Salton Sea Long-Range Plan

Appendix A: Summary of Reference Material Used to Develop Initial Concepts

March 2024

SALTON SEA MANAGEMENT PROGRAM

CALIFORNIA NATURAL RESOURCES AGENCY

DEPARTMENT OF WATER RESOURCES · STATE OF CALIFORNIA

CALIFORNIA DEPARTMENT OF FISH & WILDLIFE

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Table of Contents

List of Figures

List of Tables

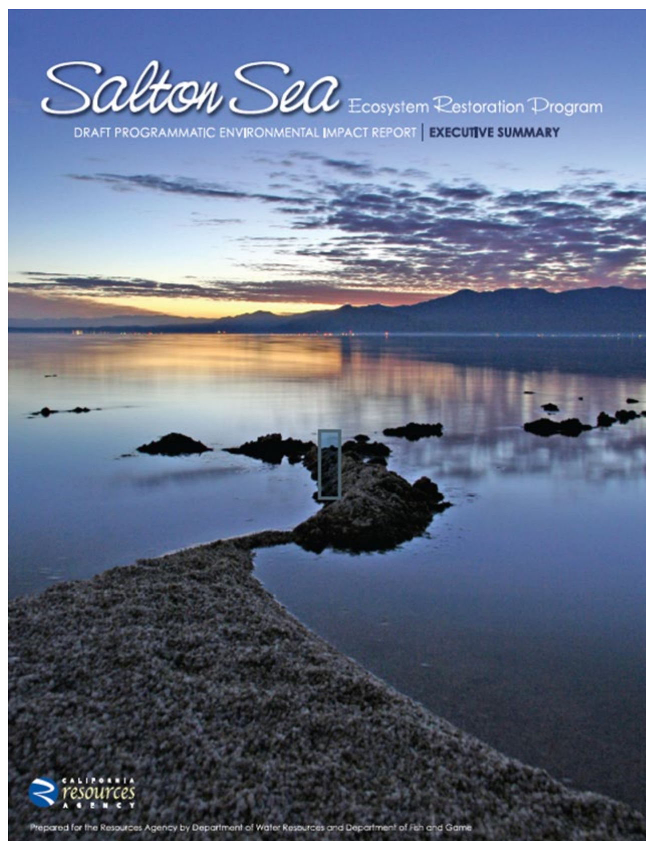
Acronyms and Abbreviations

CDFW	California Department of Fish and Wildlife
CNRA	California Natural Resources Agency
CVWD	Coachella Valley Water District
DWR	California Department of Water Resources
EA	Environmental Assessment
IID	Imperial Irrigation District
LRP	Long-Range Plan
OMER	Operation, maintenance, energy and repair
PEIR	Programmatic Environmental Impact Report
SCH	Species Conservation Habitat (Project)
SHC	Saline Habitat Complex
SSMP	Salton Sea Management Program
SSRREI	Salton Sea Restoration and Renewable Energy Initiative
USBR	United States Bureau of Reclamation
USGS	United States Geological Survey

Appendix A: Summary of Reference Material Used to Develop Initial Concepts

This appendix provides a summary of reference material used to derive initial restoration concepts for the Long-Range Plan. The restoration concepts presented in the plan build upon current and past Federal, State and local investigations and the alternatives developed in those investigations. While the restoration concepts in the plan build on elements of the past alternatives, they have been updated to meet current habitat objectives, use the latest projections for future inflows, incorporate planned changes to the landscape, and use current-year cost estimates. The following four documents are the origin for the restoration concepts considered in the Long-Range Plan:

- Ecosystem Restoration Program Draft Programmatic Environmental Impact Report (PEIR), 2006
- US Bureau of Reclamation (USBR) Final Report: Restoration of the Salton Sea, 2007
- Salton Sea Authority Funding and Feasibility Action Plan, 2016
- The SSMP 10-Year Plan as described in the Updated Draft Salton Sea Management Program, Phase 1: 10-Year Plan Project Description, 2021.



An overview of the alternatives presented in these four investigations is provided here in the chronological order mentioned above.

1.1. Ecosystem Restoration Program Draft PEIR, 2006

As described in the PEIR, State law required that "the Secretary for Resources undertake a study to determine a preferred alternative for the restoration of the Salton Sea ecosystem and the permanent protection of wildlife dependent on that ecosystem." The PEIR focused on several key elements: protecting fish and wildlife, maintaining ecosystem benefits, minimizing air quality impacts, and improving water quality. The California Natural Resources Agency (CNRA) endeavored to bring together all contributing stakeholders involved in the project. After considering a set of eight alternatives, a Preferred Alternative was outlined in detail. The alternatives were published in the Draft PEIR in October 2006. The Final PEIR, published in 2007, provided a response to comments and errata, but no updates to the alternatives.

1.1.1. Range of Alternatives Considered

In addition to the Preferred Alternative, eight action alternatives were considered in the Draft PEIR:

- **Alternative 1.** Saline Habitat Complex I (38,000 acres of Saline Habitat Complex with minimum recirculation facilities and Air Quality Management);
- **Alternative 2.** Saline Habitat Complex II (75,000 acres of Saline Habitat Complex with brine recirculation and Air Quality Management);
- **Alternative 3.** Concentric Rings (61,000 acres of Marine Sea in two concentric rings, Air Quality Management, and no Saline Habitat Complex cells);
- **Alternative 4.** Concentric Lakes (88,000 acres of habitat similar to Saline Habitat Complex in four concentric water bodies as defined by the Imperial Group, with dedicated inflows for Air Quality Management but no long-term facilities);
- **Alternative 5.** North Sea (62,000 acres of Marine Sea in the northern seabed, 45,500 acres of Saline Habitat Complex in the southern seabed, and Air Quality Management);
- **Alternative 6.** North Sea Combined (74,000 acres of Marine Sea in the northern, western, and southern seabed; 29,000 acres of Saline Habitat Complex cells in the southern seabed; and Air Quality Management);
- **Alternative 7.** Combined North and South Lakes (104,000 acres of Marine Sea in the northern, western, and southern seabed; 12,000 acres of Saline Habitat Complex cells in the eastern seabed; water treatment of inflows and water withdrawn from the eastern portion of the northern Marine Sea; and use of Brine Stabilization for Air Quality Management at lower elevations); and
- **Alternative 8.** South Sea Combined (83,000 acres of Marine Sea primarily in the southern seabed with a smaller Marine Sea in the western and northern seabed, 18,000 acres of Saline Habitat Complex in the southern seabed, and Air Quality Management).

1.1.2. Methodology to Recommend the Preferred Alternative

In accordance with restoration legislation, the Secretary for Resources was to recommend a Preferred Alternative for restoration of the Salton Sea ecosystem to the California Legislature. The Preferred Alternative, shown in Figure 1, was developed based upon input from the Salton Sea Advisory Committee, broad public input, and the results of technical evaluations. The methodology and the results of each of these processes are described below.

1.1.3. Preferred Alternative

Eight alternatives were evaluated in the Draft PEIR. The Preferred Alternative (Figure 1) closely resembles Alternative 5 but takes aspects from many of the other alternatives evaluated. The Preferred Alternative, shown in Figure 1, includes Saline Habitat Complex in the northern and southern seabed, a Marine Sea that extends around the northern shoreline from San Felipe Creek to Bombay Beach in a “horseshoe” shape, Air Quality Management facilities to reduce particulate emissions from the exposed playa, brine sink for discharge of salts, Sedimentation/Distribution facilities, and Early Start Habitat to provide habitat prior to construction of the habitat components. The Preferred Alternative also could be configured to accommodate future geothermal development. These components are described below.

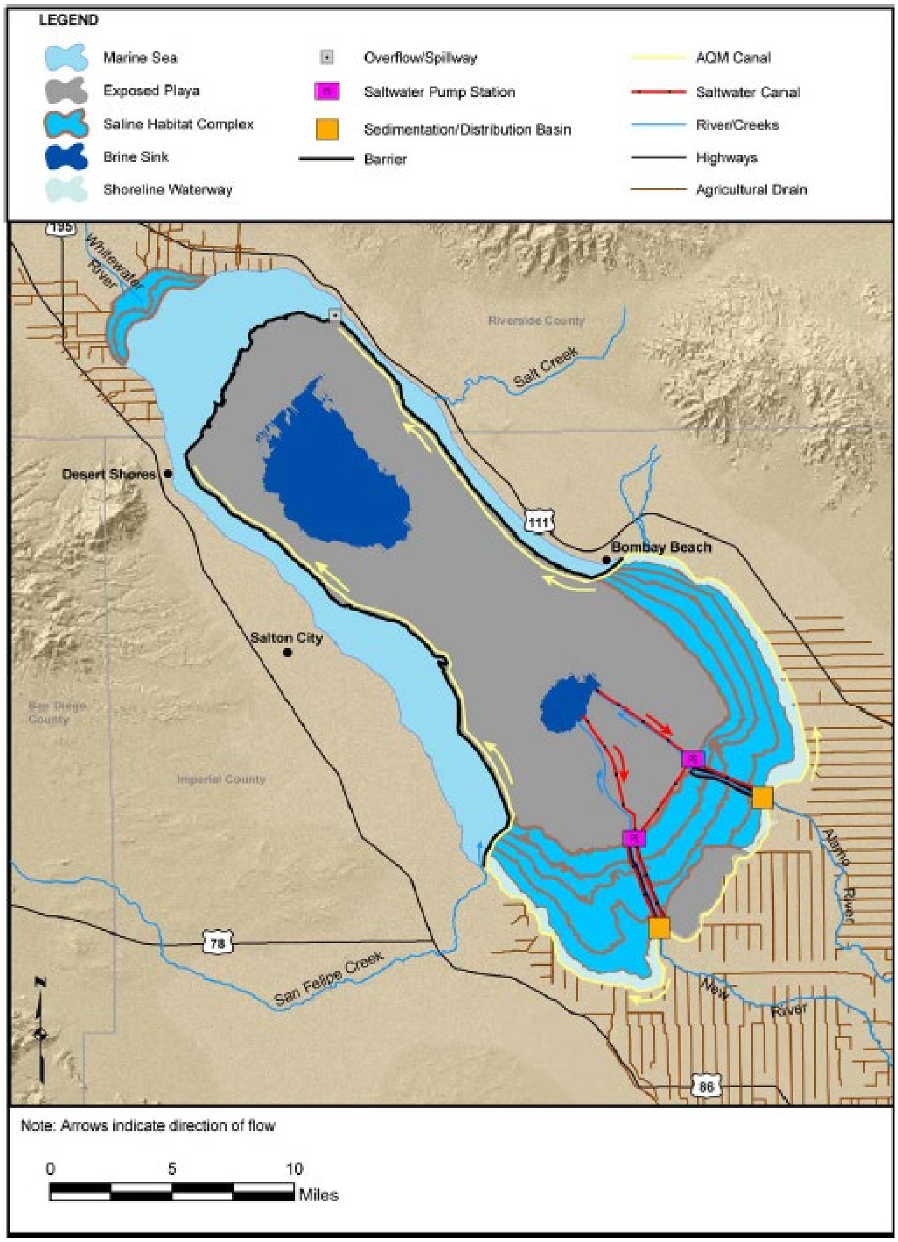


Figure 1. Preferred Alternative Layout

Saline Habitat Complex (SHC)

The Saline Habitat Complex (Figure 2) would border parts of the Marine Sea and the exposed playa to support indigenous food webs present in the area. Excavated areas of up to 15 feet in depth would be incorporated to increase habitat diversity and provide shelter for fish and invertebrates, as shown in Figure 2. To reduce vegetation growth, selenium ecorisk, and vector populations, the salinity in the complex will range from 20 PPT to 200 PPT. Supplied water would come from the New, Alamo and Whitewater rivers plus water recycled from the brine sink or upgradient Saline Habitat Complex cells to achieve a minimum salinity of 20 PPT. The first rows of the eastern and western southern Saline Habitat Complex would serve as a mixing zone for the inflows and saline water and would be maintained at a salinity of 20,000 to 30 PPT. Berms would be constructed of suitable earthfill materials excavated from the seabed with 3:1 side slopes. A 20-foot wide gravel road on top of each Berm would allow access for maintenance. Rock slope protection would be placed on the water side of the Berm. Water depths would be less than 6 feet (2 meters). Berms could not be constructed until the brine sink (residual Salton Sea) recedes to an elevation below the Berm location.

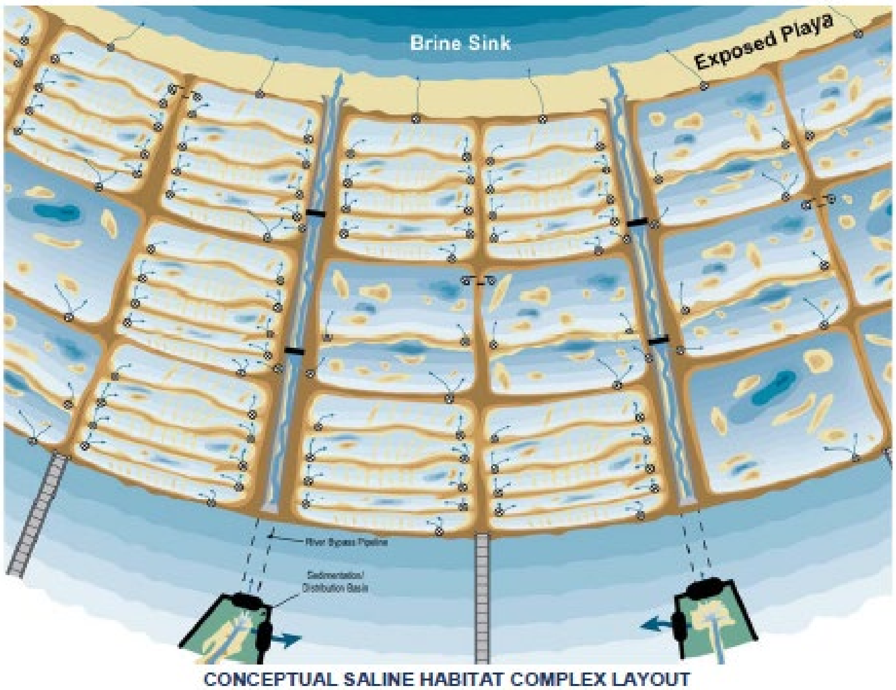


Figure 2. Conceptual Saline Habitat Complex Layout

Marine Sea

A Marine Sea would be formed through the construction of a Barrier. The Marine Sea would stabilize at a surface water elevation of -230 feet msl with salinity levels between 30 PPT and 40 PPT. Air quality Management Canals, Sedimentation/Distribution Basins, and Early Start Habitat would be constructed between the -228 and -230 foot msl contours and would avoid conflicts with existing land uses along the shoreline. Sources of inflows would include the Whitewater River, Coachella Valley drains, Salt Creek, San Felipe Creek, and local drainages. Flows from the New and Alamo rivers would be blended in a large Air Quality Management Canal and diverted into the Saline Habitat Complex and the southeastern and southwestern portions of Marine Sea. The portion of the Air Quality Management Canal located between the Sedimentation/ Distribution Basins and Marine Sea would be located along the shoreline of the Saline Habitat Complex and would be siphoned under major drainages and agricultural drains. Air Quality Management Canals would continue on the interior side of the Barrier where the Marine Sea is located. Flows from the Marine Sea would be spilled to the brine sink to maintain salinity and elevation control.

The water depth would be less than 12 meters (39 feet), but additional data should be collected, and the maximum water depth should be re-evaluated prior to final design in project-level analysis. The barrier would be constructed of rock with a seepage barrier on the upstream base.

The Barrier would be up to 47 feet above the existing seabed and up to a half-mile wide at the base. The final slope of the Barrier would be 10:1 on the Marine side and 15:1 on the down gradient side, and it would need to comply with DWR, Division of Safety of Dams regulations. The barrier would be constructed using barges and would need to be constructed before the brine sink recedes. Efficient methods of construction are still in need of evaluation.

