ATTACHMENT 9

Large Attachments to Salton Sea Authority Comment Letter

DRAFT FOR BOARD REVIEW – JULY 2006

SALTON SEA REVITALIZATION & RESTORATION

Salton Sea Authority Plan for Multi-Purpose Project

Salton Sea Authority

July 2006

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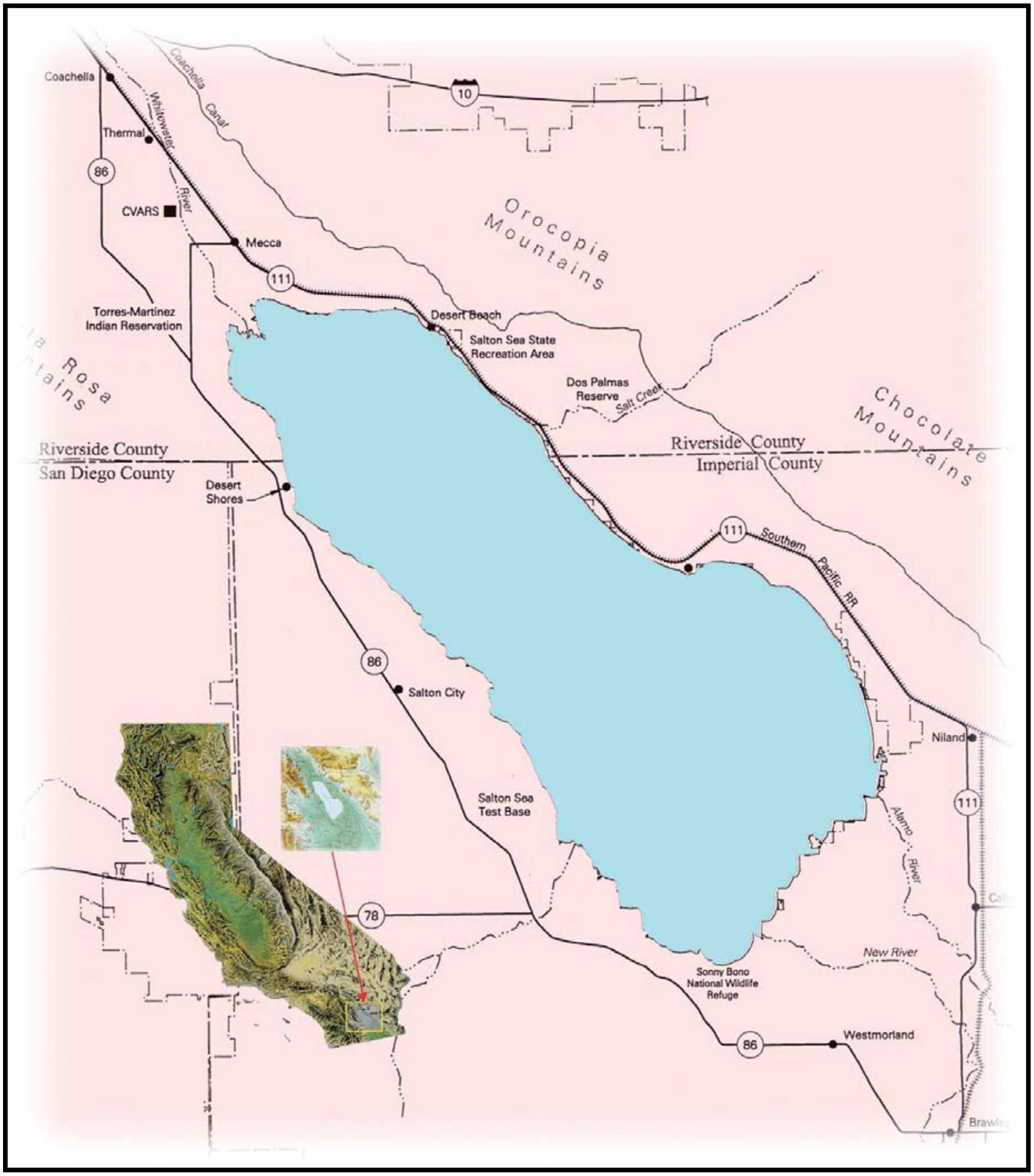

Salton Sea Location Map and Existing Surface Area (360 sq. miles)

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Shirley Palmer, Salton Community Services District
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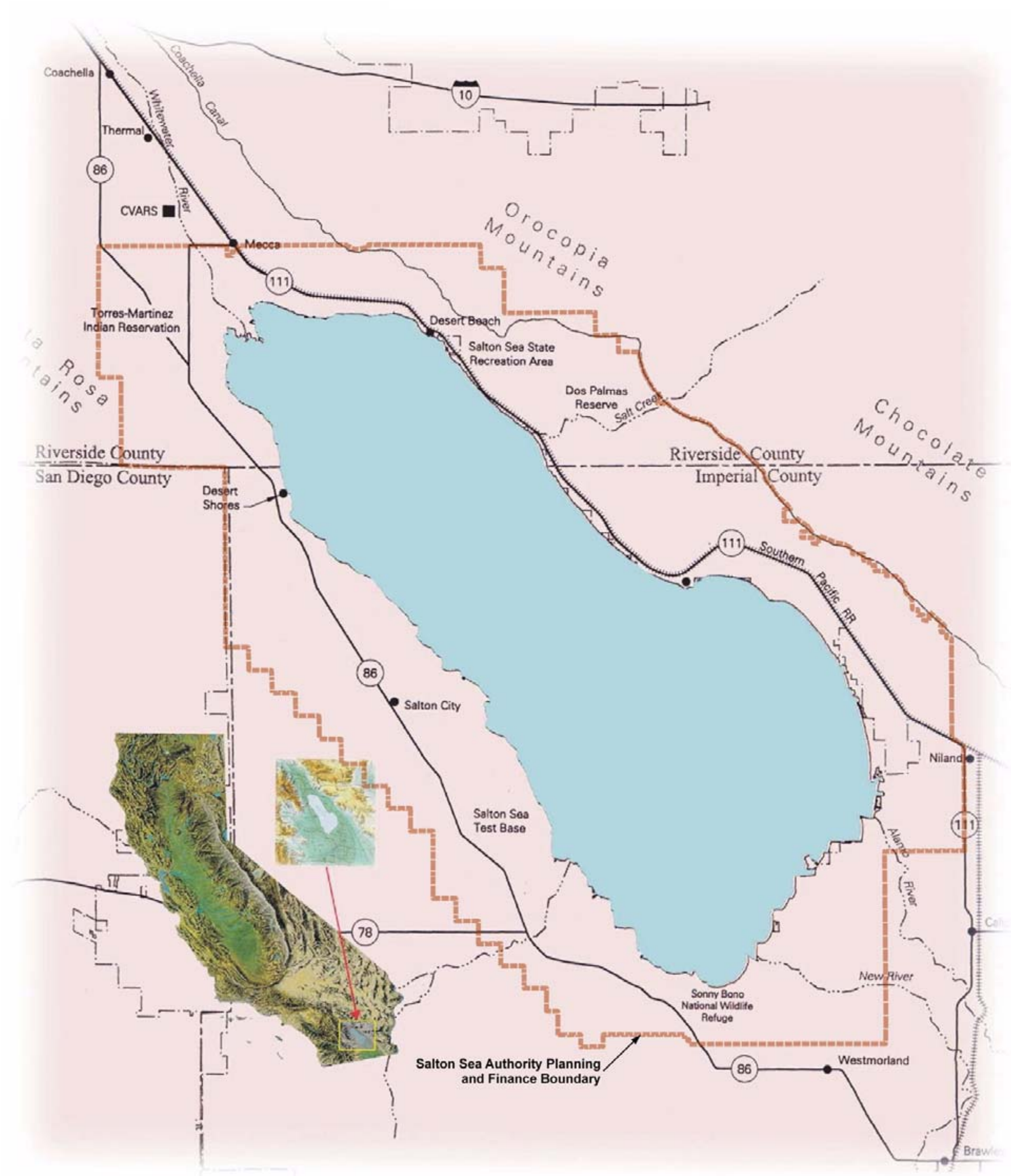

Salton Sea Location Map and Existing Surface Area (360 sq. miles)

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EXECUTIVE SUMMARY

Salton Sea Authority Plan Overview

The Salton Sea is located in a closed basin in Riverside and Imperial Counties in southern California, south of Indio and north of El Centro. The Sea is more than 220 feet below mean sea level (msl) and has no natural outlet. Land under the Sea is under a checkerboard of ownership consisting of: Federal (47%), Imperial Irrigation District (44%), tribal (5%), private (2%), State (1%) and Coachella Valley Water District (1%). The Salton Sea Basin is part of the Lower Colorado River Delta system (Figure ES-1) and, over geologic timescales; lakes have existed in the basin as the course of the Colorado River shifted, most recently, several hundred years ago.

Prior to the current Salton Sea formation, Lake Cahuilla formed periodically in the basin and provided support for tribal dwellers in the area. Currently, land owned by the Torres Martinez Desert Cahuilla Indian Tribe (the Tribe) is located along the northwest shore of the Sea. The Authority's Plan would provide a restored Sea along the current shoreline coupled with the development of habitat areas that could stimulate development and improve the economic conditions for the Tribe and Imperial and Riverside counties.

The current body of water formed in 1905 when a levee break along the Colorado River caused flows from the Colorado River to enter the basin for about 18 months. Since its formation in 1905, the Sea has been sustained predominantly by drainage flows from the nearly 600,000 acres of irrigated farmland in the Coachella and Imperial Valleys. The Sea also currently receives agricultural drainage, urban runoff, and wastewater flows from the Mexicali Valley and water from storm run-off.

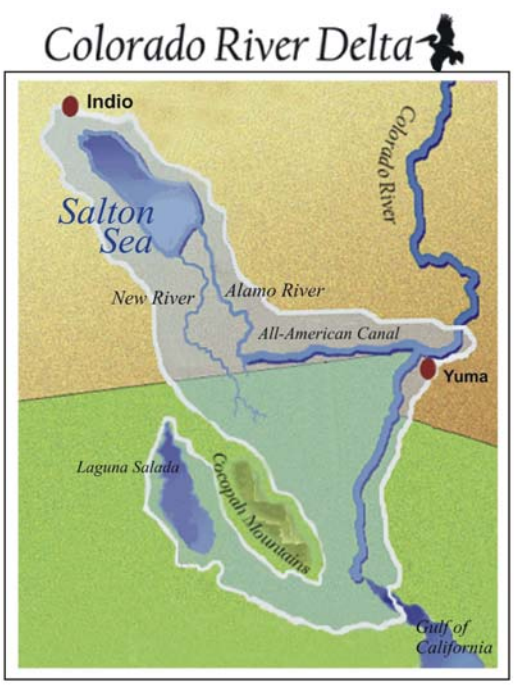


Figure ES-1. Salton Sea Setting within Colorado River Delta.

Historically, the highly productive farmlands in the Imperial and Coachella Valleys have been irrigated with 3.3 million acre-feet/year (AFY) of Colorado River water. Because farming activity in the Coachella, Imperial and Mexicali Valleys has remained relatively stable over the last 40 years, the quantity of drainage flows reaching the Sea has also been relatively stable. Since the 1950s, inflows to the Sea have averaged 1.35 million acre-feet per year (AFY) and remained within the range of 1.17 (-13%) to 1.59 (+18%) million AFY. Except for two hurricane flooding events in the late 1970s, the Sea has existed over the last 50 years as a picturesque 360-sq.-mile lake at a relatively stable elevation of –228 feet msl (±1.5 feet).

The Salton Sea was a major regional recreational destination in the 1950s and 60s attracting more visitors annually than Yosemite National Park. Nascent seaside resort and residential communities, like Salton City, North Shores and Salton Sea Beach, sprung up along the Sea's 90-mile shoreline. While the Sea continues to remain a regional recreation resource for campers, fishing, boating, hunting, bird watching and passive activities, the Sea's increasing salinity and other water quality problems have curtailed recreational use in the area beginning in the early 1970s.

The Sea and its adjacent areas have supported a diverse wildlife habitat for over 400 bird species. The Sea also serves as a critical link on the 5,000 mile international Pacific Flyway for bird migration.

Another important resource near the Salton Sea is the geothermal energy field at its south end. This important source of green energy currently has geothermal energy plants with a combined generation capacity of about 300 MW. It has been estimated that the energy field can support up to 2,000 MW of generation capacity. Part of the energy field is now under water. Under the Authority Plan, more of this area will be dry, making more geothermal production practical. The geothermal field is partially located in an area that has important shallow water habitat value. As the Authority's Plan moves from the conceptual phase to the detailed design phase, specific plans will need to be developed to minimize conflicts between these two important assets.

Even though the Sea has been relatively stable in size and elevation over the last 40 years, the dissolved salts present in the inflow water (about 3 tons per acre-foot) have been continuously accumulating in the water (except for the amount that precipitates and falls to the bottom). Consequently, salt concentrations are rising and are currently about 44 grams per liter (g/L). This is about 25% saltier than ocean water. If no remedial actions are taken, the Sea will become so saline within 15 years (over 60 g/L salt) that the sport fishery and the fish that serve as a food source for birds will be effectively eliminated. If the current inflow projections are correct, within 30 years, the Sea will evolve into a hyersaline water body (over 120 g/L salt) similar to Mono Lake in Inyo County. Some have suggested an even more rapid deterioration in habitat values (Pacific Institute, 2006). As inflows are reduced by water transfers and other factors as discussed below, the Sea will eventually become a semi-solid brine pool (over 200 g/L salt) surrounded by hard-surface salt flats similar to the Great Salt Lake in Utah and the Laguna Salada basin southwest of Mexicali.

In addition to high salinity, the Sea is also highly eutrophic, meaning that it has high levels of nutrient compounds of phosphorus and nitrogen that result from agricultural and urban runoff. Nutrients cause algal growth which creates oxygen deficiencies in the water. The near absence of oxygen in the deep bottom-water of the Sea leads to the formation and accumulation of substances such as hydrogen sulfide and ammonia that have unpleasant odors and can be toxic to fish. When wind events overturn the Sea's natural stratification, these harmful substances rise to the surface and in the past have caused sudden fish kills that have involved millions of fish. The Sea's eutrophic State also causes the unpleasant odors that permeate the residential areas surrounding the Sea (and occasionally the entire Coachella and Imperial Valleys) in certain months of the year.

Projected inflow reductions in the upcoming years will shrink the Sea's wetted surface area and further concentrate salinity and increase eutrophication problems. There are two primary reasons for the projected inflow reductions. First, the Quantification Settlement Agreement (QSA) was signed in October 2003 among Imperial Irrigation District (IID), Coachella Valley Water District (CVWD), other California Colorado River water users, the U.S. Department of Interior, and the California Department of Water Resources (DWR). Under this landmark agreement, about 300,000 AFY of Colorado River water (counting both contractual transfers and other reductions) that previously flowed into the Salton Sea will be supplied instead to other Colorado River water users. Second, New River inflows from Mexico, now about 130,000 AFY, are estimated to decline as a result of plans by Mexicali to reclaim treated-effluent and farm-drainage flows.

Notwithstanding these factors, the Authority believes that inflows to the Salton Sea will remain above 800,000 AFY over the 75-year restoration project evaluation period. This assumption is based upon several key assumptions including a review of area regional water management plans. This quantity assumes full utilization of IID's and CVWD's contractual Colorado River Entitlements over the 75-year QSA term with return flow percentages nearly equivalent to current irrigation and water use practices. The basis for the Authority's 800,000 AFY inflow projection is shown in Table ES-1 which presents a regional water balance through 2075 and is supported by the assumptions shown in Figure ES-1.

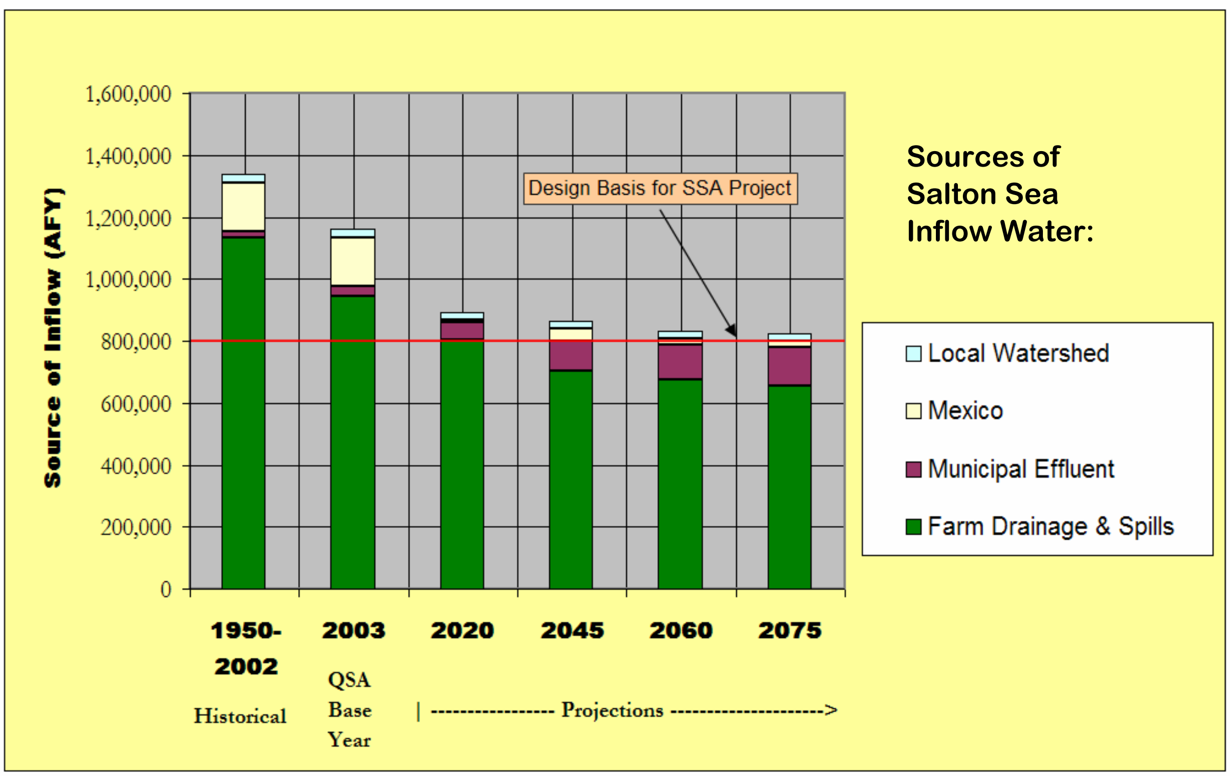


Figure ES-2 Projected Long-Term Salton Sea Inflows

Table ES-1. Salton Sea Inflow Projections under Long-Term Regional Water Balance (AFY)

	Historic[1] 1950-2002	Base Year[2] 2003	Projections[3] 2020	2045	2060	2075
			QSA Base Term		Extension (Optional)[4]	
Colorado River Supply						
IID & CVWD Colorado River Water @ 100% of Net QSA Entitlements[5]	**3,450,000**	**3,360,790** [6]	**3,019,300**	**3,066,800**	**3,066,800**	**3,066,800**
plus: CVWD SWP Transfer Water[7]		0	0	35,000	35,000	35,000
less: entitlement enforcement[8]		(59,210)	0	0	0	0
less: conveyance & storage losses	(300,000)	(261,040) [9]	(181,158)	(184,008)	(184,008)	(184,008)
Net Available for Beneficial Uses	**3,150,000**	**3,099,751**	**2,838,142**	**2,882,792**	**2,882,792**	**2,882,792**
Agriculture Use						
Farmland in Production ***acres***	***600,000***	***560,039***	***485,646***	***472,806***	***461,300***	***443,716***
Applied Irrigation Water	**3,240,000**	**2,977,459**	**2,568,327**	**2,419,666**	**2,351,194**	**2,259,369**
Farm Drainage & Operational Spill	**1,134,000**	**953,421**	**799,822**	**705,819**	**678,290**	**649,851**
% discharge to applied water	***35%***	***32%***	***31%***	***29%***	***29%***	***29%***
Municipal & Industrial Use						
Housing Units[10] ***# units***	***25,000***	***61,500***	***140,821***	***388,445***	***438,103***	***496,761***
Residential Service	12,500	30,750	70,410	194,223	219,051	248,380
Commercial, Golf Courses, Parks, etc.	60,000	120,000	145,861	186,159	215,503	254,471
CVWD Recharge Program	0	0	80,000	120,000	135,000	150,000
Total M&I and Recharge Water Use	**72,500**	**150,750**	**296,271**	**500,382**	**569,554**	**652,852**
Effluent, Runoff & Subsurface Flows	**18,125**	**29,578**	**41,652**	**84,653**	**99,657**	**116,439**
% discharge to applied water	***25%***	***20%***	***14%***	***17%***	***17%***	***18%***
Inflows from Colorado River Water	**1,152,125**	**982,998**	**841,474**	**790,473**	**777,947**	**766,290**
% Use of Colorado River Water Entitlements	103%	105%	101%	100%	100%	100%
Mexico						
Farm Drainage & Municipal Effluent[11]	90,000	90,000	0	0	0	0
Un-seweraged & Storm Flows	70,000	70,000	60,000	40,000	20,000	20,000
Subtotal - Mexico Inflows	**160,000**	**160,000**	**60,000**	**40,000**	**20,000**	**20,000**
Local Watershed						
Groundwater[12]	18,000	18,000	18,000	18,000	18,000	18,000
Creeks & Springs	8,000	8,000	8,000	8,000	8,000	8,000
Subtotal - Local Watershed	**26,000**	**26,000**	**26,000**	**26,000**	**26,000**	**26,000**
Total Salton Sea Inflows	**1,338,125**	**1,168,998**	**927,474**	**856,473**	**823,947**	**812,290**

[1] The figure shown here in Column 1 for total average historic inflows (incl. precipitation) is consistent with the DWR hydrology report (Table 3.1).
[2] The DWR figure for total inflows for the 2003 QSA Baseline in Column 2 is 1,090,181 AF (Table 3.2).
[3] The figures in these columns should be considered 5-year averages. Actual inflows in any single year may vary by ±20% based on historical data.
[4] IID may elect not to renew the 200,000 AFY IID/San Diego County Water Authority transfer in 2047. If this 200,000 AFY of supply is regained by IID and put to beneficial use in Imperial County for residential service, Salton Sea inflows would nominally increase by 40,000 AFY.
[5] Source: "Exhibit B, Quantification & Transfers," Colorado River Water Delivery Agreement, Oct. 10, 2003, among Dept. of Interior, IID, CVWD, et al.
[6] Includes 109,000 AFY entitlement overrun that will be paid back as part of the IOPP entitlement enforcement adjustment.
[7] Staring in 2025, CVWD will being receiving 35,000 of State Water Project (SWP) water through the Coachella Canal under a transfer from MWD.
[8] Payback for prior year apportionment overruns. Once the IID in-district storage reservoir is constructed (2018), this factor will be eliminated.
[9] Includes 67,000 and 26,000 AFY in All-American & Coachella Canal losses that will be recovered by lining projects and transferred to other QSA parties.
[10] Includes all homes in IID's service area, homes in Lower ID #1 in CVWD (Thermal, Mecca & Oasis area), and >250,000 new homes in the SSA District.
[11] Mexicali officials plan to upgrade their wastewater collection and treatment systems over next 20+ years and eliminate most flows into U.S.
[12] Source: *A Study on Seepage & Subsurface Inflows to Salton Sea and Adjacent Wetlands* (July 1999)

Given the current conditions and the expected future conditions, the Authority has developed and is advancing a combined, multi-purpose revitalization/restoration project aimed at concurrently: (1) restoring the Sea as a nationally important wildlife refuge; (2) maintaining the Sea as a vital link along the international Pacific Flyway; (3) preserving local tribal heritage and cultural values associated with the Sea; (4) reducing odor and other water and air quality problems; (5) reestablishing the Sea as a tourist destination and recreational playground; and (6) revitalizing the Sea as a local economic development engine. These project objectives are derived from and consistent with the Salton Sea Authority (Authority) Board Policy Positions that were enacted in October 2005 and reaffirmed at an Authority Board workshop meeting held in April 2006 and are listed in no order of priority. The Authority's Plan implements these objectives.

The Authority's proposed project design is also being considered as an alternative in the separate Salton Sea restoration project feasibility studies being conducted concurrently by the Resources Agency of the State of California (Agency) and the U.S Bureau of Reclamation (Reclamation). The Authority's project objective is to achieve the habitat restoration and air and water quality goals set out in State and Federal legislation, while simultaneously meeting the needs of the residents of the region, local property owners, and civic leaders in the Imperial, Coachella and Mexicali Valleys. These interests desire a large, sustainable recreational lake with reduced odor that serves as a catalyst for regional economic development. This lake would also provide critical habitat values as it has in the past. Historically, the Salton Sea fish population has been an important food source for resident birds and those migrating along the Pacific Flyway.

A unique feature of the Authority's "large lake" project design is that it is essentially self-mitigating with respect to selenium bioaccumulation and air-quality impacts. The 50-foot-deep saltwater lake in the Authority project is designed to maintain anoxic conditions in the sediment-water interface and trap selenium in immobile forms as currently occurs in the Sea. Selenium sequestration in sediments acts as a control on the bioavailability of this naturally occurring contaminant in the Sea and is the mechanism that has prevented selenium-related wildlife impacts to date at the Sea.

The current lakebed in the 60,000-acre salt deposit area in the south basin in the Authority project design will be covered with a thick, hard-surface sodium-chloride salt deposit that will control dust emissions as the water level recedes in that basin. These deposits will be similar to the salt formations that occur within the 40,000-acre commercial salt complex in the southern end of San Francisco Bay. Other dust control methods identified by the State and posted on their website could be used if needed in selected areas. It is expected that the need for additional measures will be limited, especially since the exposed areas in the Authority Plan will be isolated from residential areas by surrounding bodies of water and will be downslope of water features and are likely to be in more damp soil conditions. By contrast, alternatives that include recession of the current shoreline would have exposed areas immediately adjacent to residential areas and will be upslope from water bodies.

Finally, the Authority Plan includes a local funding component. The critical components in the Authority project design can be financed in significant part with local funds and all project components can be completed within 20 years. Overall the project is envisioned as a jointly funded project that will have Federal, State and local participation.

The basic features of the Authority Plan and major components of the current project design are briefly described in the remainder of this Executive Summary. The body of this report covers in greater detail the history, inflow analyses, design considerations, technical features, pilot projects in progress, conceptual land-use conservation and development plan, financing strategy, and the Authority's proposed local public/private partnership implementation approach. Results of investigations and expert opinion letters supporting the proposed project design for the Authority Plan are contained as appendices to this report. Other supporting research is referenced throughout the report and in the appendices.

The Locally Preferred Project: A Vision for the Future

The basic conceptual project design for the Authority Plan is illustrated in Figure ES-3. This locally-preferred project design includes the following essential components:

- In-Sea Barrier & Circulation Channels to separate the current Sea into two separate bodies (an outer "two lake" water system and multiple habitat complex areas, salt deposit area, and brine pool) with a channel for circulating water between the two lakes in the outer water system
- Water Treatment Facilities to improve both the existing water in the Sea and the inflow water as necessary to lessen or greatly reduce the Sea's eutrophication problem and to improve the clarity and quality of the water in both lakes to meet the recreational water quality standards set by the Regional Water Quality Control Board
- Habitat Enhancement Features to meet the needs of fish and bird populations consistent with State laws that require the "maximum feasible attainment" of specified ecosystem restoration goals
- Colorado River Water Storage Reservoir to enable the water agency to store Colorado River water to have greater flexibility for balancing supply and demand of Colorado River water use
- Park, Open Space, and Wildlife Areas including the Salton Sea State Recreation Area and the Sonny Bono National Wildlife Refuge will be preserved although it is envisioned that the boundaries of the Refuge will be modified to match the newly created habitat features.

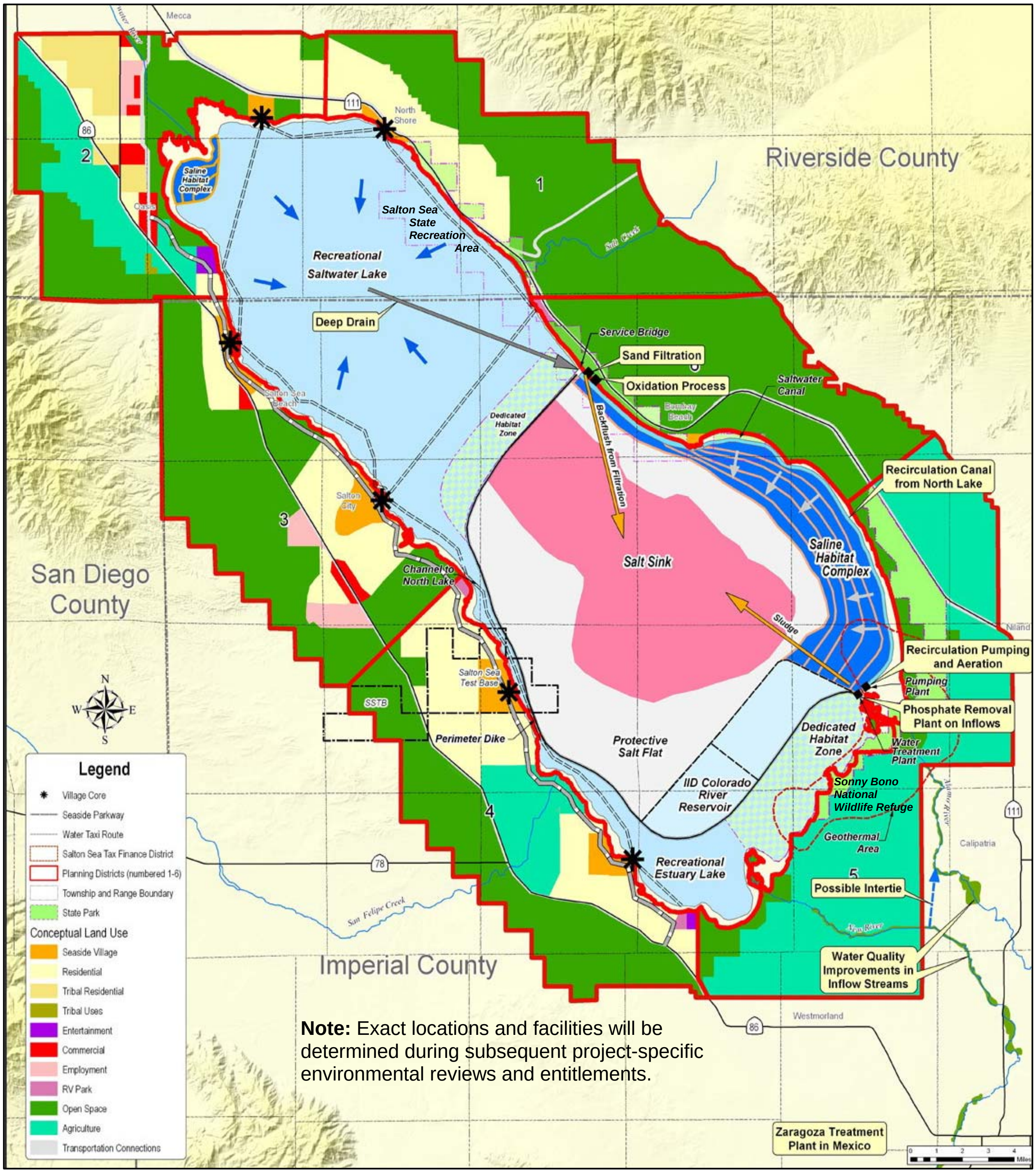


Figure ES-3 Conceptual Plan for Salton Sea Revitalization & Restoration Including Land-Use Plan for the Authority's 300,000 acre Planning & Financing District Surrounding the Sea

In addition to the features discussed above that are designed to address water quality problems and the potential air quality concerns associated with exposed lakebed, a plan for development of areas around the Sea has been prepared. The plan was prepared to guide creation of "seaside villages" and the build-out of over 250,000 new homes with accompanying entertainment, recreational, retail and business establishments within specified areas of the Authority's 300,000-acre planning and financing district around the Sea.

The project has been developed to a conceptual level at this time. The conceptual project features are discussed briefly below and in more detail in the main body of this report. Greater details will be developed in concert with site-specific environmental documentation and entitlements at the next stage of analysis. Exact locations and facilities will be determined during these subsequent reviews and a site-specific Environmental Impact Statement/Report (EIS/EIR) will be prepared. Reviews of this documentation will involve numerous local, State and Federal regulatory agencies.

In-Sea Barriers and Recirculation Canal

Once the required environmental documentation permits and approvals are finalized (including the permitting of one or more local rock sources), construction will begin on the signature feature of the Authority project: an approximately 33.5-mile-long, rock-fill, in-Sea barrier located as shown in Figure ES-3. This engineered structure will separate permanently the present 360-sq.-mile Sea into two separate water bodies, namely:

a) An outer 180-sq.-mile lake water system. This outer water body will be held at a relatively stable elevation so the shorelines of the two newly created lakes and the interconnecting boating channel on the west shore will remain unchanged as long-term inflows decrease. The water in the two joint-use recreational/habitat lakes will be treated as required and circulated to maintain recreational water-quality standards. The larger northern salt water lake (140 sq. miles) will be maintained at ocean-like salinity (35,000 mg/L salt), and the smaller southern estuary lake (40 sq.-miles) will be held at a lower salinity (20,000 mg/L salt). The south lake elevation (-228' msl) will be held about 2 feet above the north lake (-230' msl) since a slight hydraulic gradient is needed for circulating the water in both lakes in a continuous counter clockwise loop for blending and aeration. An earthen channel will be excavated along the east shore of the south basin to convey north lake water to the south lake and to support the 12,000-acre saline habitat complex in the south basin. A pumping plant will be built at the end of this channel to lift the extracted and treated north lake water into the south lake to blend with the Alamo and New River inflows.

b) An inner 180-sq.mile habitat and salt deposit area in the south end of the current Sea. The wetted surface area of this inner water body will shrink and its elevation will decline as inflows decrease over time. A salt-purge stream from the north lake will be discharged into the inner basin after being used in the saline habitat complex. The purpose of this purge stream is to balance salt inflows and outflows in the outer lake-water system. By sending salt to the inner basin in this manner, the two lakes can be held at relatively constant, controlled salinity levels. The lower inner basin will also serve as an overflow basin in the event of storm events. Salt pond pilot projects conducted at the Salton Sea indicate that as the shoreline inside the inner basin recedes, hard-surface salt deposits 12-to-24 inches thick will form on top of the old lakebed. The cement-like salt deposits will prevent blowing dust. Other air-quality mitigation techniques will be used if needed. A permanent hyersaline brine pool will eventually form in the lower depths.

Construction of the in-Sea barrier will require the excavation, sizing, transport, and placement by bottom-drop barges of approximately 64 million cubic yards of rock. The barrier will be built to seismic dam-design standards. This will require extraction by suction dredges of approximately 20 million cubic yards of soft sediments so the placed rock rests directly on the underlying stiff lacustrine clay deposits. The height of the barrier will range from 15 to 50 feet (including 10 ft of freeboard) depending on water depth.

Water Treatment Facilities

While investigations are on-going to better define treatment needs, it is currently anticipated that water treatment facilities will include a bottom drain and treatment system for removing and destroying hydrogen sulfide, ammonia, and other contaminants from the 50-foot-deep saltwater lake. A second treatment plant will remove phosphorus and other contaminants from the Alamo River inflows. The lake-water circulation system is designed to changeout the larger saltwater lake's water volume every four to five years. The circulation system will also serve to increase oxygen levels and avoid stagnation in the saltwater lake, and reduce selenium levels in the southern estuary lake. In concert these measures will improve overall water quality and fish habitat and greatly reduce odors.

Whitewater, New and Alamo Rivers Wetlands

With the Authority's assistance, the Citizens Congressional Task Force is completing the design and permitting and is beginning construction of a system of several thousand acres of water treatment wetlands along the New and Alamo Rivers in Imperial County. Similar wetlands are planned on Torres Martinez tribal land along the Whitewater River. (These wetlands coupled with a stable, better quality lake should significantly improve conditions for the Tribe and stimulate economic opportunities.) Although designed primarily for improving water quality (i.e., removing silt, nitrogen and phosphorus and increasing dissolved oxygen levels), these wetlands also provide significant wildlife habitat.

Habitat Enhancement Features

The Authority believes the greatest ecosystem benefit of its conceptual project design is the retention of a 90,000-acre, 50-foot-deep lake that will be restored to ocean-like salinity (35 g/L salt) and will be managed to maintain habitat-safe water quality. This restored saltwater lake will enhance the existing fishery and thus reestablish an abundant food source for the fish-eating birds that have historically resided at the Sea or migrated along the Pacific Flyway. The Authority project design also includes a 12,000-acre saline habitat complex located in the south and a 1,250-acre estuarine habitat complex near the mouth of the Whitewater River. In addition, half of the 26,000-acre estuary lake located in the south basin and a 6,000-acre area in front of the barrier across the north lake will be designated "habitat zones" in which motorized watercraft will be prohibited.

Colorado River Water Storage Reservoir

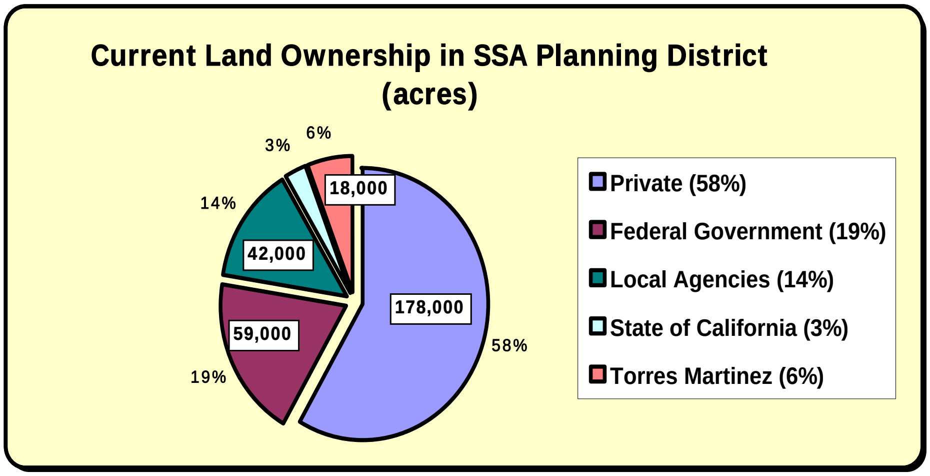
IID seeks a storage reservoir within the district's water system. A storage reservoir has been incorporated into the Authority Plan project design to provide for this need. This facility will be created by constructing a second barrier in 30-foot of water outside the initial barrier. The enclosed 11,000-acre area will create a 250,000 AF storage reservoir creating wildlife habitat. In addition, the reservoir will provide air quality mitigation by covering areas that would otherwise have exposed sediments.

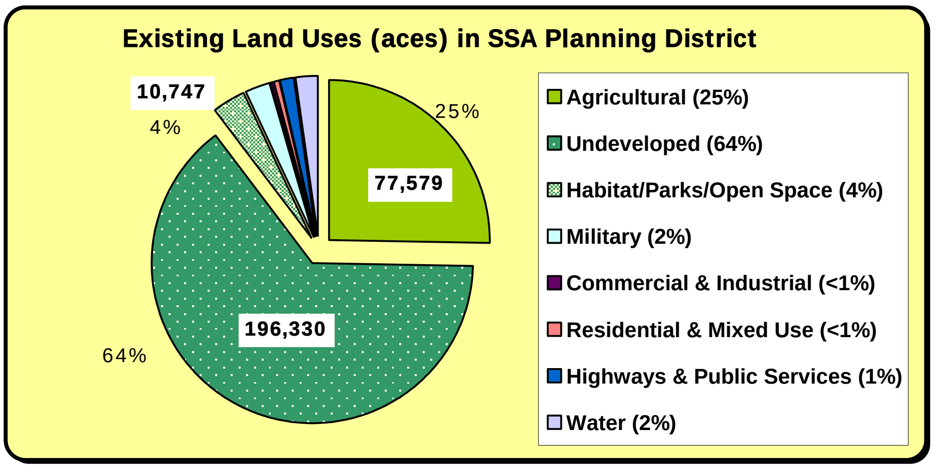
Park, Open Space, and Wildlife Areas

Park, open space, and wildlife areas around the Salton Sea will be preserved. These areas include the Salton Sea State Recreation Area (SRA, commonly referred to as the State Park) and the Sonny Bono National Wildlife Refuge. While the Wildlife Refuge will be preserved, it is envisioned that the boundaries of the Refuge will be modified to match the newly created habitat features. The SRA provides camping, fishing and boating opportunities and the Wildlife Refuge provides bird watching opportunities. With five campgrounds totaling approximately 1,600 campsites, the SRA provides more public access points than any other single shoreline access area. The estimated historic peak seasonal use of the SRA was approximately 660,000 visitors in 1961-62, and the last three years reveal evidence of a resurgence in public attendance, with a doubling of the total number of visitors in that period to 275,000. With improved water quality and habitat values at the Salton Sea, the recreation experience at both the SRA and the Wildlife Refuge is expected to be significantly improved.

Master Plan for Planning District around the Sea

In December 2005, the Authority released a Master Development Plan for the 300,000-acre planning district surrounding the Sea. Conceptual plans for creating separate and distinct seaside villages incorporating smart growth and sustainable development concepts have been developed. This plan could accommodate 250,000 new homes with associated entertainment, recreational, retail and business establishments being built over the next 75 years on 78,000 acres (less than 25% of the 300,000-acre planning district). Under this plan, over 50% of the land around the Sea would remain as habitat, parks and open space; and 20% would remain as farmland. This plan is shown in Figures ES-3 and ES-4 and is presented in greater detail later in this report.





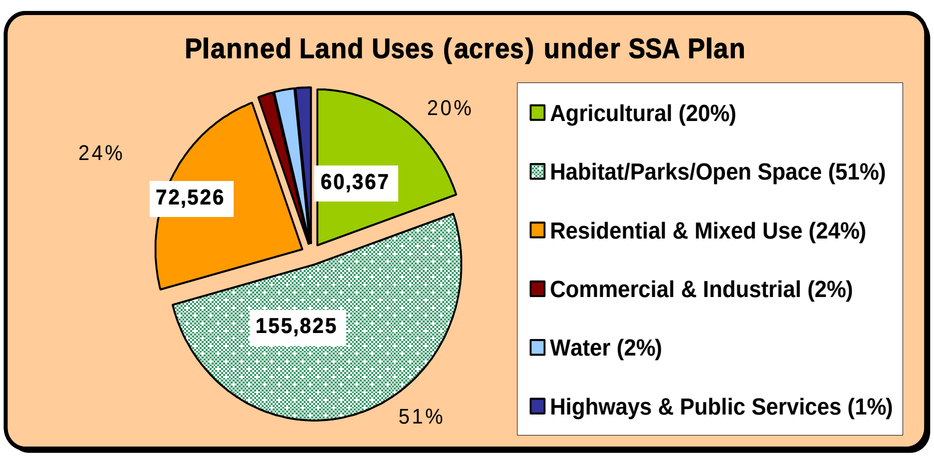


Figure ES-4 **Land Ownership and Land-Use Statistics for 300,000 acre Authority Planning District**

Cost Estimate, Financing Plan & Implementation

As shown in Figure ES-5, the total preliminary capital cost estimate is $2.2 billion for all components of the current Authority Plan. The various individual components of the overall project will be constructed in a phased manner over the next 20 years as funds become available from Federal, State and local sources.

A significant portion of the capital costs of a locally supported Plan can be locally financed through the funding mechanisms applied within the Authority's 300,000-acre planning and financing district around the Sea. These local funding mechanisms include a combination of: (1) the formation of tax-increment financing and benefit assessment districts; (2) public land acquisitions, transfers, and sales; (3) developer payments and impact fees; and (4) use of public-private partnerships for the construction and operation of the treatment plants.

The balance of the required capital funding is presumed to come from State and/or Federal sources. The State of California has historically funded major habitat restoration and water projects from both voter approved bonds and general funds. The Authority member agencies will work to have the Salton Sea included in future State bond issues and future State ballot measures. At this time, the only known State or Federal funding source is the $90 million that contractually has been (or will be) paid into the Salton Sea Restoration Fund (SSRF) by the QSA parties under the 2003 State legislation. Another $150 million of QSA-related funding is possible should the Resources Secretary determine that it is feasible to sell the balance of the mitigation water earmarked for stabilizing the Sea until a restoration project is in place. As shown in Figure ES-5, the best case is that facilities could be in place in time to obviate the need for the last two years of mitigation water. If this happens, it would add $70 million to the SSRF. There is also a water and parks bond measure on the November 2006 ballot in California with $47 million earmarked for the SSRF and another potential $100 million for wildlife habitat and water quality projects.

The in-Sea barrier in the Authority Plan project design should be constructed within 10 years and the water quality improvements necessary for returning the Sea to recreational quality water standards can be achieved within 15 to 20 years. This project implementation schedule is shown in Figure ES-5. Water system design & operating flows at design-case conditions are illustrated in Figure ES-6.

Next Steps

The Authority Plan presented in this document has been developed to a conceptual level. Specific project details and designs will be developed in concert with site-specific environmental documentation and entitlements at the next stage of analysis. Exact locations and facilities will be determined during those subsequent reviews and a site-specific Environmental Impact Statement/Report (EIS/EIR) will be prepared. Reviews of the plans, designs and environmental documentation will be accomplished in concert with appropriate local, State and Federal regulatory agencies.

Projected Capital Funding Requirements and Timeline for Phased Implementation of Salton Sea Authority Plan
($million)

Calendar Year	Cost	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Project Year from Start >>	$M	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Mitigation Water per QSA (year #)		4	5	6	7	8	9	10	11	12	13	14	15														
Quantity by Year (acre feet)		20,000	25,000	25,000	30,000	35,000	40,000	45,000	70,000	90,000	110,000	130,000	150,000														
Value if Sold ($ millions)		$5.0	$6.3	$6.3	$7.5	$8.8	$10.0	$11.3	$17.5	$22.5	$27.5	$32.5	$37.5														
SSA Components																											
Envir. Compliance & Permitting	$ 5			$5	$5																						
Design & Approvals Barriers/Quarry	$ 50	*BoR pilot project*			$20	$20	$10																				
Construction of In-Sea Barriers	$ 1,020						$1,020																				
Alamo River Treatment Plant	$ 125	*DWR pilot project (?)*				$125																					
North Lake Drain and Spillway	$ 30								$30																		
Lake Bottom-WaterTreatment Plant	$ 125	*BoR pilot project*							$125																		
Recirculation Canal & Pump Plant	$ 60												$60														
Water Supply Reliability Actions	TBD													*----- local management actions as necessary to maintain inflows >800,000 AFY ----->*													
SSA Components by Year	$ 1,415			$5	$25	$145	$1,030	$ -	$ 155				$ 60														
Joint IID/SSA Component																											
IID Reservoir & Conveyance+	$ 300											$300															
Federal Components																											
Environmental Compliance	$ 5			$3	$3																						
New & Alamo River Wetlands	$ 200	*WCB/BoR studies/pilots*			$20	$20	$20	$20	$20	$20	$20	$20	$20	$20													
Cleanup of Salton Sea Test Base+	$ 50				$25	$25																					
Federal Components by Year	$ 255			$ 3	$ 48	$ 45	$ 20	$ 20	$ 20	$ 20	$ 20	$ 20	$ 20	$ 20													
State Components		*BoR/USGS habitat field study ------------------------>*																									
Design of Habitat Features	$ 5			$3	$3																						
North Saline Habitat Complex+	$ 25				$25																						
Wildlife Easements on Farmland+	$ 50						$10	$10	$10	$10	$10																
South Saline Habitat Complex+	$ 100				$3	$3	$3	$3	$3	$3	$3	$3	$3	$3	$30	$40											
Air-Quality Mitigation Actions+	$ 50		*DWR pilot projects -->*											$5	$5	$5	$5	$5	$5	$5	$5	$3	$2				
State Components by Year	**$ 230**	**$ -**		$3	$31	$3	$13	$13	$13	$13	$13	$3	$3	$8	$35	$45	$5	$5	$5	$5	$5	$3	$2				
Total Project ($M)	$ 2,200	**$ -**	**$ -**	**$ 10**	**$ 103**	**$193**	**$1,063**	**$ 33**	**$ 188**	**$ 33**	**$ 33**	**$ 323**	**$ 83**	**$ 28**	**$ 35**	**$ 45**	**$ 5**	**$ 5**	**$ 5**	**$ 5**	**$ 5**	**$ 3**	**$ 2**				

Barrier Closure → *5 to 8 years* → Attainment of Water Quality Objectives

* In addition to $90 million in "hard" restoration funding per the QSA, unneeded mitigation water may be sold for $250/AF to fund restoration.
+These figures are allowances since no design studies or site investigations have been performed. Other cost figures are appraisal-level estimates.

Figure ES-5 Capital Funding Requirements and Timeline for Phased Implementation of Authority Plan ($million)

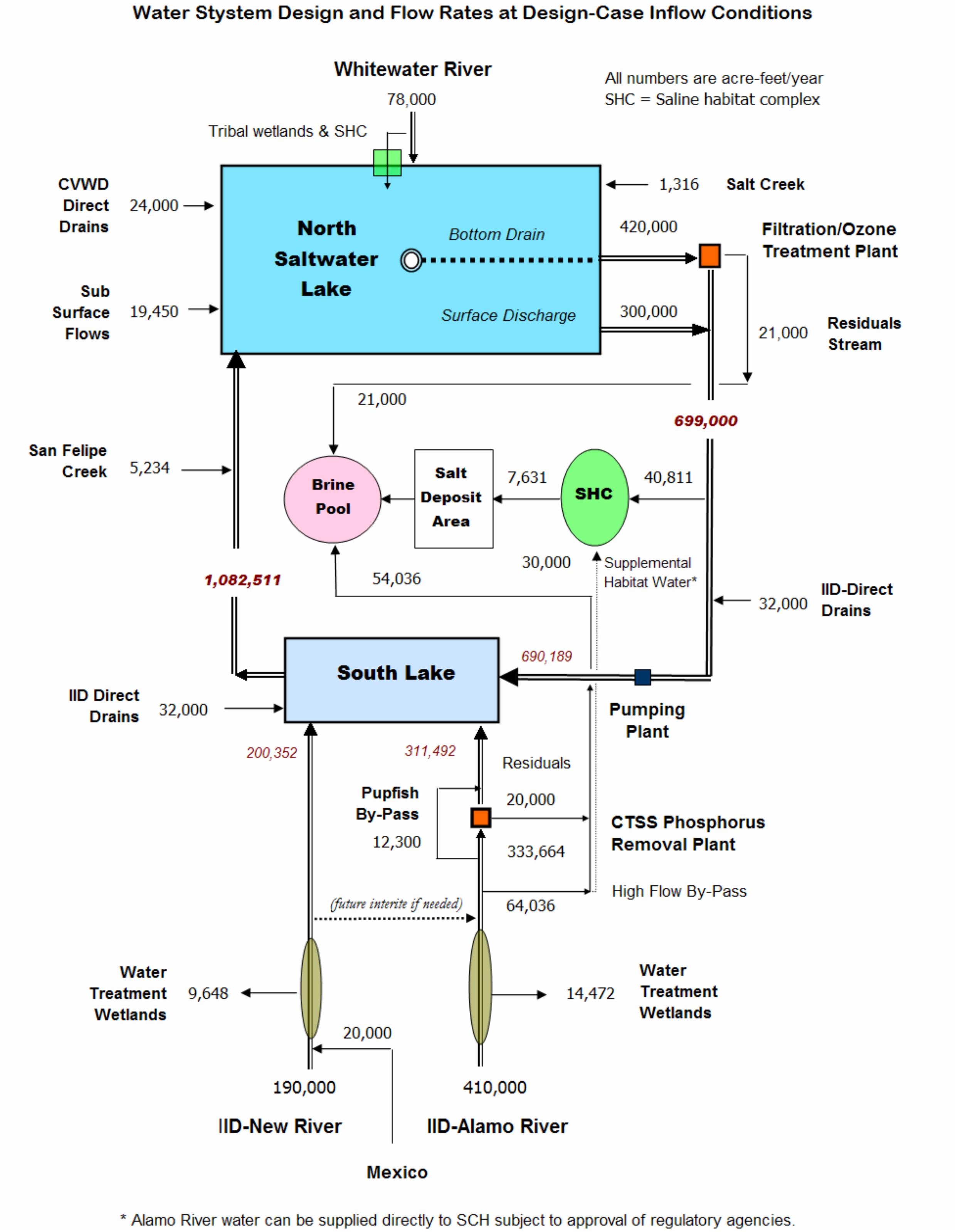


Figure ES-6. Water System Design & Operating Flows at Design-Case Conditions. Note: IID Colorado River water reservoir not shown since it is not part of Salton Sea water system

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Abbreviations and Acronyms

ac	acre
Authority	Salton Sea Authority
AF	acre feet
AFY	acre-feet per year
Agency	California State Resources Agency
CEQA	California Environmental Quality Act
CH2M Hill	Resource Agency consultant
CTSS	Chemical Treatment followed by Solids Separation
CVWD	Coachella Valley Water District
CWA	Clean Water Act
cy	cubic yard
DFG	Department of Fish & Game
DWR	California Department of Water Resources
EES	enhanced evaporation system
EFDC	Environmental Fluid Dynamics Code
EIS/EIR	environmental impact Statement/environmental impact report
EPA	U.S. Environmental Protection Agency
IFD	infrastructure financing district
FWS	U.S. Fish and Wildlife Service
g/L	grams per liter
IBWC	International Boundary & Water Commission
IID	Imperial Irrigation District
IOPP	Inadvertent Overrun and Payback Policy
JPA	Joint Powers Authority
kW	kilowatt hour
MDP	master development plan
MJS	Authority planning consultant
MWD	Metropolitan Water District
mcy	million cubic yard
mgd	million gallons per day
mg/L	milligrams per liter, roughly equivalent to parts per billion (ppb)
Model	Salton Sea Accounting Model
msl	mean sea level
NaCL	sodium chloride
Na_2CO_3	sodium carbonate
$NaHCO_3$	sodium bi-carbonate
NEPA	National Environmental Policy Act
O&M	operation and maintenance
PEIR	Programmatic Environmental Impact Report
PL	Public Law
Project	Salton Sea Restoration Project
ppb	parts per billion, roughly equivalent to milligrams per liter (mg/L)
PPT	parts per thousand

PV	present value
QSA	Quantification Settlement Agreement
Reclamation	Bureau of Reclamation
RSG	Authority financing consultant
RWQCB	Regional Water Quality Control Board
SDCWA	San Diego County Water Authority
SBSSNWR	Sonny Bono Salton Sea National Wildlife Refuge
SHC	Saline Habitat Complex
SLDFR	San Luis Drainage Features Re-evaluation
SSRF	Salton Sea Restoration Fund
SWRCB	State Water Resources Control Board
Sea	Salton Sea
Authority	Salton Sea Authority
AuthorityM	Salton Sea Accounting Model
sq. mi.	square mile
SWP	State Water Project
TDS	total dissolved solids
TMDL	total maximum daily load
ton/yr	tons per year
USFWS	United States Fish and Wildlife Service
USBR	Unites State Bureau of Reclamation
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
μg/L	micrograms/liter; roughly equivalent to parts per billion (ppb)
WCB	State of California Wildlife Conservation Board

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Chapter 1: INTRODUCTION

1.1 History and Current Status of the Salton Sea

The Salton Sea is located in a closed basin in Riverside and Imperial Counties in southern California, south of Indio and north of El Centro. The Sea is more than 220 feet below mean sea level (msl) and has no natural outlet. Land under the Sea is under a checkerboard of ownership consisting of: Federal (47%), Imperial Irrigation District (44%), tribal (5%), private (2%), State (1%) and Coachella Valley Water District (1%). The Salton Sea Basin is part of the Lower Colorado River Delta system and, over geologic timescales; lakes have existed in the basin as the course of the Colorado River shifted, most recently, several hundred years ago.

