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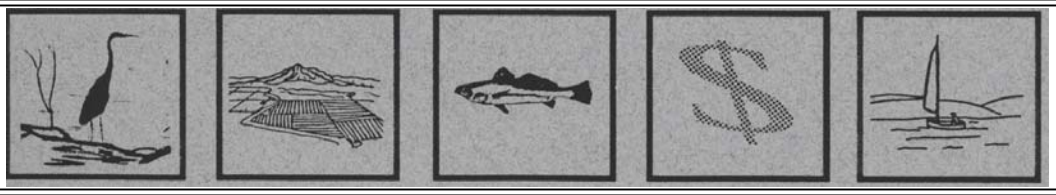

STRATEGIES FOR THE RESTORATION AND ENHANCEMENT OF THE SALTON SEA

A WHITE PAPER FOR THE SALTON SEA AUTHORITY

prepared by

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INTRODUCTION

1.0 INTRODUCTION

1.1 Purpose of Commissioning a White Paper

In 1993, the Counties of Riverside and Imperial, the Imperial Irrigation District and the Coachella Valley Water District joined forces to create the Salton Sea Authority. According to the Joint Powers Agreement creating the Salton Sea Authority, the purpose of the Authority is "to create a public agency to exercise the common power of directing and coordinating actions relating to improvement of water quality and stabilization of water elevation and to enhance recreational and economic development potential of the Salton Sea and other beneficial uses, recognizing the importance of the Salton Sea for the continuation of the dynamic agricultural economy in Imperial and Riverside Counties."

Riverside County and Coachella Valley Water District retained Dangermond & Associates, for the Salton Sea Authority, to review solutions previously proposed for various problems affecting the Sea and explore new possibilities and combinations of possibilities which might either reduce costs, generate revenues, or create access to new funding sources. This resulting white paper suggests three alternatives which incorporate portions of previously proposed solutions with several new concepts, and evaluates funding strategies and sources, including revenue generating aspects of the solutions, for each. In so doing, this white paper, only generally, identifies concepts and potentials for further study; it is beyond the scope of this preliminary analysis to consider all of the environmental, jurisdictional, economic, and technological factors which will affect the ultimate feasibility of a solution.

1.2 The Issues

Three primary issues have been previously identified by the many agencies and interests concerned with the Salton Sea: salinity, elevation, and pollutants. Because these issues have been well described in the Salton Sea Symposium "Technical Presentation Summaries" and elsewhere, they are only briefly summarized here:

Salinity

Inflow of salt into the Sea is about 4,000,000 tons per year, principally from agricultural run-off. With no outlet, the Sea's salinity concentrates steadily through evaporation. At present, the level of Total Dissolved Solids (TDS) is about 45,000 milligrams per liter (mg/L) compared to the TDS level of the ocean of about 35,000 mg/L. The rate of increase in salinity for the Sea has recently been about 700 mg/L/year. Reproduction of fish may be adversely affected at current levels, and the fish population is expected to undergo a rapid decline as salinity increases further. Recreation and associated economic values will be impacted, as will wildlife values as aquatic food sources decline and the food web is disrupted.

Elevation

Historically, the elevation of the Sea has been subject to significant change depending on the level of inflow from agricultural run-off and storm flows. In the first two decades after the Sea's creation in 1905 - 1907, the elevation declined rapidly. Increased agricultural development in the watershed then caused a steady rise in elevation, except during a period of reduced irrigation water availability from 1931 - 1935. Changing elevation over the years has flooded some developments and wildlife habitat. In recent years a balance between agricultural flows and evaporation has created a relatively stable elevation, although the seasonal fluctuation between spring and fall ranges between approximately 1 and 2 feet. In the future, water conservation measures, and efforts to reduce salinity could reduce the elevation to a lower than desirable level. The effect of siltation on elevation over time is not known.

Pollutants

Selenium levels in the Sea have captured considerable attention in recent years because of the threat posed to wildlife and the fishery. Studies have identified Colorado River water as the primary source of selenium; as it is used for agricultural purposes, the selenium level concentrates before entering the Sea. In the Sea, selenium appears to be selectively removed, possibly through concentration in bottom sediment and/or by the volatilization of selenium by selenate-respiring bacteria. Selenium levels in fish are somewhat elevated and a public health advisory warning has been issued to limit fish consumption as a precautionary measure. Studies to date have indicated that while breeding birds have been exposed to elevated levels of selenium, the risk of reproductive toxicity is low; however, the most recent tissue studies of eared grebes indicate a significant increase in recent years. Also, selenium may affect birds by weakening their immune systems at levels less than that which cause reproductive toxicity. Elevated levels of a number of heavy metals, organochlorine pesticides, and organic solvents have also been detected in the Sea, but the impact on biota in the Sea has not been fully studied. Nutrient loading of the Sea with nitrogen and phosphorus from agricultural run-off has made the Sea highly productive biologically, but has also contributed to algae blooms which, at times, creates unpleasant odors and discoloration of the water, and may cause localized depletion of oxygen leading to fish kills.

1.3 The Process

To prepare this white paper, Dangermond & Associates assembled a team which includes expertise in environmental issues (Jones & Stokes) engineering (Woodward Clyde), water reclamation (Bill Dendy), and energy (Energy National), as well as planning and economic expertise provided by Dangermond & Associates. The team met for an initial brainstorming meeting to identify preliminary ideas and information needs. Dangermond & Associates then met with a variety of agencies and interests to gather information and explore some of the preliminary concepts. This information was shared with the entire team which then conducted a two day workshop to complete the development of conceptual solutions to the Salton Sea problems and the evaluation of funding strategies and sources. This white paper presents the team's findings.

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2.0 THE SALTON SEA: PROBLEM OR OPPORTUNITY

How one perceives solutions depends significantly on how one defines the problem to be solved. If the problem is seen principally as a set of obstacles to overcome, solutions may be harder to envision and may appear to be more difficult to achieve. Thus, there may be less motivation to pursue solutions. However, if the problem is also seen as an opportunity, a wider field of solutions may become visible and a more achievable solution may be discernible.

The Salton Sea as it currently exists, is an accidental creation which, once created, had no natural system to sustain it. Without additional human intervention, the sea would simply have evaporated in a relatively short number of years. Over time, however, several agencies and interests intervened to utilize the sea for special purposes. Variously, the Sea's potential was recognized and developed, at least to some degree, as a recreational resource, a wildlife habitat, a drainage basin for agricultural run-off, a flood control basin, and a living environment. Collectively, these various uses did not constitute a comprehensive plan for the management of the Salton Sea, nor was there any attempt to avoid or minimize conflicts among these uses and optimize their respective benefits. The Sea remained an accidental creation, the life span of which was artificially extended; but there was still no natural system to sustain it.

Over the years the absence of a natural flow-through system with the capacity to maintain a water quality level which would support recreation and habitat values led to growing problems with increasing salinity and potentially hazardous levels of selenium and other elements. In addition, there was no mechanism to maintain the surface of the Sea at a desired elevation. Recreation values and usage declined, flooding problems developed, threats to wildlife began to emerge, and, increasingly, it was easy to view the Sea as a set of problems with what appeared to be perhaps prohibitively expensive solutions. In the face of such formidable obstacles, concern over the various individual problems has not in the past coalesced into a unified approach to meet the challenges.

It may be worthwhile to compare the Salton Sea to a reservoir rather than to a natural lake. A reservoir is deliberately created to serve specified functions, which can include flood control, recreation, and wildlife habitat in addition to the primary function of water storage. The reservoir is then carefully managed and deliberately maintained to serve the desired functions. The secondary function may, in some instances, also create revenue streams to help offset the costs associated with the reservoir. A primary example of this is a reservoir with power generation facilities. The point of the comparison for the Salton Sea is that it suggests that, while the Sea was accidentally created and thus had no intended functions, a set of functions has come to be defined over time, but the Sea has not been correspondingly managed and maintained. Perhaps the fundamental task at present, then, is to redefine the functions of this vast Salton Sea reservoir and integrate these into a comprehensive management plan as objectives for the Salton Sea Authority to use for any future remediation work done on the Salton Sea. Section 3.1, below, outlines the current functions of the Sea.

The Salton Sea Authority has wisely chosen to view the Salton Sea as an asset rather than a problem. The opportunity this provides is that of re-creating the Sea to maximize its diverse values while recognizing that, like a reservoir, the Salton Sea is not a naturally sustained system; thus we must create a system to sustain the Sea. The challenge in so doing is to integrate revenue generating and value creating opportunities into the solutions to current problems and the long term management plan to help defray the significant costs of rehabilitating and maintaining the current functions of the Salton Sea maximizing its future value.

In this spirit, this white paper seeks first to articulate the various current functions of the Salton Sea which Dangermond & Associates believes the Authority wishes to maintain. The report then identifies potential innovative improvements which are intended to rehabilitate and maintain the Sea's current functions thus enhancing its value. The report then discusses four specific alternatives, which utilize these innovative

improvements in several combinations to remediate the existing problems and manage the Sea productively in the future.

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3.0 MAINTAINING THE CURRENT FUNCTIONS OF THE SEA

It is Dangermond & Associates recommendation that the current functions of the Salton Sea, which are listed below, should serve as the core objectives for the Salton Sea Authority. The realization of these objectives will most likely involve the implementation of several innovative improvements on the Sea that will bring with it a revenue source, as many existing alternatives for remediation are costly. Such recommendations for possible improvements on the Sea are also listed below. The planning team has sought to maintain the Sea's current functions through incorporating combinations of these improvements within the four alternatives outlined in the paper.

3.1 Current Functions of the Sea: The Core Objectives

The existing functions, which the Sea has historically served, should also serve as the core objectives for the Authority. These functions are:

- Support agricultural activities in the Coachella and Imperial valleys by providing a drainage basin for agricultural run-off.
- Provide recreation opportunities including sport fishing, boating, camping, and birding.
- Provide wildlife habitat for resident and migratory species.
- Provide an amenity for residential and commercial development, thus enhancing the local economy.
- Assist with flood control in upstream communities by acting as a repository for storm run-off.

In order for the Sea to continue to provide these functions, remediation which addresses the problems of salinity, pollutants, and an unstable surface elevation must occur. These problems have not only contributed to the drastic decline of the Sea's functions, they have also decreased the functions ability to be self-sustaining. Historically the Salton Sea has proven to be a popular recreation destination for the greater Los Angeles and San Diego areas. In the 1970's the Salton Sea State Recreation Area was recording approximately 550,000 user days per year, while today the Recreation Area is recording approximately 85,000 per year. The same trend can be seen in fishing and development around the Sea as little or no new development has taken place within the last ten years and the once well know fishery has had a dramatic reduction in visitation. As the Sea continues to decline it will continue to loose valuable revenue opportunities that otherwise could be used to assure the protection and enhancement of the important functions the Sea has come to provide.

3.2 Possible Innovative Improvements

In evaluating both previously identified and new approaches to remediation and long term management needs, Dangermond & Associates and the planning team sought not only to maximize ways to enhance existing functions, but also how to reduce the overall cost for the continuation of these functions through several possible innovative improvements. The goal of these improvements is to create value in and around the Sea and/or to generate revenues which help offset the costs of the remediation and long term management.

The following possible innovative improvements have been identified:

- Utilize the Sea's potential for power generation in designing remediation and management

efforts.

- Reclaim areas for other uses, such as agriculture or wildlife habitat, through diking to stabilize the elevation of the Sea. Either new use would create value and, either directly or indirectly create offsetting revenue.
- Increase southern California's water supply and create revenue by harvesting and selling desalinized water and captured storm flows to water purveyors.
- Develop additional habitat values and reclaim agricultural run-off for additional use through constructed wetlands.
- Utilize created wetlands habitat as a mitigation bank to generate revenue.
- Create new land use and economic development opportunities and the mechanisms to capture a portion of the revenues generated from these.

