Alternative 25 — Pump-out Disposal of Reject Stream to Yuma

HISTORY

This proposal was presented in the Meyer Resources, Inc., report, *Summary Analysis of Authorities and Responsibilities Associated with the Salton Sea* (December 1988).

PROPOSAL DESCRIPTION

In many alternatives proposed to improve the salinity of the Sea, salts would be concentrated into a reject stream, requiring the disposal of excess brine. One possibility for such disposal would be to construct a pipeline southeast to Yuma and dispose of the brine into the existing drain that empties into the Gulf of California. The existing drain was built to dispose of brine generated by operation of the Yuma Desalting Plant.

EVALUATION OF ALTERNATIVE

This alternative did not, by itself, reduce the salinity of the Sea. It would have to be used in conjunction with another alternative to provide salinity benefits to the Sea. While it did not meet the criteria for salinity improvement, the proposal could certainly be considered for brine disposal should another alternative have such a proposed attribute.

REASON FOR ELIMINATION

This proposal failed to satisfy both the salinity target and elevation target criteria. Because of this, no further consideration of this alternative was warranted.

COMBINATION ALTERNATIVES

INTRODUCTION

A number of alternatives were proposed that would combine various multiple management techniques. These techniques could include diked impoundments, pump-out, enhanced evaporation, solar power generation, or others. These combinations were developed in an effort to exploit unique advantages of each and obtain synergistic effects.

The ultimate solution to problems posed by the Sea will, in all probability, be a combination of various technologies to address the many varied, and sometimes conflicting, objectives being considered. An example of this is the difficulty associated with simultaneous elevation control and salinity control. Since salinity is a function of evaporation and evaporation is the only currently available control on elevation, the two management methods are in conflict. If inflow to the Sea were reduced to a lower elevation, evaporation would cause a rise in salinity as the salts were left behind. If, on the other hand, more water were imported into the area to dilute the salinity, the elevation would have to rise to accommodate the increased inflows.

A common solution to conflicting management alternatives would be to combine two or more techniques to take advantage of strengths and minimize weaknesses. In the above example, if an area of the Sea were enclosed to concentrate the salts, then the pump-out cost for removing the salt would be reduced because less volume of liquid would have to be moved to remove the same amount of salt. The combination of diked impoundment and pump-out would enhance both management methods and address both elevation and salinity.

These alternatives use combinations of technology that would meet the goals for the Sea and some that would not as stand-alone ideas. They are generally presented to generate more interest and support in the alternatives by creating additional benefits and revenue.

When analyzing the combination proposals, no credit was included for power generated by proposals or revenues generated through the collection and sale of salt.

Alternative 26 **Combination Impoundment/Evaporation Pond/Pipeline-Canal to Gulf of California and/or to Yuma Desalting Plant**

HISTORY

This alternative appeared in the Dangermond and Associates report, *Strategies for the Restoration and Enhancement of the Salton Sea*, Sacramento, California (1994).

PROPOSAL DESCRIPTION

This alternative combined a diked impoundment adjacent to the shore, an onshore evaporation pond, and a pipeline to transport concentrated brine to another area, namely the Gulf of California or the Yuma Desalting Plant brine discharge canal. A 24-mi^2 diked impoundment in the southwestern end of the Sea would be constructed. The dike's specifications would be similar to those described for the diked impoundment alternatives. The impoundment would utilize the shoreline as a portion of the parameter. Pumping facilities would remove concentrated Sea water from the diked impoundment and pump it to a 22-mi^2 onshore evaporation pond located near the Sea. A pipeline would be constructed to transport the concentrated brine from the evaporation pond to either the Gulf or the Yuma Desalting Plant.

EVALUATION OF ALTERNATIVE

This alternative attempted to take advantage of attributes of several management options in order to optimize project performance. Water would first be concentrated in an in-Sea impoundment. Cost advantages of in-Sea impoundment would be realized with a smaller impoundment. A second stage of concentration would be achieved in on-shore evaporation ponds. The higher cost of these ponds would be mitigated by the smaller size required by the concentrated inflow. The final stage of disposal—pumping to an ocean discharge—would be the most expensive. Since the water is now highly concentrated, volumes would be lower and costs more reasonable.

This concept was certainly technically workable and would be amenable to alteration, if warranted. There would be, however, significant issues that would have to be resolved. Land-based evaporation ponds would require a large land area that could conflict with existing uses, impose seepage management (liner), necessitate adjustments to surface water drainage routing, dictate special wildlife considerations, and require considerable attention to operation and maintenance. Final disposal would also have its own unique areas of concern. Pumping highly saline water into the Gulf would require consideration of wildlife implications at the discharge point, available capacity in any existing facilities that would be used, and international issues.

The proposal did not provide information on the quantity or the salinity of the water to be transferred from the evaporation pond to the Gulf.

OME&R COSTS

OME&R costs for this proposal would include electrical costs for pumping, replacement costs of pumping equipment, and O&M costs for the evaporation pond. Electrical costs for pumping various quantities of water to the Gulf were provided in Alternative 21.

Assuming a 10-year life for the lining under the evaporation pond, replacement costs would total over $98 million every 10 years (640 acres per mi^2 * 22 mi^2 * $7,000 per acre for placement of liner). When spread over 10 years, the costs for replacing the liner system over a 22-mi^2 pond would be nearly $10 million per year.

With the cost of the liner system and the cost to pump water to the Gulf, total OME&R costs would exceed the $10 million annual limit.

CONSTRUCTION COSTS

Construction costs were not calculated since the OME&R costs would exceed $10 million annually.

REASON FOR ELIMINATION

This proposal would exceed the $10 million annual limitation for OME&R costs. Therefore, this alternative did not warrant further consideration.

Alternative 27 Combination Impoundment/Power Generation/Constructed Wetlands

HISTORY

Components of this alternative were first proposed by Ormat Technical Services, Inc., in the *Salton Sea Project, Preliminary Study* (March 1989). It was reexamined and expanded in the Dangermond and Associates, Inc., report for the Salton Sea Authority, *Strategies for the Restoration and Enhancement of the Salton Sea* (July 1994).

PROPOSAL DESCRIPTION

There were three main components to this proposal:

1. An on-shore Enhanced Evaporation System (EES) to reduce and control salinity levels would be combined with a solar pond power plant to generate electricity. The EES was developed by Ormat Turbines, Ltd., in the early 1980's to minimize the size of ponds used to concentration water to a level required by solar ponds. It consisted of proprietary special spray nozzles and manifolds.

2. Two diked areas, used to stabilize the elevation of the Sea, would be constructed at the south end of the Sea near the Alamo and New Rivers.