Prior to the current Salton Sea formation, Lake Cahuilla formed periodically in the basin and provided support for tribal dwellers in the area. Currently, land owned by the Torres Martinez Desert Cahuilla Indian Tribe (the Tribe) is located along the northwest shore of the Sea. The Authority's Plan would provide a restored Sea along the current shoreline coupled with the development of habitat areas that could stimulate development and improve the economic conditions for the Tribe and Imperial and Riverside counties.

The current body of water formed in 1905 when a levee break along the Colorado River caused flows from the Colorado River to enter the basin for about 18 months. Since its formation in 1905, the Sea has been sustained predominantly by drainage flows from the nearly 600,000 acres of irrigated farmland in the Coachella and Imperial Valleys. The Sea also currently receives agricultural drainage, urban runoff, and wastewater flows from the Mexicali Valley and water from storm run-off.

Historically, the highly productive farmlands in the Imperial and Coachella Valleys have been irrigated with 3.3 million acre-feet/year (AFY) of Colorado River water. Because farming activity in the Coachella, Imperial and Mexicali Valleys has remained relatively stable over the last 40 years, the quantity of drainage flows reaching the Sea has also been relatively stable. Since the 1950s, inflows to the Sea have averaged 1.35 million acre-feet per year (AFY) and remained within the range of 1.17 (-13%) to 1.59 (+18%) million AFY (Table 3.1). Except for two hurricane flooding events in the late 1970s, the Sea has existed over the last 50 years as a picturesque 360-sq.-mile lake at a relatively stable elevation of –228 feet msl (±1.5 feet).

The Salton Sea was a major regional recreational destination in the 1950s and 60s attracting more visitors annually than Yosemite National Park. Nascent seaside resort and residential communities, like Salton City, North Shores and Salton Sea Beach, sprung up along the Sea's 90-mile shoreline. While the Sea continues to remain a regional recreation resource for campers, fishing, boating, hunting, bird watching and passive activities, the Sea's increasing salinity and other water quality problems have curtailed recreational use in the area beginning in the early 1970s.

The Sea and its adjacent areas have supported a diverse wildlife habitat for over 400 bird species. The Sea also serves as a critical link on the 5,000 mile international Pacific Flyway for bird migration.

Another important resource near the Salton Sea is the geothermal energy field at its south end. This important source of green energy currently has geothermal energy plants with a combined generation capacity of about 300 MW. It has been estimated that the energy field can support up to 2,000 MW of generation capacity. Part of the energy field is now under water. Under the Authority Plan, more of this area will be dry, making more geothermal production practical. The geothermal field is partially located in an area that has important shallow water habitat value. As the Authority's Plan moves from the conceptual phase to the detailed design phase, specific plans will need to be developed to minimize conflicts between these two important assets.

Even though the Sea has been relatively stable in size and elevation over the last 40 years, the dissolved salts present in the inflow water (about 3 tons per acre-foot) have been continuously accumulating in the water (except for the amount that precipitates and falls to the bottom). Consequently, salt concentrations are rising and are currently about 44 grams per liter (g/L). This is about 25% saltier than ocean water. If no remedial actions are taken, the Sea will become so saline within 15 years (over 60 g/L salt) that the sport fishery and the fish that serve as a food source for birds will be effectively eliminated. If the current inflow projections are correct, within 30 years, the Sea will evolve into a hyersaline water body (over 120 g/L salt) similar to Mono Lake in Inyo County. Some have suggested an even more rapid deterioration in habitat values (Pacific Institute, 2006). As inflows are reduced by water transfers and other factors as discussed below, the Sea will eventually become a semi-solid brine pool (over 200 g/L salt) surrounded by hard-surface salt flats similar to the Great Salt Lake in Utah and the Laguna Salada basin southwest of Mexicali.

In addition to high salinity, the Sea is also highly eutrophic, meaning that it has high levels of nutrient compounds of phosphorus and nitrogen that result from agricultural and urban runoff. Nutrients cause algal growth which creates oxygen deficiencies in the water. The near absence of oxygen in the deep bottom-water of the Sea leads to the formation and accumulation of substances such as hydrogen sulfide and ammonia that have unpleasant odors and can be toxic to fish. When wind events overturn the Sea's natural stratification, these harmful substances rise to the surface and in the past have caused sudden fish kills that have involved millions of fish. The Sea's eutrophic State also causes the unpleasant odors that permeate the residential areas surrounding the Sea (and occasionally the entire Coachella and Imperial Valleys) in certain months of the year.

Projected inflow reductions in the upcoming years will shrink the Sea's wetted surface area and further concentrate salinity and increase eutrophication problems. There are two primary reasons for the projected inflow reductions. First, the Quantification Settlement Agreement (QSA) was signed in October 2003 among Imperial Irrigation District (IID), Coachella Valley Water District (CVWD), other California Colorado River water users, the U.S. Department of Interior, and the

California Department of Water Resources (DWR). Under this landmark agreement, about 300,000 AFY of Colorado River water (counting both contractual transfers and other reductions) that previously flowed into the Salton Sea will be supplied instead to other Colorado River water users. Second, New River inflows from Mexico, now about 130,000 AFY, are estimated to decline as a result of plans by Mexicali to reclaim treated-effluent and farm-drainage flows.

In addition to these physical problems, developing and implementing a Salton Sea restoration project is complicated by the Sea's legal status. Two presidential decrees in the 1920's permanently established the Salton Trough (defined as all lands below elevation -220 ft msl) as a repository for agricultural drainage water. By the 1930s, this agricultural drainwater repository, now a permanent water body, became commonly known as the "Salton Sea." The Federal government established a national wildlife refuge (now the Sonny Bono Salton Sea National Wildlife Refuge in honor of the late Coachella Valley congressman) on 40,000 acres in the south end of Sea in the 1940s. In the 1950s, the Sea's popularity as a recreational and tourist site led to the creation of a State park along the eastern shoreline of this agricultural drainwater repository.

IID, an Authority member agency, is the largest non-Federal landowner under and around the Sea. This land ownership is a result of IID's legacy as the successor (through the Southern Pacific Railroad) to the California Development Company, the entity responsible for developing irrigated agricultural in what is now Imperial County beginning in the 1890s. IID and CVWD also purchased large tracts of submerged shoreline lands around the Sea in the 1980s to settle flooding lawsuits caused by hurricanes in the late 1970s. During World War II, the military set up the 7,200 acre Salton Sea Test Base south of Salton City in Imperial County. This facility remained operational for various military uses until the early 1990s. This base is now officially closed, and the Navy has cleaned it up to open-space standards.

1.2 Federal & State Legislation on Salton Sea Restoration

Within the last decade, both the U.S Congress (1998) and the California State legislature (2003 and 2004) have enacted legislation establishing Salton Sea restoration as Federal and State policy and defining specific project objectives

The Federal Salton Sea Restoration Act of 1998 (P.L. 105-372) authorized the Secretary of the Interior to complete studies of restoration options that:

1. Permit the continued use of the Salton Sea as a reservoir for irrigation drainage;
2. Reduce and stabilize the overall salinity of the Salton Sea;
3. Stabilize the surface elevation of the Salton Sea;
4. Reclaim, in the long term, healthy fish and wildlife resources and their habitats; and

5. Enhance the potential for recreational uses and economic development of the Salton Sea.

The Act directed the Secretary to consider inflow reductions that could result in total inflows of 800,000 AFY or less (the now concluded IID/San Diego County Water Authority water transfer was under discussion when this legislation was enacted). Options to be considered included segregating the Sea into one or more evaporation sections, pumping water in-and-out of the Sea, augmenting inflows, combinations of various options, and other options as the Secretary deems appropriate. The Act specifically prohibited the direct use of Colorado River water for any restoration project. The prescribed study was completed and documented in an EIR/EIS in late 1999. In January 2000, Secretary of Interior directed Reclamation not to approve or publicly release this document. Subsequent Federal involvement in Salton Sea restoration was halted, except for participation in studies and pilot projects.

Four State laws (SB 277-Ducheny, SB 317-Kuehl, and SB 654-Machado in 2003; and SB 1214-Kuehl in 2004) were enacted in conjunction with the QSA and related water transfers to address Salton Sea related issues. One purpose of this legislation was to initiate a process aimed at defining and implementing a post-QSA restoration project; or ascertaining that no project (or only a minimal project) is feasible. These laws also set up mechanisms for generating money for a newly created Salton Sea Restoration Fund (SSRF). The existing funding mechanisms for the SSRF have or will produce a minimum of $90 million and as much as $250 million. Finally, under the above legislation, the State of California accepted financial liability for cost overruns, if any, on the mitigation measures prescribed in the EIR/EIS for the QSA water transfers above the $133 million paid by the QSA parties. The primary issues in this regard are air-quality impacts and endangered species protection. SB 1214 specifically allows the State of California in use monies in the SSRF for mitigation.

Following the October 2003 legislation, the California State Resource Agency (Agency) was given $20 million in Chapter 9 (Colorado River Region) Proposition 50 funds to conduct a feasibility study and Programmatic EIR on restoration options as set out in the legislation. Most notably, the legislation explicitly requires the Agency to select as the State's preferred alternative the project design that accomplishes the "maximum feasible attainment" of certain identified ecosystem restoration goals. The Agency must complete its study and PEIR and identify a preferred alternative and financing plan by December 31, 2006. The "drivers and objectives" that have been established to guide this study are shown in Figure 1.1

The enactment of SB 1214 in October 2004 States that recreation and economic development will be "considered," but this law specifically excludes these goals as project purposes under CEQA.

The Salton Sea was included in the CALFED Bay-Delta Act that was enacted by Congress in November 2004 (P.L. 108-361). This Federal legislation contains a provision stating:

> *Not later December 31, 2006, the Secretary of Interior, in coordination with the State of California and the Salton Sea Authority, shall complete a feasibility study on a preferred alternative for Salton Sea restoration.*

Reclamation began work in this separate feasibility study in early 2005 and issued a preliminary internal draft report in September and October 2005.

Salton Sea Ecosystem Restoration Plan
Drivers and Objectives for Development of Alternatives

- Habitat
  - Legislation
  - Maintain species diversity and abundance
  - Stabilize Salton Sea salinity and elevation
  - Maximize habitat values (quantity and quality)
  - Maintain mosaic of habitats, including agricultural lands
  - Maintain pupfish habitat connectivity
- Water Quality
  - Legislation
  - Minimize selenium and arsenic risks
  - Improve water quality in aquatic habitats, e.g., Reduce eutrophication in the Salton Sea
- Air Quality
  - Legislation
  - Minimize exposed playa and construction-related emissions
  - Stabilize exposed playa
- Water Infrastructure
  - Water Balance
  - Operational flexibility
  - Seismic safety
  - Configure to meet project objectives
- Other Important Considerations
  - Maintain Salton Sea as agricultural drainage repository
  - Accommodate recreational and local economic opportunities

Source: Handout at Salton Sea Advisory Committee Meeting, May 18, 2005

Figure 1-1 State Process Drivers & Objectives

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Chapter 2: THE SALTON SEA AUTHORITY

The Salton Sea Authority (the Authority or Authority) was formed in 1993 by local initiative as a joint powers authority (JPA) among four local public agencies that share a vital interest and concern over the fate of the Salton Sea. The Authority's existence and its powers, governance, and activities are governed by its By-Laws. The four founding member agencies of the Authority are:

- Imperial Irrigation District (IID)
- Imperial County
- Coachella Valley Water District (CVWD)
- Riverside County

Special State legislation was enacted in 2002 to allow the Torres Martinez Desert Cahuilla Indians (a sovereign tribal nation) to become a voting member of the Authority as a JPA among local agencies. The Authority's By-Laws were amended in 2003 to admit the Torres Martinez tribe as the Authority's fifth member agency. Each member agency appoints two persons to serve on the Authority's 10-member Board of Directors. Nine of the ten current Authority board members are local elected officials who also serve on the boards (council) of their respective member agencies (sovereign nation). The Authority typically holds ten public board meetings each year. To assist in the Authority's governance, the board has formed three standing committees: Technical Advisory, Planning & Public Policy, and Project Finance. These committee meet on a quarterly basis as needed. The committee memberships are composed of professional staff from member agencies with relevant expertise, elected officials from non-member agencies, and interested local citizens. The Authority presently has a professional full-time staff.

As a public agency, the Authority is also governed by State law. As permitted for JPAs, the Authority has elected to adopt and adhere to the administrative procedures of CVWD as a county water agency in lieu of creating its own administrative procedures.

The role of the Authority as the logical governmental entity to facilitate the process of defining, funding, designing, permitting, building, owning and operating a project for restoring the Sea Salton as a usable water body for multiple public purposes and benefits is supported by the following pertinent facts:

- Over 85% of Salton Sea inflows (over 95% once Mexico's inflows diminish) is derived from agricultural drainage from the Colorado River water from IID and CVWD.

- After the Federal government, the IID (over 90,000 acres[1]) and the Torres Martinez (24,800 acres) are the largest landowners under and around the Sea.
- The largest remaining undeveloped tracts of potentially developable land in the Coachella and Imperial Valleys lie within the Authority's 300,000-acre planning district, including the closed and surplused 7,200-acre Salton Sea Test Base in Imperial County that has remained under U.S. Department of Navy control.
- A potential source of rock (the Coolidge Mountain site west of Salton Sea Beach) for constructing in-Sea barriers is located in unincorporated Imperial County on Torres Martinez land and private property.
- IID and CVWD both have the engineering expertise and organizational capability to implement large and complex water-engineering projects (e.g. the $90 million Coachella Canal and $250 million All-American Canal lining projects now in progress).
- Riverside County, Imperial County, and the Torres Martinez tribe hold autonomous land-use decision-making authority (general plan amendments, rezonings, design standards, development project approvals, etc.) over all 300,000 acres of land in the Authority's planning district around the Sea.
- IID is the electrical-service provider within the Authority's 300,000-acre planning district; and IID or CVWD will be the municipal raw water or treated water service provider to new homes and businesses in the planning district.

2.1 Development of the Authority's Preferred Alternative

The U.S. Congress awarded $13 million in Federal grant funding to the Authority in 1998 and 1999. These grant funds, along with about $7 million in other Federal and State grants the Authority received from 1998 though 2003 were used to perform science studies aimed at identifying the causes and potential cures for the Salton Sea's myriad problems. The U.S. Geological Survey (USGS) opened and staffed a Salton Sea Science Office to provide technical oversight on how these funds were expended. Reclamation also created and staffed a Salton Sea Field Office to assist in the execution of the Authority's studies and to undertake its own studies. In addition, the Federal ly funded Salton Sea Database Program at the Redlands Institute provided an invaluable source of compiled information to support the project. The result of a six-year program, which included field pilot tests and the preliminary formulation and evaluation of restoration concepts, is a large and comprehensive library of technical reports related to all facets of the Salton Sea (bird populations,

[1] Since IID has ownership of most of the shoreline and shallow-water areas at the south end of the Sea, including some lands currently occupied by Sonny Bono Salton Sea National Wildlife Refuge facilities, IID would have control over its lands with regard to appropriate zoned use and appropriate agency use.

avian and piscine diseases, chemical and physical limnology, hydrology, bathymetry, salt characteristics, etc.)

Using the results of the 6-year, $20-million science program, Authority's staff and its consulting/engineering team developed a report titled *Salton Sea Restoration: Final Preferred Project Report* in July 2004. This report identified what become known as the "North Lake Plan" as the Authority's preferred alternative for Salton Sea restoration. The Authority's Board of Directors and Technical Advisory Committee both formally endorsed this plan in unanimous votes in April 2004.

The key feature of this project design was a straight-line barrier directly across the southern most "waist" (narrowest crossing) of the current Sea. This point is about 8 miles south of Salton City. This rock-fill barrier would have created a 180-sq.-mile recreational lake in the northern end of the Sea. The southern end of the current Sea was slated to become a brine pool and shallow-habitat wetlands area. No shoreline development or recreational water-use was envisioned south of the mid-Sea barrier. This initial Authority plan also did not include water treatment facilities or nutrient source-control measures. The total capital cost was estimated at $600 to $800 million depending on the barrier design and North Lake elevation (-230 ft or –235 ft).

Since the initial Authority North Lake Plan was formulated *after* the QSA water transfers were approved in October 2003, the project design was based on expected long-term average inflows of 950,000 AFY with the possibility that inflows could drop to 800,000 AFY in the future. The 950,000 AFY baseline figure was used since this was the post-QSA average inflow projection contained in the documents the QSA proponents had submitted to the State Board to obtain the water rights order for the QSA water transfers. This 950,000 AFY figure came from an inflow analysis prepared by Reclamation using its Salton Sea Accounting Model that was derived from the IID-certified Environmental Impact Report (EIR) and the Reclamation-certified Environmental Impact Statement (EIS) for the QSA and related water transfers (the "QSA/Transfer Project"). The Authority used 800,000 AFY as the design-case inflow projection in its July 2004 *Preferred Plan Report.*

The USGS Science Office and Reclamation organized and sponsored an Experts Workshop to evaluate and critique the Authority North Lake Plan as described in the Authority's July 2004 *Preferred Project Report.* This two-day workshop was held in Riverside in November 2005 and was attended by over 20 invited experts in technical fields relevant to Salton Sea restoration (e.g., hydrology, selenium, eutrophication, air quality, etc.) The deliberations, findings, and recommendations from this workshop are documented in a 60-page report prepared by Mike Cohen of the Pacific Institute and released in March 2005 (Pacific Institute, 2005).

The major concerns this panel of experts expressed on the viability of the initial Authority Plan, and the Authority's responses to these concerns, are summarized below.

- ***The Authority Plan did not address the existing water-quality problems***. The *Pacific Institute Report* notes that the original Authority project design did not include any means for improving the dissolved oxygen levels in the water. This design deficiency has implications for both fish and bird health. The experts also expressed concerns about sediment resuspension and the fact that resuspension is important factor in driving phosphorus dynamics. They noted the need to examine the impacts from areal nutrient loading (source control) relative to the loadings from resuspension. However, they said total loadings will increase (with more phosphorus loading per unit area) despite the implementation of TMDLs [total maximum daily loads] as a source control measure because the North Lake in the Authority Plan is much smaller than the current Sea. They also expect that North Lake will have high ammonium concentrations which will be a significant problem since current ammonia concentrations are already likely toxic to fish. A smaller North Lake also will not eliminate the current problem of stratification and periodic mixing of anoxic bottom water with the rest of the water column. This occurrence strips oxygen out of large areas of the Sea and results in massive fish kills. Because of the potential for resuspension, it is not clear that nutrients will be reduced in this plan, which could lead to algae growth, including potentially toxic algae.

As a result of these deficiencies, the Authority Plan was redesigned to include positive nutrient source control; the constant circulation and aeration of the lake-water system; and the extraction and oxidative treatment of the anoxic bottom-water in the saltwater lake.

- **Using New or Alamo River water (or blended river and lake water) in shallow-water habitat wetlands will create "selenium traps" harmful to wildlife similar to the Kesterson episode in the San Joaquin Valley in the mid-1980s**.
  The *Pacific Institute Report* notes numerous problems with the creation of 20,000 acres of shallow brackish-water ponds as habitat areas in the south end of the current Sea. The experts noted the following issues with this proposed project feature: (1) if watered with river water or blended river and lake water as proposed, such ponds would pose significant potential for selenium toxicity impacts on waterfowl similar to the Kesterson experience; (2) the potential for vector attraction and spread of mosquito-borne diseases; (3) expensive plumbing would be needed to control salinity; (4) seasonal variations of inflows may cause ponds to dry up in low-flow winter months; (5) these ponds would be poor fish habitat leading to mortality due to low dissolved oxygen levels and high temperatures; and (6) invasive plant growth (e.g., tamarisk) will be a problem.

  In response to these comments, the 20,000 acres of shallow brackish-water ponds and wetlands in the south end in the initial Authority Plan have been eliminated. Instead of these problematic shallow ponds and non-flow-through wetlands in the south end, the current Authority project design includes a 12,000 acre dedicated "habitat zone" in the eastern half of the 26,000 acre estuary lake in the south end of the current Sea. With this design change, the present shoreline and natural shallow-water areas in the south end will be retained "as is." This will obviate the need to replace the habitat values these existing features provide with artificial features. Secondly, the revised Authority project design includes a 12,000-acre shallow-water saline-habitat complex along the southeastern shoreline below the inter-lake circulation canal. However, instead of using New and Alamo River water with its 6-to-12 μg/L of selenium, *this complex will be supplied by 1-2 µg/L selenium north-lake water that will be discharged by gravity from the circulation canal. Additional habitat features in the revised Authority Plan are presented in Chapter 4.*

- **Long-term inflows may be inadequate to meet the Authority Plan's minimum water-use requirement of 800,000 AFY**
  The *Pacific Institute Report* noted: "Several of the participants thought that future inflows to the Sea would be even lower than projected.… Hydrological calculations suggest that the water is very close to being insufficient for the proposed plan."

  The Authority has been proactive in securing a firm water supply in sufficient quantity to support the minimum water requirements of the project design in the Authority Plan.. After studying this matter and evaluating various possibilities, the Authority has determined that the most feasible way to secure a water-supply commitment of at least 800,000 AFY is to seek a contractual commitment by the Imperial Irrigation District that it will not take actions beyond those set forth in the Quantification Settlement Agreement and Related Agreements. This provision was included in the Authority Board Policy Positions enacted in October 2005 as specified in item 4 of the policies discussed in the next section of this report. In February 2006, the IID board enacted a resolution committing the IID to enter a 75-year contract with the Authority stating that IID would not voluntarily take actions that would diminish inflows to the Salton Sea. The Authority Board adopted a resolution to enter into such a contract at its May 25, 2006 meeting. Inflows to the Salton Sea from the Coachella Valley are much smaller than flows from the Imperial Valley. CVWD has adopted and implemented a Water Management Plan to restore its groundwater basins through programs of conservation, source-water substitution and importing additional water supplies. A part of the additional water supplies have been secured through the QSA, CVWD's water management actions will result in flow to the Sea increasing to 120,000 to 140,000 AFY. CVWD is expected to commit to utilizing its full share of Colorado River Water consistent with the QSA and to implement its Water Management Plan. In addition, as discussed in Chapter 3 of this report, the Authority has developed a long-term water balance to provide a framework for achieving a sustainable supply-and-demand water balance within Imperial County and the Coachella Valley assuming the Salton Sea will receive 800,000 AFY of inflows in perpetuity.

In addition to modifying the original project design in the July 2004 *Preferred Project Report* based on these insightful and appreciated comments from these experts, the Authority has engaged its own experts, performed additional design studies, and undertaken several pilot projects over the last two years to improve and perfect this new project design. The Authority has also conducted a public outreach campaign to get feedback on its proposed project design from the local community. The current revised project design for the Authority Plan resulting from these efforts is presented in Chapter 4 of this report.

2.2 Authority Board Policy Positions on Salton Sea Restoration

To define clearly the regional interests and expectations for a restoration project, Authority staff and the Authority's Policy & Planning Committee developed a set of principles, policies, and desired complementary roles and funding obligations among the Authority and Federal and State agencies for the phased and coordinated implementation of a multi-purpose revitalization/restoration project. The Authority's Board of Directors unanimously approved these Authority Board Policy Positions in October 2005. The Authority's policies and related resolutions are provided in their entirety in Appendix D.

These specific principles, policies, defined project objectives, and the desired complementary roles and funding responsibilities between the Authority and the Federal and State governments are collectively the "policy positions" that define the *Authority Plan*. The *project design* for the Authority Plan, as presented and described in Chapter 4 of this report, represents the current best technical approach for implementing the Authority Plan and achieving the Authority's defined project objectives. Going forward, the Authority's *project design* inevitably will change based on further design studies, pilot-testing results, public comments on a project-level EIR/EIS, and subsequent entitlements, but it is expected that the conceptual nature of the *Authority Plan* will be maintained.

The first element of the Authority Plan is the **principles** that establish the regulatory and legal framework and desired outcome for the Authority's effort to develop and implement a multi-purpose revitalization/restoration project as a three-way local, State and Federal partnership. The principles are Stated below. These principles were developed in close cooperation with the Authority's five member agencies to address their specific concerns.

- Completely consistent with **State's Salton Sea Ecosystem Restoration Plan** "Drivers and Objectives for Development of Alternatives" [presented as Figure 1.1 in this report] and all application of State legislation;

- Completely consistent with **Federal Salton Sea Restoration Act of 1998**;

- Completely consistent with and supportive of the 2003 **Quantification Settlement Agreement** and Related Water Transfers, including the Environmental Impact Statement/Report certified by the Imperial Irrigation District Board of Directors that was used to obtain the enabling **Water Rights Order** from the State Water Quality Control Board;

- Completely consistent with the **Coachella Valley Water Management Plan** as approved by the Coachella Valley Water District Board of Directors;

- Completely consistent with and supportive of the Beneficial Uses for the Salton Sea established by Regional Water Quality Control Board in the Board's **Colorado River Basin Water Quality Control Plan**; and

- That these Policies be memorialized in a **Collaborative Agreement** among the Salton Sea Authority, the U.S. Dept. of Interior and the Resources Agency of the State of California once the U.S. Congress and the California State Legislature have enacted the required enabling legislation.

The next element of the Authority Plan is the **policies** that define project objectives and how the Authority expects to achieve these objectives. These policies are Stated below.

1. Recognition of the Salton Sea Authority's leadership role in the restoration project, representing regional interests in economic development and environmental restoration, coordinating with Federal , State and local interests, and being responsible for constructing and operating restoration related facilities, without accepting responsibility for water-transfer related environmental impacts.

2. Maintenance of the Salton Sea as a repository for untreated agricultural drain water from the Imperial and Coachella Valleys.

3. Preservation and protection of: the water rights of the Imperial Irrigation District and the Coachella Valley Water District; the uses of water by each; the terms and provisions of the Quantification Settlement Agreement and Related Agreements; and the benefits accorded to the Imperial Irrigation District and the Coachella Valley Water District under Water Code section 1013 and under legislation adopted in October 2003 to facilitate the Quantification Settlement Agreement in SB 277, SB 317, and SB 654.

4. A contractual commitment by the Imperial Irrigation District that it will not take actions beyond those set forth in the Quantification Settlement Agreement and Related Agreements, or as prudent to preserve and protect its water rights from reasonable use or water quality challenges, or as necessary to manage and operate the water supply within the Imperial Valley that will result in a material diminution in the volume of agricultural drain water.

5. Inclusion in the restoration project of a fresh water reservoir with approximately 250,000 AF storage volume constructed and maintained as part of the restoration project with a right for the Imperial Irrigation District to store water in the fresh water reservoir to enable the Imperial Irrigation District to better manage the fluctuations in Imperial Valley annual consumptive use and hence to better manage the fluctuations in agricultural drain water volumes that could benefit the Salton Sea. The Authority and IID shall use their best efforts to obtain State and/or Federal grant funding to cover the incremental construction costs for the reservoir and shall share any remaining construction costs based on an allocation of benefits. O&M costs shall also be shared based on an allocation of benefits.

6. A restoration project design that accommodates elevation and salinity fluctuations in the Salton Sea reflective of fluctuations in annual consumptive use and drain volumes.

7. A restoration project design that, to the extent feasible, includes recreation compatible, open-water lakes in both the north and south ends of the current Salton Sea basin.

8. A restoration project design that is developed through public outreach and local land-use planning and that, to the extent feasible, maximizes economic development and recreational opportunities on a regional basis and respects tribal cultural and heritage values.

9. A financing plan that includes, to the extent feasible, the use of local tax-increment bonds, community facility district funds, private investor funding, a portion of local funds in the Salton Sea Restoration Fund controlled by the State legislature, and Federal contributions.

10. A construction and operating plan that, to the maximum extent feasible, utilizes local labor resources, materials and suppliers and complies with all State, Federal and tribal labor laws.

The final elements of the Authority Plan are the desired complementary roles and funding obligations of the Federal and State governments. These roles are identified on the following two pages.

Requested Federal Government Role for the Phased and Coordinated Implementation of the Authority Plan for Salton Sea Revitalization and Restoration

1. Direction to the Bureau of Reclamation that the **feasibility study on a preferred alternative for Salton Sea restoration** referred to in Title II, Section 201 of PL 108-361 shall mean a **feasibility study performed by the Salton Sea Authority** with oversight by Reclamation on the final design for the Salton Sea Authority Plan for revitalization and restoration of the Sea in compliance with Salton Sea Restoration Act of 1998 (PL 105-372).

2. **Federal loan guarantee** on the $400 to $600 million in local tax-increment municipal bonds to be issued by the Salton Sea Authority to provide funding for constructing the water infrastructure components of the project.

3. **Conveyance of fee title** to certain Federal lands, including the 7,240 acres of BLM land comprising the closed Salton Sea Test Base, to the Salton Sea Authority so the Authority may sell and/or exchange such lands with private developers as a way to raise funding for the restoration project.

4. **Authorization** by the appropriate Federal agencies for the Salton Sea Authority **to construct revitalization project facilities** on Federal lands and to modify the configuration of the **Sonny Bono National Wildlife Refuge**.

5. Continued annual funding for the construction of **water treatment wetlands** on the New and Alamo River Direction by the Citizens Congressional Task Force and funding for wetlands construction on the Whitewater River.

6. Authorization for the Bureau of Reclamation to serve as the lead agency and perform **Environmental Impact Statements** as required for implementation of the Salton Sea Authority Plan and for the construction of wetlands and/or selenium removal projects on the New and Alamo Rivers in Imperial County and the Whitewater River in Riverside County.

Requested State Government Role for the Phased and Coordinated Implementation of the Authority Plan for Salton Sea Revitalization and Restoration:

1. At the appropriate time in the future, design, build and operate the measures required to mitigate for **air quality impacts** caused by the **water transfers** authorized under the Quantification Settlement Agreement to the extent required by / and in accordance with existing State law and the contractual documents related to the QSA.

2. Allocate to the Salton Sea Authority "first use" of funds from the **Salton Sea Restoration Fund** to provide a 25% cost-share of the Authority's capital costs for design, permitting and construction of the water infrastructure and water quality improvement facilities in the Salton Sea Authority Plan. The remaining funds in the SSRF shall be used, to the extent available, to provide 25% cost-share funding for items #3 and #4 below.

3. Support the Salton Sea Authority's request to obtain **Implementation Grant** funds under the Integrated Regional Water Management Program (Chapter 8, Proposition 50) being managed by the State Water Quality Control Board for the construction of water-quality improvement wetlands and/or selenium removal facilities on the New and Alamo Rivers in Imperial County and on the Whitewater River in Riverside County.

4. Support funding in future State bond measures for the purchase of private lands for the creation of **additional habitat areas** and/or for the **acquisition of wildlife easements** on private farmland around the Sea.

5. Direct the Department of Water Resources' **Division of Safety of Dams** to work with the Salton Sea Authority and its engineering consultants and construction contractors to ensure that all in-sea barriers are designed and built in accordance with all applicable State laws.

6. Make available to the Salton Sea Authority and its engineering consultants the finite element **water balance and water quality models** developed by the Department of Water Resources under its Salton Sea Restoration Study.

7. Direct Department of Fish and Game and State Park officials to work with the Salton Sea Authority on reconfiguring the **Salton Sea State Recreation Area** and the **Wister Unit of the Imperial Wildlife Area** so that the recreational and habitat values of these State lands are maintained after implementation of the Salton Sea Authority Plan.

The Authority's board reviewed and reaffirmed these guiding principles and policies at a strategic planning board workshop meeting held on April 27, 2006.

At this time, the Authority is endeavoring to have the Authority Plan selected as the "preferred alternative" plan in the State process that is scheduled to conclude by December 31, 2006. After this point, determination of further actions for advancing a Salton Sea restoration project will lie primarily with the California State Legislature.

Chapter 3: INFLOW PROJECTIONS

As shown in Table 3-1 below, Salton Sea inflows have averaged 1.35 million AFY and have remained within the relatively narrow range of 1.17 million AFY (-13%) to 1.59 (+19%) million AFY over the last 50 years. These historical inflow figures are accepted by the three entities (the Authority, Reclamation, and the Resources Agency) currently performing separate studies on a Salton Sea restoration project. There also is broad general agreement on the post-QSA baseline average long-term inflow case of 956,000 AFY as used in the EIR/EIS for the QSA and related water transfers. Adjusting this figure for new "reasonably foreseeable" events that have become known since the QSA was finalized 2003, one arrives at 922,000 AFY as the CEQA baseline case that the Agency is using its legislatively mandated Ecosystem Restoration Study and PEIR. While there are minor issues with the derivation of the CEQA baseline case, the 922,000 AFY figure is generally accepted as a reasonable projection of average long-term inflows based on all known and expected factors.

Table 3-1. Historical Inflows to Sea from 1950 to 2002 (AFY)

Source	Minimum		Average	Maximum	
Mexico	30,693	(1954)	131,169	269,735	(1985)
IID Service Area	830,841	(1985)	1,029,515	1,345,998	(1953)
Coachella Valley	55,573	(1957)	114,709	176,686	(1976)
Local Watershed*	17,809	(2000)	69,672	228,601	(1976)
Total Inflows	**1,171,414**	(1992)	**1,345,164**	**1,594,239**	(1953)
	87%		100%	119%	

* Includes precipitation which adds about 50,000 AFY to inflows on average.
Source: Resources Agency, Draft Hydrology Report, January 13, 2006

The Authority has taken the position that CEQA baseline case, adjusted only for definable future events, is the extent of any "uncertainty" factor should be considered in arriving at a design-case inflow assumption. This approach is different than the "probabilistic uncertainty" approach that Reclamation and the Agency are using to arrive at a design-case inflow assumption in their separate studies. The determination of a design-case inflow number is an important issue since, once built, it will generally be cost prohibitive to modify a project to function at significantly lower inflow level. Thus, the feasibility of a specific project design depends on having sufficient inflows to meet the project's minimum water needs. Put another way, no one is going to invest in a multibillion-dollar restoration project unless there are reasonable assurances enough water will be available to maintain the project's viability. Arriving at the design-case figure is confounded by the fact the Salton Sea has no explicit water right under Federal or State law.

The difference in the two approaches to assessing future uncertainty is that Reclamation and the Agency have elected to apply a second risk-based **stochastic analysis** (i.e., assigning probabilities that certain future events may happen and then running a large number of random model iterations to create a range and frequency distribution curve of outcomes) to the CEQA baseline case arrive at a design-case inflow number. Beside double-counting variability, as explained later in this chapter, this probabilistic approach does not relate assumed reductions in the individual inflow streams back to Colorado River Water diversions (the source of 95% of long-term inflows) and an overall regional water supply-and-demand balance.

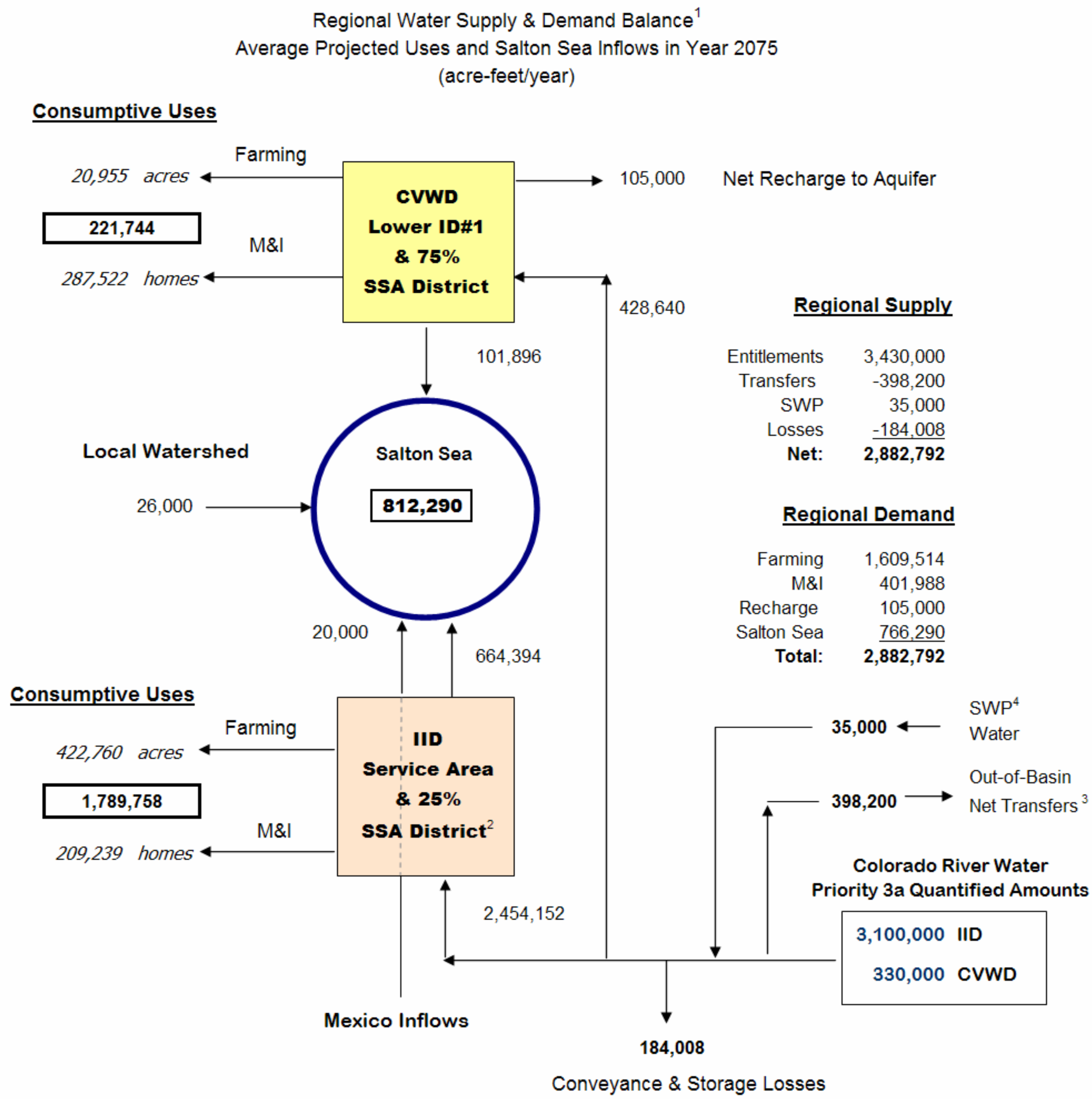
In contrast, the Authority has based its design-case inflow projection on a **deterministic analysis** (i.e., numerical values for any necessary adjustments to the CEQA baseline case are known or can be computed with reasonable certainty). The Authority believes its deterministic approach is more appropriate for arriving at a design-case number than applying a second stochastic analysis because the most important and dominant factor in projecting long term inflows – the quantity of Colorado River water that will be imported into the Salton Sea basin by IID and CVWD over the next 75 year – is set out as specific year-by-year numbers in the QSA contract documents (Colorado River Water Delivery Agreement, 2003).

3.1 Regional Water Balance

The five member agencies that comprise the Authority are the two entities (IID and CVWD) that control the Colorado River water rights for Imperial County and the Coachella Valley; and the three entities (Imperial County, Riverside County and the Torres Martinez tribal nation) that control most land-use planning decisions in Imperial County and the areas in Riverside County near the Salton Sea. In addition, the Torres Martinez tribe has rights to the groundwater under their lands. Thus, the Authority is uniquely able to develop and implement policies and plans to ensure that, after considering other water demands in Imperial County and the Coachella Valley and other constraining factors, sufficient water is available on long-term basis for sustaining a Salton Sea revitalization and restoration project that achieves all Authority project objectives as desired by the region and defined in the Authority Board Policy Positions.

Because the five Authority member agencies collectively have the responsibly and decision-making authority on water management, land use, and development decisions in the Imperial and Coachella Valleys, their elected board and council members ultimately have the final say on what level of inflows represents a reasonably prudent design case for proceeding with a specific restoration project. These local officials can eliminate the future uncertainty with respect to the inflow.

To create the basis for eliminating future uncertainty and to create a reasonably assured long-term water supply as needed for project financing, the Authority has developed a regional water balance (Figure 3-1) that includes sustaining the Salton Sea as a regional asset as a 180-sq. mile permanent multi-purpose water body. This water balance includes a set of strategies and local actions to promote the utilization of IID's and CVWD's entitlements to Colorado River water exclusively for in-valley primary (agriculture and M&I) and secondary (recycling tailwater, non-potable reuse, and the Salton Sea) beneficial uses over the 75-year term of the QSA. This water



[1] In this water-balance analysis, "region" means all of Imperial County, the unincorporated farming areas in CVWD's ID #1 (Thermal, Mecca and Oasis), and the remainder of the SSA's 300,000-acre Planning District. This region is the source of essentially all local inflows to the Salton Sea, and implementation of the SSA Plan will have the greatest impact within this region.

[2] As part of the QSA, IID can supply 30,000 AFY of Colorado River water for M&I use outside the IID service area within Imperial County.

[3] Deductions: 110,000 AFY to MWD under 1988 transfer; 200,000 AFY to San Diego under 2003 transfer; 93,700 AFY for two canal lining projects; and 14.5 AFY misc. PPRs. Additions: 20,000 AFY to CVWD from MWD. Note: San Diego transfer can be terminated in 2047.

[4] As part of the QSA, CVWD will receive 35,000 AFY of State Water Project (SWP) via the Coachella Canal as a transfer from MWD.

Figure 3-1. Regional Water Supply & Demand Balance.

balance includes recognition that Federal law (specifically the Law of the River) establishes and governs the primary beneficial uses of Colorado River water; while State laws, as implemented and enforced by the Colorado Regional Water Quality Control Board (RWQCB), establish and govern secondary beneficial uses.

In addition to the water management policies already incorporated into the Authority Board Policy Positions, the Authority's regional water balance for a sustainable Salton Sea includes the following principles and understandings:

- **Support the sustainability of agriculture in the Imperial Valley**
  Although the economy of the Imperial Valley will diversify in the 21st century, the maintenance of a strong agricultural base in Imperial County is essential for sustaining the Authority's "large lake" restoration project. This is because, even after a 10% increase in water-use efficiency gained by recycling tailwater and other measures, and a reduction in farmland due to urbanization from 485,000 acres in production in 2003 to about 420,000 acres in 2075, agricultural drainage flows from IID farms (projected to be about 626,000 AFY in 2075) will constitute 77% of all projected long-term inflows. A particular risk that the Authority must be cognizant of is outside interests coming in and buying up farmland to fallow it (like the Bass Brothers did in the early 1990s) and allowing the unused irrigation water to fall to lower priority water users on the Colorado River.

- **Request CVWD's Board of Directors enact a policy Statement not to take actions to diminish inflows to the Sea**
  Inflows to the Salton Sea from the Coachella Valley are much smaller than flows from the Imperial Valley. CVWD has adopted and implemented a Water Management Plan to restore its groundwater basins through programs of conservation, source-water substitution and importing additional water supplies. A part of the additional water supplies have been secured through the QSA, CVWD's water management actions will result in flow to the Sea increasing to 120,000 to 140,000 AFY. CVWD is expected to commit to utilizing its full share of Colorado River Water consistent with the QSA and to implement its Water Management Plan.

- **Accept the conversion of agricultural lands in the Coachella Valley to urban developments consistent with the Riverside County General Plan and Mecca Sub-Region Specific Plan**
  The Authority Plan does not assume nor require that agricultural land in the Coachella Valley remain in production. The Authority Plan assumes that farmland in production in the Coachella Valley will decline from 70,000 acres in 2003 to about 20,000 acres in 2075 with a total of about 300,000 new homes being built along the north shore of the Sea and the Highway 86 corridor.

- **Support the elimination of New River inflows from Mexico**
  As a management decision, the Authority's inflow analysis assumes and supports the early elimination of the New River inflows from Mexico. In addition to creating public health risks for Calexico residents, the high phosphorus load in this water is a major cause of the Sea's eutrophication problem. The Authority

will work proactively with the Calexico New River Committee to eliminate the Mexicali flows.

Using these premises and the Authority Board Policy Position, Authority has developed the projections shown in Table 3-2 for water supply and demands within Imperial County, the rural farming areas in CVWD's ID#1, and the remainder of the Authority's 300,000-acre planning district over the 75-year restoration planning period (2003 to 2078). These projections are intended to provide only a programmatic level analysis. Many simplifying assumptions have been used. Other assumptions and calculations used in this programmatic regional water-balance analysis are contained in the appendices.

3.2 Designs-Case Inflow Assumptions for the Authority Plan

The Authority Plan is based on the assumption that total inflows, estimated to be about 1.2 million AFY in 2003, will drop to approximately 950,000 AFY by the time the in-Sea barrier in the Authority project design is completed in 2015. From this point, average inflows will gradually decline to 812,000 AFY in year 2075. This gradual projected reduction in inflows is shown in Table 3-2. The key factors in this analysis are:

1. The full utilization by IID and CVWD of their contractual entitlements for Colorado River water as set out in the 2003 QSA.
2. A reduction of farmland in production within IID's and CVWD's service areas from a total of 560,000 acres in the 2003 base year to 445,000 acres in year 2075 (19% decrease). The corresponding reduction in agricultural drainage inflows is projected to be from 950,000 AFY in 2003 to 650,000 AFY in 2075 (32% decrease). This reduction in agricultural drainage inflow reflects both (1) the conversion of 115,000 acres of farmland to urban development within the region over the next 75-years and (2) an average system wide 10% increase on-farm water-use efficient.
3. An increase in housing units in the region from 61,500 in 2003 to nearly 500,000 by year 2075. This 3% compound long-term growth rate reflects the projected population increase of over 900,000 people in the Coachella and Imperial Valleys over the next 25 years (latest Southern California Association of Government figures) with the expectation of continued high regional growth through 2075. This factor of 8 increase in regional population is expected to increase municipal effluent, urban runoff, and subsurface inflows (due to recharge of the Coachella aquifer) from 30,000 AFY in 2003 to 116,000 AFY in year 2075 (a factor of 4 increase).
4. A decrease in inflows from Mexico from 160,000 AFY in the 2003 base year to 20,000 (urban runoff only) by year 2040. This reduction reflects the fact that Mexicali is expected to continue its program to install facilities to retain and reuse its farm drainage and municipal effluent flow for its own uses. The

Table 3-2. Salton Sea Inflow Projections Based on Long-Term Regional Water Balance (AFY)

	Historic[1] 1950-2002	Base Year[2] 2003	Projections[3] 2020	2045	2060	2075
			QSA Base Term		Extension (Optional)[4]	
Colorado River Supply						
IID & CVWD Colorado River Water @ 100% of Net QSA Entitlements[5]	**3,450,000**	**3,360,790** [6]	**3,019,300**	**3,066,800**	**3,066,800**	**3,066,800**
plus: CVWD SWP Transfer Water[7]		0	0	35,000	35,000	35,000
less: entitlement enforcement[8]		(59,210)	0	0	0	0
less: conveyance & storage losses	(300,000)	(261,040) [9]	(181,158)	(184,008)	(184,008)	(184,008)
Net Available for Beneficial Uses	**3,150,000**	**3,099,751**	**2,838,142**	**2,882,792**	**2,882,792**	**2,882,792**
Agriculture Use						
Farmland in Production ***acres***	***600,000***	***560,039***	***485,646***	***472,806***	***461,300***	***443,716***
Applied Irrigation Water	**3,240,000**	**2,977,459**	**2,568,327**	**2,419,666**	**2,351,194**	**2,259,369**
Farm Drainage & Operational Spill	**1,134,000**	**953,421**	**799,822**	**705,819**	**678,290**	**649,851**
% discharge to applied water	***35%***	***32%***	***31%***	***29%***	***29%***	***29%***
Municipal & Industrial Use						
Housing Units[10] ***# units***	***25,000***	***61,500***	***140,821***	***388,445***	***438,103***	***496,761***
Residential Service	12,500	30,750	70,410	194,223	219,051	248,380
Commercial, Golf Courses, Parks, etc.	60,000	120,000	145,861	186,159	215,503	254,471
CVWD Recharge Program	0	0	80,000	120,000	135,000	150,000
Total M&I and Recharge Water Use	**72,500**	**150,750**	**296,271**	**500,382**	**569,554**	**652,852**
Effluent, Runoff & Subsurface Flows	**18,125**	**29,578**	**41,652**	**84,653**	**99,657**	**116,439**
% discharge to applied water	***25%***	***20%***	***14%***	***17%***	***17%***	***18%***
Inflows from Colorado River Water	**1,152,125**	**982,998**	**841,474**	**790,473**	**777,947**	**766,290**
% Use of Colorado River Water Entitlements	103%	105%	101%	100%	100%	100%
Mexico						
Farm Drainage & Municipal Effluent[11]	90,000	90,000	0	0	0	0
Un-seweraged & Storm Flows	70,000	70,000	60,000	40,000	20,000	20,000
Subtotal - Mexico Inflows	**160,000**	**160,000**	**60,000**	**40,000**	**20,000**	**20,000**
Local Watershed						
Groundwater[12]	18,000	18,000	18,000	18,000	18,000	18,000
Creeks & Springs	8,000	8,000	8,000	8,000	8,000	8,000
Subtotal - Local Watershed	**26,000**	**26,000**	**26,000**	**26,000**	**26,000**	**26,000**
Total Salton Sea Inflows	**1,338,125**	**1,168,998**	**927,474**	**856,473**	**823,947**	**812,290**

[1] The figure shown here in Column 1 for total average historic inflows (incl. precipitation) is consistent with the DWR hydrology report (Table 3.1).