Sedimentation/Distribution Basins

Inflows from the New and Alamo rivers would be captured in two 200-acre Sedimentation/ Distribution Basins to divert desilted river water into one of Several Air Quality Management Canals or bypass flows into the brine sink. The unlined Sedimentation/Distribution Basins would be excavated along the shoreline and would be located from -228 to -230 feet msl. Water depths would be about 6 feet. Sediment collected in the basins would be periodically dredged and flushed into the brine sink.

Air Quality Management

For the purposes of the PEIR and the Preferred Alternative, the following assumptions were used to define Air Quality Management components:

- 30 percent of the total exposed playa would be non-emissive and require no actions;
- 20 percent of the exposed playa would use management options that do not require freshwater supplies, such as Brine Stabilization, sand fences, or chemical stabilizers; and
- 50 percent of the exposed playa would use water efficient vegetation that is irrigated with a portion of the inflows to the Salton Sea.

To control dust emission, Air Quality Management Canals could be used to convey water from the Sedimentation/Distribution Basins to a series of 2-square mile units on the exposed playa that would include water filtration and chemical treatment units. The drip irrigators would be buried to reduce potential for selenium toxicity to wildlife from the ponded water, and facilities would be included in each unit to increase the salinity of the water to 10 PPT, if needed. Drains would be constructed under the irrigated area and drainage water would be conveyed to the brine sink. Construction of the irrigation system would require excavations up to 8 feet deep for trenches throughout the exposed playa. Salt bush, or similar vegetation, would be planted every 5 feet apart in rows that would be separated by 10 feet.

Brine Sink

The brine sink would provide the repository necessary to store excess salts, water discharged from the Saline Habitat Complex, Marine Sea, and Air Quality Management areas, and excess inflows. The elevation would fluctuate seasonally based upon the patterns of these tributary flows. During project-level analyses, partitioning of the brine sink could be considered to provide another area with salinities of less than 200 PPT that could support invertebrates and provide additional habitat on the seabed.

Early Start Habitat

The Early Start Habitat would include 2,000 acres of shallow saline habitat for birds. The habitat was assumed to be located at elevations between -228 and -232 feet msl and could either be a permanent or temporary feature to be eliminated or assimilated as other components are constructed. The Early Start Habitat area would be located along the southern shoreline because the flat slope of the seabed would provide a stable source of inflows into the habitat. Saline water from the Salton Sea would be pumped into the cells to be mixed with freshwater from the drains to provide salinity between 20 and 60 PPT.

The area would be divided into cells with Berms excavated from seabed materials. Average water depths within each cell would be less than four feet, although deep holes located away from the Berms may extend to 15-foot depths. Specific design and testing criteria would be developed in a project-level analysis.

Land Ownership Assumptions

The Preferred Alternative assumes that easements or deeds would be obtained for the entire seabed below elevation -228 feet msl to allow construction and operations and maintenance activities. If other land uses extend into the seabed, the Preferred Alternative would need to be modified in project-level analyses. For example, if exposed lands were to be converted to cultivated agriculture to an elevation of -235 feet msl, either the components would need to be constructed at lower elevations or displacement dikes would be required to protect the agricultural land.

Implementing Entities Assumptions

The Preferred Alternative was defined and evaluated as if one entity or group of entities implemented the program in a uniform manner. However, the State acknowledged that it would be possible for several entities to implement facilities under separate programs with some level of coordination. For example, facilities located in the northern and southern area of the seabed could be implemented by separate entities with coordinated operations for conveyance of inflows. As another example, separate entities could implement components with different functions, such as conveyance, Air Quality Management, Marine Seas, and/or Saline Habitat Complex.

Construction Materials Assumptions

For the purposes of the PEIR, development of new rock sources or transportation facilities are not considered part of the Preferred Alternative. For stabilizing components of the Barrier Design rocks or boulders between 1 to 5 feet in diameter are ideal. This rock size was not found to be available in large quantities at existing quarries during the preparation of this PEIR. However, the Preferred Alternative assumption is that this rock would be provided from a permitted quarry and transported to within 10 miles of the shoreline by methods other than trucks. Gravel would also be necessary for the road needed on top of the berms and barriers.

1.1.4. No Action Alternative

CEQA requires the evaluation of a "no project" alternative (Figure 3) to allow comparison of impacts of the restoration alternatives with those of not implementing any project. The No Action Alternative, which is the term used in this document for the no project alternative, reflects existing conditions plus changes that are reasonably expected to occur in the foreseeable future if the restoration is not implemented. The description of the No Action Alternative includes two different assumptions regarding inflow patterns over the 75-year study period and construction of QSA related facilities in the seabed.

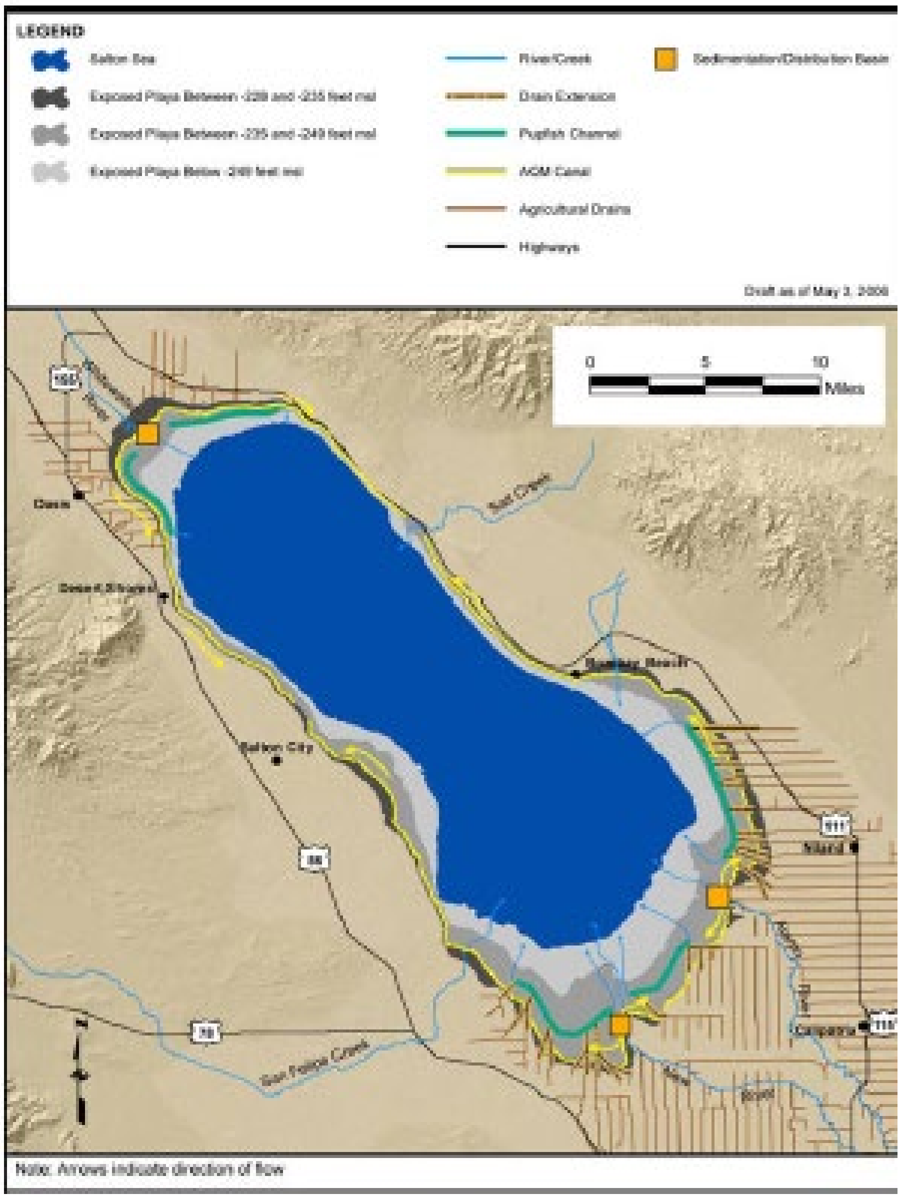


Figure 3. No Action Alternative

Definition of Inflows for the No Action Alternative

It is difficult to predict changes in inflows over a 75-year period due to the influences of many future actions that cannot at present be accurately predicted. Therefore, two inflow scenarios were developed for the No Action Alternative in the PEIR.

One scenario is based upon future actions that have been previously defined in environmental documentation, including QSA implementation, reductions in flows from Mexico (due to new wastewater management facilities in Mexicali), and groundwater management in the Coachella Valley. This scenario, referred to as the No Action Alternative-CEQA Conditions, was developed in accordance with the CEQA Guidelines requirement for a no project alternative. The average inflows assumed for the No Action Alternative-CEQA Conditions from 2018 to 2078 would be 922,000 acre-feet/year (as compared to the existing conditions value of 1,300,000 acre-feet/year).

The second scenario is based upon implementation of actions under the No Action Alternative-CEQA Conditions and a conservative projection of changes in inflows due to potential changes in agricultural practices, further reductions in inflows from Mexico, and delayed implementation of groundwater management in the Coachella Valley. The No Action Alternative-CEQA Conditions may not accurately reflect future conditions over the 75-year study period. Therefore, this second scenario, referred to as the No Action Alternative-Variability Conditions, was developed to reflect these future uncertainties, and includes consideration of a wider range of projects and plans potentially developed by others that would affect inflows to the Salton Sea. Future variability is important to consider because it would be difficult to modify facilities should conditions change in the future. Under this scenario, the average inflows from 2018 to 2078 would be 717,000 acre-feet/year. For the purposes of comparison, this more conservative inflow scenario was used to develop Alternatives 1 through 8.

Facilities to be Constructed under the No Action Alternative

The No Action Alternative in the PEIR includes numerous actions and facilities to be constructed in accordance with implementation of the QSA. Most of these actions and facilities would not be located within the seabed and would be considered to occur in all alternatives. However, several of the QSA provisions require actions or construction of components within the seabed that could be modified substantially through implementation of the following PEIR alternatives:

- **Air Quality Management.** Mitigation of particulate emissions from the exposed playa between -235 and -248 feet msl; and
- **Pupfish Connectivity.** Construction of five pupfish channels on the seabed.

These measures would be part of the mitigation for the Imperial Irrigation District (IID) Water Conservation and Transfer Program, and costs would be jointly funded by IID, SDCWA, and CVWD up to a maximum amount of $133,000,000 (in 2003 dollars). Costs in excess of this amount would be the responsibility of the State, as determined in the QSA. These measures would be modified in each of the alternatives. Estimated costs for implementing these measures and impacts from construction and operations and maintenance are presented in the PEIR for comparative purposes. Facilities and costs would be identical for No Action Alternative-CEQA Conditions and No Action Alternative-Variability Conditions.

1.1.5. Alternative 1 Saline Habitat Complex

Alternative 1 (Figure 4) would provide Saline Habitat Complex in the southern seabed. Additional features include the brine sink, desert pupfish connectivity, and air quality management components.

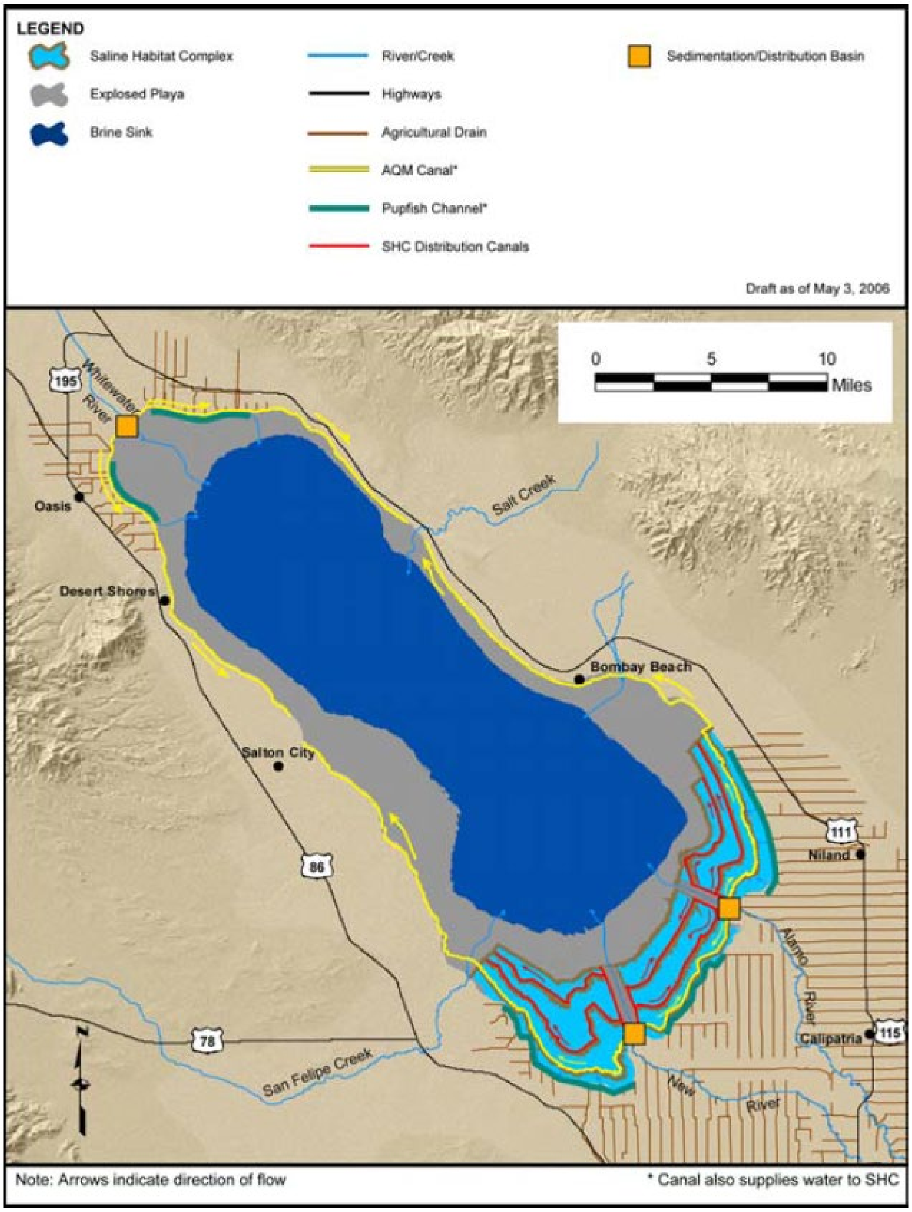


Figure 4. Alternative 1, Saline Habitat Complex 1

Pupfish channels would be constructed along the shoreline. However, because these channels would not be connected to each other, five different populations of desert pupfish would be created. San Felipe and Salt creeks would not be connected to other areas and would flow into the brine sink.

Air quality management actions would include stabilization with brine and irrigation of water efficient vegetation in emissive areas.

The primary benefit of this alternative would be to provide habitat that would support tilapia, invertebrates, and a wide variety of birds. Water along the southern shoreline would minimize changes to the effects of the proximity of a large water body on the local climate (microclimate) and aesthetic values in the agricultural lands. Alternative 1 could also provide opportunities for fishing, use of non-motorized boats, bird watching, hiking, hunting, and day use activities.

1.1.6. Alternative 2 Saline Habitat Complex 2

Alternative 2 (Figure 5) would be similar to Alternative 1, but with more areas of Saline Habitat Complex. Alternative 2 would include Saline Habitat Complex in both the southern and northern portions of the seabed. This alternative would also include brine sink, desert pupfish connectivity, and air quality management components.

Desert pupfish connectivity would occur in the northern and southern shoreline waterways. However, five different populations of desert pupfish would be created since the shoreline waterways are divided by the Whitewater River in the north and the Alamo and New rivers in the south. San Felipe Creek would be connected to the shoreline waterway during low flow but would flow into the brine sink at high flows. Salt Creek would not be connected to other areas.