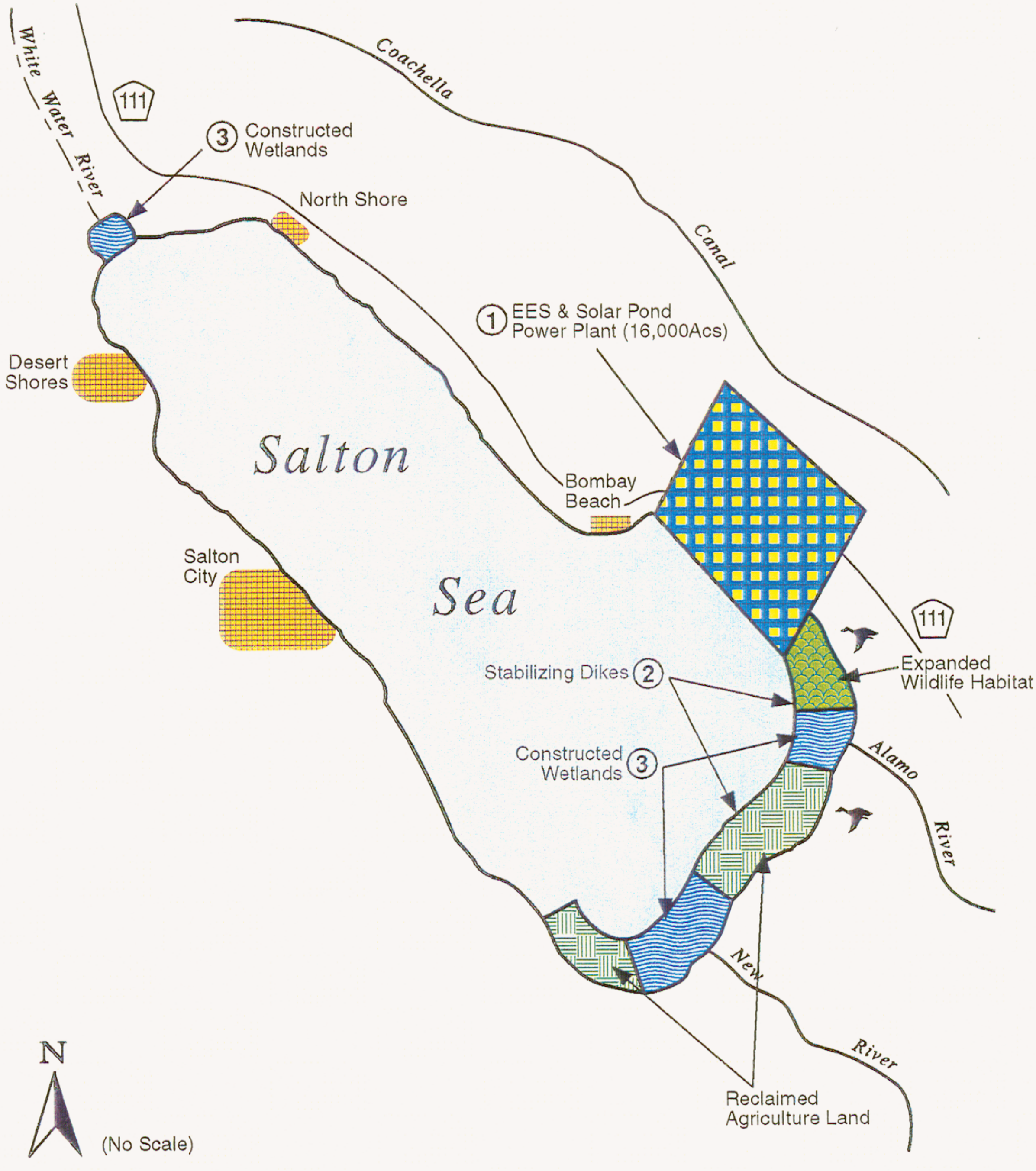
3. Constructing wetlands at or near the mouths of the Alamo, New, and Whitewater Rivers would remove contaminants. Constructed wetlands would use natural biological processes to purify wastewater. Water would be funneled through aquatic plant systems which would absorb and biodegrade organics and remove heavy metals such as selenium (see Illustration 26).

The proposal provided for pumping 250,000 AF per year from the Sea to the evaporation system and solar power ponds. Proponents estimated a power plant size of 15,000 MW (Dangermond, 1994, p.16). Production of water by desalination of a quality that would make it suitable for agricultural irrigation was presented as a project benefit.

EVALUATION OF ALTERNATIVE

Pumping 250,000 AF per year from the Sea would reduce salinities to target within a reasonable time—probably about 10 years. More problematic would be the production of electric energy. It was uncertain how Dangermond established the 15,000 MW power production potential. Ormat designed power production modules of 4 to 8 MW, which would evaporate 25,000 AF per year. Evaporation of 225,000 AF per year would support a total power plant capacity of either

Diked Areas/Solar Power Generation/ Constructed Wetlands



Alternative No. 27

Illustration No. 26

36 MW or 72 MW (Ormat Technical Services, Inc., *Salton Sea Project, Preliminary Study*, March 1989).

Production of energy by solar ponds have been demonstrated to work, but commercialization has not progressed in the United States because, in general, production costs are higher than alternative energy production methods. Ormat's costs using estimates developed in 1980 and 1989 indicated energy production costs of $0.10 to $0.20 a kWh, assuming 20-year amortization of capital investment at 7 percent interest (Ormat Technical Services, Inc., 1989; and Ormat Turbines, Ltd., *A Study of the Feasibility of a Solar Salt Pond Generating Facility in the State of California, U.S.A.*, November 1980, p. 14-9).

Desalination of water—presumably using heat or electrical energy from the solar ponds—was presented as a possible project feature. It should be recognized, however, that unless the cooling process would produce condensate that could be used for irrigation, distillation would be much too expensive to consider for irrigation or domestic uses except for highly unusual circumstances.

Wetlands could improve water quality to some degree. For example, nitrogen concentration could be reduced. However, wetlands could concentrate contaminants or act as sinks for organics (pesticides), metals, and trace elements such as selenium. Because of the fresh to brackish nature of water in wetlands, the potential for concentrating selenium and perhaps other contaminants could be higher than in the Sea. Water birds using these sites could then be at risk of contamination via food-chain bioaccumulation. In addition, the types of vegetation supported by wetlands should be considered. For example, cattails could attract the endangered Yuma clapper rail. More studies would need to be done before wetlands could be considered for water quality improvement.

The EES has been tested at several locations in Israel, but prior to full-scale use at the Sea, its operating parameters would have to be established through pilot studies using Sea water.

OME&R COSTS

Operation and maintenance costs were estimated at $500,000 per year for each 4 MW/25,000 AF per year module (Ormat Technical Services, Inc., 1989, p. 122). Nine modules would cost $4.5 million for operation and maintenance. In addition, it would cost $1.4 million to pump water from the Sea to the solar pond facility (see Table 16).

Table 16
Alternative 28
Pump to Enhanced Evaporation System

Flow AF	**Flow ft^3/s**	**Flow gal/min**	**Elevation head**	**Friction head**	**Total head**	**hp**
225,000*	620	279,000	48	2	50	5,032

kW	**kWh/yr**	**Electric cost**	**Replace cost**	**Annual replace cost**	**Annual O&M**	**Total OME&R**
3,754	16,443,000	1,151,000	1,233,000	123,000	145,000	1,419,000

hp = (12 hrs pumping/day) (gal/min * total head) / (3,960 * efficiency)

efficiency = 0.70

kW = hp * 0.746

kW/yr = kW * 12 hrs/day * 365 days/yr

Electric cost = kW/yr * $0.07 per kWh

Replacement cost = $245 per hp

Annual O&M costs = $28.80 per hp

*** denotes pumping 12 hours per day.**

Ormat reported that energy requirements for lifting and spraying water through the EES was 0.3 to 0.8 kWh per metric ton of evaporated water (Ormat Technical Services, Inc., 1989, p. 26). With 1 AF of water weighing 1,232 metric tons (calculated as 325,851 gal/AF * 8.33 lb/gal ÷ 2,204 lb/metric ton) and 225,000 AF per year being processed by the EES, annual energy requirements would be between 83,140,000 and 221,680,000 kWh.

At $0.07 per kWh, energy costs for the EES would be between $5.8 million and $15.5 million. Minimum OME&R costs would total about $22.5 million.

With production costs of $0.10 to $0.20 per kWh and retail energy available for about $0.07 per kWh, solar pond energy production would have to be heavily subsidized. With a 36-MW facility and subsidy of $0.07 per kWh (assuming a cost of $0.14 and sale at $0.07 per kWh), the annual subsidy would amount to over $10.8 million per year as follows:

36,000 kW * 12 hrs/day * 365 days/yr * $0.07 per kWh.

CONSTRUCTION COSTS

Construction costs were not calculated for this proposal since the annual OME&R costs exceeded $10 million.

REASON FOR ELIMINATION

This proposal exceeded the $10 million annual limitation for OME&R costs. In addition, the EES technology would have to be further tested before full-scale implementation could occur. Therefore, the alternative did not warrant further consideration.

