Title I Program
Colorado River Basin Salinity Control Act

Report to the
Secretary of the Interior
and the Congress

Bureau of Reclamation
Lower Colorado Region
Boulder City, Nevada
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Executive Summary

Purpose

This document updates the status of the Title I program of the Colorado River Basin Salinity Control Act (Title I)—as authorized by Public Law 93-320 and amended by Public Law 96-336—and sets forth an action plan for future activities. This document also satisfies the Title I portions of a September 1990 agreement between the Bureau of Reclamation (Reclamation) and the Office of Inspector General (OIG). The agreement was reached to resolve the recommendations contained in a 1989 OIG survey audit report on the Colorado River Basin Salinity Control Program.

In its report, OIG expressed concern about (1) the ability of the Title I program to meet its objective of providing Mexico with Colorado River water that meets negotiated salinity standards without depriving the Colorado River Basin States (Basin States) of any of their apportioned water, (2) replacement of the reject stream from the Yuma Desalting Plant (YDP), (3) increases in projected YDP operating and capital costs, and (4) alternative means of complying with Title I salinity requirements.

OIG also recommended that Reclamation "provide Congress additional information upon which to judge the reasonability and desirability of continuing with the Title I program in its current context."

Title I Objectives

Title I's objective is to allow the United States to comply with its obligations under Minute No. 242 of the International Boundary and Water Commission (Minute No. 242). Minute No. 242 is an extension of the 1944 water treaty with Mexico to address Colorado River salinity concerns without depriving the Basin States of any of their apportioned water. In enacting Title I, Congress also sought to advance desalting technologies.

History

In 1944, the United States and Mexico signed a treaty requiring the United States to deliver 1.5 million acre-feet of Colorado River water to Mexico annually. The treaty did not address salinity. However, Mexico filed a formal protest with the United States when the salinity of the delivered water increased sharply in the early 1960's. The increase was caused primarily by the discharge to the Colorado River of irrigation drainage pumped from the Wellton-Mohawk Irrigation and Drainage District (WMIDD) in Arizona, as well as a reduction in excess river flows resulting from the construction and closure of Glen Canyon Dam.

The United States and Mexico pursued a series of temporary solutions to the salinity problem throughout the 1960's and early 1970's. Then, in 1972, President Nixon appointed Herbert Brownell to study and recommend a permanent, definitive, and just solution to the problem. Among other things, Brownell recommended (1) constructing a desalting plant to treat WMIDD irrigation drainage and (2) allowing for a specified differential between the salinity of the waters arriving at Imperial Dam, near Yuma, Arizona, and the salinity of the waters delivered to Mexico.

The Presidents of the United States and Mexico approved Brownell's recommendations in the form of Minute
No. 242. The most important provision requires that the average annual salinity of the Colorado River water (approximately 1,360,000 acre-feet) delivered upstream from Morelos Dam (Mexico's principal diversion dam) would not exceed the average annual salinity of the water arriving at Imperial Dam by more than 115 parts per million (ppm) plus or minus 30 ppm. This value is known as the salinity differential.

The United States made several commitments to secure the Basin States support for Minute No. 242. Among these were that the Basin States would not bear the cost of fulfilling any agreement with Mexico and that the United States would recognize replacement of (1) the water lost to the desalting plant reject stream and (2) any bypassed WMIDD irrigation drainage as a national obligation.

Public Law 93-320, passed June 24, 1974, authorizes projects that allow the United States to comply with Minute No. 242 and satisfy the concerns of the Basin States.

**Major Title I Works**

Major Title I works are the Yuma Desalting Plant, the WMIDD irrigation drainage reduction program, concrete lining of the first 49 miles of the Coachella Canal in California, and a well field in Arizona known as the Protective and Regulatory Pumping Unit (PRPU).

**Yuma Desalting Plant**

The YDP has begun desalting operations and will be operated at one-third capacity by the end of fiscal year 1992.

When operated at full capacity, the YDP will recover the majority of WMIDD irrigation drainage for treaty deliveries to Mexico. The total cost of the recovered water will be $610 to $699 per acre-foot, comparable to the cost of desalting water in other areas of the country. Full-capacity operation will cost approximately $32 million per year.

Reclamation has secured a long-term power source (capacity and energy) for the YDP and the PRPU. Under this arrangement, Western Area Power Administration will make least-cost, spot market power purchases until September 30, 2021. For now and the near future, this is the least costly source available. However, Reclamation will periodically review and evaluate the power market to ensure the YDP and the PRPU continue to receive required power at the lowest possible cost.

