

Rawlins

CONTROLLING THE SALINITY OF THE SALTON SEA BY TRANSFERRING WATER TO THE GULF OF CALIFORNIA

BUREAU OF RECLAMATION
LOWER COLORADO REGION
DIVISION OF PLANNING AND LOANS

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TECHNICAL INFORMATION BY

TOM RAWLINS

NARRATIVE DESCRIPTION BY

MARY ELAINE RADEL
AND
WILLIAM MCKAY



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CONTROLLING THE SALINITY OF THE SALTON SEA

Information in this report was developed at a sub-reconnaissance level. Since the purpose of this effort was only to develop a general concept of the possibility of exchanging water between the Salton Sea and the Gulf of California, design numbers and cost figures should be viewed only as approximate and subject to change during any future more detailed analysis. Presentation of design and cost estimates for individual features should NOT be construed to mean that a precise analysis of those features was done. Rather, these designs and costs may be used to convey a general idea of the magnitude of costs for a water exchange project.

This report describes two options (4 alternatives) for controlling the salinity of the Salton Sea by providing a surrogate outlet to the Gulf of California. Technical data for this report was developed by the Engineering division of the Bureau of Reclamation in Denver, Colorado. Information was developed at a sub-reconnaissance level.

Two options for controlling salinity in the Salton Sea are presented in this report. The first option would stabilize salinity at about 35,000 mg/l, but would not allow control of water surface elevation. The second option would stabilize salinity at about 35,000 mg/l, and allow control of the water surface elevation.

The first option concentrates on pumping 100,000 acre-feet a year away from the Salton Sea and discharging the water at Laguna Salada in Northern Mexico. No water would be transported from the Gulf of California to the Salton Sea.

The second option deals with pumping 415,000 acre feet of water annually from the Salton Sea and discharging it into Laguna Salada. Then 400,000 acre-feet of the less salty ocean water will be pumped annually from the Gulf of California into the Salton Sea.

Both options were examined using a canal/pipeline alternative and an all pipeline alternative. The total cost of each option was obtained by adding 25% for contingencies and 30% for indirects to the total construction costs.

**Option 1
Alternative 1**

- **100,000 Acre-Foot/Year Piped from the Salton Sea to Laguna Salada**
- **Combination Canal and Pipeline**

This alternative will use an intake channel, a canal, four sections of pipeline, and three pumping plants. The total length of this option (canal, pipeline, and intake channel) is 56 miles. The canal section is 44.5 miles long, the pipeline section is 11 miles long, and the intake channel is .5 of a mile long.

The intake channel would have a water depth of 7 feet, a bottom width of 18.4 feet, and 3:1 side slopes. It will cost \$300,000.

The canal section would have a water depth of 5 feet, a bottom width of 6 feet, and a side slope of 1 1/2:1. The cost for the canal is \$27,500,000.

Four sections of pipeline are needed. The first three sections use a 72" diameter pipe size. The outfall pipeline will use a 42" diameter pipe size.

The first section of pipeline carries water from the Salton Sea Pumping Plant to the canal. The distance of this section of pipeline is 25,000 feet. The cost is \$8,100,000. The second section of pipeline is needed to carry water under the highway US 8 for 12,000 feet. The cost is \$3,500,000. The third section of pipeline will carry water as it leaves La Rosita Pumping Plant 12,000 feet to the saddle of Laguna Salada. The cost is \$3,900,000. The outfall pipeline is needed to carry water 11,000 feet from the saddle of Laguna Salada to Laguna Salada at a cost of \$1,400,000.

This plan needs three pumping plants. The first plant needed is the Salton Sea Pumping Plant, which is located on the southern tip of the Salton Sea. This is a 3947 Kw plant that will cost \$5,600,000. The second plant needed is the Canal Pumping Plant, located 2 miles south of the southern tip of the Naval Reservation. This is a 987 Kw plant that will cost \$2,800,000. The third plant needed is La Rosita Pumping Plant. It is located near the town of La Rosita in Mexico. It is a 3067 Kw plant that will cost \$4,900,000. The total cost of the pumping plants is \$13,000,000.

TOTAL COST: \$95,000,000

**Option 1
Alternative 2**

- **100,000 Acre-Feet/Year Transported from the Salton Sea to Laguna Salada**
- **Pipeline Only**

This alternative will use an intake channel, four sections of pipeline and two pumping plants. The total length of this option is 45 miles.