4.0 REMEDIATION AND LONG TERM MANAGEMENT

Three alternative approaches for remediation of some of the problems besetting the Sea have previously been identified by various agencies. These can be described as (1) the Evaporation/Solar Pond Systems approach, (2) the In-Sea Impoundment approach, and (3) the Pumpout/Gulf Waterway approach. Because these have been described elsewhere, and because each by itself fails to address some of the problems, this white paper does not further discuss these individual alternatives, however, they are shown in Figures 1 - 3. This section of the white paper instead focuses on four additional approaches to remediation of the existing problems which combine elements of the earlier alternatives with new concepts. Table 1, on the following page, provides a comparison of the earlier approaches with the four alternatives discussed in this report.

4.1 Potential Shore-Line Enhancements for the Salton Sea

Many of the previously mentioned existing and potential future functions of the Sea revolve around the Sea's shore-line. These functions can ultimately increase the overall value to the Sea via revenue generation, enhancing aesthetics of the sea and creating a sense of place. As quality enhancements develop along the Sea's shore-line, a greater understanding and appreciation of the Sea will build among the public, bringing additional opportunities and quality restoration. Benefits that could be derived from shore-line enhancements may include: reclaimed agricultural lands, recreation opportunities, wildlife habitat, residential and commercial development opportunities and power generation opportunities (Figure 4).

Shore-line enhancements can be incorporated into each one of the following alternatives for the remediation of the Salton Sea.

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4.2 Alternative 1: Diked Area/Solar Power Generation/Constructed Wetlands

This approach, as depicted in Figure 5, incorporates several earlier proposals with one additional concept and consists of three main components:

1. An enhanced evaporation system (E.E.S.) to reduce and control salinity levels, would be combined with a solar pond power plant to generate electricity.

Such a system was previously proposed by ORMAT, an Israeli geothermal development company. It combined E.E.S. utilizing spray nozzles to "mist" water, thus increasing the evaporation rate while decreasing the necessary surface area, with a power generation system in which solar heated brine evaporates organic fluid which drives a turbine to produce mechanical work which is then converted to electricity.

Cost reductions from the original concept are possible by locating it adjacent to the Salton Sea, utilizing evaporative ponds to concentrate approximately half of the salt brine and thereby reducing the capitol and operating cost of the EES system and clustering the solar ponds so as to reduce grading. The system could potentially be located between Bombay Beach and the Wister Wildlife Refuge.

2.Two diked areas, which would be used to stabilize the elevation of the Sea, would be constructed at the south end of the Sea near the Alamo River and the New River. A third area might be constructed at the north end near the Whitewater River. These areas would help stabilize the Sea's elevation by compensating for withdrawals needed to reduce salinity. In addition, the dikes would reclaim land from the Sea which might then be used for other purposes such as agriculture, wildlife habitat, or water harvesting.

3.Constructing wetlands at or near the mouths of the New, Alamo and Whitewater Rivers would address the pollutants issue. Constructed wetlands utilize natural biological processes to purify wastewater. Water is funneled through aquatic plant systems which absorb and biodegrade organics. Plants will also uptake heavy metals.

4.2.1 Benefits of this Alternative

This combination of diking, E.E.S./solar pond power plant, and constructed wetlands remediates the identified problems at the Salton Sea and provides additional benefits as follows:

a. Salinity

The E.E.S./solar pond power plant has the capacity to lower the salinity level of the Sea to 35,000 ppm in approximately 10 years. This would require pumping approximately 250,000 acre feet of water out of the Sea per year. Assuming historic levels of inflow to the Sea, the surface elevation could drop over 10 feet during this period without diking off a portion of the Sea.

b. Surface Elevation Stabilization

The construction of a diked area would reduce the total volume of the Sea thus compensating for the withdrawal of water to the E.E.S./solar pond power plant. The diked area would also provide a mechanism to stabilize the surface elevation at a drop of about 5 feet from existing levels by providing an area into which water could be diverted from the Sea or in which storm water and/or diverted agricultural run-off treated in the constructed wetlands could be stored to release into the Sea.

c. Pollutant Control

The constructed wetlands at the mouths of the New and Alamo Rivers would assist in filtering pollutants such as selenium and remove excess nutrients through biological processes. Should constructed wetlands be inadequate to completely address nutrient loading and pollutant issues, other approaches could be explored as adjuncts. Such approaches could include pumping water with high concentrations of selenium into an aquifer to fix the selenium into the soil as selenite under anaerobic conditions. Other potential approaches include pumping water from under high selenium lands, reverse osmosis treatment at selected locations where selenium concentrations are highest, and selectively retiring farm lands where the concentrations of selenium are highest.

d. Additional Benefits

- Up to 15,000 megawatts of power could be generated for sale. This creates not only useful energy, but also a revenue stream to help offset the cost of restoring the Sea.
- Desalination of water may be combined with the E.E.S./solar pond power plant and blended with agricultural return water and utilized for irrigation (utilizing distillation of cooling water). The irrigation water thus saved could be sold to water purveyors for use elsewhere in southern California. This provides an additional revenue source to help offset remediation costs.
- Diked areas might be used to capture storm runoff which could then be treated and sold along with desalinized water.
- Diked areas could also be utilized to create additional wetlands habitat or could be reclaimed for agricultural uses. Lease of this land for agricultural purposes would be another revenue source.
- Dikes could provide access for fishing and other recreational opportunities such as wildlife viewing.
- Wetlands habitat, whether in the diked area or in the constructed wetlands, could be established as a mitigation bank and credits sold.
- Stabilization of the surface elevation would create new development opportunities by eliminating the threat of inundation.

4.2.2 Issues Requiring Additional Consideration

Issues requiring further study include disposal of brine, potential environmental impacts, market demand for the energy produced, and demand for water harvested for sale.

4.2.3 Long Term Management

In exploring ways to address the major threats to the Sea, it is important to also think about the opportunities which are created for long term management. Activities and enterprises made possible by the rehabilitation of the Sea ought to help pay for the costs of remediation and long term management. What are some of these activities and enterprises?

The constructed wetlands would provide expanded wildlife habitat which could increase visitation by birders and others interested in viewing nature. If dike areas were also managed, at least in part, for wildlife habitat, this too could expand visitation. A wildlife viewing area could possibly be established at the northern end of the Sea to augment the viewing areas at the southern end. Restoration and enhancement of a sport fishery would also attract additional visitors. This would encourage state park improvements and could create additional demand for services, including camping facilities, motels, restaurants, etc.

Stabilization of the surface elevation would create opportunities to restore and enhance existing marina/recreation areas at the Sea and potentially create new facilities. Additional residential, commercial, and resort development, including golf course development might also result.

Collectively, these opportunities could lead to the realization of the Salton Sea's tourism potential. Such potential ought to be encouraged and planned for since revenues from these various improvements could help pay remediation and management costs for the Sea.

The development of a comprehensive plan would enable the Authority to evaluate remediation alternatives in the context of longer term goals and objectives, and to identify opportunities created by the rehabilitation of the Sea and the best strategies for capitalizing on them. Accompanying environmental documents would provide a sound basis for decision-making and might function as a program EIR for later project specific planning.

Alternative # 1 Diked Area/Solar Power Generation/Constructed Wetlands

Figure 5

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4.3 Alternative 2: Pumped Storage/Gulf Salt Disposal

This approach Figure 6 combines two main components:

1. A storage facility and power generation plant

2.A large canal/pipeline linking the Salton Sea with the Gulf of California.

In essence, an enormous pumped storage facility would be created utilizing two vast bodies of water: the Salton Sea and the Pacific Ocean. The canal/pipeline would carry water pumped from the Salton Sea to the Laguna Salada; from there it could flow to the Gulf of California through an improved channel. Salton Sea water would be pumped at night when electricity rates are lower. During the day, water would flow from the Gulf of California back to a storage area at the highest point of elevation between the Gulf and the Sea, and then used to generate hydroelectric power as it descends to the Salton Sea. The volume of water pumped each day would depend on the size of the power plant, however, even with a 500 megawatt plant, the elevation of the Sea would fluctuate less than 1 inch.

Since the Salton Sea's elevation presently fluctuates between spring and fall, the amount pumped could vary as well. A monthly cycle could be established with extra water pumped each day from the Sea for two weeks, and then extra power generated for two weeks as more water would be brought from the Gulf of California to the Salton Sea. This would allow the Sea to fluctuate about one foot a month, while exchanging the total volume of the Sea every few years. Functionally, at least to an extent, the Sea would become an extension of the Gulf. The connection would be accomplished with a canal approximately one fourth of a mile wide following the sea level contour and terminating at the Superstition Hills.

4.3.1 Benefits of this Alternative

a. Salinity

The gradual exchange of water between the Salton Sea and the Gulf of California would stabilize the salinity of the Sea at the level of the Gulf in less than 10 years. (The difference between the present salinity and that of the ocean would drop approximately 20% each year.)

b. Surface Elevation Stabilization

By regulating the amount of water pumped out of and into the Sea, the surface elevation of the Sea could be maintained at a desired level with a high degree of precision.

c. Pollutant Control

The exchange of water with the Gulf would effectively dilute the concentration of nutrients and pollutants in the Salton Sea. If it were determined that introducing the nutrients and pollutants from the Salton Sea into the Gulf would have an adverse

impact, constructed wetlands could be utilized to clean up agricultural run-off and other non-Gulf water flowing into the Sea. This would minimize, though not wholly eliminate, the introduction of pollutants and excess nutrients into the Gulf. Approaches to remedy high concentrations of selenium, such as those described in Section 4.1.1 (c), would probably still be needed if selenium could not be adequately controlled through constructed wetlands.

d. Additional Benefits

- From 500 to 800 megawatts of power could be generated. This creates useful energy and a revenue stream to help offset costs.
- Stabilization of the surface elevation would create new property development and land value enhancement opportunities by eliminating the threat of inundation.
- If constructed wetlands were a part of this alternative, the habitat could be established as a mitigation bank and credits sold.
- The issue of long term disposal of salt is eliminated.

4.3.2 Issues Requiring Additional Consideration

Issues requiring further study include international jurisdictional issues, potential environmental impacts from the canal and to the Gulf ecosystem, and market demand for the energy produced.

4.3.3 Long Term Management

As was discussed earlier, in exploring ways to address the major threats to the Sea, it is important to also think about the opportunities which are created for long term management. In looking beyond solving existing problems to creating new opportunities, the Authority should consider working with affected agencies and interests to develop more complete goals and objectives for the Salton Sea before implementing any remediation actions. Development of a comprehensive plan would enable the Authority to evaluate remediation alternatives in the context of longer term goals and objectives, and to identify opportunities created by the rehabilitation of the Sea and the best strategies for capitalizing on them. Accompanying environmental documents would provide a sound basis for decision-making and might function as a program EIR for later project specific planning.

Alternative # 2 Salton Sea/Gulf of California Water Exchange

Figure 6

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4.4 Alternative 3: Fresh Water Shoreline/Pumped Storage

This approach (Figure 7) combines 12 possible components:

1. A fresh water area around the north shoreline of the Sea would be created by means of a dike approximately 1 mile out from and parallel to the current shoreline. The Whitewater River would empty into this impoundment through a constructed wetlands area. The saline water in the impoundment area would be replaced with fresh water, most probably obtained from the Coachella Canal. This fresh water area could be managed for recreation, a fresh water fishery, and as habitat for waterfowl and other species.

