SALTON SEA ECOSYSTEM MANAGEMENT PLAN

Administrative Draft Alternative Concepts Report

January 2005

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CHAPTER 1
INTRODUCTION

BACKGROUND

Over the past four decades, investigations of the Salton Sea have considered numerous alternatives for solving problems at the Salton Sea. Individual study objectives have differed, but the main focus has generally been on how to control salinity and elevation of the Salton Sea. Most investigations sought alternatives to preserve the Salton Sea as a thriving fishery and recreational destination. Most of the alternatives revolved around ways to preserve the "whole Sea". More recently, alternatives have recognized that smaller "partial Sea" alternatives may be more reasonable given reduced historical and projected inflows to the Salton Sea.

Prior investigations evaluated methods to pump water out of the Salton Sea to remove salt, convey water back in to dilute salt concentrations and control the Salton Sea elevation, and provide treatment to remove salt and other constituents of concern. Prior investigations considered numerous ways to divide the Salton Sea with dikes and to reroute water flow. Some alternatives would generate revenue for use in restoration of the Salton Sea. Many alternatives, and their variations, reoccur from report to report. One notable example is that alternatives with evaporation ponds located within the Salton Sea are included in most of the prior investigations. Names, sizes, and locations may vary, but the general concept of removing salt with the evaporation ponds has remained the same. These prior investigations provide extensive information to aid compiling a list of alternative concepts for the Salton Sea Ecosystem Management Plan.

Over the 20 studies reviewed for this report, all of the reports only included conceptual planning level studies. None of the reports included detailed design layouts or preliminary design-level cost estimates. Several of the studies did evaluate a specific method in detail, such as Enhanced Evaporation Systems, and several pilot projects were implemented. The Salton Sea Ecosystem Management Plan will develop preliminary design level plans for five to ten alternatives that have been identified through a screening of alternative concepts presented in this report and those identified during review of this report. The preliminary design level plans will include preliminary plans for site layout, mechanical equipment layouts, hydraulic profiles, grading plans, and geotechnical criteria. Cost estimates will be developed based upon the preliminary plans.

PURPOSE

This report describes alternative concepts evaluated in previous reports and describes a range of alternative concepts to be considered for the Salton Sea Ecosystem Management Plan. In order to make the number of alternative descriptions more manageable and understandable, the alternatives are arranged in 27 different groups of similar alternatives. For example, the alternatives that would convey Salton Sea water to the Gulf of California are grouped together into one alternative description.

PRIOR INVESTIGATIONS

Over the past four decades, many investigations have considered a wide variety of alternatives for potential implementation at the Salton Sea. Most of these investigations looked for ways to preserve the entire Salton Sea, primarily by salinity and elevation control.

Range of Alternatives

While many of the investigations included identical or similar alternatives, the names of the alternatives were often different between investigations. Some of the alternatives in one investigation were variations of alternatives from other investigations. To help organize similar alternatives together, Table 1 (located at the end of this chapter) shows the general types of alternative concepts..

Chronology of Investigations

The following are brief summaries of prior investigations and their general conclusions:

- **December 1963,** *Conservation of the Beneficial Water Uses of Salton Sea in California*, Colorado River Basin Regional Water Pollution Control Board – The investigation included preliminary analysis towards preparation of a water quality control plan that involves separating a portion of the Salton Sea to concentrate salts for physical removal.

- **December 1965,** *A Reconnaissance Study and Preliminary Report on a Water Quality Control Plan for Salton Sea*, Pomeroy, Johnston and Bailey Engineers – The report concluded that, without controls, the fishing and recreational values of the Salton Sea would decline sooner than generally thought at the time. The report also concluded that engineering measures could preserve the uses of the Salton Sea.

- **1969,** *Federal-State Reconnaissance Report*, United States Department of the Interior and The Resources Agency of California – The report concluded that a solution for the Salton Sea should be integrated with geothermal development. The report described a large scale solar pond, along with removal of Salton Sea water by the geothermal power plants as a potential solution for the Salton Sea.

- **February 1971**, *Salinity Control Study, Salton Sea Project, Aerospace Corporation* – The report evaluated a wide range of alternatives including a waterway to the Gulf of California to serve as an outlet for the Salton Sea.

- **April 1974,** *Salton Sea Project, California, Federal-State Feasibility Report*, United States Department of the Interior and The Resources Agency of California – The report presented results of investigation of a wide range of alternatives to solve problems at the Salton Sea. The types of alternatives were those without a diked impoundment in the Salton Sea and those with a diked impoundment. Four alternative plans that included 30 square-mile to 50-squrare mile diked impoundments in southern portion of the Salton Sea were found to be technically feasible. The report noted that the alternatives could not be accomplished before salinity exposed the fish to risk of die-off. Therefore, each of the alternatives included contingency provisions for restocking of ocean fishes.

- **1983**, *The Salton Sea and the Push for Energy Exploitation of a Unique Ecosystem*, California Department of Fish and Game – The report concluded that a large scale solar pond and removal of Salton Sea water for geothermal power plant cooling and injection into the groundwater to control subsidence could provide a permanent solution for the ecosystem.

- **July 1988**, *Problems and Potential Solutions at Salton Sea*, Meyer Resources, Inc. for The California Resources Agency – The report identified three alternative concepts that were capable of salinity and flood management: 1) in-Salton Sea impoundments to evaporate and concentrate

salt, 2) solar ponds to generate electricity to raise revenue or power desalination plants, and 3) a canal to the Gulf of California.

- **July 1994**, *Strategies for the Restoration and Enhancement of the Salton Sea, A White Paper for the Salton Sea Authority*, Dangermond and Associates – The report reviewed potential alternatives from previous reports and considered possibilities which might either reduce costs, generate revenues, or create access to new funding sources. The report suggested four alternatives, all of which include some power generation for revenue. The alternatives include various combinations of solar power, pumped storage, diked areas, desalination, and a canal to the Gulf of California.

- **June 1996**, *Salton Sea Management Project, Evaluation of Salinity and Elevation Management Alternatives*, Ogden Environmental and Energy Services Co. for the Salton Sea Authority – The study evaluated a wide range of alternatives. Many of the alternatives were described in previous reports.

- **January 1997,** *Salton Sea Management Project Implementation Plan*, Salton Sea Authority – The report indicated that the Salton Sea Authority Board of Directors adopted the within-Salton Sea diked impoundment as the preferred approach on September 26, 1996.

- **September 1997,** *Salton Sea Alternative Evaluation, Final Draft Report*, Salton Sea Authority, California Department of Water Resources, and the U.S. Bureau of Reclamation – The report presented results of an appraisal level study of 54 alternatives, representing a wide variety of potential solutions at the Salton Sea. Of the five alternatives identified through a screening process, all involved separating portions of the Salton Sea with dikes.

- **March 1998**, *Evaluation of Options for Reclamation of the Salton Sea*, R. Wayne Hardie, Los Alamos National Laboratory - Only a summary of this report was reviewed.

- **November 1998**, *Salton Sea Alternatives, Final Preappraisal Report*, U.S. Department of the Interior, Bureau of Reclamation – The report reviewed 74 alternatives, including alternatives from previous reports and additional concepts. The report identified 39 alternatives for further evaluation. One of the alternatives was to divide the Salton Sea in half with a dike.

- **November 1999**, *Salton Sea Restoration Alternatives Packet*, Salton Sea Authority and Bureau of Reclamation – The packet provided an overview of the alternatives development process and identifies the highest ranking alternatives based on the 1998 screening process as: Reclaimed Water from Yuma/Pump-Out to Gulf of California, Reclaimed Water from Yuma/Pump-out to Pacific Ocean, South Half of Salton Sea Evaporation Pond, Desalination with Brine Pump-Out to Gulf of California, and Desalination/Solar Pond with Brine Pump-Out to Gulf of California. This evaluation led to a phased approach and the alternatives for the Draft EIS/EIR (see January 2000, *Draft Salton Sea Restoration Project Environmental Impact Statement/Environmental Impact Report* below.)

- **January 2000**, *Draft Salton Sea Restoration Project Environmental Impact Statement/Environmental Impact Report*, Tetra Tech, Inc. for the Salton Sea Authority and U.S. Department of the Interior – The Draft EIS/EIR did not present a preferred alternative, but evaluated five alternatives with different sizes, locations and configurations of evaporation ponds. The alternatives were structured with the recognition that Salton Sea inflows could decrease in the future and additional features may be needed. Each alternative included the same set of

common actions such as fish harvesting, recreational facilities, shoreline cleanup, integrated wildlife Salton Sea program, long-term management strategy, and strategic science plan. Recognizing that certain project components are needed before others, the alternatives were based on the concept that they could all be implemented in phases over time. Future actions could include water export to the Gulf of California, Pacific Ocean, Palen Dry Lakebed, or use of enhanced evaporation systems (EES). Future actions could also include import of water from the proposed Central Arizona Salinity Interceptor (CASI).

- **January 2000**, *Salton Sea Draft Alternatives Appraisal Report* - U.S. Department of the Interior, U.S. Bureau of Reclamation – presented appraisal level alternatives to improve the physical, biological, and water quality conditions of the Salton Sea. The report also evaluated several geological constraints and benefits of the alternatives.

- **May 2000,** *Analysis of Salton Sea Restoration Plans* - Parsons, Inc. - The report presented an independent technical review of Phase I alternatives presented in the 2000 Draft Salton Sea Restoration Project EIR/EIS and described possible modifications to the concepts and concepts to control salinity and elevation of the Salton Sea.

- **October 2001**, A *Proposal to Preserve and Enhance Habitat at the Salton Sea*, Pacific Institute – The report presented the concept of a whole Sea alternative that would create brackish water areas at the northern and southern ends with stable elevations. The alternative would not alter the main body of the Salton Sea.

- **February 2002**, *Evaluation of a Proposal for Conservation of the Salton Sea Ecosystem*, Workshop coordinated by the U.S. Department of the Interior Salton Sea Science Office – The report summarized the independent review of the project proposed by the Pacific Institute. The review identified several issues of the proposal that would need to be resolved for implementation.

- **January 2003**, *Salton Sea Study, Status Report*, U.S. Department of the Interior, Bureau of Reclamation – The report presented a summary of the evaluation of 14 alternatives. The report made no recommendation for a preferred alternative since all alternatives were "extremely expensive". The report concluded that it is difficult to make a recommendation without a decision by Congress regarding funding of the Salton Sea restoration.

- **March 2003**, *Review of US Filter Corporation Salton River Proposal, Final Report*, Tetra Tech, Inc. for the Salton Sea Authority – The report summarized evaluation of a proposal to construct a perimeter dike within the Salton Sea to create a ring of brackish water with a stable elevation and shoreline. The report concluded that the proposal should not be further evaluated, but that water reuse from desalination could generate revenues.

- **June 2003,** *Proposal for Restoration of the Salton Sea* - Black & Veatch - The proposal used evaporation or brine ponds created by diking portions of the Salton Sea perimeter to lower salinity. The proposal also included reduction in inflows by treating a portion of the inflows to provide a freshwater source to Southern California. This would also provide revenues for restoration activities. A shoreline canal would be constructed between the ponds and the existing shoreline to provide continuity between the Salton Sea and the tributaries.

- **June 2003**, *Proposal for the Restoration of the Salton Sea Based on Groundwater Sequestering*, Timothy J. Durbin, Inc. – The proposal is to extract 200,000 acre-feet per year of Imperial Valley

groundwater for export, use within the Imperial Valley, or replacement water for the Salton Sea. Water from the Salton Sea would be injected to replace the water removed from the aquifer and provide an outlet for Salton Sea salts. Sale of the groundwater would provide a revenue source that could be used to restore the Salton Sea. The report estimates that the groundwater system is finite, but could be used for 100 years.

- **July 2004**, *Salton Sea Restoration, Final Preferred Project Report*, Tetra Tech, Inc. for the Salton Sea Alternative – The report documented the process to identify a preferred project alternative. The report concluded that most of the "whole Sea" alternatives considered in previous reports would not be flexible to accommodate reduced inflows to the Salton Sea. Many of the previous alternatives that would remove salt also would remove water, which would further decrease Salton Sea elevations. The report concluded that the North Marine Lake with Elevation Control was the preferred alternative.

- **October 2004**, *Salton Sea Restoration – The Cascade Alternative*, The Salton Sea Restoration Consortium – The report presented an alternative to provide a series of relatively low concentric dikes to impound a variety of wetlands, ponds and marine lakes with different salinities and elevations. The proposal included construction of the impervious portion of the by filling a geotextile tube with material dredged from the bottom of the Salton Sea.

Table 1-1 presents the alternative concepts described in this report. The table shows which alternative groups were considered by each of the previous reports. A listing of the alternatives, with variations, can be found at the end of this report.

APPROACH TO COMPILE ALTERNATIVE CONCEPTS

The approach for compiling alternative concepts for the Salton Sea Restoration Management Plan relies heavily on work conduced by past investigations. The work included the following items.

- Gather and review all alternatives included in available prior reports. The intent is not to reevaluate all these alternatives but to take advantage of the extensive amount of work conducted by the prior investigations.

- Recognize that alternatives developed by prior investigations were studied at different times to achieve different objectives than the Salton Sea Restoration Management Plan. Also, most of the alternatives from these prior investigations were developed before recent studies (such as the Quantification Settlement Agreement (QSA)) and existing and projected reduced inflows to the Salton Sea.

- Recognize that many of the "whole Sea" alternatives may not perform well under the reduced inflow associated with the QSA but that all alternative concepts should be subjected to the screening criteria.

- Group similar concepts together to help view the breath of prior work and to make the number of alternative descriptions manageable. For example, the many different alternatives that would exchange water between the Salton Sea and the Gulf of California are grouped together.

- Look for components from past alternatives that could be used to form new alternatives.

- Prepare brief descriptions of the alternative groups, including any variations that use similar approaches or present similar issues.

- In preparing the alternative descriptions, recognize that the alternative concepts are intended for consideration in a screening process, and that more detail would be provided in the feasibility study.

- The alternative concepts are intended to show the basic approaches and may not include all of the components habitat enhancement, recreation, air quality protection, water quality treatment, or improvements to utilities.

IDENTIFICATION OF ALTERNATIVE CONCEPTS

The alternative concepts are identified in this report as a compilation of several components, including water infrastructure, water quality treatment, habitat, recreation, air quality protection, local economic development, improvements to utility and transportation facilities, and mitigation measures for environmental impacts to natural and human resources. Definitions of each of these components are presented below.

Water Infrastructure – Water infrastructure components include features that convey, control, contain water resources for the alternatives. The features include levees and dams, intake and outlet structures, weirs and gates , pumps, islands, pipelines or canals, brine ponds or other disposal methods.

Water Treatment – Water treatment components are related to removal of nutrients, selenium, arsenic, or other constituents of concern. The treatment methods range from natural passive systems, such as wetlands; to mechanical systems, such as conventional physical-biological treatment followed by physical-chemical treatment.

Habitat – Habitat components are considered for all types of aquatic organisms, including uplands, wetlands, shallow water, and deep water in the Salton Sea, conveyance areas, and adjacent lands to the existing shoreline and on exposed soils that are currently inundated. Salinity would range for different habitats in different alternatives.

Recreation – The recreation component will include ecosystem related opportunities, such as trails, visitor centers, hunting, or fishing. Additional considerations could include parks, constructed recreational pools, marinas, off-road vehicle areas, and commercial enterprises. Efforts to maintain access to recreation areas would be considered as part of the alternatives.

Air Quality Mitigation – Previous reports have considered a wide variety of air quality components to mitigate potential particulate emissions from exposure of currently inundated lands in the Salton Sea.

Local Economic Development – Previous reports have considered local economic development components associated with recreation, habitat establishment, geothermal activities, and continued agricultural activities.

Improvements to Utilities and Transportation Facilities – To implement water infrastructure, habitat, recreation, air quality protection, and local economic development components, it may be necessary to increase capacity or extend utilities, roads, or railroads.

Mitigation Measures to Protect Biological or Human Resources – These components were not necessarily included in previous reports. Components may include land use buffer zones; specific

placement of facilities to avoid historical or natural resources; or features to reduce visibility of facilities. Some mitigation measures would not be specifically identified at this time, but are considered to be used for all facilities, such as the use of non-glare lighting systems or noise reduction enclosures for electrical equipment.

CHAPTER 2
DESCRIPTIONS OF ALTERNATIVE CONCEPTS

ALTERNATIVE CONCEPTS

Most of the alternative concepts were developed in previous reports to control salinity and/or elevation of the Salton Sea to protect habitat, recreational opportunities, and/or local economic opportunities. These alternatives were organized into 27 alternative concept descriptions in this report, as listed below. Most of the alternative concepts are described in basic terms with several variations as defined in the previous reports, summaries of major characteristics or features, discussion of long-term ecosystem stability, and estimated operational life of the facilities. The following alternative concepts and variations are described in the remaining portions of this chapter.