Alternative 28 Combination
Freshwater Shoreline/Pumped Storage/Constructed Wetlands

HISTORY

This alternative was presented by Dangermond and Associates, Inc. in *Strategies for the Restoration and Enhancement of the Salton Sea* (July 1994).

PROPOSAL DESCRIPTION

This alternative combined three main features:

(1) a salt concentration impoundment within the Sea itself;
(2) a desalting plant; and
(3) a 1,500-MW solar pond energy plant (see Illustration 27).

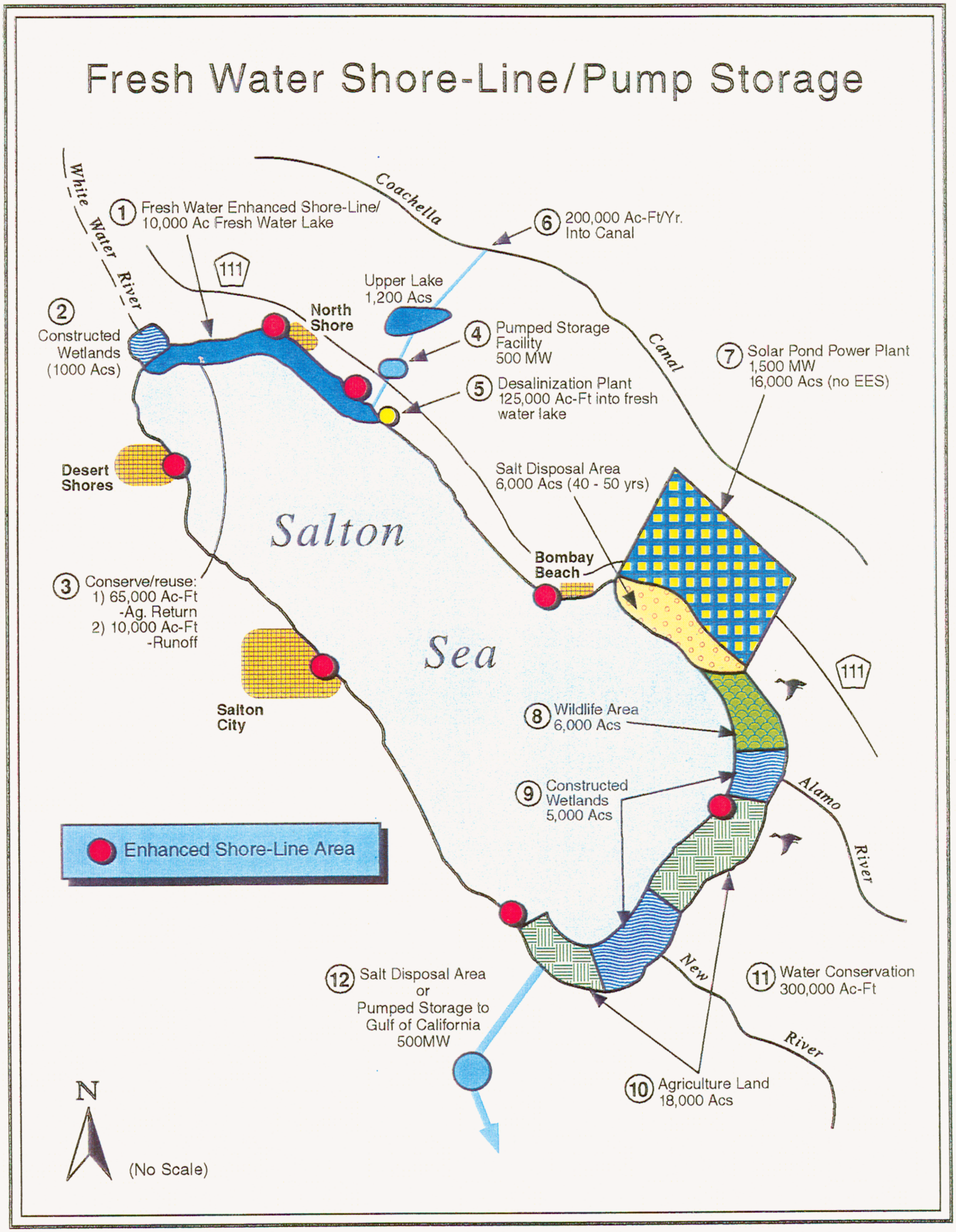
Construction of diked areas would be used to reduce the overall size of the Sea, compensating for withdrawals of water for other purposes, and, thus, would help stabilize the Sea's elevation. Constructed wetlands would filter and biodegrade many contaminants from inflow to the Sea, including selenium and excess nutrients.

In addition to the solar ponds, energy production from a pumped storage facility similar to the one proposed under Alternative 23 was presented as a possibility. The solar pond scheme contemplated in this alternative did not include the EES included in Alternative 27.

A number of other features were included in this alternative to enhance its benefits. These include a freshwater impoundment on the north end of the Sea fed by the Whitewater River and product water from a desalting plant, 6,000 thousand acres of wildlife habitat constructed in a dike system along the south shore of the Sea, and water conservation in the Imperial and Coachella Valleys.

EVALUATION OF ALTERNATIVE

There were several components of this alternative that would need further clarification. One is the area of land needed to produce 1,500 MW of power. Dangermond estimated a requirement of 16,000 acres of solar ponds. However, Ormat's solar pond module required 250 acres for a 5-MW power plant (Ormat Technical Services, Inc., 1980, p. 12-17). Using Ormat's figures, a 1,500-MW power plant would require 75,000 acres of solar ponds. Since solar ponds only work with salt concentrations in the 35 percent range (*The Desalting and Water Treatment Membrane Manual: A Guide to Membranes for Municipal Water Treatment*, Water Treatment Technology Program Report No. 1, Reclamation, September 1993, p.73), evaporation ponds would be



Alternative No. 28
Illustration No. 27

OME&R COSTS

With production costs of $0.10 to $0.20 per kWh and retail energy available for about $0.07 per kWh, solar pond energy production would have to be heavily subsidized. With a 1,500-MW facility and subsidy of $0.07 per kWh (assuming a cost of $0.14 and sale at $0.07 per kWh), the annual subsidy would amount to nearly over $500 million per year as follows:

1,500,000 kW * 12 hrs/day * 365 days/yr * $0.07 per kWh.

Membrane desalting costs are fairly well known. Product water from the Santa Barbara, California, ocean water desalination plant is reported to cost about $2,000 per AF (personal communication with Dr. Charles Moody, Reclamation, Denver, Colorado, May 1, 1997). At that unit cost, desalting 125,000 AF per year would cost $250 million annually. Therefore, OME&R costs were not estimated for each of the features included in this proposal.

If the product was eventually delivered to the Coachella Canal for agricultural use, it would have a value, but the value would be on an order of magnitude less than that of the desalting cost. Thus, the annual cost of this one feature far exceeded the OME&R ceiling of $10 million per year.

CONSTRUCTION COSTS

Construction costs were not calculated for this alternative since the annual OME&R costs exceeded $10 million.

REASON FOR ELIMINATION

The OME&R costs for the desalting component alone exceeded the $10 million annual limitation for OME&R costs. Therefore, the alternative did not warrant further consideration.

Alternative 29 Combination
Solar Power Generation/Pumped Storage/Constructed Wetlands
Laguna Salada Salt Disposal

HISTORY

This proposal appeared in a report by Dangermond and Associates, Inc., *Strategies for the Restoration and Enhancement of the Salton Sea* (July 1994).