[2] The DWR figure for total inflows for the 2003 QSA Baseline in Column 2 is 1,090,181 AF (Table 3.2).

[3] The figures in these columns should be considered 5-year averages. Actual inflows in any single year may vary by ±20% based on historical data.

[4] IID may elect not to renew the 200,000 AFY IID/San Diego County Water Authority transfer in 2047. If this 200,000 AFY of supply is regained by IID and put to beneficial use in Imperial County for residential service, Salton Sea inflows would nominally increase by 40,000 AFY.

[5] Source: "Exhibit B, Quantification & Transfers," Colorado River Water Delivery Agreement, Oct. 10, 2003, among Dept. of Interior, IID, CVWD, et al.

[6] Includes 109,000 AFY entitlement overrun that will be paid back as part of the IOPP entitlement enforcement adjustment.

[7] Staring in 2025, CVWD will being receiving 35,000 of State Water Project (SWP) water through the Coachella Canal under a transfer from MWD.

[8] Payback for prior year apportionment overruns. Once the IID in-district storage reservoir is constructed (2018), this factor will be eliminated.

[9] Includes 67,000 and 26,000 AFY in All-American & Coachella Canal losses that will be recovered by lining projects and transferred to other QSA parties.

[10] Includes all homes in IID's service area, homes in Lower ID #1 in CVWD (Thermal, Mecca & Oasis area), and >250,000 new homes in the SSA District.

[11] Mexicali officials plan to upgrade their wastewater collection and treatment systems over next 20+ years and eliminate most flows into U.S.

[12] Source: *A Study on Seepage & Subsurface Inflows to Salton Sea and Adjacent Wetlands* (July 1999) performed by Tetra Tech for the SSA.

timing of when these reductions will occur is uncertain, but the loss of these inflows has been factored in the 75-year design-case inflow projections.

5. The local watershed inflows of 26,000 AFY are assumed to remain constant over the 75-year project evaluation period. Changing climatic factors were not included in the Authority's analysis. In any event, this component is within the ±5% measurement accuracy of inflows and evaporation rates in general.

The above design-case inflow assumptions are shown in Table 3-3 below. As shown in this table. Authority's design-case mean inflow projection of 812,000 AFY is about midway between the 922,000 AFY mean in the Agency's CEQA baseline case and the 715,000 AFY mean in the Agency's Probabilistic Uncertainty case.

Table 3-3. Design-Case Inflow Assumptions for Authority Plan (AFY).

Source	CEQA Baseline Case Annual Mean (2018 – 2077)	Authority Plan Annual Mean (Year 2075)	Probabilistic Uncertainty Case Mean (2018-2075)
Mexico	97,044	20,000	40,446
IID Service Area	723,944	664,394[1]	614,856
Coachella Valley	138,446	101,896	98,043
Local Watershed	18,984	28,000	18,984
Less: IOPP[2]	-56,856	not applicable	-56,856
Total Inflows	**921,503**	**812,290**	**715,473**

1 This is the 626,000 AFY baseline figure from the IID Transfer Project/QSA EIR/EIS plus 38,394 for new M&I inflows as growth-inducing impact from implementation of the Authority Plan.

2 This adjustment and its non-applicability to the Authority Plan case are explained in the following paragraph.

The Inadvertent Overrun and Payback Policy (IOPP) deduction used in the Agency's CEQA Baseline Case (col. 1 in Table 3-3) and the Agency's Probabilistic Uncertainty Case (col. 3 in Table 3-3) is based on the assumption that IID will overrun its net Priority 3a quantified entitlement on a periodic basis. This is because IID sometimes has to order additional water to meet unplanned early fall irrigation demands that cause IID to exceed its annual water year (October 1st to September 31st) entitlement. Under the new stricter post-QSA operating rules, IID is required to deduct any prior year's overrun from its next year's entitlement. Without an in-district storage reservoir, the only way IID can not overrun, yet allow for higher than expected late year demands, is to under order (i.e., not use its full entitlement as occurred in 2004-05 water year.)

The assumption that the Agency is using in its inflow analyses is that, because of this operational constraint, IID will be required to deduct on average 59,210 AFY from its annual contractual entitlement over the 75-year Salton Sea restoration project evaluation period. This figure is reduced to 56,856 AFY to account for conveyance losses, and then is deducted from Salton Sea inflows on a 1:1 basis. While the assumption of a 1:1 reduction in Salton Sea inflows is highly questionable in the Agency's analysis, this entire "IOPP payback" issue will be moot and a non-factor in the case of the Authority Plan once the IID Colorado River water storage reservoir is completed in 2018. From this point forward, IID will be able to order and take its full contractual entitlement of Colorado River water every year and store any unused water in its in-district reservoir for use in the following year. Thus, there will be no overruns and no IOPP paybacks after 2018. However, IID will incur additional system evaporation losses due to the reservoir. This factor has been included in the conveyance and storage loss factor shown in Figure 3-1.

CVWD does not have this operational constraint since it is constructing groundwater recharge basins in ID#1. Once these facilities are completed, CVWD will be able to take its full entitlement of Colorado River water every year and charge to the Coachella aquifer any water that is not used that year. In this manner, the Coachella aquifer will serve as a storage reservoir for CVWD. The advantage of storing water underground via recharge is the avoidance of evaporation losses.

What management actions could the Authority and/or its member agencies take in future years to maintain average minimum inflows of >800,000 AFY in the event of unforeseen circumstances? A possibility mentioned below is an example of an action the Authority, working cooperatively with IID and/or CVWD as key stakeholders in the Authority, could take in future years as part of the regional water balance to ensure the long-term functionality of the Authority's project.

- ***Explore implementation of a program to buy farmland wildlife easements***. As previously noted, the biggest long-term risk to the maintenance of an 800,000 AFY inflow level is the potential decline in the number of acres of farmland that remain in production in Imperial Valley over the next 75 years. To sustain the needed 420,000 acres of farmland in IID over the next 75 years, the Authority could implement its own farmland wildlife easement program. Under such a program, the Authority would pay farmers a fee to sign a contract committing the farmer to keep his farmland in production for a certain period of time. These contracts could be structured as annual payments that would, in effect, subsidize growers to remain in business. The ecosystem benefits from this program would be twofold. First, the enrolled fields could be planted in specified crops to provide feed and shelter for birds. Secondly, the drainwater from the fields in this program would provide supplemental inflows to the Salton Sea. These supplement flow could be used to ensure the saline habitat complex receives sufficient water throughout the 75-year project planning period.

In summary, since 95% of projected long-term inflows needed to sustain the 180-sq.-mile lake-water system and other project features in the Authority project design are under the direct control of two Authority member agencies (IID and CVWD), the Authority considers an 800,000 AFY mean inflow case with a ±160,000 AFY annual variation range to be a reasonably prudent design-case assumption. As detailed above, the Authority and/or its member agencies can take management actions as may be needed to offset any shortfalls in inflows over the 75-year project evaluation period. In making this decision, a tradeoff has to be made between designing a project based on a too conservative inflow assumption that results in large quantities of unneeded water being discharged directly into the brine pool over a long period of time without ever being beneficially reused; versus making an informed decision on a reasonably prudent design case and then being compelled to manage and use water efficiently over a 75-year period. The Authority sees greater virtue and value for all Salton Sea stakeholders in the latter course as the basis for moving forward with a multi-purpose project that maximizes benefits for both wildlife and people.

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Chapter 4: PROJECT DESIGN

Over the last two years, the Authority has revised and updated the design of the initial Authority North Lake Plan as described in the July 2004 *Preferred Project Report*. The configuration of the preserved water body has been changed and other features have been modified or added based on both technical considerations (e.g., comments from the Experts Workshop in November 2005) and the largely negative public reaction in Imperial Valley to the North Lake Plan. The Authority Board Policy Positions enacted in October 2005 also added new design considerations and project features. The major changes that have been incorporated into the updated project design for the Authority Plan, as described in this Chapter 4, are summarized below.

- The addition of a **40-Sq. Mile, 20-ft-Deep Lake in the South End.** This lake replaces the shallow-water wetlands in the old plan. This lake will be divided into a habitat zone and a recreational-use area. This change was made in response to the "selenium trap" issue associated with the shallow-water wetlands (Pacific Institute, 2005) and the desire by Imperial Valley residents to have a large recreational-use lake at their end of the Sea.

- To compensate for the loss of the shallow-water wetlands in the old design, a 12,000 acre **Saline Habitat Complex** will be constructed along the eastern side of the south basin in the new design. This habitat area will be watered with low-selenium (<2 μg/L) water supplied from the large saltwater lake.

- Two **Water Treatment Plants** and a **Circulation System** have been added to the project scope. One treatment plant will be located on the Alamo River to prevent *new contaminants* from entering the Sea; while the other will be used to remove *existing contaminants* in bottom-water extracted from the 50-ftdeep saltwater lake. The water in both lakes will be constantly circulated to avoid stagnation and promote mixing and aeration.

- The south basin has been redesigned so that naturally formed **Hard-Surface Salt Deposit** will cover the old lakebed and prevent dust emissions. This change was made to take advantage of the fact that 90% of the concentrated salt in the Sea is sodium chloride (NaCl). This type of salt forms hard crystals that do not blow around. This design change both significantly reduces costs and eliminates the need to use water for air-quality mitigation which will free more water for habitat and other beneficial uses.

- A 250,000 AF **Colorado River Water Storage Reservoir** has been added to the project scope. This facility is needed so that IID has the ability to take its full annual Colorado River water entitlements under the new stricter post-QSA operating rules and can avoid IOPP deductions. Full utilization of IID's contractual entitlements per the QSA is important to the long-term regional water balance for sustaining the Salton Sea.

4.1 Project Design Overview

The current project design for the Authority Plan is illustrated on Figure 4-1. The major components of the updated design are indicated below.

- In-Sea Barrier and Channel
- Water Treatment Strategy and Project Facilities
- Constructed Wetlands on the Tributary Rivers
- Ecological Features and Selenium Management
- Air Quality Mitigation and Salt Management
- Colorado River Water Storage Reservoir
- Water System Design and Operations
- Preliminary Cost Estimates

These features are described in this chapter along with an explanation of the factors that led to their inclusion in the project design and key design considerations.

4.2 In-Sea Barrier and Boating Channel

In the new project design, the mid-Sea dam in the 2004 design that crossed the Sea's 5-mile long "waist" (narrowest and shallowest crossing point) south of Bombay Beach has been moved to the northern edge of the waist south of Salton City. This change was made to reduce the surface area of the saltwater lake in the new design from 180 sq. miles to 140 sq. miles. In the new design, the mid-Sea dam (now simply the "in-Sea barrier") has been extended south along the west shoreline from the undeveloped land below Salton City to San Felipe Creek to create a ¼-to-½ mile wide, 10-ft-deep boating and water circulation channel. The in-Sea barrier then follows a 15-ft-to-20-ft bathymetric line across the south basin to the Alamo River delta. This segment will form a 40 sq.-mile lake in the south. In total, the in-Sea barrier will be a continuous 33.5 mile long structure built in 10-ft to 45-ft of water with 5 feet of freeboard (portion of structure above water line) as shown below.

Table 4-1. In-Sea Barrier Segments and Depths.

Barrier Segment	Length (miles)	Water Depth (ft)
Central	7.5	30-45
West	9.0	10
South	17.0	15-20
Total Length	**33.5**	

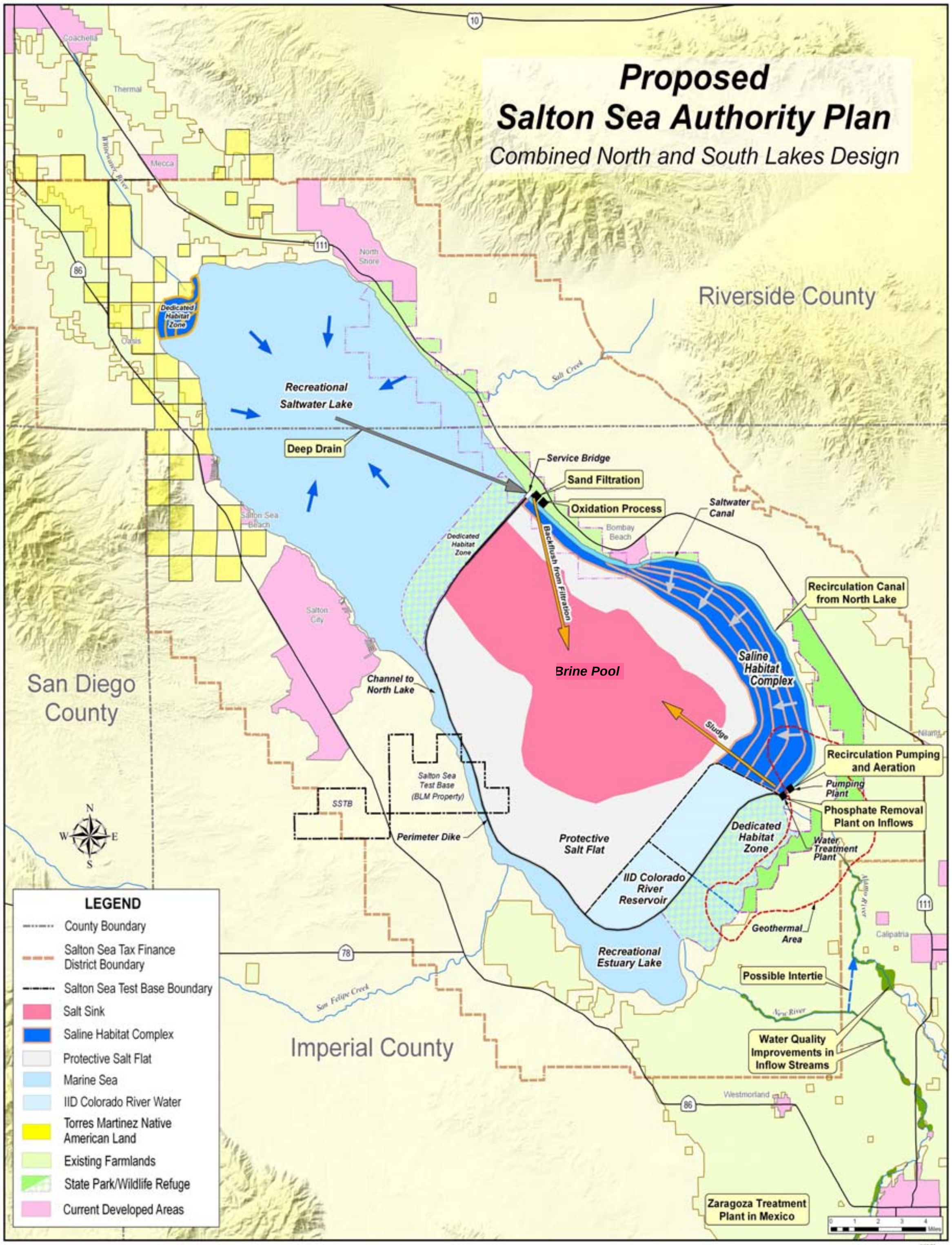

Figure 4-1. Engineering Features in the Authority Plan Project Design.

The two major considerations in selecting this alignment for the in-Sea barrier were (1) water budget and (2) cost. To create a large estuary lake in the south for recreational use and habitat as set out in the Authority Board Policy Positions while remaining within the 800,000 AFY design-case water budget, the north saltwater lake had to be made smaller. This tradeoff was necessitated because the amount of lake surface area that can be retained in a restoration project is a direct function of the inflow level. Thus, the projected long-term inflow reduction from 1.2 million AFY to 800,000 AFY necessitates a corresponding reduction in lake surface area.

The location in Figure 4-1 is as far north as a cross-Sea barrier can be built without getting into 10-to-15 feet deeper water. The cost for constructing in-Sea barriers approximately *doubles* on a per-mile basis for ever additional 10 feet of water depth. Thus, moving the cross-Sea barrier an *additional* 5 miles north to a location directly across from Salt Creek substantially increases construction costs. Based on the Authority's unit cost estimates, constructing the cross-Sea barrier at this deeper and wider location adds over $500 million to project costs. Since the Authority's 826,000 AFY design-case mean inflow projection is adequate to support a 140-square mile north saltwater lake (i.e., just under 40% of Sea's current 360-sq. mile surface area) in addition to a 40-sq. mile south estuary lake, the Authority has selected the "least cost" location – as shown in Figure 4-1 -- for the cross-Sea barrier in the Authority's project design.

This above analysis also explains why it would be cost-prohibitive in the Authority's "two lakes" project design to make the lakes more equal in size. To make the two lakes approximately equal in size, all three barrier segments would have to be extended by 2 to 4 miles. Also, the cross-Sea barrier in the north and the barrier forming the south lake would both have to be moved into 15-to-20 feet deeper water. These design changes would add at least $1.0 billion to the project costs.

The question also arises as to why the in-Sea barrier has been configured in the current Authority Plan project design so that the large saltwater lake is in the north as opposed to the south end of the current Sea. There are no compelling technical or cost considerations that would favor one design configuration over the other. The large-lake-in-the-north design was established as the Authority's preferred alternative by Authority board's selection of the North Lake Plan in April 2004, as subsequently documented in the Authority's July 2004 *Preferred Project Report.* The Authority's board then approved a policy position in October 2005 specifying "a restoration project design that, to the extent feasible, includes recreation compatible, open-water lakes in both the north and south ends of the current Salton Sea." The Authority staff has developed the current project design as the most feasible and cost-effective approach for implementing board policy.

The function of the in-Sea barrier is to separate the current Sea into two separate water bodies. As explained below, by dividing the Sea into two separate water bodies, it will be possible to stabilize permanently the elevation, shoreline, and salinity in one part; while creating a habitat area and permanent salt repository in the other part.

- ***Outer 180-sq.-mile lake water system***
  This outer water body will be held at a relatively stable elevation so the shorelines of the two newly created lakes and the interconnecting boating channel on the west shore will remain unchanged as long-term inflows decrease. The water in the two joint-use recreational/habitat lakes will be treated as required and circulated to maintain recreational water-quality standards. The larger northern salt water lake (140 sq. miles) will be maintained at ocean-like salinity (35,000 mg/L salt), and the smaller southern estuary lake (40 sq.-miles) will be held at a lower salinity (20,000 mg/L salt). The south lake elevation (-228' msl) will be held about 2 feet above the north lake (-230' msl) since a slight hydraulic gradient is needed for circulating the water in both lakes in a continuous counter clockwise loop for blending and aeration. An earthen channel will be excavated along the east shore of the south basin to convey north lake water to the south lake and to support the 12,000-acre saline habitat complex in the south basin. A pumping plant will be built at the end of this channel to lift the extracted and treated north lake water into the south lake to blend with the Alamo and New River inflows.

- ***Inner 180-sq.mile basin in the south end***
  The wetted surface area of this inner water body will shrink and its elevation will decline as inflows decrease over time. A salt-purge stream from the north lake will be discharged into the inner basin after being used in the saline habitat complex. The purpose of this purge stream is to balance salt inflows and outflows in the outer lake-water system. By sending salt to the inner basin in this manner, the two lakes can be held at relatively constant, controlled salinity levels. The lower inner basin will also serve as an overflow basin in the event of storm events. Salt pond pilot projects conducted at the Salton Sea indicate that as the shoreline inside the inner basin recedes, hard-surface salt deposits 12-to-24 inches thick will form on top of the old lakebed. The cement-like salt deposits will prevent blowing dust. Other air-quality mitigation techniques will be used if needed. A permanent hyersaline brine pool will eventually form in the lower depths.

As covered in greater detail in Appendix A, construction of the 33.5-mile-long in-Sea barrier will require the excavation, sizing, transport, and placement by bottom-drop barges of approximately 64 million cu. yds. of rock. The barrier must be built to seismic dam-design standards. This will require extraction by suction dredges of approximately 20 million cu. yds. of muck so that the placed rock rests directly on the underlying stiff lacustrine clay deposits.

4.3 Water Treatment Strategy and Project Features

As the water quality experts who attended the Experts Workshop in November 2005 Stated in the meeting report (Pacific Institute, March 2005), the original Authority Plan project design was seriously deficient with respect to improving water quality (other than salinity control) over the Sea's current problematic conditions. The Authority's project design has been revised to resolve these concerns.

Identification of the Problem

Other than salinity, the Salton Sea's eutrophic State and associated water quality problems (i.e., low dissolved oxygen levels; high hydrogen sulfide, ammonia, and toxic algae levels; and poor clarity) are all related to the 1,400 tons of phosphorus that have historically been transported into the Sea each year along with the 1.3 MAF of farm drainage and municipal effluent water (Holdren, 2002). The independent water-quality expert engaged by the Authority, Dr. William W, Walker, Jr., describes the problem as follows:

The Salton Sea shows all of the classic signs of nutrient enrichment and to an extreme degree. These include elevated nutrient concentrations, algal blooms, low transparency, oxygen depletion, hydrogen sulfide, ammonia, toxic algae, fish kills, etc. This is not unexpected given that the Sea is fed almost exclusively by agricultural drainage and urban wastewater and that it is located in a region with abundant sunlight and warm temperatures that are conducive to algal growth and oxygen depletion. All of these symptoms are linked to excessive algal growth that is in turn linked to excessive phosphorus loadings, as well as other factors, as illustrated below:

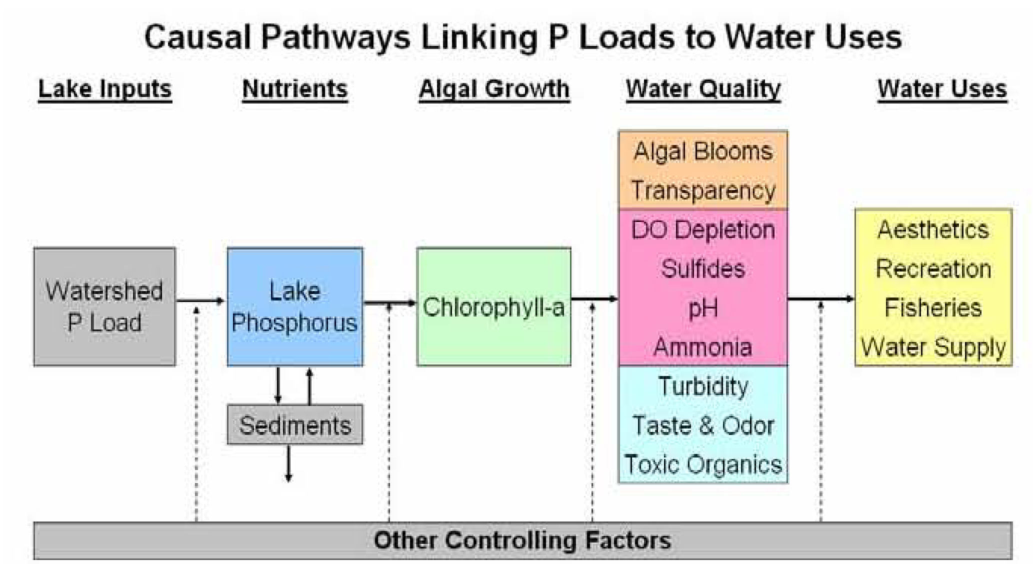

Figure 4-2. Explanation of Salton Sea's Phosphorus (P) Loading Problem. Source: Walker, 2006

As shown in Dr. Walker's diagram, there are two pathways for phosphorus to enter the lake water system in the Authority's project design: (1) *external loading* of phosphorus from the incoming drainwater which is the original source of the phosphorus now accumulated in the Sea's sediments and water column; and (2) *internal loading* from the resuspension of the phosphorus that has accumulated in the Sea over the years and now exists in the sea-bottom sediments and decayed organic matter.

While the external loading factor can be relatively easily and accurately quantified and addressed, the internal phosphorus loading factor (resuspension) is unknown and cannot be predicted accurately in advance. Accordingly, the water-quality improvement strategy developed by the Authority is predicated on the need to achieve and maintain positive control over both phosphorus loading pathways for an indeterminate period of time. While certain interim measures can be taken to achieve some improvement in the water quality conditions that cause the fish kills and offensive odors, the permanent solution to these problems requires an intensive, long-term phosphorus source control, immobilization and/or extraction effort.

Water Quality Objective

In developing a preliminary TMDL program for phosphorus source control for the Salton Sea, the Colorado River Regional Water Quality Control Board (RWQCB) has tentatively set 35 μg/L as the desired phosphorus concentration water quality objective for the Salton Sea (RWQCB, 2005). This numerical value is significant since, by law, the RWQCB is required to set water quality objectives to achieve the beneficial uses in the Region Basin Plan. In the case of the Salton Sea, existing approved beneficial uses include water-contract recreation (i.e., swimming and fishing) and aesthetical enjoyment. The Authority asked Dr. Walker to evaluate the likelihood that achieving a 35 μg/L phosphorus concentration in the lake water as water-quality improvement objective would restore the Salton Sea to a recreationally usable water body similar to the Sea's status in 1950s and 1960s. This following is excerpted from Dr. Walker's report (Walker, 2006):

A TP [total phosphorus] concentration of 35 ppb has apparently been selected by the State as a goal in the Salton Sea TMDL process. It is not clear whether that automatically translates to a requirement for the Authority plan [a higher objective may work]. The 35 ppb criterion can be compared with average concentrations of 70 – 110 ppb measured by the USBR 1999 (biweekly sampling) and by Authority/USBR in 2004-2005 (quarterly sampling). Measured average chlorophyll-a concentrations (50 - 120 ppb) are similar to those expected in this phosphorus range, based upon regression equations developed from northern lake data (Bachman & Jones, Carlson, etc). Achieving a TP concentration of 35 ppb would be expected to provide a mean chlorophyll-a concentration of ~15 ppb and a low frequency of nuisance algal blooms (instantaneous chlorophyll-a > 20-30 ppb). <u>These criteria are within ranges established in other lake restoration projects and consistent with surveys relating water quality measurements to user perceptions of aesthetic and recreational values in other States (e.g., Minnesota, Texas, and Colorado).</u>

As part of his assignment, Dr. Walker developed the criteria for a source control program as needed for achieving a 35 μg/L total phosphorus water-quality objective for the two lakes in the Authority Plan. This analysis, which involves using complex models and regression equations that have been calibrated and proven in other applications, is included with Dr. Walker's report. Dr. Walker's conclusion is that, to achieve a 35 μg/L water quality objective, average phosphorus concentrations in the inflow streams must be reduced to the range 80 to 200 μg/L. This equates to an annual external total phosphorus mass loading budget (excluding precipitation) of 69 to 172 tons/year. This mid-point of the range – 120 tons/year – is a reasonable target. As previously indicated, the current external mass loading of total phosphorus is about 1,400 tons/year (Holdren, 2002). Thus, to achieve the desired 50-67% reduction in phosphorus concentration in water column (i.e., from 70-110 μg/L to >35 μg/L), a >90% reduction in phosphorus source loading must be achieved.

Phosphorus Source Control & Treatment Plant

Given the 120 ton/year phosphorus external loading target, the Authority has developed and included as part of the project scope a source control program aimed at reducing the incoming phosphorus load by >90%. The five elements of this program are shown in Figure 4.3 and described below.

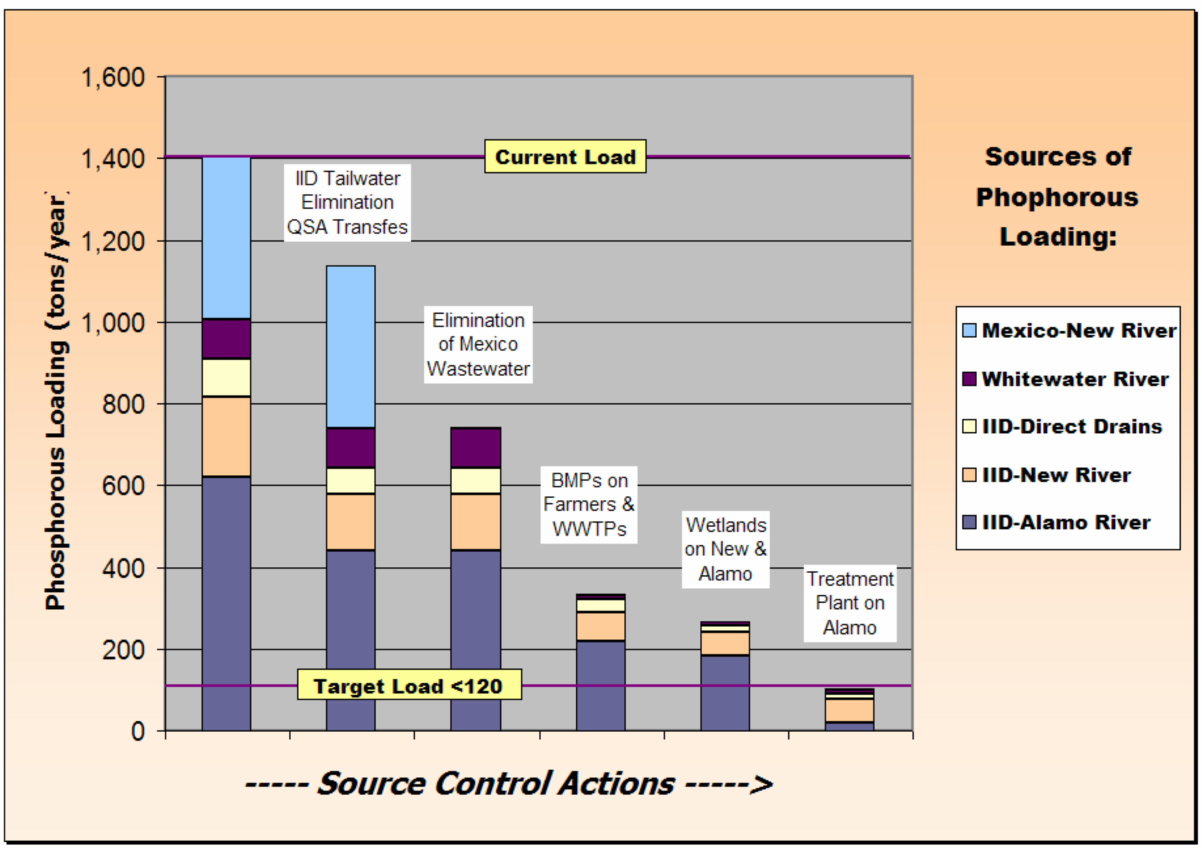

Figure 4-3. Elements of the Authority Phosphorus Source Control Program.

- ***Reductions for tailwater recycling and other conservation measures by IID to generate water to QSA water transfers***. Since essentially all the phosphorus that leaves farms as a result of phosphorus fertilizer application ends up in the surface tailwater (and not the subsurface tilewater), IID's current QSA-driven water conservation program -- which includes expanding the use of on-farm tailwater recovery systems -- will have the dual benefit of reducing phosphorus loading to the Sea. Based on the 300,000 AFY of tailwater that is expected to be eliminated under this program over the next 15 years to generate water for QSA transfers, 275 tons/year (20%) of the phosphorus load will be eliminated.

- ***Elimination of Mexicali municipal effluent and farm drainage Inflows.*** The non-storm water Mexicali inflows contribute 400 tons/year (28%) of the current phosphorus loads to the Sea. The elimination of these flows, as expected within 20 to 30 years, will remove this load from the Sea.

- ***Enforcement of Best Management Practices (BMPs) on agricultural drainage and discharge limits on wastewater treatment plants***. The Imperial County Farm Bureau has been active in promoting a BMP program for eliminating phosphorus and other contaminants that adversely affect Salton Sea water quality. The effectiveness of this program is not yet evident. Six municipal wastewater treatment plants also discharge effluent water containing phosphorus into the Sea's tributary rivers. These two sources collectively account for an additional 400 tons/year (28%) of phosphorus loading. This municipal portion of this load could be reduced by the RWQCB imposing permit restrictions on the dischargers; or by requiring that the dischargers make compensating payments to the Authority as the owner/operator of the proposed phosphorus removal plant. Such pollution credit trading/payment schemes are now common approaches for enforcing clean water laws in a cost-effective manner.

- ***Construction of Water-Treatment Wetlands on the Whitewater, New and Alamo Rivers.*** The proposed system of several thousand acres of wetlands along the Sea's three tributary river channels will have a beneficial effect on removing phosphorus. The 3-year data from two pilot projects in Imperial County show higher than expected phosphorus removal rates (more than 60% of influent loads, Tetra Tech, 2006a). While these high initial rates may hold up, constructed wetlands have often proven less efficient in sustaining initially favorable phosphorus removal rates on a long-term basis. Further, this level of load reduction requires significant area for wetland construction that may not be available near the New and Alamo Rivers. Finally, wetlands are efficient at reducing high concentrations of phosphorus are less efficient at lower concentrations. This is the case in the Everglades restoration project which relies on wetlands, but officials have considered phosphorus precipitation treatment process similar to the Authority's proposed approach to obtain lower effluent concentrations (Walker, 2006 and Carla Schiedlinger, p.c., March 2006). On the basis of the lower expected long-term removal rates, wetlands system on the three tributary rivers, if built, can be expected to remove an additional 60 tons/year of the remaining phosphorus load.

- ***Construct and Operate Phosphorus Removal Plant at Terminus of Alamo River***. If all the above reductions are achieved (a "best case" scenario), there will still be approximately 300 tons/year of phosphorus source load remaining. The majority of this load -- about 200 tons/year -- will be in the Alamo River (assuming the Mexico flows are eliminated from the New River). Since this "best case" figure is still twice the 120 tons/year target , and the probability of achieving all above reductions in a timely manner is unlikely, the Authority has included in its project scope a Chemical Treatment followed by Solids Separation (CTSS) plant for removing >90% of all remaining phosphorus load in the Alamo River. Based on field pilot tests conducted at the Everglades ecosystem restoration project (Figure 4.4), the CTSS process has been proven to be effective in achieving a >90% phosphorus removal rate down to the 10 μg/L level.[2] The Authority's project design also includes the possibility of constructing an intertie between the New and Alamo Rivers so that New River water can be sent to the CTSS plant in the event the source control measures on the New River do not occur.

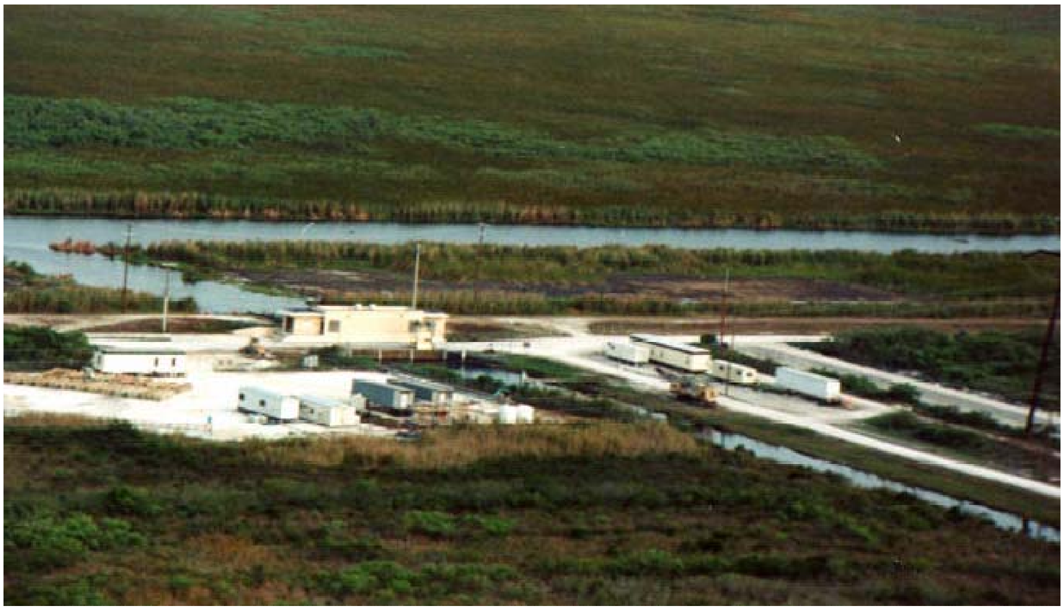

Figure 4-4. Photograph of CTSS Pilot System Testing Site at Everglades Project. Source: Final Report, CTSS Advanced Technology Demonstration Project (SFWMA, 2002)

As previously Stated, the Authority's local-control, public/private partnership funding and implementation strategy requires that the Authority have within its direct control the ability to achieve the phosphorus load reduction target within a certain time frame. By installing and operating this treatment plant, the Authority can assure the general public that the Authority's water quality objectives, including odor elimination, will be achieved in a relatively short time frame (5 to 8 years) after the in-Sea barrier is completed. To achieve this objective, Dr. Walker recommends proceeding with the construction and operation of the CTSS plant as soon as possible (Walker, 2006).

Based on the schematic design of the equivalent-size Florida Everglades CTSS system, the footprint of this proposed CTSS plant will be about 10 acres. A residuals holding/settlement pond will require another 300 acres. Unlike similar CTSS plants at municipal water and wastewater treatment plants, no dewatering facilities or drying beds are needed. This is a considerable cost savings. After the south basin dries

[2] The two 100-MGD Las Vegas wastewater treatment plants that discharge into Lead Mead use the CTSS process for final phosphorus removal to achieve 95% removal efficiency as required to meet their 13 μg/L phosphorous discharge limit. These phosphorus discharge limits on the two Las Vegas wastewater plants plus similar limits on the smaller Henderson plant equates to *less than 5 tons/year of total allowable phosphorous loading* into Lake Mead.

down, the residuals will be conveyed to the brine pool. The coagulant (alum or lime) and the flocculant (polyacrylamide) the CTSS plant uses will be delivered by railcar.

Extraction and Oxidation of Deep Lake Water

As previously mentioned, there are two components to the phosphorus loading problem, *external* (source control) and *internal* (resuspension). The source control program (including the CTSS Plant) is designed to reduce *external* loads to the target level needed to achieve the 35 μg/L phosphorus water quality objective within a certain controlled time frame – assuming resuspension is not a major factor. Unlike external loading, there is no direct way to positively control *internal* phosphorus loading caused by resuspension. To the extent resuspension occurs, it will prolong the timeline required to return the Sea to its historic non-eutrophic State. To deal with this contingency and to accelerate the timeline to achieve the desired non-eutrophic State regardless of resuspension, the Authority has conceived a treatment strategy designed to (1) ameliorate the adverse effects of the Sea's current eutrophic State until the source control program succeeds in moving the Sea back to its pre-1970's non-eutrophic State and (2) reduce the internal phosphorus load.

Other than aesthetics (i.e., the Sea's opaque brownish water color), the two main problems caused by the Sea's current eutrophic State are fish kills and repugnant odors. Both are attributable to the anoxic (lacking oxygen) condition that exists in the deep water (>40 feet) at the bottom of the current Sea. This anoxic condition will also exist in the deep water at the bottom of the north lake in the Authority project design. The combination of the Sea's highly eutrophic State and the anoxic conditions in this bottom layer promotes the generation of hydrogen sulfide gas (a toxic substance that has a distinctive "rotten eggs" smell); ammonium (which is highly toxic to fish); and organic sulfides (which cause the "sewer gas" odors that are present in the surrounding area and occasionally permeates the entire Imperial and Coachella Valleys). When wind events overturn the Sea's natural stratification, these toxic and smelly substances rise to the surface and strip all the oxygen from the water column. This phenomenon instantly kills all nearby fish and releases smelly gases into the air. In the case of the Authority project design, the phosphorus source control program will eventually eliminate the eutrophic conditions that cause the formation and buildup of these undesirable substances.

The Authority's interim plan for ameliorating the undesirable effects of these de-stratification events for as long as necessary is to install a drain at the bottom of the north lake. This drain will be used to extract the oxygen-deficient water containing the undesirable substances from the bottom of the 50-ft-deep north lake. A sea-floor pipeline 8-to-10 miles long will convey this water to an on-shore treatment plant. After treatment to destroy or remove the extracted toxic and/or malodorous substances, this water will be placed in the return-flow circulation channel that runs along the eastern shoreline from the north lake to the south lake. This system has been tentatively sized to remove ¼ of the volume of the north lake each year. This means the entire north lake will be flushed-out every four years. This novel lake-water extraction and treatment system will also help reduce internal phosphorus loading since organically bound phosphorus will be removed along with other substances in the treatment process. Although is this removal of phosphorus from the lake-water system will be helpful, it will not be significant factor in achieving the phosphorus water quality objective (Walker, 2006.)

Detailed plans for the drain have not been developed; however, general features can be described. The drain would originate in the deepest part of the north basin and convey the anoxic bottom water to a treatment facility near the start of the outlet channel on the east shore. The intake structure would need to be designed to avoid vertical currents and minimize fish entrainment. The plastic pipeline would be laid on the lake bottom and be buried only near the shoreline where it would end at an enclosed holding tank from which the drain water would enter the treatment facility. Barnacles should not be a problem because of the anoxic State of the water.

The treatment plant for lake water would include a sand filtration system followed by ozonation. This facility has been tentatively sized at a hydraulic capacity of 400 million gallons per day (MGD) which represents about 66% of 700,000 AFY recirculation stream from the north to the south lake. The filtration step would be used to remove turbidly (cloudiness) and suspended solids (primarily organic matter) from lake water as needed to improve the effectiveness of the ozone treatment. In jar tests conducted by the Authority in January 2006, sand filtration proved to be highly effective (92%) in removing turbidity from Sea water (Figure 4.5).

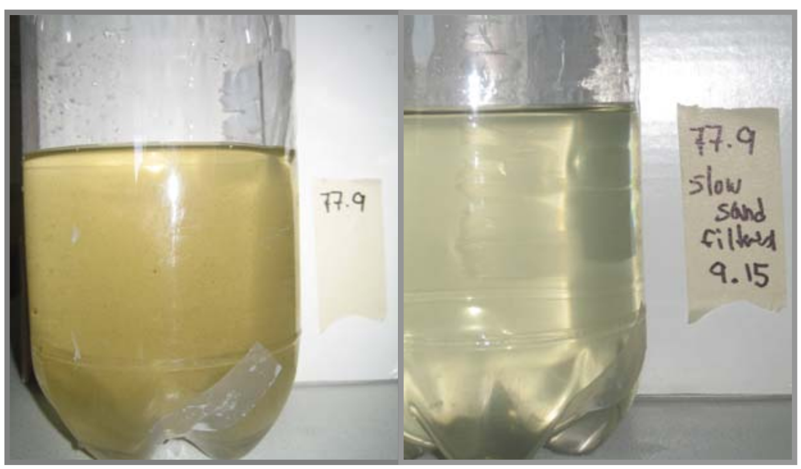

Figure 4-5. Jar-Test Results for Turbidity Removal Showing Clarity Improvement. Source: Agarian Research, assignment for Authority, January 2006

The post-filtration ozone step would be used to destroy by oxidation the problematic constituents in the anoxic lake-bottom water, including hydrogen sulfide, ammonia, organic sulfides, bacteria and viruses. Ozonation would also improve color and increase the dissolved oxygen level in the treated water. Based on preliminary calculations and assuming a 500 MGD treatment plant, the ozone generators used in this water-treatment application would be on the same scale (5 to 10 tons/per day) as the largest ozone generators in the world (Figure 4.6).

Figure 4-6. Photograph of Large-Scale Ozone Generators. Source : Ozonia website (www.ozonia.com)

Ozone has tentatively been selected as the preferred oxidation technology for this novel application for two reasons. First, ozone (the chemical O^3) is considered a "green chemical" since it oxidizes and/or destroys harmful contaminants without producing any by-products other than carbon dioxide and water. For this reason, large water utilities throughout California are converting their municipal water-supply treatment plants to ozone disinfection from chloramines. Not producing chemical by-products is an important consideration at the Salton Sea since, as a closed system, any chemicals that get into the water, stay in the water. Secondly, ozone is produced on-site using only electricity as a "raw material." This eliminates trucks hauling in chemicals. It also means that clean, locally-produced geothermal power (6-to-12 MW) can be used to produce the chemical (5 to 10 tons/day of ozone) used to clean the Sea without leaving any by-products behind. This sustainability feature is an unique environmental advantage of the Authority Plan.

Treated water will be used to periodically back-flush the filters. Similar to the CTSS plant, the filter backwash will be initially retained in an adjacent 300-acre settlement basin. After the south basin dries down, the residuals will be conveyed into the brine pool. The sand media, which can be sourced within a few miles of the plant location, will probably need to be replaced on a semiannual or quarterly basis. The used sand will also be sent to the brine pool. These materials are not expected to be classified as hazardous or pose any threats to wildlife.

Water Quality Modeling and Design Optimization

The exact capacities and specific performance parameters for the two treatment plants and the inter-lake water circulation system have not been determined. As covered in Chapter 5, the Authority is undertaking a Reclamation-sponsored design/pilot project that will include application of the EPA-approved, three-dimensional Environmental Fluid Dynamics Code (EFDC) water quality model to the lake water system in the Authority project design. The input data for this modeling analysis of the water bodies in the Authority project will be the expected improved water quality parameters for the Whitewater, New and Alamo Rivers based on implementation of the Authority's phosphorus source control program and the beneficial effects to the wetlands systems on all three tributary rivers as described in the next section.

As part of the scope of this modeling analysis, the basic EFDC model will be modified to account for the beneficial effects that filtering and oxidizing the extracted water from the north lake will have on water quality in both the south and north lakes as a function of: (1) time, (2) sediment resuspension/oxygen demand rates, (3) inter-lake recirculation rates, and (4) treatment options. The results of this modeling analysis will then be used to determine the most cost-effective overall treatment strategy and the time frame required for attaining the water quality objectives, including the critical 35 μg/L phosphorus objective, set out in the Authority Plan. These modeling results, which may cause changes to the treatment strategy outlined in this report, are expected to be known in 1^{st}-quarter 2007.

4.4 Constructed Wetlands on the Tributary Rivers

The concept of constructing a system of wetlands along the New and Alamo River channels to improve the quality of the water entering the Salton Sea originated with Imperial County resident Leon Lesicka in the late 1990s. Mr. Lesicka and other local residents formed the New River Citizens Congressional Task Force to pursue Federal funding for two initial pilot projects. These two facilities, the Brawley Wetlands and the Imperial Wetlands off Forester Road, were completed in 2000 with the assistance and involvement of Reclamation, USEPA, and IID. These two citizen-initiative pilot projects have demonstrated that created wetlands are effective in removing sediments and nutrients from the inflow waters to the Sea. Using grant funding from U.S. EPA, the Torres Martinez tribe has constructed a demonstration wetlands complex on tribal lands by the Whitewater River. In addition to improving water quality, these created wetlands provide a variety of habitats for birds as well as recreational opportunities for hunting, bird watching, and fishing. The Authority Plan includes the construction and operation of a system of several thousand acres of wetlands along the New and Alamo River channels and a wetlands complex on tribal lands adjacent to the Whitewater River delta in Riverside County.

New and Alamo River Wetlands System

The proposed locations of the wetlands along the New and Alamo Rivers have been identified in past work performed for the Citizens Congressional Task Force (Nolte, 2002). This report identified 35 sites totaling 4,300 acres that were suitable for developing wetlands. The criteria for site selection included constructability, ease of maintenance, and access to the public. The locations of the proposed wetlands are shown in Figure 4-7. Detailed footprints for each site are provided in Nolte (2002).

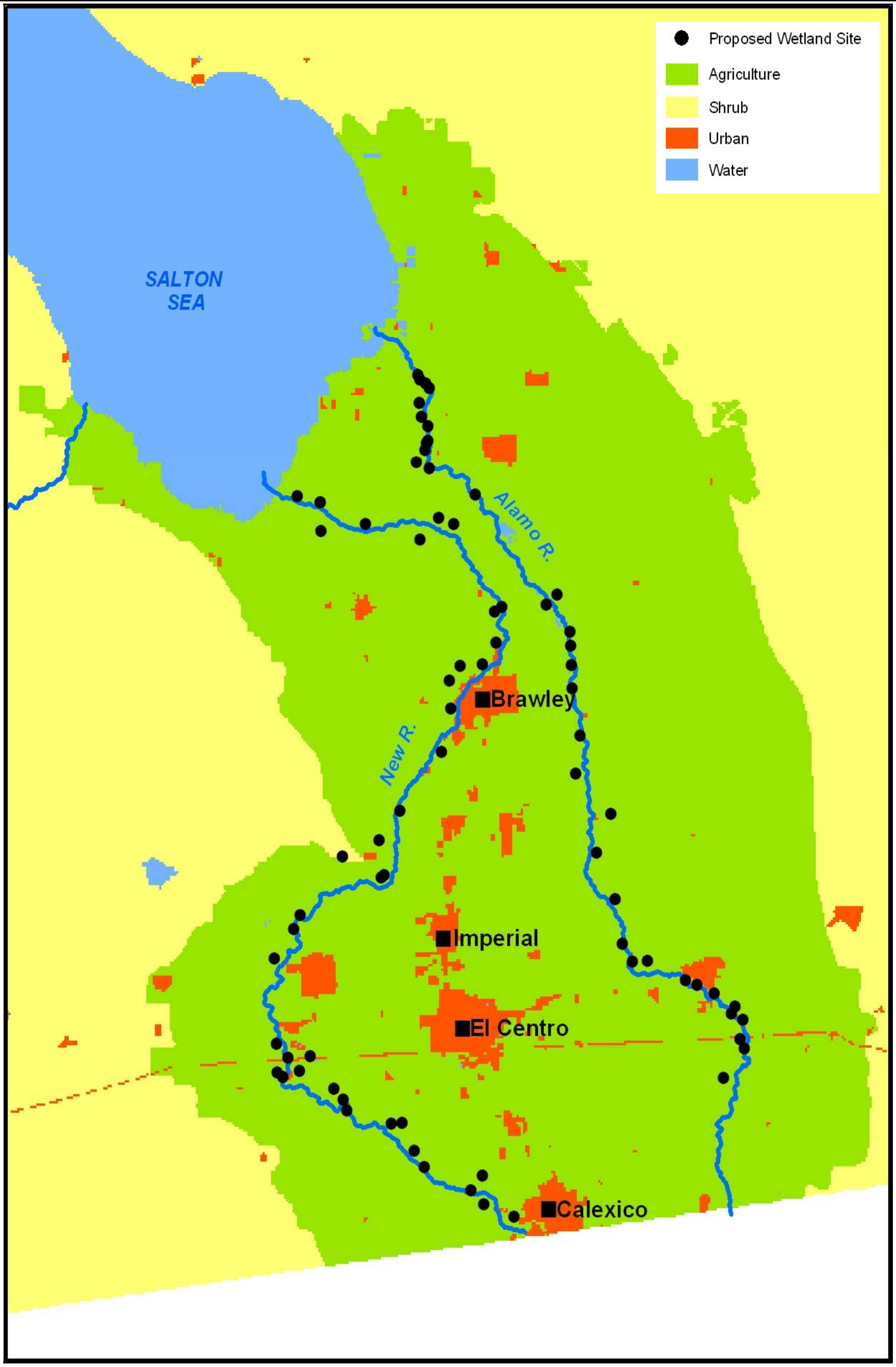

Figure 4-7. Proposed Locations of Wetlands Along New and Alamo River Channels.

The performance of the wetland network is based on an analysis of data from two pilot wetlands that have been in operation for more than five years (Tetra Tech, 2006b). The wetlands have been shown to be efficient at removing coliforms (total, fecal, and E. Coli), nitrogen, suspended solids, and phosphorus. The wetlands are not consistent with respect to removing selenium, with one wetland showing no reduction, and one showing moderate reduction. Based on the removal rate constants, the percentage load removal for each of these constituents for the Nolte network of wetlands is anticipated to be:

- Coliforms: >80%
- Suspended Solids: 38-45%
- Total Phosphorus: 35-43%
- Total Nitrogen: 26-46%

In addition to removing these contaminants, the pilot wetlands have shown the ability to increased dissolved oxygen levels by 30% to 70%.

The ranges in values are a result of alternative wetland designs and loadings. These results are being finalized in ongoing work for the Authority with funding from the State of California Wildlife Conservation Board (WCB).

Besides the removal efficiency of pollutants in wetlands, a concern remains about their potential for bioaccumulating toxics and increasing risks to wildlife. Initial results show that there is some potential for increased risk to wildlife. Preliminary data indicates that typical risks may be slight reductions in reproductive rate of birds and on the order or less than risks that birds experience from use of riparian habitat along the New and Alamo Rivers. Ongoing data collection will address this question more definitively in 4th-quarter 2006.