Alternative Concept 1 - Waterway to the Gulf of California

- Pump-Out using Pipeline
- Pump-Out using Pipelines and Canals
- Pump-Out using Pipeline with Return Flow from Gulf of California
- Pump-Out using Pipeline and Canal with Return Flow from Gulf of California
- Ocean Level Navigation Canal
- Navigable Waterway/Mexicali Salton Seaport
- Salt Pond/Shipping Channel/Canals/Desalination Facility
- Gulf of California Pump-In/Pump-Out/Diking/Treated Inflows
- Diked Impoundment and Conveyance to Gulf of California
- Pumped Storage Canal
- Yuma Desalting Plant's Bypass Drain
- Reclaimed Water from Yuma/Pump-Out to Gulf of California
- Desalination with Brine Pump-Out to Gulf of California
- Desalination/Solar Pond with Brine Pump-Out to Gulf of California
- Impoundment/Evaporation Pond/Pipeline-Canal to Gulf of California and/or to Yuma Desalting Plant

Alternative Concept 2 - Waterway to the Pacific Ocean

- Pump-Out to the Pacific Ocean
- Pump-Out and Pump-In to the Pacific Ocean
- Reclaimed Water from Yuma Desalting Plant/Pump-Out to Pacific Ocean

Alternative Concept 3 - Pump-Out to Dry Lakes

- Pump-Out to Palen Dry Lake
- Pump-Out to Ford Dry Lake
- Pump-Out to Clark Dry Lake
- Diked Impoundment, 30 Square Miles with Pumping to Dry Lake
- Diked Impoundment, 30 Square Miles with Maximum Pumping to Dry Lake

Alternative Concept 4 - Onshore Evaporation Ponds

- 110 Square Miles of Evaporation Ponds
- Ground-Based Enhanced Evaporation Systems (EES)
- Tower EES
- In-Salton Sea and On-Land Ponds
- Pump-Out Canal/Dam System to Base of Chocolate Mountains
- Evaporation Ponds in the Chocolate Mountains
- Recover Salts from Salton Sea
- Salt Concentrating Ponds
- 2000 Draft EIS/EIR Alternative 2: On-Land Evaporation Ponds near Bombay Beach with Tower EES
- 2000 Draft EIS/EIR Alternative 3: On-Land Evaporation Ponds at Salton Sea Test Base with Tower EES

Alternative Concept 5 - Desalination of Inflow, Water Returned to Salton Sea - U.S. Filter Corporation Concept

- U.S. Filter Corporation, New River Desalination or other desalination methodologies, as described in Alternative Concept 6

Alternative Concept 6 - Desalination of Salton Sea Water, Water Returned to Salton Sea

- Vertical Tube Evaporation (VTE) Desalination
- VTE Desalination with In-Salton Sea Displacement Dikes
- Slow Sand Reverse Osmosis Filtration
- Reverse Osmosis with Pump-In/Pump-Out
- Move Yuma Desalting Plant to the Salton Sea

Alternative Concept 7 - Desalination of Salton Sea Water, Water Transferred to Other Uses

- Desalination methodologies, as described in Alternative Concept 6

Alternative Concept 8 - No Salton Sea, Reclaim for Agriculture

- Irrigate with Inflows
- Irrigate with Portion of Inflows and Desalinate/Export Excess

Alternative Concept 9 - Evolving Salton Sea, No Marine Lake

Alternative Concept 10 - Pacific Institute Brackish Wetlands

Alternative Concept 11 - Displacement Dikes

- Different Sizes and Locations

Alternative Concept 12 - In-Salton Sea Evaporation Ponds

- Diked Impoundment, Various Sizes, South End
- 40 Square-Mile Pond at South End, With Seismic Design
- Diked Impoundment, 47 Square Miles, In-Salton Sea Evaporation Basins
- Phased Impoundment
- South End Off-Shore Dike
- Multiple-Dike Proposals
- In-Salton Sea and On-Land Ponds
- 2000 Draft EIS/EIR Alternative 1: Two Evaporation Ponds within the Salton Sea
- On-shore Evaporation Ponds
- 2000 Draft EIS/EIR Alternative 4: In-Salton Sea and On-Land Evaporation Ponds with Tower EES
- 2000 Draft EIS/EIR Alternative 5: In-Salton Sea and On-Land Evaporation Ponds with Ground EES

Alternative Concept 13 - North Lake without Elevation Control

- Southern Pond used as a Evaporation Pond

Alternative Concept 14 - South Lake without Elevation Control

- Diked Impoundment of 127 Square Miles in Northern Third of the Salton Sea
- Low Salton Sea

Alternative Concept 15 - North Marine Lake with Elevation Control

Alternative Concept 16 - South Marine Lake with Elevation Control

Alternative Concept 17 - Salton River

- Salton River with 10-Foot High Dike
- Salton River with 15-Foot High Dike
- Salt River

Alternative Concept 18 - Cascade Concept

Alternative Concept 19 - Replacement Water from Colorado River

- Flood Flows from Colorado River
- Water from Central Arizona Salinity Interceptor (CASI) System
- Water from Potential Tucson Desalination Plant
- Water from Yuma Desalting Plant

Alternative Concept 20 - Replacement Water from Agricultural Land Fallowing

Alternative Concept 21 - Replacement Water from Southern California

- Treated Sewage Effluent
- Northern California Rivers
- East Mesa Groundwater
- Develop Aquifer Systems
- City of Brawley Desalination Proposal
- Phased Approach: Salt Stabilized; Pump-In Later

Alternative Concept 22 - Brine Disposal in Local Wells

- Groundwater Sequestering
- Groundwater Sequestering and Replacement Water

Alternative Concept 23 - Brine Disposal in Geothermal Wells

Alternative Concept 24 - Solar Pond to Generate Power

- Enhanced Evaporation/Solar Pond/Power Generation
- Combination Impoundment/Power Generation/Constructed Wetlands
- Pump-out/Desalination/Solar Generation
- Solar Salt Gradient Pond/MED Desalination Plant with Pump-In/Pump-Out

Alternative Concept 25 - Other Water Treatment Concepts

- Poplar Tree Constructed Wetlands
- Groundwater Pumping, Selenium Management
- Venturi Air Pump
- Air Diffusion/Ultraviolet Ozone System
- Gravel Berms or Pretreatment Reservoirs
- Salton Sea Water Filtration
- Enzyme-Activated
- Pulsed Plasma
- Cleanup of the New River in Mexico
- Surface Aeration
- Collect Irrigation Flows and Treat Inflows to the Salton Sea
- Construct Wetlands to Filter Inflows to the Salton Sea
- Source Control Measures

Alternative Concept 26 - Other Methods

- Combination Freshwater Shoreline/Pumped Storage/Constructed Wetlands
- Combination Solar Power Generation/Pumped Storage/Constructed Wetlands Laguna Salada Salt Disposal
- Diked Impoundment Using Plastic Curtains
- Frontier Aquadyne Enhanced Evaporation
- Environment Enhancing Technologies, Inc. Solar Still Desalination/Colorado River Water Replacement
- Solar Still/Solar Works Disposal

- Floating Solar Still Modules
- Solar Still/Hydro: Physical Technologies/Desalination Plant
- SNAP Technology Enhanced Evaporation Tower
- Gas Turbine/Hydro/Desalination
- Geothermal Power Revitalization
- Heated Pump-Out Solar Membrane Distillation
- Pump-out Disposal of Reject Stream to Yuma
- Freshwater Blending
- Power/Freshwater Cogeneration
- Water Conservation
- Drainage Water Reuse or Blending
- Aquaculture/Evaporation Ponds
- Hydropower/Filtration System
- Electrochemical Extraction
- Land Speed Racetrack
- Electricity Production/Fish Farms/Mining Minerals
- Recreation Facilities/Impoundment/Injections Wells
- Create Salt Marsh
- Use Stabilized Dredged Sediment
- Improve Habitat in Mexico
- Improve Habitat along the Lower Colorado River
- Heat-Pump Evaporation/Condensation System

Alternative Concept 27 - Salton Sea Research Proposals

- Foraminifera Studies
- Potential Use of Study Ponds
- $10 Million Award to Develop a Working Facility

Alternative Concept 1 - Waterway to the Gulf of California

This concept is based on using the Gulf of California as an outlet for salt from the Salton Sea. Pipelines, perhaps with portions of the alignment in canals, would remove enough salty water from the Salton Sea to maintain or reduce salinity concentrations in the Salton Sea to achieve a target concentration. With return of less salty water from the Gulf of California to the Salton Sea, the level of the Salton Sea could also be maintained. Prior analyses indicate that the concept could transport between 100,000 to 400,000 acre-feet annually depending on the specific salinity target and the period of time to achieve the target concentration.

Key Features

This concept requires the construction of major civil works to transport the water. These include pumping stations, pipelines, canals, and electric generation stations for some variations. Figure 2-1 shows the general arrangement of the concept.

Variations

- **Pump-Out using Pipeline** – This concept would remove water from the Salton Sea using pumps and pipelines. Laguna Salada was considered as a possible outlet at the Gulf of California.

- **Pump-Out using Pipelines and Canals –** This is the same as the prior concept, but also would use canals. The use of canals was considered to reduce construction costs.

- **Pump-Out using Pipeline with Return Flow from Gulf of California** – This concept would control salinity by removing water from the Salton Sea and control the elevation of the Salton Sea by returning water to the Salton Sea from the Gulf of California. With similar sized facilities to the Pump-Out concept, the Pump-Out with Return Flow concept would take a longer period of time to stabilize the Salton Sea salinity concentration because the return water would contain salt from the ocean.

- **Pump-Out using Pipeline and Canal with Return Flow from Gulf of California** – This is the same as the prior concept, but also uses canals.

- **Ocean Level Navigation Canal** – This concept would provide a channel between the Gulf of California and the Salton Sea to allow recreational or commercial boat traffic to reach the Salton Sea. Being at ocean level. This concept would raise the level of the Salton Sea by about 240 feet, flooding out massive areas around the existing Salton Sea.

- **Navigable Waterway/Mexicali Salton Seaport** – This would be similar to the previous concept but would provide locks for ships between Mexicali and the Salton Sea. This concept would maintain the elevation of the Salton Sea near the present level.

- **Salt Pond/Shipping Channel/Canals/Desalination Facility** – This concept would be a combination of many different other alternative concepts. It is included here because one of the major components would be a navigable canal between the Gulf of California and the Salton Sea. The canal would be used to convey water pumped between the Salton Sea and the Gulf of California. The concept would also include diked areas within the Salton Sea to evaporate water and a desalination plant that would either return treated water to the Salton Sea or provide the treated water for sale to other users.

- **Gulf of California Pump-In/Pump-Out/Diking/Treated Inflows** – This concept would be a combination of many different alternative concepts. It is included here because one of its major components would be the pump-in and pump-out water exchange with the Gulf of California. The concept would also include diked areas within the Salton Sea to evaporate and concentrate the water before discharge to the Gulf of California. The concept would include water treatment for inflows to provide water for agriculture or other purposes.

- **Diked Impoundment and Conveyance to Gulf of California** – This concept would use a diked impoundment of about 40 square miles along the southern shore of the Salton Sea to concentrate the Salton Sea water. The brine would be pumped using solar powered pumps and conveyed in a pipeline and canal to the Gulf of California. This concept would use discarded tires to armor the dike.

- **Pumped Storage Canal** – This concept would combine a pumped storage power generation facility and a large canal/pipeline between the Salton Sea and the Gulf of California. The Salton Sea would serve as the lower reservoir and the canal would serve as the upper reservoir for the pumped storage facility. Water would be pumped from the Salton Sea during off-peak power periods when energy prices are lower than on-peak periods. Water would flow back to the Salton Sea through the generating units during on-peak periods. A net salt outlet from the Salton Sea would be provided since the volume of water pumped from the Salton Sea would exceed the volume returned to the Salton Sea. In addition, the water returned to the Salton Sea would have somewhat lower salinity than the water discharged from the Salton Sea due to mixing with water from the Gulf of California. The 1998 *Preappraisal Report* eliminated the concept because the topography would be unfavorable for producing power.

- **Yuma Desalting Plant's Bypass Drain** – This concept would discharge water to the Yuma Desalting Plant's bypass drain. The water would eventually flow into the Santa Clara Wetlands in Mexico. The drain currently conveys water with a salinity of about 3,200 mg/l.

- **Reclaimed Water from Yuma/Pump-Out to Gulf of California** – This combination alternative concept would pump water out of the Salton Sea and convey the water to the Gulf of California. The concept would convey replacement water from the Yuma desalination plant brine discharge.

- **Desalination with Brine Pump-Out to Gulf of California** – This combination alternative concept would use a desalination plant to remove salt from the Salton Sea and would convey the brine water to the Gulf of California.

- **Desalination/Solar Pond with Brine Pump-Out to Gulf of California** – This combination alternative concept is similar to the previous variation, but would include a solar pond to remove salt from the Salton Sea.

- **Impoundment/Evaporation Pond/Pipeline-Canal to Gulf of California and/or to Yuma Desalting Plant** – This concept would include a 24 square-mile diked impoundment in the southwestern end of the Salton Sea, a 22 square-mile onshore evaporation pond, and a pump/pipeline/canal system to transport the brine to the Gulf of California or the Yuma Desalting Plant. This concept was described in detail in the 1997 *Alternative Evaluation*, but eliminated from further analysis due to high operation and maintenance costs. The 1998 *Preappraisal Report* eliminated from further analysis due to the large area of land required for facilities and because this was mainly a brine disposal concept.

Characteristics of the Alternative Concepts and the Variations

- Could manage salt concentrations in the Salton Sea.
- Could manage water levels in the Salton Sea if the variation includes return water from the Gulf of California.
- Could enhance and/or maintain tourism and recreation opportunities at the Salton Sea.
- Could provide potential infrastructure benefits to Mexico depending on the variation.
- Capital expenditures appear to be among the highest of any of the alternative concepts.
- International issues of permitting, constructing, operating, and maintaining facilities within Mexico could be a problem.
- Potential exchange of exotic aquatic species between the Salton Sea and the Gulf of California through the transfer of water.
- Variations that do not return water from the Gulf of California would result in smaller surface area and lower elevation of the Salton Sea.
- Variations that return water from the Gulf of California would require much longer periods of time for salinity to stabilize because the salt is not only being discharged from the Salton Sea but is also being returned to the Salton Sea.
- The ocean level canal would flood major areas of the Salton Basin between the present elevation of –227 and a future Salton Sea level at ocean elevation, or would require much greater costs to construct locks to lift ships hundreds of feet between the Salton Sea and the Gulf of California.
- In general, because of the large facilities that need to be completed before the alternative can be effective, the alternative offers little opportunity for phasing of construction over time.

Long-Term Ecosystem Sustainability

The long-term ecosystem sustainability of this alternative concept would be among the best of any of the alternative concepts considered in this report. The salinity of the Salton Sea could be controlled within a narrow range of concentrations as long as the proposed facilities continue to operate. The size of the Salton Sea would depend upon whether ocean water is returned to the Salton Sea or not.

Estimated Operational Life

The operational life of major civil works can generally be expected to be 50 years or more with periodic work to maintain or upgrade the facilities. Assuming adequate funding for operation, maintenance and periodic facility replacement, the operational life could be extended almost indefinitely. The concept would eliminate concerns over continuous increasing salinity concentrations and the need for salt handling and disposal. Since the facilities would likely transfer more water during the initial years of operation to reduce salinity concentrations to a target concentrations, availability of excess capacity after the Salton Sea salinity stabilized would offer some flexibility to adjust to unexpected conditions that may develop in the future.

Prior Evaluations of Concept

- **1974,** *Federal-State Feasibility Study* – The pump-out with return flow concept was eliminated due to exceedingly high cost and international issues. In addition, for the pump-out only concept, the lowered water levels in the Salton Sea were considered to be detrimental to the ecology, particularly the fishery resources, and to the recreational values of the Salton Sea.

- **1988,** *Problems and Potential Solutions at Salton Sea* – The report supports a waterway with appropriate locks to enable pleasure craft to travel between the Salton Sea and the Gulf of California and provide an outlet for salinity at the Salton Sea.

- **1997,** *Salton Sea Alternative Evaluation Final Draft Report* – The concept was eliminated because of high operation and maintenance costs.

- **1998**, *Salton Sea Alternatives, Final Preappraisal Report* - The report concludes that discharging Salton Sea water to the Yuma Desalting Plant's bypass drain should not be evaluated in detail because the Salton Sea water would be too saline for the Santa Clara Wetlands in Mexico. The report rejected the diked impoundment with water pumped with solar power because the facilities could be unrealiable and expensive. The report listed other pump-out and pump-in water exchanges with the Gulf of California but did not consider them in detail. The report eliminated the navigable water way concept because it would not achieve the salinity targets in this report.

- **1999**, *Salton Sea Restoration Alternatives Packet* – The packet mentions the concept as one of the highest ranking alternatives from the November 1998 screening process.

- **2000**, *Draft Salton Sea Restoration Project Environmental Impact Statement/Environmental Impact Report* – The report retained the concept of pumping water to the Gulf of California as a future Phase 2 action after 2030, if needed.

- **2003**, *Salton Sea Study, Status Report* – The report concluded that due to expense of all alternatives, a recommendation could not made on any alternative until Congress determined the priority for funding the Salton Sea concepts.

- **2004**, *Salton Sea Restoration, Final Preferred Project Report* – The report concluded that the alternative could have significant permitting challenges and be extremely costly.

Alternative Concept 2 - Waterway to the Pacific Ocean

This alternative concept is based on using the Pacific Ocean as an outlet for salt from the Salton Sea. Pipelines would remove enough salty water from the Salton Sea to maintain or reduce salinity concentrations in the Salton Sea. The various alignments would require lifting water about 3000 feet in elevation to pass over the mountains. With return of less salty water from the Pacific Ocean to the Salton Sea, the elevation of the Salton Sea can also be maintained. Prior analyses indicate that the concept could transport between 100,000 to 400,000 acre-feet annually depending on the specific salinity target and the period of time to achieve the target concentration.

Key Features

This concept would require the construction of major civil works to transport the water. These facilities include pumping stations, pipelines, tunnels, outlet diffusers, and potentially electric generation stations to recover energy. Figure 2-2 shows the general arrangement of the alternative concept.