2. 1,000 acres of constructed wetlands would be constructed at the mouth of the Whitewater River. This would provide for additional wildlife habitat along the shore-line of the Sea as well as help to filter the water entering the fresh water enhanced shore-line area.

3. 75,000 ac-ft of water from agriculture return and other runoff would be filtered through the constructed wetlands and used for the creation of a fresh water recreation area, fishery and waterfowl habitat.

4. A pumped storage facility would be constructed on the northeast side of the Sea with a holding pond atop a nearby hill. Water from the impoundment area would be pumped into the holding pond during the evening hours when electricity rates are low, and allowed to flow back to the fresh water impoundment area during the day to generate up to 500 MW of hydroelectric energy.

5. A desalination plant would be constructed and utilized to convert approximately 100,000 ac-ft of Salton Sea water to fresh water. This created fresh water could be mixed with Whitewater River water and agricultural return water and used to increase the water quality of the north shoreline fresh water enhancement area.

6. Up to 200,000 ac-ft per year of the blended, desalinized water from the fresh water shore-line area could be pumped to the Coachella Canal and sold to water purveyors as a revenue source.

7. A solar pond power plant, without an enhanced evaporation system, could be constructed along the southeast shore of the Sea. This area could be sized to remove approximately 150,000 ac-ft/year for 10 years. In combination with the desalization plant it would bring the salinity in the Sea from 45,000 to 35,000 p.p.m. in 10 years. A 16,000 acre solar pond power plant facility, would generate 1,500 megawatts of power, creating an additional revenue source. A companion salt disposal area of 6,000 acres would dispose of salt for 40 to 50 years after the initial 10 years salt concentration period.

8. 6,000 acres of wildlife habitat could be constructed in a dike system that would reclaim areas along the south shore of the Sea.

9. The reclaimed land along the southern shore-line would include two areas, totaling 5,000 acres, of constructed wetlands to help improve water quality in the New River and Alamo Rivers as they enter the Sea.

10. Reclaimed land would be used for agriculture or habitat creation. The agriculture land could be sold or leased and the habitat could be sold as mitigation credits.

11. An additional 300,000 ac-ft of water could be conserved in the Imperial and Coachella Valleys with the implementation of this plan. This water could then be sold to urban users to help finance Salton Sea improvements.

12. As a later option, the 500 MW pumped storage facility to the Gulf of California could be created at the southwest shore of the Sea. If it was unfeasible to construct this facility then this area could be used as a salt disposal area.

4.4.1 Benefits of this Alternative

a. Salinity

This alternative combines several approaches for reducing the salinity of the Sea: (1) creating a salt concentration area within the Sea itself, (2) a desalination plant, and (3) a solar pond energy plant.

b. Surface Elevation Stabilization

The construction of diked areas would be used to reduce the overall size of the Sea, compensating for withdrawals of water for other purposes, and stabilizing the Sea at a desired elevation.

c. Pollutant Control

Constructed wetlands would filter pollutants and remove excess nutrients. Approaches to remedy high concentrations of selenium, such as those described in Section 4.1.1 (c), might still be needed if selenium could not be adequately controlled through constructed wetlands.

d. Additional Benefits

- The freshwater areas at the northern end would create habitat, fishery, and recreational opportunities. With the pumping and power generation operation, this area would actually be tidal once a day, potentially enhancing the habitat values. A double lock system could connect this area to the main part of the Sea to allow ingress and egress of boats without any fresh water/salt water exchange.
- Up to 500 megawatts of power could be generated from the pumped storage facility. This creates useful peaking energy and capacity and a revenue stream to help offset costs. If demonstrated to be economically feasible, the solar power plant could also be constructed as a separate element.
- Desalinized water could be mixed with Whitewater River water and sold to water purveyors. When combined with additional conservation the water sold could total 500,000 ac-ft each year.
- Storm water run-off could be captured in the diked areas. This captured water could then be channeled into the Sea to help with salinity reduction and/or elevation stabilization, or sold for additional revenue.

- Stabilization of the surface elevation would create new development opportunities by eliminating the threat of inundation.
- If constructed wetlands were a part of this alternative, the habitat could be established as a mitigation bank and credits sold. Similarly, if wetlands were created in the diked areas, mitigation credits might be sold.

4.4.2 Issues Requiring Additional Consideration

Issues requiring further study include potential environmental impacts, market demand for the energy produced, and demand for water harvested for sale.

4.4.3 Long Term Management

As stated before, in looking beyond solving existing problems to creating new opportunities, the Authority should consider working with affected agencies and interests to develop more complete goals and objectives for the Salton Sea before implementing any remediation actions to enable the Authority to evaluate remediation alternatives in the context of longer term goals and objectives, and to identify opportunities created by the rehabilitation of the Sea and the best strategies for capitalizing on them.

Alternative # 3 Fresh Water Shoreline/Pumped Storage

Figure 7

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4.5 Alternative 4: Joint USA/Mexico Solar Power Generation/Pumped Storage Laguna Salada Salt Disposal

This approach Figure 8 is a combination of six components:

1.A solar pond power plant, without an enhanced evaporation system, would be constructed along the southeast shore of the Sea. This facility would generate up to 960 MW and evaporate 64,800 ac-ft per year.

2.Wetlands would be constructed at the confluence of the Whitewater, Alamo and New Rivers. This would provide for additional wildlife habitat along the shore-line of the Sea as well as help to filter the water entering the fresh water enhanced shore-line area.

3. A 500 - 800 MW pumped storage facility would be constructed at the southwest side of the Sea with a 6,000 acre diked area in the Sea and a 2,000 acre lake at sea level. These areas would evaporate approximately 48,000 ac-ft each year.

4. A pipe or canal system would connect the upper lake of the pumped storage facility to the Laguna Salada and sized to discharge approximately 100,000 ac-ft of Salton Sea water to Laguna Salada.

5. A second solar pond power plant, that would also generate 960 MW, would be located in or near Laguna Salada. This power facility would utilize the Salton Sea water from the pipe or canal system connected to the pumped storage facility. The plant could evaporate approximately 64,800 ac-ft of water each year. The area would be designed with potential to expand power and evaporation capacities.

6. An area within, or near, Laguna Salada (10,000 - 15,000 acres) would be set aside to accommodate the salt disposal needs of the entire system.

4.5.1 Benefits of this Alternative

a .Salinity

This alternative combines several solutions that would remove over 210,000 ac-ft of water from the Sea and would thereby reduce salinity to ocean concentrations in approximately 15 years.

b. Surface Elevation Stabilization

Several components of this alternative address the issue of surface elevation stabilization: (1) a total of 177,600 ac-ft would be evaporated each year, (2) the pumped storage facility would divert over 100,000 ac-ft of Sea water each year (3) the construction of diked areas would reduce the overall size of the Sea, compensating for the withdrawals and evaporation of water.

c. Pollutant Control

The constructed wetlands at the mouths of the New and Alamo Rivers would assist in

filtering pollutants such as selenium and remove excess nutrients through biological processes. Should constructed wetlands be inadequate to completely address nutrient loading and pollutant issues, other approaches could be explored as adjuncts. Such approaches could include pumping water with high concentrations of selenium into an aquifer to fix the selenium into the soil as selenite under anaerobic conditions. Other potential approaches include pumping water from under high selenium lands, reverse osmosis treatment at selected locations where selenium concentrations are highest, and selectively retiring farm lands where the concentrations of selenium are highest.

d. Additional Benefits

- Up to 2,780 MW of solar power would be generated meeting the energy needs of Southern California and Mexico as well as generating revenue for the restoration of the Salton Sea.
- The construction of a power facility in Mexico would offer the country additional power.
- Financing may be available through a fund established by NAFTA, meant to encourage economic development and environmental clean up.
- Offers a large area for the disposal of salt.
- Environmentally sensitive power generation.

4.5.2 Issues Requiring Additional Consideration

The issues requiring further study include potential environmental impacts, market demand for the energy produced, and any international jurisdictional issues.

4.5.3 Long Term Management

As stated before, in looking beyond solving existing problems to creating new opportunities, the Authority should consider working with affected agencies and interests to develop more complete goals and objectives for the Salton Sea before implementing any remediation actions to enable the Authority to evaluate remediation alternatives in the context of longer term goals and objectives, and to identify opportunities created by the rehabilitation of the Sea and the best strategies for capitalizing on them.

Alternative # 4 Joint USA/Mexico Solar Power Generation/Pumped Storage Laguna Salada Disposal

Figure 8

Basin-Delta Mothersite | Salton Sea Home Page | Title Page and Contents

5.0 FUNDING STRATEGIES AND SOURCES

Conceptually, funding would derive from four sources: (1) federal funds, principally through the Bureau of Reclamation, but also through other grant programs; (2) state funds, principally through the Wildlife Conservation Board, but also through fish stamps, recreation user fees, and grants; (3) local funds, including assessments, and, potentially, landfill mitigation fees; and (4) revenues from the remediation project measures themselves, including the sale of mitigation bank credits, the tax increment from expanded development, power sales, water sales, and the sale or lease of reclaimed land.

Figure 9 illustrates how various revenue sources are associated with the solutions to the three issues of salinity, elevation, and pollutants, and with the fourth area: enhancements to wildlife habitat, recreation opportunities, etc. An important concept embodied in the chart is that of a fair share approach to financing the needed measures and improvements. Needed revenues would be derived from user groups who benefit from the Sea, including agricultural, water, wildlife, and recreation interests. Equally as important, maximum emphasis is placed on the potential to generate revenues from the solutions and improvements.

Table 2 illustrates how funding from project beneficiaries could be generated over time. Initially, assessments on agriculture and urban water users in the Salton Sea area, combined with visitor fees, would provide revenues which would enable the Authority to sell bonds to raise the capital dollars which would ultimately be derived from local funding sources. Total revenues from these sources would increase over time as improvements to the Sea created additional uses in these areas. As the improvements become significant enough to motivate new development, tax increment revenues would begin to contribute to the funding package.

Figure 10 depicts a possible incremental approach to improvements and funding. In the first three years, $100 million in revenue from the state, the two counties, and revenue bonds underwritten by the revenues from project beneficiaries **(Table 2)** would finance constructed wetlands, small diked areas, a small scale power project, needed land acquisition, and a portion of enhancements to wildlife and recreation facilities. By the end of year six, revenues from water sales, leasing of reclaimed agricultural land, grants from Bureau of Reclamation, and power generation would finance large diked areas, large scale power generation, and additional enhancements to wildlife habitat, recreation facilities, and other shoreline improvements. By the end of year nine, additional revenues from state bonds and agricultural land leasing would finance the remaining improvements and complete the project. In subsequent years, revenue from power generation and/or water sales should pay for operation and maintenance costs.

Salton Sea Partnership Funding Concept

Figure 9

Possible Incremental Beneficiary Funding Concept

Table 2

Possible Incremental Funding Concept For The Salton Sea

Figure 10

Basin-Delta Mothersite | Salton Sea Home Page | Title Page and Contents

6.0 RECOMMENDATIONS FOR INITIAL PHASE

Although the Salton Sea has tremendous potential for fisheries, wildlife, and recreation, its current rate of decline will ultimately eliminate any future possibilities to realize these potentials unless a smaller, initial phase plan can be implemented. The current level of salinity (45,000 mg/l) is already 5,000 mg/l above that at which biologists believe the Sea's main fishery, corvina, can spawn (40,000 mg/l). It is estimated that in 10 years the salinity of the Sea will be approximately 55,000 mg/l and at this level many species that are currently an important part of the Sea's food chain will be extirpated thus transforming the Sea into a less diverse ecosystem.

