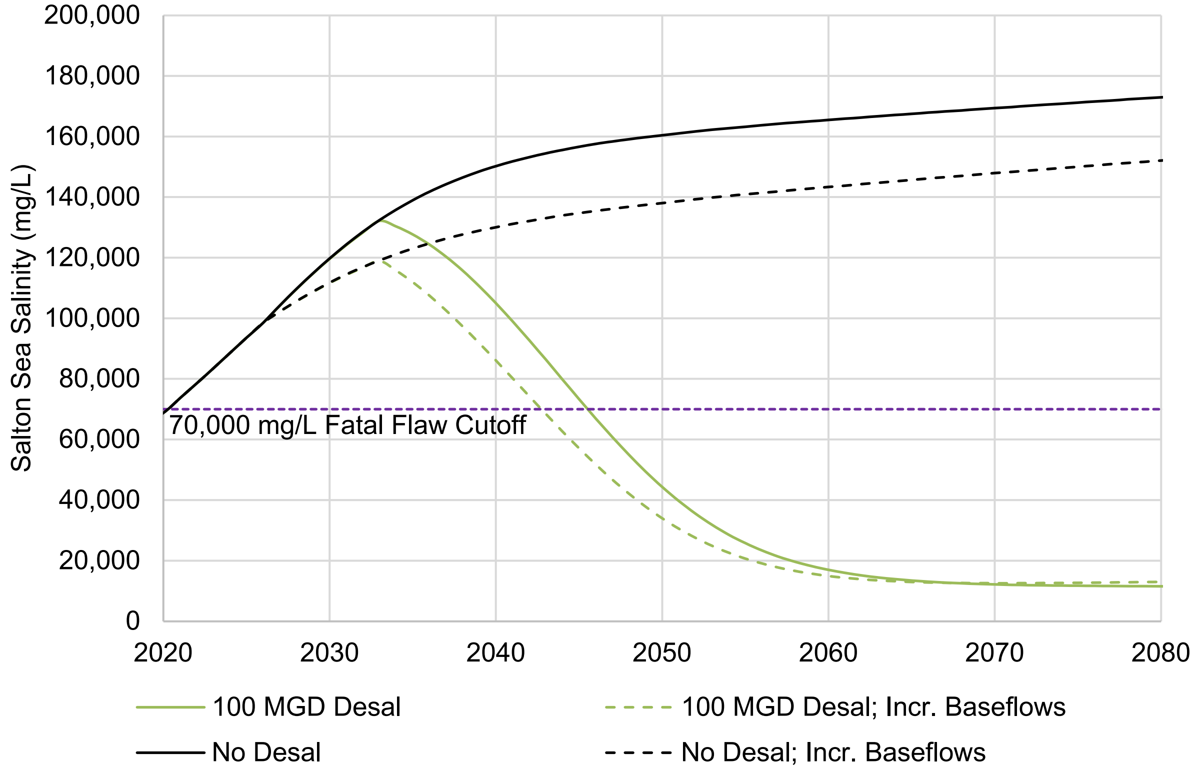


Figure 6-3: Projected average Salton Sea salinity with 100,000 AFY of Colorado River water imported and no additional desalination (black) and 100 MGD of desalination (blue) at the Salton Sea. The dashed lines indicate a 10% increase in baseflows.

Figure 6-3 shows that import in conjunction with the 100 MGD facility provides salinity reduction below 70,000 mg/L in approximately 2045 and below 40,000 mg/L by year 2051. Though, even with these declines in salinity, given the decades of hypersaline conditions, concerted efforts will be required to reintroduce species and restore the ecosystem once it is conducive to minimum ecological function again.

Salt generation from the remediation desalination facility discussed above is shown in Figure 6-4.