Variations

Variations could include different alignments, facility sizes, and operational parameters. The concept could discharge water to the ocean with or without returning ocean water to the Salton Sea. Conveyance alignments to the Hyperion Wastewater Treatment Plan in Los Angeles, to Camp Pendleton, and to the Point Loma Wastewater treatment Plans in San Diego were considered in the 1998 *Preappraisal Report*.

- **Pump-Out to the Pacific Ocean** – This concept would remove water from the Salton Sea and discharge it to the Pacific Ocean.

- **Pump-Out and Pump-In to the Pacific Ocean** – This concept would pump water to the Pacific Ocean from the Salton Sea and would also convey ocean water to the Salton Sea.

- **Reclaimed Water from Yuma Desalting Plant/Pump-Out to Pacific Ocean** – This combination alternative concept would pump water out of the Salton Sea to the Pacific Ocean and would convey replacement water from the Yuma desalting plant brine discharge to the Salton Sea.

Characteristics of the Alternative Concepts and the Variations

- Could manage salt concentrations in the Salton Sea.
- Could manage water levels in the Salton Sea if the variation includes return water from the Pacific Ocean.
- Could enhance and/or maintain tourism and recreation opportunities at the Salton Sea.
- Capital expenditures appear to be among the highest of any of the alternative concepts.
- Potential exchange of exotic aquatic species between the Salton Sea and the Pacific Ocean through the transfer of water.
- Variations that do not return water from the Pacific Ocean would result in smaller surface area and lower elevation of the Salton Sea.
- Variations that return water from the Pacific Ocean would require much longer periods of time for salinity to stabilize because the salt is not only being discharged from the Salton Sea but is also being returned to the Salton Sea.
- In general, because of the large facilities that need to be completed before the alternative can be effective, the alternative offers little opportunity for phasing of construction over time.

Long-Term Ecosystem Sustainability

The long-term ecosystem sustainability of this alternative concept would be similar to Alterantive Concept 1 and among the best of any of the alternative concepts considered in this report. The salinity of the Salton Sea could be controlled within a narrow range of concentrations as long as the proposed facilities continue to operate. The size of the Salton Sea would depend upon whether ocean water is returned to the Salton Sea or not.

Estimated Operational Life

The operational life of major civil works can generally be expected to be 50 years or more with periodic work to maintain or upgrade the facilities, as described in Alternative Concept 1. Assuming adequate funding for operation, maintenance and periodic facility replacement, the operational life could be extended almost indefinitely. The concept would eliminate concerns over continuous increasing salinity concentrations and the need for salt handling and disposal. Since the facilities would likely transfer more water during the initial years of operation to reduce salinity concentrations to a target concentrations, availability of excess capacity after the Salton Sea salinity stabilized would offer some flexibility to adjust to unexpected conditions that may develop in the future.

Prior Evaluations of Concept

- **1969,** *Federal-State Reconnaissance Report* – The report concluded that a connection with the ocean was not evaluated for technical, economic and institutional reasons.

- **1997,** *Salton Sea Alternative Evaluation Final Draft Report* – The concept was eliminated because of high operation and maintenance costs.

- **1998**, *Salton Sea Alternatives, Final Preappraisal Report* - The report listed the concept but did not eliminate the concept.

- **1999**, *Salton Sea Restoration Alternatives Packet* – The packet mentions the concept as one of the highest ranking alternatives from the November 1998 screening process.

- **2000**, *Draft Salton Sea Restoration Project Environmental Impact Statement/Environmental Impact Report* – The report retained the concept of pumping water to the Pacific Ocean as a future Phase 2 action after 2030, if needed.

- **2004**, *Salton Sea Restoration, Final Preferred Project Report* – The report concluded that the alternative could have significant permitting challenges and be extremely costly.

Alternative Concept 3 - Pump-Out to Dry Lakes

This concept is based on using the dry lakes in the vicinity of the Salton Sea as disposal site for salt from the Salton Sea. Pipelines would convey salty water from the Salton Sea to maintain or reduce salinity concentrations in the Salton Sea. Prior studies estimated initial pumping between 200,000 and 400,000 acre-feet annually.

Key Features

Key features include a pipeline and as many as 6 pumping station to move water from the Salton Sea to one of the dry lakes. One or more dams may be required at the dry lakes to contain the water to certain areas. Figure 2-3 shows the general arrangement of the concept.

Variations

- **Pump-Out to Palen Dry Lake** – This concept would pump and convey water out of the Salton Sea to Palen Lake, located about 45 miles east of the Salton Sea. The concept would require pumping water to an elevation about 1, 800 feet higher than the Salton Sea.

- **Pump-Out to Ford Dry Lake** – This concept would pump and convey water out of the Salton Sea to Ford Dry Lake, located about 50 miles east of the Salton Sea. The concept would require pumping water to an elevation about 1,800 feet higher than the Salton Sea.

- **Pump-Out to Clark Dry Lake** – This concept would pump and convey water out of the Salton Sea to Clark Dry Lake, located about 23 miles west of Salton Sea. The concept would require pumping water to an elevation about 1,300 feet higher than the Salton Sea. Clark Lake would not have the storage capacity of Palen and Ford dry lakes.

- **Diked Impoundment, 30 Square Miles with Pumping to Dry Lake** – This concept would use a combination of dikes to form evaporation ponds, and facilities pump and convey water from the evaporation ponds to the dry lakes. The concept would use a 30 square mile diked evaporation pond at the southern end of the Salton Sea. About 65,000 acre-feet per year of concentrated salt water in the evaporation pond would be pumped and conveyed through a pipeline to Palen Dry Lake, northeast of the Salton Sea. A dam constructed at Palen Dry Lake would form a brine disposal area. The 1974 *Federal-State Feasibility Study* retained this alternative for further evaluation.

- **Diked Impoundment, 30 Square Miles with Maximum Pumping to Dry Lake –** This concept is the same as the above variation with discharge to Palen Dry Lake but would include pumping replacement water from the East Mesa groundwater basin through the East Highline Canal to maintain the elevation of the Salton Sea. The 1974 *Federal-State Feasibility Study* retained this alternative for further evaluation. The 1997 *Alternative Evaluation Final Draft Report* eliminated the concept from further evaluation because of poor water quality, low yield of the aquifer wells, hydraulic connection between canals and the aquifer, high operation and maintenance costs, and potential impact on groundwater gradient to Mexico. The 1997 report also evaluated an alternative with the same facilities but with 135,000 acre-feet per year pumping of concentrated salt water to Palen Dry Lake. This alternative also was eliminated from further consideration for the same reasons as the alternative with the 65,000 acre-feet per year pumping.

Characteristics of the Alternative Concepts and the Variations

- Could manage salt concentrations in the Salton Sea.
- Discharging salt water to the dry lakes could change habitat and other environmental characteristics.
- Removal of water from the Salton Sea would lower the elevation of the Salton Sea, change the shoreline area, and expose areas currently inundated.
- Construction and annual operating costs would be higher than other concepts.
- In general, because of the large facilities that need to be completed before the alternative can be effective, the alternative offers little opportunity for phasing of construction over time.

Long-Term Ecosystem Sustainability

Although the Salton Sea salinity would be controlled, the Salton Sea would stabilize at a lower elevation as water is pumped-out to the dry lakes without the use of diked areas and/or replacement water. Environmental conditions would be sustainable as long as capacity remains at the dry lake and if required, replacement water is available.

Estimated Operational Life

The operational life of major civil works can generally be expected to be 50 years or more with periodic work to maintain or upgrade the facilities. Assuming adequate funding for operation, maintenance and periodic facility replacement, the operational life could be extended to at least 100 years. Salt would eventually fill the available storage area at the dry lakes and a different disposal area for the salt would be needed to continue operation. To maintain the salinity of the Salton Sea at a constant level, about 1,400 acre-feet of rock salt storage would be required each year.

Prior Evaluations of Concept

- **1974,** *Federal-State Feasibility Study* – The pump-out only concept was eliminated because none of the dry lakes would have the capacity to receive and evaporate 250,000 acre-feet of water per year. The report did retain the two variations that used evaporation ponds in the Salton Sea to reduce the volume of water that would be discharged to Palen Dry Lake.

- **1997,** *Salton Sea Alternative Evaluation Final Draft Report* – The concept was eliminated from further evaluation because of high operation and maintenance costs. The report also mentioned environmental impacts that could occur at the dry lakes could be a major concern.

- **1998**, *Salton Sea Alternatives, Final Preappraisal Report* - The report concluded that Clark Lake would be too small and eliminated the site from further evaluation. The report listed the Palen Dry Lake concept, but did evaluate the alternative.

- **2000**, *Draft Salton Sea Restoration Project Environmental Impact Statement/Environmental Impact Report* – The report retained the idea of pumping water to Palen Dry Lake as a future Phase 2 action after 2030, if needed.

- **2004**, *Salton Sea Restoration, Final Preferred Project Report* – The report concluded that the alternative could have significant permitting challenges and be extremely costly.

Alternative Concept 4 - Onshore Evaporation Ponds

This concept would use evaporation ponds located on land near the Salton Sea. Water from the Salton Sea would be pumped into the evaporation ponds, providing the Salton Sea with an outlet for salts. The length of time for the main body of the Salton Sea to reach a target salinity concentration would depend on the size of the ponds and the amount of water that could be discharged from the Salton Sea to the ponds. Water discharged from the Salton Sea would initially carry a higher salt load than the water entering the Salton Sea. After the salinity of the Salton Sea stabilized at an acceptable level, the flow rate and salt load discharged to the evaporation ponds would be reduced. Prior studies have considered many different locations and sizes of evaporation ponds with surface areas generally ranging from 30 to 60 square miles. The surface area could be reduced by about 50 percent with the use of a mechanical system to enhance evaporation, or Enhanced Evaporation Systems (EES).

Key Features

This concept would require excavated and diked pond areas on land adjacent to the Salton Sea with lining of the pond areas to protect groundwater quantity and quality. Pump station(s) and pipelines would be used to deliver water from the Salton Sea to the ponds. Landfill areas for crystallized salt or use of a brine disposal method as described in other alternative concepts would be required for salt disposal. Some variations could used tower or ground based EES. Figure 2-4 shows the general arrangement of the concept.

Variations

- **110 Square Miles of Evaporation Ponds** – Prior work did not identify specific locations for the ponds but indicated that the southeastern shore of the Salton Sea, between Bombay Beach and Red Hill, would be a potential location. This variation would initially evaporate about 400,000 acre-feet per year until the Salton Sea salinity concentration would reach a the target salinity. After the target salinity concentration would be achieved, the evaporation ponds could be downsized and the remaining area could be used for salt storage.

- **Ground-Based Enhanced Evaporation Systems (EES)** – This proposal would involve spraying water into the air with equipment similar to snowmaking equipment. This would accelerate the water evaporation. Estimates indicate that EES could reduce the required size of the evaporation ponds by 50 percent.

- **Tower EES** – This proposal would construct towers with connecting in-line spray lines that would be located above evaporation ponds.

- **In-Salton Sea and On-Land Ponds** – This proposal would use a combination of evaporation ponds located within the Salton Sea, such as described under Alternative Concept 12, and evaporation ponds located on adjacent land.

- **Pump-out Canal/Dam System to Base of Chocolate Mountains** – This alternative concept would provide a canal/dam system to transport Salton Sea water to the base of the Chocolate Mountains to provide an outlet for salinity from the Salton Sea. Previous reports provided insufficient data on how this variation would function. Without construction of some type of evaporation reservoir, pumped water would drain immediately back to the Salton Sea. The 1997 *Alternative Evaluation* report eliminated this variation from further consideration because the

concept as evaluated would not reduce salinity to a targeted level or control the Salton Sea elevation.

- **Evaporation Ponds in the Chocolate Mountains** – This concept is similar to the previous variation but would require high levees and specialized structural engineering at the evaporation ponds to retain the water since the topography is steep.

- **Recover Salts from Salton Sea** – This concept would include construction of a commercial saltworks adjacent to the evaporation ponds to reclaim and market the salt. The 1998 *Preappraisal Report* eliminated the concept from further evaluation because this variation did not address methods to achieve salinity or elevation targets at the Salton Sea. The report noted that this variation could be used with other alternatives to produce salt.

- **Salt Concentrating Ponds –** This proposal would use ponds to concentrate salt prior to pumping water out of the Salton Sea basin. This would reduce the amount of water that would need to be conveyed, resulting in smaller facility sizes.

- **2000 Draft EIS/EIR Alternative 2: On-Land Evaporation Ponds near Bombay Beach with Tower EES** – This concept would include about 17 square-miles of tower EES located north of Bombay Beach. The EES would process about 150,000 acre-feet per year of water from the Salton Sea. A displacement dike could be added at the southern end of the Salton Sea if inflows drop in the future. This alternative concept was evaluated through several sub-variations. One or two displacement dikes, as described in Alternative Concept 11, could be added at the southern end of the Salton Sea if inflows drop in the future. Phase 2 could remove approximately 150,000 acre-feet per year of Salton Sea water to the Gulf of California, the Pacific Ocean, or Palen Dry Lake, as described in Alternative Concepts 1, 2, and 3. Future actions could also include import of replacement water from the Central Arizona Salinity Interceptor, Colorado River flood flows, as described in Alternative Concept 19, or other water sources.

- **2000 Draft EIS/EIR Alternative 3: On-Land Evaporation Ponds at Salton Sea Test Base with Tower EES** – This variation would be similar to the previous concept except that the ponds and EES would be located at the Salton Sea Test Base.

Characteristics of the Alternative Concepts and the Variations

- Some pond area coulc be reclaimed after the Salton Sea salinity reaches the target salinity.
- Some pond area could be used for salt storage once the Salton Sea salinity reaches the target salinity.
- Requires large land acquisition and change of land use.
- Discharge of water from the Salton Sea to the evaporation ponds would further reduce the surface area and elevation of the Salton Sea from current conditions.
- Need the largest pond area early in the process to lower the Salton Sea salinity with the reduced inflow offers little opportunity for phasing of construction over time.

Long-Term Ecosystem Sustainability

The Salton Sea salinity would be controlled and the Salton Sea would stabilize at a lower elevation due to the pump-out. Environmental conditions with the lower Salton Sea level should be sustainable as long as the evaporation ponds continue operation.

Estimated Operational Life

The operational life of major civil works can generally be expected to be 50 years or more with periodic work to maintain or upgrade the facilities. Assuming adequate funding for operation, maintenance and periodic facility replacement, the operational life could be extended to at least 100 years. Salt would eventually fill the available storage area and new locations for land filling salt or providing an outlet for the salt would be needed for the alternative to continue operation. Just to maintain the salinity of the Salton Sea at a constant level a rock salt landfill about 30 feet deep and 50 acres in area would be required each year.

Prior Evaluations of Concept

- **1997,** *Salton Sea Alternative Evaluation*, Final Draft Report – The report concluded that evaporation ponds would not be economical compared with in-Salton Sea evaporation ponds because of the excessive land acquisition requirements and costs.

- **1998**, *Salton Sea Alternatives, Final Preappraisal Report* - The report concluded that evaporation ponds in the Chocolate Mountains would not be practical because of the steep terrain and eliminates the ponds on the flat land near the Salton Sea because the amount of land required and the concept would not maintain the elevation of the Salton Sea.

- **1999**, *Salton Sea Restoration Alternatives Packet* – The packet introduced the alternatives for the 2000 Draft EIS/EIR that included onshore evaporation ponds.

- **2000**, *Draft Salton Sea Restoration Project Environmental Impact Statement/Environmental Impact Report* – The report evaluated five alternatives but did not select a preferred project alternative.

- **2003**, *Salton Sea Study, Status Report* – The report concluded that due to expense of all alternatives, a recommendation could not made on any alternative until Congress determined the priority for funding of Salton Sea restoration.

- **2004**, *Salton Sea Restoration, Final Preferred Project Report* – The report concluded that the alternative would include significant problems due to the large land area required and high operation and maintenance costs.

Alternative Concept 5 - Desalination of Inflow, Water Returned to Salton Sea - U.S. Filter Corporation Concept

This concept would use desalination plants to remove salts from tributaries of the Salton Sea. It would be effective if salinity levels are lower than current salinity concentrations. This concept could be combined with other concepts to lower the Salton Sea salinity concentrations.

Key Features

This concept would include desalination plant(s). The concept would require major facilities to desalinate between 800,000 and 1,000,000 acre-feet per year of water from the tributaries. Brine disposal would occur as described in other alternative concepts. Figure 2-5 shows the general arrangement of the concept.

Variations

- **U.S. Filter Corporation, New River Desalination** – This concept would use products developed by U.S. Filter Corporation, or others, to improve the quality of water in the New River.

- Additional desalination technologies are described under Alternative Concept 6.

Characteristics of the Alternative Concepts and the Variations

- Would reduce the rate of salinity increase of the Salton Sea.
- Would not totally decrease the salinity of the Salton Sea from current levels.
- Salinity of the Salton Sea would continue to increase.
- Would reduce the inflow to the Salton Sea since the brine generated from desalination would disposed of outside of the Salton Sea - although method and location for brine disposal is unknown.
- This concept would have high costs related to the volume of inflow water to be treated.
- In general, because of the large facilities that need to be completed before the concept can be effective, the concept offers little opportunity for phasing of construction over time.

Long-Term Ecosystem Sustainability

Long-term sustainability is poor since salinity would continue to increase, but at a slower rate than in the past.