Assuming the wildlife risk in the wetlands can be adequately addressed, further CEQA/NEPA documentation is approved, and the necessary permits are obtained, additional wetlands projects could be constructed on a one-by-one basis beginning in mid-to-late 2007 with the entire system being built over the following 10-year period.

Figure 4-8. Groundbreaking on Torres Martinez Inaugural Wetlands Project (Chairman Raymond Torres and Tribal Elder Ernie Murillo). EPA Photo.

Torres Martinez Wetlands Projects by Whitewater River Delta

The Torres Martinez Desert Cahuillla Indians have recently finished construction of a wetlands demonstration project on 85 acres of tribal land adjacent to the Whitewater River channel in Riverside County. This project was funded by a $1.5 million grant from U.S. EPA (Region 9).

Update from TM on funding.

Update from Dan on MSCP.

At the groundbreaking ceremony for this inaugural wetlands project in April 2005 (Figure 4.8), Chairman Raymond Torres proclaimed, "*The Salton Sea is of great cultural and tribal significance to us. We'd like to congratulate the EPA, State of California, U.S. Bureau of Reclamation, and the Salton Sea Authority for their financial backing of this very important project, one of many that will expand the north border of the Salton Sea*" (EPA, 2005).

The Torres Martinez Tribe has formulated a master development plan for the tribe's 24,800 acres of ancestral lands in Riverside and Imperial Counties. Tribal land includes 11,000 acres under the Sea and 12 miles of shoreline property. The master plan includes dedicating over 1,000 acres in and around the Whitewater River delta for habitat. The Tribe is working with government agencies, private contractors, and environmental group to advance its wetlands projects. In addition to habitat values, these tribal wetlands projects will improve Whitewater River water quality.

CVWD has also provided land and funding for the creation of wetlands along the Whitewater Rive channel as part of Coachella Valley Multispecies Habitat Conservation Plan.

4.5 Ecological Features and Selenium Management

The greatest ecological benefit of the Authority project design will be the restoration and permanent existence of a large deep-water lake with ocean-like salinity and good water quality. After all, a "large lake" in the desert is the historical feature that singularly established the Salton Sea as paradise for over 400 species of birds. The 180-sq.-mile lake area with depths exceeding 50 feet in the Authority project design will once again provide an abundant food source for fish eating birds that reside at the Sea or migrate along the Pacific Flyway. Equally important, the Authority's project design is the only alternative with a large 50-ft-deep lake. This is a critical project feature because deep anoxic water – as currently exists in the 50-ft-deep basins in the north and south ends of the present Sea - is required to perpetuate the selenium assimilation effect that has made selenium a non-issue with respect to wildlife impacts for a 100 years (USGS, 2003).

In addition to the habitat values provided by two multi-purpose lakes, the Authority project design includes (1) a 12,000-acre saline habitat complex in the south, (2) a 1,250-acre saline habitat complex by the Whitewater River delta, (3) dedicated habitat zones in both lakes, and (4) wildlife disease prevention program. These ecological features and Authority's unique selenium management capability are presented below. These habitat features and risk prevention measures in the Authority project design are collectively intended to provide the diversity, dispersion, quality, and quantity of habitat types necessary to achieve the "maximum feasible attainment" of the Salton Sea ecosystem restoration goals set out in State law.

Saline Habitat Complex

The creation of shallow salt-water habitat is an integral component of a comprehensive ecosystem restoration strategy incorporated into the Authority project design. As a compensating factor for the unavoidable elimination of approximately 165,000 acres of water surface area due to the inflow reductions, the Authority has included a 12,000-acre "Type 3" (Figure 4-9) shallow-water saline habitat complex (SHC) in the Authority project design (Figure 4-1). This Type 3 SHC configuration was selected over the Type 1 and 2 configurations that include 20-ft-deep ponds because the 12,000 acres of 0-to-20-ft-deep lake water in the dedicated habitat zone in the south lake in the Authority project design obviates the need for deep ponds within the SHC itself. Moreover, these stagnated 20-ft-deep ponds within the SHC represent potential "selenium traps."

Creation of this 12,000-acre shallow-water saline habitat complex as shown in Figure 4.1 would allow for reclamation of flooded areas of the Sony Bono Salton Sea National Wildlife Refuge (SBSSNWR) and provide significantly more shallow-water habitat than currently exists at the Sea. It is envisioned in the Authority Board Policy Positions that, as part of the Authority Plan, the SBSSNWR would be reconfigured to include this 12,000-acre saline habitat complex and the 12,000-acre eastern half of the new south estuary lake. Under this scenario, the U.S. Fish & Wildlife Service (USFWS) would be free to design the saline habitat complex and/or make changes in the design of the south lake to maximize habitat values based on its expertise and knowledge. As mentioned in Chapter 3, the Authority also envisions the possibility of establishing a mitigation water account with USFWS, modeled after the QSA Salton Sea mitigation water account, to ensure supplemental water is available for the saline habitat complex and other key habitat areas during periods of low inflows.

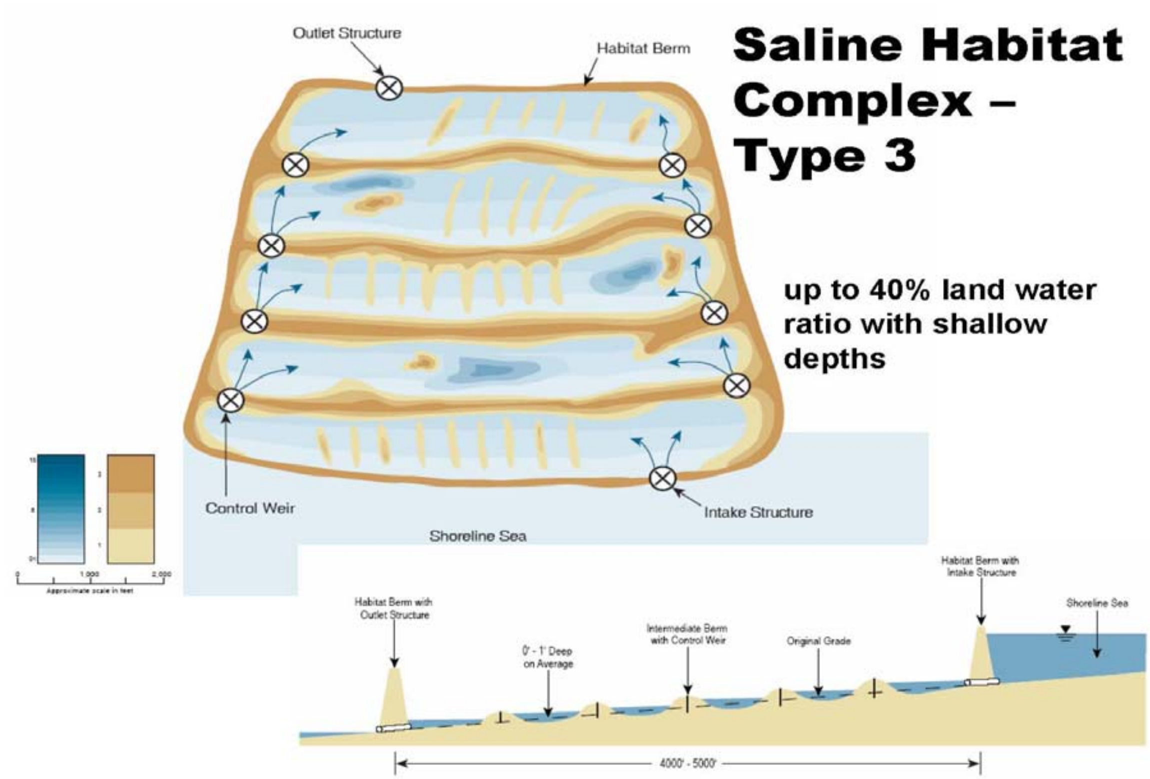

Figure 4-9. Schematic Drawing of Type 3 Saline Habitat Complex. Source: CH2M Hill, 2005.

A key issue in the design and operation of any SHC is the selenium concentration of the feed water. As noted earlier in this report, the Authority included 20,000 acres shallow brackish-water and saline-water habitat areas around the south basin in its original North Lake Plan. These areas were designated to be watered with New and Alamo River water (selenium concentrations ranging from 5 to 12 μg/L), Salton Sea water (selenium concentration of 1-2 μg/L), or a combination of both sources. The team of experts that reviewed the Authority's North Lake Plan in November 2005 included persons with direct knowledge of the selenium toxicity problems encountered at the Kesterson National Wildlife Refuge in Merced County in the 1980s when agricultural drainwater was used for watering habitat areas. In their written report, these experts specifically directed the Authority *not to use* New and Alamo River water, or a combination of river water and Sea water, to water any habitat areas (Pacific Institute, 2006). The Authority is not aware of any subsequent research that would override this expert opinion. Thus, unless and until the wildlife regulatory agencies specifically direct the Authority to use New and/or Alamo River water to water habitat area, the Authority, as the representative of the agricultural drainage dischargers who supply the inflow water that makes the Salton Sea possible, is opposed modifying its project design to include watering dedicated habitat areas with river water. For this reason, the Authority has sized the SHC in its project design and has developed its water management plan on the basis that only saltwater discharged from the north lake with projected selenium concentration of 1-2 μg/L will be used to water habitat areas.

Dedicated Habitat Zones

Dedicated Habitat Zones are proposed along the central embankment and on the eastern side of the south lake area. The zone in the south is a no-motorized-boating zone and the zone along the center dike is a no-boating zone. Both would be designated by buoys and the latter may include booms or a floating chain. No special water quality or flow controls would be required. The no-boating zone along the dike also includes safety considerations for seismic events. These areas would offer less disturbance to wildlife than other areas where motorized boating would be allowed.

Wildlife Disease Control

The Authority's comprehensive restoration strategy includes an integrated approach to wildlife disease control to reduce the incidences of wildlife disease at the Sea. Avian disease at the Salton Sea has been a chronic problem resulting in an annual loss of several thousand birds. Major epizootics (quickly spreading disease among animals) increased in frequency during the 1990s, which greatly increased the level of losses. During 1992, more than 150,000 eared grebes (*Podiceps nigricollis*) died during a single event of undetermined origin. The deaths of thousands of white pelicans (*Pelecanus erythrorhynchos*) and more than 1,000 endangered California brown pelicans (*P. occidentalis*) during 1996 from type C avian botulism focused national attention on the Salton Sea. This event served as a catalyst to begin the current Salton Sea Restoration Project.

Other diseases affecting birds of this ecosystem are avian cholera, Newcastle disease, and salmonellosis. Algal toxins are a suspected, but unproven cause of grebe mortality. Outbreaks of avian cholera affect a wide variety of bird species and have become annual events, causing the greatest losses in waterfowl, eared grebes, and gulls. Newcastle disease devaStated the Mullet Island double-crested cormorant (*Phalacrocrax auritus*) breeding colony at least twice during the 1990s. Salmonellosis has been primarily a cause of mortality in breeding colonies of egrets. Several other diseases have also been diagnosed as contributing to avian mortality at the Sea.

USFWS, with support from DFG, have conducted an on-going program to combat disease at the Salton Sea by providing response to bird die-offs. An initiative of the Salton Sea Restoration Project in the early 2000s to augment USFWS surveillance efforts enhanced the early detection of disease, and was another successful first step in minimizing losses. The existing efforts and activities are important steps to address disease impacts and should be continued and enhanced. Major bird mortality events have essentially not occurred in the past several years.

An enhanced approach that provides a continual interface between environmental monitoring, disease surveillance and response, and scientific investigations of disease ecology would be the next step. Expanded wildlife rehabilitation would also be provided because the avian botulism problem continues to affect pelicans at the Salton Sea. Therefore, the goal for the long-term disease control effort would be to provide an integrated approach to controlling wildlife disease (including fish and birds) at the Salton Sea in a manner that enhances opportunities for wildlife managers to minimize disease events and associated losses. This approach would include programs to monitor environmental conditions; detect, diagnose, and respond to disease events; collect and rehabilitate afflicted wildlife; and further development of a sound understanding of disease ecology at the Sea.

Selenium Management

Among the eight restoration project-design alternatives under consideration in the Agency's feasibility study and PEIR (Resources Agency, May 2006), the Authority believes its project design is the only configuration that will retain the Sea's historical capacity to assimilate the estimated 10 tons/year of selenium that flows into the Sea each year along with the agricultural drainage water (Setmire, 1998)[3]. This is an important, and in the Authority's opinion overriding, factor in selecting a preferred restoration project design that receives State and possibly Federal funding.

Based on a proposal made in November 2005, the Authority was awarded a $750,000 contract in January 2006 by DWR as part of the Agency's Ecosystem Restoration Study to devise and perform a pilot project to determine the feasibility of using treatment technology to remove selenium from the agricultural drainage flows and/or New and Alamo River water. The Authority staff met with IID staff, various technology vendors, and the project manager for Reclamation's San Luis Drainage Features Reevaluation (SLDFR) project in the San Joaquin Valley. Reclamation's SLDFR project is relevant since this project included the field pilot testing of a biological selenium removal process that is now a component of Reclamation's "preferred project" approach for removing selenium from agricultural drainage water in the San Joaquin Valley. After investigation of the potential applicability of this process under various schemes to the situation at the Salton Sea, Authority staff concluded, and DWR staff concurred, that treatment technology is infeasible as a selenium management strategy at the Salton Sea. (IID and Reclamation had reached this same conclusion in their EIS/EIR for the Transfer Project/QSA in 2002.) Accordingly, the Authority desires to change its field pilot-testing project for selenium removal to the CTSS process that Authority plans to use in its phosphorus source-control program (Authority, 2006).

The State Board and others have formed collaborative partnerships for implementing selenium source control efforts within the upper basin States on the Colorado River system (Utah, Colorado and Wyoming) that are the original source of the selenium that eventually makes it way into the Salton Sea (SWRCB, 2006). These efforts have had only nominal success, and the possibly of achieving significant reductions in the future is improbable unless large acreages of farmland in the upper

[3] The Setmire reference is to his 1988-89 field sampling of selenium concentrations and loads in the Alamo and New Rivers which totaled 8.2 tons. Allowing for direct drains, the Whitewater River, and other sources, this figure has been adjusted to 10 tons/year. Inflows and selenium concentrations have not changed materially since 1988-89. The Authority is not aware of a more recent or more definitive analysis of selenium mass loading into the Sea.

basin States are taken out of production. This is not likely to happen. (Comments by upper basin officials at the WEF-sponsored Selenium Summit in November 2005.)

Since treatment and source control are not feasible, the only feasible long-term solution to the selenium management issue at the Salton Sea is to design the ecosystem restoration project so that the natural selenium assimilation capacity of the Sea -- which has prevented any known selenium-related wildlife impacts over the last 100 years -- is retained. Thus, the only "highly likely" case for retaining the Sea's selenium assimilation capacity is a project design that retains a 50-ft-deep lake of comparable size as the existing water body in either the north or south basin of the present Sea. This consideration was a major factor in the design and selection of the North Lake Plan as the Authority's preferred project in April 2004.

The Sea's natural ability as a 50-ft-deep water body to assimilate and render harmless the 10 tons/year of selenium load was documented at a meeting of 13 selenium experts convened by USGS Salton Sea Science Office in March 2003. The various selenium assimilation mechanisms these experts identified as being at work in the Sea are identified in the diagram from the meeting report shown in Figure 4-10. Other key findings from this meeting were:

- *Current inflows to the Sea contain low to moderate levels of selenium. However, because the inflow volume of water is so great, total selenium burden to the Salton Sea annually is equivalent to that of Kesterson Reservoir.*
- *The existing Sea appears to accommodate selenium. While most major ions increase by evaporative concentration in the Salton Sea, water-borne selenium levels are lower in the Sea than in the inflows. In contrast to major ions, selenium in water entering the Sea is diluted by the lower selenium concentration water in the Sea where it is continually removed by a variety of biological processes.*
- *Selenium is currently bioavailable through invertebrate and fish consumption of bacteria and algae in the water column or in shallow sediments. However, the greatest portion of this selenium appears to become incorporated into deep anoxic sediments as the algae and bacteria die, becoming a detrital rain. These deep sinks [in the north and south basins] have little or no biological activity, and thus for all practical purposes the selenium is biologically unavailable so long as the deep water and anoxic sediment conditions are maintained. (USGS, 2003).*

Preserving a 50-ft-deep anoxic sink as a proven long-term solution to potential wildlife impacts from selenium bioaccumulation is a unique feature of the Authority Plan among eight alternatives under consideration in the Agency's Ecosystem Restoration study. Given the Kesterson experience and the fact that providing safe, sustainable habitat for wildlife is the main objective of the Agency's legislatively mandated study, it seems implausible that any plan could be rated higher than the Authority Plan on providing the legislatively mandated wildlife values.

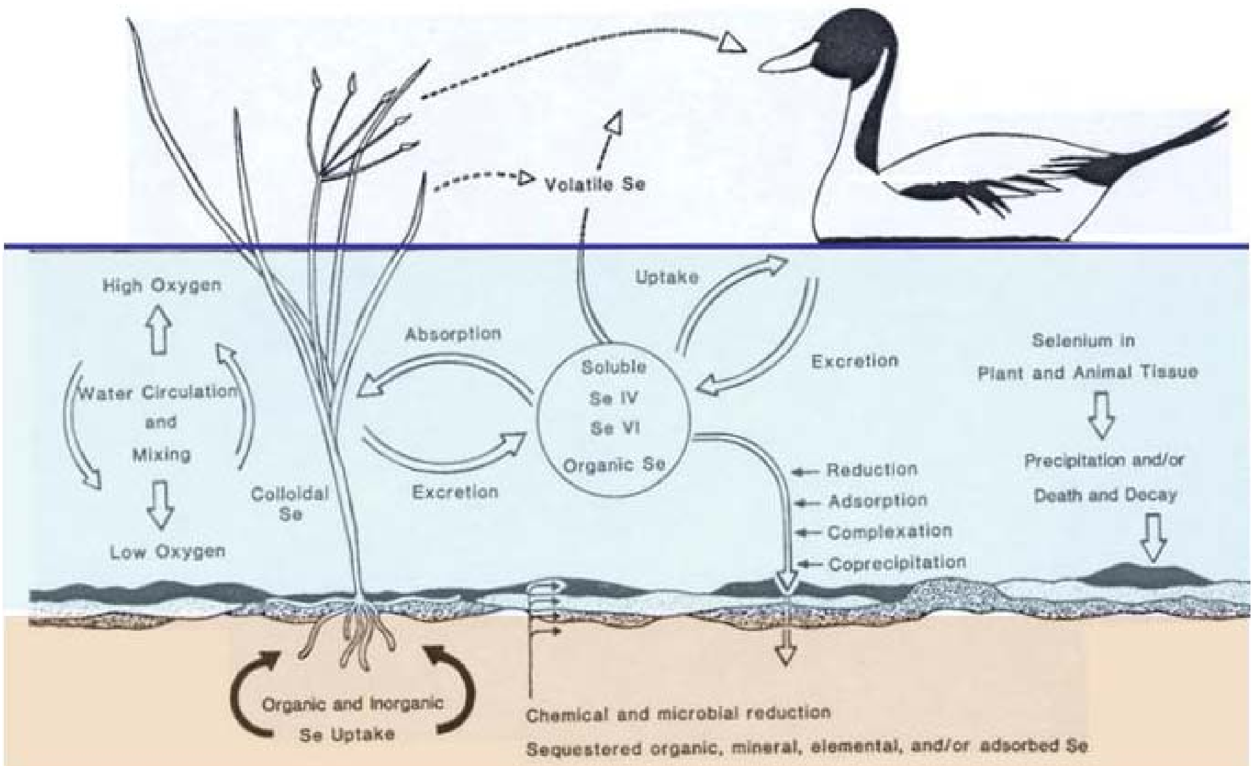

Figure 4-10. Natural Selenium Assimilation Processes in Current Sea. Source: USGS Salton Sea Science Office, Selenium and the Salton Sea, March 2003 (color added). Caption in USGS Source Document: Processes for the immobilization of selenium include chemical and microbial reduction, adsorption, co-precipitation, and deposition of plan and animal tissue; mobilization processes include uptake of selenium by rooted plants and sediment oxidation due to water circulating and mixing

4.6 Air Quality Mitigation and Salt Management

The Salton Sea related State legislation enacted in 2003 as part of the QSA requires that (1) mitigation measures for the potential air-quality impacts created by the reduced inflows resulting from the QSA water transfer be included in the Agency's recommended preferred alternative project design and (2) the State assume financial liability for any required air-quality mitigation actions related to the QSA transfer that exceed the $133 million in mitigation costs paid by the QSA parties. Thus, air quality mitigation is a major consideration in the Agency's Ecosystem Restoration Project feasibility study as a matter of State law.

Air quality mitigation is a major consideration of the Authority and its member agencies because their constituents, i.e., the residents of the Coachella and Imperial Valley, will be the persons most affected by future poor air-quality conditions in the vicinity of the Salton Sea. In fact, air-quality impacts caused by the Salton Sea already are a regional issue due to the noxious odors which, depending on wind direction, carry as far as Palm Springs, Borrego Springs, and Calexico. Thus, the Authority's aggressive phosphorus source-control program that is designed to transition the eutrophic State of the Sea back to its non-odorous State as existed in the 1950s and 60s is an integral component of the Authority's air-quality management plan.

The air quality issue that has drawn the most attention is the possibility of blowing dust storms caused by exposed sea-bed sediments. Many people make a direct comparison between the Salton Sea and the Owens Valley with respect to potential dust-emission problems and mitigation costs (Pacific Institute, 2006; Salton Sea Coalition, 2006; and comments at various State Advisory Committee meetings). The Agency has based the air-quality management approach in its Ecosystem System Restoration study on the explicit premise that "Owens Valley is the Working Model" (CH2M Hill, 2005).

These assumptions on the similarity of likely air quality issues at the Salton Sea and Owens Valley are directly contradicted by the facts and findings made by IID and Reclamation in their certified EIR/EIS for the Transfer Project QSA:

To further consider the potential impact for emissions from the Salton Sea, a comparison was made to existing dry lake beds where dust impacts have been observed. Fortunately, conditions found to produce dust storms on dry salt lake beds, such as Owens Lake, were not found to be present at the Salton Sea. The following three primary factors would be expected to make the situation at the Salton Sea much less severe than at Owens Lake:

- ***Soil chemistry**: …The soil system at the Salton Sea is predominately sodium sulfate and sodium chloride. These salts do not change in volume significantly with fluctuations in temperature, so the crust at the Salton Sea should be fairly stable and resistant to erosion. This anticipated situation at the Salton Sea is different from similar current situations at Owens and Mono Lakes, where a significant portion of the salinity is in the form of carbonates. The volume of carbonate salts is much more sensitive to temperature fluctuations, and desiccation of these salts produces fines that are readily suspended from playa at these lakes. Therefore, the salt crust on the exposed playa at the Salton Sea should be more stable and less emissive than Owens Lake. Also, distribution of mobile sand on the dry lakebed at Owens Lake is part of what drives high emissions rates, and comparable conditions are not expected at the Salton Sea.*

- ***Meteorology**: The frequency of high wind events at the Salton Sea is less than at Owens Lake. Therefore, the dust storms at the Salton Sea would be less frequent than at Owens Lake. …The predominant wind direction at the Salton Sea is also favorable; during high wind events at the Sea, it is from the west and northwest, perpendicular to the orientation of the playa. Dust suspension on the playa of the Salton Sea would be higher if the playa were oriented parallel to the predominant wind direction.*

- ***Recession Rate**: The anticipated decline in water levels at the Salton Sea is predicted to be significantly slower than what occurred at Owens Lake (only about 20 percent as fast). Natural processes may contribute more to controlling dust emissions at the Salton Sea than they have at Owens. These natural processes could include (a) the enabling of vegetation through development of soil conditions favorable to plant growth (including improvement in natural*

> *drainage), (b) development of native plant communities; (c) sequestration of sand into relatively stable dunes; and (d) formation of relatively stable crusts. [IID, 2002, pp. 3.74-34/35, emphasis added].*

The above key findings in the EIS/EIR for the Transfer Project/QSA were supported and upheld by the State Board in the water rights order its issued for the QSA transfers. These legal determinations are supported by the fundamental historical and geological differences between the Owens Valley and the Salton as noted by the Lahontan Regional Water Quality Control Board (2005):

Only since the 1913 export of water [to Los Angeles] has a saline playa existed … the salt deposit on the [Owens Lake] playa surface is thin, and has been formed by the evaporation of saline groundwater rather than from the desiccation of the historic lake.

The opposite is true in the case of the Salton Sea. Areas exposed by receding water levels of the Salton Sea will become covered by desiccated agricultural drainage salt deposits; not indigenous salts leached from soil matrix. This difference is significant because it is the uniqueness of the indigenous salts in the Owens Valley that accounts for the area's notorious air quality problem. This fact is also Stated by Lahontan Region Water Quality Control Board (2005):

Owens Lake is the largest single source of particulate air pollution in the United States. This situation is related to the lake's salt chemistry. The salt crust on the playa contains a higher proportion of sodium carbonate [soda ash], sodium bicarbonate [baking soda] and sodium sulfate salts than most other playas in California. Most other plays are strongly dominated by sodium chloride salt (halite) [table salt]. Halite does not undergo the dramatic volumetric phase change that [sodium] carbonate and sulfate salts do on Owens Lake. These [volumetric phase] changes break apart the playa surface and allow salts to be easily suspended by the winds." [emphasis added]

Thus, rather than being concerned about lakebed soil emissivity (the focus of the Agency's air mitigation approach), the pertinent concern in assessing the potential for air quality impacts at the Salton Sea is the **friability of desiccated salts that will be deposited on the surface of the exposed lakebed as the sea recedes**. As shown in the graph in Figure 4-11, the carbonate salts (Na_2CO_3 and $NaHCO_3$) that are the known cause for the air quality problems at Owens Valley account for 60% to 83% of the total salt in the salt deposits that formed during evaporation tests. Note that in these data that sodium chloride salt (NaCl) – the type of salt most prevalent at the Salton Sea -- was only 10% to 20% in these tests.

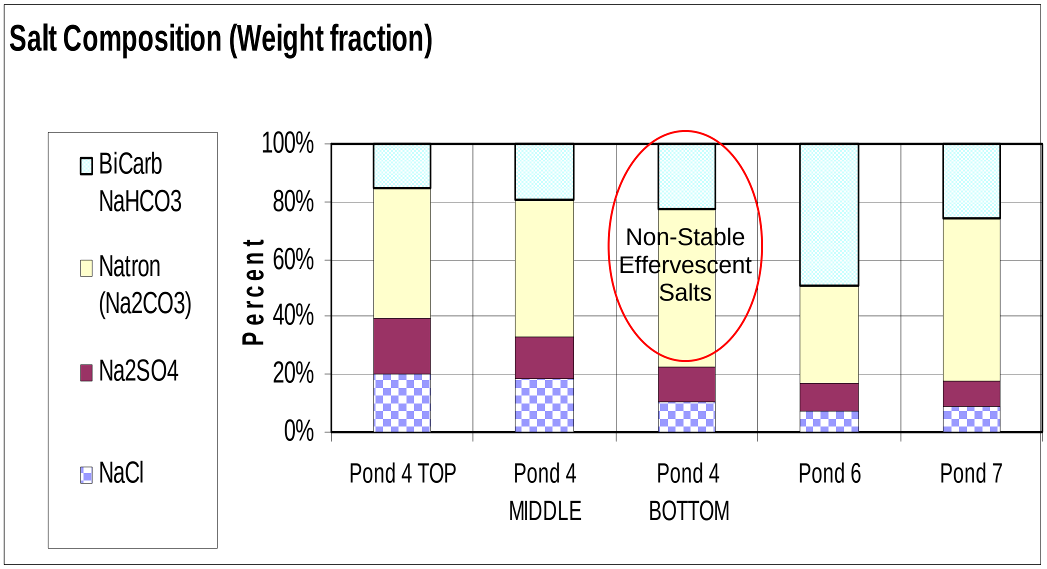

Figure 4-11. Salt Chemistry from Evaporation Tests at Owens Valley: Agrarian Research

The Authority has conducted salt pond evaporation tests on Salton Sea water. The same firm (Agrarian Research) that performed the Owens Valley salt evaporation tests performed the Salton Sea test. After first concentrating the salts in the Salt Sea water by a factor of 3x to 4x (which would be equivalent to running it through the saline habitat complex in the Authority project design), the concentrate was placed into crystallizer cells (the equivalent to shallow impoundment ponds in the south basin in the Authority project design) and allowed to dry into a solid. The chemistry of these salt deposits formed from the concentrated Sea water is shown in Figure 4-12.

	CaSO4	MgSO4	Na2SO4	NaCl	KCl
Salt	1.06	4.28	4.51	89.81	0.32

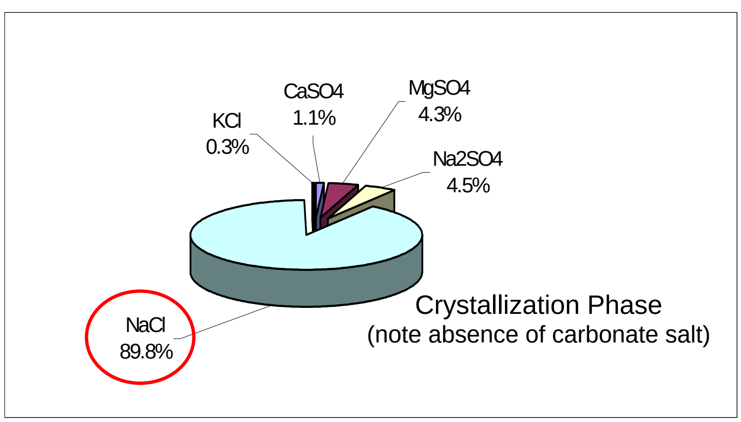

Figure 4-12. Salt Chemistry from Evaporation Tests at Salton Sea. Source: Agrarian Research

The key figure in Figure 4.-12 is the 90% sodium chloride (NaCl). This is plain table salt. The commercial salt industry is quite familiar with the techniques and procedures involved in operating crystallizer basins for growing NaCl salt crystals from seawater or brackish water while washing away other unwanted salts (like sodium sulfate). Agrarian Research used these same techniques to grow the NaCl crystal from Salton Sea water shown in Figure 4-13.

Figure 4-13. NaCl Salt Crystal formed from Salton Sea water. Source: Agarian Research

Given the large quantity of salt in the Salton Sea (over 400 million tons – enough to cover the Sea's entire 360 sq. mile surface area with a 14-inch thick solid deposit) and realizing that 90% of this salt (after concentration) is NaCl that dries into hard crystals, the Authority advanced the concept of using naturally formed NaCl deposits to cover exposed areas in the south basin in the Authority project design as an air quality mitigation measure. The Authority had previous experience forming large, stable salt deposits from Salton Sea water from the solar evaporator tests it conducted with Reclamation in 2000-02 (Figure 4-14).

Figure 4-14. Thick Salt Deposit formed from Sea water during solar evaporator tests in 2002. (Authority photo)

To confirm the practicality and efficacy of using naturally formed salt deposits for air-quality mitigation, the Authority engaged a salt industry expert (John Pyles). Before his retirement, Mr. Pyles managed the 40,000-acre Cargill commercial salt pond complex in San Francisco Bay. He had also previously worked as a consultant on a Salton Sea project. In his letter to the Authority, Mr. Pyles States that in his 21 years of work at the Cargill salt complex in San Francisco Bay:

The company never experienced any blowing dust or other air quality problems, including odor complaints while the crystallizers were in operation. New housing developments and commercial buildings were built within 1 mile of the solar ponds on both ends of the Dumbarton Bridge without any dust or odors being an issue (Pyles, 2006).

After familiarizing himself with the Authority project design and recent work by Agrarian Research, Mr. Pyles expressed the following expert opinion:

A managed salt deposit with such a high content of NaCl would be competent and highly cemented body capable of supporting repeated use of heavy equipment if desired. This characteristic is seen all over the world in salt deposits high in sodium chloride content, regardless of other co-precipitated salt. I believe that forming a thick, competent deposit high in NaCl on top of the exposed areas within the south basin in the Authority Plan is a well proven concept that is both feasible and technically sound. (Pyles, 2006.)

A photograph of the cemented, durable (4-year-old) surface of an experimental 5-acre salt deposit formed from Sea water is shown in Figure 4-15. For comparison, a photograph of the expansive salt deposits within the 200-sq. mile old Laguna Salada lakebed (also part of the ancient Colorado River delta) is shown in Figure 4-16. In terms of salt chemistry and local hydrologic, geologic and climatic factors affecting the characteristics of the salt deposits that will form when the Salton Sea drys down, the Sea is more analogous to its historic relative, the Laguna Salada, about 50 miles away in Mexico; than the dry Owens Lake bed, 250 miles away in a very different climatic, hydrologic, and geologic setting. As a cemented salt deposit as referred to in Mr. Pyles' letter, the Laguna Salada does not have a blowing dust problem.[4]

To determine the area within the south basin that will eventually become covered with a naturally formed NaCl salt deposit as the water level in the south basin recedes, Tetra Tech developed a model to calculate (1) the decline in water elevation in the south basin based on the inflow reduction scenario presented in Chapter 3, and (2) the elevation at which the salt concentration in the south basin will exceed the precipitation point for NaCl. These projections are shown in Figures 4-16 and 4-17. Under this scenario, the model shows that hypersalinity (defined to be the salt concentration at which NaCl precipitates) would reach the –255-ft msl elevation in 2023 (i.e., about 10 years after construction of the in-Sea barrier is completed).

[4] Mexicali has held concerts attended by 40,000 people at the Laguna Salada (info@TourMexico.com) and two Federal highways cross the salt flats.

Figure 4-15. Experimental Salt Deposit Formed from Salton Sea Water.

Figure 4-16. Salt Deposits on old Laguna Salada Lakebed near Mexicali.

The map shown in Figure 4-17 illustrates the –255-ft msl contour line inside the south basin. The area within this contour will be covered with either (1) a cemented NaCl salt deposit or (2) the semi-solid brine pool. Of the 90,000 acres in the south basin (excluding the habitat complex and water storage reservoir), the modeling shows that only about 7,000 acres—less than 8% -- *may* have a possible exposure problem. This area is the strip between the west barrier and the -250-ft msl contour. Even this area is unlikely to experience dust problems for these reasons:

- it will be at the toe of the in-Sea barrier where there will be seepage or thus the likelihood of natural vegetation growing;
- this area is isolated from public exposure by a surrounding water body; and
- this location lies 20-to-25 feet below the surface water of the surrounding lake which again suggest seepage and natural vegetation will occur.

If blowing dust is a problem in this small area, magnesium chloride from the brine pool could be pumped to form a protective chemical cover as is commonly done as an air-quality mitigation measure at construction sites. Other mitigation measures will be applied as necessary and appropriate based techniques developed by the State as part of its Ecosystem Restoration Study "tool box" and future pilot projects. Over time, salt deposit management and maintenance will be required as suggested by Mr. Pyles in his letter.

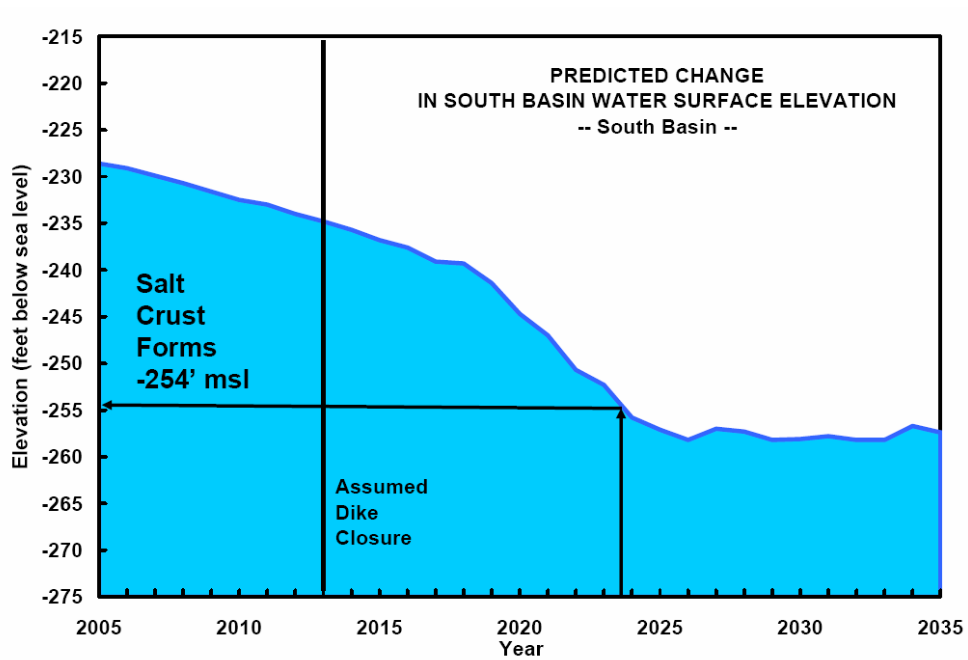

Figure 4-17. Predicted Elevation in the South Basin Brine Pool.

Figure 4-18. Map Showing Natural Salt Deposit Formation Area.

4.7 Colorado River Water Storage Reservoir

The Authority Board Policy Positions include the construction of a 250,000 acre-foot storage reservoir for Colorado River water for use by IID as a component of the Authority's project design. The proposed location and 11,000-acre footprint for this reservoir is shown in Figure 4-1. As planned, the reservoir will be constructed in the 5-year period after the in-Sea barrier is completed (i.e., 2013 to 2018), but this schedule depends on funding.

To construct this reservoir, a second barrier (about 11 miles long) would be placed in the south basin in 30-ft of water outside the main in-Sea barrier that will be constructed in 20-ft of water. Thus, the incremental cost to add this reservoir to the project scope is simply the cost for this additional 11-mile barrier and the hydraulic structures and equipment needed for moving water in and out. This piggyback approach provides a low-cost way for achieving IID's long-sought goal of obtaining in-district water storage.

The construction concept is to place the second barrier needed for the reservoir in the "wet" so the enclosed 110,000 acre area never dries out. The reservoir would act as dust control measure for 11,000-acre area that it covers. However, if the reservoir is not built for some reason, salt deposits will be formed in this area as necessary to protect against wind erosion and dust formation similar to other portions of the Salt Deposit Area. The primary area of concern for potential dust emissions would be the area above –255-ft msl elevation contour (about half the reservoir footprint).

The proposed in-district reservoir would give IID the ability to carry over and use in the next year Colorado River water that is not used in the year in which it was delivered. This is common practice for MWD. There would be consumptive losses due to evaporation of about 60,000 AFY if all compartments have standing water all year. These losses will reduce net amount of carryover water. Most importantly, IID's use of this reservoir would enable it to take its full entitlement to Colorado River water on a consistent annual basis as called for in the long-term regional water balance described in Chapter 3.

No design or site investigations have been performed for the reservoir. The preliminary cost estimate presented later in this chapter is based on the same barrier design, construction techniques and unit costs as used for the main in-Sea barrier.

4.8 Water System Design and Operation

The Authority has based the water system design in its project on:

1. The 812,000 AFY design-case inflow projection from Chapter 3;
2. 180 sq. miles of lake surface (i.e., 50% of the current 360 sq. miles); and
3. Average net evaporation rate of 66.4 inches per the Draft Hydrology Report.

In addition to the lake-water system, other consumptive uses in the Authority's basic project design include the wetlands on the three tributary rivers, the two habitat complexes, the salt deposit area, and the residuals streams from the two water treatment plants. As previously noted, the size of the south saline habitat complex was not independently determined; rather, it is limited by the 40,000 AFY purge steam used to transport salt from the lake water system to the salt deposit area in the inner basin. This stream is the only source of low-selenium water available for consumptive use in the Authority Plan. However, if approved by regulatory agencies, the Authority will use river water which generally has higher selenium levels than Salton Sea water as a supplemental supply for the habitat area. As shown in Table 4-2, all consumptive uses in the current Authority basic project design total about 748,000 AFY.

Table 4-2. Water System Operating Factors at Design-Case Conditions.

Design-Case Inflows	AFY	**Surface Areas & Consumptive Water Uses**	acres	AF/ac	AFY
New River (ex-Mex)	190,000	New & Alamo Wetlands	4,000	6.03	24,120
Alamo	410,000	North Lake (ex-NSCH)	87,800	5.53	485,534
IID Direct Drains	64,000	South Lake & Channels	27,400	5.53	151,522
Sub-Total IID	**664,000**	North Saline Habitat Complex	1,800	2.77	4,977
Whitewater	78,000	South Saline Habitat Complex*	12,000	2.77	33,180
CVWD Drains	24,000	IID Reservoir	11,000	n/a	n/a
Sub-Total CVWD	**102,000**	CTSS Treatment Plant	n/a	n/a	20,000
Mexico	20,000	Filter/Ozone Treatment Plant	n/a	n/a	21,000
Local	26,000	Salt Deposit Area & Brine Pool	90,000	n/a	7,631
TOTAL	**812,000**	**TOTAL** (ex-Wetlands)	**230,000**		**747,964**

* can be expanded if regulatory agencies approve direct use of untreated New and Alamo river water

The consumptive use figure of about 748,000 AFY in the basic project design is 9% (65,000 AFY) below the design-case inflow assumption of 812,000 AFY as also shown in Table 4.2. Thus, the Authority project design has a 9% safety margin between the minimum consumptive use requirements and the design-case inflow projection. There are three reasons why the project features were sized to allow for this 9% margin of safety:

1. At the scale of this project, the measurement accuracy of flows, evaporation rates, and surface areas are, at best, within a ± 5% range.
2. Even though the Authority is highly confident its salt deposit approach for air-quality mitigation will obviate the need to use water to grow salt-tolerant vegetation, there will be 50,000 AFY available for this purpose if needed.
3. If further research shows that selenium bioaccumulation is not a problem when New and/or Alamo River water is used to water shallow habitat areas, the 65,000 AFY of "extra" water (assuming it is not needed for air-quality mitigation) could be used to supply shallow brackish-water habitat wetlands.

A schematic design of the water system in the Authority's project is shown in Figure 4-19. This diagram also shows internal operating flows at the 812,000 AFY design-case inflow conditions. The fundamental task of the water system in the project design is to take "as available" agricultural drainwater and upgrade and manage this water so it can be put to beneficial reuse on a sustainable basis for swimming, boating, fishing and wildlife habitat. The overall concept of a "treatment and circulation" approach for accomplishing this task is readily apparent in this diagram. Other key features and design considerations in the Authority's water system are:

- **Flexible to accommodate unforeseen situations and high flows.** By designing the lake water system as a single, continuously moving water body, the flexibility exists to easily change flow rates, plant capacities, and/or treatment steps to deal with unexpected problems or to accommodate new regulatory requirements. Seasonal variations in inflows are a non-issue since all parts of the system are hydraulically connected. The 1.3 million AFY "high inflow" case can be easily accommodated by use of the by-pass connection to the brine pool.

- **Mixing of saltwater with estuary lake water to achieve salinity and selenium water quality objectives**. The main purpose for recirculating water from the saltwater lake back to the estuary lake is to achieve the water quality objectives in the estuary lake for salinity (<20 g/L salt) and selenium (< 5 µg/L). By mixing water from the saltwater lake (35 g/L salt and < 2 µg/L selenium) with the New and Alamo River water (3 g/L salt and ±8 µg/L selenium) in a 1:1 ratio, water quality objectives in the estuary lake can be met. The recirculation flow rate (nominally 700,000 AFY) will be set based on this consideration.

- **Pupfish connectivity**. As shown in the water-system flow diagram, all existing rivers, creeks and drains empty directly into the contiguous lake water system. A by-pass will be built around the treatment plant on the Alamo River so pupfish connectivity will be maintained here as well.

- **Bottom vs. surface discharge from the 50-ft-deep saltwater lake**. The optimal ratio between bottom-water discharge vs. surface discharge of north lake water will be determined in the EFDC modeling analysis that Tetra Tech will be performing late this year. There are many variables and trade-offs in this determination. The modeling results also will be used to determine the initial size of the filtration/ozonation plant for treating the extracted bottom-water.

- **Lake water change-out rates**. At the design-case operating rates shown in Figure 4-19, the approximate 700,000 AFY out-flow stream from the saltwater lake in the north will serve to change-out the saltwater lake's estimated volume of 3 million AF about every four years. The 1.1 million AFY out-flow stream from the estuary lake in the south will change-out this lake's estimated 1.0 million AF volume in less than a year. These relatively high change-out rates (7-to-10 years is typical for many healthy natural lakes) will help achieve the water quality objectives by avoiding stagnation and promoting mixing and aeration; although wind events will still be the predominant factor in this regard.

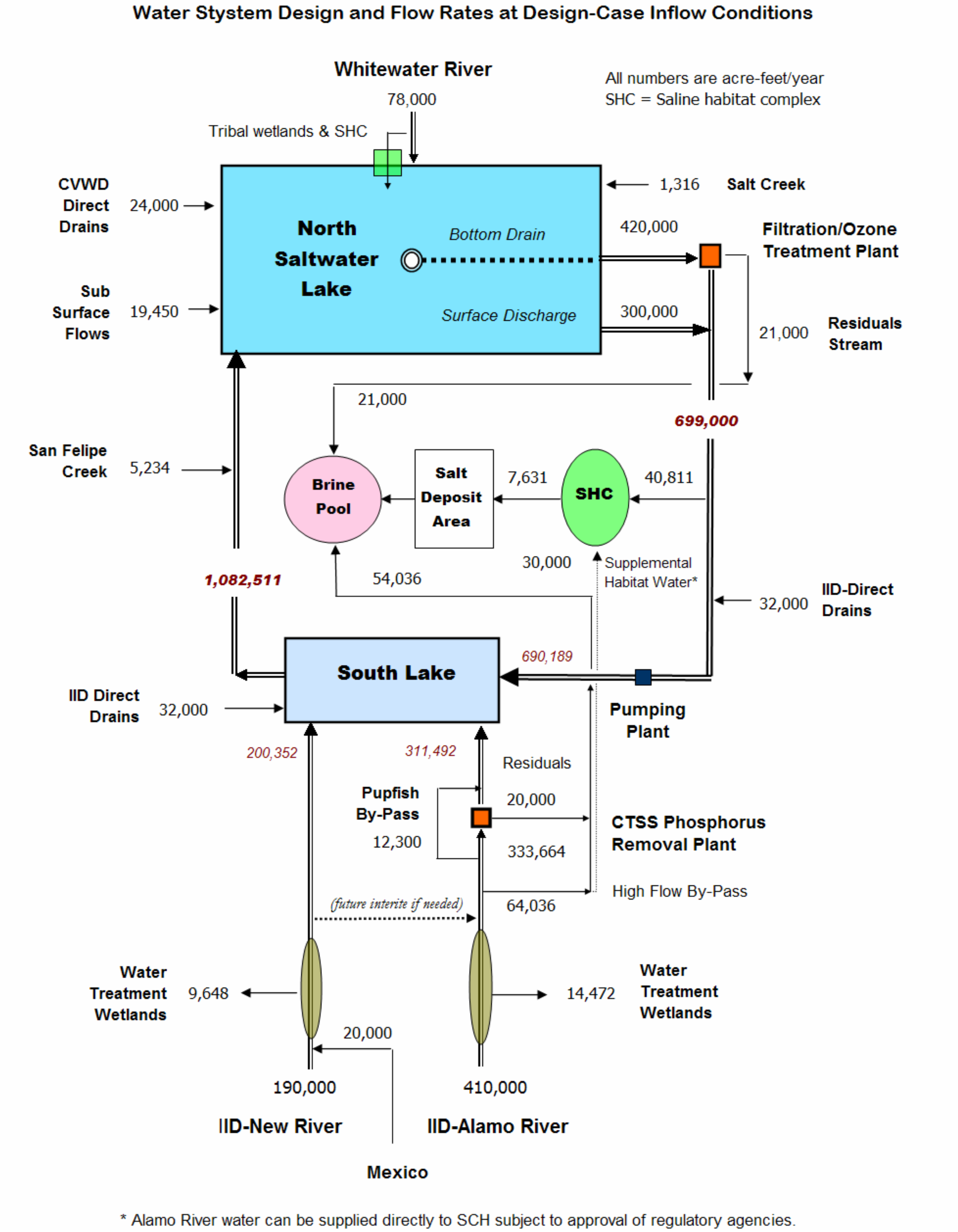

Figure 4-19. Water System Design & Operating Flows at Design-Case Conditions. Note: IID Colorado River water reservoir not shown since it is not part of Salton Sea water system.

As shown in Figure 4-1, a 20-mile channel past the Bombay Beach area is required for moving water from the water from the saltwater lake to the south SHC and the estuary lake. The hydraulic calculations for the channel are shown in the Table 4-3 below. Four possible configurations of width and depth are shown on the table, using a head differential of 3 feet. The head differential is the drop in water surface elevation from the upstream end of the channel to the downstream end. The pumping plant shown in the Figure 4-19 water-system diagram will lift the water in the recirculation channel to provide this 3-foot head differential. About 600 kW of power will be required to operate this pumping plant. Like the ozone water treatment plant, this power can be supplied using near-by green geothermal electricity.

Table 4-3. Return Flow Channel Design & Cost Calculations.

Variable	Design 1	Design 2	Design 3	Design 4
Q (AFY)	700,000	700,000	700,000	700,000
Q (cfs)	967	967	967	967
Manning n	0.03	0.03	0.03	0.03
Head Differential (ft)	3	3	3	3
Slope	0.000028	0.000028	0.000028	0.000028
$AR^{2/3}$	3670.7	3670.7	3670.7	3670.7
Area (sq ft)	1000	1020	1040	1060
Wetted Perimeter (ft)	142	149	157	164
Hydraulic Radius (ft)	7.03	6.83	6.63	6.44
Side Slope L (1:SS)	2	2	2	2
Side Slope R (1:SS)	2	2	2	2
Ave. Side Slope (1:SS)	2	2	2	2
Bottom Width (ft)	105.5	114.3	123.2	132.2
Top Width (ft)	138.3	145.7	153.3	161.1
Depth in Main Channel (ft)	8.20	7.85	7.52	7.23
Ave. Depth (ft)	7.23	7.00	6.78	6.58
Velocity (fps)	0.97	0.95	0.93	0.91
Froude Number	0.059	0.060	0.060	0.060
Freeboard[1] (ft)	2	2	2	2
Freeboard Area (sq ft)	146	154	161	169
Length (mi)	20.2	20.2	20.2	20.2
Length (ft)	106,656	106,656	106,656	106,656
Channel Excavation (cu yd)	4,528,223	4,636,401	4,745,365	4,855,134
Total Excavation (cu yd)	4,528,223	4,636,401	4,745,365	4,855,134
Excavation Unit Cost ($/cu yd)	$2.35	$2.35	$2.35	$2.35
Compact Embankment ($/cu yd)	$1.50	$1.50	$1.50	$1.50
Channel Cost	$17,433,659	$17,850,145	$18,269,656	$18,692,268
Channel Cost	$17,433,659	$17,850,145	$18,269,656	$18,692,268
Mobilization (5%)	$871,683	$892,507	$913,483	$934,613
Unlisted Items (15%)	$2,745,801	$2,811,398	$2,877,471	$2,944,032
Contingencies (25%)	$5,262,786	$5,388,513	$5,515,153	$5,642,728
FIELD COST	$26,313,930	$26,942,563	$27,575,763	$28,213,641
Total wo Non-Contract	**$26,313,930**	**$26,942,563**	**$27,575,763**	**$28,213,641**
Evaporative Losses in Channel (AFY)	2,032	2,141	2,252	2,366

It is anticipated that there would be some seasonal variations in inflows and evaporation, similar to current conditions and so there would be some seasonal fluctuations in elevation and salinity in the lake similar to current conditions. Seasonal fluctuations of elevation are expected to be on the order of inches and in salinity less than 1 mg/L. As long as average annual inflows are equal to or greater than the design inflow conditions, year-to-year variations in lake elevation would generally be less than current conditions since the south basin brine pool could be used as a regulator with excess flows diverted into this area.

Details of the mechanism for handling and conveyance for bypass of high flows from the rivers have not been developed. However, it is anticipated that a fairly simple system could be devised. It could be as simple as an overflow weir on the south dike coupled with a small gated diversion channel to divert water from the Alamo around the dike to the brine pond. The weir would allow salt water to flow to the brine pond and the channel would divert fresh water. Having these two mechanisms would facilitate salinity and elevation management.