Air quality management actions would include stabilization with brine and irrigation of water efficient vegetation in emissive areas.

The primary benefit of this alternative would be to provide habitat that would support tilapia, invertebrates, and a wide variety of birds. Water along the southern, western, and northern shorelines would minimize changes to the microclimate and aesthetic values in these areas. Alternative 2 could also provide opportunities for fishing, use of non-motorized boats, bird watching, hiking, hunting, and day use activities.

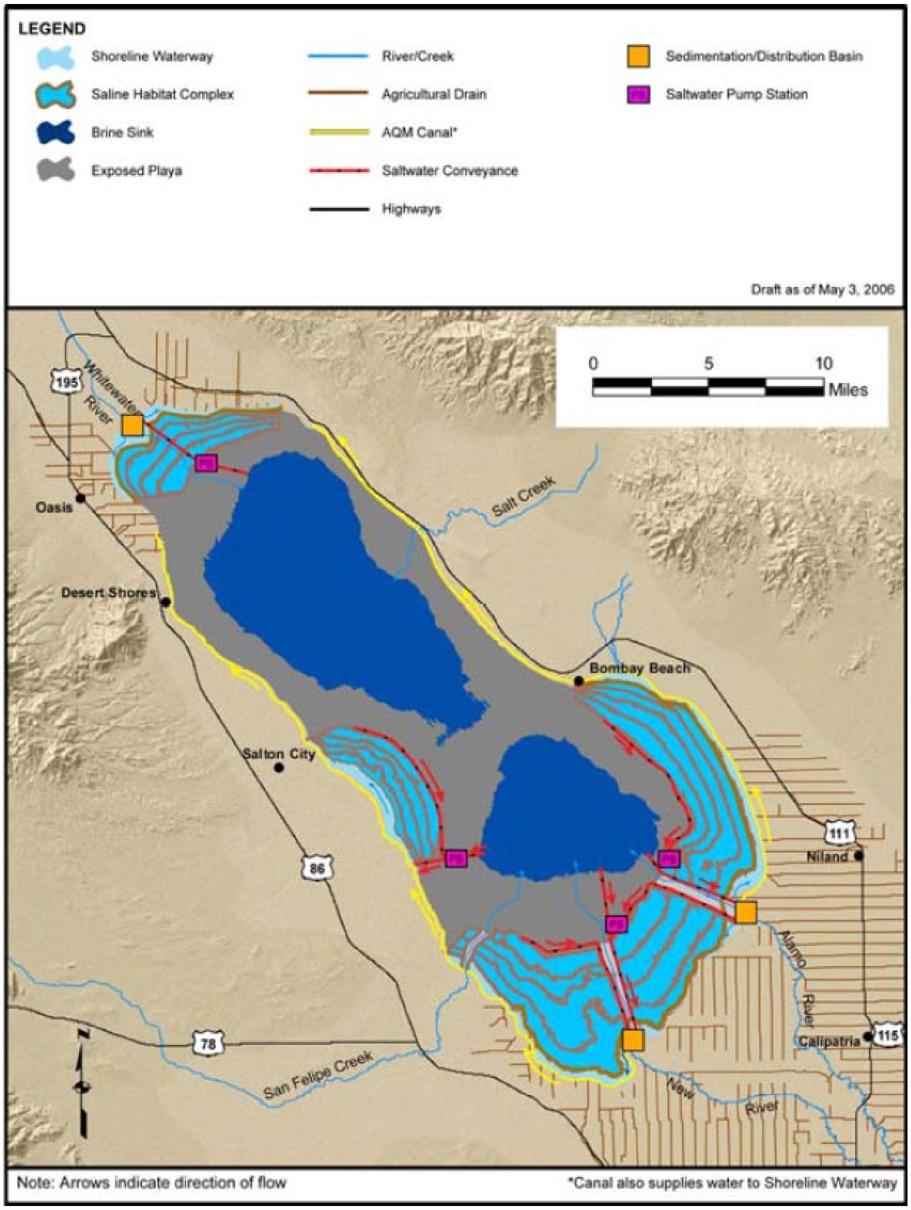


Figure 5. Alternative 2 Saline Habitat Complex 2

1.1.7. Alternative 3 Concentric Rings

Alternative 3 (Figure 6) would include Concentric Rings that would provide moderately deep Marine Seas. The alternative also includes brine sink, desert pupfish connectivity, and air quality management components. All desert pupfish populations would be connected in the First Ring.

Air quality management actions would include stabilization with brine and irrigation of water efficient vegetation in emissive areas.

The primary benefit of this alternative would be to provide habitat that would support marine sport fish as well as tilapia, invertebrates, and a wide variety of birds. This alternative would also provide habitat and water along all of the shoreline and connect all desert pupfish populations.

Water along the shoreline would minimize changes to the microclimate and aesthetic values. Alternative 3 could also provide opportunities for fishing, use of motorized and non-motorized boats, water skiing, bird watching, hiking, hunting, swimming, camping, and day use activities.

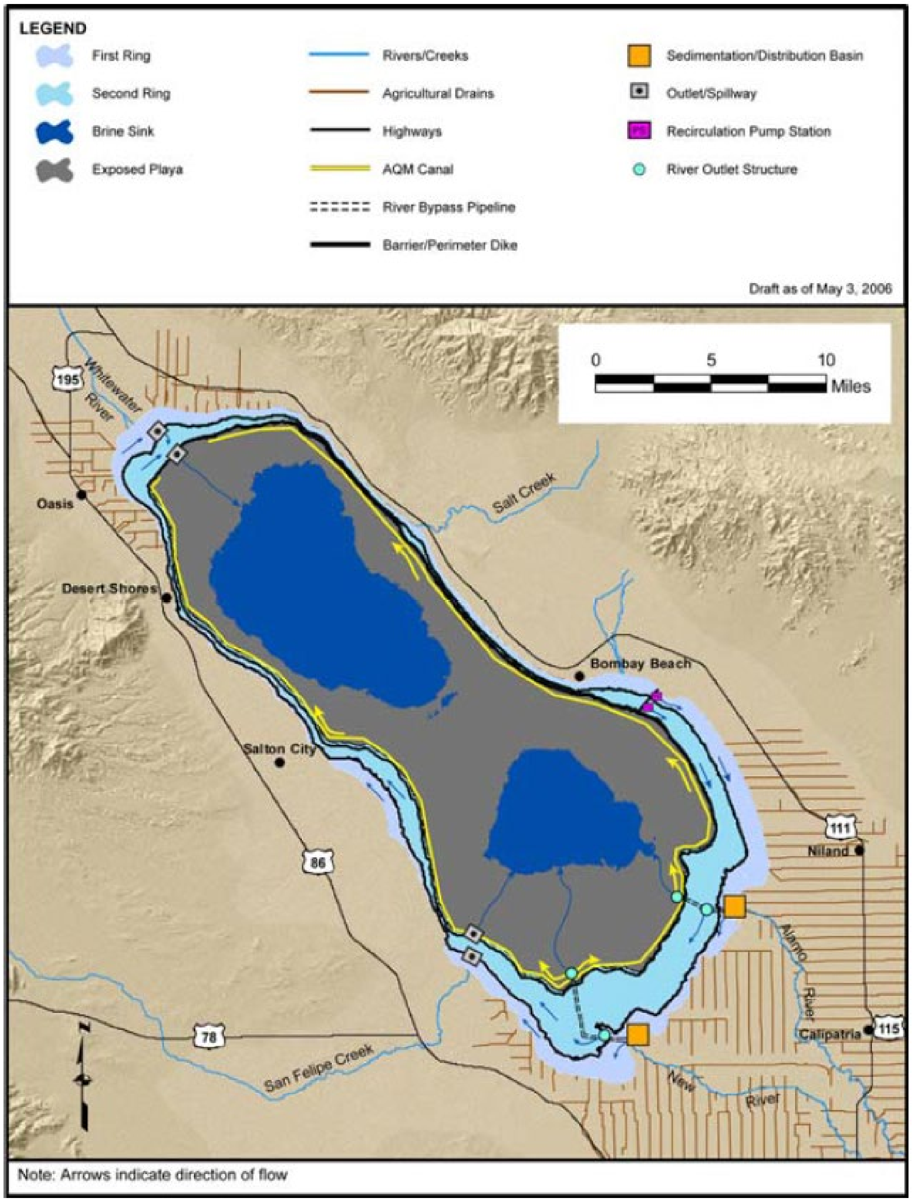


Figure 6. Alternative 3 Concentric Rings

1.1.8. Alternative 4 Concentric Lakes

Alternative 4 (Figure 7) was defined by the Imperial Group, which is a coalition of Imperial Valley farmers. This alternative is comprised of four separate lakes that provide habitat like the Saline Habitat Complex without individual cells, with design salinity of 20 to 60 PPT. The alternative includes brine sink, desert pupfish connectivity, and air quality management components. The First Lake would provide desert pupfish connectivity for all of the direct drains, San Felipe Creek, and other tributary waters along the southern shoreline. The Second Lake would connect all the northern drains and Salt Creek.

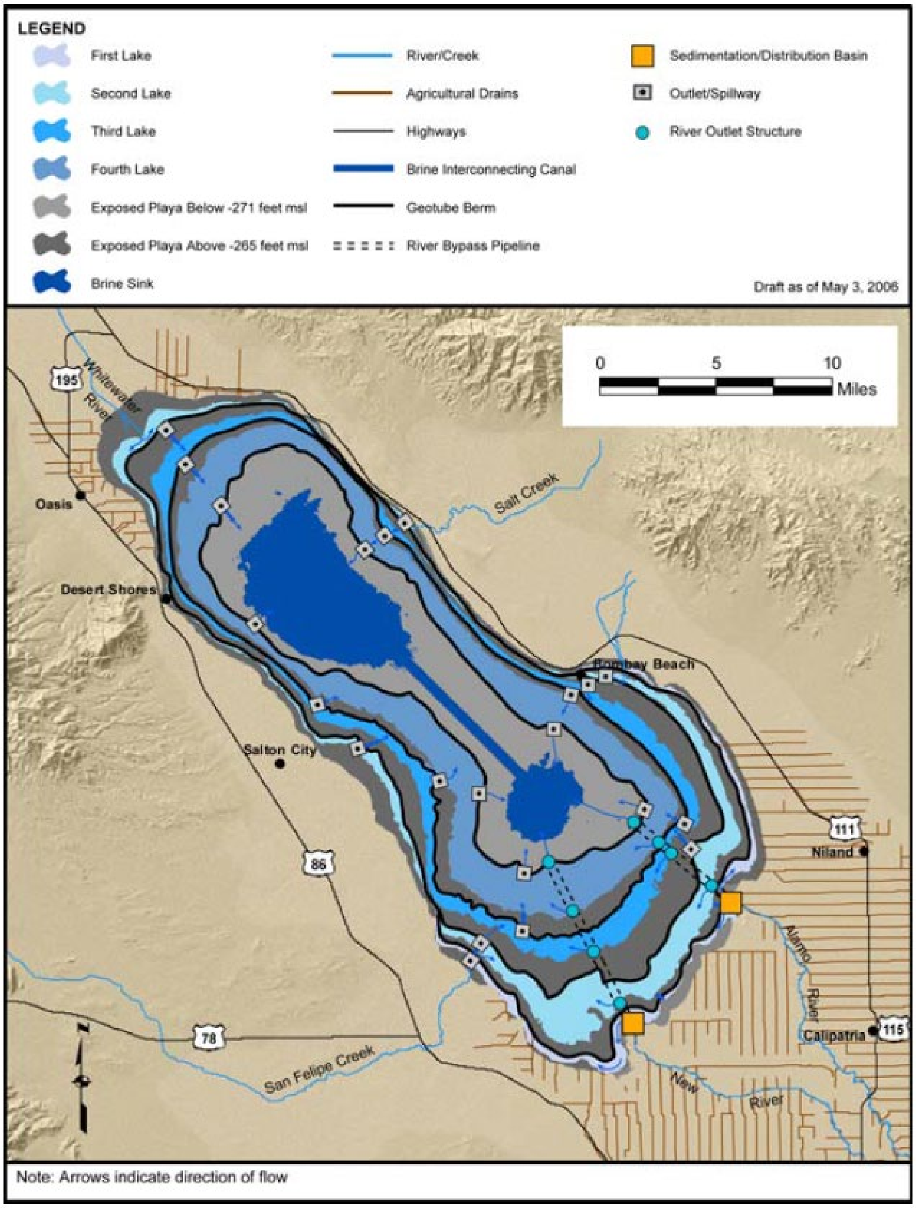


Figure 7. Alternative 4 Concentric Lakes

This alternative includes irrigation water supply. However, based upon the information provided by the Imperial Group, no long-term irrigation facilities were included. Therefore, long-term air quality management is not included in this alternative.

The lakes would be formed by berms using a different method than those employed in the other alternatives. Alternative 4 would use Geotube® berms which deploy geo-membrane tubes filled with dredged material from the seabed. The berms would primarily be constructed using barges.

The primary benefit of this alternative would be to provide habitat that would support tilapia, invertebrates, and a wide variety of birds. Water along the southern shoreline would minimize changes to the microclimate in the agricultural lands. Water would not be located, however, along the current western or northern shorelines. Alternative 4 could also provide opportunities for fishing, use of motorized and non-motorized boats, water skiing, bird watching, hiking, hunting, swimming, camping, and day use activities.

1.1.9. Alternative 5 North Sea

Alternative 5 (Figure 8) would include a deep Marine Sea at the north side of the seabed. Other features include Saline Habitat Complex in the south, brine sink, desert pupfish connectivity, and air quality management components.

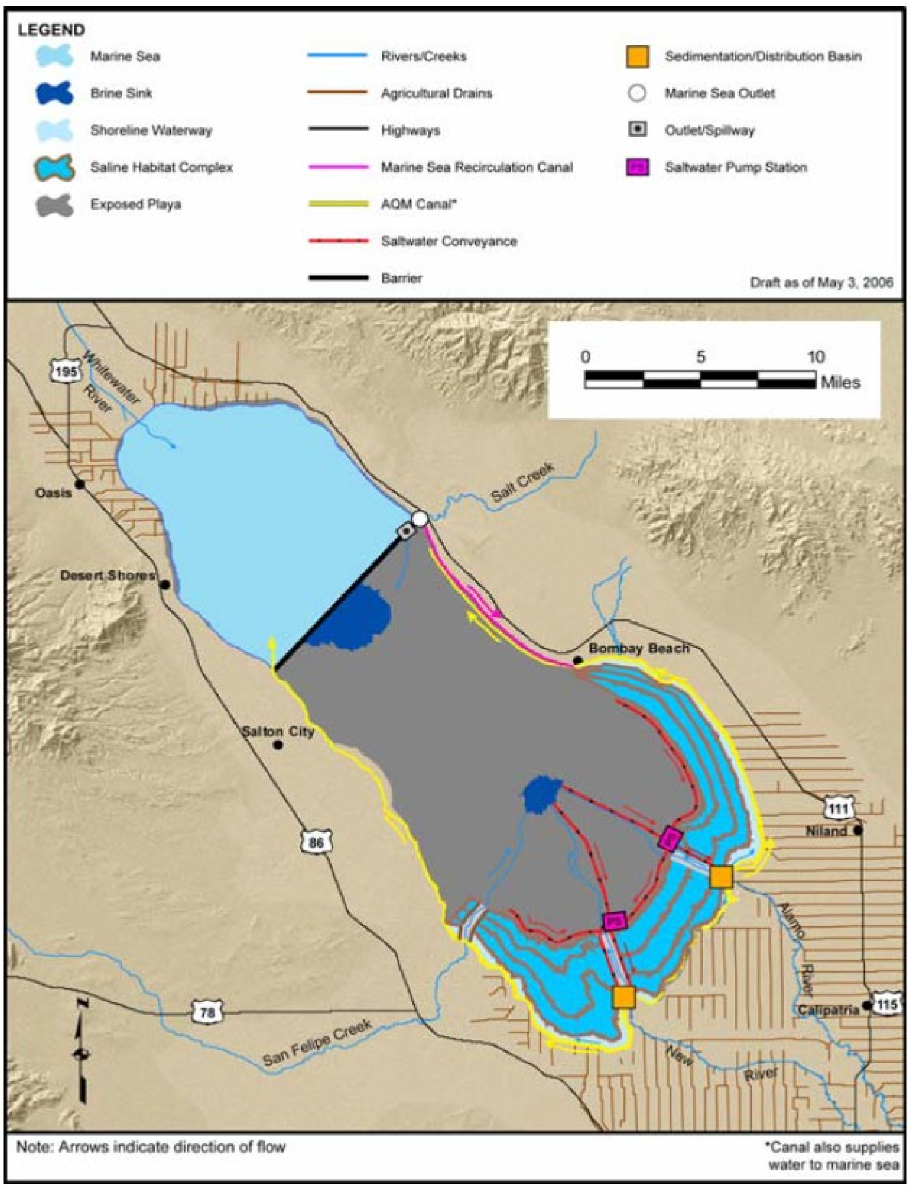


Figure 8. Alternative 5 North Sea

Three separate areas containing desert pupfish would occur along the southern shoreline in the shoreline waterway, including one area that would connect San Felipe Creek, which would flow to the brine sink during high flows. The Marine Sea would connect all of the northern drains and Salt Creek.