Estimated Operational Life

The operational life of a desalination plant may be expected to be about 30 years assuming adequate funding for operation, maintenance. With funding for periodic maintenance and facility replacement, the operational life could be extended to beyond 100 years. Replacement of components within the treatment plant would be required on a regular basis. For example, a reverse osmosis desalination plant that treats brackish water typically requires about 5 percent of the membranes to be replaced each year. Salt would eventually fill the available storage areas and new locations for land filling salt or providing an outlet for the salt would be needed for the alternative to continue operation. To maintain the salinity of the Salton Sea at a constant level, a rock salt landfill about 30 feet deep and 50 acres in area would be required each year.

Prior Evaluations of Concept

- **1974,** *Federal-State Feasibility Study* – The study eliminated the concept from further evaluation because several treatment plants would be required at the various inflow points and would have high capital and operation costs.

- **1997,** *Salton Sea Alternative Evaluation Final Draft Report* – The concept was eliminated from further evaluation because of high operation and maintenance costs. In addition, the report noted that the concept would not be as effective if the salinity was lower. The report mentioned concern over the effectiveness of some of the technologies at the scale required at the Salton Sea.

- **1998**, *Salton Sea Alternatives, Final Preappraisal Report* - The report eliminated the concept from further evaluation because the concept would not meet salinity or elevation targets for the Salton Sea.

Alternative Concept 6 - Desalination of Salton Sea, Water Returned to Salton Sea

This concept would use a desalination plant(s) to remove salts from the Salton Sea. The treated water would be returned to the Salton Sea to help maintain the Salton Sea elevation. The brine water from the process would need to be handled in one of the disposal methods described in the other alternative concepts.

Key Features

This alternative includes desalination plant(s) and brine disposal as described in other alternative concepts. Figure 2-6 shows the general arrangement of the concept.

Variations

- **Vertical Tube Evaporation (VTE) Desalination –** This concept would use VTE technology powered by the waste stream from geothermal energy plants in the area. Salt brine would be disposed in an on-land pond or injected into a geothermal formation.

- **VTE Desalination with In-Salton Sea Displacement Dikes** – This concept is similar to the above variation but would include displacement dikes (as described in Alternative Concept 11) within the Salton Sea that could be used for brine disposal and to maintain the elevation of the Salton Sea.

- **Slow Sand Reverse Osmosis Filtration** – This proposal would combine slow sand filtration, and/or nanofiltration with reverse osmosis to remove salt. The sand filtration would remove the organic material. The nanofiltration would reject macro molecules. The two filtrations would eliminate major fowling problems associated with high dissolved solids applications and allow the reverse osmosis unit to run at a higher efficiency and have a longer membrane life.

- **Reverse Osmosis with Pump-In/Pump-Out** – The concept would be a phased project where 170,000 acre-feet per year would initially be pumped-out to one of the dry lakes, the Pacific Ocean or the Gulf of California. The desalination plant would be added later with 60,000 acre-feet per year returned to the Salton Sea to help maintain the salinity and elevation of the Salton Sea. The 1998 *Preappraisal Report* contains more detail on this proposal.

- **Move Yuma Desalting Plant to the Salton Sea** – The concept would move the Yuma Desalting Plant to the Salton Sea. The plant would need to be updated and maintained for use when needed.

Characteristics of the Alternative Concepts and the Variations

- Would control salinity of the Salton Sea.
- Would reduce the inflow to the Salton Sea due to disposal of brine outside of the Salton Sea.
- Would require brine disposal area.
- Could enhance and/or maintain tourism and recreation opportunities at the Salton Sea.
- In general, because of the large facilities that need to be completed before the alternative can be effective, the alternative offers little opportunity for phasing of construction over time.

Long-Term Ecosystem Sustainability

The long-term ecosystem sustainability of this alternative would be among the best of any alternative. The salinity of the Salton Sea could be controlled within a narrow range as long as the proposed facilities continue to operate.

Estimated Operational Life

The operational life of a desalination plant may be expected to be about 30 years assuming adequate funding for operation, maintenance. With funding for periodic maintenance and facility replacement, the operational life could be extended to beyond 100 years. Replacement of components within the treatment plant would be required on a regular basis. For example, a reverse osmosis desalination plant that treats water with ocean salinity typically requires about 20 percent of the membranes to be replaced each year. Salt would eventually fill the available storage areas and new locations for land filling salt or providing an outlet for the salt would be needed for the alternative to continue operation. To maintain the salinity of the Salton Sea at a constant level a rock salt landfill about 30 feet deep and 50 acres in area would be required each year.

Prior Evaluations of Concept

- **1969,** *Federal-State Reconnaissance Report* – The report concluded that desalination should not be considered further for technical, economic and institutional reasons.

- **1974,** *Federal-State Feasibility Study* – The study eliminated the desalination concept from further consideration because due to high costs.

- **1997,** *Salton Sea Alternative Evaluation Final Draft Report* – The concept was eliminated because of high operation and maintenance costs. In addition, the report noted that the concept would be more effective at lower salinity concentrations. The report mentioned concern over the effectiveness of some of the technologies at the scale required at the Salton Sea.

- **1998,** *Salton Sea Alternatives, Final Preappraisal Report* – The report concluded that moving the Yuma Desalting Plant would not be feasible since the Yuma Desalting Plant may still be needed on the Colorado River system. The Yuma Desalting Plant also was not designed to desalt water saltier than ocean water, and therefore may require extensive modifications.

- **1999**, *Salton Sea Restoration Alternatives Packet* – The packet mentioned the concept as one of the highest ranking alternatives from the November 1998 screening process.

- **2003**, *Salton Sea Study, Status Report* – The report concluded that due to high expenses, a recommendation could not made on any alternative until Congress determined the funding for the Salton Sea restoration.
- **2004**, *Salton Sea Restoration, Final Preferred Project Report* – The report noted that most desalination technologies evaluated in the past were eliminated from further evaluation because of the high cost of energy.

Alternative Concept 7 - Desalination, Water Transferred to Other Uses

This concept could either use a desalination plant(s) to desalt water from the Salton Sea or to desalt water from the tributaries to produce water for use outside the Salton Sea. Desalination in this alternative is different than the other desalination alternatives in that it produces water that would be sold. Revenue from the water sales could be used to fund Salton Sea restoration activities.

Key Features

This alternative concept includes a desalination plant(s) to treat tributary flows, brine disposal as described in other alternative concepts, and may need pumps and pipelines to deliver treated water to users that purchased the water. Figure 2-7 shows the general arrangement of the concept.

Variations

- Desalination technologies would be the same as in Alternative Concept 6.

Characteristics of the Alternative Concepts and the Variations

- Could control salinity of the Salton Sea.
- Would not control salinity of the Salton Sea if the inflow rivers are the source water for the desalination plants.
- Removal of water from the Salton Sea or reducing inflow to produce water for sale would reduce the elevation of the Salton Sea.
- Construction of desalination facilities could easily be phased over time; an initial desalination unit could function as a pilot plant to test the concept and the market for the water with additional unit(s) added at a later time.
- Selling of water from the Salton Sea would reduce the surface area of the Salton Sea.
- This alternative concept would require components from other alternative concepts.
- May only be viable for use with alternative concepts that provide reduced surface areas of the Salton Sea.
- Could provide a revenue source for use in Salton Sea restoration.

Long-Term Ecosystem Sustainability

Ecosystem sustainability depends on what other alternative concepts would be used. The revenue source would contribute to the long-term sustainability of this alternative concept.

Estimated Operational Life

The operational life of a desalination plant may be expected to be about 30 years assuming adequate funding for operation, maintenance. With funding for periodic facility replacement, the operational life could be extended to beyond 100 years. Replacement of components within the treatment plant would be required on a regular basis. For example, a reverse osmosis desalination plant that treats water with ocean salinity typically requires about 20 percent of the membranes to be replaced each year. Salt would eventually fill the available storage areas and new locations for land filling salt or providing an outlet for the salt would be needed for the alternative to continue operation. Just to maintain the salinity of the

Salton Sea at a constant level a rock salt landfill about 30 feet deep and 50 acres in area would be required each year.

Prior Evaluations of Concept

- **2004**, *Salton Sea Restoration, Final Preferred Project Report* – The report concluded that with reduced inflows, the desalination system would need to be extremely large and would be expensive. Transferring the product water to other uses would further reduce the surface area in the Salton Sea.

Alternative Concept 8 - No Salton Sea, Reclaim for Agriculture

This concept would reclaim area in the Salton Sea for agriculture as the Salton Sea recedes. Reduced inflows would lower the Salton Sea level in the No Action Alternative and expose land. The amount of reclaimed agricultural land could be up to 200,000acres or more.

Key Features

This alternative concept would include irrigation water distribution systems, on-farm infrastructure for the expanded agricultural areas, include some portion of the Salton Sea to remain as a sump for agricultural drainage water, possibly use reservoirs to regulate the river flows, and treatment of river flows for irrigation or a desalination plant(s).
Figure 2-8 shows the general arrangement of the concept.

Variations

- **Irrigate with Inflows** - This concept would use inflow to the Salton Sea for irrigation of exposed Salton Sea bed. This may require reservoirs to regulate the river flows and may require treatment of the flows before irrigation or the use of salt tolerant crops.

- **Irrigate with Portion of Inflows and Desalinate/Export Excess** – To help balance the flows in the rivers with that used for irrigation, a portion of the inflows could be desalinated and exported for municipal use.

Characteristics of the Alternative Concepts and the Variations

- Would require a detailed water balance between flows in the rivers, water used for irrigation of the exposed Salton Sea bed, and the size of the remaining Salton Sea.
- Implementation of this alternative could be phased over time. Agricultural land would be reclaimed as the Salton Sea recedes.
- Water may require treatment before use for irrigation or use of salt tolerant crops.
- Would require some area in the Salton Sea as a agricultural sump.
- Salt would continue to accumulate in the smaller Salton Sea.
- The reclaimed farmland may be vulnerable to reflooding during periods of high runoff.
- The requirement for salt leaching from the exposed soils and the amount of drain water created is unknown at this time. The drain water would contribute to the size of the remaining Salton Sea.

Long-Term Ecosystem Sustainability

The ecosystem would be different under this alternative concept than the other alternative concepts that control the salinity in the Salton Sea. New habitat would be developed associated with the farmland, and may be sustainable as long as farming is continued.

Estimated Operational Life

Assuming adequate funding for operation, maintenance and periodic facility replacement of the irrigation system, the operational life could be extended almost indefinitely. However, salt from the drainage flows into the Salton Sea could eventually fill the available storage areas and new locations for land filling salt or providing an outlet for the salt would be needed for the alternative to continue operation. The salt

entering the Salton Sea each year could fill a landfill about 30 feet deep and 50 acres in area each year. Eventually, some agricultural land may need to be used to make more area available for salt storage.

Prior Evaluations of Concept

This concept has never evaluated in previous reports.

ALTERNATIVE CONCEPT 9 - EVOLVING SALTON SEA (NO MARINE LAKE)

This concept is based on the fact that the Salton Sea has continuously changed since the first day of the most recent inundation in 1905. Variability in natural conditions and human influenced conditions has caused the Salton Sea to evolve with each passing year. This concept recognizes the trajectory of change and would enhance the Salton Sea as it changes. This concept would be similar to the No Action Alternative, but would include enhancements to the lands exposed by the shrinking Salton Sea. Eventually, salinity in the Salton Sea would become similar to salinity in Mono Lake and then to the salinity in the Great Salt Lake. Higher salinities would provide habitat that would be different than current habitat. This alternative concept would not control salinity or elevation of the Salton Sea.

Key Features

The Salton Sea with higher salinities and exposed areas would be available for a variety of habitats. Portions of the exposed area could be developed into shoreline habitat, mudflats, shallow wetlands, agriculture and other uses that would maintain and enhance the wildlife diversity of the area. Figure 2-9 shows the general arrangement of the concept.

Variations

No identified variations. Variations for use of the exposed lands can be developed in more detail if this concept is retained for further analysis.

Characteristics of the Alternative Concepts and the Variations

- Would be relatively inexpensive as compared to other alternative concepts.
- Would allow incremental implementation as the Salton Sea salinity and elevation changes.
- Flexibility to changing conditions including inflow conditions.
- Could support diverse wildlife.
- Would not provide for the salinity or elevation control.
- Would not support historic or present recreational or economic opportunities.
- The evolution of the Salton Sea physical characteristics may change faster than wildlife can adapt.

Long-Term Ecosystem Sustainability

The concept may be one of the most sustainable of any alternative concept because it recognizes and supports the changing of the Salton Sea.

Estimated Operational Life

The operational life of the alternative is indefinite due to dynamic nature of the improvements over time, but would require periodic changes in the plan.

Prior Evaluations of Concept

- **2004**, *Salton Sea Restoration, Final Preferred Project Report* - The report considered a concept similar to the No Action Alternative, but did not include the concept of enhancement of the Salton Sea.

Alternative Concept 10 - Pacific Institute Diked Improvements

This concept is based constructing dikes within the Salton Sea near the north and south shores to capture inflows and stabilize the water surface at elevation -230 feet. The Whitewater River would enter the northern area and the New and Alamo River would enter the south area. The impounded areas would quickly become brackish. Inflows would pass through the impounded areas and discharge to the main body of the Salton Sea. The concept also includes constructed wetlands along the Alamo and New rivers and the implementation of management practices to reduce nutrient loads that enter the Salton Sea. The alternative does not include salinity or elevation controls for the main body of the Salton Sea.

Key Features

The facilities would include about 45 miles of dikes if constructed with depths of 15 feet of water. The northern impoundment would be characterized by about 2010 acres and a volume of about 9000 acre-feet. The southern impoundment would be characterized by about 26,800 acres and a volume of about 181,000 acre-feet. Overflows and channels from the impoundments to the main body of the Salton Sea would be included. About 9000 acres of constructed wetlands would be located along the New and Alamo rivers. Figure 2-10 shows the general arrangement of the concept.

Variations

To provide a structure for the evaluation, the February 2002 *Evaluation of a Proposal for Conservation of the Salton Sea Ecosystem* made assumptions about the configuration were the detail was not provided in the Pacific Institute proposal. For example, the evaluation assumed the northern dike would be constructed along the -240 foot contour and the southern dike would be constructed along the -245 contour. The report considered that the larger impoundments could mitigate many of the potential issues.

Characteristics of the Alternative Concepts and the Variations

- The main body of the Salton Sea would decline and increase in salinity.
- Could be constructed at any time and the impounded areas would quickly witin weeks or months become brackish.
- Implementation of the various portions could easily be phased without jeopardizing the total implementation.
- The elevation and salinity stability of the impounded areas may initially promote recreation and economic development, but the characteristics will change over time.
- New fisheries habitat and freshwater food web would quickly be established within the impoundments to provide food sources for fish eating birds. However, there may be less fish and they may be more subject to accumulation of contaminants. Fish would not occur in the main body of the Salton Sea.
- The impoundments would likely experience more frequent and more extreme temperature fluctuations than the present Salton Sea.
- Would increase abundance of biting insects, parasites and pathogens in the brackish impoundments.
- Vascular plants would become abundant in the impoundments and along the shoreline.

Long-Term Ecosystem Sustainability

The February 2002, *Evaluation of a Proposal for Conservation of the Salton Sea Ecosystem* concluded that the concept would not be sustainable due to water quality and shallow water depths.

Estimated Operational Life

The operational life of major civil works can generally be expected to be 50 years or more with adequate funding for operation, maintenance, and periodic work to upgrade the facilities. However, without providing reasonable ecosystem sustainability, the practical operational life may only be a few years.

Prior Evaluations of Concept

- **2001**, A *Proposal to Preserve and Enhance Habitat at the Salton Sea* – The report presented the concept for consideration for restoration of the Salton Sea.

- **2002**, *Evaluation of a Proposal for Conservation of the Salton Sea Ecosystem* – The report presented many potentially negative impacts of this concepts, including increased abundance of parasites and vectors and increased selenium levels.

- **2003**, *Salton Sea Study, Status Report* – The report concluded that due to expense of alternatives, a recommendation could not made on any alternatives until Congress determined funding for the Salton Sea restoration.

- **2004**, *Salton Sea Restoration, Final Preferred Project Report* – The report concluded that the alternative may create water quality and health impacts for wildlife and humans and would be expensive to implement.

Alternative Concept 11 - Displacement Dikes

This concept is based diking off portions of the Salton Sea to reduce the surface area of the Salton Sea and maintain the Salton Sea elevation. The area surrounded by dikes could also be used as solar evaporation ponds.

Key Features

The facilities would include dikes, and potentially solar evaporation ponds. Figure 2-11 shows the general arrangement of the concept.

Variations

The variations would be related to different locations and sizes.

Characteristics of the Alternative Concepts and the Variations

- If multiple diked areas were used, it would be possible to phase construction as the inflow to the Salton Sea recedes.
- Diked areas could be used as solar evaporation ponds.
- Displacement dikes would probably be used with other alternative concepts.
- Reduction in inflows to the Salton Sea would require dikes to be constructed in deeper water and to enclose extremely large areas to be effective, making them very expensive.

Long-Term Ecosystem Sustainability

Displacement dikes alone would not do much to improve the ecosystem. As inflows decrease in the No Action Alternative, displacement dikes could be stranded above the Salton Sea water level, rendering them useless for water elevation control. Therefore, displacement dikes are unlikely to contribute significantly to long-term ecosystem sustainability.

Estimated Operational Life

The operational life of major civil works can generally be expected to be 50 years or more with adequate funding for operation, maintenance, and periodic work to upgrade the facilities. However, unless constructed in deep water and surrounding extremely large areas, displacement dikes could become stranded above the Salton Sea level, rendering them useless for their intended purpose.