Reclamation is also pursuing an aggressive YDP cost reduction program. Some of the measures are described below. All cost savings are based on full-capacity operation of the YDP.

- Increasing the life of desalting membranes (potential annual savings of $1.5 million).
- Improving pretreatment processes to potentially reduce costs for chemicals or equipment and membrane replacement.
- Marketing desalted water. The city of Yuma has investigated purchasing water treated by the YDP to help meet its increasing need for potable water. The city has decided to meet its short-term needs by expanding its own water treatment facilities but will pursue purchasing YDP-treated water in the future.
- Marketing the YDP's waste calcium carbonate sludge. However, even if the sludge were given away, up to $2.7 million in disposal costs could be saved per year.
- Studying lower pressure and higher recovery membranes (potential annual savings of $1.5 million).
• Investigating techniques to recycle the waste calcium carbonate sludge using waste heat from a turbine generator (potential annual savings of $2 million).

Implementing cost-effective solutions identified by this program would significantly reduce operation and maintenance costs. Reclamation also plans to develop a technical review committee to review and recommend improvements to the YDP and its operations.

WMIDD Irrigation Drainage Reduction Program

This program has reduced WMIDD irrigation drainage pumping and, thus, the required size of the YDP by improving irrigation efficiencies and reducing irrigated acreage. Before the program was initiated, irrigation efficiency was about 56 percent. While the program was active, irrigation efficiency met and exceeded the target efficiency of 72 percent. Irrigation drainage dropped from 220,000 acre-feet to a low of 118,500 acre-feet per year, and irrigated lands were reduced by 10,000 acres.

The permanent measures implemented by WMIDD are still in use, although no active Federal program currently exists. Irrigation efficiency has declined to about 60 percent, and irrigation drainage pumping has increased to about 145,000 acre-feet per year.

Reclamation continues to investigate the causes of increased irrigation drainage pumping. As part of its continuing Title I activities, Reclamation, together with the WMIDD, Soil Conservation Service, and others, will explore irrigation efficiency improvement measures, with a goal of permanently reducing irrigation drainage pumping to 108,000 acre-feet or less per year.

In addition to the Title I activities described above, the Salt River Pima Maricopa Indian Community Water Rights Settlement Act of 1988, executed in 1991, reduced WMIDD irrigated lands by an additional 2,125 acres and reduced WMIDD maximum contractual consumptive use from 300,000 to 278,000 acre-feet per year.

Coachella Canal Lining

Concrete lining of the first 49 miles of the Coachella Canal was completed in 1982. Since then, water conserved as a result of lining the canal (an estimated 132,000 acre-feet per year) has been credited toward the replacement of WMIDD irrigation drainage bypassed to comply with the salinity differential.¹

Protective and Regulatory Pumping Unit

The PRPU was constructed to manage and conserve ground water for the United States and for delivery to Mexico. Currently, 21 of the planned full complement of 35 wells and associated structures have been completed. With 35 wells, the PRPU would be capable of producing about 160,000 acre-feet of water per year.

Ultimately, approximately 125,000 acre-feet of water from the PRPU, combined with 15,000 acre-feet of water from wasteways and drains in the Yuma Valley, would furnish 140,000 acre-feet of Mexico's total 1.5-million-acre-foot annual entitlement.

¹ Except at such times when there existed surplus water of the Colorado River under the terms of the 1944 water treaty with Mexico (1983 through 1988).
The water will be delivered at the Southerly International Land Boundary near San Luis, Arizona. Currently, water from wasteways and drains in the Yuma Valley exceeds 15,000 acre-feet per year. Should these wasteway and drain flows diminish in the future, wells will be added to the PRPU, as needed, to ensure that approximately 140,000 acre-feet can be delivered at the Southerly International Land Boundary at all times.

**Title I Capital Costs**

Approximately $390 million was allotted for Title I works through fiscal year 1992; $9 million has been requested for 1993, and $52 million will be required after 1993 to complete the Title I program.

The Title I authorized appropriations ceiling, in October 1992 dollars, is $472.8 million, adequate to fund the program as proposed.