4.9 Preliminary Project Cost Estimates

In the Authority's July 2004 *Preferred Project Report*, the preliminary cost assessment for the mid-Sea barrier in the Authority's North Lake Plan, assuming a rock-fill/slurry-wall design and a lake elevation of -235 ft/ msl, was $489 million. Additional project features including two channels to convey water to the north lake and wetlands on the tributary streams brought the total preliminary capital cost estimate to **$730 million.** Annual O&M costs were estimated at $11 million per year, mainly for maintenance of the barrier and water channels to the North Lake. This estimate was based on a limited number of test borings in the lakebed along the proposed alignment for the mid-Sea barrier, a conceptual barrier design concept that was peer reviewed by Reclamation's and DWR's dam-design experts, and a cursory quarry site investigation.

In the new Authority Plan, the scope of the proposed project has increased considerably. The additional project components and features include an additional 26 miles of in-Sea barriers, the two water treatment plants, the IID Colorado River water storage reservoir, new habitat features, and expanded system of wetlands on the New and Alamo Rivers. The overall project costs also include an allowance for future air-quality mitigation action which is a State responsibility under the QSA; and an allowance for cleaning up the closed Salton Sea Test base which is a Federal responsibility. These additional project components, including the desired or required involvement of the State and Federal governments, have increased overall project cost estimate to $2.2 billion as shown in Table 4.4. As covered in Chapter 8 later in this report, the $2.2 billion in funding for the overall project will be needed and spent over a 20-year year period with the assumption that the State and Federal governments will have important complementary roles to play in the overall project.

Table 4-4. Preliminary Capital Cost Estimate ($M) -- Total Project

Authority:	In-Sea barrier, treatment & pumping plants	**$1,415**
Joint IID/Authority:	Colorado River water storage reservoir	**300**
Federal:	EIS, wetlands, base cleanup	**255**
State:	Habitat features & air quality mitigation	**230**
Total for Overall Project Over 20-Year Period		**$2,200**

The $1.42 billion estimate for the project scope that is assumed to be performed by the Authority is shown in greater detail in Table 4.5. Projected O&M costs for the these facilities are shown in Table 4.6. The $1.42 billion capital cost estimate is based on only a 15% markup for non-contract costs. This markup is applicable only if a local agency, like the Authority, serves as the contracting entity and project manager. The non-contract markup factor used by Reclamation for Federal projects is 30%.

Table 4-5. Preliminary Capital Cost Estimates ($M) -- Authority Scope

	Direct Construction Costs[1]	Owners Cost[2]	Total Capital Costs
Basic Design & Permitting[3] incl. environmental compliance, permitting and project management	**--------**	**$55**	**$55**
In-Sea Barrier[4] incl. quarry, mine-car & barge transport system, mobilization, mitigation during construction	**$930**	**$90**	**$1,020**
Treatment & Pumping Plants[5] incl. conveyance channels, pipelines, electrical substation, service roads, etc.	**$300**	**$40**	**$340**
Total for Authority Components	**$1,230**	**$185**	**$1,415**

[1] Contractors' materials, labor, supervision & equipment, incl. progressive markups for mobilization (5%), unlisted items (10%) and contingency (25%)
[2] Non-contract costs incl. design, construction mgmt, insurances, safety, etc.
[3] Only about 3% of total costs because of $40 million in studies already spent.
[4] Appraisal-level estimate based on preliminary field investigations, design studies, and initial discussions with California's Division of Safety of Dams (State permitting agency). More detailed cost information is given in Appendix A.
[5] Preliminary conceptual CTSS treatment plant costs were arrived at by scaling published estimates appearing in a design/study report for a similar treatment plant designed to improve water quality in the Everglades. The filtration/ozone plant cost estimate is based on EPA cost curves. Pumping plant and conveyance facilities based on preliminary conceptual estimates by Tetra Tech. The Authority has received new Federal funding to develop improved estimates for these facilities in the last half of 2006.

The largest line item in this $1.42 billion estimate is $500 million for the rock (about 64 million cu. yds.) needed for building the in-Sea barrier. While the *quantity* of rock needed could vary slightly from this estimate based upon the geometry of final approved design and actual field conditions, the greatest risk factor is the *unit cost* for rock. The $500 million in the estimated $890 million for the contractor cost for the barrier contract assumes sufficient quantity and quality of rock can be sources from one or more rock quarries in the Coolidge Mountain area west of Salton Sea Beach or other available near-by sources.

Table 4-6. Preliminary O&M Cost Estimate ($M/yr) for Authority Facilities[1]

Phosphorus Removal Plant[2] (chemicals, power, etc.)	**$31.1**
Filtration/ozone Plant[2] (power, media, etc.)	**13.4**
Pumping Plant[2] (power & repairs)	**0.8**
Barrier Maintenance[3] (materials & labor)	**5.0**
Vegetation Control[3] (chemicals & labor)	**3.0**
Management, Operations and Security[3] (personnel, vehicles & office)	**8.0**
Total Annual O&M Costs	**$61.30**

[1] Assumes wetlands and habitat areas are maintained by others; excludes IID reservoir; assumes State is responsible for air-quality mitigation costs.
[2] Appraisal-level estimates based initial studies and costs parameters from EPA technical bulletins and other similar projects (e.g., Everglades CTSS study and City of Indianapolis ozone wastewater plants).
[3] Owners' estimates based on local labor rates and expected scope of required work.

Furthermore, it is assumed a mine-car rail line can be installed to move the rock from the quarry to a barge loading pier south of Salton Sea Beach. The rock will then be barged to the appropriate in-Sea location and dropped. If the Coolidge Mountain rock quarry site with its low-cost/low-emission transportation advantage proves to be infeasible for any reason, the rock will have to be sourced from alternate quarry locations 30-to-50 miles away. In this case, the cost of the in-Sea barrier will increase by $500 million to $1 billion. No additional geotechnical field work has been done over the last two years to improve the reliability of the barrier cost estimate. However, a pilot project to do more borings and to investigate the Coolidge Mountain quarry site is just beginning.

The other major cost uncertainty is the two treatment plants. As noted earlier, the capacities and performance parameters (e.g., alum/lime dosage, ozone dosage, clarifier loading rates, filtration regeneration cycle, etc.) for these plants will not be known until the various pilot projects (including the EFDC modeling analysis) that are just now starting are completed in 2007. The results from the projects could easily change the current capital and operating costs estimates for the two treatment plants by -50%/+100%.

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Chapter 5 – PILOT PROJECTS IN PROGRESS

As part of the Authority's current internal work program, the Authority has in progress about $2.6 million of pilot projects all aimed at providing design, cost, or required permitting information on various components in the Authority project design. These projects and an explanation of how they contribute to the advancement of the Authority Plan is presented in the following sections.

5.1 Wetlands Projects and Studies on the New and Alamo Rivers

The construction of a series of water-treatment wetlands are proposed for the New and Alamo River system as part of the Authority's phosphorus source control program and overall water-quality improvement strategy. The New and Alamo Rivers receive water and a wide variety of contaminants from agricultural drains, municipal sources, and industrial sources. The goal of these wetlands is to improve water quality in the rivers as well as in the final discharge to the Sea. The pollutant levels that will be reduced by the wetlands include nutrients, silt, coliforms, pesticides, and other chemicals. Constructed wetlands have been used widely for the treatment of several of these pollutants all over North America. Although wetlands are good at removing the pollutants listed above, they have the potential to bio-magnify selenium present in the source waters and create a risk to wildlife species that will use these wetlands.

The current pilot project being performed by the Authority involves the development of master plans for wetlands along the New and Alamo rivers. Two previous wetland pilot projects were constructed along the New River more than three years ago. An investigation was commissioned to evaluate both rivers and prepare a report that identifies and ranks other possible wetland sites.

The project was divided into two phases. The first phase, which is still in progress, involves the following tasks:

- Initial data collection
- Water quality sampling
- Evaluation of treatment options
- Site evaluation and election
- Evaluate cost effectiveness of treatment options
- Water quality modeling
- Preliminary wetland/treatment designs

Phase IA is complete and a draft report has been prepared (Tetra Tech, 2006b). Phase IB, which includes measurement of tissue concentrations of contaminants (selenium and organochlorine pesticides) and ecological risk assessment of the wetlands is currently under way. When Phase IB is completed later this year, the second phase will begin. The main tasks in Phase II will be additional design work and preparation of an EIR and EIS for the total systems of wetlands. The total project was budgeted at $2,500,000 including the cost of preparing applications and environmental compliance documents.

5.2 In-Sea Geotechnical and Quarry Site Investigations

Initial geotechnical core sampling along the proposed alignment of the mid-Sea barrier and elsewhere in the lakebed was completed in 2003. Data from these investigations were used to perform the design analyses and develop the cost estimate for the mid-Sea barrier in the Authority's July 2004 *Preferred Plan Report*. The purpose of these additional investigations is to obtain more actual field data so a more precise design and cost estimate can be developed. This is a key issue since cost estimates for the in-Sea barriers vary by a factor of 8 times (i.e., the Authority's $1.1 million estimate vs. Reclamation's preliminary $8+ billion estimate). This discrepancy is based on part on the degree of conservatism each entity is applying in its feasibility study due to the lack of actual field data. Along with additional in-Sea core sampling, this pilot project will include investigating the feasibility of establishing a quarry for rock for the in-Sea barrier on Torres Martinez land in the Coolidge Mountain west of Desert Shores. Exploratory drilling will be done at this site to determine whether the quantity and quality of rock potential available is adequate for supplying rock for the in-Sea barriers. This $999,000 project is being funded by Reclamation.

5.3 Water Quality Modeling and Field Pilot Testing of Filtration/ Ozonation Process for Treating Lake Bottom-Water

Reclamation is also funding an $798,000 water-quality improvement pilot project that involves applying the widely-used and EPA-approved EFDC integrated hydrodynamic/water quality model to analyze the Authority's water system as shown in Figure 4-19. This modeling analysis will provide information on how the Authority's water system design can be optimized to best achieve the water quality objectives, as well as determining the level of treatment and timeline needed to achieve the desired water quality conditions for recreational use. This model has been calibrated and used in similar real world situations like the Florida Everglades, Lake Okeechobee, and Chesapeake Bay. A second part of the pilot project will involve the field pilot testing of the proposed sand filtration/ozonation process for oxidization of the bottom-water extracted from the 50-ft-deep basin in the north lake. Besides determining efficacy, this pilot testing will establish ozone dosing rates for this novel application. Field data will also be collected on hydrogen and organic sulfides outgassing rate from the bottom sediments which are key data needed for the modeling analysis.

5.4 Pilot Testing of CTSS Phosphorus Removal Process

Similar to the South Florida Water Management Agency in the Everglades restoration project, the Authority proposes to conduct field pilot testing of the chemical treatment followed by solids separations (CTSS) process for phosphate removal from the Alamo River. Dr. Chris Amrhein from UC Riverside performed lab jar-testing and field-trials project that demonstrated the basic efficacy of using alum or lime as coagulants and polymers as flocculants for removing phosphorus from New and Alamo River water. The purpose of this follow-on field pilot testing project would be to develop data needed for designing and determining a more accurate capital and operating cost estimate for the proposed $100+ million, 380-mgd CTSS plant as envisioned in the Authority's phosphorus source control plan.

5.5 Solar-Powered Circulators for Stagnant Water Areas

The concept for this demonstration project was to use solar-powered water circulators, with the trade name Solar Bee, in backwater areas at the Salton Sea that generate high odors. The $323,000 in State funding for this project was part of a Members' Request grant that the Authority received to evaluate water-treatment processes for odor abatement. The units circulate water to provide increased oxygen levels throughout the water column and to the bottom sediment by bringing oxygen deficient water to the surface where natural oxygenation occurs. The pilot program involved testing of three units located at Varner Harbor and Desert Shores. A report on data gathered as part of the pilot test is currently under preparation. The preliminary analysis suggests that the data were largely inconclusive for the effect of the Solar Bees on most parameters. Water temperature, clarity, and a variety of water quality parameters were tested. Although the preliminary scientific data has been inclusive, the local residents involved with the project believe the devices have been helpful in reducing odors.

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Chapter 6 - MASTER DEVELOPMENT PLAN

The land around the Salton Sea –termed the "Salton Riviera" -- was identified as having tremendous regional recreation and economic development potential by an initial wave of investors and developers in the 1950s and 60s. Flooding caused by rising lake levels and unusual hurricane events in the late 1970s coupled with rising salinity and other water quality problems contributed to the economic decline and near cessation of development around the shoreline in the years that followed the initial boom. In addition to providing permanent habitat values, the Authority's Salton Sea Revitalization and Restoration Plan, as described in this report, is intended to provide a permanent, sustainable solution to the Sea's water quality problems, including the conditions that cause the unpleasant odors. In addition, the project's water system (Figure 4-19) is specifically designed to maintain all shoreline areas at a constant elevation (±1.5 feet as the fluctuations between high- and low-flow years) and to protect shoreline property owners against the possibility of flooding.

If implemented, the Authority Plan will create the physical conditions necessary for rejuvenating the Salton Sea as a regional recreational destination and as a stimulus for economic development and job creation for the bi-national Tri-valley Region (Coachella, Imperial and Mexicali) throughout the 21st century. To plan for this regional growth and to quantify the economics benefits the Authority's project will create, the Authority engaged a professional land-use planning firm to develop a conceptual Master Development Plan (MDP) for the Authority's 300,000-acre planning and financing district around the Sea. Conducting public outreach meetings and meeting privately with large land owners, the consultant developed and has put forth a conceptual MPD that envisions the creation of six separate and distinct seaside villages incorporating smart growth and sustainable development concepts.

Using this approach, the Authority envisions 250,000 new homes with associated entertainment, recreational, retail and business establishments being built in the future on 78,000 acres (less than 25% of the 300,000-acre planning district). Under this plan, over 50% of the land around the Sea would remain as habitat, parks and open space; and 20% would remain as farmland. In developing this plan, the Authority held six public meetings and met privately with the Torres Martinez tribe and other large landowners. This conceptual MDP is shown in Figure 6-1 and the land-use statistics associated with implementation of this MPD are presented in

Figure 6-2. The purpose of the MDP is to strike a balance between environmental protection and economic stimulation that is consistent with the Revitalization Plan and to provide a vision that will help local jurisdictions implement this plan.

A set of broad land use designations has been created with the intent to incorporate many land use designations or programs from the three land use jurisdictions included in the Authority Plan, which consist of Riverside County, Imperial County and the Torres Martinez-Tribe. However, new or more generalized land use designations are proposed. Since the Authority does not have land use authority, the local jurisdictions within the Authority boundary will be asked to update their land use policies to be consistent with the MDP.

Approximately 250,000 new dwelling units have been factored into the MDP planning area. The MDP area is organized into six Planning Districts. The western districts will be more intensely urbanized than the eastern Districts. Each District will include communities adjacent to the Salton Sea, also known as "seaside villages". These villages would incorporate elements of New Urbanism and Smart Growth including mixed-used communities, compact urban centers, pedestrian orientated streets and a sense of place. As local jurisdictions update their land use policies, a series of public workshops would be recommended to incorporate all interested stakeholders in the design of each seaside village.

6.1 Geothermal Expansion

It is widely known that areas of geothermal resource potential are located at the southern end of the Salton Sea in the vicinity of Red Hill Marina and the Vail farming area. The red dotted line in Figure 6.1 shows the locations of potential geothermal resources. The total potential new electrical power generating capacity of this area is estimated to be 1,400 MW. This figure is triple the existing and planned capacity of existing geothermal operations in this area.

The exact location of geothermal power plants in this area has not been determined at this State of the project. It is noted that in the Authority project design the geothermal area overlaps into the saline habitat complex. Once specific plant sites are determined, the saline habitat area will be configured to provide a separation between the plant sites and power lines and the habitat areas. Consideration also will be given to placing power lines underground or otherwise providing for mitigation against potential wildlife impacts.

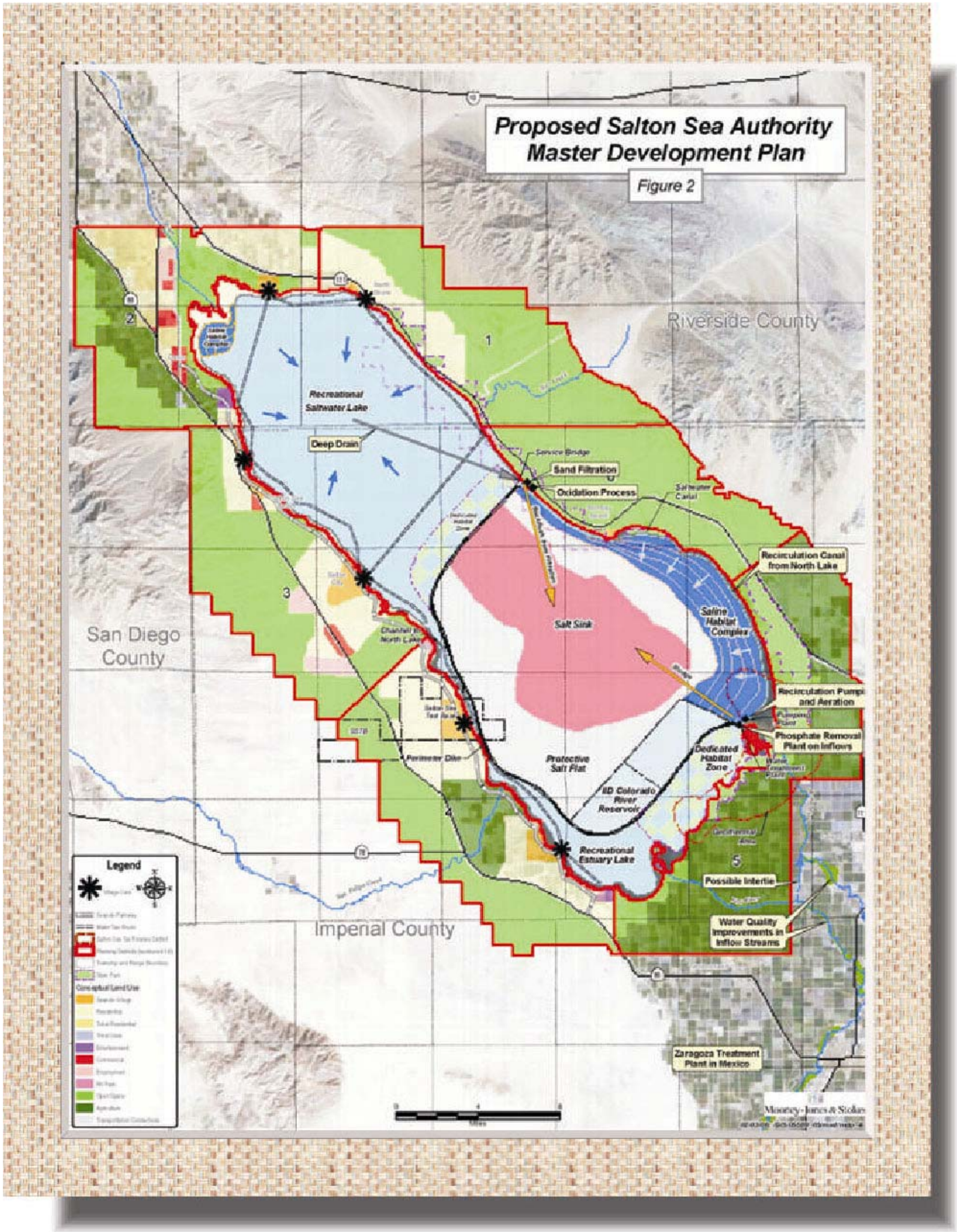
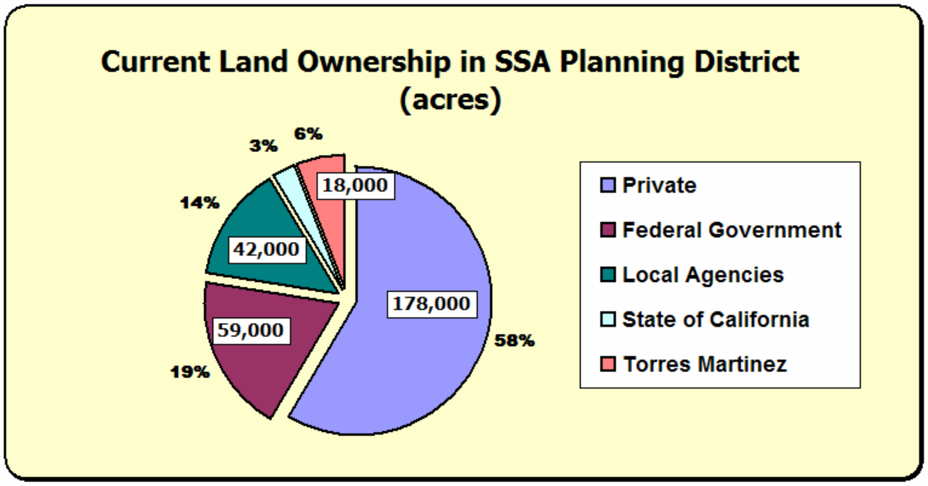
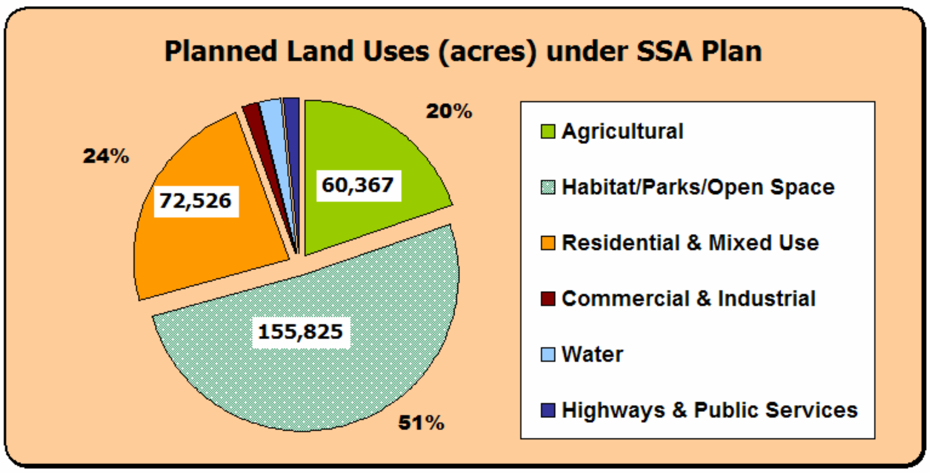


Figure 6-1 Proposed Redevelopment Plan.





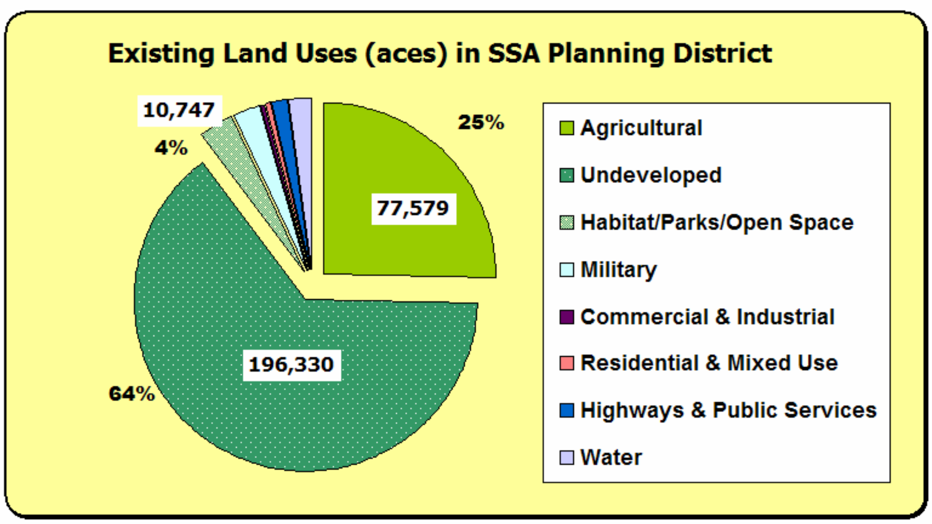


Figure 6-2. Land Ownership and Land-Use Statistics for 300,000 acre Authority Planning District

Chapter 7 – PROJECT FINANCING

As shown earlier in Chapter 4 and repeated below as Table 7.1, the total 20-year projected capital cost for the multi-purpose Salton Sea Revitalization and Restoration Project as envisioned by the Authority is $2.2 billion.

Table 7-1. Preliminary Capital Cost Estimate ($M) -- Total Project

Authority:	In-Sea barrier, treatment & pumping plants	**$1,415***
Joint IID/Authority:	Colorado River water storage reservoir	**300***
Federal:	EIS, wetlands, base cleanup	**255**
State:	Habitat features & air quality mitigation	**230**
Total for Overall Project Over 20-Year Period		**$2,200**

*As Stated in the Authority Policy Positions, a portion of the costs for these components are assumed to be provided by State funds.

Although the overall project cost estimate is $2.2 billion, the funding needed within the next 5 years is one-half this amount; namely the $1.1 billion required for starting and completing the project-level design work, environmental documentation, and permitting work, and then awarding the $930-million, 5-year contract for construction of the 33.5-mile-long Sea barrier built. In the Authority Plan project design, the completion of this structure is the necessary milestone for simultaneously preventing (1) the irreversible loss of the current ecosystem that presumably will happen once salinity level in the Sea exceeds 60 g/L and (2) the 20-ft surface-elevation drop (and thus exposing over 100,000 acres of exposed shoreline areas) within 20 years if nothing is done (Pacific Institute, 2006). While some improvement in the Sea's eutrophic State can be achieved by source control measures prior to completion of the in-Sea barrier, the 5-to-8 year timeline for eliminating the Sea's odor problem will not start until the entire 33.5-mile barrier structure is completed.

In addition to the $1.1 billion initial capital-funding requirement discussed above, funding would be required for the treatment and pumping plants. These facilities could be constructed under a build-own-operate contact with a private firm. Such an arrangement could require a master developer to back up the monthly payment obligation until a benefit assessment district could be established.

The Authority's implementation plan calls for having these two tasks accomplished within the next 5 years. The combination of funding sources that realistically could be put together within this period to secure $1.1 billion in initial project funding is discussed below.

- **Formation of a local tax-increment financing and/or benefit assessment district within the Authority's 300,000-acre planning/financing district around the Sea.** The Authority took the initiative in 2001 to have special State legislation enacted that allows the Authority to form and use a tax-increment financing vehicle known as an "infrastructure financing district" (IFD). This legislation specifically allows the Authority to bond against the tax increment for new development within the boundaries of an IFD around the Sea that the Authority's board can set. The actual formation of the IFD requires a majority vote of voters living within the boundaries. The Authority engaged a financial planning firm to perform an analysis of the bond funding potential that an IFD could create based on a 160,000 home build-out in Authority's MDP as part of the Recreation and Economic Development Study the Authority performed in 2005.[5] In this study, which was an update of a similar study performed for the Authority in December 2003 (RSG, 2003), the financial planner indicated the potential for $626 million in local bond funding from an IFD around the Sea. In discussions with private developers, the possibility of imposing a $10,000 fee on each new home (or equivalent commercial space) has been discussed. On a present value basis, this approach would also support about $600 million in local bond financing and avoid the need to back-fill lost property tax revenues required by an infrastructure financing district.

- **Acquisition, cleanup, rezoning, entitlement and resell to developers the 7,200-acre of contiguous Federal s in Imperial County that comprised the old Salton Sea Test Base.** This is a funding concept that the Authority conceived in March 2005 and has been pursuing with the Salton Sea Congressional Task Force Members and with Imperial County officials. Presently, Imperial County is taking the lead to acquire this property from the Federal government. The expectation is that this undeveloped property (which has been identified as one of the six proposed seaside villages in the MDP), once cleaned up and entitled for residential and commercial, could be resold to private interests at a price that could yield over $500 million in net proceeds. It is envisioned that, pursuant to the Federal legislation that effects the transfer of this property to Imperial County, the majority of the proceeds for the sale of this land to private interests would be earmarked for Salton Sea restoration.

- **Salton Sea Restoration Fund and Future State Bond Issues.** The State legislation that was enacted at the time of the QSA water transfers in October 2003 created a State legislature-control Salton Sea Restoration Fund and several mechanisms for generating funds for this account. As a minimum, these funding mechanisms will create $90 million for the SSRF. The possibility theoretically exists for additional $100 million or so in funding based on the sale of unneeded mitigation water designated for the Salton Sea over the next 12 years; and a $20/AF fee attached to surplus Colorado River water that MWD receives over the next 12 years. However, the possibility of either of these transactions occurring is highly remote at this time. A more likely source of additional funding is the **$47 million**

[5] In the bond-financing study for the Authority's 2005 Recreational & Economic Opportunities Report, the consultant calculated that the $626 million in bond funding could be generated from the build-out of 80,000 homes in the IFD. However, this analysis assumed that all tax-increment above the approximate 50% that goes to schools by law within the IFD would be used to pay off the bonds. A more realistic scenario that only 25% of the tax-increment would be dedicated to bond service with the other 25% remaining available to the counties and other taxing entities. Thus, the $626 million applies to 160,000 homes.

earmarked for the SSRF in a voter-initiative State bond measure that will be on the November 2006 ballot in California.

- **Other Local Fees and Loans**. Given the tremendous economic development potential that the Authority's project will have for the region, other sources of local private-sector funding will be pursued. This could include loans from large property owners and developers who stand to profit from the project, user and access fees, property transfer taxes, etc.

The above $1.0-billion-plus in potential realistic near-term local and State funding sources, plus continued Federal funding by the U.S. Congress to advance work on the wetlands systems on the three tributary rivers and to cover Reclamation's costs for performing a project-level EIS on the Authority's plan, provides a credible basis for assembling a funding plan that enables the contract for construction of the mid-Sea barrier to be awarded within 5 years.

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Chapter 8 – IMPLEMENTATION PLAN

As set out in the Authority Board Policy Positions, the Authority envisions a phased and coordinated implementation approach as a three-way partnership among the Authority and the appropriate State and Federal agencies. This overall approach and the project schedule is shown in Figure 8.1.

This schedule assumes that the current pilot projects that the Authority has underway to develop better design and cost information on the components in its project and to generate data needed for obtaining the requisite permits and approvals will continue through the end of 2007. The Agency is expected to undertake pilot projects related to habitat enhancement and air-quality mitigation measures. Starting in 2007, the Authority expects to have funding available to begin a project-level EIR/EIS as a cooperative effort with Reclamation. It is expected that this work will be completed and the funding package put together for awarding the construction contract for the mid-Sea barrier by early 2011.

As shown in Figure 8.1, this schedule will result in the barrier being completed by the end of 2015 assuming a five-year contract performance period. This period is consistent with the five-year construction period for MWD's $2-billion Diamond Valley Reservoir near Hemet. As shown in Table 8-1, the Diamond Valley project involved moving twice as much rock and fill material as projected for the in-Sea barrier in the Authority project design. This schedule also assumes that key elements of phosphorus source-control program (specifically the Federal ly funded wetlands on the tributary rivers and the contractor-funded treatment plant on the Alamo River) proceed during the barrier-construction period (2011-2015). If these actions are concurrently taken, then within 5 to 8 years after the barrier is completed (2020-22), the Sea should be transformed into a less eutrophic water body with noticeably fewer odor events. The water quality objectives needed to make the Sea swimmable and fishable and safe for habitat should also be achieved within the 2020-25 time frame, although this assumption needs to be validated by the modeling analysis.

Construction of the habitat enhancement features (e.g., the saline habitat complex in the south basin and the reconfiguration of the wildlife refuge) generally have to wait until the barrier is completed and the water level in the south basin begins to recede, although the Authority understands that the Agency is planning some "early start" and interim mitigation actions to protect wildlife until the permanent facilities are in place. Air quality mitigation actions are not foreseen until several years after the barrier is completed and water levels in the south basin recede. Construction on the IID Colorado River water reservoir will start after the barrier is completed and funding is available. Management actions to maintain inflows above 800,000 AFY will commence as needed after the QSA water transfer take full effect after 2030.

If the project schedule can be achieved, it will be possible to eliminate the need for the last two years of mitigation water which would add $70 million to the SSRF.

Calendar Year	Cost	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Project Year from Start >>	$M	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Mitigation Water per QSA (year #)		4	5	6	7	8	9	10	11	12	13	14	15									
Quantity by Year (acre feet)		20,000	25,000	25,000	30,000	35,000	40,000	45,000	70,000	90,000	110,000	130,000	150,000									
Value if Sold ($ millions)*		$5.0	$6.3	$6.3	$7.5	$8.8	$10.0	$11.3	$17.5	$22.5	$27.5	$32.5	$37.5									
SSA Components											Barrier Closure											
Envir. Compliance & Permitting	$ 5			$5	$5																	
Design & Approvals Barriers/Quarry	$ 50	*BoR pilot project*			$20	$20	$10															
Construction of In-Sea Barrier	$ 1,020						$1,020						*5 to 8 years* →				Attainment of Water Quality Objectives					
Alamo River Treatment Plant	$ 125	*DWR pilot project (?)*				$125																
North Lake Drain and Spillway	$ 30								$30													
Lake Bottom-Water Treatment Plant	$ 125	*BoR pilot project*							$125													
Recirculation Canal & Pump Plant	$ 60												$60									
Water Supply Reliability Actions	TBD													*---- local management actions to maintain inflows >800,000 AFY ---->*								
SSA Components by Year	**$ 1,415**	$ 2	$ 2	$ 5	$25	$145	$1,030	$ -	$ 155				$ 60									
Joint IID/SSA Component																						
IID Reservoir & Conveyance[+]	**$ 300**											$300										
Federal Components																						
Environmental Compliance	$ 5			$3	$3																	
New & Alamo River Wetlands	$ 200	*WCB/BoR studies/pilots*			$20	$20	$20	$20	$20	$20	$20	$20	$20	$20								
Cleanup of Salton Sea Test Base[+]	$ 50				$25	$25																
Federal Components by Year	**$ 255**	$ 2	$ 2	$ 3	$ 48	$ 45	$ 20	$ 20	$ 20	$ 20	$ 20	$ 20	$ 20	$ 20								
State Components		*BoR/USGS habitat field study ---------------------->*																				
Design of Habitat Features	$ 5			$3	$3																	
North Saline Habitat Complex[+]	$ 25				$25																	
Wildlife Easements on Farmland[+]	$ 50						$10	$10	$10	$10	$10											
South Saline Habitat Complex[+]	$ 100														$100							
Air-Quality Mitigation Actions[+]	$ 50		*DWR pilot projects -->*											$6	$6	$6	$5	$6	$6	$6	$6	
State Components by Year	**$ 230**	$ -	$2	$3	$25									$6	$106	$6	$5	$6	$6	$6	$6	$0
Total Project ($M)	**$ 2,200**	$ 4	$ 6	$ 10	$ 98	$190	$1,050	$ 20	$ 175	$ 20	$ 20	$ 320	$ 80	$ 26	$ 106	$ 6	$ 5	$ 6	$ 6	$ 6	$ 6	$ -

[+] In addition to $90 million in Salton Sea restoration funding paid by QSA parties (incl. the sale of 800,000 AF of water from IID to MWD), unneeded QSA mitigation water may be sold for $250 per AF to fund restoration.

+These figures are allowances since no design studies or site investigations have been performed on these components. The cost figures for other components are appraisal-level estimates.

Figure 8-1. Capital Funding Requirements and Timeline for Phased Implementation of Authority Plan ($million)

In Table 8-1, the Authority project schedule and cost estimate are compared with two other similar projects: construction of the rock-fill causeway across the Great Salt Lake in Utah in the 1950s and MWD's $2.0 billion Diamond Valley Reservoir that was built near Hemet in the 1990s. The table shows many of the same permitting, engineering, and construction challenges likely to be encountered in Authority's project have been successfully addressed in these previous similar projects.

Table 8-1. Case Study Comparison of Similar Projects

	Great Salt Lake Dike	**Diamond Valley Reservoir**	**Salton Sea Revitalization Project**
Status	Complete & In-service	Complete & In-service	*Planning & Pre-Design*
Owner & Funder	Southern Pacific Railroad	Metropolitan Water District	Salton Sea Authority
Project Period:	1951 -1959 (actual = **8 years**)	Oct 1991 - Mar 2000 (actual = **8 ½ years**)	2007-2015 (major components <**10 yrs**)
Major Project Features	Excavation of 35-ft of lake bottom and construction of 12-mile long rock-and-gravel railroad causeway in 25 feet of water	Three (3) dams totaling 4.2 miles; in/out tower; pumping/generator plant; relocation of San Diego Canal; creation of 20,000 acres of mitigation habitat	8-mile mid-Sea dam and 26 miles of dikes in southend; 400 MGD nutrient-removal & 500 MGD filtration plants; creation of 12,000 acres of mitigation habitat
Pre-Construction Period & Tasks		Actual: 4 years: final design, land acquisition & litigation, dam-safety approval (DSOD), EIR, agency permits, special state legislation on schools	Est: 4 years: final design, dam safety approval (DSOD); EIR/EIS; special federal & state legislation, agency permits, General Plan Amendment(s); voter approved finance districts
Construction Period	6 years + 1 ½ year settlement period	Actual <5 years (includes 4 months for demobilization)	Est: 5 years (assumes 2 near-by rock quarries)
Dredging/Over Excavation	**15 million cu. yds.**	**40 million cu. yds.**	**±20 million cu. yds.**
Rock & Gravel Fill Material	**34 million cu. yds.**	**110 million cu. yds**.	**64 million cu. yds.**
Site Preparation & Mobilization	Built construction city for 300 workers and barge harbor	Relocate road; demolish existing structures	rock quarries, mine-car rail line to Sea; barge loading pier(s)
Major Construction Equipment	Tugboats, dredges and 11 special bottom-dump barges; **2-mile-long conveyor**	On-site rock quarry & crushing plant; super-large earthmover trucks	Tugboats, dredges, special bottom dump barges, special electric mine-car train
Special Problems	remote location; subsidence; wet construction	Seismic issues; endangered species; potential flooding of schools; blasting & dust control (SCAMD)	Seismic issues; endangered species; blasting & dust control; wet construction
Cost Elements	Special Equipment: **$15 million** Rock & Earth Work: **$49 million** Management & Other: *Unknown* **Total: ±$100 million**	Design, Land Acquisition, Legal Settlement & Permitting: **$200 million** Rock & Earth Work:: **$1.3 billion** Hydraulic Features: **$400 million** Management & Other: **$100 million** **TOTAL: $2.0 Billion**	Design & Permitting **$125 million** Rock & Earth Work: **$890 million** Treatment Plants & Hydraulic Features: $**300 million** Management & Other **$100 million** **TOTAL: ±$1.4 Billion**

ACKNOWLEGEMENTS

This Authority Plan for the Revitalization and Restoration of the Salton Sea has been developed over the last three years based on previous work performed by the Authority as a cooperative community effort involving the Authority's Board Members, Committee Members, and staff and the Authority's team of engineering firms, consultants, technical experts, and advisors. The contributions of theses individuals and entities in the preparation of this report and in conducting the underlying studies, meetings and public outreach efforts over the last three years are greatly appreciated.

Salton Sea Authority Board Members

- **Coachella Valley Water District**
  - Director Peter Nelson
  - Director Patricia (Corky) Larson
  - Director Russell Kitahara
- **Imperial County**
  - Supervisor Gary Wyatt
  - Supervisor Larry Grogan
  - Supervisor Wally Leimgruber
- **Imperial Irrigation District**
  - Director Andy Horne
  - Director Stella Mendoza
- **Riverside County**
  - Supervisor Roy Wilson
  - Supervisor Marion Ashley
- **Torres Martinez Desert Cahuillla Indians**
  - Councilmember Al Loya
  - Tribal Officer Joe Loya
  - Chairman Ray Torres

Salton Sea Authority Committee Chairs

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  - Dan Parks, CVWD
  - Robert Ham, Imperial County
  - Michael O'Connor, Riverside County
- **Planning and Public Policy**
  - Cheryl Walker, Councilmember and Mayor, City of El Centro
- **Project Finance**
  - Michael Wilson, Councilmember, City of Indio

Engineering Firms, Consultants, Technical Experts and Advisors

- **Tetra Tech, Inc.**

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- Sujoy Roy, Ph.D. (Carnegie Mellon)
- John Hamrick, Ph.D. (UC, Berkeley)
- Robert Johns, Ph.D. (Stanford)
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❑ **Mooney • Jones Stokes**
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- Brain Mooney, AICP
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❑ **Solar Bee/Pump Systems, Inc.**
Water-treatment and salt-water equipment design/operations expertise
- Joel Bleth, President
- Sandy Walker, California Region Manager

❑ **Agarian Research**
Air-quality and salt-management expertise with related experience (Owens Valley)
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❑ **John Pyles**
Salt industry expert with related experience (Cargill salt ponds in San Francisco Bay)

❑ **Kenneth Dieker**, Del Rio Advisors, LLC, MBA (UC, Berkeley)
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❑ *Community Relations Consultants & Advisors*
- **Michael Shephard,** The Shepherd Group
- **Bill Gay**, Reliance Communications
- **Brian Nestande**, Nestande & Associates
- **Scott Kiner**, Kiner Communications
- **Kay Hazen**, Hazen & Associates

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Appendix A: IN-SEA BARRIER DESIGN & COST INFORMATION

Engineering and Geotechnical Features of Embankments

The embankments constructed in the Sea would be built out of rockfill to significantly reduce or eliminate the potential of seismically induced liquefaction of the embankment materials. The rockfill would be quarry run material with a maximum particle size of 1 to 3 feet. This is similar to materials used to retain shorelines of harbors in highly seismic areas, and other rockfill dams. Larger rock, with maximum sizes of 4 to 5 feet, would armor the slopes of the embankments exposed to wave action. The hydraulic barrier of the embankments in the shallower water (less than about 10 feet of water) would consist of corrosion resistant vinyl sheet piles. A bentonite slurry wall would be used as the hydraulic barrier for the embankments in the deeper water. The low embankments constructed for the saline habitat complex would be constructed in the dry, using soil and conventional earthwork techniques.

Design Features

It is estimated that about 65 to 70 million cubic yards of rockfill would be required to construct the in-Sea embankments; with 2 million cubic yards of rip rap. This rock would be obtained from a quarry developed for the project near the Sea. The saline habitat complex berms would be borrowed from areas within the complex.

A typical cross section for the in-Sea embankments is shown in Figure A-1. The total lengths of embankment (of varying heights) would be approximately 34 miles. The crest width would be between 15 and 30 feet wide. The upstream and downstream slopes of the embankments would have inclinations of 3:1 and 4:1, respectively (horizontal:vertical).

The soft lacustrine deposits and potentially liquefiable alluvial deposits would be excavated from below the slopes of the embankment to attain the required slope stability. In areas where potentially liquefiable soils do not exist, some soft lacustrine deposits may be left below the crest of the embankment. The depth of the materials to be removed is anticipated to be about 10 feet in areas where the water depth is 10 feet, and about 25 feet in areas where the water depth is 45 feet. This method of stabilization is not expected to require long-term maintenance.

It is anticipated that the embankments would fall under the jurisdiction of the California Division of Safety of Dams (DSOD). Accordingly, the embankments would be designed to resist the deterministic ground motions induced by the Maximum Credible Earthquake on the Coachella Segment of the San Andreas Fault.

The embankments would be designed in accordance with standard geotechnical practice. The slopes would be designed for a static factor of safety of at least 1.5. Filter zones would be incorporated into the embankment design to prevent internal erosion of finer grained materials via seepage waters into the rockfill. The embankment would be constructed of nonliquefiable materials and the potentially liquefiable materials in the foundation would be removed. The design criteria for seismically induced deformations would be developed based on dynamic response analyses. It is anticipated that the lateral deformations would be limited to 3 to 5 feet. Seismically induced vertical deformations can be accommodated by a temporary loss of freeboard. The removal of the soft lacustrine deposits would mitigate settlement of the embankment, however, the estimated post-construction settlement would be accommodated with the embankment freeboard.

The performance criteria for the embankments following a seismic event would be that the available freeboard is sufficient to mitigate earthquake induced deformations, and that the deformations do not impair the safety of the embankment. The embankments would be designed to resist the deterministic ground motions induced by a rupture on the Coachella Segment of the San Andreas Fault. It is anticipated that the 84th percentile of the peak ground acceleration would be on the order of 0.45 g along the westerly shore of the Sea and 0.90 g along the easterly shore of the Sea. A number of rockfill dams in the western United States and central and eastern

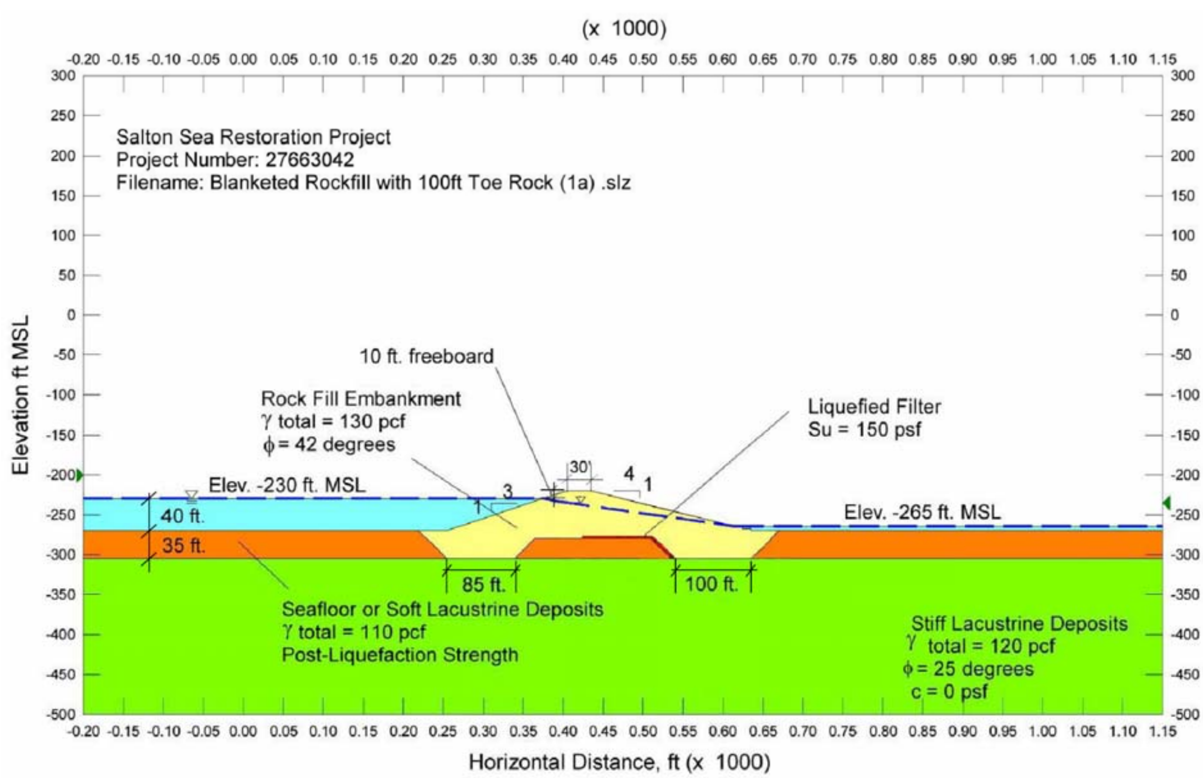

Figure A-1. In-Sea Embankment (Dike) Design.

Asia are in similar high seismic areas and have performed well in earthquakes that have occurred. Wieland , in recent studies of the seismic aspects of dam design worldwide concluded that rockfill dams have performed well.

The infrastructure required for the Plan involves large earthworks. Extensive geotechnical investigations would need to be undertaken during design of the facilities. This would include investigations to further characterize the foundation conditions at the locations of proposed embankments, canals, and appurtenant facilities, and to characterize the quality and quantity of rockfill available at potential quarry sites. Test embankments and test quarries would be constructed to evaluate construction techniques and provide prototype engineering evaluations. It is currently planned to commence an additional in-Sea geotechnical investigation in 2006 to further characterize embankment foundation conditions.

Construction Methods

Marine construction techniques would be used to construct the in-Sea embankments. Barge-mounted clamshell dredges would be used to excavate the unsuitable soils below the embankments. The dredge spoils would be loaded into bottom-dump barges and towed to the disposal area. Barge-mounted cranes would be used to drive the vinyl sheet piles for the lower height embankments. Rock would be delivered to the embankments from the shoreline using bottom-dump and flat-topped barges. Once the embankment is above Sea level, the remainder of the embankment would be placed using off highway dump trucks. Slurry walls would be constructed from the crest of the embankment once filling is complete.

The in-Sea embankments pose significant constructability challenges. These include the scale of the facilities, construction below Sea levels, construction in shallow waters, construction in a highly corrosive environment, weak foundation soils, disposal of dredge spoils, stability of foundation excavations and embankments, construction in a remote and harsh environment, and availability of marine construction equipment.

A potential source of the rockfill that would be required for the embankments is Coolidge Mountain, located adjacent to the northwesterly shoreline of the Sea. A quarry would be established and either off highway trucks or a conveyor system would deliver the rockfill materials to the shoreline. A quaywall would be constructed to load the rockfill in to bottom dump and flat-topped barges. The barges would be towed to the embankment location where the rockfill would be placed. Once the embankment breached the Sea surface, the rockfill would be placed by either derrick barges or off road trucks.

The Coolidge Mountain quarry site is not currently permitted. The Salton Sea Authority is currently planning an investigation that would include a review of permitting issues. Since the site is on tribal land certain permit issues associated with other sites may not apply.

The anticipated construction rate for excavation and disposal of the soft and potentially liquefiable soils from beneath the embankments would be about 20,000 cubic yards per day. Rockfill for the embankments would be placed at a rate of about 25,000 cubic yards per day.

The soft lacustrine deposits and potentially liquefiable alluvial deposits would be excavated from below the slopes of the embankment to attain the required slope stability. These materials would be disposed of in areas planned to become hypersaline. The materials could also be stockpiled for use in constructing the saline habitat complex and habitat islands.

Cost Calculation for In-Sea Barriers

The major cost element for construction of in-Sea barrier structures would be the excavation, transportation of fill material, primarily rock fill. Unit prices for fill material were estimated by evaluating the material, equipment and labor costs, or precedence with recent bids on similar projects. The unit price considered the costs for material development and processing, transport, and placement. These unit prices were applied to the estimated quantities to obtain an estimated construction cost for each of the concepts.

An evaluation was also performed as to whether transporting stockpiles of rockfill material available at Eagle Mountain and Mesquite mines would be more economical than developing a new quarry on Torres-Martinez property for rockfill. This evaluation indicated that developing a new quarry within 15 miles of the mid-Sea location would be more cost-effective than transporting rockfill from the mine stockpiles, which are located approximately 40 to 50 miles from the mid-Sea location. It has been assumed that suitable rock would be available from the knob of mountainous land that Torres-Martinez owns and projects very near Desert Shores. The quality and availability of this material will need to be confirmed in further studies. It was assumed that the rockfill would be trucked for three miles to the Sea, and then barged 12 miles to the mid-Sea location. A unit price of $7.02 per cubic yard was developed for the rockfill. This compares favorably with the $3 to $4 per cubic yard cost for rockfill that was developed (1997 was the middle year of construction) within a couple of miles of the dams constructed for the Diamond Valley Reservoir project in Hemet, California.

In-Sea barriers would be constructed in depths of water that would vary by location. Material volumes and associated costs were calculated in individual worksheets using water depths ranging from 5 to 45 feet in five foot increments. Using this method, estimates of cost per mile of barrier were prepared for each incremental water depth. Table A-1 shows a typical calculation worksheet for material volume and cost per mile of a barrier in 40 feet of water. A summary of material volume and cost per mile of a barrier from individual worksheets is provided in Table A-2. Table A-3 shows the length and depth requirements for the Authority's Plan and the associated volumes taken from the Table A-4. Finally, the total estimate for contracted cost for barrier construction is provided in Table A-5. The cost calculation assumes that full over-excavation of lacustrine materials would be needed on the east side of the barrier nearer the major faults and partial excavation would be needed on the west side and in the shallower barriers in the eastern and southern areas.