PROPOSAL DESCRIPTION

This proposal included a combination of several features to remove over 210,000 AF of water from the Sea and reduce salinity to ocean concentrations in approximately 10 years:

(1) A joint United States-Mexico solar pond power plant, without an EES, to generate power and evaporate Sea water;
(2) Wetlands constructed at the confluence of the Alamo, New, and Whitewater Rivers to help filter the water entering the freshwater enhanced shoreline area;
(3) A pumped-storage facility at the southwest side of the Sea with a 6,000-acre diked area in the Sea and a 2,000-acre pond at Sea level;
(4) A pipe or canal system to connect the pumped-storage facility to the Laguna Salada;
(5) A second solar pond power plant located in or near Laguna Salada to create power using water being pumped from the Sea; and
(6) An area within or near Laguna Salada for salt disposal (see Illustration 28).

The proposal provided for two 10,800-acre solar pond sites producing 960 MW each and a 500- to 800-MW pumped storage facility.

EVALUATION OF ALTERNATIVE

As noted in Alternative 28, the land area requirement for solar pond power production seemed highly than estimated by the proponent. Using Ormat's numbers of 50 acres for each 1 MW of electrical capacity, 48,000 acres of solar ponds would be required at each site. Additional land would be required to initially concentrate Sea water to the level required for solar pond operation (see discussion under Alternative 28).

The viability of pumped storage was addressed under Alternative 23.

The wetlands feature would provide for additional wildlife habitat along the shoreline of the Sea as well as assist filtering the water entering the shoreline area.

Alternative No. 29
Illustration No. 28

This alternative could lower salinity levels in the Sea and, depending upon operational aspects of the pumped storage facility, address water surface elevation concerns as well. In order to manage elevations, the pumped storage facility would have to have the ability to transport water of a better quality salinity than ocean water back to the Sea. From the description provided, it was questionable whether the facility was designed to do that. A conveyance system sized to transport 100,000 AF per year could be too small to provide enough water exchange to effectively manage water surface elevation.

Institutional and environmental issues in Mexico would create complications for this proposal.

OME&R COSTS

As noted in Alternative 27, economics have not favored commercialization of solar ponds for power generation. With costs of $0.10 to $0.20 per kWh and retail energy available for about $0.07 a kWh, solar pond energy production would have to be heavily subsidized. With a 700-MW facility (approximately the capacity needed to match 200,000 AF annual withdrawal from the Sea) and a subsidy of $0.07 per kWh (assume a cost of $0.14 and sale at $0.07 per kWh), we calculated that the annual subsidy would amount to over $200 million per year (700,000 kW * 12 hr/day * 365 days/year * $0.07/kWh).

Other annual costs would include maintenance of the wetlands and operation and maintenance of the pumped storage/conveyance to the Laguna Salada.

CONSTRUCTION COSTS

Construction costs were not calculated for this proposal since the annual OME&R costs exceeded $10 million.

REASON FOR ELIMINATION

The cost to operate this proposal exceeded the $10 million annual limitation for OME&R costs. Therefore, the alternative did not warrant further consideration.

REMOVAL OF INFLOW SALT

INTRODUCTION

One of the major issues facing the Sea is increased salinity levels in the water. Moving millions of tons of salt over mountain ranges or long distances would add significancy to construction and OME&R costs and could have environmental and political consequences when deciding where the salt would be disposed. If the salts could be removed before they entered the Sea, these concerns and costs would be reduced.

The options discussed in this section address alternatives that focus on removing salts from tributaries to the Sea before they could become a problem.

These types of projects may have had some merit before the Sea's salinity became a problem. In order for them to work now, salt would have to be taken from the Sea itself to reduce the total salt load. As long as the cleaned-up inflow water was put in the Sea in volumes equal to the Sea evaporation, the salinity of the Sea could be stabilized. Excess potable water would have to be discharged to the Sea to improve salinity, thus increasing the water surface elevation.

Alternative 30 Removal of Salt Before Water Enters the Sea
Move Yuma Desalting Plant to the Sea

HISTORY

Although there has been considerable speculation on this alternative over the past several years, the first recorded version of this alternative was by Mrs. Iver Watkins, Salton Sea Beach, California (et al.) in the two public workshops held in September and October 1995. This alternative was also proposed by Mr. Alex Michaels, of the Alex Michaels Company, during the same public workshops.

PROPOSAL DESCRIPTION

This proposal would move the Yuma Desalting Plant, which was designed to desalt water that comes out of the drain from the Wellton-Mohawk Irrigation and Drainage District, to the Sea and begin removing salt from Sea water. A reverse osmosis desalination plant would use a specially developed membrane to filter out 90 percent of the salt. In reverse osmosis, pressure would be applied to the intake water, forcing the water molecules through a semipermeable membrane. The salt molecules would not pass through the membrane, and the water that would pass through would become potable product water.

EVALUATION OF ALTERNATIVE

The basis for this alternative was that the Yuma Desalting Plant (YDP) was no longer needed for its original purpose. This assumption is not correct. The YDP was built under authority of Title I of the Colorado River Salinity Control Act, Public Law 93-320, for the purpose of meeting the salinity requirement of Minute 242. This agreement between Mexico and the United States defined the level of salinity in waters of the Colorado River delivered to Mexico. While it is true that the YDP is not currently being operated because the salinity differential is being met through water management techniques, it is maintained in a ready reserve mode because it is recognized that those techniques are temporary. In the event that hydrologic conditions change, YDP operation would be necessary to meet Minute 242 requirements.

In its current configuration, YDP was not intended to desalinate water saltier than ocean water. Significant changes and additions would have to be made to the plant equipment to handle this type of brine water. For purposes of this analysis, it was assumed that a new desalination plant would be built at the Sea.

It was suggested that the salt and minerals extracted from Sea water be used to produce energy, thereby reducing the costs of operating the desalting system and possibly producing a source of surplus energy. No information was offered about the salt removal membrane or how energy would be generated from the salt and the minerals. Product water from the plant would have economic value, but under today's conditions, the cost of producing water would far exceed its value.

Disposal of the reject brine would also need careful consideration. Disposal options could include deep well injection, evaporation, or transport to the Gulf of California. Each of those options would require resolution of significant issues.

OME&R COSTS

O&M costs for membrane desalting are fairly well known. Product water from the Santa Barbara, California, ocean water desalting plant was reported to cost about $2,000 per AF (personal communication with Dr. Charles Moody, Reclamation, Denver, Colorado, May 1, 1997; additional information provided on internet by American Desalination Association, www. Goodnet.com/~karink/ada). $5 to $10 per 1,000 gallons calculates as follows:

$\$5/1000 \text{ gal} * 1 \text{ gal}/0.00379 \text{ m}^3 * 1{,}233.5 \text{ m}^3 / 1 \text{ AF} = \$1{,}627/\text{AF}$ to $3,255/AF.

At that unit cost, desalting 125,000 AF per year would have an annual cost of $250 million.

CONSTRUCTION COSTS

Construction costs were not calculated since the proposal exceeded the $10 million annual limit for OME&R costs.

REASON FOR ELIMINATION

This proposal exceeded the $10 million annual limitation for OME&R costs. For these reasons, this alternative did not warrant further consideration.

Alternative 31 Removal of Salt Before Water Enters the Sea — Poplar Tree Constructed Wetlands

HISTORY

This idea was proposed by Mr. Neil J. Maxwell, Salton Sea Beach, California, in the August 1995 public workshop by letter dated August 11, 1995. Mr. Maxwell indicated in his letter that additional information was available from studies being done around the River Bend Landfill in Iowa.