The intake channel would have a water depth of 7 feet, a bottom width of 6 feet, and a side slope of 1 1/2:1. It will cost \$300,000.

Four sections of pipeline are used. The first three sections use a 72" diameter pipe size. The outfall pipeline will use a 42" diameter pipe size.

The first section of pipeline carries water from the Salton Sea Pumping Plant to a water storage tank. The distance of this section is 31,000 feet and the cost is \$13,400,000. The second section of pipeline goes from the water storage tank to La Rosita Pumping Plant. The distance is 182,000 feet at a cost of \$61,700,000. The third section of pipeline will carry water from La Rosita Pumping Plant 12,000 feet to the Saddle of Laguna Salada. The cost is \$3,900,000. The outfall pipeline is needed to carry water a distance of 11,000 feet from the saddle of Laguna Salada to Laguna Salada at a cost of \$1,400,000.

This plan needs two pumping plants. The first plant is the Salton Sea Pumping Plant which is located on the Southern tip of the Salton Sea. This is a 6,510 Kw plant and it will cost \$7,700,000. The second pumping plant is the 4,120 Kw La Rosita Pumping Plant which will cost \$4,900,000. The total cost of the pumping plants is \$12,600,000.

Handwritten notes:
100,000 ac-ft/yr @ 2.5¢/ac-ft = \$2,500,000/yr
27,000,000 ac-ft @ 2.5¢/ac-ft = \$67,500,000/yr energy cost

TOTAL COST: \$153,000,000

**Option 2
Alternative 1**

- **415,000 Acre-Feet a Year from the Salton Sea to Laguna Salada**
- **400,000 Acre-Feet a Year from the Gulf of California to the Salton Sea**
- **Combination Canal and Pipeline**

The plan to transport 415,000 acre-feet a year from the Salton Sea to Laguna Salada:

This part of the alternative will use an intake channel, a canal, four sections of pipeline, and three pumping plants. The total length of this option (canal, pipeline, and intake channel) is 56 miles. The canal section is 44.5 miles long, the pipeline section is 11 miles long, and the intake channel is .5 of a mile long.

The intake channel will have a water depth of 12 feet, a bottom width of 60 feet, and a side slope of 3:1. The cost will be \$3,000,000.

The canal would have a water depth of 8.5 feet and a bottom width of 10 feet. The canal will cost \$54,500,000.

Five sections of pipeline are needed. The first four sections use 2-96" diameter pipes. The outfall pipeline uses an 84" diameter pipe.

The first section of pipeline carries water from the Salton Sea Pumping Plant to the canal. The distance of this section of pipeline is 25,000 feet. The cost is \$28,200,000. The second section of pipeline is needed to carry water around the southern tip of the Naval Reservation for 12,000 feet. It will cost \$13,000,000. The third section of pipeline will carry water as it leaves La Rosita Pumping Plant 12,000 feet to the saddle of Laguna Salada. The cost is \$12,500,000. The outfall pipeline/channel is needed to carry water from the saddle of Laguna Salada to Laguna Salada. For this, an 84" diameter pipe would be used for 8,000 feet until we got to sea level. Then a channel would be constructed (with the same dimensions of the intake channel but with 1:1 side slopes) that is 3,000 feet long. The cost for this section will be \$6,400,000.

This plan needs three pumping plants. The first pumping plant that is needed is the Salton Sea Pumping Plant. It will be located on the southern tip of the Salton Sea. This is a 16,400 Kw plant and will cost \$20,000,000. The second plant we need is the Canal Pumping Plant which is located 2 miles south of the southern tip of the Naval Reservation. It is a 4,100 Kw plant, and it will cost \$10,100,000. The third plant is the La Rosita Pumping Plant which is located one mile south of the town of La Rosita in Mexico. It is a 13,000 Kw plant and it will cost \$17,400,000. The total cost of the pumping plants is \$47,500,000 and the annual energy use is 257,000,000 Kwhr/yr.

SUB COST: \$270,000,000

The plan to transport 400,000 acre-feet a year from the Gulf of California to the Salton Sea:

This part of the alternative will use an intake channel, a canal, a pipeline, a siphon, an outlet channel, a small power plant, and one pumping plant. The total length of this option is 583,000 feet or 110 miles long.

The intake pipeline and the pumping plant would be located at Las Amajas, Mexico.

The canal would have a water depth of 8.5 feet, and a bottom width of 10 feet. The canal will cost \$87,500,000.