Air quality management actions would include stabilization with brine and irrigation of water efficient vegetation in emissive areas.

The primary benefit of this alternative would be to provide habitat that would support marine sport fish as well as tilapia, invertebrates, and a wide variety of birds. Water along the southern shoreline would minimize changes to the microclimate in the agricultural lands. This alternative also would provide habitat and water along the northern shoreline. Alternative 5 could also provide opportunities for fishing, use of motorized and non-motorized boats, water skiing, bird watching, hiking, hunting, swimming, camping, and day use activities.

1.1.10. Alternative 6 North Sea Combined

Alternative 6 (Figure 9) would include a deep Marine Sea in the north combined with a moderately deep Marine Sea in the south, connected along the western shoreline. Saline Habitat Complex would be developed in the southern seabed. The alternative includes brine sink, desert pupfish connectivity, and air quality management components.

Desert pupfish in the drains along the southern shoreline and San Felipe Creek would be connected by the Marine Sea Mixing Zone. A pupfish channel would connect drains that are north of the Alamo River. All of the northern drains and Salt Creek would be connected by the Marine Sea.

1.1.11. Alternative 7 Combined North and South Lakes

Alternative 7 (Figure 10) was developed by the Salton Sea Authority and would include a deep Marine Sea (i.e., Recreational Saltwater Lake) in the north combined with a moderately deep Marine Sea (i.e., Recreational Estuary Lake) in the south. Saline Habitat Complex would be developed along the southeastern shoreline. Other features include brine sink, desert pupfish connectivity, air quality management components, and an 11,000-acre freshwater reservoir to be operated by IID.

Desert pupfish in drains along the northern and southern shorelines and San Felipe and Salt creeks would be connected by the Saltwater and Estuary lakes. The drains along the southeastern shoreline would not be connected.

Air quality management actions would include creation of a protective salt crust using salt crystallizer ponds.

The primary benefits of this alternative would be similar to those of Alternative 6. The main difference between Alternative 6 and 7 is the location of the barrier. Alternative 7 includes a barrier that would form a larger Marine Sea if average inflows from 2018 to 2078 were 800,000 acre-feet/ year. However, to provide a uniform basis of comparison, this alternative also was evaluated assuming an average inflow of 717,000 acre-feet/year. Under the lower flows, the surface area would be smaller, and the salinity would be higher than projected in the definition of this alternative. Alternative 7 could also provide opportunities for fishing, use of motorized and non-motorized boats, water skiing, bird watching, hiking, hunting, swimming, camping, and day use activities.

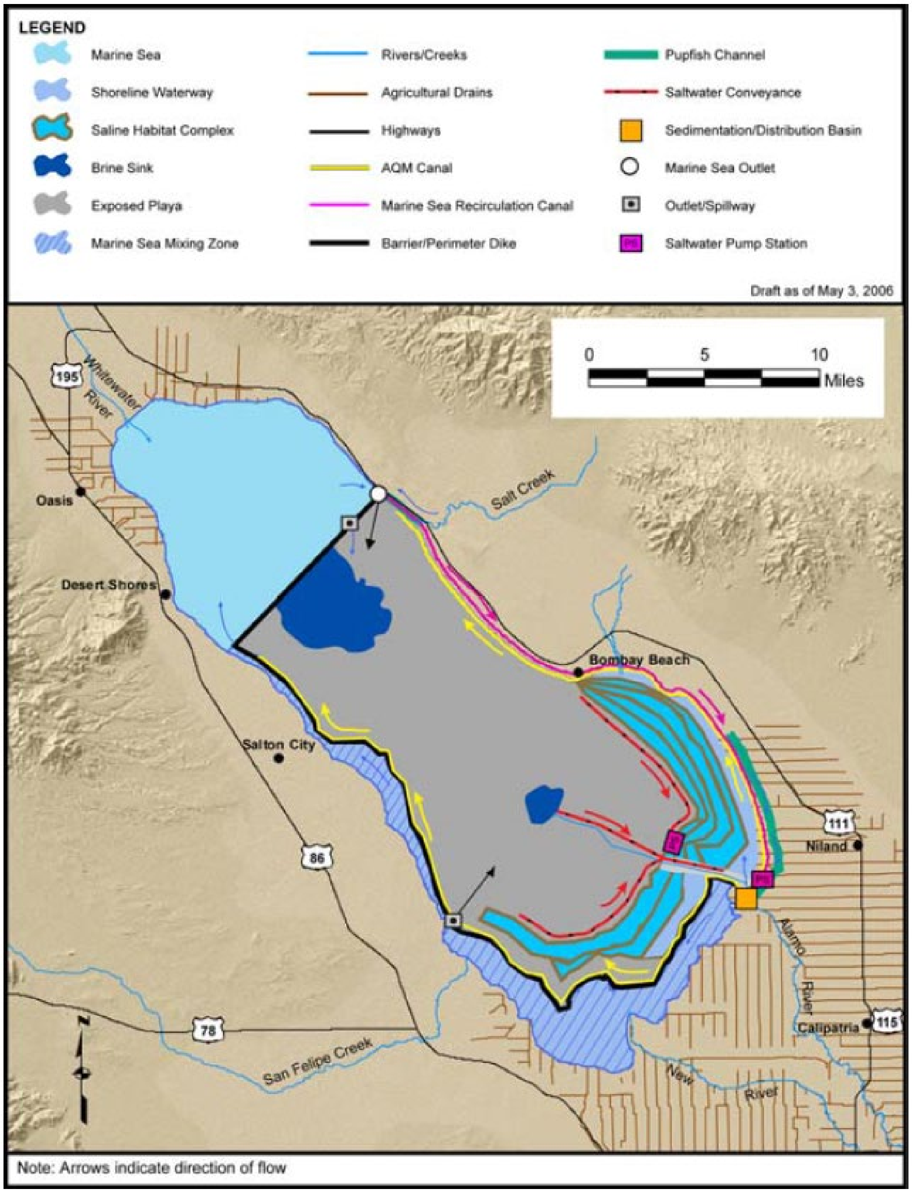


Figure 9. Alternative 6 North Sea Combined

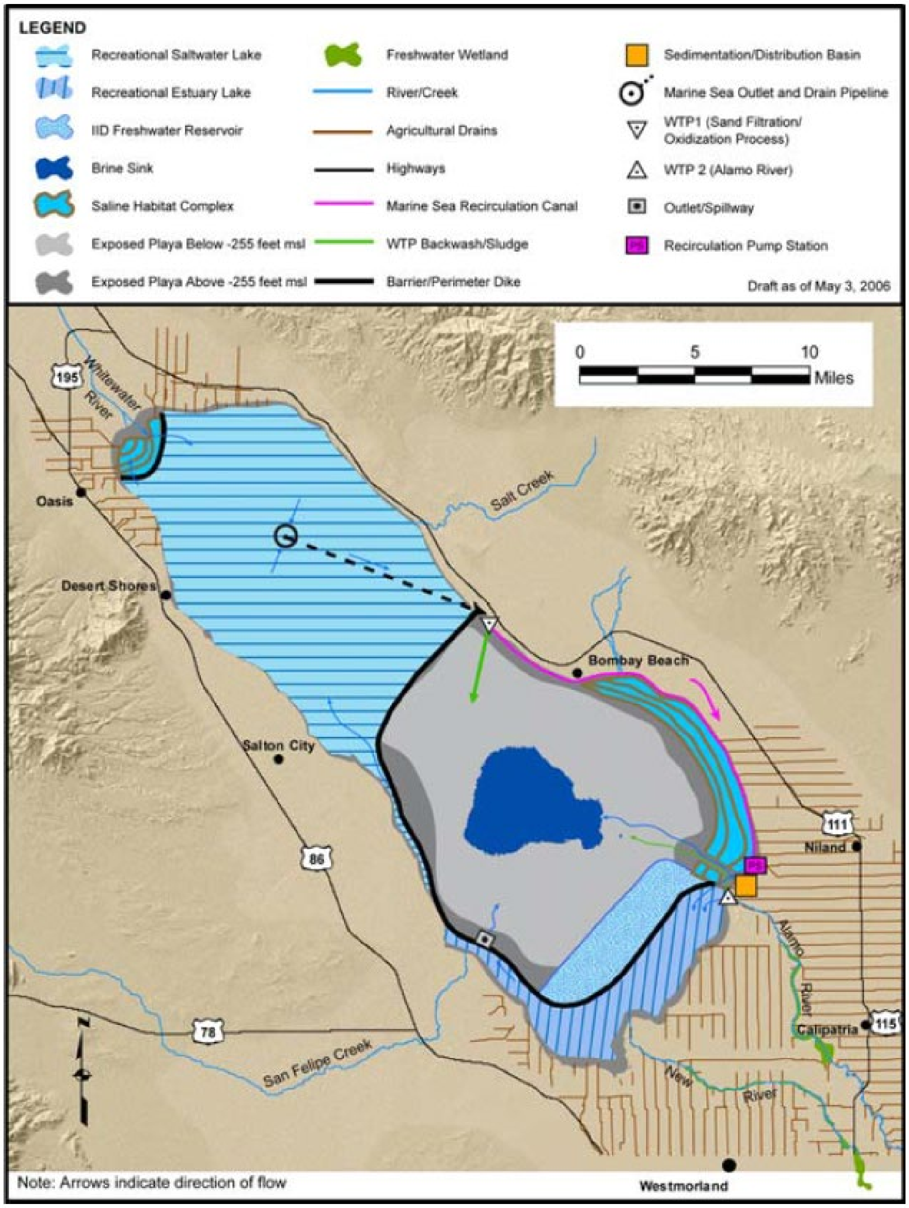


Figure 10. Alternative 7 Combined North and South Lakes

1.1.12. Alternative 8 South Sea Combined

Alternative 8 (Figure 11) would include a deep Marine Sea in the south combined with a moderately deep Marine Sea in the north, connected along the western shoreline. Saline Habitat Complex would be created along the southwestern and southeastern shorelines. The alternative includes brine sink, desert pupfish connectivity, and air quality management components.

Desert pupfish would be connected along the northern and southern shorelines which would include all of the drains and San Felipe Creek. Desert pupfish in Salt Creek would not be connected to other populations.

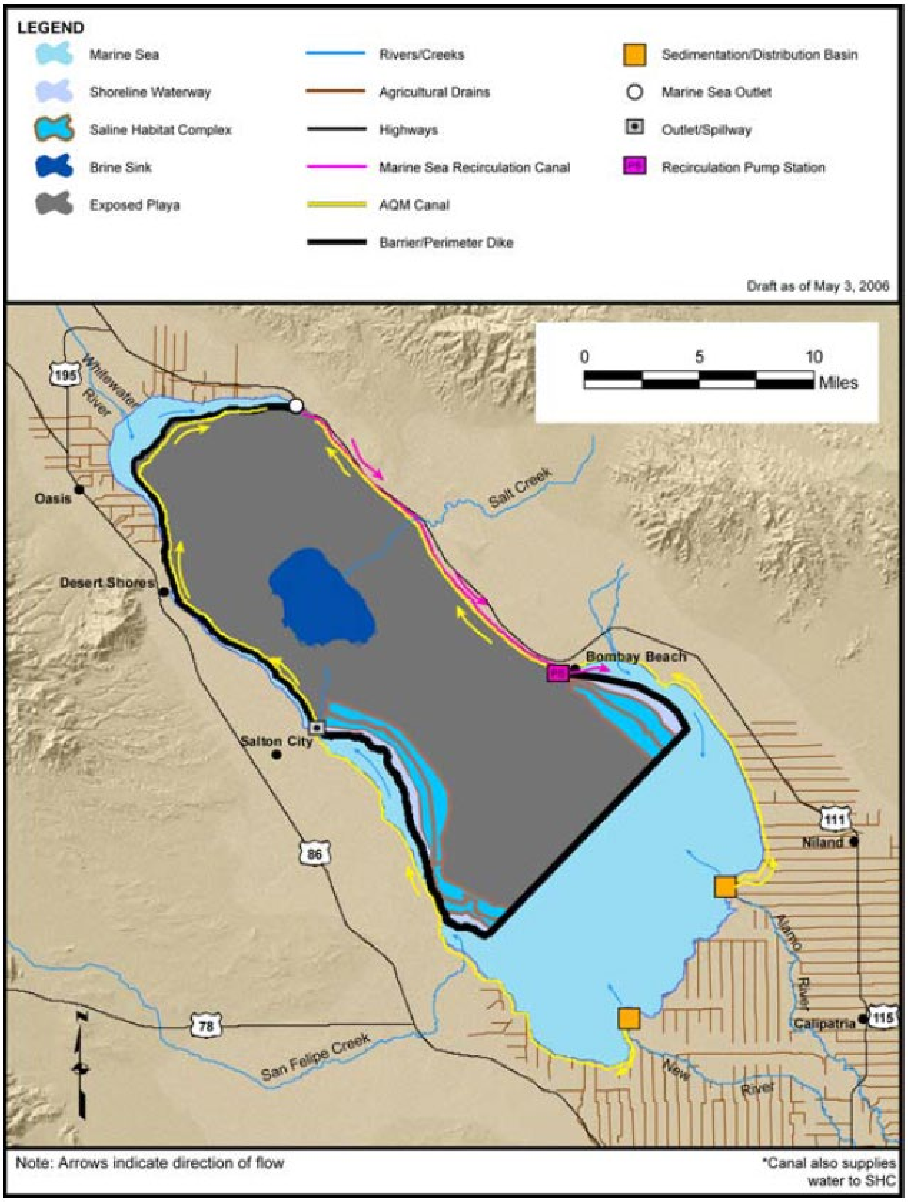
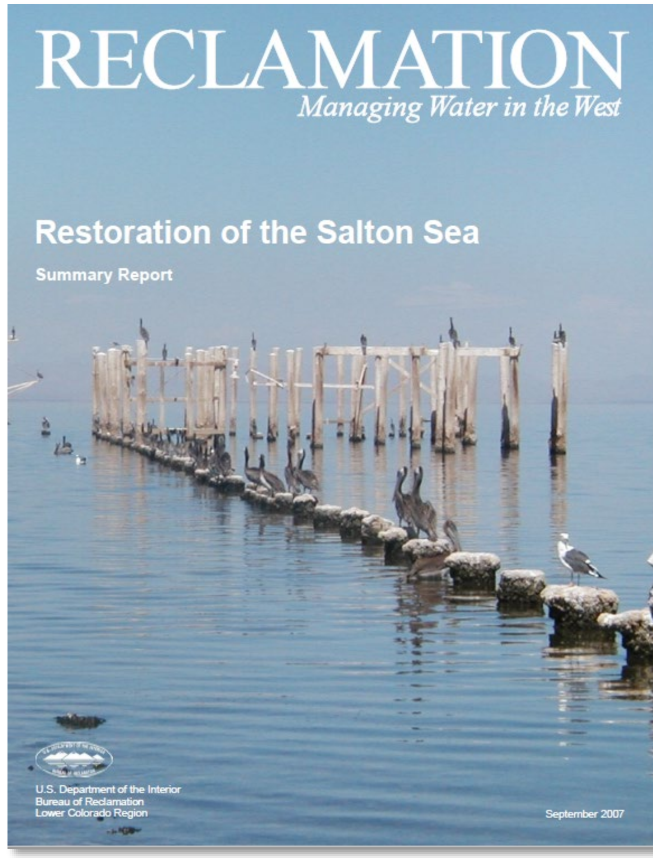


Figure 11. Alternative 8 South Sea Combined

Air quality management actions would include stabilization with brine and irrigation of water efficient vegetation in emissive areas.