PROPOSAL DESCRIPTION

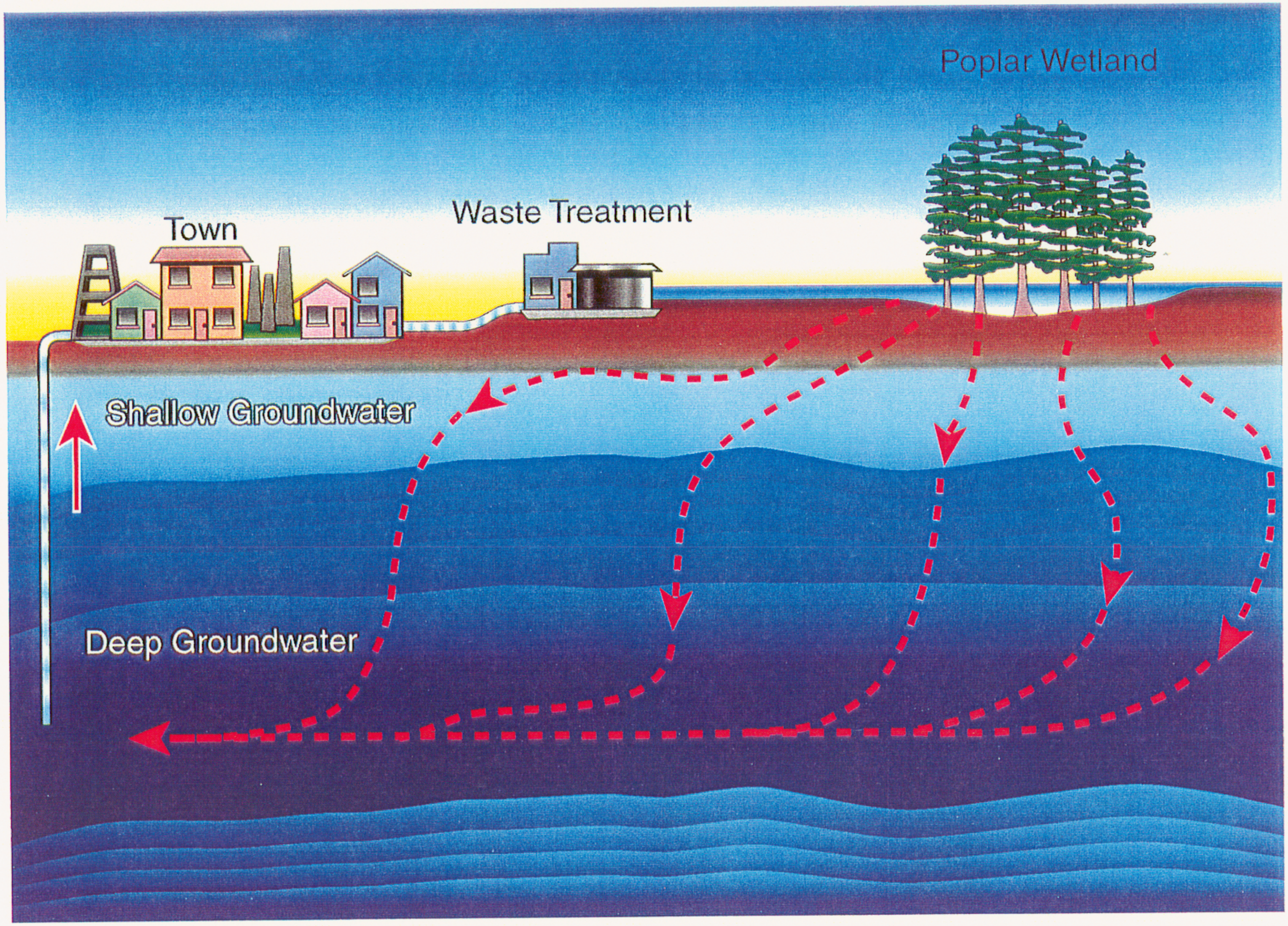
This proposal used a stand of poplar trees planted in such a way that nitrates contained in the inflow to the Sea would be removed by flowing through the trees (see Illustration 29). The proposal would work in the same way as a constructed wetland, which could be used to remove certain organics and other constituents found in agricultural runoff. No information was given as to locations, densities, or other parameters.

EVALUATION OF ALTERNATIVE

Creation of a wetlands environment or bosque of popular trees could have some beneficial effect on the quality of water flowing into the Sea. There would also certainly be benefits associated with creation of wildlife habitat. However, this proposal primarily addressed concentrations of nitrates. It did not address salinity of the Sea. The salt load now in the Sea would remain and the water would become more concentrated over time through the evaporation process.

To grow a mature stand of softwood poplar trees would take between 20 and 30 years (Beck, D.E. 1990. "Liriodendron tulipifera" in *Silvics of North America, Vol. 2*. Edited by Burns, R.M. and B.H. Honkala. *USDA Forest Service Agriculture Handbook 645*, pp. 405-415). As young trees, the seedlings would offer very little in the ability to remove nitrates from the water. Salinity could stunt the growth of the seedlings.

Significant increases in riparian vegetation along drainages into the Sea could result in decreased flow through increases in transpiration. While this would reduce inflow to the Sea, it would in no way provide control over Sea elevations.



Conceptual diagram illustrating the use of poplar wetlands for wastewater recycling. A similar concept is used in small communities throughout Florida.

Alternative No. 31
Illustration No. 29

REASON FOR ELIMINATION

This proposal failed to achieve and maintain the target salinity requirement of 35 to 40 ppt. No further consideration of this alternative was warranted.

Alternative 32 Removal of Salt Before Water Enters the Sea
Special Pretreatment Reservoirs

HISTORY

This alternative was proposed by Mr. Tim Bloom, of Diversified Scientific Technologies, P.O. Box 388, Rancho Mirage, California 92270, (619) 201-0347, in a workshop proposal dated August 15, 1995.

PROPOSAL DESCRIPTION

This proposal would use pretreatment reservoirs to capture water before it enters the Sea in order to remediate inflow pollution. In addition, overflow reservoirs would be built to hold excess water. A special remediation treatment would be applied to the main body of the Sea as well as to the special pretreatment reservoirs. This treatment reportedly would reduce salinity and pollution. No information was provided on what this special treatment consists of or how it would work.

Percolation would play a role in the treatment process since the reservoirs would be designed and built to percolate water at twice the normal rate. There would be continued testing of remediation methods. Mr. Bloom, the proponent, also suggested concentrating on legislation which focuses on controlling pollution and deals with issues such as farming practices and Mexican influences.

EVALUATION OF ALTERNATIVE

There was not enough information provided to determine how this proposal would provide either salinity or elevation control to the Sea. Verification of the effectiveness of any "treatment" to reduce salinity would have to be provided through successful field testing.

REASON FOR ELIMINATION

This proposal failed to satisfy at least three of the four elimination criteria. It would not achieve or maintain the target salinity requirement of 35 to 40 ppt; it would have no influence on elevation; much more research, development, and testing would be required to determine its viability. For these reasons, this alternative warranted no further consideration. Should additional information become available which satisfies the elimination criteria, further consideration would be given to this alternative.

Alternative 33 Removal of Salt Before Water Enters the Sea
United States Filter Corporation
(New River Desalting)

HISTORY

This proposal was presented by Mr. Eldon Gill, of Lobland-Waring, 73-350 El Paseo, Suite 106, Palm Desert, California 92260, (619) 340-4641, in a commentary solicited for the Salton Sea Symposium (undated).

PROPOSAL DESCRIPTION

The United States Filter Corporation designs and manufactures customized and pre-engineered systems and equipment to filter and purify water. These systems are used in industrial production processes and elsewhere. The company offers products for gas filtration, separation of dissolved and suspended solids, and separation of organic matter and inorganic matter from other liquids. The company also operates a centralized industrial hazardous waste treatment and recovery facility. The proposal suggested that this technology be used by the Mexican Government to improve the quality of the New River.

EVALUATION OF ALTERNATIVE

As noted earlier, treatment of inflow to the Sea could improve water quality and reduce the rate of increase of salinity of the Sea, but it would not suppress the salinity increase or reduce salinity to the targeted levels. In addition, inflow treatment would not manage water surface elevations.

Many claims are being made for various processes that are supposed to offer less costly ways of desalting poor quality water. Unfortunately, most of these processes are untested in the field on actual water that would be treated. While U.S. Filter has successfully applied their technology to other processes, the technology would have to be tested further to determine its ability to successfully treat surface waters of the Imperial Valley at an acceptable cost.