From the "bigger picture" alternatives described in this Paper, the initial phase of an incremental plan can be elaborated. This incremental plan should begin by identifying common elements of the most likely "bigger picture" alternatives and then implementing smaller initial phase components of these ideas, which would arrest the decline of the Sea as well as test the genuine feasibility of those "bigger picture" ideas. Such a plan, as seen in Figure 11, is recommended to include:

1. Shore-Line Enhancement Areas

The development of perhaps one or two shore-line enhancement areas in each county could have many immediate benefits. Some of these may include improved recreation and interpretation facilities, wildlife habitat, "freshwater" areas for fisheries, etc.

It is recommended that further study be done on area needs, potentials and designs and on how to maximize the benefit of shore-line enhancements for the Sea and the local communities.

2. Development of Evaporative Areas

The development of approximately 20,000 acres of evaporation areas, in the most inexpensive manner possible, would help to keep the Sea at present salinity levels. Several areas in the southern region of the Sea appear to be suitable for this type of land use; however, it is recommended that a detailed land use study take place to identify specific areas and evaluate their suitability.

3. Construct a Sample Salt Pond Solar Power Generation Facility

Proceed with a solar salt pond power plant that would generate approximately 40 MW at a scale of 10 - 45 acre ponds. Actual costs, power production and revenues would then be determined and could be used to project costs and revenues for potential larger facilities.

4. Constructed Wetlands/Wildlife Habitat

The Wildlife Conservation Board may have funding available for the construction of wetlands and wildlife habitat that would increase the quality and quantity of habitat for migratory and resident species. These areas may also help to alleviate, or reduce, pollutants entering the Sea from the New, Alamo and Whitewater Rivers. A 1,000 acre test site is recommended to be constructed at one of the three river mouths.

5. Investigate and Implement Sample Alternate Creative Ideas that Address Selenium

Several universities and the Bureau of Reclamation have done some work in the area of alternative ways to address the clean up of high levels of selenium. Some ideas that have been looked at include fixation into local aquifers, created wetlands, and microbial digestion. Alternative ideas should be further researched and implemented as appropriate.

6. Investigate the Potential to Sell Water to MWD

The Metropolitan Water District of Southern California has expressed interest in the purchase of any additional water that might be available. The sale of this water would generate revenue for the enhancement of the Sea. Potential sources of water for sale could result from operation of a reverse osmosis or distillation plant.

7. Investigate Interest on Part of Power Companies to do Solar or Pumped Storage

It is believed that there may be several areas appropriate for pumped storage facilities in the Salton Sea area that merit further study. If feasible, these facilities would generate revenue for the Sea as well as address issues of salinity and stability.

8. Investigate International Interest on the Feasibility of a Joint Project

It is recommended that the feasibility of an international economic development project with major environmental benefits between Mexico and the U.S. be investigated. Discussions between the Mexican government and the International Boundary Waters Commission may uncover any interest from Mexico to enter into a joint project of this kind.

Three potential options to explore with Mexico include:

- Discharge of Salton Sea water in the Gulf only
- Solar Power/Pumped Storage Project
- Pumped Storage Project only

9. Investigate Environmental Benefits and Constraints

The Authority has already proceeded with this process in the development of a Request for Qualifications/Proposals via the Clean Lakes Program grant. Alternatives for the remediation of the Sea should be reviewed for environmental and economic values.

10. Develop Conceptual Master Plan for the Salton Sea

In looking beyond solving existing problems to creating new opportunities, the Authority should consider working with affected agencies and interests to develop more complete goals and objectives for the Salton Sea before implementing any remediation actions. Either a general plan level document or a coordinated resource management plan might be an ideal vehicle for establishing a policy direction and conceptual plans for the future of the Salton Sea and adjacent lands. Development of a comprehensive plan would enable the Authority to evaluate remediation alternatives in the context of longer term goals and objectives, and to identify opportunities created by the rehabilitation of the Sea and the best strategies for capitalizing on them. Accompanying environmental documents would provide a sound basis for decision-

making and might function as a program EIR for later project specific planning.

11. Follow Through on Suggested Funding and Implementation Measures

The following are recommended actions related to funding that may underwrite some of the cost of restoring the Salton Sea. This report has not significantly investigated these potential sources since its primary thrust was to evaluate potential revenue generating concepts.

State

1. Investigate possible legislation that would allocate funds from:

a) Salton Sea State Recreation Area

Several decades ago the State Recreation Area had approximately 550,000 user days each year, today the Recreation Area sees approximately 85,000 user days each year. As these numbers continue to decrease, due to the Sea's poor condition, revenue for the state will continue to decrease until the Sea becomes stagnant and the Recreation Area closes, ending all revenue from the Recreation Area.

One potential source for funding may be legislation that would allocate user fee revenue from the Recreation Area to the remediation costs of the Sea. If done for a thirty year period, revenue bonds could multiply this funding several-fold. This would ultimately help to solve those issues associated with the Sea that have discouraged recreation use. With the restoration more recreational visitors would be attracted to the Recreation Area and thus more revenue for the State in the long run.

b) Salton Sea fishing license stamps

Another potential funding source would be special legislation authorizing the State Department of Fish and Game to institute a special Salton Sea stamp on all fishing activities at the Salton Sea. These could then be earmarked exclusively for restoration purposes and authorization granted for use to repay revenue bonds.

c) Tax increments/financing

A third potential would be legislation authorizing the Salton Sea Authority to establish a special form of redevelopment agency surrounding the Sea. This could then be utilized to capture an increment of the increased property taxes from future improvements and value increases resulting from a restored Salton Sea.

2. Investigate and secure any and all State funding possibilities.

State funding possibilities that could be used at the Salton Sea include funds for state recreation area improvements, Wildlife Conservation Board expenditures, state funds from Boating and Waterways for boating facilities, etc.

These state agencies may have funding available in the future for planning and project

implementation. These funding sources should be followed closely, and funds should be directed to the Salton Sea as appropriate opportunities present themselves.

Federal

1. Monitor long term grant possibilities from BOR, USF&WS and EPA.

For future funding possibilities these federal agencies may have funding available periodically for planning and project implementation. These funding sources should be followed closely, and funds should be directed to the Salton Sea as appropriate opportunities present themselves.

BOR may have additional money to complete studies of the sea and fund initial problem/solution identification studies, planning studies and implementation/construction costs.

Local

1. Investigate possibility of water assessments.

As described in **Table 2**, assessments on agriculture and urban water users in the Salton Sea area, combined with visitor fees, would provide revenues for the sale of bonds, raising the initial capital dollars needed to begin remediation efforts. As improvements to the Sea became significant, new development would be motivated and tax increment revenues would begin to contribute to the funding package.

2. Investigate possibility of benefit assessments.

It is recommended that a study be performed in Imperial County and the Coachella Valley portion of Riverside County to evaluate the geographic extent of the area of benefit from an improvement to the Salton Sea. A study of this nature would provide the basis for the possible institution of a benefit assessment on the land within this zone. Information we obtained indicated there were 27,000 parcels in the immediate vicinity of the Salton Sea. The study should also verify this number as well as determine the number within the larger benefit zone within the two Counties.

3. Investigate possible water sales to the Metropolitan Water District of Southern California.

As described earlier in this paper, up to 500,000 ac-ft/yr of water may be available through conservation and desalinization. It is our understanding that MWD has expressed a need for an additional 600,000 ac-ft/yr from the Colorado River. Negotiations among MWD, CVWD and IID would need to occur and decide whether or not this is a true possibility and how the purchase of such water could offset Salton Sea remediation costs.

4. Investigate needs and possibilities of power generation.

A representative of Southern California Edison informally offered to see if Edison would perform an investigative study for the power generation ideas outlined in this report. In addition, the alternative energy company of ORMAT, INC., which performed a preliminary study of a small salt pond project at the Sea in 1989, may also be interested in additional studies in this area. If either the pump storage or solar pond

concepts prove to be feasible they could offset most of the costs of Sea remediation. We recommend that the Salton Sea Authority request these two companies to assist in these evaluations.

Other

1. Investigate potential for mitigation banking

There may be many needs for wetlands mitigation credits within the region. The Sea would be an excellent place to build additional wetlands which would satisfy mitigation needs elsewhere, while assisting to help clean up the inflow to the Sea and increase the amount of quality habitat within the Pacific Flyway. A preliminary evaluation of this possibility should be made with the U.S. Fish and Wildlife Service and the California Department of Fish and Game.

First Stage Incremental Plan

Figure 11

Alternatives For The Salton Sea

Table 1

	CONTROL OBJECTIVES						IMPACTS			
	Salinity	Stability	Selenium	Ag/Other Pollution	Algae Control	New River	Jurisdictional	Environmental	Existing Studies	Revenue Generating
IDENTIFIED ALTERNATIVES										
Desalinization/Solar Generation	●	●						●	✓	✓
Salt Water Impoundment	○	○						●	✓	
Gulf Waterway Option	●	●	○*	○	●	○*		●	✓	
POTENTIAL ALTERNATIVES										
Dike/Solar Generation/Const. Wetlands	●	●	○*	●	●	●*		●		✓
Pumped Storage/Gulf Salt Disposal	●	●	○*	●	●	●*	●	●		✓
Fresh Water Shoreline/Pumped Storage	●	●	○*	●	●	●*		●		✓
Joint USA/Mexico Solar/Pumped Storage	●	●	○*	●	●	●*	●	●		✓

○ Least ● Moderate ● Most

* Majority of New River clean up & selenium control is unrelated to Salton Sea Solution

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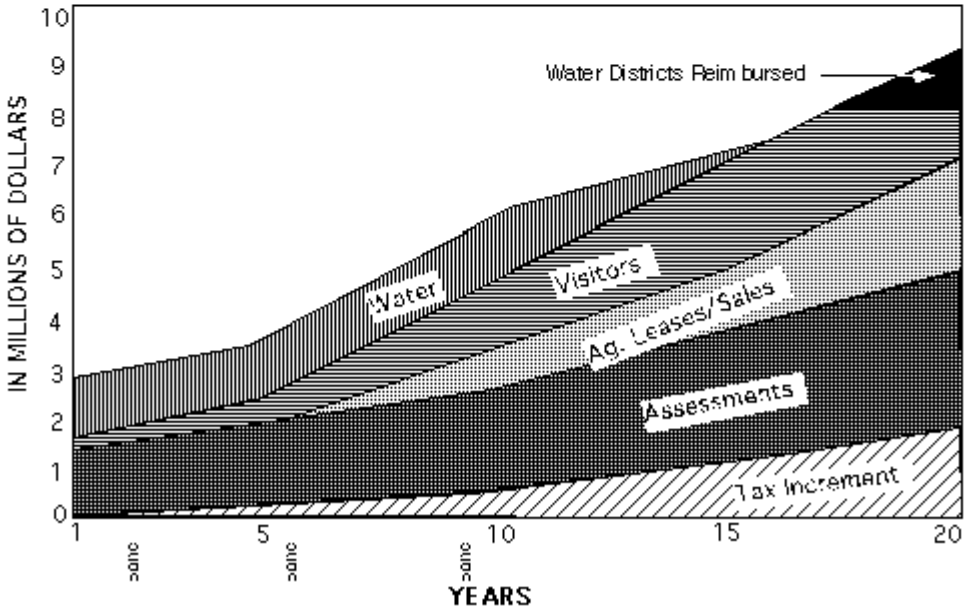
POSSIBLE INCREMENTAL BENEFICIARY FUNDING CONCEPT