The primary benefit of this alternative would be to provide habitat that would support marine sport fish as well as tilapia, invertebrates, and a wide variety of birds. A large water body along the southern shoreline would maintain the microclimate in the agricultural lands. This alternative would also provide habitat and water along the western and northern shorelines. Alternative 8 could also provide opportunities for fishing, use of motorized and non-motorized boats, water skiing, bird watching, hiking, hunting, swimming, camping, and day use activities.

1.2. US Bureau of Reclamation Summary Report: Restoration of the Salton Sea, 2007



In September 2007, the US Bureau of Reclamation (Reclamation) proposed alternatives in their *Summary Report: Restoration of the Salton Sea*. The investigation was performed in fulfillment of the requirements of Public Law (P.L.) 108-361, the Water Supply Reliability and Environmental Improvement Act, November 2004 which states the following: "Not later than December 31, 2006, the Secretary of the Interior, in coordination with the State of California and the Salton Sea Authority, shall complete a feasibility study on a preferred alternative for Salton Sea restoration."

The primary objective for Reclamation's list of alternatives was to identify methods to restore the Sea's ecosystem and provide permanent protection of the wildlife sustained by that ecosystem. Two secondary objectives of Reclamation's study were to promote human activities supported by the Sea and to manage air quality. To accomplish their objectives, Reclamation lists six different alternatives: Alternative 1 Mid-Sea Dam with North Marine Lake, Alternative 2 Mid-Sea Barrier with South Marine Lake, Alternative 3 Concentric Lakes, Alternative 4 North-Sea Dam with Marine Lake, Alternative 5 Habitat Without Marine Lake, and Alternative 6 No Project.

During Reclamation's evaluation of alternatives, a series of risks were considered: selenium risks to fish-eating birds, selenium risks to invertebrate-eating birds, hydrodynamic/stratification risks, eutrophication risks, fishery sustainability risks, and future inflow risks. Due to a "lack of data" and irresolvable issues of "hydrologic and biologic uncertainties" none of the alternative presented in the 2007 Executive Summary Report were recommended.

1.2.1. Mean Possible Future Inflows

The alternatives were assessed using computer modeling techniques. Each alternative was modeled using a statistics-based approach to inflows in which 10,000 different possible future Salton Sea inflows scenarios were simulated. The mean (or average) inflow computed from all of these possible future scenarios is described as the "Mean Possible Future Inflow Condition" and would have a value of 727,000 acre-feet per year.

1.2.2. Original Authority Alternative

The Authority's original alternative incorporated a mid-Sea dam about 1.5 miles farther south than what is presented in Figure 12. This alternative also included a smaller SHC of 12,000 acres. Cost estimates were prepared for the Authority's original alternative. These estimates provide a basis for making comparisons to cost estimates prepared by DWR and the Authority for this same original alternative. Attachment A of the *Final Summary Report* contains these cost estimates assuming that embankments would be built using rock fill embankments similar to those being proposed by the Authority (Alternative 1B). The estimate presented in Attachment A assumes the use of salt crusting (as originally proposed by the Authority) via construction of small earth embankments (2.5 feet tall) to impound brine released from the SHC. Reclamation evaluated the rockfill embankment concept and determined it would not meet Reclamation's general design criteria.

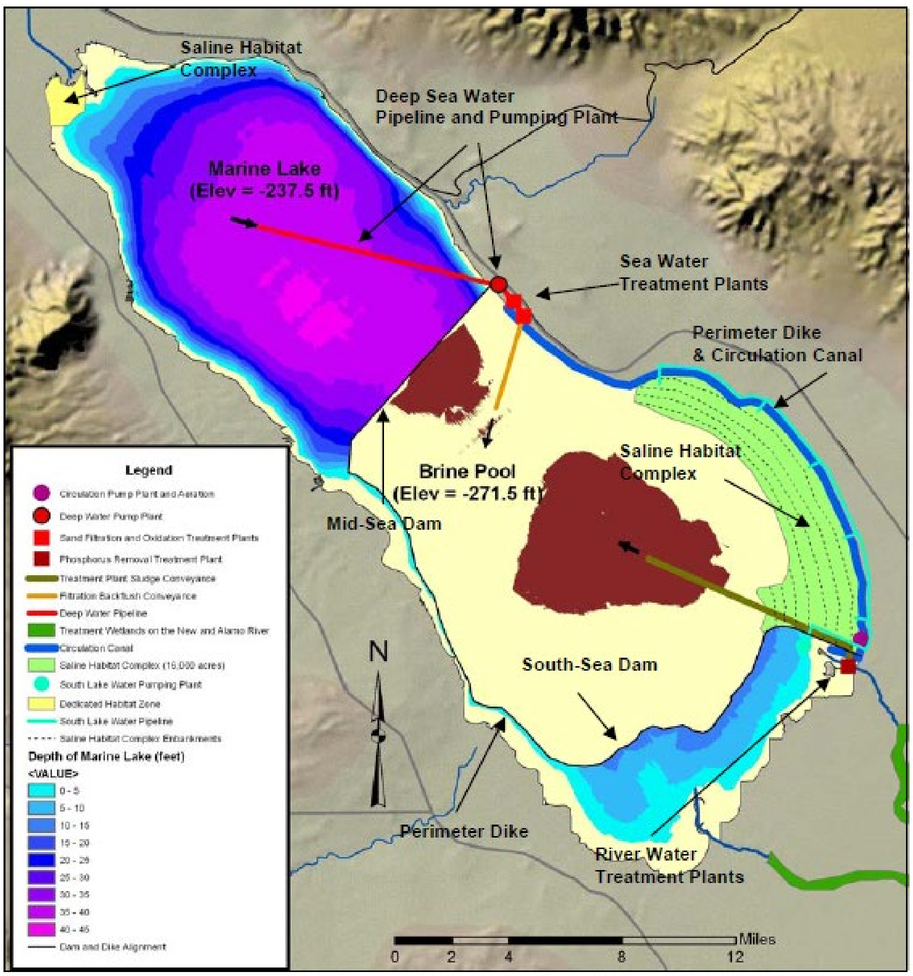


Figure 12. Alternative No. 1: Mid-Sea Dam with North Marine Lake (The Authority's Alternative)

1.2.3. Alternative No. 1: Mid-Sea Dam with North Marine Lake (The Authority's Alternative)

Alternative No. 1 would provide both salinity and elevation control and up to 16,000 acres of SHC. Further details of this alternative are presented in Table 1. As shown in Figure 12, Alternative No. 1 includes a total of four embankments: (1) an impervious mid-Sea dam, (2) an east-side perimeter dike, (3) a west-side perimeter dike, and (4) a south-Sea dam. These structures would be built using the sand dam with stone columns concept (See Figure 13). The embankments would be constructed so the water north of the mid-Sea dam would be maintained at a higher elevation than the brine pool on the south side. The area south of the mid-Sea dam would serve as an outlet for water and salt from the north and would rapidly shrink in size and increase in salinity to form a brine pool. In addition to the north marine lake, a smaller south marine lake would be created by the south-Sea dam. These two bodies of water would be connected along the western edge of the Sea by the west-side perimeter dike and along the eastern edge by the east-side perimeter dike and canal. The north marine lake would have a mean future water surface elevation of about -238 feet msl under mean possible future inflows. The estimated long-term elevation of the brine pool is about -272 feet msl. The alternative includes 16,000 acres of SHC and a dedicated habitat area on the north end of the Sea. It also includes a deep-water pipeline, an ozonation treatment plant, a water circulation system, and a phosphorous removal treatment plant. The conveyance features included in this alternative consist of a circulation canal, sludge conveyance pipeline, back-flush waste pipeline, three pumping plants, and two associated pipelines.

Table 1. Physical features of Alternative No. 1: Mid-Sea Dam with North Marine Lake

Physical Feature	Value
Marine lake surface area	98,900 acres
Marine lake maximum depth	43.5 feet
SHC surface area	16,000 acres
Total open water habitat surface area	106,900 acres
Total shoreline habitat surface area	26,600 acres
Brine pool surface area	17,600 acres
Exposed playa surface area	103,800 acres

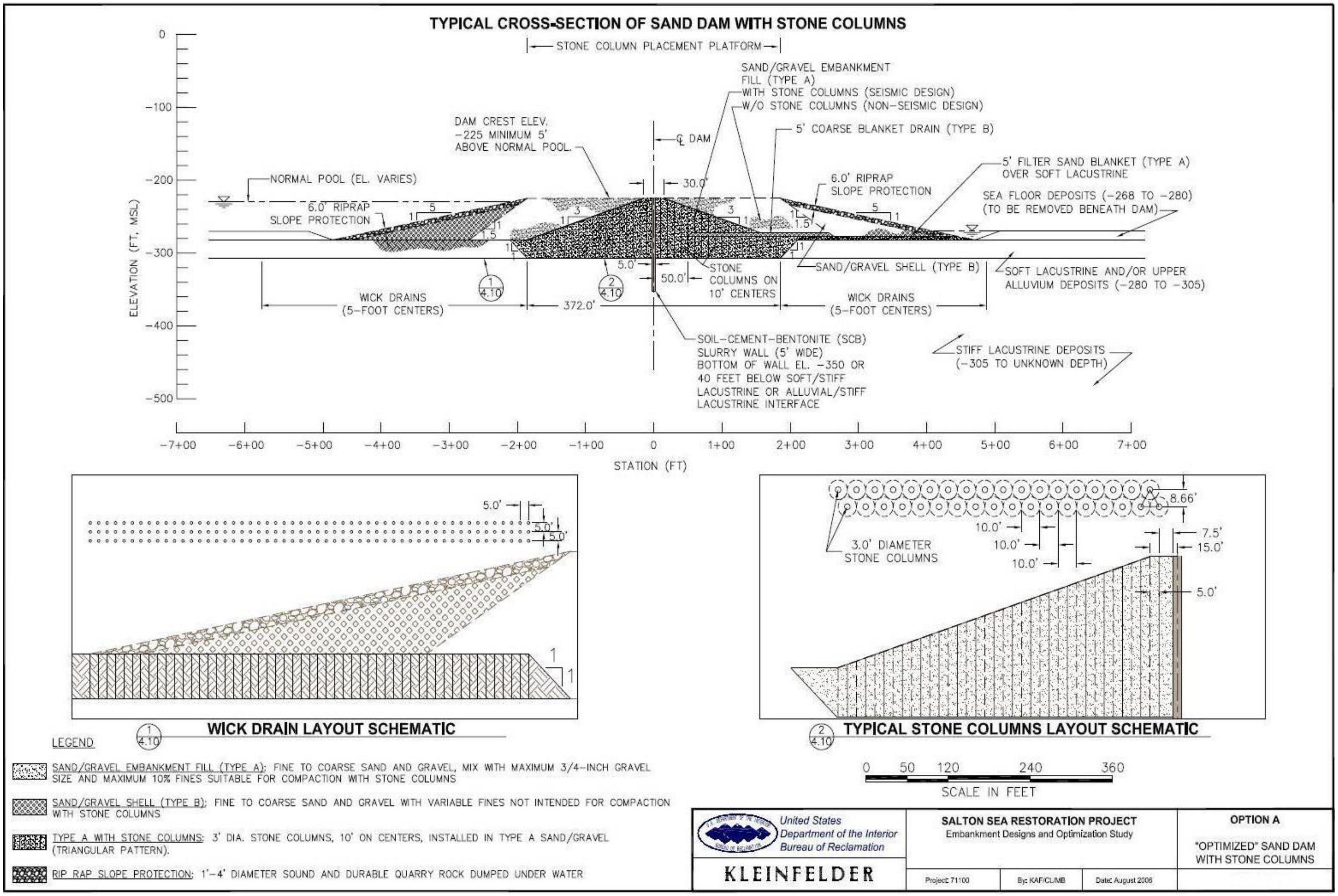


Figure 13. Typical cross-section of sand dam with stone columns

1.2.4. Alternative No. 2: Mid-Sea Barrier with South Marine Lake

Alternative No. 2 would provide salinity control but no elevation control and up to 21,700 acres of SHC (See Figure 14 and Table 2). The alternative includes a mid-Sea barrier designed to generally be operated with equal heads on both sides and to accommodate a differential head of up to 5 feet.

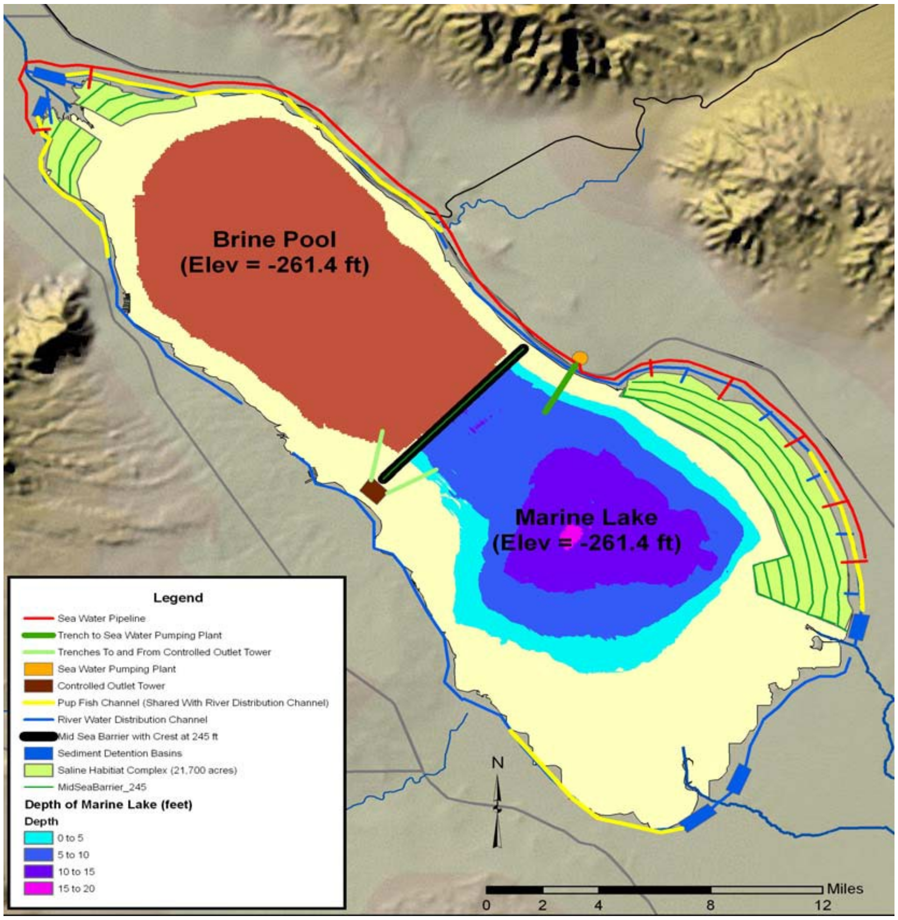


Figure 14. Alternative No. 2: Mid-Sea Barrier with South Marine Lake Under Mean Possible Inflow Conditions.