Table A-1. Example Cost Worksheet for Water Depth of 40 Feet

Seafloor Elevation (ft MSL)	Length (lineal feet)	Upstream Configuration			Downstream Configuration			Quantities per Lineal Foot of Barrier					
		Slope Inclination (h:v)	Depth of Overex [a,f] (feet)	Average Width of Overex [a] (feet)	Slope Inclination (h:v)	Depth of Overex [a,f] (feet)	Average Width of Overex [a] (feet)	Upper Overex [d] (cy/lf)	Upstream Toe Overex (cy/lf)	Downstream Toe Overex (cy/lf)	Upstream Shell (cy/lf)	Core below Crest [g] (cy/lf)	Downstream Shell (cy/lf)
-270	5,280	3	25	165	4	25	215	167	153	199	139	56	185

	Quantities per Lineal Foot of Barrier			
	Total Overex (cy/lf)	Rock Fill (cy/lf)	Riprap (cy/lf)	Slurry Wall [g] (sq ft/lf)
	519	898	9	60
Total Quantities	2,737,778	4,742,222	46,380	316,800
Unit Costs	$2.90	$7.02	$8.00	$12.00
Total Costs	$7,939,556	$33,290,400	$371,041	$3,801,600

TOTAL CONSTRUCTION COSTS		$45,402,596
MOBILIZATION (5% of construction)		$2,270,130
UNLISTED ITEMS	10%	$4,540,260
CONTRACT COST		$52,212,986
CONTINGENCIES	25%	$13,053,246
FIELD COST		$65,266,232
TOTAL CONTRACT COST PER MILE		**$65,266,232**

Notes:

a. Below overexcavation beneath entire dam.
b. Assumes -230 feet MSL as Sea level.
c. Assumes 10 feet of freeboard.
d. Assumes 10 feet of overexcavation below entire dam, or completely to top of Stiff Lacustrine, whichever is more.
e. Assumes 30 foot wide crest.
f. Assumes -305 feet MSL as top of Stiff Lacustrine Deposit
g. Includes 6% compression of soft soils remaining.
h. Includes 10 feet embedment of slurry wall below dam.

Table A-2. Summary of Unit Quantities and Costs from Individual Worksheets

Water Depth (feet)	Dam Cost ($M/Mile)			Rock Quantities (Mcy/Mile)			Qty of Filter Rock (Mcy/Mile, 5 ft thick below dwnstrm)
	With Toe Overex	With Complete Overex	Average	With Toe Overex	With Complete Overex	Average	
5	NA	$9.57	$9.57	NA	0.55	0.55	0.073
10	$16.86	$17.81	$17.33	1.07	1.13	1.10	0.093
15	$21.46	$25.20	$23.33	1.42	1.67	1.55	0.112
20	$26.99	$33.92	$30.46	1.84	2.32	2.08	0.132
25	$30.60	$39.84	$35.22	2.13	2.77	2.45	0.152
30	$37.55	$50.72	$44.13	2.68	3.59	3.13	0.171
35	$46.47	$57.82	$52.14	3.37	4.15	3.76	0.191
40	$52.25	$65.27	$58.76	3.85	4.74	4.29	0.210
45	$57.71	$73.06	$65.38	4.31	5.37	4.84	0.230

Water Depth >>>	5	10	15	20	25	30	35	40	45	Total	Cum
Central Barrier Volume (Mcy/mi)	**0.55**	**1.10**	**1.55**	**2.08**	**2.45**	**3.13**	**3.76**	**4.29**	**4.84**		
South & West Volume (Mcy/mi)	**0.55**	**1.07**	**1.42**	**1.84**	**2.13**	**2.68**	**3.37**	**3.85**	**4.31**		
Central, Lengths (mi) >>		0.2	0.3	0.4	0.5	0.7	1.1	2.6	1.9	7.6	7.6
Rockfill, MCY	0.0	0.2	0.5	0.7	1.2	2.0	4.0	10.6	8.6	27.7	27.7
Filter Material, MCY	0.0	0.0	0.0	0.0	0.1	0.1	0.2	0.5	0.4	1.5	1.5
West, Lengths (mi) >>		8.9								8.9	16.5
Rockfill, MCY	0.0	8.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.7	36.4
Filter Material, MCY	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	2.3
South, Lengths (mi) >>	0.7	3.0	7.2	5.3	0.8					17.0	33.5
Rockfill, MCY	0.3	3.0	9.4	9.0	1.5	0.0	0.0	0.0	0.0	23.2	59.6
Filter Material, MCY	0.1	0.3	0.8	0.7	0.1	0.0	0.0	0.0	0.0	2.0	4.3

Note: Vinyl sheetpile core and 15" crest width for dikes up to 10' depth; slurry wall and 30' crest width for deeper dikes.

Table A-3. Lengths, Depths and Material Requirements for In-Sea Barriers

Table A-4. Contract Cost Estimate for In-Sea Barriers

Water Depth >>>	5	10	15	20	25	30	35	40	45	Total	Cum
Central Dam Cost ($M/mi)	**$9.57**	**$17.33**	**$23.33**	**$30.46**	**$35.22**	**$44.13**	**$52.14**	**$58.76**	**$65.38**		
South & West Barrier Cost ($M/mi)	**$9.57**	**$16.86**	**$21.46**	**$26.99**	**$30.60**	**$37.55**	**$46.47**	**$52.25**	**$57.71**		
Central, Lengths (mi) >>		0.2	0.3	0.4	0.5	0.7	1.1	2.6	1.9	7.6	7.6
Cost	$0	$3	$8	$11	$18	$30	$58	$153	$122	$402	$402
West, Lengths (mi) >>		8.9								8.9	16.5
Cost	$0	$150	$0	$0	$0	$0	$0	$0	$0	$150	$551
South, Lengths (mi) >>	0.7	3.0	7.2	5.3	0.8					17.0	33.5
Cost	$7	$51	$155	$142	$24	$0	$0	$0	$0	$379	$930
Bombay, Lengths (mi) >>		0.0								0.0	33.5
Cost	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$930

Cost Summary ($M)	
Central Barrier	**$402**
Southern Area Barriers	**$528**
Total Contracted Cost	**$930**

Appendix B: SUPPORTING TECHNICAL INFORMATION

1. Authority and IID Letters on Inflow Projections to Secretary Chrisman (January 13, 2005)
2. Backup Spreadsheet on Computation of Regional Water Supply and Demand Balance
3. Expert Opinion Letter on Eutrophication Issues (Dr. Walker)
4. Expert Opinion Letter on Salt Deposits as Air Quality Mitigation Measure (John Pyles)

Salton Sea Authority

January 13, 2005

Mike Chrisman
Secretary for Resources
Resources Agency
1416 Ninth Street, Suite 1311
Sacramento, CA 95814

Subject: Salton Sea Inflow Projections for Evaluating Project Alternatives in the Programmatic Environmental Impact Report (PEIR) for Selection of a Preferred Salton Sea Restoration Alternative

Dear Secretary Chrisman:

The Salton Sea Authority (SSA), a five-member joint powers public agency that represents local interests regarding Salton Sea restoration matters, questions the validity of certain assumptions about future inflow volumes to the Salton Sea that the Department of Water Resources (DWR) may use as a basis for evaluating Salton Sea Restoration Project alternatives in the PEIR that DWR is performing under state legislative mandate. This is a critical issue for the SSA and its member agencies since the SSA's locally endorsed Preferred Alternative -- the so-called "North Lake" plan which has been developed after years of meticulous studies and public involvement – may be eliminated from consideration (or unfavorably evaluated) if DWR's inaccurate inflow assumptions are used in the $20 million PEIR DWR is performing.

In the materials presented by DWR's consultant at the November 30th Salton Sea Advisory Committee meeting in Palm Springs, the expected average annual inflows to the Salton Sea over the 75-year project evaluation period are projected to be 962,000 acre-feet/year (page 5).* However, it appears that DWR may also be proposing to evaluate Restoration Project feasibility by examining whether the Project can function at inflows levels of "less than 500,000 acre-feet/year" (page 8). While we believe the 962,000 acre-feet/year inflow figure as a long-term average is reasonably accurate and is supported by facts and laws and "reasonably foreseeable" events, a "less than 500,000 acre-feet/year" functionality requirement -- allegedly required for "flexibility/sustainability" -- is not supported by facts and laws or "reasonably foreseeable" events as required by California Environmental Quality Act (CEQA) guidelines. As noted by the Imperial Irrigation District ("IID") in its letter to you on the same subject (attached hereto for your convenience), it appears that DWR's analysis on future inflow volumes is incorrect, and that CEQA concepts of Baseline, Project feasibility, selection of Project alternatives, Project impacts,

* 9-page handout prepared by CH2MHill titled "Cumulative Impacts – Range of Inflows to the Salton Sea," dated November 30, 2004 (the "handout"). This document is included herewith as Attachment 1.

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and Cumulative impacts are being confused and intermixed. The SSA agrees with IID's letter on these points.

In fact, a projection that Salton Sea inflows may decline to less than 500,000 acre-feet/year within the next 75 years directly contradicts or is inconsistent with: 1) the Environmental Impact Report/Statement (EIR/S) used to validate the Quantification Settlement Agreement (QSA); 2) existing Colorado River law and California's declared policy on Colorado River water allocations during drought periods; and 3) opposition by the general public and the elected boards of the Imperial Irrigation District and the Imperial County Board of Supervisors to future water transfers out of Imperial County. These contradictions and inconsistencies are explained below.

- Salton Sea Inflow Projections Used in IID-Certified EIR/S for the State Water Resources Control Board (SWRCB) Water Rights Order (WRO # 2002-0013) and the QSA

  DWR is using the same engineering firm (CH2M Hill) and the same analytical tool (U.S. Bureau of Reclamation's Salton Sea Accounting Model [SSAM]) for performing its PEIR on Salton Sea restoration alternatives as were used to formulate the post-QSA Salton Sea inflow projections for the EIR/S used for the WRO and QSA. It is not surprising, therefore, that SSAM data charts essentially identical to those shown used in the handout (pages 5 and 6) also appear in the EIR/S for the WRO and QSA. The SSAM data charts cover the same 75-year project evaluation period (2000-2075) in both cases; and both analyses show the projected mean post-QSA inflows to the Salton Sea to be approximately 962,000 acre-feet/year with a ± 1.0 standard deviation sensitivity range of approximately ±100,000 acre-feet/year.

  However, the chart that appears on the bottom of page 8 in the handout -- which modifies the page 5 chart by adding an additional sensitivity range of +100,000 to -400,000 acre-feet/year of inflows to allegedly accommodate extreme climatic conditions -- does not appear anywhere in the EIR/S for the WRO and the QSA.[†] Moreover, the statement made on the page 8 chart that "In 2078, flows [into the Salton Sea] may range from 1,110,000 to less than 500,000 acre-feet" does not appear anywhere in the EIR/S for the WRO and the QSA.

[†] Since the SSAM is a stochastic model (i.e., uses random numbers and probabilities to generate a wide range of inflow scenarios to account for uncontrollable events like variations in climatic conditions), the ±1.0 standard deviation band shown on the page 5 chart of the handout already statistically accounts for variations in climatic conditions, including extreme conditions. Thus, the addition of second range to account for extreme conditions – as proposed by DWR -- is statistically invalid and thus purely arbitrary.

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- Colorado River Law and California State Policy on Sharing Drought-Induced Cutbacks on Water Deliveries Among Other States in the 7-State Compact

  The flaw in the chart on page 8 of the handout, and the reason why it is not "reasonably foreseeable" that inflows to the Salton Sea may drop to less than 500,000 acre-feet/year within the next 75 years *due solely to climatic conditions* (i.e., multiple consecutive drought years on the Lower Colorado River as indicated on page 7 of the handout) is because of Colorado River law. After implementation of the QSA water transfers, about 850,000 acre-feet/year of the 962,000 acre-feet/year of stochastically projected mean inflows to the Salton Sea will be drainage water arising from agricultural lands in the IID service area. The reliability of these flows – even during periods of multiple drought years as has occurred from 1999 to present on the Colorado River – is rooted in the extremely high priority among all Colorado River water users in the 7-state basin accorded IID's 3.1 million acre-feet/year of Colorado River water rights under both federal and state law. IID's letter to you challenges the fundamental premise that climactic conditions on the Colorado River could reduce inflows as described by your consultant. The SSA agrees with IID.

  In order for the Salton Sea to experience a 462,000 acre-foot/year reduction in inflows over the stochastically projected mean value as presumed by DWR in its handout, IID would have to experience a nearly 1.5 million acre-foot/year curtailment of its Colorado River water deliveries over a multiple-year period. Under present law, total Lower Colorado River flows would have to drop below 3.0 million acre-feet/year on a prolonged basis (i.e., less than 25% of the long-term average annual river flow rate) for such 50% curtailment of IID's Colorado River water deliveries to occur. Since Colorado River flows have never dropped below 3.0 million acre-feet in even one year of the 108 years of historical data, the possibility of IID having its Colorado River water deliveries curtailed to less than 50% for a multiple year period – as would have to occur for Salton Sea inflows to drop below 500,000 acre-feet/year -- is clearly not a "reasonably foreseeable" event that should be included in the PEIR.

- IID Board of Directors' and Imperial County Board of Supervisors' Opposition to Future Water Transfers Out of Imperial County

  The SSA is not aware of any presently serving elected official in Imperial County who supports additional voluntary water transfers out of the county. Indeed, IID's letter identifies its current policy of no additional transfers and the statutory protection against future transfers.

  Neither variations in climatic conditions on the Colorado River (the stated reason) nor future voluntary water transfers out of Imperial County (a possible implied reason) represent valid factual bases for imposing a "less than 500,000 acre-feet/year inflow" functionality analysis on Salton Sea restoration alternatives. Hence, we believe once again that neither is

Secretary Chrisman
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"reasonable foreseeable" within CEQA guidelines and therefore should be not included in the PEIR. ‡

In sum, we find no factual basis for inclusion of the "less than 500,000 acre-feet/year inflows" functionality requirement on Salton Sea restoration project alternatives. If DWR uses dramatically lower inflows projections in its PEIR for the Salton Sea restoration project alternatives than were used by IID in its EIR/S, the PEIR for the Salton Sea restoration will be vulnerable to challenge, and require costly and timely supplements. We do not believe proceeding down this path is in the best interest of the State or those of us committed to achieving the restoration of the Salton Sea before it becomes an ecological disaster and public nuisance.

Given our concerns on this matter, we request that the issue of inflow projections used in the PEIR for screening and evaluating alternatives be readdressed at a future Salton Sea Advisory Committee meeting.

Sincerely,

Ronald J. Enzweiler
Executive Director

Attachments: "Cumulative Impacts – Range of Inflows to the Salton Sea" (handout at November 30, 2005 Salton Sea Advisory Committee meeting)

Letter from Imperial Irrigation District General Manager, Jesse P. Silva, dated January 13, 2005

cc: Senator Dianne Feinstein
Senator Barbara Boxer
Salton Sea Congressional Task Force
Congressman Bob Filner
State Senator Jim Battin
State Senator Denise Ducheny

‡ To affirmatively secure a quantity of water available for use in a permanent Salton Sea restoration project, SSA is in discussions with IID about how to stabilize and make reliable certain volumes of drain flow beneficial to the Restoration Project. This is a matter that the SSA plans to pursue in 2005 in cooperation with its member agencies.

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State Assemblywoman Bonnie Garcia
State Assemblyman John Benoit
Salton Sea Authority Board of Directors
Salton Sea Technical Advisory Committee
Salton Sea Advisory Committee

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IMPERIAL IRRIGATION DISTRICT

GENERAL MANAGER'S OFFICE • P.O. BOX 937 • IMPERIAL, CA 92251

January 13, 2005

Via Facsimile & U.S. Mail

Mike Chrisman
Secretary for Resources
Resources Agency
1416 Ninth Street, Suite 1311
Sacramento, California 95814

Re: Salton Sea Inflow Projections for Evaluating Project Alternatives in the Programmatic Environmental Impact Report (PEIR) for Selection of a Preferred Salton Sea Restoration Alternative.

Dear Secretary Chrisman:

The Imperial Irrigation District ("IID") writes this letter to educate and assist the Department of Water Resources ("DWR") in its preliminary considerations regarding the Salton Sea Restoration Project. As a result of materials presented by CH2MHill at the November 30th Salton Sea Advisory Committee meeting and conversations with the Salton Sea Authority, IID is concerned that DWR may have significant misconceptions about the nature of IID's senior priority water rights, the prospects for additional conserved water transfers by IID, and the possible interplay of both on future inflow volumes to the Salton Sea.

As you know, IID holds senior water rights to the Colorado River under federal and state law and contracts which, after execution of the QSA and Related Agreements, are highly insulated from legal challenges and capped at 3.1 million acre-feet (MAF) per year in non-surplus years. IID's senior water rights are senior to the right of the State of Arizona to receive Central Arizona Project water totaling 1.2 MAF per year and the right of The Metropolitan Water District of Southern California to receive 550,000 acre-feet (AF) per year, and behind only 420,000 AF per year of higher priority agricultural water uses within California. Thus, as a matter of legal priority, it is highly unlikely Salton Sea inflows from the IID service area will vary dramatically as a result of drought on the Colorado River. After five years of a serious Colorado River drought never before reflected in the records of history, there is still no realistic foreseeable prospect of a cutback in Colorado River deliveries with a magnitude that would eliminate deliveries to junior right holders and reduce IID's 3.1 MAF per year senior right to such an extent that Salton Sea inflow would be reduced by more than 400,000 AF. Therefore, IID does not believe that DWR should suggest that notwithstanding IID's senior water rights, climatic conditions on the Colorado River could produce Salton Sea inflow reductions as suggested in the CH2MHill materials.

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January 13, 2005
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Similarly, IID may choose to initiate and implement conserved water transfers in addition to those set forth in the QSA and Related Agreements. But, IID has no obligation to do so. IID has contractual and legislative protections which prohibit others from seeking to cause IID to do additional transfers. See Water Code § 1013(e). Furthermore, it is the existing policy of the IID not to engage in any water transfers other than pursuant to the QSA and Related Agreements. Thus, there is no basis for CH2MHill to project substantial Salton Sea inflow reductions as a result of additional IID transfers.

Notwithstanding the above, the IID agrees that the DWR needs to be realistic and recognize that Salton Sea inflows may vary from year to year by large amounts as a consequence of variability in IID's diversion and use of Colorado River water related to crop selection, weather, crop markets, insects, salinity and other factors, as well as improvements in efficiency by farmers independent of the QSA and Related Agreements. Furthermore, Salton Sea inflows may vary if IID chooses to recapture and reuse drain water before it reaches the Salton Sea. IID's existing senior water rights extend to the recapture and reuse of drain water. As IID explained in a letter to the Salton Sea Authority dated October 7, 2004 (copy enclosed), "the water rights of an irrigation district include the right to change, eliminate, recapture and reuse drain flow within the district. See Stevens v. Oakdale Irrigation District, 13 Cal.2d 343 (1939)." In addition, the historical flow of drain water to the Salton Sea does not preclude IID from exercising its senior water rights to such flow in the future. The state legislature granted IID and other Colorado River contractors protection from reductions in water rights that might otherwise occur by virtue of forfeiture or abandonment, non-continuity of use, or failure to apply the water for use for any period. See Water Code § 1005. Therefore, no applicant to appropriate New and Alamo River water can obtain a reliable noninterruptible source of water. IID recognizes that the availability of drain flow to the Salton Sea is of concern to the Salton Sea Authority and others. In light of that concern, IID has entered into discussions with the Salton Sea Authority to explore whether there exists a mutually-beneficial means to make more stable and reliable the long-term volume of IID generated drain flow for the Salton Sea. IID will keep you informed if progress is made in these discussions.

IID also believes that further clarification from an environmental process perspective is needed with respect to several aspects of the CH2MHill material on Salton Sea inflows presented on November 30, 2004. IID recognizes that DWR is the Lead Agency responsible for preparing the referenced PEIR to evaluate the environmental impacts of a proposed Restoration Project and various project alternatives, pursuant to the California Environmental Quality Act ("CEQA"). IID is a member of the Salton Sea Advisory Committee ("SSAC"), which is assisting DWR in developing and evaluating alternative Restoration Projects.

IID was the Lead Agency for CEQA purposes for the EIR/EIS for the IID Water Conservation and Transfer Project ("Transfer Project EIR/EIS"), and a Co-Lead Agency for preparation of the PEIR for the Quantification Settlement Agreement ("QSA PEIR"). In this capacity, IID supervised the preparation of detailed hydrological studies relating to the Salton

Sea, including the projection of future inflows to the Sea. The CH2MHill materials are in summary, bullet-point format, and they are confusing to IID in a number of respects which causes IID concern and the need for further clarification regarding both (1) the evidentiary basis for the range of inflow reductions projected in the CH2MHill materials and (2) the proposed use of these projections in connection with the PEIR.

IID's primary concern relates to the prediction, on pages 8-9 of the CH2MHill materials, of a reduction of annual inflows to the Salton Sea within a range extending from 1.1 MAF to less than 500,000 AF in year 2078. These projections do not appear to be consistent with the assessment contained in the Transfer Project EIR/EIS or the QSA PEIR, and we request further details of CH2MHill's analysis and evidentiary support for a reduction of inflows to a level of 500,000 AF.

IID's assessment, using the in-Valley model IIDSS described in the Transfer Project EIR/EIS, indicated that Baseline conditions, projected to year 2078, would result in average annual inflows to the Sea from the IID service area of approximately 1,100,0000 AF and that implementation of the Transfer Project/QSA would reduce the Baseline projection to an average annual 793,000 AF, a reduction on average of 28%. IID provided these results to the U.S. Bureau of Reclamation for utilization in its Salton Sea Accounting Model ("SSAM"), which was developed to provide a consistent methodology for projecting total Sea inflows, and elevation and salinity estimates. The SSAM used a stochastic methodology to simulate variable existing conditions and trends projected into the future over a 75-year period relevant to the Transfer Project/QSA. The IID accounted for variability from year to year to reflect weather, cropping patterns, agricultural practices, soil type and infestation. In projecting impacts of the Transfer Project, IID also considered variations in the type of conservation measures implemented within the IID service area. IID's assessment, which included both the IIDSS and SSAM modeling assumptions, did not indicate a reduction of average annual inflows to a level as low as 500,000 AF as indicated in the CH2MHill materials. Therefore, we ask DWR to explain the basis for its assumptions regarding future inflows and reconcile its projections with those used in prior environmental studies.

IID believes it is important to address the validity of CH2MHill's inflow projections prior to using or relying on them in connection with the PEIR for the Restoration Project. Frankly, the CH2MHill materials are very confusing in the use of CEQA terminology. It suggests that the projections may be used: (1) to establish the Baseline, (2) to establish Project feasibility parameters, (3) as a criterion for selecting Project alternatives to assess in the PEIR, (4) to establish the No Project Alternative, (5) to determine Project impacts, and (6) to determine cumulative impacts. However, under CEQA, each of these purposes is distinct and requires analysis in accordance with separate and different standards and evidentiary support.

The hydrologic Baseline is to be used to identify the impacts of the Restoration Project. If the Baseline conditions are exaggerated (e.g., by unrealistically severe inflow reductions), impacts associated with the Project would be inappropriately understated. Similarly, the No

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Project Alternative must assess Baseline conditions plus what reasonably would be expected to occur in the foreseeable future if the proposed Project were not approved. If unrealistic or unreasonable projections are used to define the No Project Alternative, the impacts of the proposed Project, in comparison, will be improperly understated.

IID is also concerned about use of the projections to evaluate the feasibility of the Restoration Project alternatives to be considered in the PEIR. CEQA requires that the PEIR assess a reasonable range of alternatives which could feasibly achieve most of the Project objectives, but would reduce significant impacts of the Project. Since the maximum projected inflow reduction is not supported by facts known to us or identified by CH2MHill, IID questions whether this criterion should be utilized to disqualify alternatives which may not function at the low end of the range of inflow reductions, but may have potential for minimizing other impacts of restoration.

IID requests that DWR and CH2MHill re-examine the proposed inflow reductions, clarify and identify the basis and methodology used to develop the projections, indicate whether and why the extreme low range is reasonable or probable, and explain how CH2MHill intends to utilize the projections for purposes of the required CEQA analysis.

Very truly yours,

JESSE P. SILVA
General Manager

Attachment: Letter from Imperial Irrigation District President, Bruce Kuhn, to Gary Wyatt, dated October 7, 2004

Copy: IID Board of Directors
John P. Carter, IID Chief Counsel
Gary Wyatt, President, Salton Sea Authority
Ron Enzweiler, Executive Director, Salton Sea Authority

IMPERIAL IRRIGATION DISTRICT

OPERATING HEADQUARTERS • P. O. BOX 937 • IMPERIAL, CALIFORNIA 92251

October 7, 2004

Via Facsimile & U.S. Mail

Gary Wyatt
President
Salton Sea Authority
78401 Highway 111, Suite T
La Quinta, California 92253

Re: Salton Sea Inflows

Dear Gary:

This letter is sent in response to my recent review of the "Discussion Agenda for SSA/MWD Meeting (9/24)" and the interview with new Salton Sea Authority ("SSA") Director Ron Enzweiler published in the *Desert Sun* on September 30, 2004. Both documents reflect the same fundamental misunderstanding of California water law and water rights relevant to the ownership and control of irrigation drain flow into the Salton Sea.

The Agenda and the interview express a goal of the SSA to obtain "water rights" from the State of California ("State") or from The Metropolitan Water District of Southern California ("MWD") to the New and Alamo Rivers in order to protect inflows into the Salton Sea, protect environmental interests, and possibly generate desalinated water to sell for use outside the Imperial Valley. Presumably the SSA believes that the State can grant a water right to the inflows, or that MWD has a priority right to the inflows because of its applications to appropriate water from the New and Alamo Rivers filed in 2003 and 1997 respectively. However, the source of the vast majority of inflow to the Salton Sea is irrigation drain flow from the IID service area which, under California law, is not available to be appropriated as a new water right, nor is it available to be obtained by MWD under its applications to appropriate water from the New and Alamo Rivers. The right to keep and use the drain flow is already part of IID's water rights to the Colorado River.

Current inflows to the Salton Sea from the Imperial Valley occur as a matter of irrigation drainage either directly into the Sea, or by draining into IID drain ditches that empty into the New and Alamo Rivers and the Sea. The IID is the water right holder for the Colorado River water that is used by Imperial Valley water users and that is the source of the drain flow into the Salton Sea. The IID, and the water users through the IID, are not obligated to order a certain amount of Colorado River water or obligated to use the water in a manner that will generate a certain supply of drainage. Neither are the IID and the water users obligated to create or release drain water at all. In fact, the IID has the right

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Re: Salton Sea Inflows

to prevent, recapture and reuse any drain flow before it leaves the IID drainage system. A long-standing California Supreme Court decision recognizes that the water right of an irrigation district includes the right to change, eliminate, recapture and reuse drain flow within the district. See Stevens v Oakdale Irrigation District, 13 Cal. 2d 343 (1939).

It is true that as a condition of approval of a transfer of conserved water by IID, but only as a condition of approval, the State Water Resources Control Board ("SWRCB") required environmental-mitigation water be delivered to the Salton Sea for a period of 15 years. But this requirement was only to protect the Sea from the impacts of the transfers. The SWRCB did not find that the IID had any independent duty or obligation to allow drain flows to reach the Salton Sea. Furthermore, the SWRCB recognized that the Salton Sea restoration effort would have to find a way to acquire water for the Salton Sea. The SWRCB did not find that the Salton Sea already had or could acquire a water right. It is expected that as part of the State's CEQA compliance for evaluating and selecting a Salton Sea restoration alternative, the level of inflow necessary to sustain the selected restoration alternative will be identified. It is possible that the State's CEQA review will also discuss the possible sources, methods and estimated costs for acquiring the necessary inflow.

IID would be pleased to discuss with you further the needs of the Salton Sea and the role that IID drain water might play in the restoration effort. IID is somewhat surprised that the SSA has not explored this topic with the IID before discussing it with MWD and others, but perhaps that is based on a misunderstanding of IID's water rights. I hope this letter is helpful in clarifying that subject.

Very truly yours,

Bruce Kuhn
President
Board of Directors

Copy: Salton Sea Authority Board Members (via fax & U.S. Mail)
Ron Enzweiler, Executive Director, Salton Sea Authority (via fax & U.S. Mail)
Imperial Irrigation District Board of Directors
Jesse Silva, General Manager, Imperial Irrigation District
John Carter, Chief Counsel, Imperial Irrigation District

Long-Term Regional Colorado River Water Management Plan for Sustaining SSA Plan for Salton Sea Revitalization & Restoration

Simplified Analysis to Demonstrate Supply & Demand Balance and Validate the SSA's Inflow Assumptions over 75-Year Project Evaluation Period

			2003	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050	2055	2060	2065	2070	2075
			Baseline	← Initial QSA Term →								← Extended QSA Term (optional) →						
Colorado River Diversions																		
IID Entitlements per QSA		af/year	3,073,000	2,933,500	2,733,800	2,564,800	2,825,300	2,812,800	2,607,800	2,607,800	2,607,800	2,607,800	2,610,800	2,610,800	2,610,800	2,610,800	2,610,800	2,610,800
CVWD Entitlement per QSA		af/year	347,000	347,000	333,000	357,000	394,000	419,000	424,000	424,000	424,000	424,000	421,000	421,000	421,000	421,000	421,000	421,000
plus: CVWD SWP water			0	0	0	0	0	25,000	30,000	35,000	35,000	35,000	35,000	35,000	35,000	35,000	35,000	35,000
less: IOPP deduction		af/year	(59,210)	(59,210)	(59,210)	(59,210)	0	0	0	0	0	0	0	0	0	0	0	0
Net Priority 3(a) Diversions		af/year	3,360,790	3,221,290	3,007,590	2,862,590	3,019,300	3,056,800	3,061,800	3,066,800	3,066,800	3,066,800	3,066,800	3,066,800	3,066,800	3,066,800	3,066,800	3,066,800
less: conveyance losses	6%	af/year	(261,040)	(254,065)	(150,380)	(143,130)	(181,158)	(183,408)	(183,708)	(184,008)	(184,008)	(184,008)	(184,008)	(184,008)	(184,008)	(184,008)	(184,008)	(184,008)
Net Available for Beneficial Uses		af/year	**3,099,751**	**2,967,226**	**2,857,211**	**2,719,461**	**2,838,142**	**2,873,392**	**2,878,092**	**2,882,792**	**2,882,792**	**2,882,792**	**2,882,792**	**2,882,792**	**2,882,792**	**2,882,792**	**2,882,792**	**2,882,792**
Agricultural Demand Factors	Attrition Factor																	
Farmland in IID Service Area	1.0%	acres	480,039	480,525	475,720	470,963	486,253	446,590	442,124	440,703	436,296	436,933	435,564	434,208	432,866	428,538	425,252	422,760
temporary fallowing adjustment:		acres		(15,000)	(28,000)	(52,000)	(32,000)											
Farmland in CVWD ID#1	8.0%	acres	70,000	66,000	60,720	55,862	51,393	47,262	43,499	40,019	38,818	35,872	33,003	30,362	28,433	28,159	24,066	20,955
Total Acres in Production:			**560,039**	531,525	508,440	474,825	485,646	493,872	485,624	480,723	473,114	472,806	468,567	464,571	461,300	454,696	449,318	**443,716**
Agricultural Water Use	Efficiency Gain																	
IID Service Area	0.3%	af/acre	*5.50*	*5.48*	*5.45*	*5.42*	*5.39*	*5.18*	*5.17*	*5.15*	*5.15*	*5.16*	*5.15*	*5.14*	*5.13*	*5.13*	*5.12*	*5.12*
		af/year	2,695,215	2,552,706	2,440,341	2,268,895	2,338,821	2,314,712	2,284,690	2,270,514	2,245,428	2,255,069	2,241,257	2,231,921	2,222,676	2,198,133	2,178,990	2,166,064
CVWD ID#1	0.5%	af/acre	*4.80*	*4.78*	*4.75*	*4.73*	*4.70*	*4.68*	*4.66*	*4.63*	*4.61*	*4.59*	*4.57*	*4.54*	*4.52*	*4.50*	*4.47*	*4.45*
		af/year	282,240	277,390	259,694	237,724	229,702	221,336	202,611	185,470	169,779	164,592	150,669	137,921	126,513	117,641	107,689	93,300
Total Applied: Agricultural Water Use:			**2,977,459**	**2,830,101**	**2,700,039**	**2,507,624**	**2,568,327**	**2,536,052**	**2,487,306**	**2,455,988**	**2,415,212**	**2,419,666**	**2,391,930**	**2,369,847**	**2,351,194**	**2,315,779**	**2,286,683**	**2,259,369**
Agricultural Drainage & Spill	Efficiency Gain																	
IID Farmland 33%	12.0%	af/acre	*1.82*	*1.59*	*1.61*	*1.59*	*1.59*	*1.52*	*1.52*	*1.52*	*1.52*	*1.52*	*1.52*	*1.51*	*1.49*	*1.49*	*1.48*	*1.48*
		af/year	869,421	764,878	764,808	751,177	739,375	678,872	673,298	668,734	661,546	664,671	660,104	657,588	646,161	640,049	630,092	**626,316**
CVWD Farmland & Other CVSC Flows 25%	0.0%	af/acre	*1.20*	*1.19*	*1.19*	*1.18*	*1.18*	*1.17*	*1.16*	*1.16*	*1.15*	*1.15*	*1.14*	*1.14*	*1.13*	*1.12*	*1.12*	*1.12*
			64,000	63,804	62,137	61,034	60,448	55,334	50,653	46,368	42,445	41,148	37,667	34,480	32,128	29,410	26,922	23,535
Total Agricultural Drainage Inflows			**953,421**	**828,682**	**826,946**	**812,212**	**799,822**	**734,206**	**723,950**	**715,101**	**703,991**	**705,819**	**697,771**	**692,046**	**678,290**	**669,459**	**657,014**	**649,851**
Municipal Demand Factors	Growth Rate																	
Homes in IID Service Area	8.0%	#	43,500	46,980	50,738	54,797	59,181	63,916	69,029	74,551	80,515	86,957	93,913	101,426	109,540	118,304	127,768	137,989
Homes in Lower ID#1 (ex-SSA)	8.0%	#	15,000	16,200	22,496	29,298	31,639	34,170	36,904	39,856	43,045	46,489	50,208	54,224	58,562	63,247	68,307	73,772
Homes in SSA Finance District		#	3,000	4,000	10,000	25,000	50,000	100,000	150,000	200,000	**250,000**	255,000	260,000	265,000	270,000	275,000	280,000	285,000
Total:			**61,500**	67,180	83,234	109,093	140,821	198,086	255,933	314,408	373,560	388,445	404,121	420,651	438,103	456,551	476,075	**496,761**
M & I and Recharge Water Use	Application Rate																	
Residential Service	0.5	AFY/home	30,750	33,590	41,617	54,547	70,410	99,043	127,967	157,204	186,780	194,223	202,060	210,325	219,051	228,275	238,037	248,380
Commercial, Golf, Parks, etc.	5.0%	growth	120,000	126,000	132,300	138,915	145,861	153,154	160,811	168,852	177,295	186,159	195,467	205,241	215,503	226,278	237,592	254,471
Recharge Program (per CVWD Water Mgmt Plan)			0	5,000	10,000	50,000	80,000	100,000	120,000	120,000	115,000	120,000	125,000	130,000	135,000	140,000	140,667	150,000
Total Applied: M&I and Recharge Water Use			**150,750**	**164,590**	**183,917**	**243,462**	**296,271**	**352,197**	**408,778**	**446,056**	**479,075**	**500,382**	**522,528**	**545,566**	**569,554**	**594,553**	**616,296**	**652,852**
Total Inflows from M&I and Recharge			**5,153**	**8,381**	**12,617**	**28,324**	**41,652**	**54,412**	**67,301**	**74,325**	**79,994**	**84,653**	**89,477**	**94,474**	**99,657**	**105,036**	**109,326**	**116,439**
Total Water Use by District																		
IID Entitlement Water			2,817,340	2,681,696	2,577,210	2,416,182	2,496,012	2,486,798	2,471,964	2,473,499	2,464,681	2,485,555	2,483,603	2,486,793	2,490,782	2,480,225	2,475,867	2,478,577
CVWD Entitlement Water			310,865	312,990	306,742	334,899	368,582	401,447	424,115	428,540	429,601	434,488	430,850	428,615	429,961	430,103	427,108	428,640
Total Use of Co. River Water			3,128,205	2,994,686	2,883,952	2,751,081	2,864,593	2,888,245	2,896,079	2,902,040	2,894,282	2,920,043	2,914,453	2,915,408	2,920,743	2,910,327	2,902,975	2,907,217
% Utilization of Colorado River Entitlement			**105%**	**101%**	**101%**	**101%**	**101%**	**100%**	**100%**	**99%**	**99%**	**100%**	**100%**	**100%**	**100%**	**100%**	**99%**	**100%**
Salton Sea Inflows (ex-Mexico & local):			**958,573**	**837,063**	**839,563**	**840,535**	**841,474**	**788,618**	**791,251**	**789,426**	**783,984**	**790,473**	**787,248**	**786,523**	**777,947**	**774,496**	**766,340**	**766,290**
% Net Co. River Water Diversions Reaching Sea:			*31%*	*28%*	*29%*	*31%*	*30%*	*27%*	*27%*	*27%*	*27%*	*27%*	*27%*	*27%*	*27%*	*27%*	*27%*	*27%*

* CVWD does not supply Colorado River water directly to homes; instead, river water is used to recharge the groundwater basin and wells are used for domestic supply. The "residential service" figure in Lower ID#1 is the amount of canal-water recharge to balance extractions.

Long-Term Regional Colorado River Water Management Plan for Sustaining SSA Plan for Salton Sea Revitalization & Restoration

Simplified Analysis to Demonstrate Supply & Demand Balance and Validate the SSA's Inflow Assumptions over 75-Year Project Evaluation Period

Backup Calculations to Show Water Use and Water Balance by Disrict

		2003	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050	2055	2060	2065	2070	2075
Allocation of Net River Water																	
IID		2,785,244	2,653,363	2,546,968	2,387,183	2,467,782	2,456,032	2,451,332	2,451,332	2,451,332	2,451,332	2,454,152	2,454,152	2,454,152	2,454,152	2,454,152	2,454,152
CVWD		314,507	313,863	310,242	332,277	370,360	417,360	426,760	431,460	431,460	431,460	428,640	428,640	428,640	428,640	428,640	428,640
TOTAL REGION		**3,099,751**	**2,967,226**	**2,857,211**	**2,719,461**	**2,838,142**	**2,873,392**	**2,878,092**	**2,882,792**	**2,882,792**	**2,882,792**	**2,882,792**	**2,882,792**	**2,882,792**	**2,882,792**	**2,882,792**	**2,882,792**
IID Service Area																	
# acres	% SSA	490,039	480,525	475,720	470,963	466,253	446,590	442,124	440,703	436,296	436,933	435,564	434,208	432,866	428,538	425,252	422,760
# houses	25% share	44,250	47,980	53,238	61,047	71,681	88,916	106,529	124,551	143,015	150,707	158,913	167,676	177,040	187,054	197,768	209,239
Agricultural Supply		2,695,215	2,552,706	2,440,341	2,269,895	2,338,621	2,314,712	2,284,690	2,270,514	2,245,428	2,255,069	2,241,257	2,231,921	2,222,676	2,198,133	2,178,990	2,166,064
Domestic Supply	0.5 af/house	22,125	23,990	26,619	30,524	35,841	44,458	53,265	62,276	71,508	75,353	79,457	83,838	88,520	93,527	98,884	104,620
Commercial, etc.	5% growth	100,000	105,000	110,250	115,763	121,551	127,628	134,010	140,710	147,746	155,133	162,889	171,034	179,586	188,565	197,993	207,893
Sub-Total M&I		122,125	128,990	136,869	146,286	157,391	172,086	187,274	202,986	219,253	230,486	242,346	254,872	268,106	282,092	296,877	312,512
Total Demand		**2,817,340**	**2,681,696**	**2,577,210**	**2,416,182**	**2,496,012**	**2,486,798**	**2,471,964**	**2,473,499**	**2,464,681**	**2,485,555**	**2,483,603**	**2,486,793**	**2,490,782**	**2,480,225**	**2,475,867**	**2,478,577**
Over/Under Supply		**(7,671)**	**(3,909)**	**(5,817)**	**(4,573)**	**(3,805)**	**(6,341)**	**3,793**	**2,258**	**11,076**	**(9,798)**	**(5,026)**	**(8,216)**	**(12,205)**	**(1,648)**	**2,710**	**(0)**
Ag Consumptive Use		1,805,794	1,787,828	1,675,532	1,518,718	1,599,246	1,635,840	1,611,392	1,601,780	1,583,882	1,590,397	1,581,153	1,574,353	1,576,514	1,558,084	1,548,898	1,539,748
Crop ET (AF/acre):	Consumption Factors	*3.7*	*3.7*	*3.5*	*3.2*	*3.4*	*3.7*	*3.6*	*3.6*	*3.6*	*3.6*	*3.6*	*3.6*	*3.6*	*3.6*	*3.6*	*3.6*
Houses CU	80%	17,700	19,192	21,295	24,419	28,673	35,566	42,612	49,821	57,206	60,283	63,565	67,071	70,816	74,821	79,107	83,696
Commercial CU	80%	80,000	84,000	88,200	92,610	97,241	102,103	107,208	112,568	118,196	124,106	130,312	136,827	143,669	150,852	158,395	166,314
Total M&I CU		97,700	103,192	109,495	117,029	125,913	137,669	149,819	162,389	175,403	184,389	193,877	203,898	214,485	225,673	237,502	250,010
Total Consumptive Use		**1,903,494**	**1,891,020**	**1,785,028**	**1,635,747**	**1,725,159**	**1,773,509**	**1,761,212**	**1,764,169**	**1,759,285**	**1,774,786**	**1,775,030**	**1,778,251**	**1,790,999**	**1,783,757**	**1,786,400**	**1,789,758**
Ag Drainage & Base Year M&I		889,421	764,878	764,808	751,177	739,375	678,872	673,298	668,734	661,546	664,671	660,104	657,568	646,161	640,049	630,092	626,316
New M&I Effluent & Runoff	24,425	0	1,373	2,949	4,832	7,053	9,992	13,030	16,172	19,426	21,672	24,044	26,549	29,196	31,993	34,950	38,077
Total Salton Sea Inflows		**889,421**	**766,251**	**767,757**	**756,010**	**746,428**	**688,864**	**686,328**	**684,906**	**680,971**	**686,343**	**684,149**	**684,117**	**675,358**	**672,043**	**665,042**	**664,394**
TOTAL IID USES		**2,792,915**	**2,657,271**	**2,552,785**	**2,391,757**	**2,471,587**	**2,462,373**	**2,447,539**	**2,449,074**	**2,440,256**	**2,461,130**	**2,459,178**	**2,462,368**	**2,466,357**	**2,455,800**	**2,451,442**	**2,454,152**
CVWD Service Area																	
# acres	% SSA	70,000	66,000	60,720	55,862	51,393	47,282	43,499	40,019	36,818	35,872	33,003	30,362	28,433	26,159	24,066	20,955
# houses	75% share	17,250	19,200	29,996	48,046	69,139	109,170	149,404	189,856	230,545	237,739	245,208	252,974	261,062	269,497	278,307	287,522
Agricultural Supply		282,240	277,390	259,694	237,724	229,702	221,336	202,611	185,470	169,779	164,592	150,668	137,921	128,513	117,641	107,689	93,300
Domestic Supply	0.5 af/house	8,625	9,600	14,998	24,023	34,570	54,585	74,702	94,928	115,272	118,869	122,604	126,487	130,531	134,749	139,153	143,761
Commercial, etc.	5% growth	20,000	21,000	22,050	23,153	24,310	25,526	26,802	28,142	29,549	31,027	32,578	34,207	35,917	37,713	39,599	41,579
Sub-Total M&I Supply		28,625	30,600	37,048	47,175	58,880	80,111	101,504	123,070	144,822	149,896	155,182	160,694	166,448	172,462	178,752	185,339
Recharge Program		**0**	**5,000**	**10,000**	**50,000**	**80,000**	**100,000**	**120,000**	**120,000**	**115,000**	**120,000**	**125,000**	**130,000**	**135,000**	**140,000**	**140,667**	**150,000**
Total Demand		**310,865**	**312,990**	**306,742**	**334,899**	**368,582**	**401,447**	**424,115**	**428,540**	**429,601**	**434,488**	**430,850**	**428,615**	**429,961**	**430,103**	**427,108**	**428,640**
Over/Under Supply		**3,642**	**873**	**3,500**	**(2,622)**	**1,778**	**15,913**	**2,645**	**2,920**	**1,859**	**(3,028)**	**(2,210)**	**25**	**(1,321)**	**(1,463)**	**1,532**	**0**
Ag Consumptive Use		218,240	213,586	197,557	176,689	169,254	166,002	151,958	139,103	127,334	123,444	113,001	103,441	96,385	88,231	80,766	69,766
Crop ET (AF/acre):	Consumption Factors					*3.3*	*3.5*	*3.5*	*3.5*	*3.5*	*3.4*	*3.4*	*3.4*	*3.4*	*3.4*	*3.4*	*3.3*
Housing CU	82%	7,073	7,872	12,298	19,699	28,347	44,760	61,256	77,841	94,523	97,473	100,535	103,719	107,036	110,494	114,106	117,884
Commercial CU	82%	16,400	17,220	18,081	18,985	19,934	20,931	21,978	23,076	24,230	25,442	26,714	28,050	29,452	30,925	32,471	34,094
Sub-Total M&I CU		23,473	25,092	30,379	38,684	48,281	65,691	83,233	100,918	118,754	122,915	127,249	131,769	136,488	141,418	146,577	151,978
Recharge Flows to Aquifer	70%	0	3,500	7,000	35,000	56,000	70,000	84,000	84,000	80,500	84,000	87,500	91,000	94,500	98,000	98,467	105,000
Total Consumptive		**241,713**	**242,178**	**234,936**	**250,373**	**273,535**	**301,693**	**319,191**	**324,020**	**326,588**	**330,359**	**327,750**	**326,210**	**327,372**	**327,649**	**325,810**	**326,744**
Ag Drainage		64,000	63,804	62,137	61,034	60,448	55,334	50,653	46,368	42,445	41,148	37,667	34,480	32,128	29,410	26,922	23,535
M&I Effluent & Runoff		5,153	5,508	6,669	8,492	10,598	14,420	18,271	22,153	26,068	26,981	27,933	28,925	29,961	31,043	32,175	33,361
Recharge Flow to Sea	30%	0	1,500	3,000	15,000	24,000	30,000	36,000	36,000	34,500	36,000	37,500	39,000	40,500	42,000	42,200	45,000
Total Salton Sea Inflows		**69,153**	**70,812**	**71,806**	**84,526**	**95,046**	**99,754**	**104,923**	**104,520**	**103,013**	**104,129**	**103,100**	**102,405**	**102,589**	**102,453**	**101,298**	**101,896**
TOTAL CVWD USE:		**310,865**	**312,990**	**306,742**	**334,899**	**368,582**	**401,447**	**424,115**	**428,540**	**429,601**	**434,488**	**430,850**	**428,615**	**429,961**	**430,103**	**427,108**	**428,640**
TOTAL REGION		3,103,780	2,970,261	2,859,527	2,726,656	2,840,168	2,863,820	2,871,654	2,877,615	2,869,857	2,895,618	2,890,028	2,890,983	2,896,318	2,885,902	2,878,550	2,882,792
Over/Under Supply		**(4,029)**	**(3,036)**	**(2,316)**	**(7,195)**	**(2,026)**	**9,572**	**6,438**	**5,177**	**12,935**	**(12,826)**	**(7,236)**	**(8,191)**	**(13,526)**	**(3,110)**	**4,242**	**0**

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MEMO

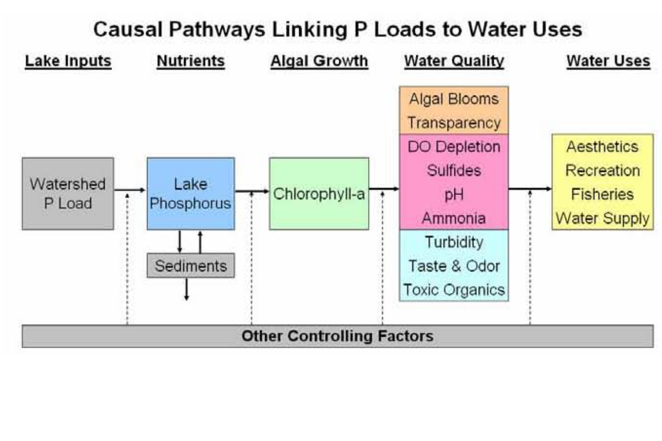
To: Ron Enzweiler, Salton Sea Authority
Subject: SSA's Plan for Revitalizing the Salton Sea to Support Recreational Uses
Date: March 22, 2006

Introduction

This memo summarizes my initial thoughts on the feasibility of SSA's plan for revitalizing the Salton Sea to support recreational uses, as limited by eutrophication. My opinions are based upon review of reports that you provided, some published literature and web sites, attendance at two TAC meetings, tours of the shoreline and watershed, review of monitoring data collected by USBR in 1999 and SSA/USBR in 2004-2005, preliminary mass-balance calculations, and experience with relevant research and restoration projects described at wwwalker.net.

While there are always uncertainties in forecasting responses to implementation of restoration projects, particularly in ones of this scope and given unique features of the Sea, and there are always needs for additional data and analysis, I don't see any "fatal flaws" that should preclude further evaluation of the SSA Plan. I interpret "fatal flaw" to mean a likelihood of failure with respect to restoring recreational water quality, given information reviewed and level of analysis that I am able to provide in this time frame. Assuming that inflows required to sustain the Sea are supplied, there is a greater likelihood of success, especially given the long time frame and components of the SSA plan that can be adjusted in response to actual as opposed to foreseen conditions. The private funding mechanism also promotes efficiency and flexibility for adapting to changing conditions, as compared with typical state or federally funded restoration projects.

The Salton Sea shows all of the classic signs of nutrient enrichment and to an extreme degree. These include elevated nutrient concentrations, algal blooms, low transparency, oxygen depletion, hydrogen sulfide, ammonia, toxic algae, fish kills, etc. This is not unexpected given that the Sea is fed almost exclusively by agricultural drainage and urban wastewater and that it is located in a region with abundant sunlight and warm temperatures that are conducive to algal growth and oxygen depletion. All of these symptoms are linked to excessive algal growth that is in turn linked to excessive phosphorus loadings, as well as other factors, as illustrated below:



The Sea is an ideal environment (sunlight, temperature, nutrients) for algal growth. Monitoring data indicate that algal growth is controlled primarily by phosphorus because other nutrients are present in excess. This is confirmed by the fact that algal density (as measured by chlorophyll-a) is consistent with empirical models that predict chlorophyll-a as a function of Total P concentration. Those models (Jones/Bachman, Carlson) are based upon data from other P-limited lakes and commonly used in eutrophication assessments. So, while other factors also influence the various water quality problems that affect recreational uses, they are fundamentally fueled by phosphorus loads, control of which is a major focus of the SSA plan. As discussed below, control of H_2S is also a major focus of the SSA plan; that problem is also linked to phosphorus.

The USBR (Holdren et al) pointed out that Sea TP concentrations have not changed since the 1960's, despite the fact that the phosphorus loads have approximately doubled. The notion that the Sea TP concentrations have not changed since the 1960's is inconsistent with anecdotal yet undisputed evidence that water quality was much better then, at least enough to foster resort development around the shoreline and to support boating, swimming, water skiing, etc... In my experience, comparisons of modern and historical P measurements and load estimates are typically clouded by changes in investigators, sampling methods, labs, analytical techniques, and load computation techniques, especially over a 30+ year period. While that may or not be the case here, the fact that the Sea once supported recreational uses is an encouraging sign that the goals of the SSA plan are not unrealistic.

Because of the above cause-effect pathways, it is likely that the ~90% reduction in the existing external P load contemplated under the SSA Plan would improve water quality to a significant degree. The question that you have asked is whether there is a fatal flaw in that the plan to revitalize water quality to "recreational" water quality, given the degree of phosphorus control being contemplated. The sub-questions pertain to:

- definition of the "recreational" goal in quantitative terms (equivalent TP concentration, algal bloom frequency, etc.);
- assimilative capacity of the Sea (linkage between TP load and Sea water quality); and
- feasibility of control technology to accomplish the required TP load reductions
- feasibility of technology to control hydrogen sulfide problems

These factors are discussed below.

Phosphorus Goal

A TP concentration of 35 ppb has apparently been selected by the State as a goal in the Salton Sea TMDL process. It is not clear whether that automatically translates to a requirement for the SSA plan. The 35 ppb criterion can be compared with average concentrations of 70 – 110 ppb measured by the USBR 1999 (biweekly sampling) and by SSA/USBR in 2004-2005 (quarterly sampling). Measured average chlorophyll-a concentrations (50 - 120 ppb) are similar to those expected in this phosphorus range, based upon regression equations developed from northern lake data (Bachman & Jones, Carlson, etc).