For The Salton Sea

Table 2

In Millions Of Dollars

FUNDING SOURCE	Yr 1	Yr 5	Yr 10	Yr 15	Yr 20
Tax Increments	0.0	0.25	0.75	1.25	2.0
Assessments	1.5	2.0	2.5	2.75	3.0
Ag. Leases/Sales	0.0	0.0	0.5	1.0	2.0
Visitors	0.25	0.5	1.5	2.0	2.5
Water	1.25	1.25	1.25	0.0	(1.25)
TOTAL	**3.0**	**4.0**	**6.5**	**7.0**	**8.25**



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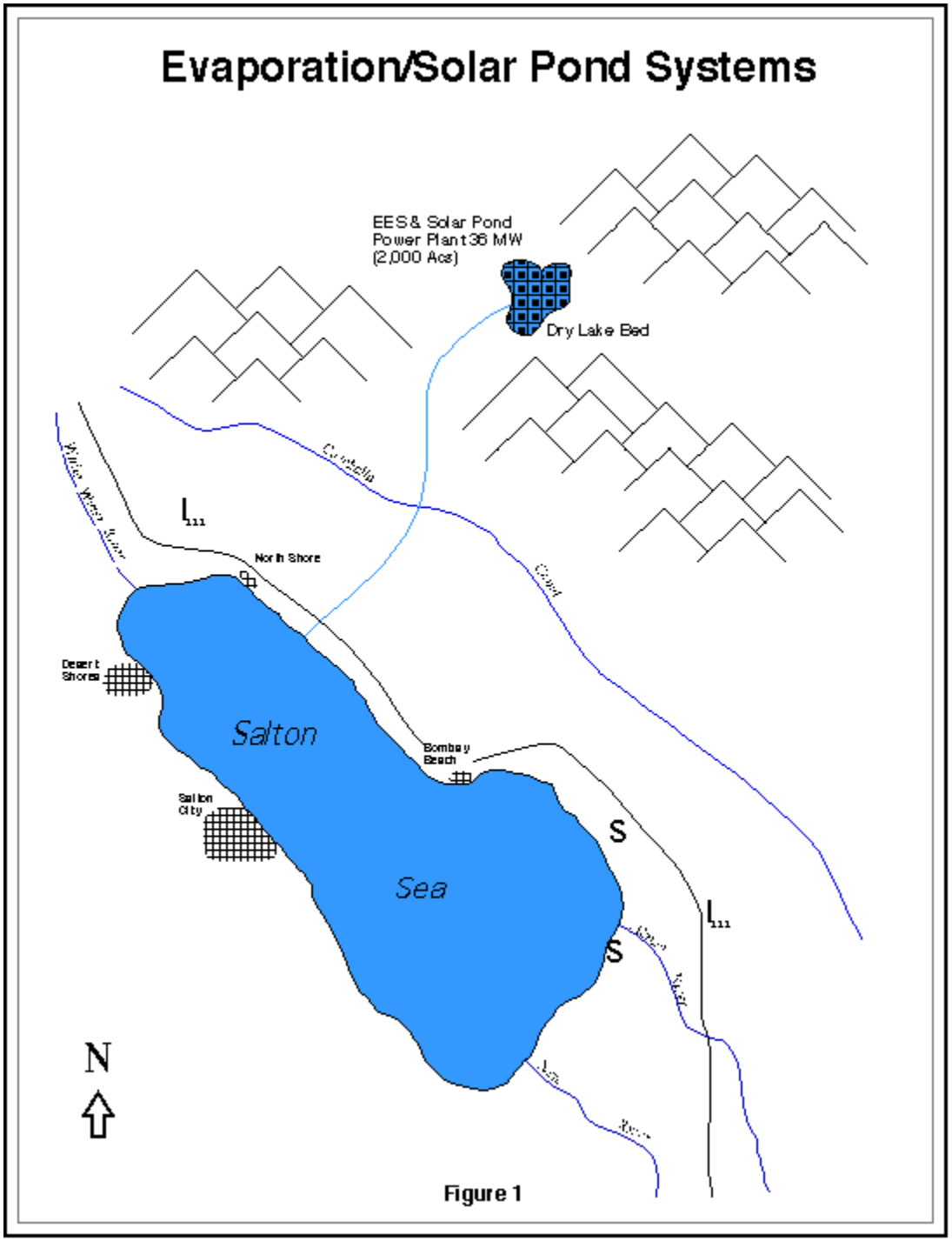
Evaporation/Solar Pond Systems
EES & Solar Pond
Power Plant 36 MW
(2,000 Acs)
Dry Lake Bed
North Shore
Desert Shores
Salton
Sea
Bombay Beach
Salton City
S
S
N
Figure 1

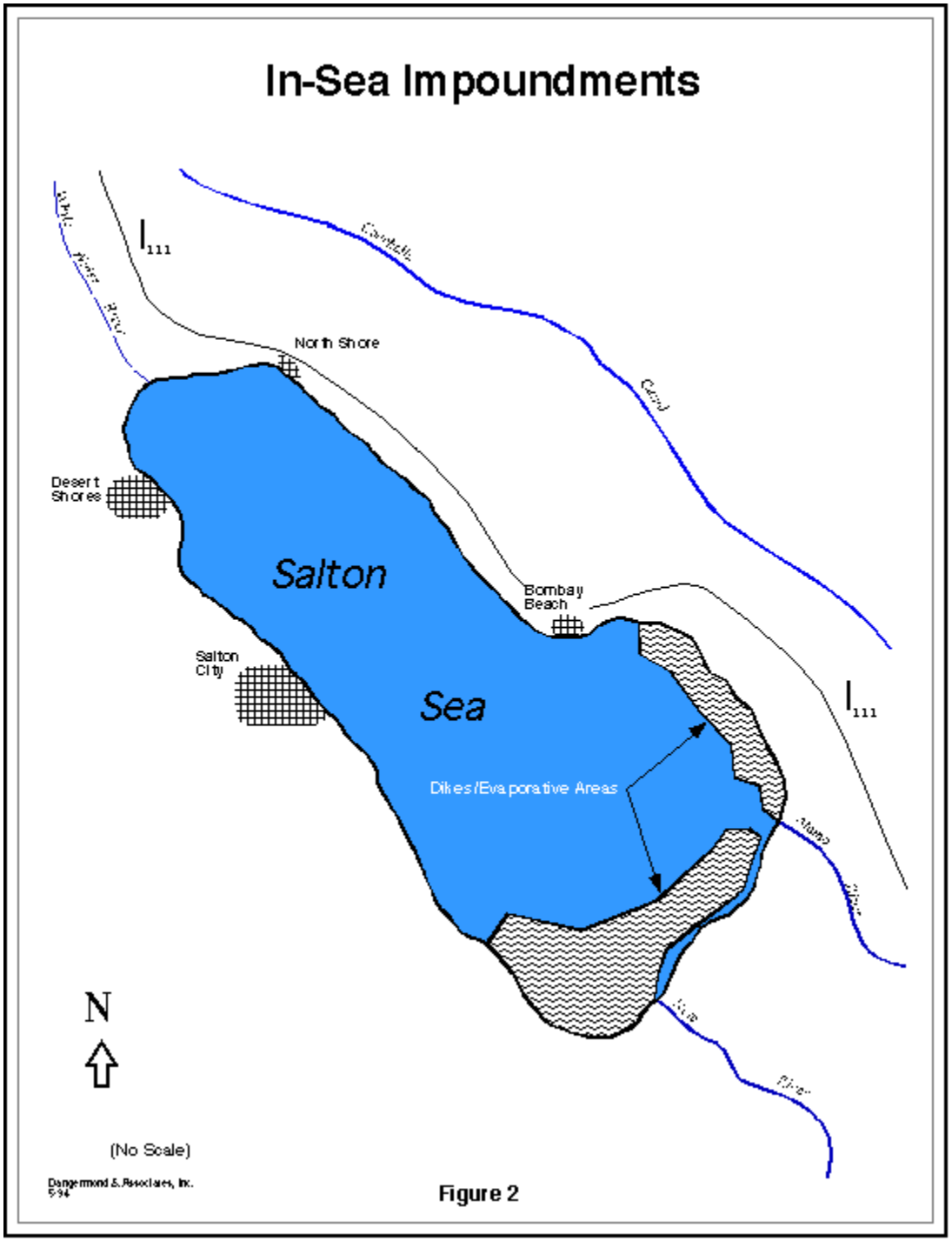
In-Sea Impoundments
I 111
North Shore
Desert Shores
Salton
Sea
Bombay Beach
Salton City
I 111
Dikes/Evaporative Areas
N
(No Scale)
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Figure 2