Table 2. Physical features of Alternative No. 2 Under Mean Future Conditions:
Mid-Sea Barrier with South Marine Lake.

Physical Feature	Value
Marine lake surface area	59,700 acres
Marine lake maximum depth	15.5 feet
SHC surface area	21,700 acres
Total open water habitat surface area	49,000 acres
Total shoreline habitat surface area	34,700 acres
Brine pool surface area	66,000 acres
Exposed playa surface area	73,600 acres

The water entering the Sea from the south into the south marine lake would support a large marine habitat. The estimated long-term elevation of the marine lake and brine pool under mean future conditions is -261 feet msl. Most inflows are expected to occur from the south end; therefore, the area north of the barrier embankment is expected to serve as an outlet for water and salt from the south side. The north side would quickly form a brine pool. As the main body of the Sea shrinks, embankments would be constructed to create SHC. The mid-Sea barrier would be constructed with a crest elevation of -245 feet and would accommodate the forecasted reductions in inflows. The 21,700 acres of SHC would be constructed on the southeast and north ends of the Salton Sea.

The conveyance features included in this alternative consist of five diversion points and sediment detention basins, four pupfish/river water channels, five river water channels, and a pumping plant and two associated pipelines. These conveyance features would be used to provide water to AQM projects as well as to provide marine lake water to be mixed with river water delivered to the SHCs. A controlled outlet tower on the west end of the barrier would provide the ability to maintain up to a 5-foot head differential between the marine lake and brine pool.

The mid-Sea barrier embankment would be built using the fundamental concepts of the sand dam with stone columns (See Figure 13).

1.2.5. Alternative No. 3: Concentric Lakes (Imperial Group Alternative)

Alternative No. 3 was proposed by the Imperial Group. It provides both elevation and salinity control (See Table 3 and Figure 15).

Table 3. Physical features of Alternative No. 3 Under Mean Future Conditions: Concentric Lakes

Physical Feature	Value
Marine lakes surface area	47,600 acres[1]
Marine lakes maximum depth	6 feet
SHC surface area	0 acres[2]
Total open water habitat surface area	817 acres
Total shoreline habitat surface area	46,800 acres
Brine pool surface area	127,800 acres
Exposed playa surface area	65,000 acres

1 The 47,600 acres shown are for three concentric lakes. The fourth lake proposed by the Imperial Group is not necessary under the risk-based approach to future inflows described in Chapter 4. Including the fourth lake proposed by the Imperial Group would result in a total marine lakes surface area of 88,000 acres.
2 This alternative has habitat areas that are similar to SHC, which is reflected in the shoreline habitat surface area listed in this table.

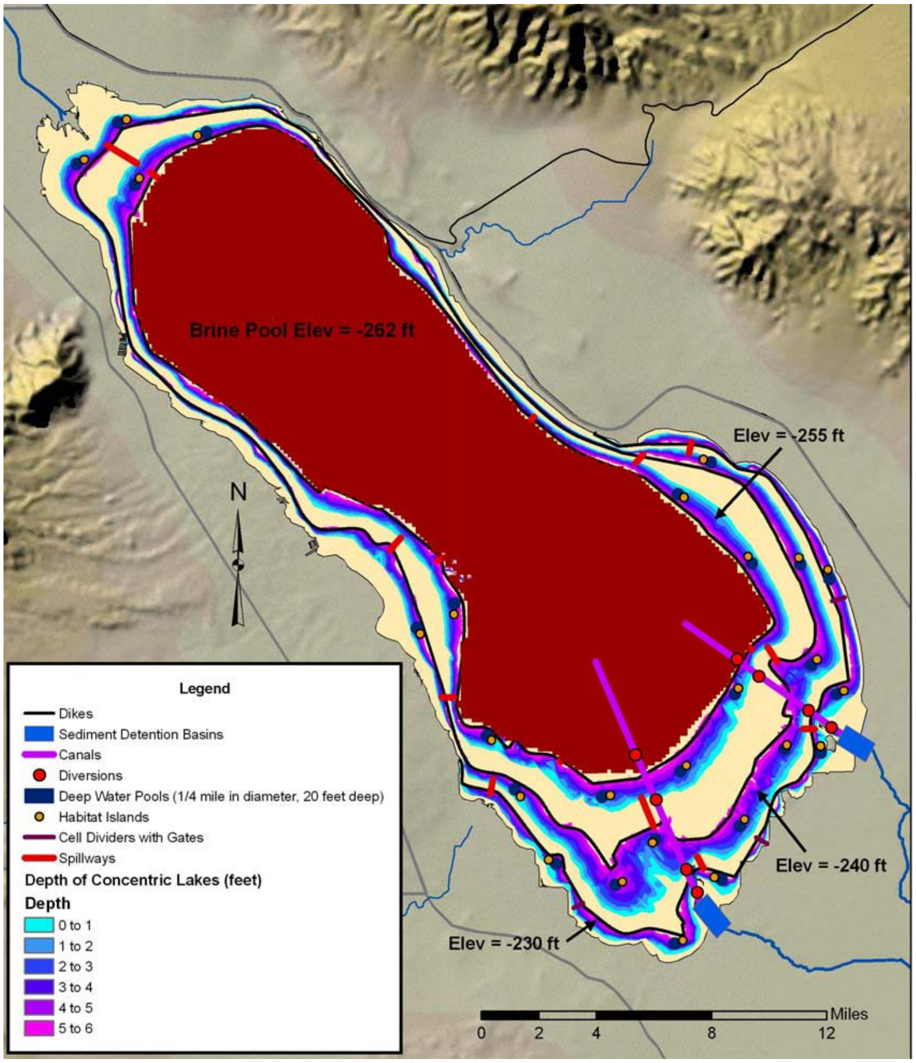


Figure 15. Alternative No. 3: Concentric Lakes Under Mean Possible Inflow Conditions.

The alternative consists of a series of three (or, as the Imperial Group proposed, four) independent lakes, with deep pools and habitat islands. Each lake would receive water directly from canals from the New and Alamo Rivers. Each lake would operate at increasingly higher salinities, with evaporation concentrating salinities from 20 to 60 PPT. The lakes would be formed by constructing dikes in a concentric ring pattern. The outermost lake would be formed by a partial ring dike located at the south end of the project. A brine pool would exist within the area of the innermost dike. Deep pool areas up to 20 feet in depth would be formed within the lakes with adjacent habitat islands. Outside of the deep areas, the maximum lake depth would be 6 feet.

The outer lake is shown with cell dividers that could allow different habitat types to be managed in a way similar to that under the SHC concept. The cell divider concept could be applied to any of the concentric lakes. Due to costs, it is assumed that cell dividers are only incorporated into the outer partial concentric lake.

This alternative would be constructed in stages with an estimated time frame of 40 years for completion. First, the outermost lake features would be constructed. The second, third, and fourth (if required) reservoir lakes would be constructed as the water surface of the residual Sea recedes to the target reservoir water surface elevation of the next lake to be constructed. The conveyance features included in this alternative consist of two river water channels to convey all flows from the Alamo and New rivers into the concentric lakes and brine pools area. Diversion structures would provide for control of flows into each lake to manage salinity levels.

The Imperial Group proposed using Geotube® technology to construct the concentric lake dikes as shown in Figure 16.

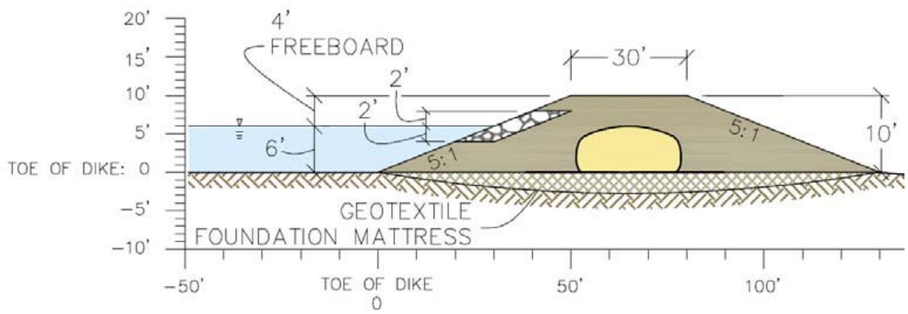


Figure 16. Typical Geotube® design

1.2.6. Alternative No. 4: North-Sea Dam with Marine Lake

Alternative No. 4 would provide both elevation and salinity control and up to 37,200 acres of SHC (See Table 4 and Figure 17).

Under Alternative No. 4, an impervious dam embankment would be constructed to impound Whitewater River inflows. The impervious dam would include an embankment built using the sand dam with stone columns concept as described later in this chapter. The embankment design would provide both static and seismic risk reduction. Water north of the embankment would be maintained at a higher elevation than the brine pool on the south side. The area south of the embankment would serve as an outlet for water and salt from the north and would shrink in size to achieve equilibrium with inflows from the south and discharges from the north marine lake. The salinity of the brine pool would increase over time. The north marine lake would have a water surface area of up to 19,500 acres at elevation -229 msl and would be operated to maintain a salinity of 35 PPT or less. SHC (37,200 acres) would be constructed on the south end of the Salton Sea.

As the main body of the Sea shrinks, these complexes would be constructed on the exposed seabed to take advantage of the gently sloping seafloor. The conveyance features included in this alternative consist of three diversion points and sediment detention basins, three pupfish/river water channels, three river water channels, and two pumping plants and associated pipelines. These conveyance features would be used to provide water to AQM projects as well as to provide brine to be mixed with river water delivered to the SHCs. The brine and river water would be mixed in impoundments constructed in the seabed. These mixing impoundments would need to be moved over time as the residual Sea recedes.

Table 4. Physical features of Alternative No. 4 Under Mean Future Conditions: North-Sea Dam with Marine Lake

Physical Feature	Value
Marine lake surface area	19,500 acres
Marine lake maximum depth	33 feet
SHC surface area	37,200 acres
Total open water habitat surface area	23,800 acres
Total shoreline habitat surface area	32,900 acres
Brine pool surface area	91,300 acres
Exposed playa surface area	91,800 acres

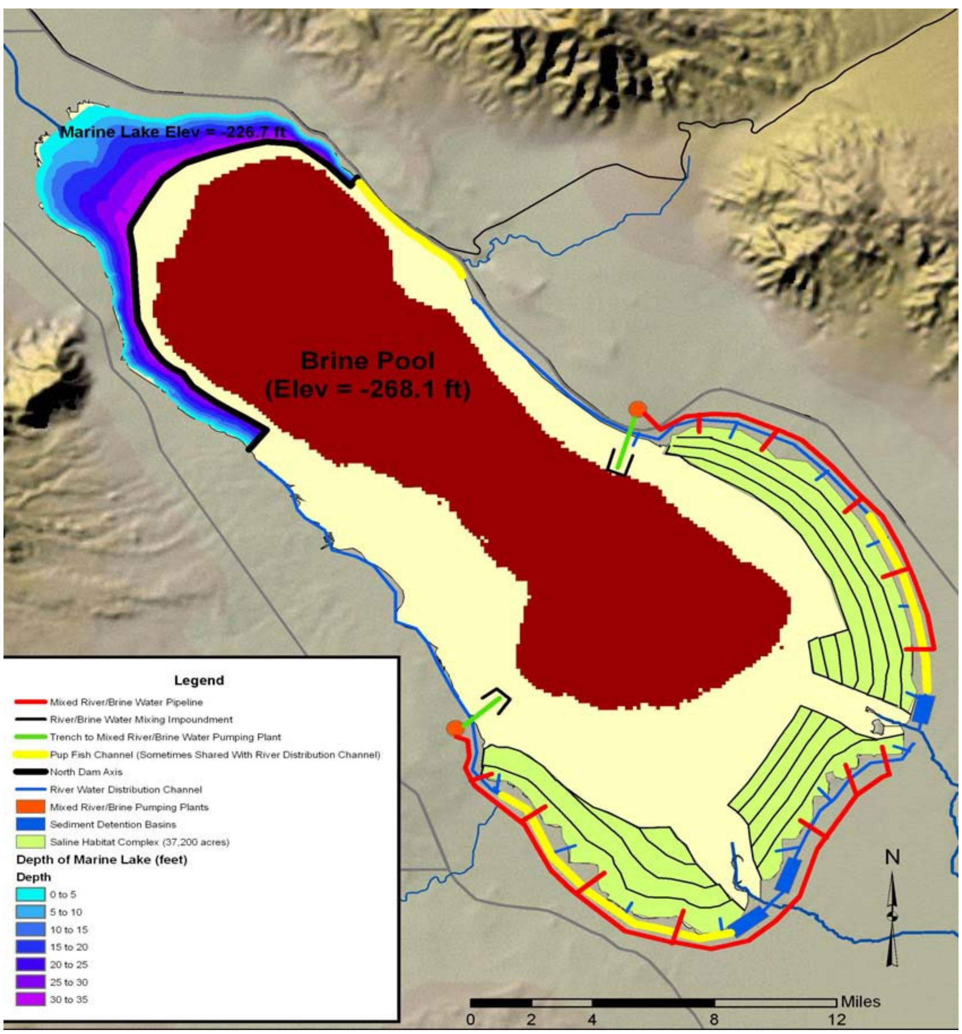


Figure 17. Alternative No. 4: North-Sea Dam with Marine Lake

The 19,500-acre lake was designed to reduce as much as possible the requirement to achieve acceptable salinity levels without dependence on long detention times in the marine lake. Smaller lakes would require evapoconcentration of salt without making releases from the lake for many years, which would result in the concentration of contaminants.

1.2.7. Alternative No. 5: Habitat Enhancement Without Marine Lake

Alternative No. 5 provides no structural solution for a marine lake. The alternative would rely entirely upon SHC to provide open water and shoreline habitat. Under this alternative, SHCs would be constructed at the south and north ends of the Sea (See Table 5 and Figure 18).

This alternative would not provide in-Sea marine habitat. About 20 percent of the SHC would be deep open water (up to 10 feet) for fisheries. These deep-water pond areas would be constructed through excavation; the excavated material would be used to create islands behind cell embankments. The remaining portion of the SHC would be divided into areas suitable for different species and their use; up to a quarter of these areas would be land. The majority of these shallow water pond habitats would be less than 3 feet deep.

Inflows to the SHCs would be managed to achieve an average starting cell salinity of more than 20 PPT through the mixing of waters from the rivers and residual Sea brine pool. The brine and river water would be mixed in impoundments constructed in the seabed. These mixing impoundments would have to be moved through time as the residual Sea recedes. Water would flow by gravity through each of the SHC cells. The salinity of each cell would increase until it reaches about 150 PPT, when discharges from the last cell would be made to the brine pool. The water is expected to have habitat value up to a salinity of about 150 PPT.

The conveyance features included in this alternative consist of five diversion points and sediment detention basins, three pupfish/river water channels, five river water channels, two mixing impoundments, three pipelines, and two pumping plants. These conveyance features would be used to provide water to AQM projects as well as to provide brine to be mixed with river water delivered to the SHCs.