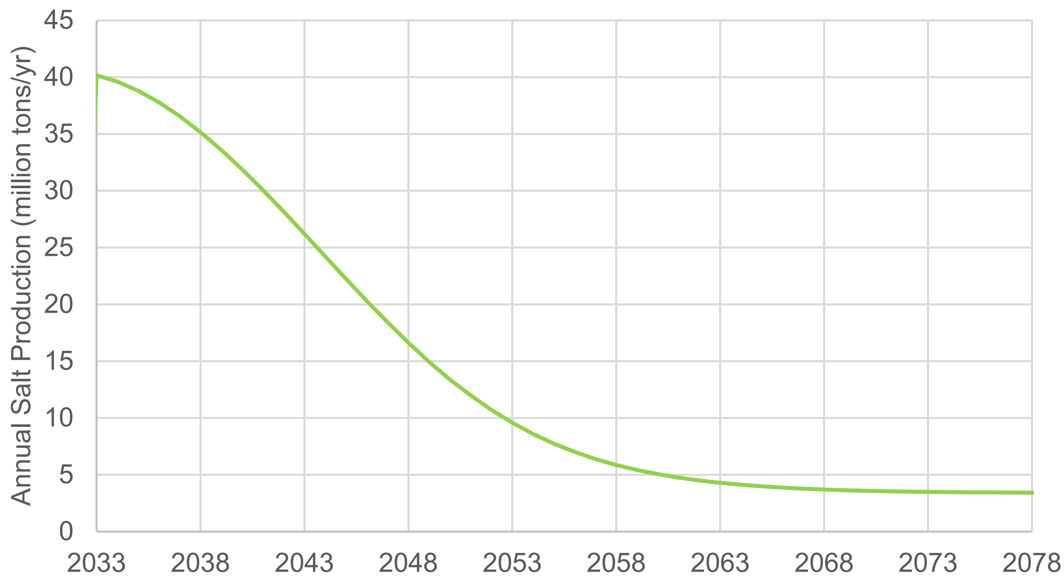


Figure 6-4: Projected annual salt production from proposed remediation desalination facility of 100 MGD at the Salton Sea.

With potential salt production ranging from 4 million to 40 million tons per year, salt management will be a critical component of project success.

In addition to removal of salt, desalination of Salton Sea water is likely to reduce the concentrations of heavy metals, selenium, nutrients, and pesticides. Removal rates would be dependent on the remediation desalination facility intake location, effectiveness of mixing for both desalinated Salton Sea water and imported water, concentrations in existing inflows, and distribution of contaminants in the water column and sediments. While these factors prevent quantification of potential contaminant removal rates from the Salton Sea, increased desalination at the Salton Sea will decrease the overall concentrations of these contaminants.

6.4.2 Water Quantity

The Colorado River Water via Voluntary Fallowing will import an annual quantity of approximately 100,000 AFY and this would be coupled with a remediation desalination facility that effectively removes tons of salt from the sea each year.

Figure 6-5 illustrates that SSAM modeling projected the water surface elevation at the Salton Sea would continue to decline to -258 to -261 ft msl.

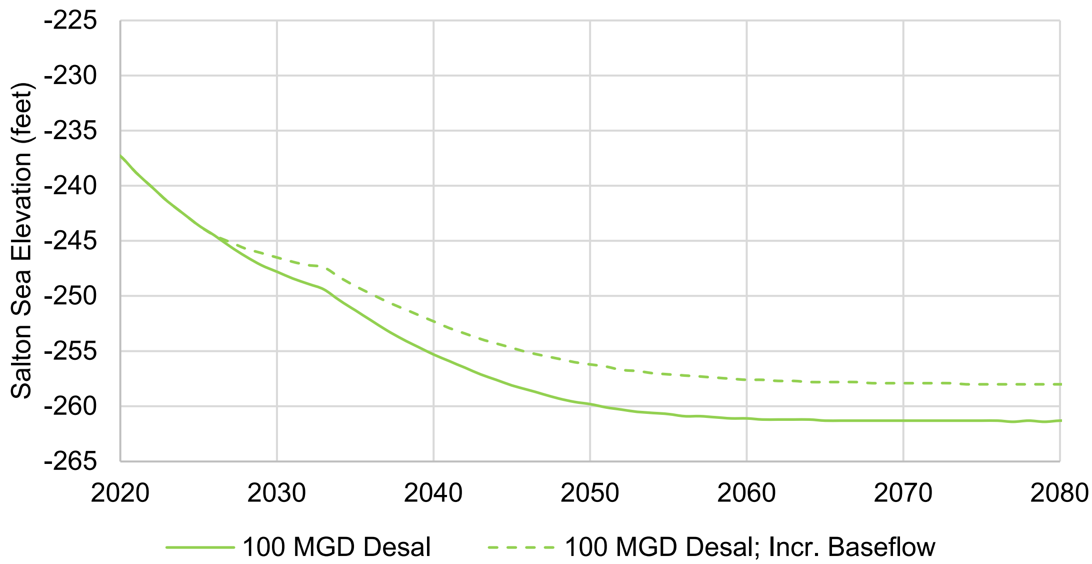


Figure 6-5: Projected Salton Sea elevation with 100,000 AFY of water imported under the Colorado River Voluntary Transfer Concept. The dashed lines indicate a 10% increase in baseflows.