Prior Evaluations of Concept

- **2000**, *Draft Salton Sea Restoration Project Environmental Impact Statement/Environmental Impact Report* – The report evaluated five alternatives that included displacement dikes as a potential future phase, but did not select a preferred project alternative.

- **2003**, *Salton Sea Study, Status Report* – The report concluded that due to expense of all alternatives, a recommendation could not made on any alternative until Congress determined the funding for the Salton Sea restoration.

Displacement dikes are components of other alternative concepts described in this chapter.

Alternative Concept 12 - In-Salton Sea Evaporation Ponds

This concept involves constructing dikes within the Salton Sea to isolate areas for use as evaporation ponds. Water from the Salton Sea would be discharged into evaporation ponds, providing the Salton Sea with an outlet for salts. A series of eight to twelve shallow solar evaporation ponds would concentrate the salt. Water would be pumped into the first pond and then flow by gravity from pond to pond, each with increasing salinity. Brine in the last pond would be pumped to a disposal module. The length of time for the main body of the Salton Sea to reach a target salinity would depend on the size of the ponds and the amount of water that could be discharged from the Salton Sea to the ponds. Water discharged from the Salton Sea would initially carry a higher salt load than the water entering the Salton Sea. After the salinity of the Salton Sea stabilized at an acceptable level, the water and salt discharge to the evaporation ponds would be reduced. Prior studies have considered many different locations and sizes of evaporation ponds, generally in the 30 square mile to 60 square mile range. EES could reduce the size of the ponds by approximately half.

Key Features

The key features are dikes that separate the Salton Sea from the evaporation areas. An inlet structure in the dike could allow water to flow by gravity from the Salton Sea into the evaporation pond. As the Salton Sea elevation decreases, pumps could be required to discharge water from the Salton Sea to the ponds. Some brine or salt disposal area would be required outside the Salton Sea for the concept to have long-term viability. Figure 2-12 shows the general arrangement of the concept.

Variations

- **Diked Impoundment, Various Sizes, South End** – Prior studies considered an alternative with a continuous 37-mile earth structure to enclose 50 square miles of land in the southern end of the Salton Sea. The dike would completely encircle the area, with the near-shore portion of dike located about 0.5 mile to 1 mile from shore. A variation could construct a similar structure at the north end of the Salton Sea instead of the south. Prior investigations also considered building a 27 mile long dike to enclose 40 square miles. Use of the 50 square mile area could reduce salinity in the Salton Sea somewhat faster than use of the 40 square mile area. The 1974 *Federal-State Feasibility Report* retained both the 50 square-mile and the 40 square-mile alternatives for further evaluation.

- **40 Square-Mile Pond at South End, With Seismic Design** – This variation would include a stronger dike to withstand seismic forces.

- **Diked Impoundment, 47 Square Miles, In-Salton Sea Evaporation Basins** – Prior studies considered creating two in-Salton Sea evaporation basins totaling 47 square miles at the south end of the Salton Sea by constructing 40 miles of dikes. The impoundment would evaporate approximately 180,000 acre-feet of water annually.

- **Phased Impoundment** – This concept would use dikes to partition the Salton Sea into a number of different areas with different salinities. While the number and location of the zones could vary depending on the goals, the areas could be constructed separately over many years. The concept shown in the 1997 *Alternative Evaluation Final Draft Report* used three areas to be implemented in three phases. The first construction phase would partition off about 25 square miles along the southeast shore with a 10-mile long dike. The Alamo River would flow into this impoundment to

create brackish salinity in the 6,000 to 10,000 mg/L range. The report indicated that this impoundment may have high possibility for federal funding because of the federal interest in the wildlife refuge, migratory birds, and habitat for endangered and/or threatened species. The remaining Salton Sea would be divided by a 13-mile long dike similar to that described in Alternative Concept 14, where the southern portion of Salton Sea would be characterized by salinity within the range of 35,000 to 40,000 mg/L and the northern portion would be characterized by higher salinity and serve as a final salt sink for the Salton Sea.

- **South End Off-Shore Dike** – This concept is similar to other in-Salton Sea diked alternative concepts, but the impoundment would be completely surrounded by dikes. The dikes would retain large volumes of water, eliminating the need for salt disposal for over 100-years.

- **Multiple-Dike Proposals** – In 2003, the consulting firm of Black & Veatch suggested a series of displacement dikes, up to 1,000 feet wide, constructed of dredged material from the Salton Sea. Some of the dikes would be used for evaporation and brine pools. The dikes would separate about 88,000 acres from the Salton Sea. Up to 400,000 acre-feet of agricultural drainage water could be treated for other uses. A shoreline canal would surround the dike system to create a stable shoreline, similar to that shown in Alternative Concept 17.

- **In-Salton Sea and On-Land Ponds** – This concept would use a combination of ponds located within the Salton Sea and ponds located on adjacent land.

- **2000 Draft EIS/EIR Alternative 1: Two Evaporation Ponds within the Salton Sea** – This concept included two evaporation ponds with a combined area of about 33 square-miles, within the Salton Sea. Approximately 98,000 acre-feet per year of water would be pumped from the Salton Sea into the ponds. The ponds would be located at the south end of the Salton Sea: one pond located to the west of the mouth of the New River and the other pond located near the previous site of the Salton Sea Test Base on the west side of the Salton Sea. A displacement dike, as described in Alternative Concept 11, could be added at the southern end of the Salton Sea if inflows decline in the future. This concept also included a future second phase to remove approximately 150,000 acre-feet per year of Salton Sea water to the Gulf of California, the Pacific Ocean, or Palen Dry Lake, as described in Alternative Concepts 1, 2, and 3. Future actions could also include import of replacement water from the Central Arizona Salinity Interceptor, Colorado River flood flows (as described in Alternative Concept 19), or other sources.

- **On-shore Evaporation Ponds -** These ponds would be similar to the variations described under Alternative Concept 4 based upon *2000 Draft EIS/EIR* Alternatives 2 and 3.

- **2000 Draft EIS/EIR Alternative 4: In-Salton Sea and On-Land Evaporation Ponds with Tower EES** – This concept would include about tower EES facilities located on the previous area of the Salton Sea Test Base on the west side of the Salton Sea and an in-Salton Sea evaporation pond near the previous Salton Sea Test Base on the west side of the Salton Sea. The EES would be sized to process about 100,000 acre-feet per year of water from the Salton Sea and the evaporation pond would receive about 68,000 acre-feet per year from the Salton Sea. A displacement dike could be added at the southern end of the Salton Sea if inflows drop in the future. This concept also included a future second phase to remove approximately 150,000 acre-feet per year of Salton Sea water to the Gulf of California, the Pacific Ocean, or Palen Dry Lake. Future actions could also include import of replacement water from the Central Arizona Salinity Interceptor, Colorado River flood flows, or other source, as described in previous variations.

- **2000 Draft EIS/EIR Alternative 5: In-Salton Sea and On-Land Evaporation Ponds with Ground EES** – This concept includes an in-Salton Sea evaporation pond near the previous Salton Sea Test Base on the west side of the Salton Sea and ground-based EES to process about 150,000 acre-feet per year of water from the Salton Sea. One or two displacement dike could be added at the southern end of the Salton Sea if inflows decrease in the future. This concept also included a future second phase to remove approximately 150,000 acre-feet per year of Salton Sea water to the Gulf of California, the Pacific Ocean, or Palen Dry Lake. Future actions could also include import of replacement water from the Central Arizona Salinity Interceptor, Colorado River flood flows, or other source, as described in previous variations.

Characteristics of the Alternative Concepts and the Variations

- In-Salton Sea evaporation ponds could be built at several locations within the Salton Sea.
- In-Salton Sea evaporation ponds could be built and operated without the need to acquire land outside the existing Salton Sea area.
- Depending on the size, the ponds could be used to maintain or lower the Salton Sea salinity.
- The in-Salton Sea evaporation ponds tend to be more efficient when inflow volumes to the Salton Sea are similar or higher than those experienced over the past few decades. With reduced inflows from present levels, the evaporation ponds need to be enlarged to accommodate higher salt concentrations in the Salton Sea. In addition, with reduced inflows the ponds are not as effective in controlling the elevation of the main portion of the Salton Sea. Due to uneven topography under the Salton Sea, water may accumulate at higher elevations of the Salton Sea as the Salton Sea elevation declines.
- The ponds would help eliminate potential air quality problems by covering portions of the Salton Sea area that would be exposed due to the reduction in Salton Sea inflows.
- Some land area may be able to be reclaimed after the Salton Sea salinity reaches the target salinity since less pond area would then be needed to maintain the salinity.
- Some pond area could be used for salt storage once the Salton Sea salinity reaches the target salinity.
- The ponds would eventually become ineffective as they fill with salt, unless the salt could be removed for disposal. Off-site disposal of brine or crystallized salt would require additional land area and costs.
- In the first phase, the largest pond area would be required to lower the Salton Sea salinity. This would make prevent phasing of pond construction.

Long-Term Ecosystem Sustainability

The ponds would be effective in controlling salinity of the Salton Sea, providing for long-term ecosystem sustainability.

Estimated Operational Life

The operational life of these types of facilities can generally be expected to be 50 years or more with periodic work to upgrade the facilities. Assuming adequate funding for operation, maintenance and periodic facility replacement the operational life could be extended to at least 100 years. Salt would eventually fill the available storage area and new locations for land filling salt or providing an outlet for the salt would be needed for the alternative to continue operation. To maintain the salinity of the Salton Sea at a constant concentration, a rock salt landfill about 30 feet deep and 50 acres in surface area would be required each year. In-Salton Sea evaporation ponds can become stranded in the future above the

Salton Sea elevation, rendering them useless for helping to maintain Salton Sea elevation unless constructed in deep water and designed for changes in inflow.

Prior Evaluations of Concept

- **1963,** *Conservation of the Beneficial Water Uses of Salton Sea in California* – The investigation concluded that salinity of the Salton Sea could be controlled by using in-Salton Sea ponds to concentrate salts for physical removal.

- **1969,** *Federal-State Reconnaissance Report* – The report concluded that a diked impoundment within the Salton Sea used for evaporation and salt storage should be retained for further analysis. This report indicated that the impoundment could be developed as a solar pond to generate electricity (as described in Alternative Concept 24) with Salton Sea water used as part of the geothermal power development.

- **1974,** *Federal-State Feasibility Study* – The study retained the concept of using 40 square-mile and the 50 square-mile impoundments for further evaluation.

- **1983**, *The Salton Sea and the Push for Energy Exploitation of a Unique Ecosystem* – The report concluded that a large scale solar pond and removal of Salton Sea water for geothermal power plant cooling and injection into the groundwater to control subsidence could be used to establish a stable ecosystem.

- **1988,** *Problems and Potential Solutions at Salton Sea* – The report retained the concept of using 40 square-mile and the 50 square-mile impoundments for further evaluation.

- **1996**, *Salton Sea Management Project Evaluation of Salinity and Elevation Management Alternatives* – The report retained the concept of using the 47 square mile in-Salton Sea evaporation ponds as a viable option.

- **1997,** *Salton Sea Management Project Implementation Plan*, Salton Sea Authority – The report notes that the Salton Sea Authority Board of Directors adopted within-Salton Sea diked impoundment as the preferred approach on September 26, 1996.

- **1997,** *Salton Sea Alternative Evaluation, Final Draft Report* – The report retained the concept of using 50 square-mile, the 47 square-mile, the 40 square-mile, and the phased impoundments for further evaluation.

- **1998**, *Salton Sea Alternatives, Final Preappraisal Report* - The report retained the concept of using 50 square-mile, the 47 square-mile, and the 40 square-mile impoundments for further evaluation.

- **1999**, *Salton Sea Restoration Alternatives Packet* – The packet described the alternatives for the 2000 Draft EIS/EIR that included in-Salton Sea evaporation ponds.

- **2000**, *Draft Salton Sea Restoration Project Environmental Impact Statement/Environmental Impact Report* – The report evaluated five EIS/EIR alternatives including impoundments.

- **2003**, *Salton Sea Study, Status Report* – The report concluded that due to expense of all alternatives, a recommendation could not made on any alternative until Congress determined the funding for Salton Sea restoration.

- **2004**, *Salton Sea Restoration, Final Preferred Project Report* – The report concluded that with the potential for reduced inflows, in-Salton Sea ponds would need to be extremely large. Also, reduced inflow would cause the Salton Sea elevation to decline, potentially reducing the advantage of in-Salton Sea ponds by stranding them above the Salton Sea elevation.

Alternative Concept 13 - North Lake without Elevation Control

This concept is based on creating a smaller Salton Sea by constructing an in-Salton Sea barrier to separate the northern portion of the Salton Sea from the southern portion. Water north of the barrier would have marine-like salinity. The area south of the barrier would serve as the outlet for water and salt from the northern portion and would gradually shrink in size and increase in salinity. Water elevations on both sides of the barrier would be similar.

Key Features

This concept would include a 7 mile to 8.5 mile-long barrier (causeway) across the center portion of the Salton Sea, depending upon the elevation of the Salton Sea during construction. Control structure(s) would be used to convey saline water from the southern area of the Salton Sea to blend with water in the northern pond to maintain salinity near 35,000 to 40,000 mg/L. Figure 2-13 shows the general arrangement of the concept.

Variations

- **Southern Pond used as a Evaporation Pond** – This concept would use the southern half of the Salton Sea as a very large evaporation pond. The 1999 *Alternatives Packet* mentioned the concept as one of the highest ranking alternatives, but provided no detail on its configuration. The 1997 *Alternative Evaluation Final Draft Repor*t considered a similar concept with the evaporation pond being located in the northern portion of the Salton Sea, as described in Alternative Concept 14.

Characteristics of the Alternative Concepts and the Variations

- Exposure of land in the southern portion of the Salton Sea would allow expansion of geothermal development, but not to the extent as with the North Marine Lake with Elevation Control, as described under Alternative Concept 15.
- Would require conveyance of water from the New and Alamo rivers to a discharge location north of the in-sea barrier
- The lack of elevation control would make adjustments in salinity between the two portions of the Salton Sea more difficult. The salinity of the northern portion would quickly become brackish. Routing a portion of the water with higher salinity from the southern portion of the Salton Sea into the northern portion would be necessary if salinity conditions in the northern portion were to remain between 35,000 to 40,000 mg/L.
- Because of the need for a large dike across the Salton Sea and conveyance from the New and Alamo rivers to the northern portion of the Salton Sea, there is little opportunity for phasing of construction. Construction of the habitat areas could be implemented in phases.
- The dike could be made smaller and less expensive if the Salton Sea elevation is allowed to recede before the dam is built, but this plan could delay achieving salinity targets by about 20 years.
- Recreational and economic opportunities would occur at the northern and southern portions of the Salton Sea.
- Exposed sediments in the southern portion of the Salton Sea could cause air pollution problems.

Long-Term Ecosystem Sustainability

Long-term ecosystem sustainability would probably occur because of the relatively stable salinity concentrations.

Estimated Operational Life

The operational life of major civil works can generally be expected to be 50 years or more with periodic work to upgrade the facilities. Assuming adequate funding for operation, maintenance and periodic facility replacement the operational life could be extended well beyond 100 years. Salt would eventually fill the southern area, but in the lifetime of the facilities.

Prior Evaluations of Concept

- **1999**, *Salton Sea Restoration Alternatives Packet* – The packet mentioned the South Half of Salton Sea Evaporation Pond as one of five highest ranking alternatives from the November 1998 screening process.

- **2004**, *Salton Sea Restoration, Final Preferred Project Report* – The report considered a marine lake in the north and in the south, with and without elevation control.

Alternative Concept 14 - South Marine Lake without Elevation Control

This concept is based on creating a smaller Salton Sea by constructing an in-Salton Sea barrier to separate the northern portion of the Salton Sea from the southern portion. Water south of the barrier would have marine-like salinity. The area north of the barrier would serve as the outlet for water and salt from the south and would gradually shrink in size and increase in salinity.

Key Features

This concept would include a 7 to 8.5 mile-long barrier (causeway) across the center portion of the Salton Sea. Control structure(s) would convey saline water from the north to blend with water in the southern portion of the Salton Sea to maintain salinity of 35,000 to 40,000 mg/L. Figure 2-14 shows the general arrangement of the concept.

Variations

- **Diked Impoundment of 127 Square Miles in Northern Third of the Salton Sea** – The 1997 report considered constructing a 10-mile dike across the Salton Sea to maintain salinity in the southern portion of the Salton Sea and an in-Salton Sea evaporation pond in the northern third of the Salton Sea.

- **Low Salton Sea** – This variation would be very similar to the above variation except that the Salton Sea would be allowed to recede before a smaller dam is built to form the evaporation pond in the northern portion of the Salton Sea. Salinity would dramatically increase over present levels until the evaporation (brine) pond is constructed.

Characteristics of the Alternative Concepts and the Variations

- This concept is a simple configuration that uses a central barrier to separate the Salton Sea into two portions.
- Would enhance values of the existing wildlife refuges.
- The New and Alamo rivers would flow directly into the southern portion of the Salton Sea and would not require conveyance to the north of the barrier.
- The lack of elevation control would make adjustments in salinity between the two portions of the Salton Sea more difficult. The salinity of the southern portion would quickly become brackish. Routing some of the higher salinity water from the northern portion of the Salton Sea into the southern portion would be necessary if salinity conditions of 35,000 to 40,000 mg/L were desired in the northern portion of the Salton Sea.
- Sediments located to the north of the barrier would be exposed, but not to the extent as with the South Marine Lake with Elevation Control concept (Alternative Concept 16). These sediments may have higher selenium concentrations than sediments south of the barrier.
- Because of the need for the large structure across the Salton Sea, there is little opportunity for phasing of construction. Construction of the habitat areas could be phased over time.
- The barrier could be made smaller if the Salton Sea elevation is allowed to recede before the dam is constructed, but this would delay achieving salinity targets by about 20 years.
- Increases recreational and economic potential at the southern end of the Salton Sea.