OME&R COSTS

No costs were submitted in the proposal. Mr. Roy A. Davis, of The Dow Chemical Company, Liquid Separations, Larkin Laboratory, Midland, Michigan, has estimated that optimistic costs for nanofiltration of agricultural drain water in the Imperial Valley would be about $0.50 per 1,000 gallons (reported by Dr. Yousif K. Kharaka of the U.S. Geological Survey, Menlo Park, California, during a presentation at the National Irrigation Water Quality Program Conference in La Jolla, California, September 10, 1996). As a comparison, Dr. Kharaka reported operating costs of nanofiltration of North Sea water at $1.08 per 1,000 gallons and Gulf Coast water at $0.71 per 1,000 gallons. It is uncertain if these costs would include all costs associated with the treatment process—especially pretreatment—and would take into account appropriate membrane life. Other estimates put nanofiltration costs at $1.00 to $1.50 per 1,000 gallons (Dr. Charles Moody, Reclamation, personal communication, September 10, 1996).

REASON FOR ELIMINATION

Although the technology used in this alternative is developed for some applications, the proposal would have to be tested on waters of the Imperial Valley to determine its potential for that application. The proposal would not satisfy either the salinity target or the elevation considerations. In addition, annual OME&R costs would most likely exceed the $10 million limitation by treating as little as 30,000 AF per year. For these reasons, no further consideration of this alternative was warranted.

Alternative 34 Removal of Salt Before Water Enters the Sea Groundwater Pumping (Selenium Management)

HISTORY

This concept was proposed by Hydrologic Consultants, Inc., 1947 Galileo Court, Suite 101, Davis, California 95616, (916) 756-0925, in *Proposal to Plan and Operate a Pilot Program for the Management of Selenium by Groundwater Pumping,* dated December 8, 1995. It was also proposed by HCI in another formal proposal, *Proposed Solution to Reduce Selenium Loads in Drainage Waters in the Salton Sea Area*, dated November 7, 1994.

PROPOSAL DESCRIPTION

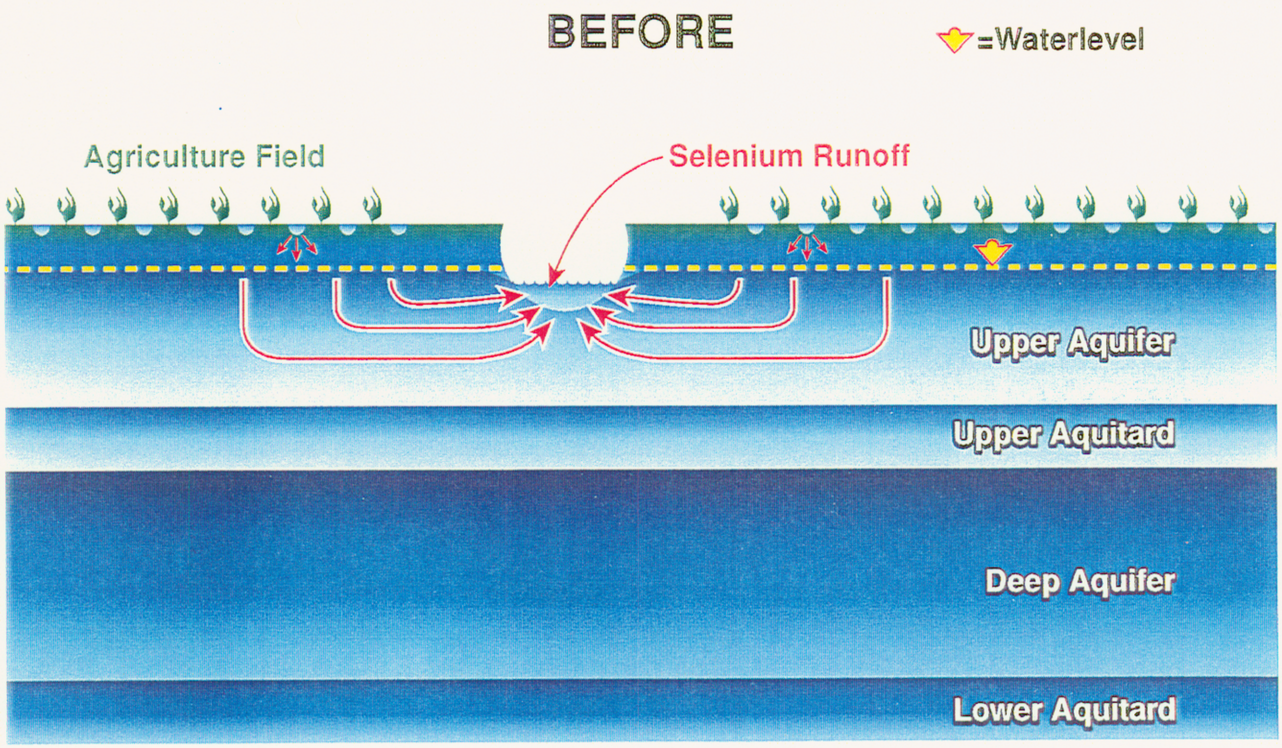
In this proposal, selenium would be managed by pumping groundwater from a deep aquifer, which underlines those areas that presently produce high selenium concentrations in drainage water flows (see Illustration 30). This pumping would occur within the depth interval of 200 to 1,000 feet below the land surface and would create a downward hydraulic gradient in the upper (near-surface) aquifer. The imposed gradient would lower the present shallow water table, directly reducing the present volume of drainage-water discharging into drains. Dissolved selenium, which now discharges to drains, would instead percolate downward to depths where it would be stored within a clay aquitard zone that occurs within the depth interval between the upper aquifer and the deep aquifer. A pilot program that would include about 5,000 acres of irrigated land and six production wells was suggested.

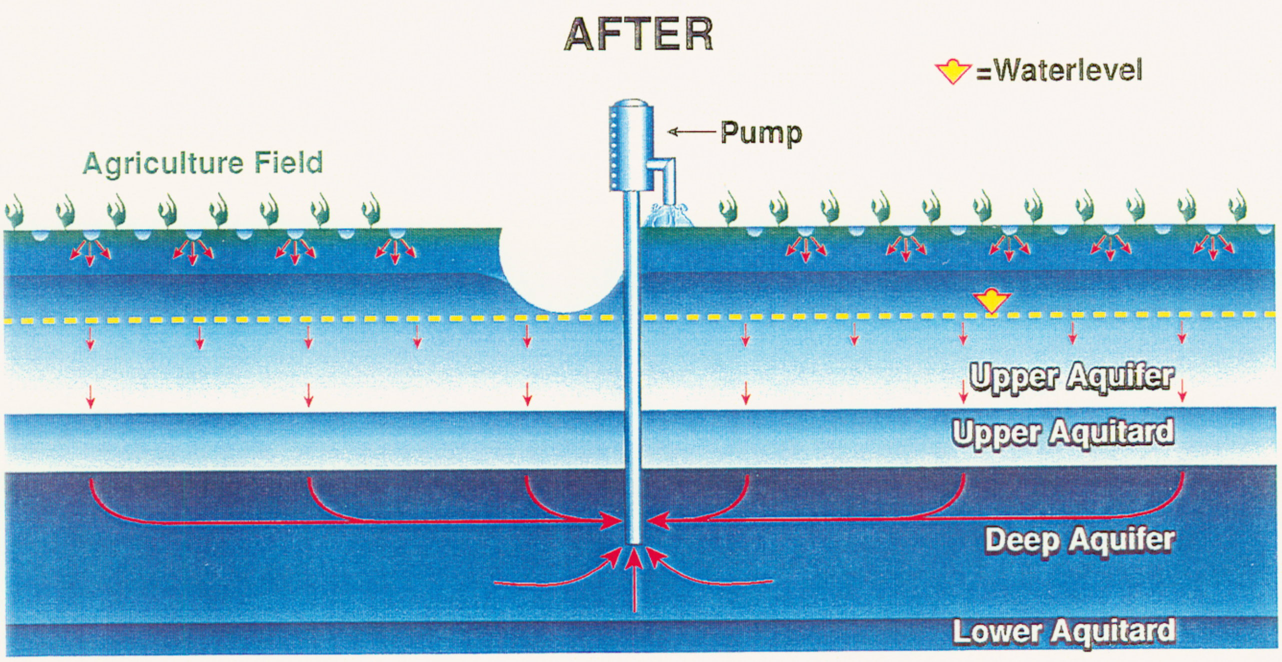
EVALUATION OF ALTERNATIVE

This proposal specifically addressed the elevated concentrations of selenium in some of the surface water of the Imperial Valley. The proponent proposed to evaluate the feasibility of selenium management through groundwater pumping by performing a pilot study that would confirm or refute the management concept. In the event of confirmation of the concept, full-scale implementation would substantially reduce flows in surface drains.