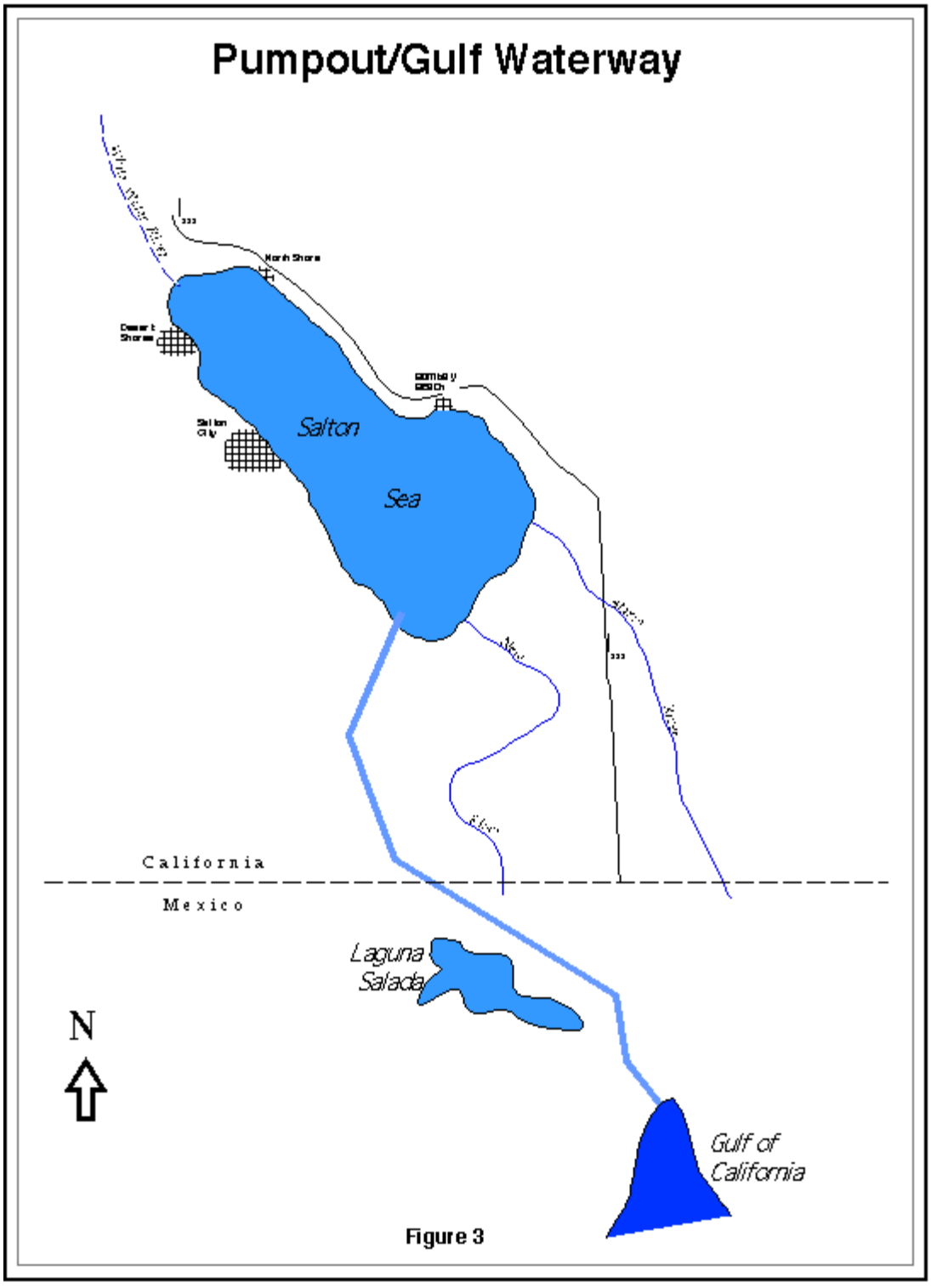
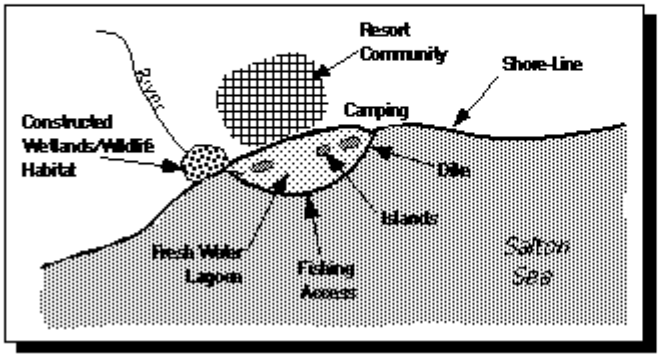
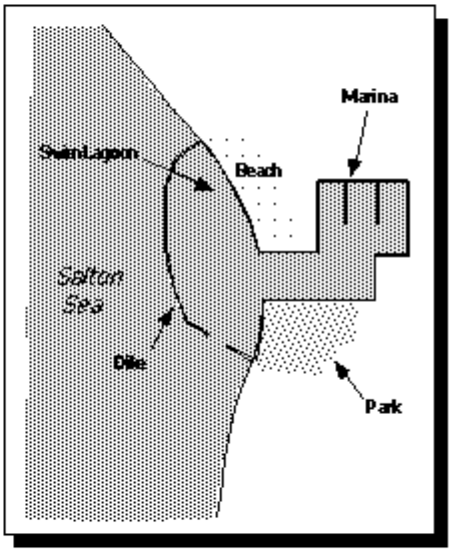
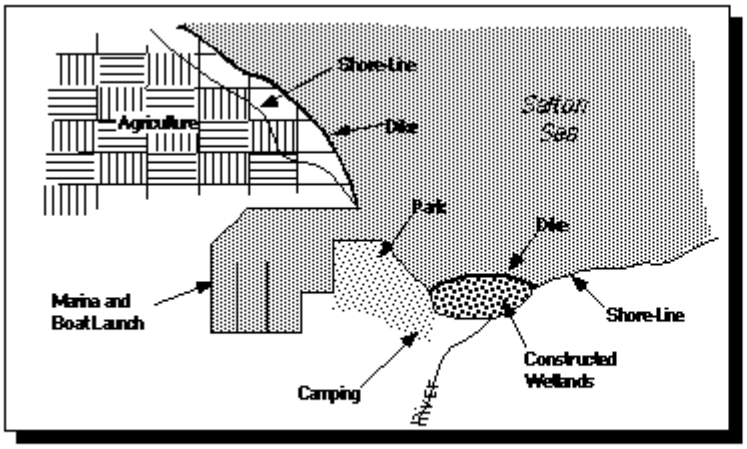

Pumpout/Gulf Waterway
Salton
Sea
California
Mexico
Laguna
Salada
N
Gulf of
California

Figure 3

Possible Shore-Line Enhancements







(No Scale)

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Figure 4

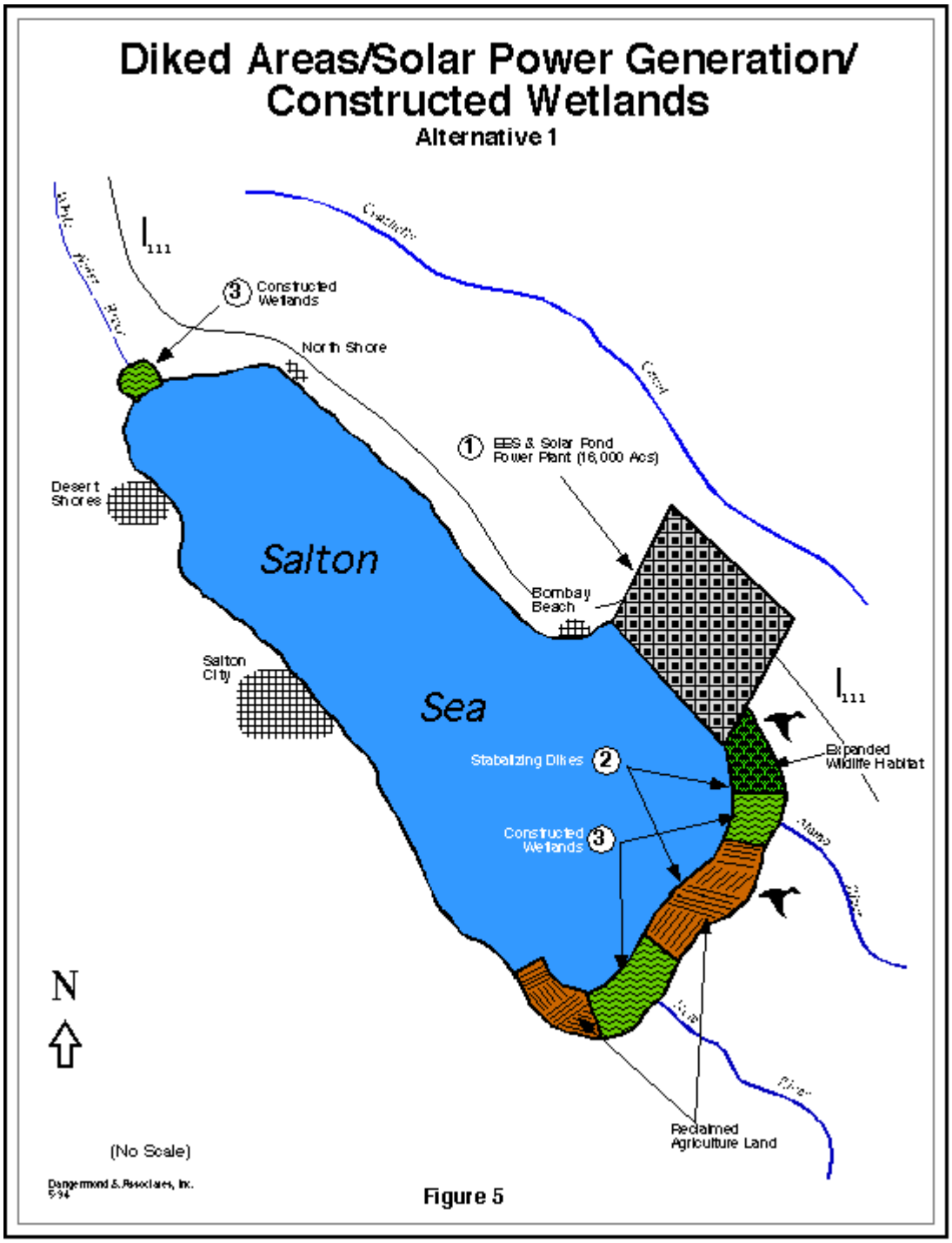
Diked Areas/Solar Power Generation/
Constructed Wetlands
Alternative 1
111
3 Constructed Wetlands
North Shore
Coachella
Canal
1 EBS & Solar Pond
Power Plant (16,000 Acs)
Desert
Shores
Salton
Sea
Bombay
Beach
Salton
City
111
Stabilizing Dikes 2
Expanded
Wildlife Habitat
Constructed
Wetlands 3
Alamo
River
New
River
N
(No Scale)
Reclaimed
Agriculture Land
Dangermond & Associates, Inc.
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Figure 5

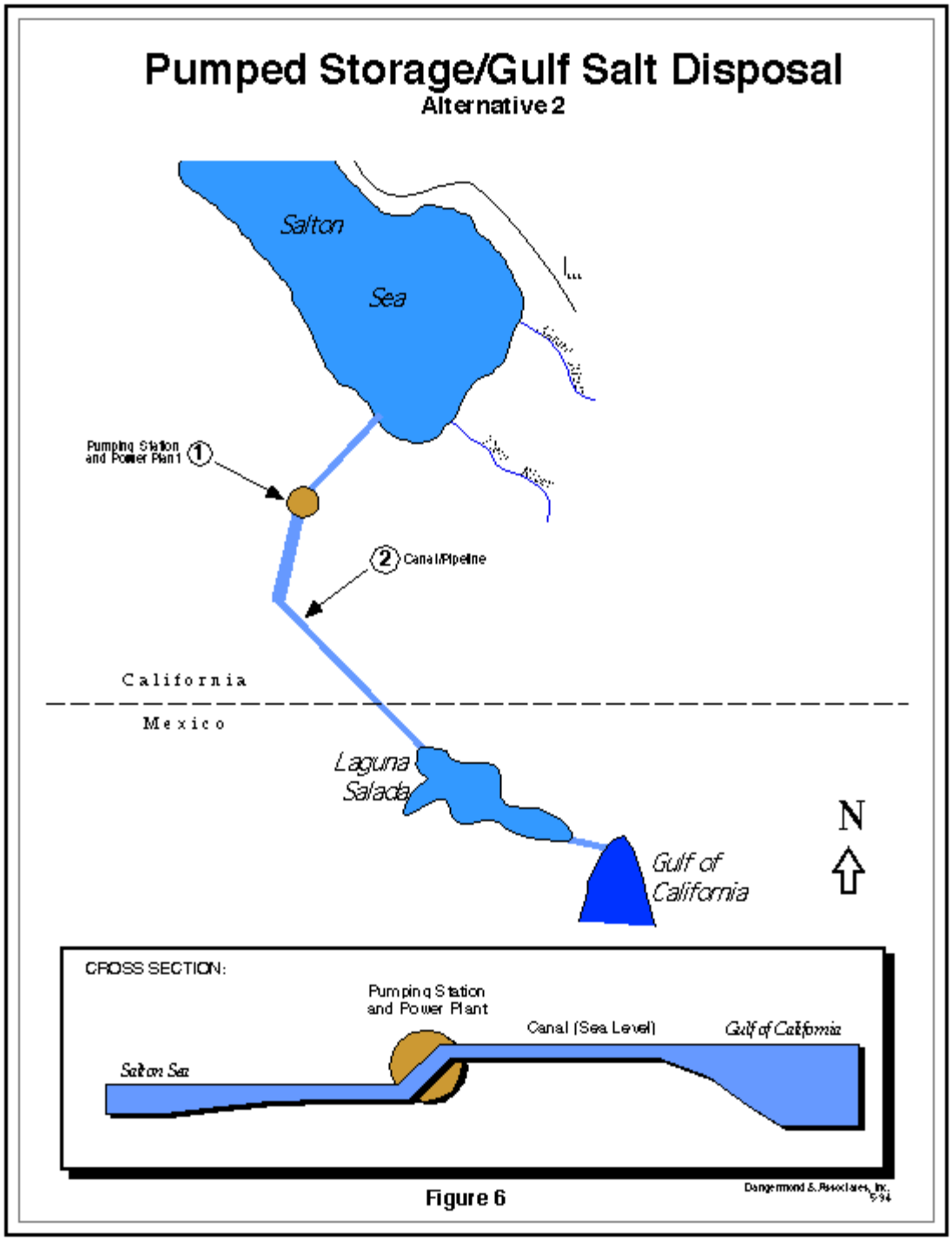
Pumped Storage/Gulf Salt Disposal
Alternative 2
Salton
Sea
Pumping Station
and Power Plant 1
1
2
Canal/Pipeline
California
Mexico
Laguna
Salada
Gulf of
California
N
CROSS SECTION:
Pumping Station
and Power Plant
Canal (Sea Level)
Gulf of California
Salton Sea