Long-Term Ecosystem Sustainability

Long-term ecosystem sustainability should be good because there would be relatively stable salinity.

Estimated Operational Life

The operational life of major civil works can generally be expected to be 50 years or more with periodic work to upgrade the facilities. Assuming adequate funding for operation, maintenance and periodic facility replacement the operational life could be extended well beyond 100 years. Salt would eventually fill the northern area, but not within the 100 year life.

Prior Evaluations of Concept

- **1997,** *Salton Sea Alternative Evaluation, Final Draft Report* – The report retained this concept to divide the Salton Sea with a dike to form a 127 square-mile evaporation area in the northern portion of the Salton Sea for further evaluation.

- **1998**, *Salton Sea Alternatives, Final Preappraisal Report* - The report retained the concept to divide the Salton Sea with a dike to form a 127 square-mile evaporation area in the northern portion of the Salton Sea for further evaluation.

- **2003**, *Salton Sea Study, Status Report* – The report concluded that due to expense of all alternatives, a recommendation could not made on any alternative until Congress determined funding for the Salton Sea restoration.

- **2004**, *Salton Sea Restoration, Final Preferred Project Report* – The report evaluated marine lakes in the north and in the south, both with and without elevation control.

- **2004**, *Salton Sea Restoration – The Cascade Alternative* – The report considered this concept and determined that the change in the shoreline would not be advantageous.

Alternative Concept 15 - North Marine Lake with Elevation Control

This concept is based on creating a smaller Salton Sea by constructing an in-Salton Sea barrier to separate the northern portion of the Salton Sea from the southern portion. The barrier would be constructed so the water north of the barrier could be maintained at a higher elevation than the water on the south side. Water north of the barrier would have salinity of about 35,000 to 40,000 mg/L. The area south of the barrier would serve as the outlet for water and salt from the north and would gradually shrink in size and increase in salinity. The northern portion would have an area of up to 140 square-miles and would require an inflow of about 800,000 acre-feet per year. Both the surface area and the inflow would decrease if a lower elevation for the northern pond was acceptable.

Key Features

This concept would include a 7 to 8.5 mile-long barrier (causeway) across the center portion of the Salton Sea. Control structure(s) would provide an outlet from the northern to southern sections. Figure 2-15 shows the general arrangement of the concept.

Variations

No variations have been defined for this concept.

Characteristics of the Alternative Concepts and the Variations

- Recreational and economic opportunities would occur along the northern portion of the Salton Sea.
- Provides a large marine lake with stable elevation.
- Lowers salinity in northern portion of the Salton Sea.
- Would require conveyance of from the New and Alamo Rivers to north of the barrier.
- Would continue to inundate sediments north of the barrier. These sediments may have higher selenium concentrations than sediments south of the barrier.
- Exposure of land in the southern portion of the Salton Sea would allow expansion of geothermal development.
- Because of the need for the large barrier across the Salton Sea and facilities to convey water from the New and Alamo rivers to north of the barrier, there is little opportunity for phasing of construction over time. Construction of the habitat areas could be phased over time.
- The elevation control in the northern portion of the Salton Sea provides opportunity to distribute water south of the barrier for habitat and dust control.

Long-Term Ecosystem Sustainability

Long-term ecosystem sustainability should be very good considering that there would be relatively stable salinity and elevation in the northern portion of the Salton Sea, and many opportunities for habitat enhancements on the exposed areas.

Estimated Operational Life

The operational life of major civil works can generally be expected to be 50 years or more with periodic work to upgrade the facilities. Assuming adequate funding for operation, maintenance and periodic facility replacement the operational life could be extended well beyond 100 years. Salt would eventually fill the southern area designated as, but not in the life time of this concept.

Prior Evaluations of Concept

- **2003**, *Review of US Filter Corporation Salton River Proposal, Final Report* – The report retained this concept for further evaluation.

- **2004**, *Salton Sea Restoration – The Cascade Alternative* – The report considered a North Marine Lake concept more expensive than the Cascade concept, as described in Alternative Concept 18.

Alternative 16 - South Marine Lake with Elevation Control

This concept is based on creating a smaller Salton Sea by constructing an in-Salton Sea barrier to separate the northern and southern portions of the Salton Sea. The barrier would be constructed to maintain water at a higher elevation in the southern portion than in the northern portion of the Salton Sea. Water south of the barrier would have salinity in the 35,000 to 40,000 mg/L range of concentrations. The area north of the barrier would serve as the outlet for water and salt from the southern portion and would gradually shrink in size and increase in salinity. The southern portion would have a surface area up to 200 square-miles and would require an inflow of about 980,000 acre-feet per year. Both the area and the required inflow would decrease if a lower elevation for the southern portion was acceptable.

Key Features

This concept would include a 7 to 8.5 mile-long barrier (causeway) across the center portion of the Salton Sea. Control structure(s) would provide an outlet from the southern to northern sections. Figure 2-16 shows the general arrangement of the concept.

Variations

No variations have been defined for this concept.

Characteristics of the Alternative Concepts and the Variations

- Lowers salinity in southern portion of the Salton Sea as compared to the northern portion.
- Provides a large marine lake with stable elevation in the southern portion of the Salton Sea, including the areas with the wildlife refuges.
- Increases recreational and economic opportunities at the southern end of the Salton Sea
- Sediments located to the north of the barrier would be exposed. These sediments may have higher selenium concentrations than sediments south of the barrier.
- Because of the need for the large barrier across the center of the Salton Sea, there is little opportunity for phasing of construction over time. Construction of the habitat areas could be phased over time.
- Would not require conveyance of flows from the New and Alamo rivers to the northern portion of the Salton Sea.
- Is less adaptable to reductions in inflow than other cross-Salton Sea barrier alternatives because of the greater surface area of the South Marine Lake.
- The elevation control in the southern portion of the Salton Sea provides opportunity to distribute water north of the barrier for habitat and dust control.

Long-Term Ecosystem Sustainability

Long-term ecosystem sustainability should be very good due to relatively stable salinity and elevation and many opportunities for habitat enhancements on the exposed Salton Sea bed.

Estimated Operational Life

The operational life of major civil works can generally be expected to be 50 years or more with periodic work to upgrade the facilities. Assuming adequate funding for operation, maintenance and periodic facility replacement the operational life could be extended well beyond 100 years. Salt would eventually fill the northern area, but not for the life of the project.

Prior Evaluations of Concept

- **2004**, *Salton Sea Restoration, Final Preferred Project Report* – The report considered a marine lake in the north and in the south, both with and without elevation control.

- **2004**, *Salton Sea Restoration – The Cascade Alternative* – The report indicated that the South Marine Lake would be more expensive than the Cascade concept.

Alternative Concept 17 - US Filter Salton River Proposal

The copyrighted proposal by US Filter Corporation would create a 25,000 to 44,000 acre ring of moderately saline water, or "Salton River," along the shore of the Salton Sea by constructing a perimeter dike. The water depth would be about 10 feet. Since the majority of the Salton Sea's inflow enters in the southern portion of the Salton Sea, the river would flow from south to north where a desalination plant would remove water from the Salton River to produce a new source of fresh water for sale. The surface area of the water in the middle of the Salton Sea (inside the dike) would shrink from evaporation and become a hypersaline sink, or brine pond. When the interior pond becomes smaller and exposes land, an irrigation ditch would distribute the brine water for dust control and environmental improvements on the exposed soils. Brine from the desalination facility would be discharged to the brine pond.

A detailed review of this proposal is presented in the March 2003 report, *Review of US Filter Corporation Salton River Proposal Final Report*, prepared by Tetra Tech, Inc. for the Salton Sea Authority.

Key Features

This concept would include a 95-mile long dike if constructed in 10 feet of water with 140,000 acre-feet of storage, or a 92-mile-long dike if constructed in 15 feet of water with 376,000 acre-feet of storage. A desalination plant to produce up to about 500,000 acre-feet of fresh water that could be pumped into the Colorado River Aqueduct. Figure 2-17 shows the general arrangement of the concept.

Variations

- **Salton River with 10-Foot High Dike** – Construct the 10-foot dike.

- **Salton River with 15-Foot High Dike** – Construct the 15-foot dike. This variation may improve water quality in the Salton River as compared to the variation with 10-feet depth of water, but would likely cost more.

- **Salt River** – This variation, suggested by the Colorado River Basin Regional Water Quality Control Board, would create a saltier river rather than the brackish river. This variation also would locate the desalination plant at the southern end of the Salton Sea to produce water for use within the basin. A mid-Salton Sea dam would be constructed similar to the North Lake alternative, but would be much smaller since it would be constructed after the Salton Sea recedes to a lower elevation. More discussion of this concept can be found in the 2003 *Review of US Filter Corporation Salton River Proposal, Final Report*.

Characteristics of the Alternative Concepts and the Variations

- Would allow reuse of a substantial amount of water diverted for use in the basin through the desalination plant.
- Revenue from sale of water could be used to fund Salton Sea restoration or other basin programs.
- Shoreline would be stabilized in both the northern and southern portions of the Salton Sea.
- Water quality in the Salton River would be similar to the inflow river water quality.
- Flow rates in the Salton River would be slow.
- Average depth in the Salton River would be about 5 feet.
- May be sedimentation problems near the river mouths.
- Potential for flooding near the New and Alamo Rivers.

- Likely high turbidity and constituent levels throughout the Salton River since it would be and extension of the existing rivers. Dissolved oxygen concentrations may be reduced in the Salton River, and fish kills may occur.
- Constituents, including selenium, would be concentrated in the brine pond by evaporation
- Temperature ranges would be similar to the rivers, which can vary over time more than in the Salton Sea
- Because the salinity in the Salton River would be less than the current Salton Sea salinity, the food web would change. Freshwater algae would become a major food base.
- Extensive growth of freshwater or brackish water vascular vegetation would occur along the shoreline.
- Fish, bird and human diseases could increase due to water borne parasites, contaminants, and mosquitoes that occur more frequently in freshwater and brackish water than the higher salinity in the existing Salton Sea.
- In general, because of the large facilities that need to be completed before the alternative can be effective, the alternative offers little opportunity for phasing of construction over time.

Long-Term Ecosystem Sustainability

Depending upon the salinity in the Salton River, water quality and potential for water related vectors may limit long-term ecosystem sustainability of the proposal.

Estimated Operational Life

The operational life of major civil works can generally be expected to be 50 years or more with adequate funding for operation, maintenance, and periodic work to upgrade the facilities. However, without providing reasonable ecosystem sustainability, the practical operational life is may be less than 10 years before the ecosystem would change significantly.

Prior Evaluations of Concept

- **2003**, *Salton Sea Study, Status Report* – The report concluded that due to expense of all alternatives, a recommendation could not made on any alternative until Congress determined funding for the Salton Sea restoration.

- **2003**, *Review of US Filter Corporation Salton River Proposal, Final Report* – The report concluded that this concept should not be evaluated in further detail, but that water reuse from desalination may be used to generate revenue.

- **2004**, *Salton Sea Restoration, Final Preferred Project Report* – The report concluded that the concept may create many water quality and wildlife and human health issues, and have higher costs than other concepts. The report also concluded that a Multiple-Dike Proposal would be very expensive, and would require further study to evaluate the integrity of hydraulically dredged and placed material for the dikes. The report indicated that the large diked areas would be flexible for reductions in inflow.

- **2004**, *Salton Sea Restoration – The Cascade Alternative* – The report considered the long perimeter dike to be expensive and would have other disadvantages (not defined in report), as compared to the Cascade concept.

Alternative Concept 18 - Cascade Concept

This concept is based constructing a series of relatively low concentric dikes to form different terraces of wetlands, ponds, marine lakes, and islands. The concept would include four terraces, each with about 300,000 acre-feet of water. Terraces near the present Salton Sea shore would be located at the highest elevation. The elevation of the terraces would become successively lower and water salinity would become successively higher as the water flows towards the center of the Salton Sea. The terraces would be connected with overflows, rapids and/or siphons to control water levels and help water aeration as the water "cascades" from terrace to terrace. The final pool(s) would be the saltiest and serve as brine ponds. Each terrace would include various habitats. Each terrace could be up to seven miles in length and a mile wide.

Key Features

The dikes would include an impervious center constructed by filling tubes made of geotextile fabric with dredged material from the bottom of the Salton Sea, or "geotubes." The geotubes would be encased in a protective fill of earth, gravel, and/or rock. Total dredged material would be about 100 million cubic yards and rock rip-rap would be about 2 million cubic yards. The design would also include structures to control water flow between terraces and locks between water bodies to allow boat passage. Figure 2-18 shows the general arrangement of the concept.

Variations

None presented to date.

Characteristics of the Alternative Concepts and the Variations

- Maintains a relatively stable water elevation around the perimeter of the Salton Sea.
- Provides relatively equal recreational and economic opportunities among interests around the Salton Sea.
- Provides a wide variety of habitats in the form of wetlands, ponds and marine lakes that vary from shallow to deep and through a range of water salinities.
- Construction can be phased as the Salton Sea level declines, allowing for lower dike heights. The first phase could be constructed in about 18 months.
- Provides flexibility over many fixed configuration alternatives in operation and in design. The configuration of future terraces may be redesigned in an adaptive management manner and to accommodate inflows to the Salton Sea.
- Dikes are lower than mid-Salton Sea barriers due to shallower terraces in the middle of the Salton Sea.
- Provides inundation of most sediments, including areas with selenium.
- Design flexibility of terrace dikes could allow exposure of areas to allow expansion of geothermal resources at the southern end of the Salton Sea.
- Use of in-Salton Sea material to form dikes would reduce traffic and air quality concerns related to construction. However, additional evaluations would be required to develop final design criteria.
- May have similar water quality concerns as the Salton River and Pacific Institute Proposals, as described in Alternative Concepts 17 and 10, respectively.

Long-Term Ecosystem Sustainability

The alternative could have long-term ecosystem sustainability issues similar to those for the Salton River, as described in Alternative Concept 17.

Estimated Operational Life

The operational life of major civil works can generally be expected to be 50 years or more with periodic work to upgrade the facilities. Assuming adequate funding for operation, maintenance and periodic facility replacement the operational life could be extended well beyond 100 years. However, this would require resolution of potential water quality concerns in the relatively shallow impoundments. Salt would eventually fill the center area, but probably not in the life time of the facilities.

Prior Evaluations of Concept

- **2004**, *Salton Sea Restoration – The Cascade Alternative* – The report presented the Cascade Alternative to maintain shoreline elevations, provide recreational and economic opportunities, and minimize construction impacts.

Alternative Concept 19 - Replacement Water from Colorado River Area

This concept is based on importing fresh water from the Colorado River to the Salton Sea for dilution of the salinity and/or to maintain the elevation of the Salton Sea. During wet years, when the Colorado River reservoirs are full, excess water may be available for use at the Salton Sea with "Excess Water" defined as flows to Mexico higher than water ordered by Mexico.

Key Features

Depending on available capacity, the existing All-American Canal could be use to transport replacement water to the facilities that convey water to the Salton Sea. Expanded facilities may be required to accommodate conveying Colorado River flows during wet years when large volumes of water may be available. Figure 2-19 shows the general arrangement of the concept.

Variations

- **Flood Flows from Colorado River** – Occasional flood flows from the Colorado River could be use as replacement water. This water may not become available for 25 years or more and may be available infrequently.

- **Water from Central Arizona Salinity Interceptor (CASI) System** – The use of brine reject streams from the proposed CASI could be a source of replacement water.

- **Water from Potential Tucson Desalination Plant** – The potential plant would desalinate water from the Central Arizona Project and produce about 67,000 acre-feet per year of brine discharge from the plant. The brine discharge would be characterized by 10,000 mg/L salinity. Up to 200,000 acre-feet per year of this brine discharge from Tucson and other cities in the Southwest future may be needed in the future to maintain salinity at the Salton Sea.

- **Water from Yuma Desalting Plant** – Brine discharge from the Yuma Desalting Plant could be a source of replacement water.

Characteristics of the Alternative Concepts and the Variations

- Could temporarily slow the rate of salinity increase in the Salton Sea.
- Could be used to maintain elevation of the Salton Sea.
- Water from the Colorado River, including surplus flows, is already legally allocated. Therefore, availability of surplus flows may not be sufficient for this concept.
- Even if occasional wet period flow would become available, long (perhaps decades) periods between deliveries should be expected.
- Lack of access to adequate amounts of Colorado River water on a consistent basis would result in large fluctuations in the Salton Sea elevation and salinity.

Long-Term Ecosystem Sustainability

This concept does not provide reliable flows for long-term ecosystem sustainability. The magnitude and frequency of obtaining flood flows from the Colorado River is uncertain. Decades could pass before any water could be diverted to the Salton Sea.

Estimated Operational Life

As a stand-alone alternative, importing replacement water would only provide a benefit to maintain the elevation of the Salton Sea. The opportunity to obtain and divert flood flows from the Colorado River is foreseen to occur infrequently.

Prior Evaluations of Concept

- **1969,** *Federal-State Reconnaissance Report* – The report concluded that importing surplus water from the Colorado River could be a temporary solution until a long-term alternative could be implemented.

- **1974,** *Salton Sea Project, California, Federal-State Feasibility Report* – The report concluded that the potential for delivering additional water from the Colorado River would be limited.