The pipeline would be from the Gulf of Mexico to Cerro Prieto is 185,000 feet or 35 miles long. The cost of this pipeline is \$220,000,000.

One pumping plant will be needed at the Gulf. The pumping plant will cost \$21,000,000.

An 11,000 foot long double inverted siphon will carry water around the southern tip of the Naval Reservation,. Each siphon is sized at 78" in diameter. Siphon cost is \$7,500,000.

The outlet channel at the Salton Sea has 3:1 side slopes, a depth of 12 feet, and width of 60 feet. The cost for this outlet channel is \$2,900,000.

Preliminary studies show that an energy recovery program for the 30,000 foot line to the Salton Sea would be beneficial and economical. The power plant would be sized at 6000 Kw and generate 53,000,000 Kwhr/yr. The power plant will use the energy it generates partially to offset pumping requirements. The power plant will cost \$11,000,000.

SUB COST: \$605,000,000

The total cost of Option #2, Alternative #1, using a canal and pipeline combination that transports 415,000 thousand feet of water from the Salton Sea to Laguna Salada and 400,000 acre feet of water from the Gulf of California to the Salton Sea is:

TOTAL COST: \$775,000,000

**Option 2
Alternative 2**

- **415,000 Acre-Feet/Year from the Salton Sea to Laguna Salada**
- **400,000 Acre-Feet/Year from the Gulf of California to the Salton Sea**
- **Pipeline Only**

The plan to transport 415,000 acre-feet a year from the Salton Sea to Laguna Salada:

This part of the alternative will use an intake channel, four sections of pipeline and two pumping plants. The total length of this option is 236,000 feet or 44.5 miles long.

The intake channel will have a water depth of 12 feet, a bottom width of 60 feet, and a side slope of 3:1. The cost will be \$3,000,000.

Four sections of pipeline are used. The first three sections use 2-96" pipes in the same trench. The outfall pipeline will use an 84" diameter pipe.

The first section of pipeline carries water 31,000 feet from the Salton Sea Pumping Plant to a water storage tank. The cost is \$43,000,000. The second section of pipeline goes from the water storage tank to La Rosita Pumping Plant. The distance is 182,000 feet at a cost of \$171,000,000. The third section of pipeline will carry water from La Rosita Pumping Plant 12,000 feet to the Saddle of Laguna Salada. The cost is \$12,500,000. The outfall pipeline is needed to carry water from the saddle of Laguna Salada to Laguna Salada. Here, an 84" diameter pipe will be used for 8,000 feet until it got to sea level. Then a channel would be constructed (with the same dimensions of the intake channel but with side slopes 1:1) that is 3,000 feet long. The cost for this section will be \$6,400,000.

Two pumping plants will need to be constructed. The Salton Sea Pumping Plant which will cost \$27,000,000, and the La Rosita Pumping Plant which will cost \$17,400,000. The annual energy use is 302,000,000 Kwhr/yr.

SUB COST: \$532,000,000

The plan to transport 400,000 acre-feet a year from the Gulf of California to the Salton Sea:

The total length of this part of the alternative is 583,000 feet or 110 miles long. Three pipeline sections, using two pipes in the same trench, and one pumping plant are needed.

The first pipeline is the intake into the Las Amajas Pumping Plant. 2-96" pipes would be used for this. The second pipeline is 35 miles long and goes from the pumping plant at the Gulf of California to EL 82, which is near town of Cerro Prieto. The pipes are sized at 96" in diameter, and the cost of the second pipeline is \$220,000,000. The next section of pipeline runs between EL 82 and the Salton Sea. Two different size pipes are needed. For 266,000 feet to EL -20, we need to use a 108" diameter pipe size, then we will use a 78" diameter pipe down to the Salton Sea. This sections of pipeline will cost \$343,000,000.

The outlet channel at the Salton Sea has 3:1 side slopes, a depth of 12 feet, and width of 60 feet. The cost for this outlet channel is \$2,900,000.

The 18,000 Kw Las Amajas pumping plant will cost \$21,000,000.

There is not an opportunity for energy recovery. Results have shown that the additional cost of the larger size pipes is not worth the additional energy savings. An energy dissipation structure will be needed however. The cost for the structure is \$2,000,000.

SUB COST: \$964,000,000

The total cost of Option #2, Alternative #2, using an all pipeline alternative that pipes 415,000 thousand feet of water from the Salton Sea to Laguna Salada and 400,000 acre feet of water from the Gulf of California to the Salton Sea is

TOTAL COST: \$1496,000,000