At this point, it is uncertain whether this pumping proposal would work because of clay layers that are dispersed throughout the Valley. The basic technology, however, is proven.

Operation of this proposal, if proven successful, would reduce inflow into the Sea and associated constituent load. Salinity of the Sea itself, however, would continue to rise as evaporation continued and the existing salt load became more concentrated. The proposal also did not address water surface elevations in the Sea. With the reduction of water inflow, the Sea's water level would drop significantly.





Alternative No. 34
Illustration No. 30

REASON FOR ELIMINATION

The alternative did not achieve and maintain the target salinity requirement of 35 to 40 ppt or provide any elevation control. For these reasons, further consideration of this alternative was not warranted.

WATER IMPORTS

INTRODUCTION

The alternatives discussed in this section address lowering salinity by dilution with imported water. The two alternatives discussed under this category would have some serious concerns with respect to implementation because of the scarcity of good quality water in the area. The sources proposed had at least one other claimant with legal precedence that supersede use for this purpose in the Sea. Since an outlet to the Sea was not provided with the proposals, these alternatives would not achieve the target salinity requirements on a permanent basis. Each of the alternatives, however, was evaluated on an individual basis.

Alternative 35 | **Water Imports Freshwater Blending (Calexico)**

HISTORY

This alternative was proposed by Mr. J. Wendell Graves of Brawley, California, at one of the public workshops in 1995. Mr. Graves provided a hand-written description of the proposal at the forum provided at the workshop.

PROPOSAL DESCRIPTION

This alternative proposed pumping New River water to a storage reservoir located about 30 feet above sea level. Sea water would be pumped to another reservoir in the same vicinity. The two waters would then be blended, and freshwater would be added before releasing the flows back to the Sea (see Illustration 31). No source for the freshwater was given in the proposal. In addition, no calculations or quantities were provided in the proposal.

Mr. Graves also proposed using power from the hydroelectric plants on the All-American Canal to supply the necessary pumping energy. He included a suggestion for forming a watershed-wide "Salton Sea Reclamation District" as well.

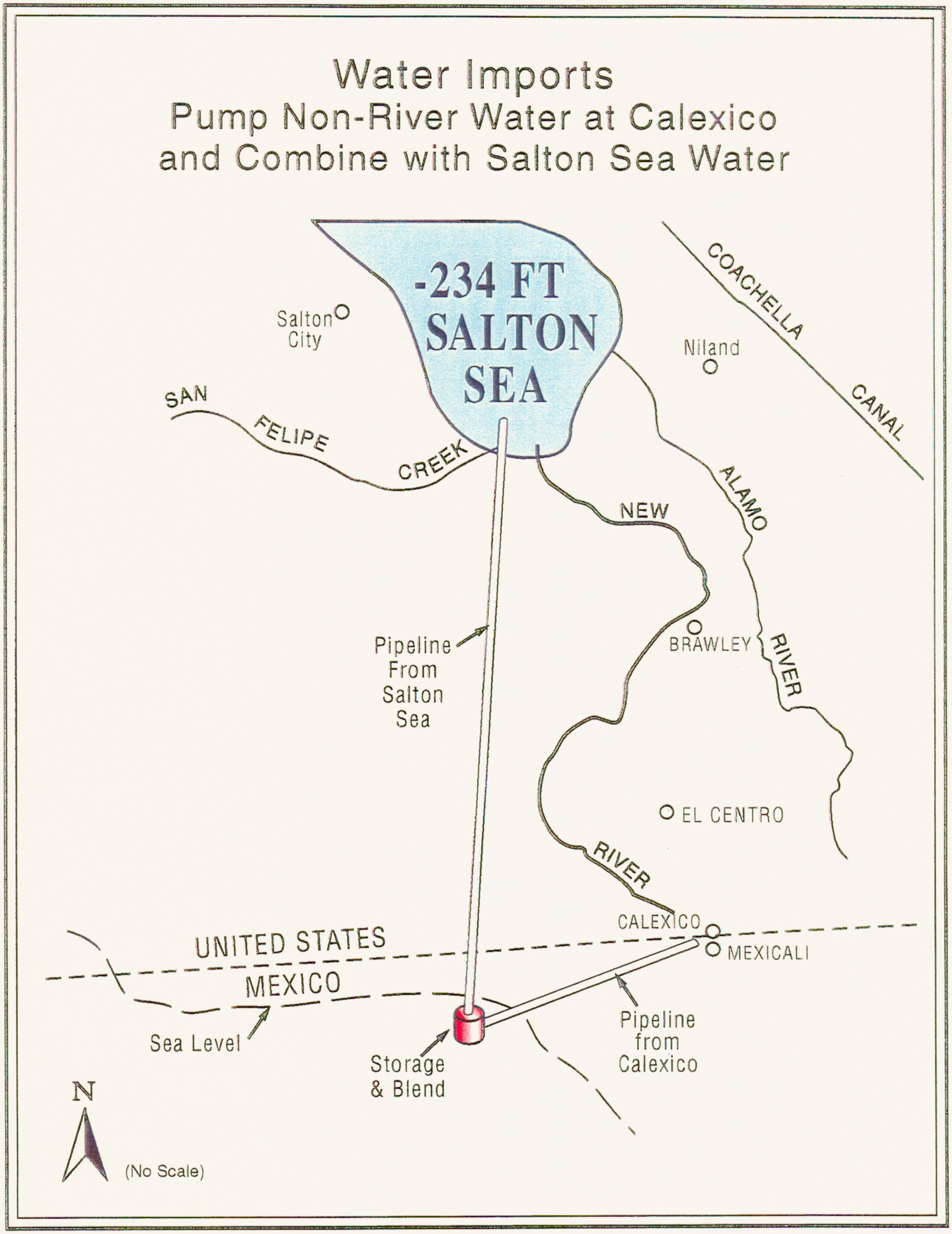
EVALUATION OF ALTERNATIVE

It appeared from the description provided that there would be no net discharge from the Sea, but there would be a net inflow of freshwater. Since the New River already flows to the Sea and is blended with Sea water at the River/Sea interface, the only unique aspect of this alternative was the proposal to introduce freshwater to the Sea.

The availability of freshwater would pose a real problem. As explained in Alternative 36, water from the Colorado River would not be available except under unusual circumstances. Groundwater in the Imperial Valley also would not be a viable option. As proposed, this alternative would not remove salt from the Sea and, therefore, would not provide a long-term solution to the salinity problem.

REASON FOR ELIMINATION

This proposal would not provide for an artificial outlet to the Sea and, therefore, would not contribute to a declining salt concentration. Because the salinity target would not be reached with this alternative, no further consideration was warranted.



Alternative No. 35
Illustration No. 31

Alternative 36 **Water Imports**
Replenishment by Colorado River Surplus

HISTORY

This proposal appeared in the Meyer Resources, Inc., *Problems and Potential Solutions at Salton Sea*, for the RAC (December 1988).