6.4.3 Playa Exposure

A decrease in Salton Sea elevation has a direct correlation to playa exposure and a decrease in air quality. The Colorado River Voluntary Transfer Concept could result in 73,000 to 86,000 acres of additional exposed playa, beyond that occurring in 2018. The acreage of playa exposure could be offset by the 30,000 acres of playa remediation proposed as part of the SSMP. It could be further reduced by placing the approximately 22,500 acres of evaporation ponds needed in a manner to reduce the surface area of exposed playa. This would leave roughly 30,000 acres of playa that would need to be remediated to return conditions to that approximating 2018. The costs of the Colorado River Voluntary Transfer Concept include costs needed to remediate approximately 30,000 acres of playa.

6.5 Project Cost Estimate

As detailed in Section 2.2 accuracy of a Class 5 conceptual estimate is -50% to +100%. Subtotals in the tables below have been rounded to the nearest ten thousand dollars. Table 6-6 summarizes the estimated capital costs, planning and permitting costs, and land acquisitions cost for the Colorado River Water via Voluntary Fallowing.

In addition to capital cost estimates and annual operation and maintenance (O&M) costs were developed. Annual O&M consists of labor, power, and chemical costs to run the remediation desalination plant as well as the purchase of water made available through voluntary fallowing. These costs are summarized in Table 6-7. Operation of evaporation ponds include removal and hauling of salts from the evaporation ponds associated with the remediation desalination plant.

Finally, life cycle net present value costs were evaluated in Table 6-8. As described in Section 2.1.9, the live cycle net present value calculation considered the initial costs, operational costs, assumed financing costs, and assumed a discount rate. Net present value costs were also generated for just the importation components (no remediation desalination components at the Salton Sea) to generate a cost per AF of imported water for the Concept (assuming the project operates year 2026 to 2078). The cost of importation assuming 100,000 AFY of imported water for the project duration is $230.

Table 6-6: Capital, Planning, Permitting, and Land Acquisition Costs: Colorado River Voluntary Transfer Concept

Cost Item	Unit	Unit Price ($)	Quantity	Total ($)
Salton Sea Pump Station, 200 MGD	BHP	10,250	25,000	256,250,000
Salton Sea Intake, 98-inch, steel pipe with polyurethane lining	LF	10,780	10,000	107,800,000
Remediation Desalination Facility (RO), 100 MGD	LS	1,216,880,000	1	1,216,880,000
Sea Return Pipeline, 70-inch steel pipe with polyurethane lining	LF	8,855	18,000	159,390,000
Brine Discharge Pipeline, 70-inch steel with polyurethane lining	LF	8,855	48,840	432,478,000
Playa Remediation Costs	Acre	25,000	30,000	750,000,000
Evaporation Ponds with liner and bird netting (22,000 acres)	LS	5,784,030,000	1	5,784,030,000
Subtotal				**$8,706,830,000**
Mobilization/Demobilization		@4%		348,273,000
Bonds and Insurance		@4%		348,273,000
Taxes		@8%		696,546,000
Overhead and Profit		@15%		1,306,025,000
Contingency		@30%		2,612,049,000
Subtotal Construction				**$14,018,000,000**
Studies, Permitting, Preliminary Engineering		@15%		1,306,025,000
Engineering/Design/CM		@15%		1,306,025,000
Subtotal Planning and Design				**$2,612,050,000**
Salton Sea Pump Station and Desalination Facility Site	Acre	16,000	15	240,000
Evaporation Ponds	Acre	16,000	22,000	352,000,000
Subtotal Land and Easements				**$352,240,000**
Total Estimated Initial Costs				**$16,982,290,000**
Conceptual Cost Range (-50% to +100%)		**$8,491,150,000**	**to**	**$33,964,580,000**