- **1988,** *Problems and Potential Solutions at Salton Sea* – The report retained use of Colorado River excess flows for use with other alternatives if replacement water would be needed.

- **1997,** *Salton Sea Alternative Evaluation Final Draft Report* – The concept was eliminated from further evaluation because it would be a temporary measure and could not permanently be used to maintain salinity concentrations.

- **1998**, *Salton Sea Alternatives, Final Preappraisal Report* - The report eliminated the concept from further evaluation because water availability would be unreliable.

- **1999**, *Salton Sea Restoration Alternatives Packet* – The packet discusses periodic flood flows from the Colorado River as potential replacement water.

- **2000**, *Draft Salton Sea Restoration Project Environmental Impact Statement/Environmental Impact Report* – The report retained the concept of importing replacement water from the Central Arizona Salinity Interceptor, Colorado River flood flows, or other source as future Phase 2 action after 2030, if needed.

- **2004**, *Salton Sea Restoration, Final Preferred Project Report* – The report concluded that replacement water from the Colorado River would be highly uncertain. The use of brine reject streams from CASI proposal was also considered to be uncertain.

Alternative Concept 20 - Replacement Water from Agricultural Land Fallowing

This concept is based on fallowing a portion of the farmland and using the irrigation water allocated to these lands as replacement water for the Salton Sea.

Key Features

This concept relies upon fallowing or eliminating irrigation on a portion of the farmland to provide water to the Salton Sea. To minimize dust impacts, a cover crop may need to be grown before the land is fallowed.

Variations

No variations have been identified.

Characteristics of the Alternative Concepts and the Variations

- May require payments to farmers to provide for willing participation.
- Would require social and political support to be successful.
- Fallowing could cause significant loss of jobs and other socioeconomic adverse impacts.
- May be combined with other alternative concepts.

Long-Term Ecosystem Sustainability

Long-term ecosystem sustainability of this alternative is low and would reduce sustainability of a portion of the agriculture in the basin.

Estimated Operational Life

This concept does not appear to be a viable long-term plan due to the reduction in irrigated acreage.

Prior Evaluations of Concept

- **2004**, *Salton Sea Restoration, Final Preferred Project Report* – The report concluded that the concept would cause significant socioeconomic impacts and may not be implementable.

Alternative Concept 21 - Replacement Water from Southern California

This concept is based on finding replacement water for the Salton Sea from sources in Southern California. The quantities of water that may be available are generally relatively small, available only on a temporary basis, or uncertain since the source is not yet developed. Most of the potential sources would require significant conveyance features to deliver the water to the Salton Sea.

Key Features

Pumps, pipelines, and canals would be required to convey water to the Salton Sea. Figure 2-20 shows the general arrangement of the concept.

Variations

- **Treated Sewage Effluent** – The 1974 *Federal-State Feasibility Report* considered using treated wastewater effluent from the southern California coastal area as a possible source of water for replenishment and dilution of the Salton Sea. The report did not consider the concept for further evaluation because physical, legal, and institutional limitations.

- **Northern California Rivers** – The 1969 *Federal-State Reconnaissance Report* considered importing water from northern California rivers. The report did not consider the concept for further evaluation due to technical, economic and political reasons.

- **East Mesa Groundwater** – Pumping replacement water from the East Mesa groundwater basin through the East Highline Canal could be used to maintain the elevation of the Salton Sea.

- **Develop Aquifer Systems** – Groundwater in the Middle Amargosa Valley, Soda lake Valley, Caves Canyon Valley, Chuckwall Valley, and the Calzona-vidal Valley could be used to maintain the elevation of the Salton Sea. Estimates from the 1998 *Preappraisal Report* indicated that 575 miles of pipeline would be needed to collect and convey the groundwater to the Salton Sea.

- **City of Brawley Desalination Proposal** – The use of brine reject streams from the City of Brawley for a desalination plant on the Colorado River Aqueduct could be a source of replacement water.

- **Phased Approach: Salt Stabilized; Pump-In Later** – In the first phase, this concept would stabilize salinity in the Salton Sea by pumping-out to some location, as described in other alternative concepts. The second phase would convey water from one of the replacement water locations.

Characteristics of the Alternative Concepts and the Variations

- Replacement water is not readily available in large quantities
- May be used with another alternative concept

Long-Term Ecosystem Sustainability

Due to the uncertain nature of the concept, long-term sustainability would not be good until reliable water sources were developed.

Estimated Operational Life

Since the volumes of water that may be available appear to be relatively small, this alternative may satisfy only a portion of the replacement water needs. Substantial conveyance facilities would be required. The operational life of major civil works can generally be expected to be 50 years or more with adequate funding for operation, maintenance, and periodic work to upgrade the facilities.

Prior Evaluations of Concept

- **1974,** *Salton Sea Project, California, Federal-State Feasibility Report* – The report concluded that the potential to obtain replacement water would be limited.

- **1998**, *Salton Sea Alternatives, Final Preappraisal Report* - Since recharge of the groundwater in the southern California desert area is very small, the report indicated that any groundwater development to provide replacement water would have an adverse impact.

- **2004**, *Salton Sea Restoration, Final Preferred Project Report* – The report investigated use of brackish groundwater resources in the East Mesa area, but noted that it is unlikely that there would be enough water, and that this concept would not be sustainable in the long term. The report also indicated that delivery costs would be high. The use of brine reject streams from the City of Brawley proposal was also considered too be uncertain.

Alternative Concept 22 - Brine Disposal in Local Wells

This concept is based disposing of brine from the evaporation ponds or generated from desalination facilities by injections into the local groundwater near the Salton Sea. The concept could also be used by removing water directly from the Salton Sea and injecting the water into the groundwater basin.

Key Features

This concept would use pumping plants, pipelines, and wells. Figure 2-21 shows the general arrangement of the concept.

Variations

- **Groundwater Sequestering** – A proposal by Timothy J. Durbin, Inc. would extract 200,000 acre-feet per year of from the eastern portion of the Imperial Valley groundwater basin for treatment and use. While most of the groundwater of the area is very high in dissolved solids, this water would come from an area of moderate dissolved solids (about 1,900 mg/L) and could be sold for other uses. Water from the Salton Sea would be injected into the deep groundwater aquifer to prevent land subsidence and to provide an outlet for salt in the Salton Sea. The proposal considered that 75,000 and 150,000 acre-feet would be removed from the Salton Sea each year.

- **Groundwater Sequestering and Replacement Water** – This proposal, also by Timothy J. Durbin, Inc., is the same as the preceding variation but the water extracted from the groundwater would be used as replacement water for the Salton Sea.

Characteristics of the Alternative Concepts and the Variations

- Pumped groundwater would be sold to provide revenues for Salton Sea Restoration.
- Fouling of the injection wells may be a problem without pretreatment of the Salton Sea water.
- If water removed from the Salton Sea is not replaced with groundwater, the Salton Sea elevation would decline further.
- May be little opportunity for phasing construction over time due to need for construction of major facilities.

Long-Term Ecosystem Sustainability

This concept has the potential to help control the Salton Sea's salinity levels for at least many decades. However, long-term sustainability is unknown until studies determine if 100,000 acre-feet to 200,000 acre-feet from the Salton Sea can be recharged on a long-term basis. This would not only depend on adequate aquifer capacity but appropriate water chemistry to prevent well and aquifer fowling.

Estimated Operational Life

The groundwater source is finite. The life of the alternative was estimated by Timothy J. Durbin, Inc. as 100 years. Even though the groundwater source is finite, the estimated operational life is similar to many of the other concepts. Some studies have estimated that a quantity of only about 75,000 acre-feet may be available for only 20 years to 30 years, which would yield a significantly smaller volume than estimated by Timothy J. Durbin, Inc.

Prior Evaluations of Concept

- **2003**, *Proposal for the Restoration of the Salton Sea Based on Groundwater Sequestering* – The report describes the removal of groundwater and replacement with Salton Sea water.

Alternative Concept 23 - Brine Disposal in Geothermal Wells

This concept would provide an outlet from the Salton Sea by injecting Salton Sea water or brine from one of the desalination concepts into high-salinity geothermal resource areas.

Key Features

Pumps and a pipeline system to distribute Salton Sea water would be required to convey water to geothermal wells. Pretreatment of the Salton Sea water may be required. Figure 2-22 shows the general arrangement of the concept.

Variations

No variations have been identified.

Characteristics of the Alternative Concepts and the Variations

- Geothermal wells are located at the Salton Sea.
- Would provide replenishment water to the geothermal aquifer to maintain pressure is the aquifer and as a potential source of geothermal water in the future.
- Discharge of water from the Salton Sea would result in lower Salton Sea elevation.
- Injecting up to 200,000 acre-feet of water into the aquifer could result in cooling of the geothermal reservoir.
- High solids in the Salton Sea water could cause well plugging without pretreatment.
- May be required to be implemented with other alternative concepts.

Long-Term Ecosystem Sustainability

Long-term ecosystem sustainability would likely depend on further development of the geothermal resources and studies to determine the technical and economic feasibility of using Salton Sea water to recharge the geothermal area.

Estimated Operational Life

The operational life depends on how much of the geothermal resource is developed in the future and how much water can be injected. Geothermal wells typically require rehabilitation every 2 years. Recent environmental documentation in July 2002 for the proposed Salton Sea Unit 6 geothermal powerplant indicates that only 4,808 acres of the 102,887 acres of the Salton Sea Known Geothermal Resource Area (KGRA) have been developed. Unit 6 would add 3,180 acres to the developed acreage. Therefore, over 92 percent of the KGRA would remain to be developed after Unit 6 begins operation. This indicates much more potential for injecting brine in the future than exists presently.

Prior Evaluations of Concept

- **1974 –** *Federal-State Feasibility Study* – The concept was eliminated from further evaluation because the magnitude of the facilities, operating characteristics, and water needs of the geothermal development were not known at the time of the study.

- **1983**, *The Salton Sea and the Push for Energy Exploitation of a Unique Ecosystem* – The report concluded that a large scale solar pond and removal of Salton Sea water for geothermal power plant cooling and injection into the groundwater to control subsidence could provide a permanent option for the ecosystem.

- **1997 –** *Salton Sea Alternative Evaluation Final Draft Report* – The concept was eliminated from further evaluation due to high operation and maintenance costs.

- **1998**, *Salton Sea Alternatives, Final Preappraisal Report* – The concept was eliminated from further evaluation because there were too many unknowns, including pretreatment requirements, to determine viability.

Alternative Concept 24 - Solar Ponds to Generate Power

This concept would use solar ponds to generate power that could provide revenue to fund restoration activities at the Salton Sea. The solar ponds could also provide power for desalination plants at the Salton Sea.

Key Features

Solar ponds, power plants, substations, and transmission facilities would be required. Figure 2-23 shows the general arrangement of the concept.

Variations

- **Enhanced Evaporation/Solar Pond/Power Generation** – This concept, originally provided by Ormat Turbines, would use a combination of lined solar ponds, EES, and a power plant. The EES would spray water from the Salton Sea to accelerate evaporation and reduce the size of the ponds. The project could be built in ten modules. Each module would include:

  - Evaporation of 25,000 acre-feet per year of water from the Salton Sea
  - 612 acres of EES
  - 4 (and up to 8) 1.0 MW Ormat Energy Converters
  - 4 (and up to 8) 40-acre solar ponds
  - A 75-acre crystallization pond
  - 1 deep injection well (optional)

  The 1997 *Alternative Evaluation* described this concept in detail. However, the 1997 report eliminated this variation from further evaluation because the technology had not been used at this large scale and high operation and maintenance costs.

- **Combination Impoundment/Power Generation/Constructed Wetlands** – This concept, originally described by Ormat Turbines, is similar to the preceding variation. It would include about 16,000 acres of on-shore EES, two diked areas at the south end of the Salton Sea to control elevation of the Salton Sea, constructed wetlands along the New, Alamo, and Whitewater rivers and solar power ponds to generate power and desalt water. The 1997 *Alternative Evaluation* described this concept in detail. However, the 1997 report eliminated this variation from further evaluation because the technology had not been used at this large scale and high operation and maintenance costs. The 1998 *Preappraisal Report* also eliminated the concept from further evaluation because it did not appear to be cost effective and the lack of proven technology at the required scale.

- **Pump-out/Desalination/Solar Generation** – This concept would pump water from the Salton Sea into evaporation ponds. The salt residue would be used in a solar plant to generate energy to power desalination of the Salton Sea water.

- **Solar Salt Gradient Pond/MED Desalination Plant with Pump-In/Pump-Out** – This concept uses combinations of components from several other concepts. The concept would remove 170,000 acre-feet per year from the Salton Sea, of which 23,500 acre-feet per year would be used as cooling water and 146,500 acre-feet per year would be used as feed water to the desalination plant. The desalination plant would be powered by energy collected in the solar pond. The

desalination plant would return 58,600 acre-feet per year to the Salton Sea and would produce 87,900 acre-feet per year of brine. The 1998 *Preappraisal Report* describes this concept in detail.

Characteristics of the Alternative Concepts and the Variations

- Need the largest pond area early in the process to lower the Salton Sea salinity as inflows are reduced, therefore phasing of pond construction would not be practical

Long-Term Ecosystem Sustainability

Due to the lack of experience in using this technology at this scale, the long-term ecosystem sustainability is not known.

Estimated Operational Life

The operational life of solar pond power generation facility may be about 30 years assuming adequate funding for operation and maintenance. With funding for periodic facility replacement, the operational life could be extended to beyond 100 years. Replacement of components within the treatment plant would be required on a regular basis. Salt would eventually fill the available storage areas and new locations for land filling salt or providing an outlet for the salt would be needed for the alternative to continue operation. Just to maintain the salinity of the Salton Sea at a constant level, a rock salt landfill about 30 feet deep and 50 acres in area would be required each year.

Due to the lack of experience of other technologies at this scale, the operational life of other components is not known.

Prior Evaluations of Concept

- **1969,** *Federal-State Reconnaissance Report* – The report suggested the possibility of using a large scale solar pond to generate electricity and remove salts from the Salton Sea water.

- **1988,** *Problems and Potential Solutions at Salton Sea* – The report retained the Pump-out/Desalination/Solar Generation option as a viable concept for further evaluation.

- **1994**, *Strategies for the Restoration and Enhancement of the Salton Sea, A White Paper for the Salton Sea Authority* – The report recommended solar ponds to generate power.

- **1997,** *Salton Sea Alternative Evaluation, Final Draft Report* – The report eliminated the concept because the technology had not been used that the required scale needed at the Salton Sea.

- **1998**, *Salton Sea Alternatives, Final Preappraisal Report* - The report mentioned that a November 1991 report by Ormat Turbines, Ltd., concluded that low efficiency electric powerplants, such as the organic rankine powerplant, would not be cost-effective as compared to conventional powerplants unless fossil fuel costs increase, but that the solar salt gradient pond with EES may be cost effective use with multiple effect distillation (MED) for desalination.

- **1999**, *Salton Sea Restoration Alternatives Packet* – The packet mentioned that the concept was part of high ranking alternatives from the November 1998 screening process.

Alternative Concept 25 - Other Water Treatment Concepts

There are many other water treatment concepts presented in previous reports that are not stand-alone concepts for the Salton Sea. However, these can be considered as components of other alternatives to provide improved water quality for inflows to the Salton Sea.

Key Features

Key features vary considerably by the concept, as described below.

Variations

- **Poplar Tree Constructed Wetlands** – This concept would use a stand of poplar trees to remove nitrates from the inflow water. The concept would be a similar to a constructed wetland, but the trees would take 20 to 30 years to become mature. The 1997 *Alternative Evaluation* report provided details on this concept and eliminated this variation because it did not control salinity or elevation of the Salton Sea.

- **Groundwater Pumping, Selenium Management** – This concept would manage groundwater pumping from a deep aquifer which underlies the area of irrigated lands with high selenium concentrations in drainage water flows. The lowered water table would allow drainage water to percolate downwards where the selenium would be captured and stored within a clay aquitard zone. The 1997 *Alternative Evaluation* report provided details on this concept, and eliminated this variation because it did not control salinity or elevation of the Salton Sea.

- **Venturi Air Pump** – This concept would pass inflow water from the tributary rivers through new structures that would use venturi action to oxygenate the water and help remove organic material. Under this concept, electricity could be generated in the process. The 1997 *Alternative Evaluation* report provided details on this concept. The 1997 report and the 1998 *Preappraisal Report* eliminated this variation from further evaluation because it did not control salinity or elevation of the Salton Sea.

- **Air Diffusion/Ultraviolet Ozone System** – This concept would use a diffused air and ultraviolet ozone system constructed on the Salton Sea floor to oxygenate and recirculate water to primarily reduce organic material. The 1997 *Alternative Evaluation* report provided details on this concept. The 1997 report and the 1998 *Preappraisal Report* eliminated this variation because it did not control salinity of the Salton Sea.

- **Gravel Berms or Pretreatment Reservoirs** – This concept would construct pervious gravel berms at several locations along the tributaries to function as coarse filters to remove large solid matter. The concept could remove some organic material that flows into the Salton Sea. The 1997 *Alternative Evaluation* report provided details on this concept. The 1997 report and the 1998 *Preappraisal Report* eliminated this variation because it did not control salinity or elevation of the Salton Sea.

- **Salton Sea Water Filtration** – This concept would use a free energy source which would cause chemicals to separate from the Salton Sea water and kill all bacteria, viruses, and small growth such as algae and parasites. The 1997 *Alternative Evaluation* report described this concept. No data were available on the chemical, biological, or physical processes included in the treatment.

Also, there was no description of the energy source. The 1997 report eliminated this concept because the technology was not proven.