Figure 6

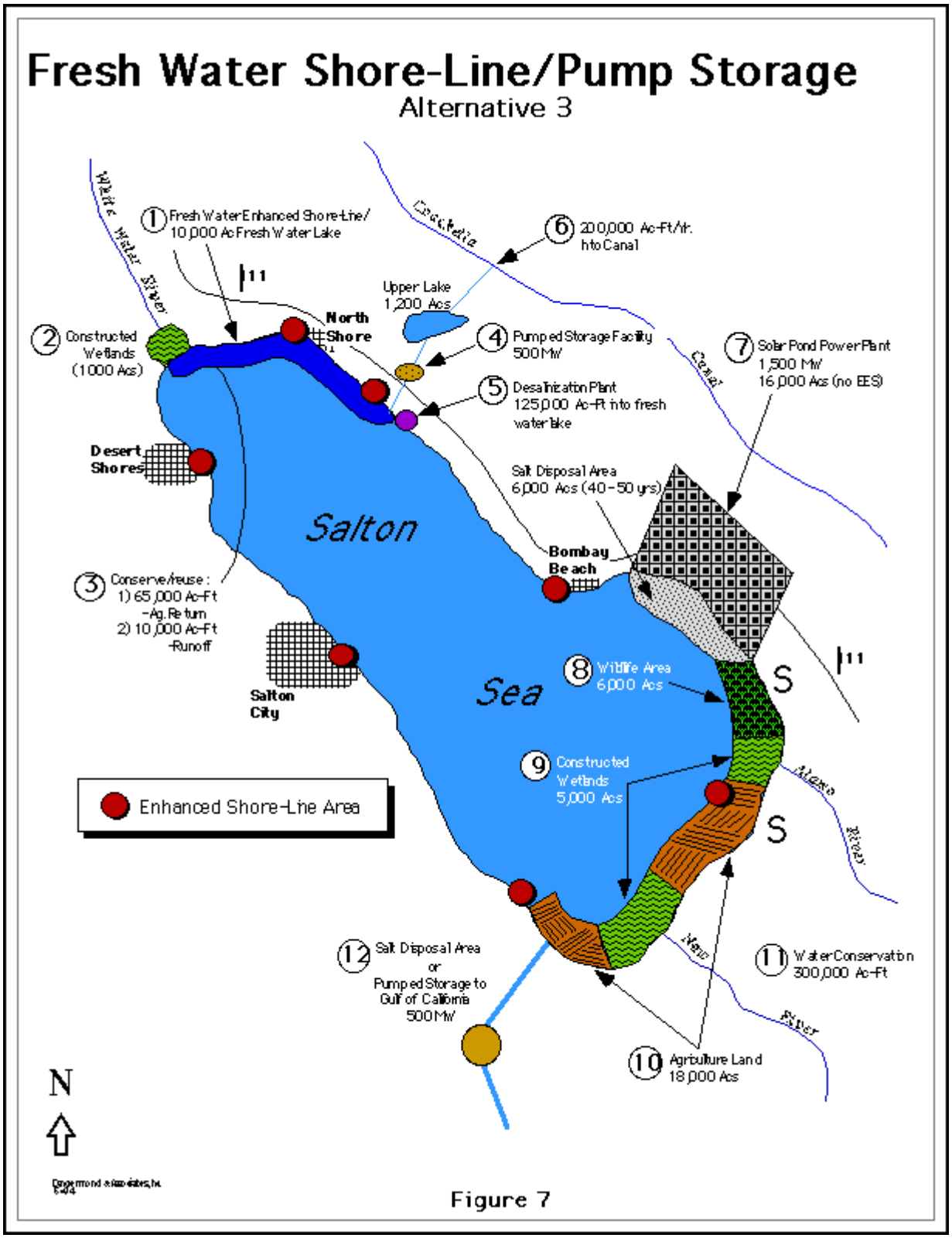
Fresh Water Shore-Line/Pump Storage
Alternative 3
1 Fresh Water Enhanced Shore-Line/ 10,000 Ac Fresh Water Lake
2 Constructed Wetlands (1000 Acs)
3 Conserve/reuse : 1) 65,000 Ac-Ft -Ag. Return 2) 10,000 Ac-Ft -Runoff
4 Pumped Storage Facility 500 MW
5 Desalinization Plant 125,000 Ac-Ft into fresh water lake
6 200,000 Ac-Ft/Yr. into Canal
7 Solar Pond Power Plant 1,500 MW 16,000 Acs (no EES)
8 Wildlife Area 6,000 Acs
9 Constructed Wetlands 5,000 Acs
10 Agriculture Land 18,000 Acs
11 Water Conservation 300,000 Ac-Ft
12 Salt Disposal Area or Pumped Storage to Gulf of California 500 MW
Salt Disposal Area 6,000 Acs (40-50 yrs)
Upper Lake 1,200 Acs
North Shore
Desert Shores
Salton City
Bombay Beach
Salton Sea
Enhanced Shore-Line Area
Alamo River
New River
Coachella Canal
N

Figure 7

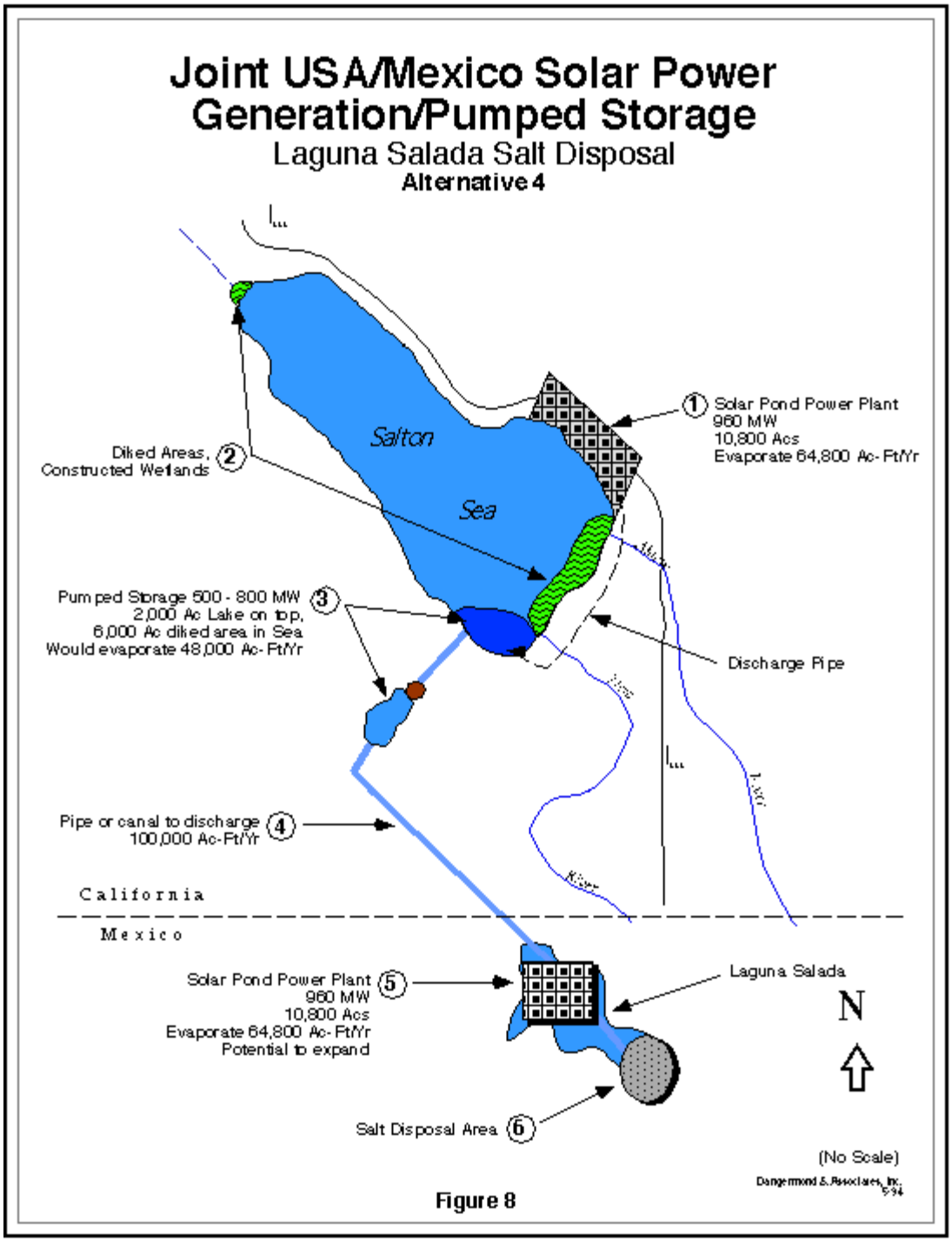
Joint USA/Mexico Solar Power Generation/Pumped Storage
Laguna Salada Salt Disposal
Alternative 4
Salton Sea
1 Solar Pond Power Plant
960 MW
10,800 Acs
Evaporate 64,800 Ac-Ft/Yr
2 Diked Areas, Constructed Wetlands
3 Pumped Storage 500 - 800 MW
2,000 Ac Lake on top,
6,000 Ac diked area in Sea
Would evaporate 48,000 Ac-Ft/Yr
Discharge Pipe
4 Pipe or canal to discharge
100,000 Ac-Ft/Yr
California
Mexico
5 Solar Pond Power Plant
960 MW
10,800 Acs
Evaporate 64,800 Ac-Ft/Yr
Potential to expand
Laguna Salada
N
6 Salt Disposal Area
(No Scale)