Table 6-7: Annual O&M Costs: Colorado River Voluntary Transfer Concept

Item	Cost ($US)	*Notes*
Water Purchase Costs		
Water Purchase Costs	22,770,000	1
Subtotal	*22,770,000*	
Remediation Desalination Facility (100 MGD) and Intake		
Power	83,905,000	2
Chemicals	19,183,000	3
Maintenance and Materials	2,253,000	3
Labor	18,373,000	4
Replacement	12,169,000	3
O&M Contingency	55,911,000	5
Subtotal	*191,790,000*	
Salton Sea Pump Station		
Power	163,260,000	1
O&M (4% capital cost)	11,029,000	6
Subtotal	*174,290,000*	
Evaporation Ponds		
O&M (36% of capital cost)	2,082,250,000	7
Subtotal	*2,082,250,000*	
Total	**2,741,100,000**	

1. Assuming $157/AF. Purchase of 145,000 AFY less the 30% lost return flow results in an additional inflow to the Salton Sea of 100,000 AFY.
2. $0.19/kWh. Average cost Pacific United States May 2022. Bureau of Labor Statistics www.bls.gov/regions/midwest/data/AverageEnergyPrices_SelectedAreas_Table.htm
3. Estimated, scaled from 80 MGD RO plant.
4. Assumes 73 Full Time Equivalents at $121/hr
5. Assumed to be 10% of power, chemical, maintenance, and replacement costs.
6. Assumed to be 4% of capital costs
7. Assumed to be 36% of capital costs, consistent with *Binational Study of Water Desalination Opportunities in the Sea of Cortez, TM2: Desalination Technologies and Brine Management Options.*

Table 6-8: Calculation of Net Present Value: Colorado River Voluntary Transfer Concept

Schedule Input			
Base Year:	2022	**Construction:**	Years 8-11
Study/Design/Approval:	Years 1-8	**Project Operates:**	Years 11-56
Bond Repayment	Years 8-37		
Cost Input			
Initial Costs ($US)	17.0B	**Annual Costs ($US)[1]:**	22.7M – 2.5B
Assumed Bond Rate:	4.00%	**Assumed Discount Rate:**	3.00%
Net Present Value Estimate 2078 (all costs)			
$63.6B			
Net Present Value Estimate 2078 (imported water only costs)			
$1.2B			
Present Value Per AF (imported water only costs, assumes 100,000 AFY import)			
$230			

1. Annual O&M costs will vary dependent on which facilities are operating.

There is potential to reduce the production of the remediation desalination facility once a desired Salton Sea salinity is reached, such as 40,000 mg/L as discussed in the Programmatic EIR (California Department of Water Resources 2007). To evaluate the impact on the project cost, a 50% reduction in O&M costs associated with the remediation desalination facility was investigated after the year 2051, with no change in capital costs. The resulting reduction in net present value was up to 18%, a significant potential savings, but well within the range of uncertainty of the cost estimate.

6.6 Benefits Analysis

Section 4.1.16 above includes a discussion on the economic revitalization, ecosystem services, air quality and human health benefits that could occur with implementation of water importation concepts. The analysis in Section 4.1.16 for Scenario 2 is generally applicable to the Colorado River Water via Voluntary Fallowing.

Table 6-9: Estimated Benefits of the Colorado River Water via Voluntary Fallowing

	Benefit Range	
Benefit Category	*Low*	*High*
Economic Revitalization		
Tourism and recreation	$1.4 B	$4.1 B
Real estate development	$540 M	$1.6 B
Property Tax	$32 M	$95 M
Property value	$98 M	$294 M
Total Monetized Benefits		
	$2.1 B	**$6.1 B**
Ecosystem Services[1]		
	++	++
Air Quality and Human Health[1]		
	++	++

Present Values over period 2022 through 2078, at 3% discount rate; 2022 USD
1. A qualitative indicator using the following key: + would likely increase benefits; ++ would likely increase benefits to a greater degree.