Achieving a TP concentration of 35 ppb would be expected to provide a mean chlorophyll-a concentration of ~15 ppb and a low frequency of nuisance algal blooms (instantaneous chlorophyll-a > 20-30 ppb). These criteria are within ranges established in other lake restoration projects and consistent with surveys relating water quality measurements to user perceptions of aesthetic and recreational values in other states (e.g., Minnesota, Texas, Colorado).

Phosphorus criteria for recreational use vary regionally and depend to some extent on what users are used to seeing, access to high quality lakes, and how you define "recreational". For example, TP criteria for recreational uses in Minnesota vary from ~15 ppb in the north to ~50 ppb in the south. Northern lakes tend to have relatively high quality because they are mostly deep and have forested watersheds. Southern lakes tend to have relatively low quality because they are mostly shallow and have agricultural watersheds. Lakes are commonly used for contact recreation in both regions of Minnesota, despite the significantly different P concentrations. It would be unlikely, however, that swimmers would flock to a 50 ppb lake in the north because higher-quality lakes are nearby. Similar regional patterns and user "adaptation" were observed in a recent study of Texas reservoirs.

While another Lake Tahoe is clearly not attainable or necessary here, a TP concentration of 35 ppb would provide reasonable assurance that recreational potential would be restored. It should not be interpreted as a red line for failure vs. success. Assuming that the H_2S problem is addressed (see below), significant reductions in P concentration and algal growth would improve aesthetics and recreation potential (especially for shoreline uses, bird-watching, fishing, boating), even the 35 ppb criterion (more appealing for contact recreation) were not achieved. I kayaked on the Sea and visited many ghost resorts on the shoreline in early February. I found the views hypnotizing and was astounded that nobody else was there to enjoy them. I suspect that residents and potential visitors have been traumatized by the stifling sulfide odor in other seasons, as I was in November.

The closest analogy in my experience with respect to goal-setting is Cherry Creek Reservoir, a small impoundment close to Denver intensively used for recreation and located in a region where other recreational lakes are not accessible within reasonable driving times. A mean chlorophyll-a concentration of 15 ppb (expected with SS TP concentration of 35 ppb) was adopted as a restoration goal. While that goal has not been achieved (at least as 2000), the reservoir has always been used intensively for recreation, despite the relatively chlorophyll-a concentrations (24 ppb, in 1997-1999). The key difference is that Cherry Creek does not suffer from H_2S problems, control of which will be critical to the success of the SSA plan.

Reductions in nutrients and algal productivity have been shown to decrease fish biomass in harvest in some lakes. This is balanced against beneficial impacts on fish, including changes from less desirable to more desirable species, reduced risk of oxygen depletion leading to fish kills, and improved conditions with respect to pH and ammonia. While the issue should be examined by fisheries experts, it seems unlikely that achieving a mesotrophic state (TP= 35 ppb, Chl-a = 15 ppb) could be viewed has having a net negative impact on the fish community or its predators.

Ammonia toxicity is another water quality problem that is linked to algal productivity and phosphorus loading. Free ammonia concentrations increase with total ammonia concentrations, temperature, and pH. Total ammonia concentrations would be expected to decrease as a consequence of reductions in external total nitrogen load resulting from wastewater diversion, agricultural BMP's, and wetland treatment. Reductions in internal ammonia nitrogen load would be expected to occur as a result of the decrease in organic matter production and decomposition.

Another linkage between algal growth and free ammonia is that the highest pH's (promoting free ammonia) tend to occur during algal blooms (highest chlorophyll-a concentrations), as a consequence of photosynthetic removal of carbon dioxide. This pattern is typical of other lakes and evident in the 2004-2005 monitoring data. Reducing the magnitude and frequency of algal blooms would therefore be expected to reduce free ammonia concentrations, even if total ammonia concentrations did not change. While modeling might be helpful, my initial assessment is that ammonia toxicity would not be a problem if the phosphorus reduction goals were achieved.

Phosphorus Assimilative Capacity

The assimilative capacity can be loosely defined as the maximum external P load consistent with achieving the Sea target P concentration. Modeling studies by the USGS (D. Robertson) showed that SSA's north basin would have a lower assimilative capacity than the existing Sea as a consequence of its smaller volume. Significant reductions in external P load would be required to offset the effects of reduced volume and to reduce the existing Sea TP concentration sufficiently to achieve recreational water quality. These relationships can be explored with relatively simple mass balance models, as described by Robertson and extended below.

The fact that the Sea is not flushed (no outlet) is a minor factor for phosphorus. It is not condemned to hyper-eutrophy because there is no outflow, as long as there is enough inflow to maintain the water level and salinity. Phosphorus loads are effectively trapped in the sediments, due to accretion of organic and inorganic sediment that is enhanced by calcite precipitation (as documented by Orem et al, USGS). While P cycles back and forth between the water column and sediment, the fact that P buildup is generally not observed in the bottom waters during periods with stable stratification (commonly observed in eutrophic stratified lakes) suggests net P releases from the sediments are small. That is a good sign.

Relatively simple mass-balance models can express the relationship between external TP loads and Sea water quality, as measured by Sea TP, chlorophyll-a, algal bloom frequency, and transparency (Tables 1 & 2). These calculations use empirical models calibrated to data from a wide range of freshwater lakes and commonly used in lake eutrophication assessments. While these models have not been widely applied to saline lakes, the predicted TP, chlorophyll-a, and transparency values for the existing Sea are within the range of recent measurements (1999, 2004-2005). Mass-balance modeling by the USGS (D Robertson) have also indicated that the Canfield/Bachman phosphorus retention model (used here) is consistent with existing Salton Sea phosphorus and water budgets. Other, first-order models (e.g. settling velocity concept) may also be applicable and would tend to yield more favorable results (predict lower Sea P concentrations for a given degree of external load control, after calibration to the existing data).

Tables 1 and 2 present steady-state water, salinity, and phosphorus balances for the existing Sea and each basin of the SSA plan under two external loading scenarios corresponding to average inflow concentrations of 200 ppb and 80 ppb, respectively, for all tributaries. The water and salinity budgets are consistent with those proposed by the SSA to provide a stable salinity of ~35 ppt in the north basin and ~22 ppt in the south basin.

Two TP loading scenarios representing different degrees of P control are evaluated. Table 1 indicates that reducing the combined inflow TP concentration to each basin from ~900 ppb to 200 ppb would provide concentrations of 70 ppb and 34 ppb in the south and north basins, respectively. Table 2 indicates that reducing the average inflow concentration to 80 ppb would provide concentrations of 36 ppb and 22 ppb, respectively. My calculations do not reflect potential P removal from the recycle stream by the ozone/filtration scheme being considered. This is not likely to have a large effect on the long-term P balances, but would accelerate the water quality responses to reductions in external P loads and control H_2S odors associated with the deep-water withdrawal and recirculation, as discussed below.

While alternative flow and loading scenarios could be explored, results indicate that inflow treatment down to the 80-200 ppb range would be sufficient to attaining the 35 ppb TMDL goal.

Even if the 35 ppb level were not reached in the South basin, water quality would be considerably improved relative to the existing Sea. Because it will be relatively shallow and rapidly flushed, it is unlikely that south basin will suffer from hydrogen sulfide problems, regardless of the TP concentration.

Monitoring data indicate that the TP residence time in the water column (mass stored in lake / external load) is less than a year. This suggests that Sea TP concentrations would respond relatively rapidly (2 years or so) to reductions in external load if storage and recycling of TP from the bottom sediments were relatively unimportant. Recycling may delay the response until the sediments equilibrate to the new loading and water quality regimes. That time scale is difficult to estimate, but would be limited to some degree by calcite precipitation that is expected to continue, even after reductions in salinity.

There is considerable uncertainty associated with any model forecasts, given the drastic changes in Sea configuration, salinity, flow, loading regime, etc... Further analysis would be required to estimate uncertainty and test sensitivity to alternative model assumptions, as well as to evaluate transitional responses to the predicted changes in inflow and P loads over the next decade or so. Uncertainties in future flow, basin P sources, salinity, potential role of fish in P retention, and other factors introduce additional uncertainty in forecasting the Sea response.

Within reasonable bounds, components of the SSA plan can be operated or modified in response to actual conditions as the project evolves. For example, the technology exists for treating the inflow streams down to concentrations approaching 10 ppb, should that be necessary to achieve Sea water quality objectives, even though the initial calculations indicate that 80-200 ppb would be sufficient to achieve 35 ppb. Similarly, operation of the recirculation stream can be adjusted in response to observed thermal stratification, sulfide buildup, and salinity regimes.

Phosphorus Controls

As discussed above, the fact that technology already exists for treating inflows well below the 80-200 ppb range provides a hedge against uncertainty in predicting Sea response. Both natural and physical/chemical treatment technologies exist for reducing inflow P concentrations below the 80 to 200 ppb range. Under the Everglades restoration effort, full-scale treatment wetlands have reduced TP concentrations in agricultural runoff down to 15 - 30 ppb. Pilot tests of physical/chemical treatment reached concentrations of 10 - 15 ppb. A variety of technologies are commonly used to treat municipal wastewaters down to the 50-200 ppb range. Implementation of lake restoration plans on a global scale is stimulating development of cost-effective technology for removing phosphorus that may be relevant over the extended time frame of the SSA plan.

While cost analysis is beyond the scope of my memo, I understand that cost estimates for CTSS (Chemical Treatment followed by Solids Separation) based on Everglades pilot studies are within the budget contemplated by the SSA. Since inflow P reduction is the cornerstone of the SSA plan, pilot scale testing of chemical treatment, and further cost analyses should be immediate priorities. Even though the technology has been widely applied, pilot studies are absolutely necessary to obtain reliable performance and cost estimates.

Reductions in the existing suspended solids concentrations at the mouths of the tributaries (via BMP's, basin wetlands, and/or sedimentation basins) are necessary to provide cost-effective chemical treatment to remove phosphorus. Existing TSS concentrations in the Alamo and New Rivers (~ 200-300 ppm) are much higher than those tested in the Everglades studies (~5-27 ppm). Assuming that suspended solids can be controlled, chemical dosage requirements to remove phosphorus are likely to be lower in this case, as compared with the Everglades, because of higher target P range (80-200 ppb vs. 10 ppb) and lower dissolved organic carbon content (~10 ppm vs. ~18 ppm). Capital costs would also tend to be lower in this case because of the relatively low variability in streamflow, as compared with the Everglades facilities that had to be designed to handle much larger runoff pulses.

Source controls (BMP's, wetlands, CTSS) should be implemented as soon as possible and preferably before separation of the Sea. While BMP's and wetlands will help to reduce nutrient and suspended solids loads, CTSS appears to be necessary in order to provide average inflow concentrations in the 80–200 ppb range necessary in order to achieve the water quality goals of the SSA plan. The existing monitoring program for the Sea and tributaries should be expanded and continued indefinitely. Otherwise, there will be no way of measuring progress and no signal for guiding the adaptive implementation of the plan.

Hydrogen Sulfide Controls

Excessive hydrogen sulfide (H_2S) production appears to be the major factor limiting potential beneficial uses of the Sea as it exists today and suitability as a habitat for humans, fish, and other wildlife. It also seems to create a significant regional air quality problem. Sulfide production may be enhanced to some extent by high sulfate concentrations, but the primary driving force is likely to be the excessive organic matter generated via photosynthesis, in turn controlled by phosphorus. Both sulfate concentrations and phosphorus loadings would be reduced significantly under the SSA plan.

Dr. Shadlow's one-dimensional hydrodynamic modeling indicates that the smaller north basin will have more stable (possibly permanent) vertical stratification, as compared with the existing Sea, apparently because of smaller wind fetch and resulting reductions in seiche activity and other wind-driven mixing events. Hypothetically, with more stable stratification, H_2S concentrations in the bottom waters would tend to increase relative to existing conditions, assuming that the rate of H_2S production is constant. The latter assumption would not hold in evaluating the SSA's plan that is likely to provide reductions in both algal productivity and sulfate concentrations. Dr. Shadlow's analysis only accounted for increases in transparency potentially resulting from phosphorus control.

The Feasibility Study - Phase I Alternatives Viability Report (October 2005, Science Paper 6) does not discuss calibration procedures for the 1-D model. Figures 3.1 & 3.2 (Pages 13-14) do not convince me that the calibrations are accurate. Perhaps there is additional supporting information on this model. Simplifying assumptions were made in order to simulate seiche activity (inherently a 3-dimensional phenomenon) with a 1-dimensional model. A 3-dimensional hydrodynamic model, coupled with a water quality model (as proposed by Tetra Tech), would be needed to simulate the full plan and evaluate various withdrawal and recycle strategies to control H_2S. Absent such a model, other mechanisms and SSA plan features should be considered in assessing the viability of the SSA plan with respect to H_2S problems, as discussed below.

It is not clear that stable stratification would be "worse" than the existing situation with respect to H_2S and risk of catastrophic surface oxygen depletion. I understand that massive fish kills at the Sea's northern end have been associated with seiche events that transport large quantities of H_2S rich bottom water into localized areas and cause sudden oxygen depletion and atmospheric H_2S releases. Seiche upwelling events can be characterized as "flows" that transport bottom water from far reaches of the Sea into localized surface waters. Seiche upwelling or other wind-mixing events can occur in summer when saturation dissolved oxygen concentrations are low and the thermocline is shallow, so there is a relatively small mass of oxygen in the water column to offset the H_2S load, as compared with turnover events in the fall/winter.

According to the 1-D model, vertical mixing events would be less likely under the SSA plan, particularly during summer. Turnover events may occur (if at all) over the entire Sea and be diluted in a much larger volume of surface water, as compared with localized seiche upwelling. Any turnover events would tend to occur during fall/winter, when water temperatures would be lower, oxygen concentrations in the surface water would be higher because of the higher saturation values, and when the thermocline would be lower. Even if the rate of H_2S generation were constant, the buildup of H_2S concentrations in the hypolimnion would be limited to some extent by diffusion across the thermocline. The higher surface dissolved oxygen concentration and greater epilimnion volume in the fall/winter would reduce the risk of surface oxygen depletion following an H_2S recycle event for a given initial H_2S concentration in the bottom water, as compared with summer mixing events and oxygen depletion occurring in the existing Sea.

If a 35 ppb TP goal were achieved, the corresponding ~65% reduction in Sea TP concentrations would be expected to provide a ~78% reduction in mean chlorophyll-a concentration (Jones/Bachman regression). That would, in turn, reduce the organic load on the bottom waters that is the primary fuel for H_2S generation. The percentage reduction in H_2S generation would tend to be larger than the percentage reduction in organic load because a portion of the oxygen demand is satisfied by the oxygen and nitrate present in the water column when stratification first develops and by diffusion of oxygen across the thermocline.

Aside from phosphorus control, another component of the SSA plan (withdrawal, treatment, and recirculation of bottom waters) is designed to reduce the risk that H_2S will be a problem in the future. This measure could reduce H_2S accumulation in the bottom waters by four potential mechanisms: (1) removal of H_2S from the bottom and subsequent treatment; (2) reduction in vertical density gradients resulting from withdrawal of cool bottom waters; that would promote H_2S oxidation within the Sea by increasing the diffusive exchange of hydrogen sulfide and oxygen across the thermocline; (3) lowering the thermocline (assuming that the recycle stream is heated to surface temperatures before being discharged back into the surface of the north basin) and thereby increasing the volume of oxygenated surface water available to offset H_2S releases; (4) reducing the surface area of the hypolimnion as a consequence of the deeper thermocline.

Based on the morphometry of the north basin, withdrawal of 770 kac-ft/yr (700 kac-ft/yr for the recycle stream and 70 kac-ft/yr for the salt sink) from the bottom would displace the volume between elevations -260 and -279 feet (bottom of basin). With a surface elevation of -231 feet, that would correspond to the water depths between 29 and 48 feet. That would displace about 55% of the hypolimnetic volume, assuming an average thermocline depth of 20 ft. If the withdrawal rate were constant over the year, the volume displacements during the stratified period would be about half of those indicated above. Hydrodynamic modeling is needed to evaluate the net effects on stratification and H_2S buildup.

If it turns out that higher withdrawal rates are needed to sufficiently control the stratification and H_2S buildup, one additional option would be to increase the withdrawal rate but return a portion directly to the surface waters of the north basin, since the 700 kac-ft/yr recycle stream is constrained by the need to control salinity in the south basin.

While there is uncertainty in forecasting the net effect of all of the above mechanisms and controls on the H_2S problem, the SSA's Plan is sufficiently viable as to justify further evaluation. The 3-D hydrodynamic and water quality modeling effort will provide substantial additional information. In any case, the Plan should not be rejected based upon pessimistic forecasts derived from the 1-D model, which do not account for several important factors and which I believe over-state the stratification and H2S buildup problems potentially developing in the north basin as a consequence of its smaller surface area relative to the existing Sea.

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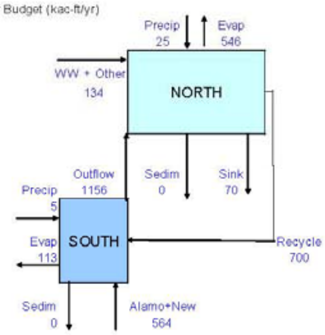
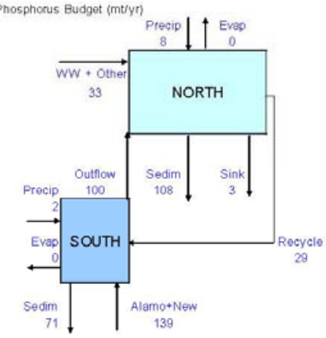
Table 1 – Water & Mass Balances for Inflow TP = 200 ppb

Salton Sea Water & Mass Balances

Water Budget (kac-ft/yr)



Phosphorus Budget (mt/yr)



Model Inputs in Red

			SSA Plan	
		Existing	South	North
Area	mi2	366	32	155
Mean Depth	ft	31	15	30
External Inflow	kac-ft/yr	1278	564	134
Inflow Salinity	ppt	2.2	3.5	3.5
Inflow TP	ppb	896	200	200

Recycle Flow	kac/ft/yr	700
Rainfall	in/yr	3
Evaporation	in/yr	66
Atmos P Deposition	mg/m2-yr	20

Predicted Lake Conditions		Existing	South	North	Notes
Lake TP	ppb	95	70	34	Canfield/Bachman Lake P Retention Model
Lake Chl-a	ppb	63	40	14	Jones/Bachman Chl-a vs. TP Regression
Bloom Freq	%	89%	63%	4%	BATHTUB Freq Chl-a > 30 ppb, Lognormal, CV = 0.5
Transparency	m	0.6	0.8	1.8	BATHTUB Secchi vs. Chl-a Model
Salinity	ppt	58	23	35	Mass Balance
H2O Resid Time	yrs	150.5	0.3	3.9	Sea Volume / Outflow
TP Resid Time	yrs	0.60	0.16	0.89	TP Mass in Lake Water Column / Inflow Load

Water Budget (kac-ft/yr)	Existing	South	North
Recycle Inflow		700	1156
External Inflow	1278	564	134
Precipitation	59	5	25
Total Inflow	1337	1269	1315
Evaporation	1288	113	546
Sedimentation			
Total Outflow	48	1156	770
Recycle Outflow			700
Sink			70

Salinity Budget (kmt/yr)	Existing	South	North
Recycle Inflow		30.3	32.7
External Inflow	3.5	2.4	0.6
Precipitation			
Total Inflow	3.5	32.7	33.3
Evaporation			
Sedimentation			
Total Outflow	3.5	32.7	33.3
Recycle Outflow			30.3
Sink			3.0

		SSA Plan	
Salinity Conc (ppt)	Existing	South	North
Recycle Inflow		35.1	22.9
External Inflow	2.2	3.5	3.5
Precipitation			
Total Inflow	2.1	20.9	20.5
Evaporation			
Sedimentation			
Total Outflow	58.3	22.9	35.1
Recycle Outflow			35.1
Sink			35.1

P Budget (mt/yr)	Existing	South	North
Recycle Inflow		29	100
External Inflow	1414	139	33
Precipitation	19	2	8
Total Inflow	1433	170	141
Evaporation			
Sedimentation	1427	71	108
Total Outflow	6	100	32
Recycle Outflow			29
Sink			3

P Conc (ppb)	Existing	South	North
Recycle Inflow		34	70
External Inflow	896	200	200
Precipitation	262	262	262
Total Inflow	869	109	87
Evaporation			
Sedimentation			
Total Outflow	95	70	34
Recycle Outflow			34
Sink			34

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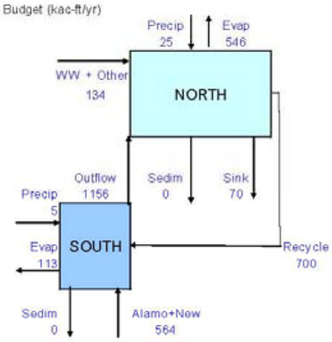
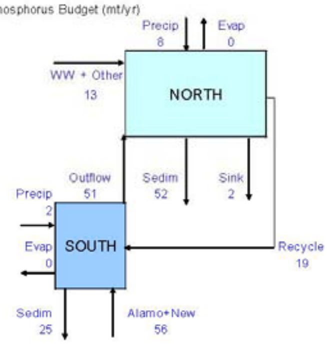
Table 2 – Water & Mass Balances for Inflow TP = 80 ppb

Salton Sea Water & Mass Balances

Water Budget (kac-ft/yr)



Phosphorus Budget (mt/yr)



Model Inputs in Red

			SSA Plan	
		Existing	South	North
Area	mi2	366	32	155
Mean Depth	ft	31	15	30
External Inflow	kac-ft/yr	1278	564	134
Inflow Salinity	ppt	2.2	3.5	3.5
Inflow TP	ppb	896	80	80

Recycle Flow	kac/ft/yr	700
Rainfall	in/yr	3
Evaporation	in/yr	66
Atmos P Deposition	mg/m2-yr	20

Predicted Lake Conditions					Notes
Lake TP	ppb	95	36	22	Canfield/Bachman Lake P Retention Model
Lake Chl-a	ppb	63	15	7	Jones/Bachman Chl-a vs. TP Regression
Bloom Freq	%	89%	5%	0%	BATHTUB Freq Chl-a > 30 ppb, Lognormal, CV = 0.5
Transparency	m	0.6	1.7	2.6	BATHTUB Secchi vs. Chl-a Model
Salinity	ppt	58	23	35	Mass Balance
H2O Resid Time	yrs	150.5	0.3	3.9	Sea Volume / Outflow
TP Resid Time	yrs	0.60	0.18	1.12	TP Mass in Lake Water Column / Inflow Load

Water Budget (kac-ft/yr)			
Recycle Inflow		700	1156
External Inflow	1278	564	134
Precipitation	59	5	25
Total Inflow	1337	1269	1315
Evaporation	1288	113	546
Sedimentation			
Total Outflow	48	1156	770
Recycle Outflow			700
Sink			70

Salinity Budget (kmt/yr)				Salinity Conc (ppt)	Existing	SSA Plan South	SSA Plan North
Recycle Inflow		30.3	32.7	Recycle Inflow		35.1	22.9
External Inflow	3.5	2.4	0.6	External Inflow	2.2	3.5	3.5
Precipitation				Precipitation			
Total Inflow	3.5	32.7	33.3	Total Inflow	2.1	20.9	20.5
Evaporation				Evaporation			
Sedimentation				Sedimentation			
Total Outflow	3.5	32.7	33.3	Total Outflow	58.3	22.9	35.1
Recycle Outflow			30.3	Recycle Outflow			35.1
Sink			3.0	Sink			35.1

P Budget (mt/yr)				P Conc (ppb)			
Recycle Inflow		19	51	Recycle Inflow		22	36
External Inflow	1414	56	13	External Inflow	896	80	80
Precipitation	19	2	8	Precipitation	262	262	262
Total Inflow	1433	76	73	Total Inflow	869	49	45
Evaporation				Evaporation			
Sedimentation	1427	25	52	Sedimentation			
Total Outflow	6	51	21	Total Outflow	95	36	22
Recycle Outflow			19	Recycle Outflow			22
Sink			2	Sink			22

3/22/2006

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March 20, 2006

Ronald Enzweiler
Executive Director
Salton Sea Authority

Dear Mr. Enzweiler,

Thank you for giving me the opportunity to become reinvolved in the Salton Sea restoration effort. I was previously involved in the Salton Sea as a team member on the Parsons' "Analysis of Restoration Options" independent technical review study conducted in 2000, and on the subsequent Agrarian Research solar-pond pilot project.

I have been working professionally in the solar salt industry since 1977. I currently consult worldwide on salt, including environmental projects that remove salts from an area or process. My professional experience includes managing the operations of the 40,000 acres of commercial solar salt ponds that were located in San Francisco Bay. These facilities produced 1,250,00 tons/year of 99% pure sodium chloride (NaCl) salt by the controlled evaporation of San Francisco Bay water (which contains about 10,000 mg/L of total dissolved solids). In my 21 years of work at these Cargill facilities, we never experienced blowing dust or other air quality problems, including odor complaints in the salt crystallizers while in operation. New housing developments and commercial buildings were built within 1 mile of these solar ponds on both ends of the Dumbarton Bridge without dust or odors being an issue.

You have presented an overview to me of the current Salton Sea Authority (SSA) plan. That plan includes maintaining the current water level over most of the existing shoreline, and addresses odors, salinity and other water quality and habitat issues. A major feature of the plan is to create an isolated brine pool and salt deposit area by installing a perimeter dike around the south end of the current Sea.

The Agrarian Research (AR) project and the work done by the Bureau of Reclamation at the Salton Sea Test Base demonstrate conclusively that a thick salt deposit can be made from Salton Sea water. The AR test results show that 1.6 ft of deposit can be made in one year and that about 1 ft can be deposited during the warm months in a managed salt crystallizer pond. The solids deposited were about 87% NaCl. This thickness and quality could be duplicated in the exposed areas within the south basin in the current SSA project plan. With further work, there is a possibility that the percentage of hard-surface NaCl

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Ronald Enzweiler
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salt in the protective salt desposits can be increased to improve the durability of this low-cost dust-control mitigation measure. The technique to achieve a high NaCl content in the protective salt deposits in the SSA Plan would be the same as the techniques used in the commercial solar salt industry, namely: once the salinity in the crystallizer ponds reaches a certain point, the remaining supernatant (i.e., the brine containing the sodium sulfate salt and other more soluble salts) would be decanted off and channeled into the brine pool that will form and permanently exist in the lower depths of the south basin. Rain could also be a mechanism for purifying the salt deposit by removing the more soluble sodium sulfate that can co-precipitate with the sodium chloride. This would require establishing a method of draining away entrained brine in the selected areas. The approach would require the construction of berms at 3-to-5 ft contour levels around the upper areas of the south basin. However, given the layout of the SSA Plan, these "terraced" crystallizer basins could be fed by gravity from the brine outflow at the foot of the Saline Habitat Complex (SHC) located along the upper eastern perimeter of the south basin. Thus, pumping and other O&M costs to form a thick salt deposit in the lower exposed areas of the south basin would be minimal.

A managed salt deposit with such a high content of NaCl would be a competent and highly cemented body capable of supporting repeated use of heavy equipment if desired. This characteristic is seen all over the world in salt deposits high in sodium chloride content, regardless of the other co-precipitated salts. I believe that forming a thick, competent deposit high in NaCl on top of the exposed areas within the south basin in the SSA Plan is a well proven concept that is both feasible and technically sound.

Any salt deposit exposed to the elements will require some maintenance. This is part of managing the deposit. Occurrences such as localized upwelling, seepage from the dike, and rain can dissolve the salt deposit. Upwelling and seepage tend to be localized in their effects, while rain is more generalized in its effect. There are established methods for both reducing seepage and upwelling at their source, and negating the adverse effects of either. Although rain at less than 3 inches per year is minimal, it would eventually remove enough of any deposit to require reestablishing the salt layer. The salt desposit could be reestablished simply by refilling each crystallizer basin with brine from the SHC outflow and decanting the supernatant on a periodic, "as required" basis. Based on my professional experience, I see this rebuilding operation being required on roughly 10-year or longer cycles.

Thank you again for giving me the opportunity to work with you on the Salton Sea restoration project. Please let me know if you have any questions or would like for me to perform further work on this assignment.

Regards,

John Pyles

cc: William Brownlie, Tetra Tech

Appendix C: MASTER DEVELOPMENT PLAN

The complete Master Development Plan as prepared by Mooney Jones Stokes is available under separate cover. A four-page summary is included on the following pages.

Salton Sea Authority
Salton Sea Master Development Plan Update

Mooney • Jones Stokes
January 23, 2006

Introduction

The following information is a description of the draft Master Development Plan for the Salton Sea Authority's 300,000 acre planning/financing district around the Sea. The information incorporates public input gathered from a series of community workshops held in the Salton Sea vicinity and discussions with the land use jurisdictions. It is intended to demonstrate the type and intensity of future land uses that would be developed around a revitalized Salton Sea.

Land Uses

The following are descriptions of the land uses included in this draft Master Development Plan.

Seaside Village: The Seaside Villages will be designed with New Urbanism principles and will be walkable, vibrant and compact, mixed-use communities that embody a sense of place. In maintaining the unique water-oriented opportunities of the Salton Sea, each village will be located along the water with marinas and public beaches. The core of the village will emphasize an integration of higher-density uses including mixed-use, commercial, residential, institutional and public spaces. Moving away from the village core, land uses will become less dense and more residential. Average gross residential density within a Seaside Village is anticipated to range from 8 to 10 dwelling units per acre. Each village will be surrounded by open space or recreational uses as a means to define each Seaside Village. The following are examples of uses that may be included in each Seaside Village:

- Multi-Family Residential
- Commercial Mixed-Use
- Tourist Commercial
- Marina Commercial
- Single-Family Residential
- Marina Residential
- Highway Commercial
- Arts Community
- Institutional (i.e. medical facilities, schools, public spaces, civic uses

Residential: In areas just outside the Seaside Villages, and in other parts of the Salton Sea region, there will be areas designated primarily for residential use with limited neighborhood commercial. It is anticipated that these residential uses will be predominately single-family with the potential for limited multi-family residential. Average gross residential densities are anticipated to range from 4 to 6 dwelling units per acre. There are already approximately 29,000 existing mapped lots in the Salton Sea region and it is anticipated that the existing lots outside of the Seaside Villages will continue to remain designated as residential. Other specific areas of residential use could be age qualified to provide single-family or multi-family residential opportunities for seniors. At a gross density of 4du/ac for Residential and 8 du/ac for Seaside Village, the dwelling units total about 250,000. Tribal Residential on about 5,000 acres not included in this figure. The build-out on these lands would bring the total projected housing element in the 300,000 acre planning area to approximately 300,000 units.

Tribal Residential: A variety of residential land uses are allowed in this land use category as described in Category 1 of the Torres-Martinez Reservation Land Use Plan. Some compatible

\\SSAADMFS1\Users\renzweiler\My Documents\MDP Write-up MJS.doc land uses allowed in Category IV, such as Historical, Cultural, Tribal Governance and Public Facilities are included in the Tribal Residential land use category.

Tribal Uses: Typical land uses included in this land use designation include Category IV uses such as Historical, Tribal Governance, Cultural and Public Facilities as described in the Torres-Martinez Reservation Land Use Plan.

Entertainment: There will be unique opportunities for entertainment uses on the trust land of the Torres Martinez Desert Cahuilla Indian Tribe. It is anticipated that there will be one major center on the North Lake that may include a casino, hotel and other entertainment-related uses. A similar establishment on the south shore of the revitalized Sea is also desirable. The following is a list of possible entertainment land uses:

- Casino
- Hotels
- Restaurants
- Live Theater/Music Venues
- Marinas
- Museums
- Amusement/Water Park

Commercial Center: At several locations along the State Route 86 corridor, there will be a commercial center for highway, tourist, and business park commercial uses. These commercial uses will consist of regional scale commercial uses rather than the local commercial and mixed-use areas of the Seaside Villages.

Employment: There are opportunities for light industrial, institutional and educational uses on the west side the State Route 86 transportation corridor in the vicinity of Salton City. It will be integral to the success of the region to maintain an employment base so that people living in the Salton Sea region will have the opportunity of also working in the area. Examples of uses that may succeed in the Salton Sea region on the west side of State Route 86 include the following:

- Research and Development
- Office Parks
- Airports
- Education Centers/Universities
- Medical Facilities
- Light Manufacturing
- Publishing and Printing
- Repair Shops
- Warehousing and Wholesale Distribution

RV Park: This land use designation will provide support facilities for visitors with recreational vehicles. These facilities should be located in various areas around the Salton Sea for visitors interested in a variety of recreational opportunities.

Open Space/Recreation: Open space areas are used for preservation of natural habitat and cultural resources, passive recreation, or active recreation.

— *Habitat:* A large portion of the area surrounding the Sea will be set aside for preservation restoration and conservation including a reconfigured Sony Bono National Wildlife Refuge. These habitat areas are located in the eastern portion of the southern Estuary Lake, an area to the north of the primary east-west dike and along the Whitewater River corridor north of the Sea and in the North Lake itself in the vicinity of the Whitewater River delta. There is also an opportunity to create a saline habitat complex within the salt sink portion of the Sea. In some cases, these areas will be preserved in their existing natural condition; and in other cases constructed wetlands and other habitat-friendly features will be added. There may be opportunities for interpretive centers and limited institutional uses for the purposes of education and research.

— *East Shores Open Space:* There is an opportunity to provide additional recreational camping and RV Park facilities immediately adjacent to the east of the Salton Sea State Recreation Area. Uses for the areas between the State lands and the Chocolate Mountains are still being considered for this area but will likely be active recreation, passive recreation or maintained as natural habitat. Existing and future recreation/resort development associated with hot springs resources would be consistent with open space uses.

— *Recreation:* The Salton Sea has a history of being a destination for active recreational and leisure activities. The following examples of recreational uses will be included in open space areas surrounding the Sea:

- Trails
- RV Parks
- Parks
- Camping
- Rock Hounding
- Natural History Museum
- Fisheries/Fish Farming
- Off-Road Vehicles

Between the Seaside Villages, active recreational uses may be used to separate each community. The following are several examples of what uses may be seen in these areas:

- Golf Course
- Golf Course Residential
- Bicycle/Pedestrian Trail

Agriculture: The opportunity to continue existing agricultural uses is desirable for the economic vitality of the Salton Sea region. The reality, however, is that demand for new housing and increasing property values already are driving the conversion of agricultural land in the Coachella Valley to urban uses. Over 50,000 homes on converted agricultural lands are in the planning process in unincorporated Riverside County (e.g., Santa Rosa, Thermal, Mecca and Oasis areas) in proximity to the northern rim of Salton Sea. As this conversion continues, it is likely that agricultural production in the Coachella Valley will be significantly reduced over the next 30 years or so. With a revitalized Salton Sea that provides recreational and economic development opportunities along the southwestern rim of the current Sea, a similar conversion of agricultural lands to urban development along the State Route 86 corridor north of Westmoreland is likely to occur. However, unlike the Coachella Valley, the 10,000 to 15,000 acres of agricultural lands that potentially may be converted to urban development as a consequence of a revitalized Salton Sea will represent only a small fraction (less than 3%) of the existing 485,000-acre agricultural land base in Imperial County. No changes to the unique agriculture lands located southeast of the Sea (the Vail area) is planned or anticipated. Small-scale eco-tourist facilities, such as small bed and breakfast hotels or fishing camps would be allowed in this area when they would not conflict with agricultural operations.

Transportation Connections: Opportunities exist for transportation links that would including a "Seaside Parkway" adjacent to the Sea that runs parallel to State Route 86, but allows for internal circulation connecting each of the Seaside Villages to each other. A recreational multi-purpose trail could be built adjacent to this new parkway. Where the parkway intersects with the center of each Seaside Village, it is anticipated that there will be a lively, walkable, commercial center with opportunities for mixed-use development, public spaces, and community/civic uses.

Another unique transportation opportunity is for water taxis to connect to each of the Seaside Villages via the Sea, forming an additional connection between communities.

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SSA Plan for Salton Sea Revitalization & Restoration
Preliminary Ownership and Land-Use Statistics

Prepared by: Mooney • Jones Stokes

Land Ownership by Planning Areas within the SSA Infrastructure Financing District

Ownership	1	2	3	4	5	6	*Total*
Federal	22,622	4,452	2,161	12,296	10,065	7,682	**59,278**
Private	20,551	29,678	30,441	8,123	62,420	26,984	**178,197**
State	883	1	4,748	893	608	1,017	**8,150**
Local Agencies	2,106	3,982	6,592	10,324	14,902	4,167	**42,073**
TM Tribe	0	11,280	6,720	0	0	0	**18,000**
Total	**46,162**	**49,393**	**50,662**	**31,636**	**87,995**	**39,850**	**305,698**

Existing Total Acres by Land-Use Category

Land Use	1	2	3	4	5	6	*Total*
Agriculture	813	27,207	370	1,174	47,813	202	**77,579**
Commercial	17	48	35	0	131	2	**233**
Manufacturing/Industrial	29	72	129	0	11	327	**568**
Military	0	0	54	7,356	0	0	**7,410**
Parks/Open Space	37	1,125	205	0	9,155	225	**10,747**
Public/Utility	310	102	27	0	431	360	**1,230**
Residential	329	625	522	4	176	215	**1,871**
Transportation	459	564	5	480	246	1,020	**2,774**
Vacant	43,639	18,716	49,168	22,529	25,081	37,197	**196,330**
Water	529	934	147	93	4,951	302	**6,956**
Total	**46,162**	**49,393**	**50,662**	**31,636**	**87,995**	**39,850**	**305,698**

Proposed Total Acres by Land-Use Category in SSA's Master Development Plan

Land Use	1	2	3	4	5	6	*Total*
Agriculture	0	1,733	0	3,368	55,275	0	**60,376**
Commercial	0	1,527	862	0	0	0	**2,389**
Employment	0	845	2,072	0	0	0	**2,917**
Entertainment	0	503	60	0	213	0	**776**
Parks/Open Space	34,622	19,866	32,756	11,696	18,652	38,233	**155,825**
Residential	10,028	17,501	11,199	13,847	6,538	0	**59,113**
RV Park	0	0	0	201	213	212	**626**
Seaside Village	358	574	2,978	1,741	1,239	175	**7,065**
Tribal Uses	0	154	0	0	0	0	**154**
Tribal Residential	0	4,946	0	0	0	0	**4,946**
Highway & Public Use	625	810	588	690	914	927	**4,554**
Water	529	934	147	93	4,951	303	**6,957**
Total	**46,162**	**49,393**	**50,662**	**31,636**	**87,995**	**39,850**	**305,698**

Note: Agriculture and open space account for **71%** *of the land uses in this development plan.*

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Appendix D: SALTON SEA AUTHORITY POLICIES AND RESOLUTIONS

Policies and resolutions of the Authority and its Board of Directors related to the multi-purpose plan are provided on the following pages.

SALTON SEA AUTHORITY BOARD POLICY POSITIONS

FOR

REVITALIZATION SALTON SEA AND ITS ENVIRONMENT AND PERMANENT ECOSYSTEM RESTORATION

Principles

- **Completely consistent with State's Salton Sea Ecosystem Restoration Plan "Drivers and Objectives for Development of Alternatives" (attached) and all application State legislation;**

- **Completely consistent with the Federal Salton Sea Restoration Act of 1998;**

- **Completely consistent with and supportive of the 2003 Quantification Settlement Agreement and Related Water Transfers, including the Environmental Impact Statement/Report certified by the Imperial Irrigation District Board of Directors that was used to obtain the enabling Water Rights Order from the State Water Quality Control Board;**

- **Completely consistent with the Coachella Valley Water Management Plan as approved by the Coachella Valley Water District Board of Directors;**

- **Completely consistent with and supportive of the Beneficial Uses for the Salton Sea established by Regional Water Quality Control Board in the Board's Colorado River Basin Water Quality Control Plan; and**

- **That these Policies be memorialized in a Collaborative Agreement among the Salton Sea Authority, the U.S. Dept. of Interior and the Resources Agency of the State of California once the U.S. Congress and the California State Legislature have enacted the required enabling legislation**

Salton Sea Ecosystem Restoration Plan

Drivers and Objectives for Development of Alternatives

Habitat

- Legislation
- Maintain species diversity and abundance
- Stabilize Salton Sea salinity and elevation
- Maximize habitat values (quantity and quality)
- Maintain mosaic of habitats, including agricultural lands
- Maintain pupfish habitat connectivity

Water Quality

- Legislation
- Minimize selenium and arsenic risks
- Improve water quality in aquatic habitats
    - e.g., Reduce eutrophication in the Salton Sea

Air Quality

- Legislation
- Minimize exposed playa and construction-related emissions
- Stabilize exposed playa

Water Infrastructure

- Water Balance
- Operational flexibility
- Seismic safety
- Configure to meet project objectives

Other Important Considerations

- Maintain Salton Sea as agricultural drainage repository
- Accommodate recreational and local economic opportunities

Policy Position of the Salton Sea Authority Board of Directors

Enacted: October 27, 2005___

DEFINITION OF SALTON SEA AUTHORITY PLAN FOR REVITALIZATION OF THE SALTON SEA AND ITS ENVIRONMENT AND PERMANENT ECOSYSTEM RESTORATION

The locally developed and preferred **Salton Sea Authority Plan** for Salton Sea revitalization and restoration shall include the following essential elements:

1. Recognition of the Salton Sea Authority's leadership role in the restoration project, representing regional interests in economic development and environmental restoration, coordinating with federal, state and local interests, and being responsible for constructing and operating restoration related facilities, without accepting responsibility for water-transfer related environmental impacts.

2. Maintenance of the Salton Sea as a repository for untreated agricultural drain water from the Imperial and Coachella Valleys.

3. Preservation and protection of: the water rights of the Imperial Irrigation District and the Coachella Valley Water District; the uses of water by each; the terms and provisions of the Quantification Settlement Agreement and Related Agreements; and the benefits accorded to the Imperial Irrigation District and the Coachella Valley Water District under Water Code section 1013 and under legislation adopted in 2003 to facilitate the Quantification Settlement Agreement in SB 277, SB 317 and SB 654.

4. A contractual commitment by the Imperial Irrigation District that it will not take actions beyond those set forth in the Quantification Settlement Agreement and Related Agreements, or as prudent to preserve and protect its water rights from reasonable use or water quality challenges, or as necessary to manage and operate the water supply within the Imperial Valley that will result in a material diminution in the volume of agricultural drain water.

5. Inclusion in the restoration project of a fresh water reservoir with approximately 200,000 AF storage volume constructed and maintained as part of the restoration project with a right for the Imperial Irrigation District to store water in the fresh water reservoir to enable the Imperial Irrigation District to better manage the fluctuations in Imperial Valley annual consumptive use and hence to better manage the fluctuations in agricultural drain water volumes that could benefit the Salton Sea**.** The SSA and IID shall use their best efforts to obtain state and/or federal grant funding to cover the incremental construction costs for the reservoir and shall share any remaining construction costs based on an allocation of benefits. O&M costs shall also be shared based on an allocation of benefits.

6. A restoration project design that accommodates elevation and salinity fluctuations in the Salton Sea reflective of fluctuations in annual consumptive use and drain volumes.

7. A restoration project design that, to the extent feasible, includes recreation compatible, open-water lakes in both the north and south ends of the current Salton Sea basin.

8. A restoration project design that is developed through public outreach and local land-use planning and that, to the extent feasible, maximizes economic development and recreational opportunities on a regional basis and respects tribal cultural and heritage values.

9. A financing plan that includes, to the extent feasible, the use of local tax-increment bonds, community facility district funds, private investor funding, a portion of local funds in the Salton Sea Restoration Fund controlled by the state legislature, and federal contributions.

10. A construction and operating plan that, to the maximum extent feasible, utilizes local labor resources, materials and suppliers and complies with all state, federal and tribal labor laws.

Policy Position of the Salton Sea Authority Board of Directors

Approved: June 23, 2005

REQUESTED FEDERAL INVOLVEMENT IN SALTON SEA REVITALIZATION AND RESTORATION EFFORTS FOR THE PHASED AND COORDINATED IMPLEMENTATION OF THE SALTON SEA AUTHORITY PLAN

The Salton Sea Authority requests the following support from the federal government for the phased and coordinated implementation of the Salton Sea Authority Plan for the revitalization of the Salton Sea and restoration of its ecosystem as a joint local, state and federal undertaking in accordance with Salton Sea Restoration Act of 1998 (PL 105-372) and the CALFED Bay-Delta Authorization Act of 2004 (PL 108-361):

1. Direction to the Bureau of Reclamation that the **feasibility study on a preferred alternative for Salton Sea restoration** referred to in Title II, Section 201 of PL 108-361 shall mean a **feasibility study performed by the Salton Sea Authority** with oversight by Reclamation on the final design for the Salton Sea Authority Plan for revitalization and restoration of the Sea in compliance with Salton Sea Restoration Act of 1998 (PL 105-372).

2. **Federal loan guarantee** on the $400 to $600 million in local tax-increment municipal bonds to be issued by the Salton Sea Authority to provide funding for constructing the water infrastructure components of the project.

3. **Conveyance of fee title** to certain federal lands, including the 7,240 acres of BLM land comprising closed Salton Sea Test Base, to the Salton Sea Authority so the Authority may sell and/or exchange such lands with private developers as a way to raise funding for the restoration project.

4. **Authorization** by the appropriate federal agencies for the Salton Sea Authority **to construct revitalization project facilities** on federal lands and to modify the configuration of the **Sonny Bono National Wildlife Refuge**.

5. Continued annual funding for the construction of **water treatment wetlands** on the New and Alamo River by the Citizens Congressional Task Force and funding for wetlands construction on the Whitewater River.

6. Authorization for the Bureau of Reclamation to serve as the lead agency and perform **Environmental Impact Statements** as required for implementation of the Salton Sea Authority Plan and for the construction of wetlands and/or selenium removal projects on the New and Alamo Rivers in Imperial County and the Whitewater River in Riverside County.

Policy Position of the Salton Sea Authority Board of Directors

Enacted: _October 27, 2005____

REQUESTED STATE INVOLVEMENT IN SALTON SEA REVITALIZATION AND RESTORATION EFFORTS FOR PHASED AND COORDINATED IMPLEMENTATION OF THE SALTON SEA AUTHORITY PLAN

In addition to having the lead role in determining, funding and implementing ecosystem restoration measures, the State of California shall:

1. At the appropriate time in the future, design, build and operate the measures required to mitigate for **air quality impacts** caused by the **water transfers** authorized under the Quantification Settlement Agreement to the extent required by / and in accordance with existing state law and the contractual documents related to the QSA.

2. Allocate to the Salton Sea Authority "first use" of funds from the **Salton Sea Restoration Fund** to provide a 25% cost-share of the Authority's capital costs for design, permitting and construction of the water infrastructure and water quality improvement facilities in the Salton Sea Authority Plan. The remaining funds in the SSRF shall be used, to the extent available, to provide 25% cost-share funding for items #3 and #4 below.

3. Support the Salton Sea Authority's request to obtain **Implementation Grant** funds under the Integrated Regional Water Management Program (Chapter 8, Proposition 50) being managed by the State Water Quality Control Board for the construction of water-quality improvement wetlands and/or selenium removal facilities on the New and Alamo Rivers in Imperial County and on the Whitewater River in Riverside County.

4. Support funding in future state bond measures for the purchase of private lands for the creation of **additional habitat areas** and/or for the **acquisition of wildlife easements** on private farmland around the Sea.

5. Have the Department of Water Resources' **Division of Safety of Dams** work with the Salton Sea Authority and its engineering consultants and construction contractors to ensure that all in-sea barriers are designed and built in accordance with all applicable state laws.

6. Make available to the Salton Sea Authority and its engineering consultants the finite element **water balance and water quality models** developed by the Department of Water Resources under its Salton Sea Restoration Study.

7. Direct Department of Fish and Game and State Park officials to work with the Salton Sea Authority on reconfiguring the **Salton Sea State Recreation Area** and the **Wister Unit of the Imperial Wildlife Area** so that the recreational and habitat values of these state lands are maintained after implementation of the Salton Sea Authority Plan.

IMPERIAL IRRIGATION DISTRICT
RESOLUTION 6-2006

SUPPORT OF THE SALTON SEA AUTHORITY POLICY POSITIONS FOR REVITILIZATION OF THE SALTON SEA ENVIRONS AND RESTORATION OF THE SALTON SEA ECOSYSTEM

WHEREAS, the Imperial Irrigation District (IID), formed under the laws of the State of California, operates and maintains a vast system of water control, conveyance and distribution facilities, and an extensive drainage network; and

WHEREAS, IID has rights to certain portions of the waters of the Colorado River, such rights having been appropriated and perfected at the beginning of the last Century and having been recognized by the State of California, the Congress, the Supreme Courts of the United States and the State of California, and by other individuals and entities; and

WHEREAS, water from the Colorado River, delivered through the All-American Canal, is the vital natural resource to the Imperial Valley and the very foundation for all present and future economic development; and

WHEREAS, additional transfers of conserved water would erode the foundation for future economic development in the Imperial Valley, especially if such transfers are based on the fallowing of productive farmland; and

WHEREAS, peace treaty provisions in the QSA and Related Agreements restrict transfers from IID to others outside of the Imperial Valley.

NOW, THEREFORE, be it hereby resolved as follows:

1) IID resolves that it will enter into a contractual commitment with the Salton Sea Authority to not take actions beyond those set forth in the Quantification Settlement Agreement and Related Agreements or as prudent to preserve and protect its water rights from reasonable use or water quality challenges, or as necessary to manage and operate the water supply within the Imperial Valley, that will result in a material diminution in the volumes of agricultural drain water available for the revitalization of the Salton Sea environs and restoration of the Salton Sea ecosystem

2) IID remains committed to the preservation and protection of: the water rights of the Imperial Irrigation District; the terms and provisions of the Quantification Settlement Agreement and Related Agreements; and the benefits accorded to the Imperial Irrigation District and the Coachella Valley Water District under Water Code section 1013 and under legislation adopted in 2003 to facilitate the Quantification Settlement Agreement in SB 277, SB 317 and SB 654.

3) IID recognizes the Salton Sea Authority's leadership role in the revitalization and restoration project, representing regional interests in economic development and environmental restoration, coordinating with federal, state and local interests, and being responsible for constructing and operating restoration related facilities, without accepting responsibility for water-transfer related environmental impacts.

4) The IID will support inclusion in the restoration project of a fresh water reservoir with approximately 250,000 AF storage volume constructed and maintained as part of the restoration project with a right for the Imperial Irrigation District to store water in the fresh water reservoir to enable the Imperial Irrigation District to better manage the fluctuations in Imperial Valley annual consumptive use and hence to better manage the fluctuations in agricultural drain water volumes that could benefit the Salton Sea. The Salton Sea Authority and IID shall use their best efforts to obtain state and/or federal grant funding to cover the incremental construction costs for the reservoir.

PASSED AND ADOPTED this 7th day of February, 2006.

IMPERIAL IRRIGATION DISTRICT
ORGANIZED
JULY 25, 1911
EL CENTRO, CALIFORNIA

President

Secretary

SALTON SEA AUTHORITY
RESOLUTION # 06-01

DEFINITION OF THE SALTON SEA AUTHORITY PLAN AND FOR THE REVITILIZATION OF THE SALTON SEA AND ITS ENVIRONMENT AND PERMANENT ECOSYSTEM RESOTORATION

WHEREAS, the Board has directed the Executive Director to develop a unified set of policy positions that defines the Salton Sea Authority's overall plans, objectives, and implementation strategy for implementing Salton Sea revitalization and restoration with the Authority in the lead role and,

WHEREAS, the Board has requested that the Imperial Irrigation District consider and adopt a resolution as per Salton Sea Authority Policy Position Definition of the Salton Sea Authority Plan for Revitalization of the Salton Sea and its Environment and Permanent Ecosystem Restoration and,

WHEREAS, the Imperial Irrigation District has adopted a resolution in conjunction with the Salton Sea Authority Policy Position Definition of the Salton Sea Authority Plan for Revitalization of the Salton Sea and its Environment and Permanent Ecosystem Restoration accepting the Salton Sea Authority Policy Positions and,

NOW THEREFORE, Let it be resolved as follows:

1. The Salton Sea Authority's Executive Director, with the assistance of legal counsel, is hereby authorized to enter into contract negotiations with Imperial Irrigation District (IID) for the purpose of memorializing the commitment that IID has expressed its willingness to make to the Authority, stating that: "IID will not take actions beyond those set forth in the Quantification Settlement Agreement and related agreements or as prudent to preserve and protect it's water rights from reasonable use on water quality challenges, or as necessary to manage and operate the water supply within the Imperial Valley, that will result in a material diminution in the volumes of agricultural drain water from IID farms that flow into the Salton Sea." This contract between the Authority and IID will be presented to the Authority's board of directors for its review and approval before it shall become effective.