PROPOSAL DESCRIPTION

For evaluation purposes of this alternative, excess water has been defined as flows in the Colorado River to Mexico in excess of their orders. This alternative suggested that, during wet years in the Colorado River Basin when the reservoirs on the Colorado River are full, excess water could be released down the river and could be made available to the Sea, either through existing canals or via an expanded canal system. Water from the Colorado River is much fresher than the Sea water and would, depending upon the volume, quickly reduce salinity levels in the Sea.

EVALUATION OF ALTERNATIVE

Because of the problems associated with the current Sea elevation, prior lowering of the Sea's surface level would seem a prerequisite to avoid flooding. Water would be delivered to the Sea only when excess water would be available from the Colorado River. This could be infrequent, and long periods of time could elapse between events. This would result in periodic fluctuations in both water level and salinity of the Sea.

There are many organizations who have legally established a prior option on excess flows in the Colorado River. Legal and institutional impediments could make this alternative difficult or impossible to implement. Given the value of water in the Colorado River, current users would make every attempt to divert any excess flows for municipal, industrial, agricultural, or environmental mitigation uses before it was made available for the Sea.

Even if Colorado River flows were periodically available for delivery to the Sea, salinity control would not be achieved. Without an outlet, the existing salt load in the Sea would remain and the Sea would continue to become more saline, although in a more erratic manner.

REASON FOR ELIMINATION

This proposal would improve salinity only temporarily and could not permanently satisfy the salinity target. Elevation control also would not be possible. Extreme elevation fluctuation would occur. Because the alternative would meet neither the salinity nor water surface elevation criteria, no further consideration of this alternative was warranted.

OTHER OPTIONS

INTRODUCTION

While most suggested alternatives are discussed in the previous sections, there remains a significant number that do not fit in the categories discussed. This section contains options that range from research proposals designed to obtain additional information about the Sea to innovative or emerging technology that could reduce costs or add to the performance of previous proposals. It should be recognized that research proposals and emerging technology, as a viable solution, by definition, do not meet elimination criteria. However, this does not mean that the research proposed would not benefit efforts initiated for the Sea.

Alternative 37 **Other**
Venturi Air Pump

HISTORY

This proposal was submitted in a letter, dated January 1990, written by Burke Hensley and Son, 5700 West Wilson SP51, Banning, California 92220.

PROPOSAL DESCRIPTION

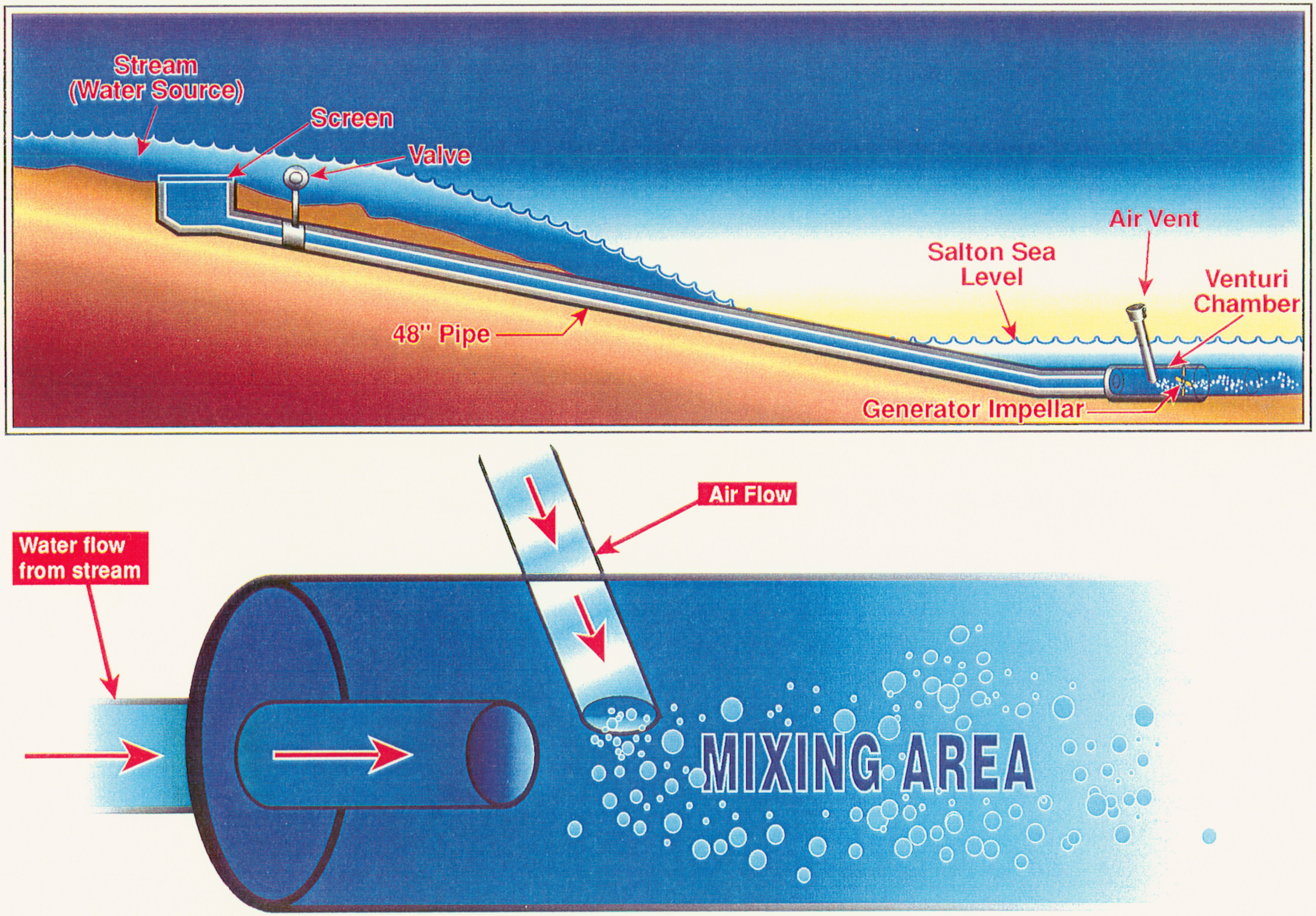
This alternative proposed the use of venturi action to pull air into tributary inflow and oxygenate the water to stimulate the natural purification process (see Illustration 32). One of the prominent suspects in large fish kills is a low dissolved oxygen content in Sea water. This is a common problem in stagnant ponds, small lakes, and other bodies of water. The system would consist of a series of underground pipes (or concrete-lined channels) that would be laid or built at a fairly steep angle. The upper ends of the pipes would be connected to a stream, runoff drainage system, or other water source, while the outlet would terminate in a venturi chamber located below the water surface of the Sea. An air vent would be connected to the chamber such that water passing over the vent opening would pull air down through the pipe and be mixed with the water. It was also suggested that an impeller could be located downstream of this vent to power a generator. A valve located near the inlet would be necessary for flow control. This system could be produced in a variety of different sizes and configurations, depending on the site in question.

In operation, the oxygenation provided by the venturi pump would provide a means of artificially stimulating the natural purification process and, theoretically, would turn an otherwise stagnant body of water into one that could be used for irrigation, recreation, and other purposes. Incorporation of a generator could also enable it to be used as an efficient, clean method of producing electricity.

EVALUATION OF ALTERNATIVE

The appealing features of this system would be its adaptability and efficiency. In concept, it could provide a low cost method of increasing the oxygen content of the Sea, thereby improving the environment for fish and other aquatic species. Its ability to generate electricity was questionable because of the very low hydraulic heads available. It was doubtful that enough water head exists between the pipe inlet and outlet to allow for production of electric energy.

While this alternative addressed stagnation issues of the water, it did not address salinity or elevation.



VENTURI CHAMBER

Alternative No. 37
Illustration No. 32

REASON FOR ELIMINATION

This proposal did not meet the target salinity or elevation elimination criteria. For these reasons, no further consideration of this alternative was warranted.