Section 7: Summary and Next Steps

7.1 Feasibility of the Importation Concepts

The high-level analysis of the concepts evaluated found that all three concepts are feasible. However, the three concepts evaluated have differing levels of uncertainty related to permitting, and likelihood of benefits being realized. A summary of concept components, costs, and benefits are shown in Table 7-1:

Table 7-1: Summary of Concepts

Parameter	Sea of Cortez Import		Sea of Cortez Exchange	Colorado River Voluntary Transfer
	Scenario 1	Scenario 2		
Components				
Water Source for Salton Sea	Desalinated Sea of Cortez water		Colorado River (via exchange)	Colorado River
Sea of Cortez Desalination Facility Size (MGD)	490		100	N/A
Estimated Labor Force – Sea of Cortez (Full Time Equivalents)	340		73	N/A
Earliest Anticipated Water Import	2045		2045	2026
Remediation Desalination Facility Size (MGD)	13.5	100	100	100
Estimated Labor Force – Remediation Desalination (Full Time Equivalents)	13	73	73	73
Earliest Anticipated Facility Startup	2033	2033	2033	2033
Annual Power Consumption (million kWh per year)	2,806	3,349	1,142	605
Estimated Annual CO_2E emissions (metric tons)	1,145,000	1,263,000	452,000	131,000
Outcomes				
Modeled 2078 Salton Sea Elevation	-233	-239	-261	-258
Project year achieving 40,000 mg/L Salton Sea Salinity	N/A	2046	2048	2051
Modeled Minimum 2078 Salton Sea Salinity (mg/L)[1]	64,600	21,000	12,900	12,600
Acres of exposed playa remediated[2]	0	0	30,000	30,000

Parameter	Sea of Cortez Import Scenario 1	Sea of Cortez Import Scenario 2	Sea of Cortez Exchange	Colorado River Voluntary Transfer
Benefits				
Ecosystem Services	+	++	++	++
Air Quality and Human Health	++	++	++	++
Net Present Value Monetized Benefits (2022 to 2078) ($B)	1.1 — 2.2	2.1 — 6.1	2.1 — 6.1	2.1 — 6.1
Costs				
Initial Costs ($B)	65.7	78.4	45.4	17.0
Annual O&M ($/yr)[3]	305M – 1.6B	2.4B - 3.8B	2.4B - 3.0B	22.7M - 2.5B
Net Present Value ($B)	94.7	147.7	102.1	63.6
Water Importation Costs ($/AF)[3]	4,700 – 5,900[4]		9,000 – 11,300[5]	230

1. Minimum salinity represents remediation desalination facility operating at full capacity for the project duration. Capacity may be reduced at a future date to maintain higher salinity targets
2. Includes only exposed playa remediation; playa covered by water not included
3. Annual O&M costs will vary dependent on which facilities are operating
4. Includes only importation components (no remediation desalination)
5. Assumes 430,00 - 540,000 acre feet per year (AFY) production for the project duration
6. Assumes 90,000 - 112,000 AFY production for the project duration

The present value total monetized benefits of the water import concepts are estimated at a range of $1.1B to $6.1B. At first look, this gives the impression of project costs far outweighing its benefits. However, it is common in analyses like these that benefits are not able to be monetized as thoroughly as costs. Here, the major unquantified benefits are improvements in ecosystem services and in air quality and human health. These benefits are key goals of restoration of the Salton Sea, and likely in the billions of dollars. Not enough is known to provide defensible estimates, even with wide error bars. Without monetized values for these benefit categories, providing a benefit-cost ratio is inappropriate at this stage of the analysis. The Panel will provide a more detailed discussion of the project benefits and costs in its Summary Report.

7.1.1 Future Work to Advance the Importation Concepts

This Report evaluates the feasibility of three water importation concepts at the conceptual level. For any concept selected by the SSMP as the preferred alternative for Salton Sea Restoration, a greater level of project definition would be required to understand all the issues and challenges that may face design, construction, and operation. Detailed project definition would include siting studies for the major facilities and conveyance pipelines as well as the needed electrical connections.

To assess design requirements and costs for construction installation operations, a phased geotechnical program would need to better define the soils/bedrock likely to be encountered during installation. This phased geotechnical approach would be considered as part of the step-by-step progressive process toward developing a final design that includes desalination plant site selection, pipeline alignment and any other pertinent elements such as pump stations, intake/outfall pipe support systems and evaporation ponds.

Additional analyses are required to determine the optimal capacity of each major facility, particularly any desalination facility. These analyses would help determine if upsizing a given facility would provide a better cost–benefit result.