Figure 8

SALTON SEA PARTNERSHIP FUNDING CONCEPT

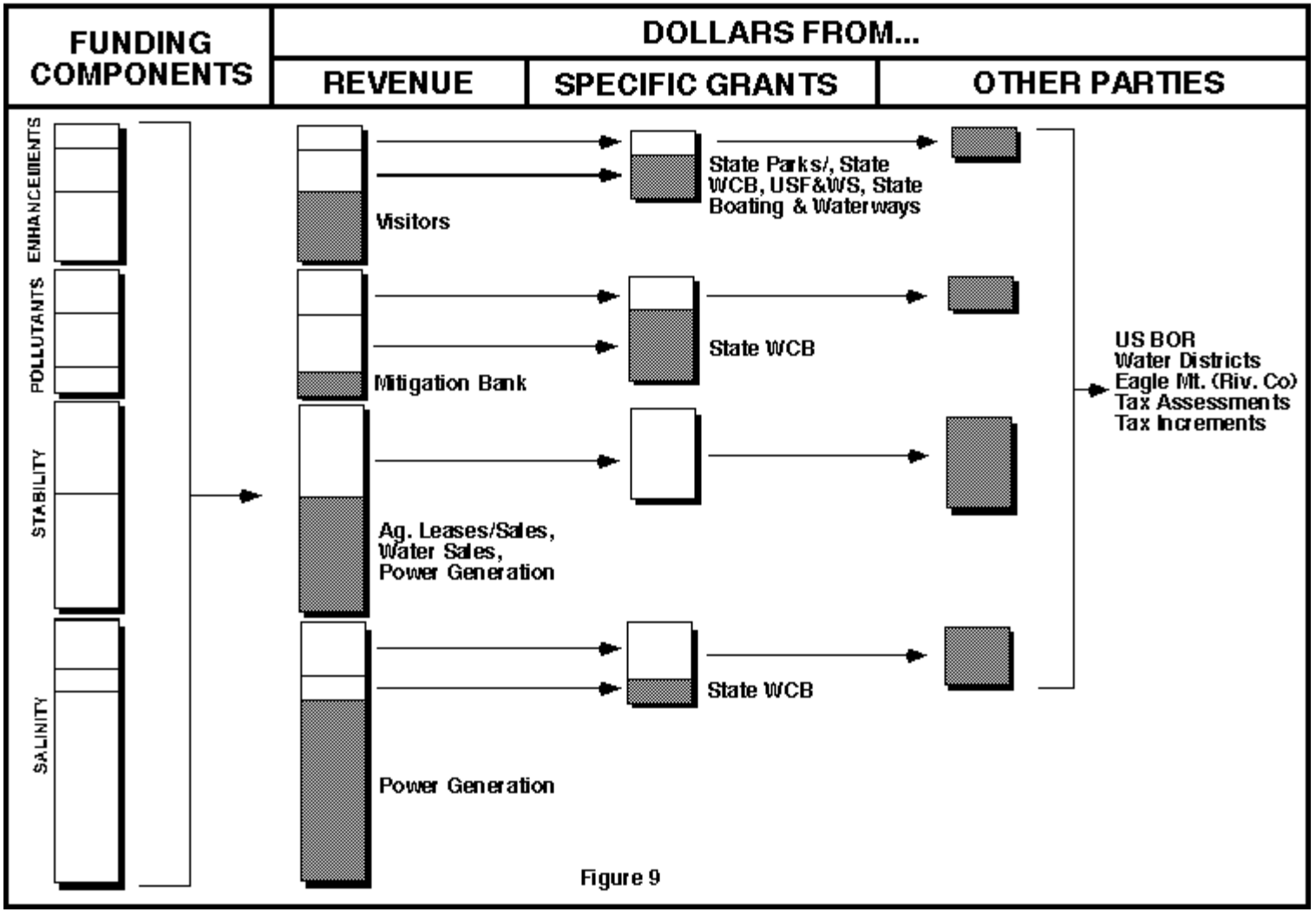

Figure 9

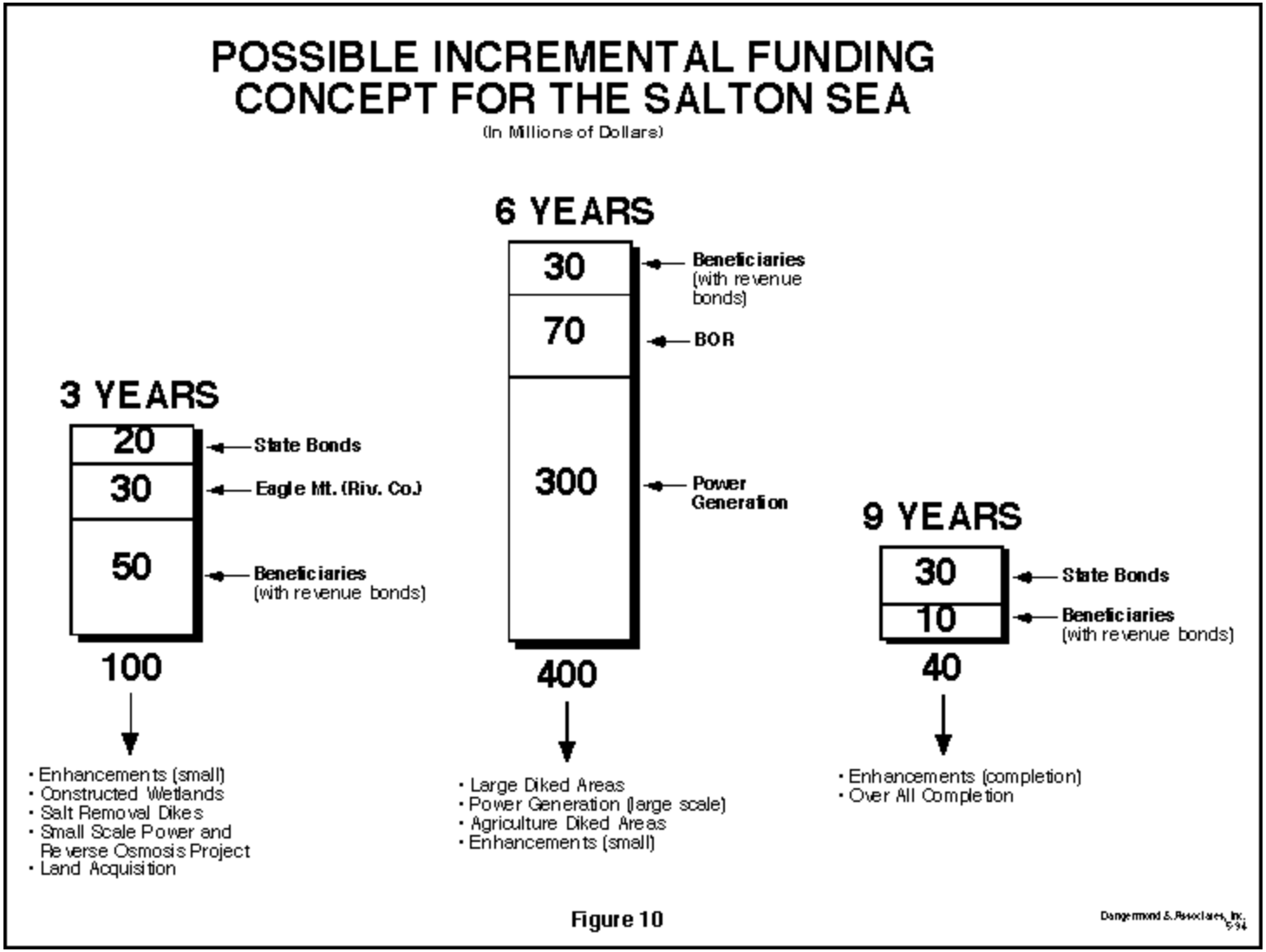
POSSIBLE INCREMENTAL FUNDING CONCEPT FOR THE SALTON SEA
(In Millions of Dollars)
3 YEARS
20
State Bonds
30
Eagle Mt. (Riv. Co.)
50
Beneficiaries (with revenue bonds)
100
• Enhancements (small)
• Constructed Wetlands
• Salt Removal Dikes
• Small Scale Power and Reverse Osmosis Project
• Land Acquisition
6 YEARS
30
Beneficiaries (with revenue bonds)
70
BOR
300
Power Generation
400
• Large Diked Areas
• Power Generation (large scale)
• Agriculture Diked Areas
• Enhancements (small)
9 YEARS
30
State Bonds
10
Beneficiaries (with revenue bonds)
40
• Enhancements (completion)
• Over All Completion

Figure 10

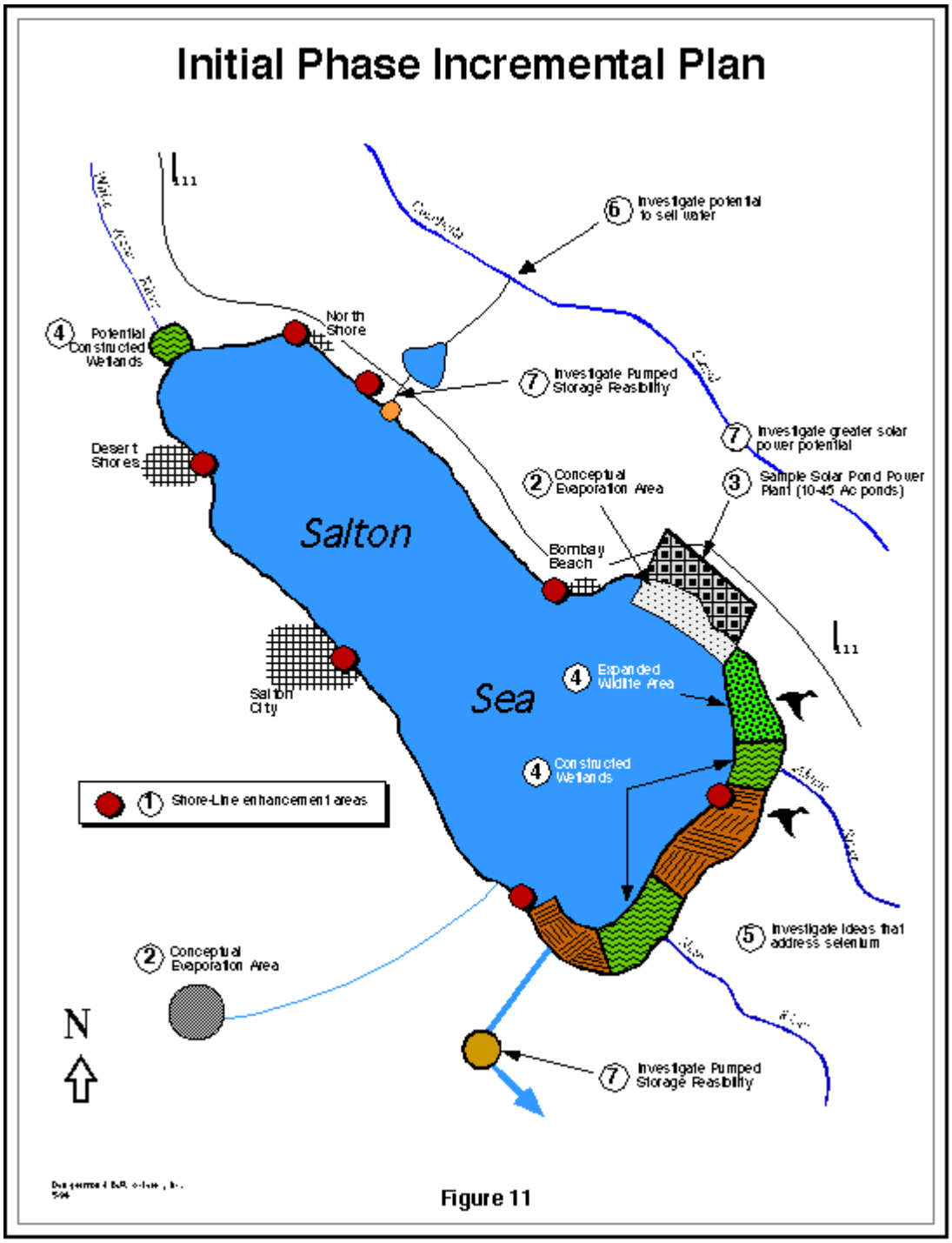
Initial Phase Incremental Plan
111
Whitewater River
Coachella Canal
6 Investigate potential to sell water
4 Potential Constructed Wetlands
North Shore
7 Investigate Pumped Storage Feasibility
7 Investigate greater solar power potential
Desert Shores
2 Conceptual Evaporation Area
3 Sample Solar Pond Power Plant (10-45 Ac ponds)
Salton
Bombay Beach
111
4 Expanded Wildlife Area
Salton City
Sea
4 Constructed Wetlands
1 Shore-Line enhancement areas
5 Investigate ideas that address selenium
2 Conceptual Evaporation Area
N
7 Investigate Pumped Storage Feasibility

Figure 11