- **Enzyme-Activated Removal** – This concept would use enzyme-treated porous material to remove metals and organic and inorganic compounds from water. The process would combine ion exchange and filtering. The 1997 *Alternative Evaluation* report described this concept. The process was proprietary and therefore, details were not included in the description. The 1997 report and the 1998 *Preappraisal Report* eliminated this concept since the technology is not defined at this time and unproven.

- **Pulsed Plasma** – This concept would use pulsed plasma discharge wastewater treatment technology to remove metals and toxic substances from the Salton Sea. The technology uses bursts of high energy shock waves as well as free radicals, ultraviolet radiation, and X-rays to kill bacteria and cause dissolved and suspended solids and suspended solids to settle. The 1997 *Alternative Evaluation* report described this concept. The 1997 report and the 1998 *Preappraisal Report* eliminated this concept since the concept since the technology is unproven for the scale required at the Salton Sea, and due to the extremely high operation and maintenance costs. The 1998 report eliminated the concept because it did not control salinity and elevation at the Salton Sea.

- **Cleanup of the New River in Mexico** – The concept used many methods to improve water quality of the New River before it enters the United States. The 1988 *Problems and Potential Solutions at Salton Sea* report retained the option for use with other alternative concepts. The 1997 *Alternative Evaluation* report described this concept. The 1997 report and the 1998 *Preappraisal Report* eliminated this proposal because it did not control salinity of the Salton Sea.

- **Surface Aeration** – This concept would use aeration fountains to improve the quality of the Salton Sea water through oxygenation. The 1997 *Alternative Evaluation* report and the 1998 *Preappraisal Report* eliminated this proposal because it did not control salinity of the Salton Sea.

- **Collect Irrigation Flows and Treat Inflows to the Salton Sea** – This concept would remove salinity or other constituents in the irrigation flows. This alternative would be used with other concepts because it would not be able to reduce constituents in the existing Salton Sea.

- **Construct Wetlands to Filter Inflows to the Salton Sea** – This concept The New River Wetlands project is an example of this concept. The 1998 *Preappraisal Report* eliminated this concept because it did not control salinity of the Salton Sea.

- **Source Control Measures** – This concept would implement source control measures in the upper Colorado River Basin to reduce selenium flowing in the Colorado River and diverted to the Imperial Valley. This concept is difficult to implement solely for improving water quality of the Salton Sea. However, this concept has been considered by other users of the Colorado River.

Characteristics of the Alternative Concepts and the Variations

This grouping of concepts includes methods that require additional studies to evaluate.

Long-Term Ecosystem Sustainability

Long-term ecosystem sustainability would depend upon further evaluations.

Estimated Operational Life

Operational live would depend upon further evaluations.

Prior Evaluations of Concept

- **1988**, *Problems and Potential Solutions at Salton Sea* – The report recommended water quality improvements of the New and Alamo Rivers and management of selenium combined with other alternative concepts.

- **1997 –** *Salton Sea Alternative Evaluation Final Draft Report* – The concepts considered in the variations were eliminated from further evaluation as described above.

- **1998**, *Salton Sea Alternatives, Final Preappraisal Report* – The concepts considered in the variations were eliminated from further evaluation as described above.

Alternative Concept 26 - Other Methods

Other concepts include many methods that focus on a narrow aspect of the Salton Sea or use processes that may be considered to be unproven technologies. Many of the concepts described in previous reports did not include sufficient information to completely define the concept. Few of these concepts could be considered as complete alternative concepts for restoration of the Salton Sea, but could be considered as components for consideration with other alternatives.

Key Features

The key features vary by concept, as described below.

Variations

- **Combination Freshwater Shoreline/Pumped Storage/Constructed Wetlands** – This variation, proposed by Dangermond and Associates, includes a freshwater impoundment at the north end of the Salton Sea, a desalination plant, and a pumped storage facility to generate electricity. The 1997 *Alternative Evaluation* report described this concept in detail. The 1997 report eliminated this variation from further evaluation because the technology was unproved for the scale needed at the Salton Sea and because of high operation and maintenance costs. The 1998 *Preappraisal Report* eliminated the concept from further evaluation due to high costs, unproven technology for the scale needed at the Salton Sea, and could not meet the salinity and elevation targets.

- **Combination Solar Power Generation/Pumped Storage/Constructed Wetlands Laguna Salada Salt Disposal** – This concept, proposed by Dangermond and Associates, is similar to the above variation and Alternative Concept 1. The 1997 *Alternative Evaluation* report described this concept in detail. The 1997 report eliminated this variation from further evaluation because the technology was unproved for the scale needed at the Salton Sea and because of high operation and maintenance costs. The 1998 *Preappraisal Report* eliminated the concept from further evaluation due to unproven technology for this application and high costs.

- **Diked Impoundment Using Plastic Curtains** – This concept would use a plastic curtain, instead of dikes, to divide the Salton Sea. A system of three curtains was considered in previous reports to limit mixing effects caused by wave action and provide protection incase of a liner tear. The 1997 *Alternative Evaluation* report described this concept in detail. The 1997, and the 1998 *Preappraisal Report* eliminated this variation from further evaluation because it did not use proven technology.

- **Frontier Aquadyne Enhanced Evaporation** – This concept would pump water out of the Salton Sea and deliver it to a treatment system developed by Frontier Aquadyne for evaporation and concentration of wastewater with high mineral and solids content. The treatment system would be use low-grade or waste heat sources. Previous reports indicated that about 10,000 units would be needed to evaporate 200,000 acre-feet of Salton Sea water annually. The 1997 *Alternative Evaluation* report described this concept in detail. The 1997 report eliminated this variation from further evaluation because the technology was not proven for the scale needed at the Salton Sea and because of high operation and maintenance costs. The 1998 *Preappraisal Report* eliminated the concept from further evaluation because of the unproven technology.

- **Environment Enhancing Technologies, Inc. Solar Still Desalination/Colorado River Water Replacement** – This concept would use an enhanced solar still to desalinate Salton Sea water

with replenishment water from the Colorado River. The distilled water could be sold or returned to the Salton Sea. The 1997 *Alternative Evaluation* report described this concept in detail. The 1997 report eliminated this variation from further evaluation because the technology was not proven for the scale needed at the Salton Sea and because of high operation and maintenance costs. The 1998 *Preappraisal Report* eliminated the concept from further evaluation because of unproven technology and the lack of replenishment water from the Colorado River.

- **Solar Still/Solar Works Disposal** – This concept would use a solar still desalination plant with pump-in of desalinated water to the Salton Sea and pump-out to dispose of the brine to evaporation ponds in a saltworks with ultimate disposal of salt at an off-site location. The salt would be hauled to the off-site location by railroad. The 1998 *Preappraisal Report* indicated that the technology was not competitive with reverse osmosis plants.

- **Floating Solar Still Modules** – This concept would use floating in-Salton Sea solar desalination modules to enhance evaporation rates and collect salt. The concept would use solar batteries to supply electrical power. The 1998 *Preappraisal Report* indicated that the technology was not competitive with reverse osmosis plants and did not control elevation of the Salton Sea.

- **Solar Still/Hydro: Physical Technologies/Desalination Plant** – This concept combined solar still desalination and a proprietary unit. The 1998 *Preappraisal Report* eliminated this variation from further evaluation because the technology was not proven for the scale needed at the Salton Sea.

- **SNAP Technology Enhanced Evaporation Tower** – This concept would use a tower 3,300 feet high and 1,500 feet in diameter tower to produce electricity and desalinate water from the Salton Sea. The heavier cool air from evaporation in the tower would flow down the inside of the tower and power wind turbines located in openings at the bottom of the tower. About 400,000 acre-feet per year of Salton Sea water would be pumped to the top of the tower to generate about 80,000 acre-feet of distilled water. About 160,000 acre-feet of concentrated salt water created during the process would be conveyed to the Colorado River. The 1997 *Alternative Evaluation* report described this concept in detail. The 1997 report and the 1998 *Preappraisal Report* eliminated this variation from further evaluation because the technology was not proven for the scale needed at the Salton Sea.

- **Gas Turbine/Hydro/Desalination** – This concept would use a gas-fired combined cycle turbine that generates electricity and steam for a MED desalination plant that is enclosed in a 50-story-tall concrete tower. The electrical power that is generated would be used in combination with a pumped storage hydroelectric powerplant. The 1998 *Preappraisal Report* eliminated this concept from further evaluation because the technology was not proven for the scale needed at the Salton Sea.

- **Geothermal Power Revitalization** – This concept included methods that the Salton Sea restoration may be used to revitalize the geothermal industry in California. This concept was listed but not described in detail in previous reports. The 1998 *Preappraisal Report* indicated that the concept was not proven technology.

- **Heated Pump-Out Solar Membrane Distillation** – Membrane distillation is a heat-driven process using a hydrophobic microfilter to separate vapor and liquid streams of water. However as described in the 1997 *Alternative Evaluation* and 1998 *Preappraisal Report,* the technology has not been proven for the scale needed at the Salton Sea and would require further testing..

- **Pump-out Disposal of Reject Stream to Yuma** – This concept could be used to dispose of the brine generated from one of the salt concentration alternative concepts, such as evaporation ponds or desalination. A pipeline would be built to Yuma to transfer the brine into the existing drain that flows into the Gulf of California. The 1988 *Problems and Potential Solutions at Salton Sea* report considered the pumping of brine to Yuma as a viable option for use with alternatives where brine disposal was necessary. The 1997 *Alternative Evaluation* report described this concept in detail. The 1997 report eliminated this proposal from further consideration because it was not a stand-alone concept. The 1998 *Preappraisal Report* indicated that the concept could be used with other methods.

- **Freshwater Blending** – This concept would pump water from the New River to a new storage reservoir. Water from the Salton Sea would be pumped to a different new reservoir in the same vicinity. Water from the two reservoirs would be blended and freshwater, from an undetermined source, would be added before releasing the blended water back to the Salton Sea. The 1997 *Alternative Evaluation* report described this concept in detail. The report noted that New River and Salton Sea water are already blended in the Salton Sea and that the only unique part of this proposal was the introduction of freshwater. The 1997 report and the 1998 *Preappraisal Report* eliminated this variation from further consideration because it would not help control salinity in the Salton Sea.

- **Power/Freshwater Cogeneration** – This concept would build an electrical power generation plant using an unnamed heat source. The waste steam from the plant would be used to produce freshwater by thermal distillation. The 1997 *Alternative Evaluation* report described this concept in detail. The 1997 report eliminated this variation from further evaluation because of high operation and maintenance costs. The 1998 *Preappraisal Report* eliminated the concept from further evaluation because of high costs and unproven technology.

- **Water Conservation** – This concept would use water conservation to help reduce water used by irrigation, thereby reducing inflows to the Salton Sea and rising elevation of the Salton Sea in the mid-1980s. Since that time, Also, water conservation measures have has been implemented in the Salton Sea watershed. The 1997 *Alternative Evaluation* report described this concept in detail. The 1997 report eliminated this variation from further evaluation because it would not help control salinity in the Salton Sea. The 1998 *Preappraisal Report* eliminated the concept because it would decrease the Salton Sea elevation and increase salinity.

- **Drainage Water Reuse or Blending** – This concept included irrigating salt-resistant crops with agricultural drainage water. The concept indicated that the water could be blended with fresh water. The concept also included that the more concentrated drainage flows would need to be disposed of through evaporation, desalination, transport to the ocean, or some other methods. The 1997 *Alternative Evaluation* report described this concept in detail. The 1997 report and the 1998 *Preappraisal Report* eliminated this proposal from further evaluation because it would not control salinity in the Salton Sea.

- **Aquaculture/Evaporation Ponds** – This concept would include raising fish in ponds created with water pumped from the Salton Sea. Water from the fish rearing ponds would be disposed into evaporation ponds. Remaining salt would be hauled to the Pacific Ocean. Previous reports estimated that 617 truck trips would be required every day. The 1997 *Alternative Evaluation* report described this concept in detail. The 1998 *Preappraisal Report* eliminated the concept because it would not control the Salton Sea elevation.

- **Hydropower/Filtration System** – This concept would use a combination of solar cells and fuel cells to pump water through a vapor desalination chamber into a storage tank 150 feet above mean sea level. Water in the tank would fall through a dual-purpose turbine system to recover energy and allow water to flow through a reverse osmosis process to remove salt. The 1997 *Alternative Evaluation* report described this concept in detail. The 1997 report and the 1998 *Preappraisal Report* eliminated this concept from further evaluation due to unproven technology for the scale required at the Salton Sea.

- **Electrochemical Extraction** – This concept would apply low voltage direct current to metal plates suspended in the Salton Sea. The plates would attract and collect oppositely charged ions. The 1997 *Alternative Evaluation* report described this concept in detail. Physical removal of the material collected on the plates would be difficult and expensive. The 1997 report eliminated the concept from further evaluation due to unproven technology for the scale required at the Salton Sea and high operation and maintenance costs. The 1998 *Preappraisal Report* eliminated the concept from further evaluation due to unproven technology for the scale required at the Salton Sea.

- **Land Speed Racetrack** – This concept would use the salt developed from other evaporation or desalination alternatives to build a land speed racetrack. The 1997 *Alternative Evaluation* report described this concept in detail. The 1997 report eliminated this variation from further evaluation because it would not control salinity in the Salton Sea. The 1998 *Preappraisal Report* eliminated this concept from further evaluation as an independent concept because it was only a brine disposal option and did not control salinity or elevation of the Salton Sea.

- **Electricity Production/Fish Farms/Mining Minerals** – This concept produced electricity; established fish farms; and mined salt, precious metals, and nitrogen. The 1998 *Preappraisal Report* eliminated the concept from further evaluation because it did not control salinity and elevation of the Salton Sea.

- **Recreation Facilities/Impoundment/Injections Wells** – This concept would use water pumped out of the Salton Sea for various recreational activities and inject brine disposal into the ground. The 1998 *Preappraisal Report* eliminated the proposal from further evaluation because the concept as described in the report would not control salinity and elevation of the Salton Sea.

- **Create Salt Marsh** – This concept would create a salt marsh to remove the salt from the Salton Sea. The 1998 *Preappraisal Report* eliminated the proposal from further evaluation because it did not control salinity and elevation of the Salton Sea.

- **Use Stabilized Dredged Sediment Material** – This concept would combine dredged material with either municipal solid waste ash or coal fly ash and lime kiln dust to make a grout material that would bind the contaminants for use in a structural fill. The 1998 *Preappraisal Report* eliminated this concept from further evaluation because the concept as described in previous reports would not control salinity and elevation of the Salton Sea and the technology appeared to be unproven.

- **Improve Habitat in Mexico** – This concept recognizes that some of the birds that frequent the Salton Sea also spend time in the Colorado River delta in Mexico. Improved habitat conditions in Mexico could also benefit bird populations at the Salton Sea.

- **Improve Habitat along the Lower Colorado River** – This concept recognizes that some of the birds that frequent the Salton Sea also spend time along the lower Colorado River. Improved habitat conditions along the River could also benefit bird populations at the Salton Sea.

- **Heat-Pump Evaporation/Condensation System** – This concept would evaporate water in a heat pump and recapture the energy in a condenser system to heat the next batch of water. The 1998 *Preappraisal Report* eliminated the concept from further evaluation because of the unproven technology.

Characteristics of the Alternative Concepts and the Variations

This grouping of concepts includes methods that require additional studies to evaluate.

Long-Term Ecosystem Sustainability

Long-term ecosystem sustainability would depend upon further evaluations.

Estimated Operational Life

Operational live would depend upon further evaluations.

Prior Evaluations of Concept

- **1988**, Problems and Potential Solutions at Salton Sea – The concepts considered in the variations were eliminated from further evaluation as described above.

- **1997 –** *Salton Sea Alternative Evaluation Final Draft Report* – The concepts considered in the variations were eliminated from further evaluation as described above.

- **1998**, *Salton Sea Alternatives, Final Preappraisal Report* – The concepts considered in the variations were eliminated from further evaluation as described above.

Alternative Concept 27 - Salton Sea Research Proposals

Various research proposals have been suggested to improve knowledge in specific areas. None of these can be considered as stand-alone concepts.

Key Features

These vary significantly with the proposal.

Variations

- **Foraminifera Studies** – This concept would evaluate microscopic forms of life with shells (*Foraminifera*) which are preserved in the Salton Sea's sediments. This study would require resampling of sites used in a 1950s study of *Foraminifera*. The study would attempt to determine which constituents may cause deformities in the *Foraminifera*. The 1997 *Alternative Evaluation* provided detail on the alternative.

- **Potential Use of Study Ponds** – This concept would use floating platforms to create several ponds for Salton Sea purposes. The 1997 *Alternative Evaluation* provided detail on the alternative.

- **$10 Million Award to Develop a Working Facility** – This concept would establish up to $10 million in a fund to be awarded when a working facility is developed for producing potable water from the ocean in large quantities at marketable prices.

Characteristics of the Alternative Concepts and the Variations

- These concepts would improve knowledge of the Salton Sea
- These are only studies and not alternative concepts that define management methods for the Salton Sea

Long-Term Environmental Sustainability

Long-term ecosystem sustainability would depend upon further evaluations.

Estimated Operational Life

Operational live would depend upon further evaluations.

Prior Evaluations of Concept

- **1997**, *Salton Sea Alternative Evaluation Final Draft Report* – The report eliminated the concepts from further evaluation because they were only studies and not alternative concepts for the Salton Sea.

- **November 1998**, *Salton Sea Alternatives, Final Preappraisal Report* - The report eliminated the concepts from further evaluation because they were only studies and not alternative concepts for the Salton Sea.