This conceptual feasibility analysis utilized assumptions that merit additional investigation. Specifically:

- This analysis assumed the Sea of Cortez and Salton Sea desalination intake facilities extend approximately 2 miles offshore. Similarly, the brine outfall in the Sea of Cortez was assumed to be approximately 3.4 miles offshore. The location of any desalination facility should follow extensive biological surveys of the marine and coastal ecosystems likely affected by brine discharge, as well as examination into site geotechnical conditions. Placement of the intake and brine outfall should be confirmed with bathymetric and ecological surveys and hydrodynamic modeling to identify optimal locations for operation of the desalination facility as well as protection of the local environment.
- The analyses assumed the appropriate power could be obtained with connections to the Mexican CFE and/or IID, but this has not been confirmed. A particular area of uncertainty is the ability to obtain the necessary power for any facilities on the western side of the Sea of Cortez.
- Testing of desalination technologies at demonstration scale is required for technology selection, facility sizing, and intake/outflow design.
- As the evaporation ponds at the Salton Sea have significant acreage requirements, their location and the resulting land cost could significantly impact project cost. Construction costs as well as annual O&M costs, estimated to be ~$2B per year, comprise a significant portion of the O&M costs for the concepts. Brine management strategies should be investigated to reduce costs.
- The desirability of using evaporation ponds as a method to limit exposed playa should be examined in detail.
- It should be confirmed that it will be possible to acquire necessary rights-of-way and land parcels needed for right-of-way and the potential to cross or avoid impacts to other utilities.

7.2 Next Steps

The Panel will consider the results of the feasibility analysis and provide recommendations in its final deliverable, the Summary Report. The Summary Report will consist of an overview of the Panel’s work and findings, followed by recommendations by the Panel for actions to be taken for restoration of the Salton Sea, and for further research.

References

Black & Veatch, 2020, Binational Study of Water Desalination Opportunities in the Sea of Cortez, B&V Project No. 400584. April.

BP Statistical Review of World Energy, Ember Global Electricity Review 2022. Accessed 8/5/2022. https://www.bp.com/en/global/corporate/energy-economics/statistical-review-of-world-energy.html

Buck, B. J., King, J., & Etyemezian, V. 2011. Effects of Salt Mineralogy on Dust Emissions, Salton Sea, California. Soil Science Society of America Journal, 75(5), 1971–1985. https://doi.org/10.2136/sssaj2011.0049

California Department of Water Resources. 2007. Salton Sea Ecosystem Restoration Final and Draft Programmatic Environmental Impact Report. January.

Camacho-Valdez, V., A. Ruiz-Luna, A. Ghermandi, and P. Nunes. 2013. Valuation of ecosystem services provided by coastal wetlands in northwest Mexico. Ocean & Coastal Management, 78:1-11.

Cohen, M.J. 2014. Hazard's toll: the costs of inaction at the Salton Sea. Available at: http://pacinst.org/publication/hazards–toll. Accessed: July 9, 2022.

Delavan Lake, WI; Onondaga Lake, NY; cited in Tourism Economics, 2017.

Fogel, M.L., H. Ajami, E. Aronson, R. Bahreini, W.A. Elders, D. Jenerette, D. Lo, T. Lyons, M. McKibben, W. Porter, A. Raju, K. Schwabe, C. Hung, and J. Nye. 2020. Crisis at the Salton Sea: Research Gaps and Opportunities. Accessed at: https://www.researchgate.net/publication/347535556_Crisis_at_the_Salton_Sea_Research_Gaps_and_Opportunities_THE_EDGE_INSTITUTE_UNIVERSITY_OF_CALIFORNIA_RIVERSIDE_SALTON_SEA_TASK_FORCE_Cover_Photo_Salton_Sea_at_North_Shore_Yacht_Club-Photo_Credit_Jonat Accessed date: July 14, 2022.

Imperial Irrigation District & Formation Environmental 2018. Salton Sea Air Quality Mitigation Program 2016/2017 Annual Report and Emissions Estimates (Issue June). http://www.co.imperial.ca.us/announcements/PDFs/SaltonMitigation.pdf

Imperial Irrigation District, & Formation Environmental LLC. 2019. Salton Sea Emissions Monitoring Program 2017/2018 Annual Report and Emissions Estimates Prepared (Issue May).

Imperial Irrigation District, & Formation Environmental LLC. 2020. Salton Sea Emissions Monitoring Program 2018/2019 Annual Report and PM_{10} Emissions Estimates Prepared (Issue March).