Table 5. Physical features of Alternative No. 5 Under Mean Future Conditions: Habitat Enhancement without Marine Lake

Physical Feature	Value
Marine lake surface area	0 acres
Marine lake maximum depth	---
SHC surface area (Combined surface area of five complexes).	42,200 acres
Total open water habitat surface area	8,400 acres
Total shoreline habitat surface area	33,800 acres
Brine pool surface area	117,400 acres
Exposed playa surface area	81,200 acres

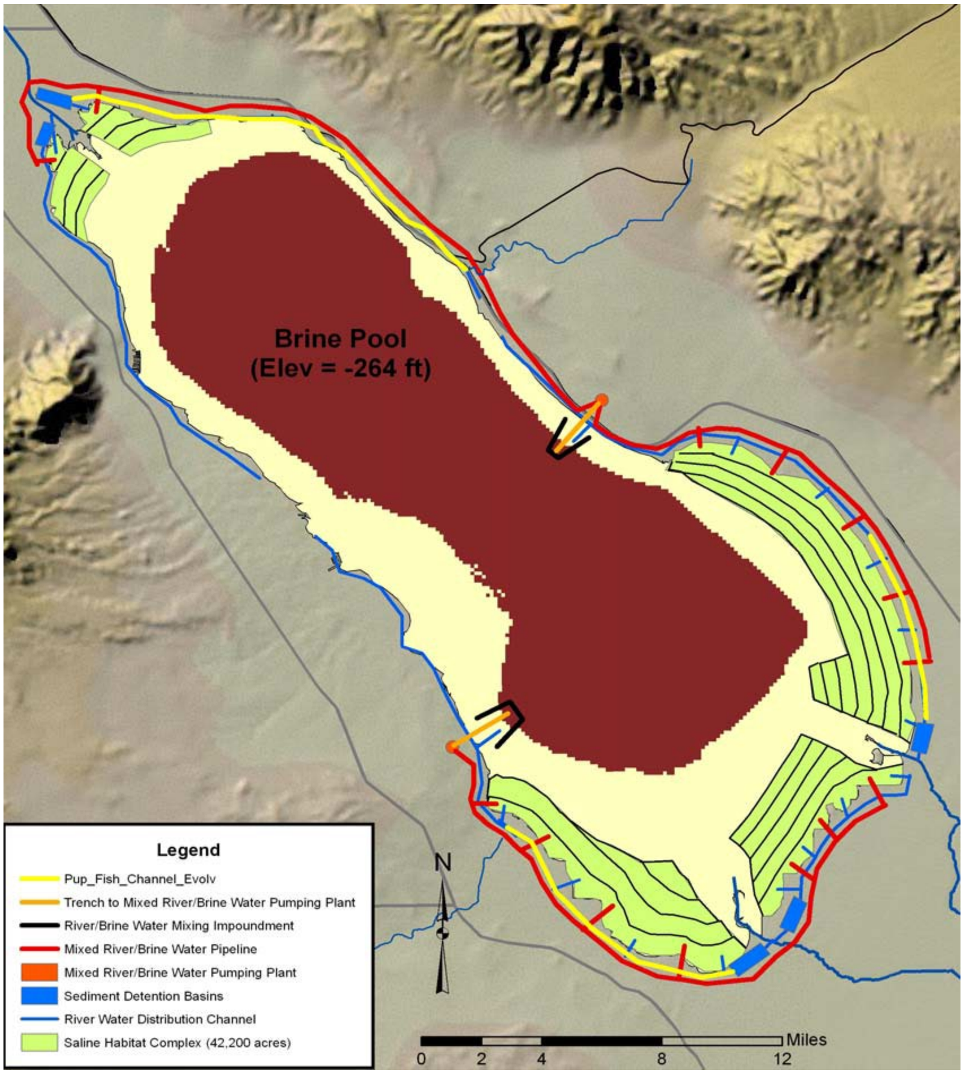


Figure 18. Alternative No. 5: Habitat Enhancement without Marine Lake
(Note the SHC on both the north and south ends of the Sea)

1.2.8. Embankment Design

The general design criteria determined for the mid-, south-, and north-Sea dams; the perimeter dikes; the concentric ring dikes; the mid-Sea barrier; and the habitat pond embankments would be as follows:

- Resist and control embankment seepage, foundation seepage, internal erosion, and static settlements.
- Resist large offsets, slope instability, and deformations due to seismic loading and flooding.
- Provide for constructability using proven methods and safe construction.

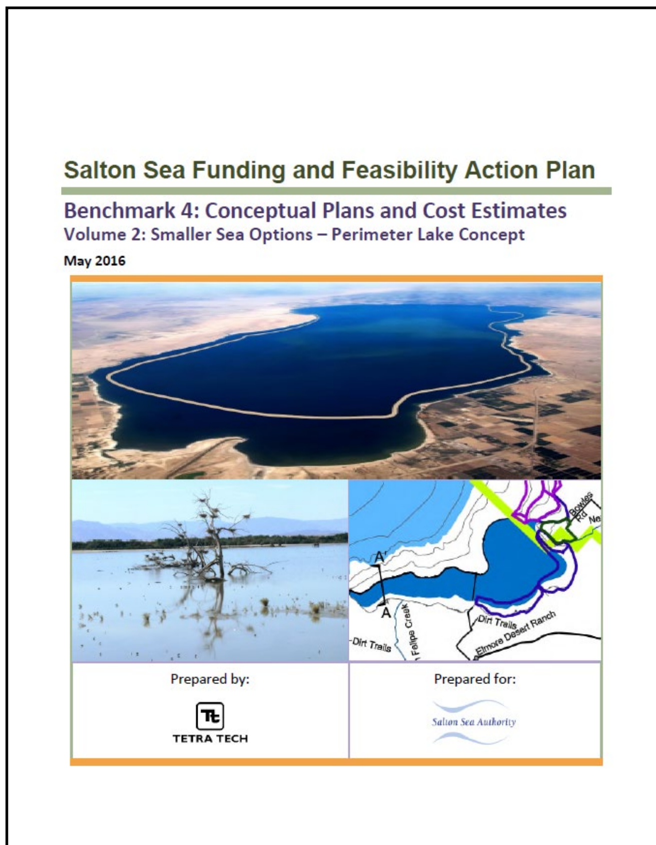
Reclamation developed guidelines to assist in the management of risk associated with its existing dam inventory and in considering new structures. These guidelines for public protection are published in the document *Bureau of Reclamation, June 2003, Guidelines for Achieving Public Protection in Dam Safety Decision-Making.*

Reclamation's guidelines focus on two assessment measures of risks related to Reclamation structures: (1) the estimated probability of a dam failure and (2) the potential life loss consequences resulting from the unintentional release in the event of failure. As a water resource provider, Reclamation must maintain and protect its dams and dikes that store water. The second measure addresses the potential life loss component of societal risk. Protection of human life is of primary importance to public agencies constructing, maintaining, and/or regulating civil works.

Within these guidelines, to ensure a responsible performance level across the inventory of Reclamation's dams, it is specified that decision makers consider taking action to reduce risk if the estimated annual probability of failure exceeds 1 chance in 10,000. To achieve compliance with Reclamation guidelines, an annual probability of failure of any embankment (classified as significant or high hazard structures) at the Salton Sea must be below 1 in 10,000.

1.3. Salton Sea Authority Funding and Feasibility Action Plan, 2016

With a grant from CNRA, the Salton Sea Authority conducted a funding and feasibility investigation in 2015-2016. The most significant outcome from the investigation was the perimeter lake proposal in their Benchmark 4, Volume 2 Report. Benchmark 4, Volume 1 included concepts for exporting water via pipelines to provide an outlet for salts that enter the Sea each year in its inflows. Both concepts are discussed below.



1.3.1. Perimeter Lake Proposal

Following reviews of the features and benefits of past plans, a new smaller lake concept was proposed. The concept was referred to as the Perimeter Lake for the Salton Sea. It considered the immediate need for action, the limitations on water supply for the lake, and the possibility of constructing a project with incremental funding.

The perimeter lake approach would involve constructing a lake around the perimeter of the Sea along with a central saline pool within the current Sea footprint. This concept was planned to work with other projects being planned in the 2015-2016 timeframe by the State and the Imperial Irrigation District (IID) as part of an overall SSMP. A complete management plan for the Salton Sea would include the Perimeter Lake concept combined with IID's Salton Sea Restoration and Renewable Energy Initiative (SSRREI) Initiative, an air quality management plan, and other smaller projects around the Sea such as the Red Hill Bay and SCH projects, as illustrated Figure 19.

Benchmark 4 Volume 2 describes the Perimeter Lake in more detail. Important aspects of the concepts that are outlined in this document include the following:

- Project goals and Perimeter Lake concept overview;
- Conceptual construction details;
- Water inflow requirements and water quality improvement in inflow;
- Conceptual design of spillways and air quality mitigation (AQM);
- Geotechnical feasibility study; and
- Construction scenario, cost estimate, funding, and cost comparisons to past alternatives

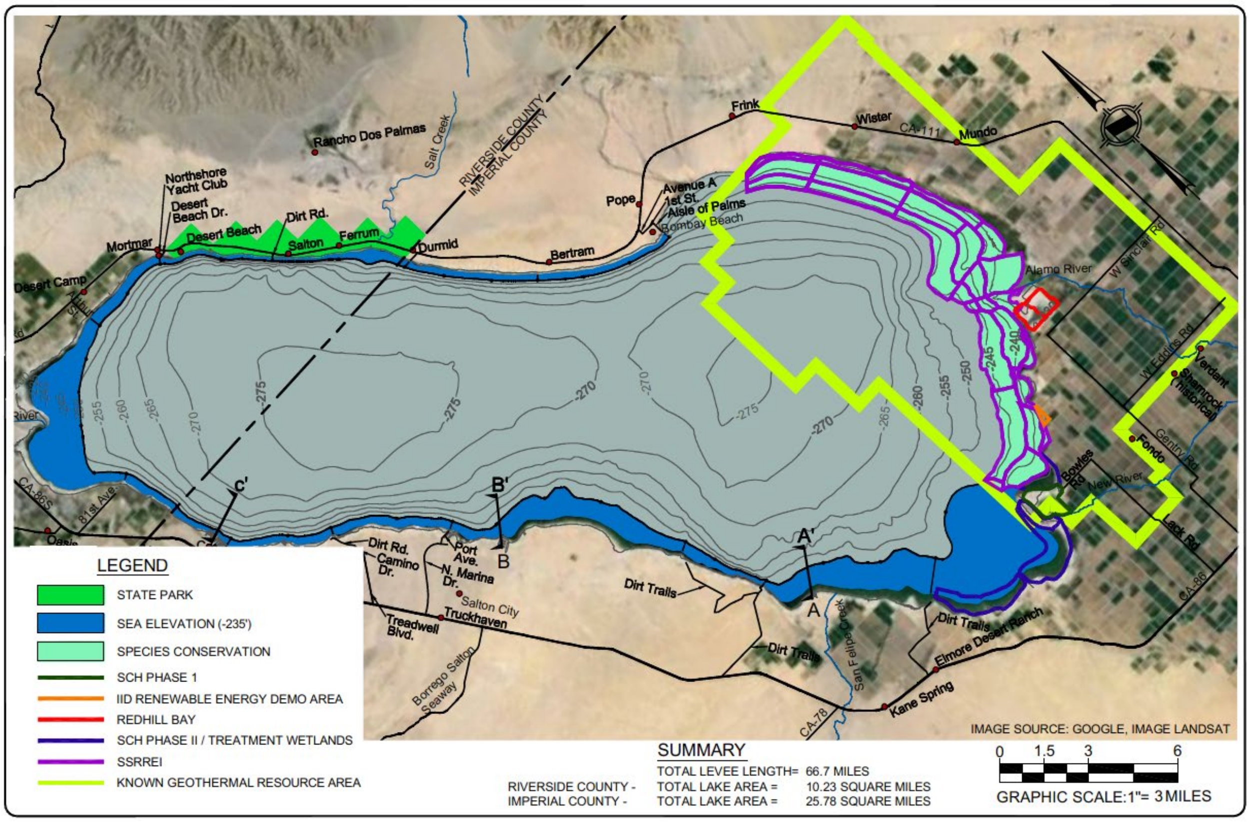


Figure 19. Perimeter Lake Concept

The Perimeter Lake would rely upon a system of low-profile levees to create a reasonably affordable and sustainable water body. This system would generally resemble an in-stream reservoir built along a slowly flowing river. It would include wider recreational areas in the north and south ends of the Sea, although boating would be accommodated along the entire 60+ miles of lake front property. The exposed playa on the southern end of the Sea near the Perimeter Lake project site was designated for IID's SSRREI concept. Built incrementally, the water used in the

Perimeter Lake system would initially flow through a series of linked but separated elongated ponds.

Treatment wetlands, possibly those incorporated in the SCH project, were proposed near or upstream from the mouth of the New River to provide higher quality water entering the system, although no specific plans have been developed at this point. In sections ranging from 500 ft to over 2 miles in width, water entering the Perimeter Lake system would arrive in a wide area at the south end of the Sea, flow northward along the western shore, and arrive at another wide area in the north. Water would flow out of the northern area and move southward along the eastern shore to a terminus spillway. Here, at the terminus spillway, excess water would be channeled into a permanent saline pool in the center of the historic seabed.

Spillways at several locations within the system and the quantity and salinity of water diverted into the system would allow for management of salinity from near fresh to marine, with the expectation that the target salinity would be brackish (15-20 PPT). Excess salinity would concentrate in the saline pool located near the center of the Sea.

At full build out, the total length levee running parallel to the shore would be approximately 61 miles. Additionally, 13 perpendicular connector levees or dikes totaling 6 miles would connect to existing roads so that construction could proceed as individual cells. The total area of all 13 cells would be approximately 36 square miles, with 10 square miles in Riverside County and 26 square miles in Imperial County. The levees would be constructed by dredging a channel along the lake side of the levee which would create a deep-water habitat area of up to 25 ft in depth for the full length of the lake.

The annual inflow required to balance evaporative and seepage losses is estimated at 167,000 AFY (acre-ft per year). Initially, additional water could be run through the system to reduce salinity and nutrients in the water column and clean out detritus. Once in operation, the water body could be used to convey water to other habitat areas or for dust control.

Conceptual Construction Details

The Perimeter Lake concept has evolved over time and would work in concert with IID's SSRREI Initiative Project, the State of California's Species Conservation Habitat (SCH) project, Red Hill Bay Restoration Project, and Imperial County (AQM) objectives. The Benchmark 4, Volume 2 document describes concept development and conceptual construction details for the Perimeter Lake. Various depths, levee configurations and lake sizes for the Perimeter Lake were considered. Three embankment configurations were considered for use as levees on the seaside of the new lake configuration: Earthen Levees with broad 15:1 side slopes created from local dredging, Geotube® Levees, and Sheet Pile Levees. Each design was evaluated with respect to the following performance criteria: constructability, cost, maintenance, environmental considerations, permitting, footprint derived from angle of repose, and risk and uncertainty.

The earthen levee embankment was considered to have multiple advantages and was selected for further analysis in the Perimeter Lake concept. It was expected to be the lowest cost solution and rated best in constructability and related considerations. Furthermore, a significant allocation of the construction cost would be for dredging, which would have the advantage of creating deep water areas with ecological and recreational benefits. Figure 20 illustrates the earthen levee concept.

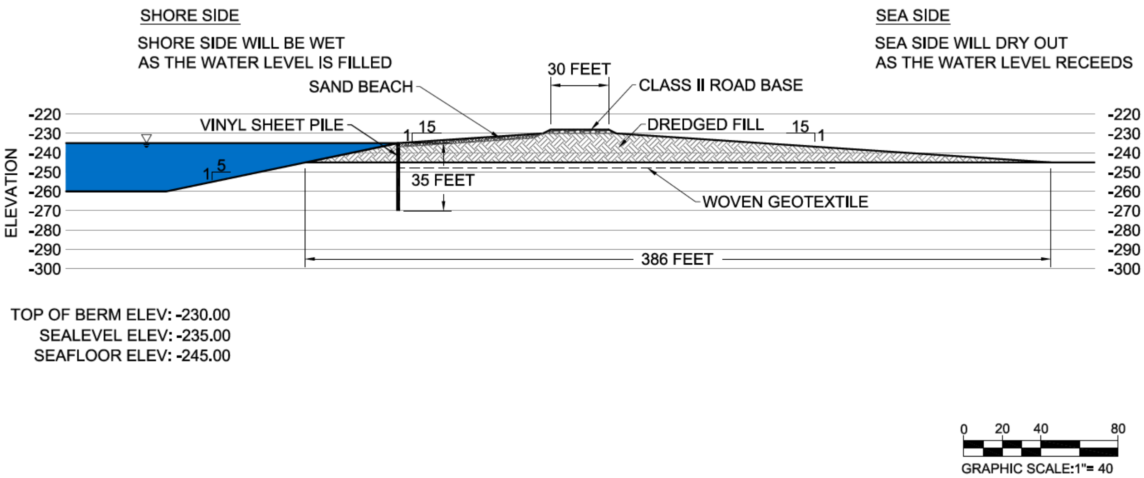


Figure 20. Levee Cross-Section Configuration with Seepage Barrier

Two possible scenarios were considered for construction of the levees. The levee construction could be completed with one team in approximately ten years, or it could be completed with two teams working in parallel in approximately five years. The selected scenario would depend on the availability of funding.