2. The Salton Sea Authority shall remain committed to the preservation and protection of: the water rights of the Imperial Irrigation District and the Coachella Valley Water District; the uses of water by each; the terms and provisions of the Quantification Settlement Agreement and Related Agreements; and the benefits accorded to the Imperial Irrigation District and the Coachella Valley Water District under Water Code section 1013 and under legislation adopted in 2003 to facilitate the Quantification Settlement Agreement in SB 277, SB 317 and SB 654.

3. The Salton Sea Authority's accepts the assumption of a leadership role in the restoration project; and in assuming such role, the Authority shall seek to

promote regional interests in economic development and environmental restoration; shall coordinate its activities with federal, state and other local interests; and shall assume responsibility for constructing and operating restoration related project facilities, without accepting responsibility for water-transfer related environmental impacts.

4. Salton Sea Authority shall support the inclusion in the restoration project of a fresh water reservoir with approximately 250,000 AF of storage volume. This reservoir shall be constructed and maintained as part of the restoration project with a right for the Imperial Irrigation District to store water in the fresh water reservoir to enable the Imperial Irrigation District to better manage the fluctuations in Imperial Valley annual consumptive use and hence to better manage the fluctuations in agricultural drain water volumes that could benefit the Salton Sea. The Salton Sea Authority and Imperial Irrigation District shall use their best efforts to obtain state and/or federal grant funding to cover the incremental construction costs for the reservoir and shall share any remaining construction costs based on an allocation of benefits. O&M costs shall also be shared based on an allocation of benefits.

PASSED AND ADOPTED this 25th day of May 2006.

SALTON SEA AUTHORITY

[signature]
President

[signature]
Attest

SALTON SEA REVITALIZATION & RESTORATION

Salton Sea Authority Plan for Multi-Purpose Project

Ecological Features and Selenium Management

Salton Sea Authority

October 2006

Ecological Features and Selenium Management

The Authority Plan will provide the ecological benefits of a large deep-water lake with ocean-like salinity and good water quality coupled with shallow water features in areas that currently provide some of the best shallow water habitat in the existing Sea. The concept of a large lake in the desert is the historical feature that singularly established the Salton Sea as a paradise for over 400 species of birds. The nearly 160-sq.-mile lake area with depths exceeding 50 feet in the Authority project design will once again provide an abundant food source for fish eating birds that reside at the Sea or migrate along the Pacific Flyway. This is a critical project feature because deep anoxic water – as currently exists in the 50-ft-deep basins in the north and south ends of the present Sea - is required to perpetuate the selenium assimilation effect that has made selenium a non-issue with respect to wildlife impacts for a 100 years (USGS, 2003).

In addition to the habitat values provided by two multi-purpose lakes, the Authority project design includes (1) a 16,000-acre saline habitat complex in the south, (2) a 1,800-acre saline habitat complex by the Whitewater River delta, (3) dedicated habitat zones in both lakes, and (4) wildlife disease prevention program. These ecological features and Plan's unique selenium management capability are presented below. The habitat features and risk prevention measures in the Authority project design are collectively intended to provide the diversity, dispersion, quality, and quantity of habitat types necessary to achieve the "maximum feasible attainment" of the Salton Sea ecosystem restoration goals set out in State law.

Saline Habitat Complex

The creation of shallow salt-water habitat is an integral component of a comprehensive ecosystem restoration strategy incorporated into the Authority project design. As a compensating factor for the unavoidable elimination of approximately 165,000 acres of water surface area due to the inflow reductions, the Authority has included a 16,000-acre "Type 3" (Figure 1) shallow-water saline habitat complex (SHC) in the Authority project plan. This Type 3 SHC configuration was selected over the Type 1 and 2 configurations that include 20-ft-deep ponds because the 16,000 acres of 0-to-20-ft-deep lake water in the dedicated habitat zone in the south lake in the Authority project design obviates the need for deep ponds within the SHC itself.

Creation of a 16,000-acre shallow-water saline habitat complex would allow for reclamation of flooded areas of the Sony Bono Salton Sea National Wildlife Refuge (SBSSNWR) and provide significantly more shallow-water habitat than currently exists at the Sea. It is envisioned in the Authority Board Policy Positions that, as part of the Authority Plan, the SBSSNWR would be reconfigured to include this 16,000-acre saline habitat complex and the 16,000-acre eastern half of the new south estuary lake. Under this scenario, the U.S. Fish & Wildlife Service (USFWS) would be free to design the saline habitat complex and/or make changes in the design of the south lake to maximize habitat values based on its expertise and knowledge. Water management priorities would be established to ensure that the SHC has high priority for receiving water during low inflow periods. Such priorities would work with the overall plan since it would be necessary to maintain an outflow from the lake to the SHC area to control salinity levels in the large lake.

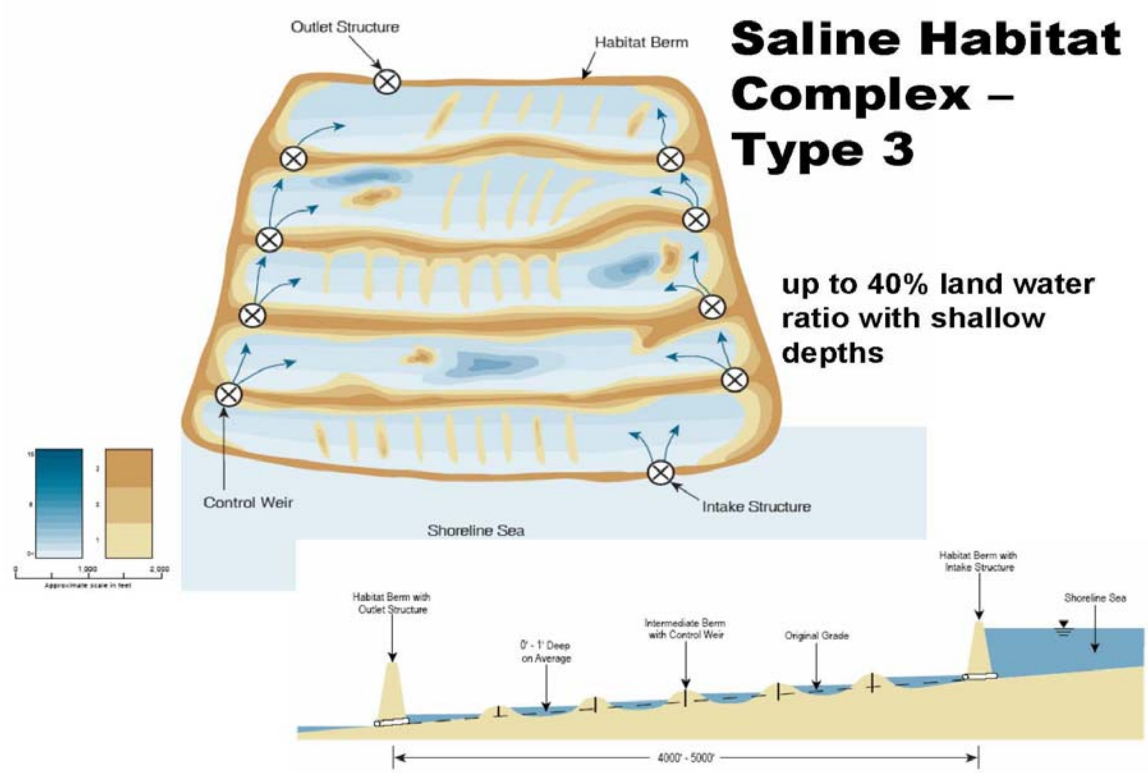

Figure 1. Schematic Drawing of Type 3 Saline Habitat Complex. Source: CH2M Hill, 2005.

A key issue in the design and operation of any SHC is the selenium concentration of the feed water. As noted earlier in this report, the Authority included 20,000 acres shallow brackish-water and saline-water habitat areas around the south basin in its original North Lake Plan. These areas were designated to be watered with New and Alamo River water (selenium concentrations ranging from 5 to 12 μg/L), Salton Sea water (selenium concentration of 1-2 μg/L), or a combination of both sources. The team of experts that reviewed the Authority's North Lake Plan in November 2005 included persons with direct knowledge of the selenium toxicity problems encountered at the Kesterson National Wildlife Refuge in Merced County in the 1980s when agricultural drainwater was used for watering habitat areas. In their written report, these experts specifically directed the Authority *not to* *use* New and Alamo River water, or a combination of river water and Sea water, to water any habitat areas (Pacific Institute, 2006).

Reclamation and the USGS Salton Sea Science Office are currently conducting a pilot project to investigate created shallow habitat using a combination of Alamo River water and water from the Salton Sea. The investigation will include an analysis of selenium bioaccumulation. Information from the shallow habitat pilot project will be helpful in developing the final designs for the SHC. As currently planned, the Authority has sized the SHC in its project plan and has developed its water management strategy using saltwater discharged from the north lake with projected selenium concentration of 1-2 μg/L as the primary supply for SHC areas. Additional brackish water from the south lake area will be blended to complete the supply for the SHC. The Authority has assumed that about 50% of the 16,000 acre SHC are in the south would be wet, whereas the State has assumed 60% would be wet as shown in Figure 1. Slight adjustments to the dike configuration in the Authority Plan would allow for the additional 10,000 AFY that would be needed for the added wet area.

Early Start for Habitat Features

As the inflow to the Sea declines in the future and the surface area begins to shrink, salts and other constituents will become more concentrated providing greater stress to the existing fish populations. Therefore, the ability to create habitat features early in the implementation process will be an important element for any Salton Sea revitalization plan. The area designated for the SHC in the southern area of the current Salton Sea could be contoured through hydraulic dredging. As the Sea recedes, the contoured areas would serve as the pools and islands shown in Figure 1. A pump system would be installed to bring salty lake water to the upper reach of the SHC and then blend with river water to serve as the water supply for the complex. Salinity management would be accomplished by the blend and may vary seasonally or be adjusted through an adaptive management process. The shallow habitat pilot project being conducted by Reclamation and the USGS Salton Sea Science Office uses such a pumping system that blends lake water with river water to provide a gradient of salinities across the project area.

Construction of the SHC could be accomplished in phases and could commence as soon as the design and environmental compliance and permitting process is completed. Figure 2 illustrates a conceptual phasing plan. This plan shows diked areas along five-foot contours. Under this scheme, hydraulic dredging would be used to contour the area of Phase 1 to create areas that would become pools and islands as the Sea level recedes. Dredge spoil would be placed along the five-foot contour lines to serve as berms. As the lake level retreats and the first phase is completed, dredging could begin in the second phase area and the process would be repeated until the entire SHC is complete.

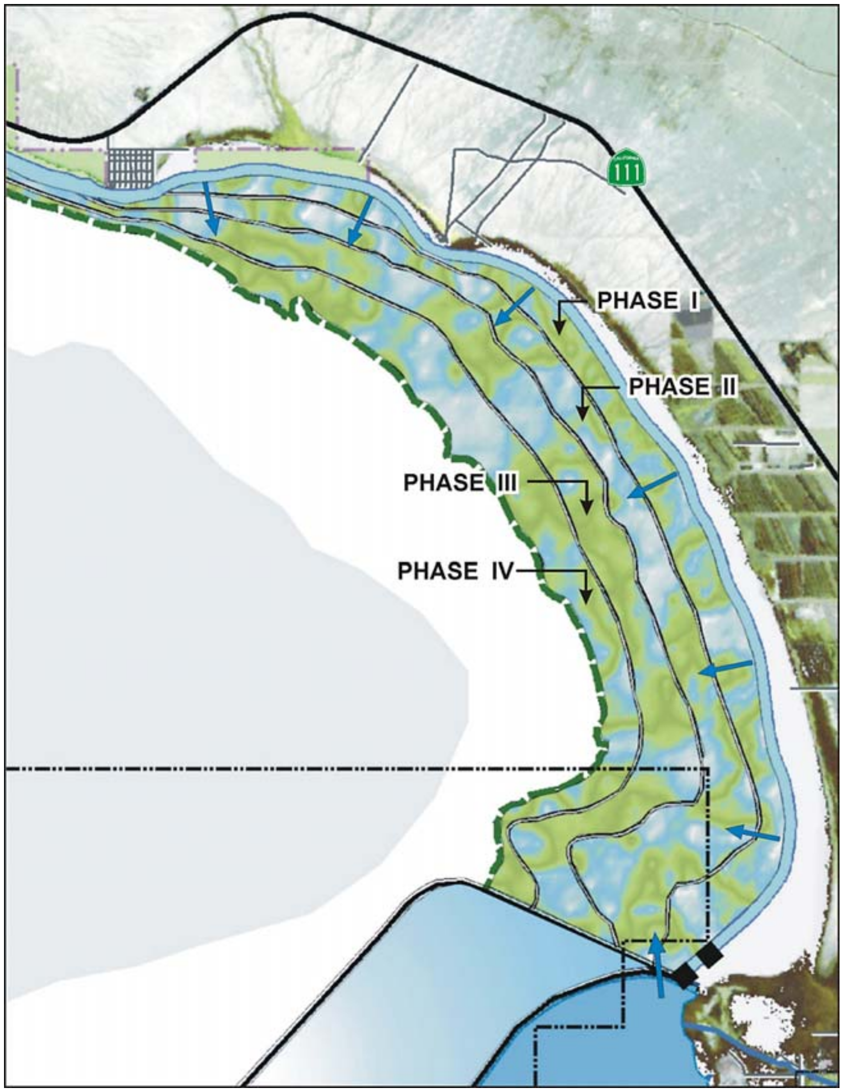

Figure 2. Potential Phasing to Allow Early Construction of Saline Habitat Complex.

The timeline for the Authority Plan is being developed to show the construction of these areas at the earliest practical time with appropriate budget. Specific details about the construction plan will be developed at the next phase of design during the site-specific EIR process.

Dedicated Habitat Zones

Dedicated Habitat Zones are proposed along the central embankment and on the eastern side of the south lake area. The zone in the south is a no-motorized-boating zone and the zone along the center dike is a no-boating zone. Both would be designated by buoys and the latter may include booms or a floating chain. No special water quality or flow controls would be required. The no-boating zone along the dike also includes safety considerations for seismic events. These areas would offer less disturbance to wildlife than other areas where motorized boating would be allowed.

Wildlife Disease Control

The Authority's comprehensive restoration strategy includes an integrated approach to wildlife disease control to reduce the incidences of wildlife disease at the Sea. Avian disease at the Salton Sea has been a chronic problem resulting in an annual loss of several thousand birds. Major epizootics (quickly spreading disease among animals) increased in frequency during the 1990s, which greatly increased the level of losses. During 1992, more than 150,000 eared grebes (*Podiceps nigricollis*) died during a single event of undetermined origin. The deaths of thousands of white pelicans (*Pelecanus erythrorhynchos*) and more than 1,000 endangered California brown pelicans (*P. occidentalis*) during 1996 from type C avian botulism focused national attention on the Salton Sea. This event served as a catalyst to begin the current Salton Sea Restoration Project.

Other diseases affecting birds of this ecosystem are avian cholera, Newcastle disease, and salmonellosis. Algal toxins are a suspected, but unproven cause of grebe mortality. Outbreaks of avian cholera affect a wide variety of bird species and have become annual events, causing the greatest losses in waterfowl, eared grebes, and gulls. Newcastle disease devaStated the Mullet Island double-crested cormorant (*Phalacrocrax auritus*) breeding colony at least twice during the 1990s. Salmonellosis has been primarily a cause of mortality in breeding colonies of egrets. Several other diseases have also been diagnosed as contributing to avian mortality at the Sea.

USFWS, with support from DFG, have conducted an on-going program to combat disease at the Salton Sea by providing response to bird die-offs. An initiative of the Salton Sea Restoration Project in the early 2000s to augment USFWS surveillance efforts enhanced the early detection of disease, and was another successful first step in minimizing losses. The existing efforts and activities are important steps to address disease impacts and should be continued and enhanced. Major bird mortality events have essentially not occurred in the past several years.

An enhanced approach that provides a continual interface between environmental monitoring, disease surveillance and response, and scientific investigations of disease ecology would be the next step. Expanded wildlife rehabilitation would also be provided because the avian botulism problem continues to affect pelicans at the Salton Sea. Therefore, the goal for the long-term disease control effort would be to provide an integrated approach to controlling wildlife disease (including fish and birds) at the Salton Sea in a manner that enhances opportunities for wildlife managers to minimize disease events and associated losses. This approach would include programs to monitor environmental conditions; detect, diagnose, and respond to disease events; collect and rehabilitate afflicted wildlife; and further development of a sound understanding of disease ecology at the Sea.

Selenium Management

The Authority believes its project plan provides the best configuration for retaining the Sea's historical capacity to assimilate the estimated 10 tons/year of selenium that flows into the Sea each year along with the agricultural drainage water (Setmire, 1998)[1]. This is an important, and in the Authority's opinion overriding, factor in selecting a preferred restoration project design that receives State and possibly Federal funding.

The Authority has reviewed treatment technologies for removal of selenium from agricultural drainage flows and New and Alamo River water. The Authority staff met with IID staff, various technology vendors, and the project manager for Reclamation's San Luis Drainage Features Reevaluation (SLDFR) project in the San Joaquin Valley. Reclamation's SLDFR project is relevant since this project included the field pilot testing of a biological selenium removal process that is now a component of Reclamation's "preferred project" approach for removing selenium from agricultural drainage water in the San Joaquin Valley. After investigation of the potential applicability of this process under various schemes to the situation at the Salton Sea, Authority staff concluded, and DWR staff concurred, that treatment technology is infeasible as a selenium management strategy at the Salton Sea. (IID and Reclamation had reached this same conclusion in their EIS/EIR for the Transfer Project/QSA in 2002.) Accordingly, the Authority Plan relies on the source of water for the SHC which is most likely to be the lowest in selenium, i.e. the lake water, as discussed above.

The State Board and others have formed collaborative partnerships for implementing selenium source control efforts within the upper basin States on the Colorado River system (Utah, Colorado and Wyoming) that are the original source of the selenium that eventually makes it way into the Salton Sea (SWRCB, 2006). These efforts have had only nominal success, and the possibly of achieving significant reductions in the future is improbable unless large acreages of farmland in the upper basin States are taken out of production. This is not likely to happen. (Comments by upper basin officials at the WEF-sponsored Selenium Summit in November 2005.)

Since treatment and source control are not feasible, the only feasible long-term solution to the selenium management issue at the Salton Sea is to design the ecosystem restoration project so that the natural selenium assimilation capacity of the Sea -- which has prevented any known selenium-related wildlife impacts over the last 100 years -- is retained. Thus, the only "highly likely" case for retaining the Sea's selenium assimilation capacity is a project design that retains a 50-ft-deep lake of comparable size as the existing water

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[1] The Setmire reference is to his 1988-89 field sampling of selenium concentrations and loads in the Alamo and New Rivers which totaled 8.2 tons. Allowing for direct drains, the Whitewater River, and other sources, this figure has been adjusted to 10 tons/year. Inflows and selenium concentrations have not changed materially since 1988-89. The Authority is not aware of a more recent or more definitive analysis of selenium mass loading into the Sea.

body in either the north or south basin of the present Sea. This consideration was a major factor in the design and selection of the North Lake Plan as the Authority's preferred project in April 2004.

The Sea's natural ability as a 50-ft-deep water body to assimilate and render harmless the 10 tons/year of selenium load was documented at a meeting of 13 selenium experts convened by USGS Salton Sea Science Office in March 2003. The various selenium assimilation mechanisms these experts identified as being at work in the Sea are identified in the diagram from the meeting report shown in Figure 3. Other key findings from this meeting were:

- *Current inflows to the Sea contain low to moderate levels of selenium. However, because the inflow volume of water is so great, total selenium burden to the Salton Sea annually is equivalent to that of Kesterson Reservoir.*
- *The existing Sea appears to accommodate selenium. While most major ions increase by evaporative concentration in the Salton Sea, water-borne selenium levels are lower in the Sea than in the inflows. In contrast to major ions, selenium in water entering the Sea is diluted by the lower selenium concentration water in the Sea where it is continually removed by a variety of biological processes.*
- *Selenium is currently bioavailable through invertebrate and fish consumption of bacteria and algae in the water column or in shallow sediments. However, the greatest portion of this selenium appears to become incorporated into deep anoxic sediments as the algae and bacteria die, becoming a detrital rain. These deep sinks [in the north and south basins] have little or no biological activity, and thus for all practical purposes the selenium is biologically unavailable so long as the deep water and anoxic sediment conditions are maintained. (USGS, 2003).*

Preserving a 50-ft-deep anoxic sink as a proven long-term solution to potential wildlife impacts from selenium bioaccumulation is a unique feature of the Authority Plan among eight alternatives under consideration in the Agency's Ecosystem Restoration study. Given the Kesterson experience and the fact that providing safe, sustainable habitat for wildlife is the main objective of the Agency's legislatively mandated study, it seems implausible that any plan could be rated higher than the Authority Plan on providing the legislatively mandated wildlife values.

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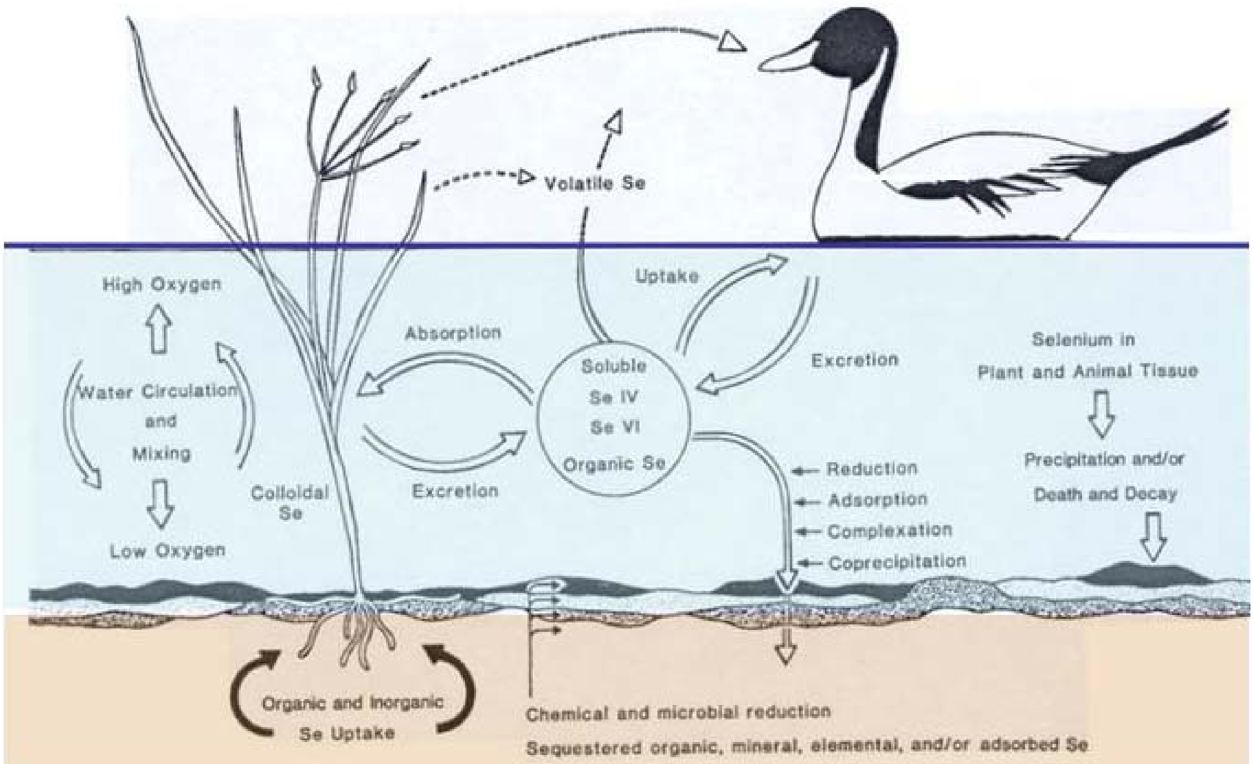


Figure 3. Natural Selenium Assimilation Processes in Current Sea. Source: USGS Salton Sea Science Office, Selenium and the Salton Sea, March 2003 (color added). Caption in USGS Source Document: Processes for the immobilization of selenium include chemical and microbial reduction, adsorption, co-precipitation, and deposition of plan and animal tissue; mobilization processes include uptake of selenium by rooted plants and sediment oxidation due to water circulating and mixing

SALTON SEA REVITALIZATION & RESTORATION

Salton Sea Authority Plan for Multi-Purpose Project

Air Quality Mitigation and Salt Management

Salton Sea Authority

September 2006

Background

The Salton Sea related State legislation enacted in 2003 as part of the QSA requires that (1) mitigation measures for the potential air-quality impacts created by the reduced inflows resulting from the QSA water transfer be included in the Agency's recommended preferred alternative project design and (2) the State assume financial liability for any required air-quality mitigation actions related to the QSA transfer that exceed the $133 million in mitigation costs paid by the QSA parties. Thus, air quality mitigation is a major consideration in the Agency's Ecosystem Restoration Project feasibility study as a matter of State law.

Air quality mitigation is a major consideration of the Authority and its member agencies because their constituents, i.e., the residents of the Coachella and Imperial Valley, will be the persons most affected by future poor air-quality conditions in the vicinity of the Salton Sea. In fact, air-quality impacts caused by the Salton Sea already are a regional issue due to the noxious odors which, depending on wind direction, carry as far as Palm Springs, Borrego Springs, and Calexico. Thus, the Authority's aggressive phosphorus source-control program that is designed to transition the eutrophic State of the Sea back to its non-odorous State as existed in the 1950s and 60s is an integral component of the Authority's air-quality management plan.

Air Basin Setting

The air quality issue that has drawn the most attention is the possibility of blowing dust storms caused by exposed sea-bed sediments. Many people make a direct comparison between the Salton Sea and the Owens Valley with respect to potential dust-emission problems and mitigation costs (Pacific Institute, 2006; Salton Sea Coalition, 2006; and comments at various State Advisory Committee meetings). The Agency has based the air-quality management approach in its Ecosystem System Restoration study on the explicit premise that "Owens Valley is the Working Model" (CH2M Hill, 2005).

These assumptions on the similarity of likely air quality issues at the Salton Sea and Owens Valley are directly contradicted by the facts and findings made by IID and Reclamation in their certified EIR/EIS for the Transfer Project QSA:

To further consider the potential impact for emissions from the Salton Sea, a comparison was made to existing dry lake beds where dust impacts have been observed. Fortunately, conditions found to produce dust storms on dry salt lake beds, such as Owens Lake, were not found to be present at the Salton Sea. The following three primary factors would be expected to make the situation at the Salton Sea much less severe than at Owens Lake:

- ***Soil chemistry**: …The soil system at the Salton Sea is predominately sodium sulfate and sodium chloride. These salts do not change in volume significantly with fluctuations in temperature, so the crust at the Salton Sea should be fairly stable and resistant to erosion. This anticipated situation at the Salton Sea is different from similar current situations at Owens and Mono Lakes, where a significant portion of the salinity is in the form of carbonates. The volume of carbonate salts is much more sensitive to temperature fluctuations, and desiccation of these salts produces fines that are readily suspended from playa at these lakes. Therefore, the salt crust on the exposed playa at the Salton Sea should be more stable and less emissive than Owens Lake. Also, distribution of mobile sand on the dry lakebed at Owens Lake is part of what drives high emissions rates, and comparable conditions are not expected at the Salton Sea.*

- ***Meteorology**: The frequency of high wind events at the Salton Sea is less than at Owens Lake. Therefore, the dust storms at the Salton Sea would be less frequent than at Owens Lake. …The predominant wind direction at the Salton Sea is also favorable; during high wind events at the Sea, it is from the west and northwest, perpendicular to the orientation of the playa. Dust suspension on the playa of the Salton Sea would be higher if the playa were oriented parallel to the predominant wind direction.*

- ***Recession Rate**: The anticipated decline in water levels at the Salton Sea is predicted to be significantly slower than what occurred at Owens Lake (only about 20 percent as fast). Natural processes may contribute more to controlling dust emissions at the Salton Sea than they have at Owens. These natural processes could include (a) the enabling of vegetation through development of soil conditions favorable to plant growth (including improvement in natural drainage), (b) development of native plant communities; (c) sequestration of sand into relatively stable dunes; and (d) formation of relatively stable crusts. [CH2M Hill, 2002, pp. 3.74-34/35, emphasis added].*

The above key findings in the EIS/EIR for the Transfer Project/QSA were supported and upheld by the State Board in the water rights order its issued for the QSA transfers. These legal determinations are supported by the fundamental historical and geological differences between the Owens Valley and the Salton as noted by the Lahontan Regional Water Quality Control Board (2005):

Only since the 1913 export of water [to Los Angeles] has a saline playa existed … the salt deposit on the [Owens Lake] playa surface is thin, and has been formed by the evaporation of saline groundwater rather than from the desiccation of the historic lake.

The opposite is true in the case of the Salton Sea. Areas exposed by receding water levels of the Salton Sea will become covered by desiccated agricultural drainage salt deposits; not indigenous salts leached from soil matrix. This difference is significant because it is the uniqueness of the indigenous salts in the Owens Valley that accounts for the area's notorious air quality problem. This fact is also Stated by Lahontan Region Water Quality Control Board (2005):

Owens Lake is the largest single source of particulate air pollution in the United States. <u>This situation is related to the lake's salt chemistry</u>. The salt crust on the playa contains a higher proportion of sodium carbonate [soda ash], sodium bicarbonate [baking soda] and sodium sulfate salts than most other playas in California. Most other plays are strongly dominated by sodium chloride salt (halite) [table salt]. Halite does not undergo the dramatic volumetric phase change that [sodium] carbonate and sulfate salts do on Owens Lake. <u>These [volumetric phase] changes break apart the playa surface and allow salts to be easily suspended by the winds."</u> [emphasis added]

Proposed Air Mitigation Approach

Thus, rather than being concerned about lakebed soil emissivity (the focus of the Agency's air mitigation approach), the pertinent concern in assessing the potential for air quality impacts at the Salton Sea is the **friability of desiccated salts that will be deposited on the surface of the exposed lakebed as the sea recedes**. As shown in the graph in Figure 1, the carbonate salts (Na_2CO_3 and $NaHCO_3$) that are the known cause for the air quality problems at Owens Valley account for 60% to 83% of the total salt in the salt deposits that formed during evaporation tests. Note that in these data that sodium chloride salt (NaCl) – the type of salt most prevalent at the Salton Sea -- was only 10% to 20% in these tests.

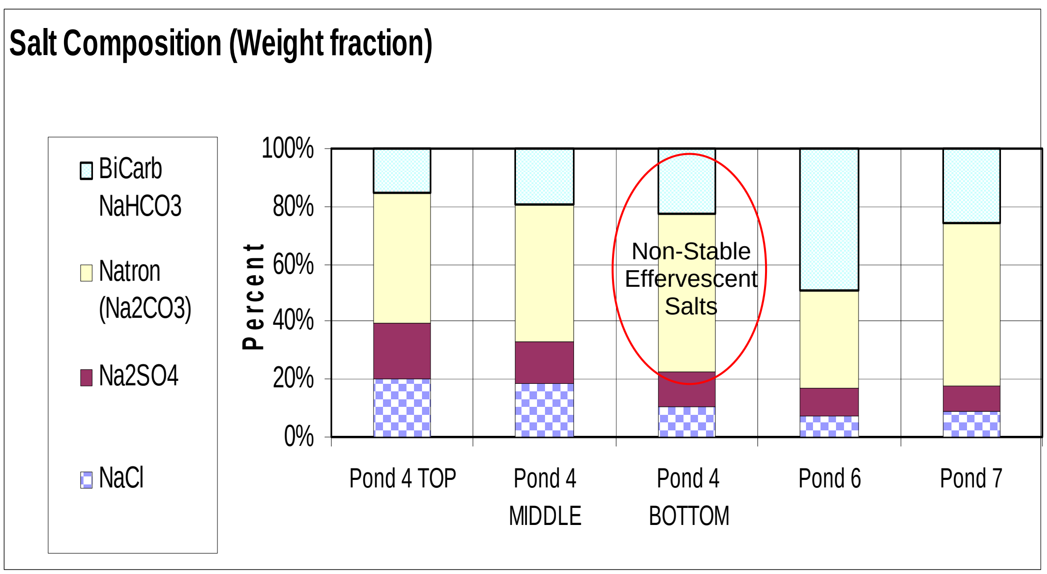


Figure 1. Salt Chemistry from Evaporation Tests at Owens Valley: Agrarian Research.

The Authority has conducted salt pond evaporation tests on Salton Sea water. The same firm (Agrarian Research) that performed the Owens Valley salt evaporation tests performed the Salton Sea test. After first concentrating the salts in the Salt Sea water by a factor of 3x to 4x (which would be equivalent to running it through the saline habitat complex in the Authority project design), the concentrate was placed into crystallizer cells (the equivalent to shallow impoundment ponds in the south basin in the Authority project design) and allowed to dry into a solid. The chemistry of these salt deposits formed from the concentrated Sea water is shown in Figure 2.

	$CaSO_4$	$MgSO_4$	Na_2SO_4	NaCl	KCl
Salt	1.06	4.28	4.51	89.81	0.32

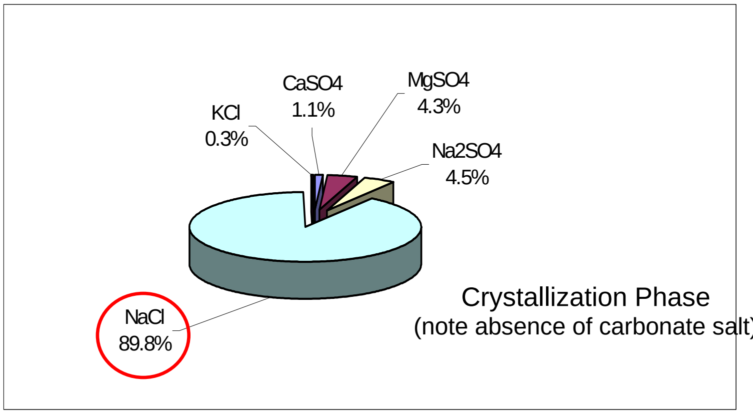


Figure 2. Salt Chemistry from Evaporation Tests at Salton Sea. Source: Agrarian Research.

The key figure in Figure 2 is the 90% sodium chloride (NaCl), plain table salt. The commercial salt industry is familiar with the techniques and procedures involved in operating crystallizer basins for growing NaCl salt crystals from seawater or brackish water while washing away other unwanted salts (like sodium sulfate). Agrarian Research used these same techniques to grow the NaCl crystal from Salton Sea water shown in Figure 3.

Figure 3. NaCl Salt Crystal formed from Salton Sea water.
Source: Agarian Research

Given the large quantity of salt in the Salton Sea (over 400 million tons – enough to cover the Sea's entire 360 sq. mile surface area with a 14-inch thick solid deposit) and realizing that 90% of this salt (after concentration) is NaCl that dries into hard crystals, the Authority advanced the concept of using naturally formed NaCl deposits to cover exposed areas in the south basin in the Authority project design as an air quality mitigation measure. The Authority had previous experience forming large, stable salt deposits from Salton Sea water from the solar evaporator tests it conducted with Reclamation in 2000-02 (Figure 4).

Figure 4. Thick Salt Deposit formed from Sea water during solar evaporator tests in 2002. (Authority photo)

To confirm the practicality and efficacy of using naturally formed salt deposits for air-quality mitigation, the Authority engaged a salt industry expert (John Pyles). Before his retirement, Mr. Pyles managed the 40,000-acre Cargill commercial salt pond complex in San Francisco Bay. He had also previously worked as a consultant on a Salton Sea project. In his letter to the Authority, Mr. Pyles States that in his 21 years of work at the Cargill salt complex in San Francisco Bay:

The company never experienced any blowing dust or other air quality problems, including odor complaints while the crystallizers were in operation. New housing developments and commercial buildings were built within 1 mile of the solar ponds on both ends of the Dumbarton Bridge without any dust or odors being an issue (Pyles, 2006).

After familiarizing himself with the Authority project design and recent work by Agrarian Research, Mr. Pyles expressed the following expert opinion:

A managed salt deposit with such a high content of NaCl would be competent and highly cemented body capable of supporting repeated use of heavy equipment if desired. This characteristic is seen all over the world in salt deposits high in sodium chloride content, *regardless of other co-precipitated salt. I believe that forming a thick, competent deposit high in NaCl on top of the exposed areas within the south basin in the Authority Plan is a well proven concept that is both feasible and technically sound.* (Pyles, 2006.)

A photograph of the cemented, durable (4-year-old) surface of an experimental 5-acre salt deposit formed from Sea water is shown in Figure 5. For comparison, a photograph of the expansive salt deposits within the 200-sq. mile old Laguna Salada lakebed (also part of the ancient Colorado River delta) is shown in Figure 6. In terms of salt chemistry and local hydrologic, geologic and climatic factors affecting the characteristics of the salt deposits that will form when the Salton Sea drys down, the Sea is more analogous to its historic relative, the Laguna Salada, about 50 miles away in Mexico; than the dry Owens Lake bed, 250 miles away in a very different climatic, hydrologic, and geologic setting. As a cemented salt deposit as referred to in Mr. Pyles' letter, the Laguna Salada does not have a blowing dust problem.[1]

To determine the area within the south basin that will eventually become covered with a naturally formed NaCl salt deposit as the water level in the south basin recedes, Tetra Tech developed a model to calculate (1) the decline in water elevation in the south basin based on the inflow reduction scenario presented in Chapter 3, and (2) the elevation at which the salt concentration in the south basin will exceed the precipitation point for NaCl. These projections are shown in Figures 6 and 7. Under this scenario, the model shows that hypersalinity (defined to be the salt concentration at which NaCl precipitates) would reach the –255-ft msl elevation in 2023 (i.e., about 10 years after construction of the in-Sea barrier is completed).

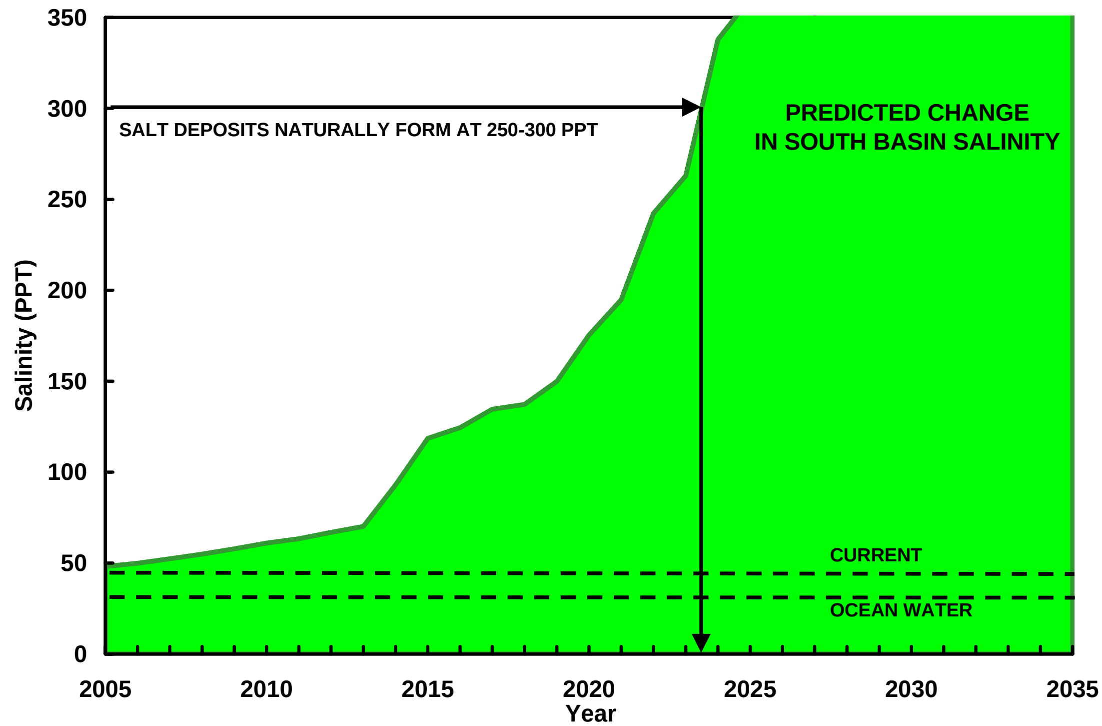
The map shown in Figure 7 illustrates the –255-ft msl contour line inside the south basin. The area within this contour will be covered with either (1) a cemented NaCl salt deposit or (2) the semi-solid brine pool. Of the 90,000 acres in the south basin (excluding the habitat complex and water storage reservoir), the modeling shows that only about 7,000 acres—less than 8% -- *may* have a possible exposure problem. This area is the strip between the west barrier and the -250-ft msl contour. Even this area is unlikely to experience dust problems for these reasons:

- It will be at the toe of the in-Sea barrier where there will be seepage or thus the likelihood of natural vegetation growing;
- This area is isolated from public exposure by a surrounding water body; and
- This location lies 20-to-25 feet below the surface water of the surrounding lake which again suggest seepage and natural vegetation will occur.

[1] Mexicali has held concerts attended by 40,000 people at the Laguna Salada (info@TourMexico.com) and two Federal highways cross the salt flats.

Figure 5. Experimental Salt Deposit Formed from Salton Sea Water.

Figure 6. Salt Deposits on old Laguna Salada Lakebed near Mexicali.



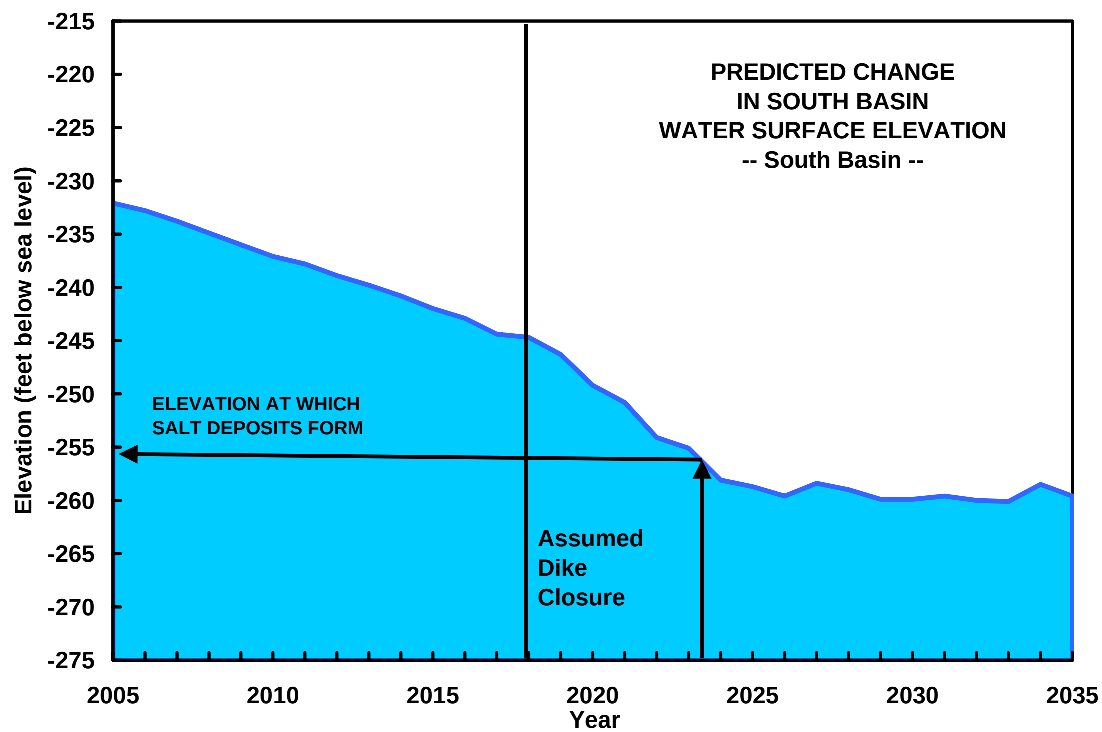


Figure 7. **Predicted Salinity and Elevation in the South Basin Brine Pool.**

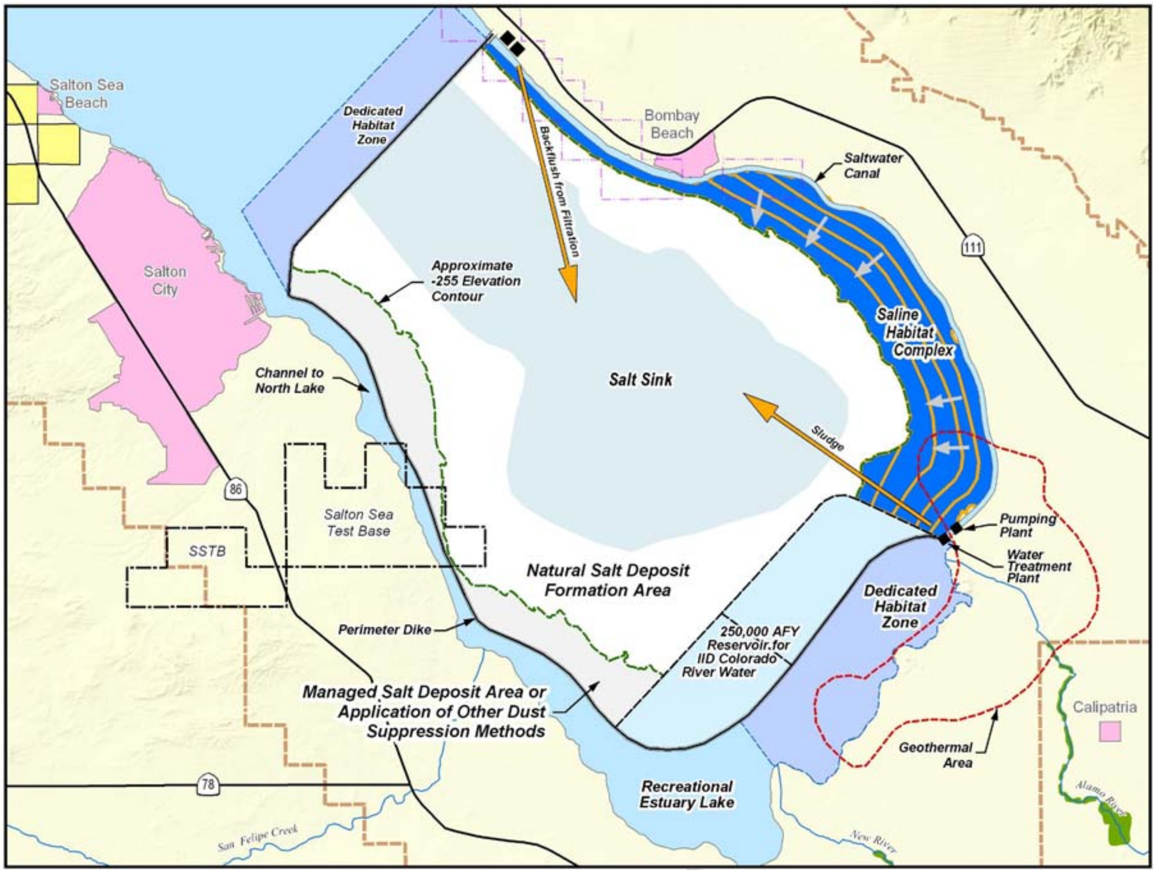


Figure 8. Map Showing Natural Salt Deposit Formation Area.

If blowing dust is a problem in this small area, magnesium chloride from the brine pool could be pumped to form a protective chemical cover as is commonly done as an air-quality mitigation measure at construction sites. Other mitigation measures will be applied as necessary and appropriate based techniques developed by the State as part of its Ecosystem Restoration Study "tool box" and future pilot projects. Over time, salt deposit management and maintenance will be required as suggested by Mr. Pyles in his letter.

References

CH2M Hill. 2002. IID Water Conservation and Transfer Project Draft Environmental Impact Report/Environmental Impact Statement.

Pacific Institute, 2006 (Michael Cohen). Hazard: The Future of the Salton Sea with No Restoration Project. May.

Pyles, John. 2006. Letter from John Pyles, Applied Solar Technologies, to Ronald Enzweiler, Salton Sea Authority. March 20th. (provided on following pages)

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March 20, 2006

Ronald Enzweiler
Executive Director
Salton Sea Authority

Dear Mr. Enzweiler,

Thank you for giving me the opportunity to become reinvolved in the Salton Sea restoration effort. I was previously involved in the Salton Sea as a team member on the Parsons' "Analysis of Restoration Options" independent technical review study conducted in 2000, and on the subsequent Agrarian Research solar-pond pilot project.

I have been working professionally in the solar salt industry since 1977. I currently consult worldwide on salt, including environmental projects that remove salts from an area or process. My professional experience includes managing the operations of the 40,000 acres of commercial solar salt ponds that were located in San Francisco Bay. These facilities produced 1,250,00 tons/year of 99% pure sodium chloride (NaCl) salt by the controlled evaporation of San Francisco Bay water (which contains about 10,000 mg/L of total dissolved solids). In my 21 years of work at these Cargill facilities, we never experienced blowing dust or other air quality problems, including odor complaints in the salt crystallizers while in operation. New housing developments and commercial buildings were built within 1 mile of these solar ponds on both ends of the Dumbarton Bridge without dust or odors being an issue.

You have presented an overview to me of the current Salton Sea Authority (SSA) plan. That plan includes maintaining the current water level over most of the existing shoreline, and addresses odors, salinity and other water quality and habitat issues. A major feature of the plan is to create an isolated brine pool and salt deposit area by installing a perimeter dike around the south end of the current Sea.

The Agrarian Research (AR) project and the work done by the Bureau of Reclamation at the Salton Sea Test Base demonstrate conclusively that a thick salt deposit can be made from Salton Sea water. The AR test results show that 1.6 ft of deposit can be made in one year and that about 1 ft can be deposited during the warm months in a managed salt crystallizer pond. The solids deposited were about 87% NaCl. This thickness and quality could be duplicated in the exposed areas within the south basin in the current SSA project plan. With further work, there is a possibility that the percentage of hard-surface NaCl

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salt in the protective salt desposits can be increased to improve the durability of this low-cost dust-control mitigation measure. The technique to achieve a high NaCl content in the protective salt deposits in the SSA Plan would be the same as the techniques used in the commercial solar salt industry, namely: once the salinity in the crystallizer ponds reaches a certain point, the remaining supernatant (i.e., the brine containing the sodium sulfate salt and other more soluble salts) would be decanted off and channeled into the brine pool that will form and permanently exist in the lower depths of the south basin. Rain could also be a mechanism for purifying the salt deposit by removing the more soluble sodium sulfate that can co-precipitate with the sodium chloride. This would require establishing a method of draining away entrained brine in the selected areas. The approach would require the construction of berms at 3-to-5 ft contour levels around the upper areas of the south basin. However, given the layout of the SSA Plan, these "terraced" crystallizer basins could be fed by gravity from the brine outflow at the foot of the Saline Habitat Complex (SHC) located along the upper eastern perimeter of the south basin. Thus, pumping and other O&M costs to form a thick salt deposit in the lower exposed areas of the south basin would be minimal.

A managed salt deposit with such a high content of NaCl would be a competent and highly cemented body capable of supporting repeated use of heavy equipment if desired. This characteristic is seen all over the world in salt deposits high in sodium chloride content, regardless of the other co-precipitated salts. I believe that forming a thick, competent deposit high in NaCl on top of the exposed areas within the south basin in the SSA Plan is a well proven concept that is both feasible and technically sound.

Any salt deposit exposed to the elements will require some maintenance. This is part of managing the deposit. Occurrences such as localized upwelling, seepage from the dike, and rain can dissolve the salt deposit. Upwelling and seepage tend to be localized in their effects, while rain is more generalized in its effect. There are established methods for both reducing seepage and upwelling at their source, and negating the adverse effects of either. Although rain at less than 3 inches per year is minimal, it would eventually remove enough of any deposit to require reestablishing the salt layer. The salt desposit could be reestablished simply by refilling each crystallizer basin with brine from the SHC outflow and decanting the supernatant on a periodic, "as required" basis. Based on my professional experience, I see this rebuilding operation being required on roughly 10-year or longer cycles.

Thank you again for giving me the opportunity to work with you on the Salton Sea restoration project. Please let me know if you have any questions or would like for me to perform further work on this assignment.

Regards,

John Pyles

cc: William Brownlie, Tetra Tech