Imperial Irrigation District, & Formation Environmental LLC. 2021. Salton Sea Emissions Monitoring Program 2019/2020 Annual Report and PM_{10} Emissions Estimates Prepared (Issue September).

Imperial Irrigation District, & Formation Environmental LLC. 2022. Salton Sea Emissions Monitoring Program 2020/2021 Annual Report and PM_{10} Emissions Estimates (Issue June).

Imperial Irrigation District. 2020 Power Content Label. https://www.iid.com/energy/renewable-energy/power-content-label

Intergovernmental Panel on Climate Change. 2014. Annex III of Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. https://www.ipcc.ch/report/ar5/wg3/

International Renewable Energy Association. 2012. Renewable Energy Technologies: Cost Analysis Series. Volume 1: Power Sector/Issue 3/5 Hydropower. June.

Jones, B. A. and J. Fleck, 2020. Shrinking Lakes, Air Pollution, and Human Health: Evidence from California's Salton Sea, Science of the Total Environment, vol. 712 (April 10, 2020).

King, J., Etyemezian, V., Sweeney, M., Buck, B. J., & Nikolich, G. 2011. Dust emission variability at the Salton Sea, California, USA. Aeolian Research, 3(1), 67–79. https://doi.org/10.1016/j.aeolia.2011.03.005

Mankins, J.C. 1995. Technology Readiness Levels, Advanced Concepts Office, Office of Space Access and Technology, NASA, Internal white paper.

Marcé, R., Obrador, B., Gómez-Gener, L., Catalán, N., Koschorreck, M., Arce, M. I., Singer, G., & von Schiller, D. 2019. Emissions from dry inland waters are a blind spot in the global carbon cycle. Earth-Science Reviews, 188, 240–248. https://doi.org/10.1016/j.earscirev.2018.11.012

Parajuli, S. P., & Zender, C. S. 2018. Projected changes in dust emissions and regional air quality due to the shrinking Salton Sea. Aeolian Research, 33(January), 82–92. h https://doi.org/10.1016/j.aeolia.2018.05.004

Ostro, B., A. Yewande, and E. Sanchez-Triana. 2021. When the Dust Settles: A Review of the Health Implications of the Dust Component of Air Pollution. World Bank Publications.

Parsons, G.R. and M.J. Kealy. 1994. Benefits transfer in a random utility model of recreation. Water Resources Research, VOL. 30, NO. 8, pgs. 2477-2484.

US Bureau of Reclamation. 2022. Press Release June 14, 2022: Commissioner Touton asks Basin States and Tribes to conserve an additional 2-4 million acre-feet of water in 2023.

Schwabe KA, Baerenklau KA. 2007. A Preliminary Investigation of the Potential Non-Market Benefits Provided by the Salton Sea. Report submitted to the Salton Sea Authority under K2 Economics. June.

Schwabe, K., and N. Negris. 2008. Fundamentals of estimating the net benefits of ecosystem preservation: The case of the Salton Sea. Hydrobiologia, 604: 181-195. DOI 10.1007/s10750-008-9317-0. March.

Sheikh, P.A., and C.V. Stern. 2021. Salton Sea Management. Prepared for the Congressional Research Service. https://crsreports.congress.gov

Salton Sea Management Program. 2022. Long Range Plan, Salton Sea Summit, University of California at Riverside, Palm Desert Campus, April 6-7, 2022.

Slyker, R.G. 1970. Geologic and geophysical reconnaissance of the Valle de San Felipe region, Baja California. Master's Thesis. San Diego, California, San Diego State College, 97p.

Stratus Consulting, 2009. A triple bottom line assessment of traditional and green infrastructure options for controlling CSO events in Philadelphia's watersheds.

Sweeney, M. R., McDonald, E. V., & Etyemezian, V. (2011). Quantifying dust emissions from desert landforms, eastern Mojave Desert, USA. Geomorphology, 135(1–2), 21–34. https://doi.org/10.1016/j.geomorph.2011.07.022

Tourism Economics. 2017. Revitalized Salton Sea: Analysis of potential economic benefits. December. Accessed at: saltonsea.com/wp-content/uploads/2019/11/Oxford-Tourism-Revitalized_Salton_Sea_Benefit_FlipBook.pdf

US International Trade Administration. 2021. Mexico – Country Commercial Guide – Electricity Sector. September.