Water Inflow Requirements and Water Quality Improvement in Inflow

Benchmark 4, Volume 2 includes a water budget analysis and a discussion of the residual saline pool. The water budget and salinity analysis for the Perimeter Lake is presented based on expected evaporation and seepage losses and other possible inflow considerations. Accounting for these variables, three scenarios were analyzed to estimate the water budget for the project: a base scenario that includes no releases for beneficial operations such as dust control, and two scenarios that would feature water releases for dust control or other beneficial uses.

Inflow water quality needs to be improved to achieve the full beneficial use potential of the Perimeter Lake. Treatment wetlands were proposed for this purpose and discussed in Section 4.0. These wetlands would be used to improve the water quality, particularly nutrients and suspended sediments, of the New River before they flow into the Perimeter Lake. Estimated area requirements were based on pilot wetland results from Brawley and Imperial. To meet project targets of 2-3 mg/l total nitrogen and 0.1-0.25 mg/l total phosphorus, the project would require surface areas from 590-1,150 acres under low infiltration conditions and 470-610 acres under mean infiltration conditions.

Conceptual Design of Spillways

Although the Salton Sea is set in an arid region, it is subject to occasional floods that must be considered in the Perimeter Lake design. Benchmark 4, Volume 2 includes conceptual designs of overflow spillways to address both the average annual inflow as well as the occasional flooding produced from the rare storm event. The intent of the structures is to allow the average inflow of water to circulate within the Perimeter Lake while maintaining a desired water level, provide emergency flood relief to prevent overtopping of the levee, and still maintain sufficient freeboard for safety purposes. The overflow structures include three 20-ft bellmouth spillways near the

North Shore Yacht Club, the Bombay Beach, and the old base; and a 1,000 ft wide broad crested weir near the North Shore Yacht Club. These structures would stimulate clockwise internal circulation and exchange water inside the Perimeter Lake up to a rate equal to the entire lake volume twice annually.

Geotechnical Feasibility Study

A feasibility-level geotechnical assessment was conducted to evaluate slope stability and seepage associated with the Perimeter Lake design. The evaluation did not identify any geotechnical factors that would preclude the successful design and construction of the project. However, several factors would require special consideration during the design, engineering and construction of the project. These factors would include dewatering of excavated materials and mechanical placement and compaction, mitigation of settlement and seepage, and soil liquefaction and seismic deformation mitigation, all of which were considered in developing the construction scenario and detailed cost estimates and schedules.

Construction Scenario and Cost Estimate

Construction would involve sheet pile installation, geotextile deployment, dredging and stockpiling of sediments, construction of spillway structures, grading and armoring of the levees, construction of roadways on top of the levees, and construction of causeways. Ferry barges or floating bridges would allow access to the levees for maintenance once causeways dividing the cells are breached.

A detailed feasibility-level cost estimate was prepared for two construction scenarios: construction of Phase 1 and 2 in series, and construction of Phase 1 and 2 in parallel. While funding sources were still being investigated, a review of funding sources was included. Details on the construction scenarios, the cost estimates, and the possible funding sources can be found in Benchmark 4, Volume 2. Alternative A was estimated at a total cost of $1.7 billion including contingencies with a 10-year construction period. Alternative B was estimated at a total cost of $1.8 billion including contingencies with a 5-year construction period. Cell and access levee locations are shown in Figure 21. Further details on funding sources and costs are presented in Benchmark 4 Volume 2.

Benefits of the Perimeter Lake Concept

According to the Salton Sea Authority documents, the Perimeter Lake concept would revitalize the Salton Sea and the surrounding area by providing the following benefits: stable shoreline with elevation control in a lake with an area of 36 square miles; improved water quality with reduced salinity; a source of water for AQM; compatibility with other Salton Sea management projects; and a deep-water habitat that would also be suitable for recreational uses. Spillways in the north and south would provide salinity control and allow management of water in the Perimeter Lake at brackish levels (15-20 PPT). Initial flushing would help remove detritus and nutrients that are already present in the lake at high levels, and proposed treatment wetlands would improve the quality of water flowing in from the New River.

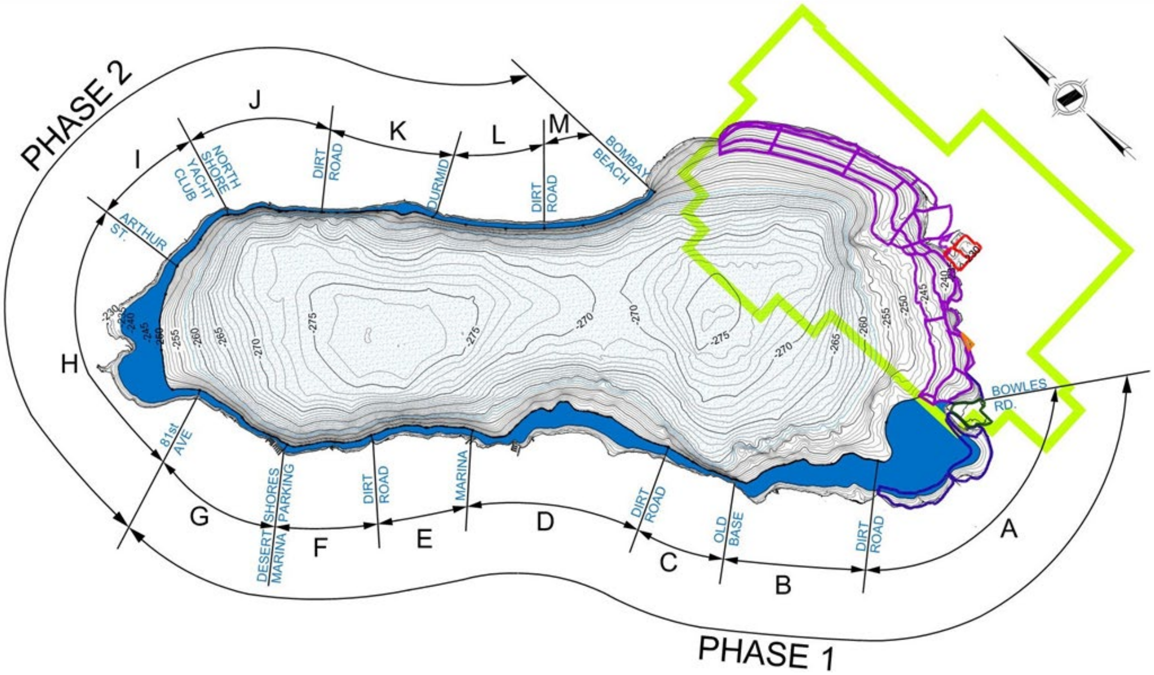


Figure 21. Access Levee Locations and Construction Phases

Lake elevation with this plan would be slightly below historic shorelines from 1960-2010 period; however, these levels would reduce the water requirement for the Perimeter Lake component to only 167,000 AFY, and remaining inflow (522,000-689,000 AFY) could be used for other projects such as SCH, IID's SSRREI, AQM, or other habitat projects. The Perimeter Lake was planned to be outside the boundaries of the KGRA and thus would not interfere with opportunities for development of geothermal or other renewable energy projects.

The deep-water areas of up to 25 ft have recreational value for boating and fishing, and they would also benefit habitat by providing a food source for resident and migratory piscivorous birds. Additionally, the Perimeter Lake plan would include 130 miles of shallow habitat along the existing shoreline and levees for wading birds. At 36 square miles, the Perimeter Lake would be significantly larger than all other lakes in southern California, including the 32-square mile Lake Havasu.

1.3.2. Pump Out Pipeline Options

Because the Salton Sea does not have an outlet, even low levels of salt in the inflow have no other place to go but to concentrate in the Sea. Therefore, the Salton Sea Authority investigated ways of creating an outlet by constructing a pipeline to various locations. The analysis considered four factors: water quantity removed, the conveyance system and hydraulics necessary for removal, capital and operational cost, and institutional considerations. An applicable screening level performance analysis using a salinity and elevation model was also conducted.

One of the largest challenges facing the Salton Sea is the lack of an outlet, as the salt content conveyed into the sea concentrates over time due to evaporation. Salt has historically been conveyed into the Sea with irrigation drainage and other flows with an average salinity of about

2.5 PPT. If the salinity in the Sea could be reduced to concentrations similar to the ocean salinity of 35 PT, the outflow would need to be only 2.5/35 or 1/14 times the inflow.

The Salton Sea Authority investigated several possible discharge locations:

- Laguna Salada
- La Cienega de Santa Clara (Santa Clara Slough, Wetland)
- Gulf of California
- Land-based discharge areas

Export to the Gulf of California is probably the most feasible of these and, therefore, is discussed further below. Regardless of the discharge location, the concept of creating an outlet by pumping would have the same effect of controlling salinity in the Salton Sea.

Pipeline to the Gulf of California

As shown in Figure 22, the Gulf of California is approximately 120 miles from the Salton Sea and 30 miles away from La Cienega de Santa Clara. There is an existing and operational canal system which covers 80 percent of the distance from the Gulf of California to the US-Mexico border. Additionally, 95 percent of the distance from the Gulf to the border is below sea level, with an average elevation of -25 MSL. The general terrain in the area is loose, rocky to sandy soil. The Gulf of California has been losing coastal land at a very high rate over the last 50 years, and the environmental impact of discharging flows from the Salton Sea must be evaluated thoroughly. The flow paths to the Gulf of California could originate from either the southwest or southeast portions of the Salton Sea.

Water Quantity

The quantity of water that could be exported from the Salton Sea to the Gulf of California would depend on several factors. These factors include levels of salinity in the Salton Sea, environmental impacts of discharging the higher salinity water from the Salton Sea into the Gulf of California, and the associated costs and capabilities of the pumping systems and pipelines from the Salton Sea to the Gulf of California. Modeling was performed with an initial pump out rate of 150,000 AFY starting in 2025, which could be reduced to 100,000 AFY or less after 20 years. For this scenario, it would take about 25 years for the Sea to return to a salinity that could support fish populations and another 10 years to return to ocean-like salinity of 35 PPT. After that, the pump-out rate could be further reduced to 60,000 or 70,000 AFY for long-term salinity control. The effect of the outlet would be a reduction of the surface area of the Sea by about 7%.

Conveyance System and Hydraulics

Delivery of 150,000 AFY of water from the Salton Sea to the Gulf of California would require 120 miles of pipeline that is 86-inch diameter with two pump stations as shown in Figure 22. There is an elevation gain of about 530 feet from the Salton Sea to the Gulf of California with the high point south of the international border near the Mexicali-Tecate Highway 2. Delivery of water to the Gulf of California would also require a minimum of two pump stations. The first pump station would be located near the Salton Sea to convey water into the pipeline. A second pump station would be necessary along the pipeline alignment to deliver water to the final discharge point.

Each pump station would be designed with a discharge head of 500 feet, and pipeline design would be based on internal pressure of 300 psi, accounting for surge.

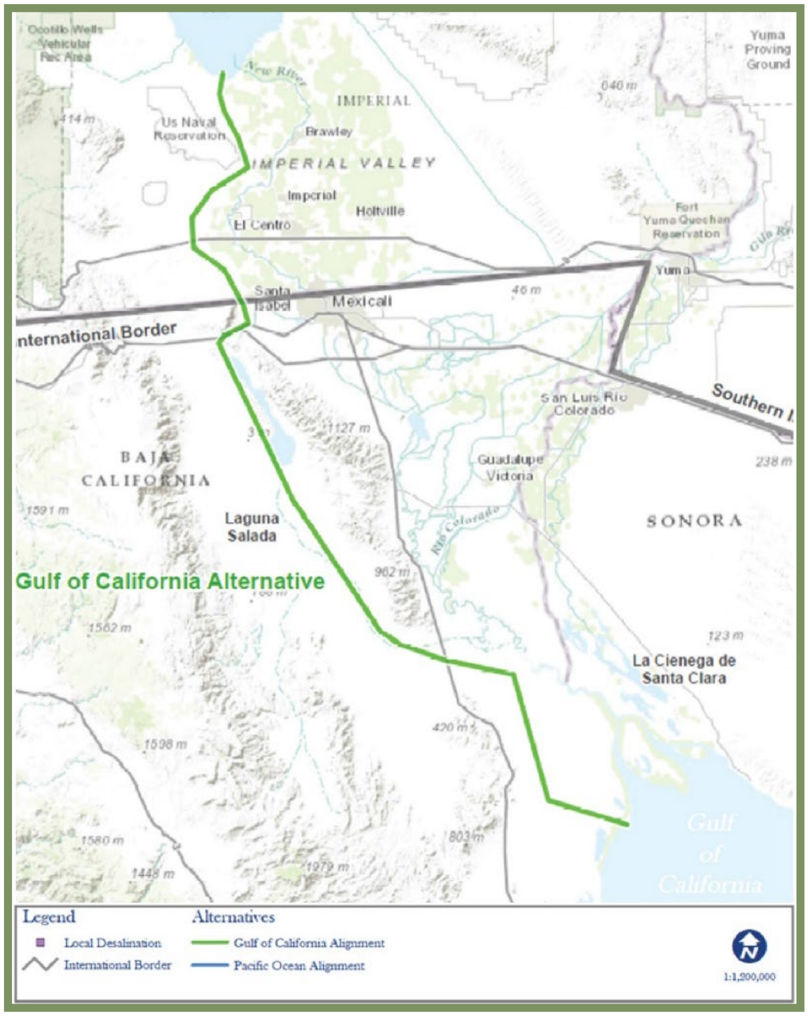


Figure 22. Possible Pipeline Route from the Salton Sea to the Gulf of California

Institutional Considerations

The average salinity in the ocean is generally 35 PPT, whereas salinity values in the Salton Sea are currently around 70 PPT and projected to go substantially higher. Evaluation of discharge methods into the Gulf of California and significant consideration of environmental impacts to the coastal habitats would be necessary for determining whether this option is feasible. The cost-effectiveness of transporting a significant volume of water for 120 miles over significant elevation gains must also be evaluated. Again, this option requires a transfer of water across international borders, and the feasibility and validity of this option relies heavily on collaboration, permits, and approvals being resolved between the governments of the United States and Mexico.

Conceptual plans

Conceptual plans prepared for the Gulf of California Pipeline alternative can be found in Appendix 11.5 of the Salton Sea Authority's Benchmark 4-1 Report. These plans were used to form the basic concept for the pipeline route and its key components. Conceptual level cost estimates were then developed from the layouts presented in these plans. Appendix 11.5 contains hydraulic profiles, pump station mechanical plans and sections, typical intake structures, and discharge headers.

Summary

Water xportation from the Salton Sea to the Gulf of California would require significant infrastructure and operational costs for pumping the high salinity water for a distance over 120 miles. The environmental impact of importing higher salinity water to the already impacted coastline habitats must be considered. Should blending or treatment be required, the added costs and baseline conveyance costs may significantly impact the feasibility and cost-effectiveness of this option.

1.4. References

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