**Ability of Title I to Support Its Objectives**

**Before Completion of the YDP**

The United States has complied with the salinity differential without the YDP since 1974 through the temporary measures of bypassing WMIDD irrigation drainage, substituting water from upstream storage for treaty deliveries to Mexico, and, since 1982, claiming as replacement the water conserved by lining the Coachella Canal.

As stated previously, under Public Law 93-320, the replacement of irrigation drainage bypassed to meet the salinity differential is recognized as a national obligation. The United States has secured interim use of 132,000 acre-feet per year of replacement water by lining the Coachella Canal. However, the United States has not secured water to replace the amount of WMIDD irrigation drainage bypassed in excess of 132,000 acre-feet per year, which totaled 5,900, 6,000, and 13,000 acre-feet in calendar years 1989, 1990, and 1991, respectively.

**Future With the YDP**

In the future, if WMIDD irrigation drainage pumping is permanently reduced to 108,000 acre-feet per year (the volume the YDP was sized to accommodate) and the YDP is operated at full capacity, no untreated irrigation drainage will be bypassed, except during extremely low salinity conditions in the river. This use of the YDP will conserve water by maximizing the recovery of WMIDD irrigation drainage for treaty deliveries to Mexico.

Reclamation has pursued, and continues to pursue, measures to replace the YDP reject stream and bypassed WMIDD irrigation drainage, as well as other measures to reduce loss of water to the Basin States. For example, Reclamation is studying ways to improve YDP efficiencies to reduce the volume of the reject stream. New membrane technologies, an integral part of the YDP cost reduction program, would contribute most directly to improved efficiencies.

To obtain a source of replacement water for the reject stream, Reclamation is studying a plan to remove riparian salt cedar along the lower Colorado River and replace it with vegetation with lower water demands and greater wildlife habitat and recreation values.

As a fiscal year 1994 planning start, Reclamation is also investigating a proposal to create additional storage on the lower
Colorado River to capture water ordered, but not diverted, and regulatory waste that would otherwise be lost to Mexico as excess deliveries.

**Future Without the YDP**

No permanent approach to complying with the obligations of Minute No. 242, other than operating the YDP, is under active consideration. If the YDP is not operated, all WMIDD irrigation drainage would continue to be bypassed.

After the United States loses use of the water conserved by lining the Coachella Canal, it will have a significantly reduced ability to replace this bypass. Should the United States secure water to replace the reject stream, that amount of water would be available to replace bypassed WMIDD irrigation drainage. Otherwise, the United States would have no means of replacing any bypassed drainage.

As defined in section 102(a) of Public Law 93-320, the United States will lose use of the water conserved by lining the Coachella Canal

...the first year that the Secretary delivers main stream Colorado River water to California in an amount less than the sum of the quantities requested by (1) the California agencies under contracts made pursuant to section 5 of the Boulder Canyon Project Act (45 Stat. 1057) and (2) Federal establishments to meet their water rights acquired in California in accordance with the Supreme Court decree in Arizona against California (376 U.S. 340).

If the United States decides not to operate the YDP, Mexico could view this as unwillingness to comply with Minute No. 242, the permanent and definitive solution to the salinity problem. Relations with Mexico could be further strained over the differential to be maintained in the future. The United States is already under pressure to maintain the differential at 115 ppm at all times. To conserve water for use in the United States, the Basin States could urge a differential closer to 145 ppm (115 ppm plus 30 ppm).

**Advancing Desalting Technologies**

Herbert Brownell stated in his report on the salinity problem:

The desalting plant itself would materially assist in the development of desalting technology. The information and experience gained through it would be of value in solving salinity problems predicted to occur in the future elsewhere in the United States and Mexico.

Research performed in support of the YDP has played an important role in advancing desalting technologies. For example, testing at the Yuma Desalting Test Facility in the 1970's and early 1980's provided information that led to improved desalting equipment that has been adopted by the membrane manufacturers.

Reclamation will continue to develop research and development programs focusing on desalting technology exchange, membrane fouling prevention, alternative biocide identification, and pretreatment optimization, among other tasks. An ad hoc professional board will be created to help develop, monitor, evaluate, and identify changes in program direction.

Reclamation also continues to share information with the desalting industry through cooperative studies and technology exchange forums.
Conclusion

Need For and Benefits of the YDP

The United States must operate the YDP to meet the salinity differential and to minimize the bypass of WMID irrigation drainage.

The YDP will (1) conserve water and (2) maximize the beneficial use of Colorado River water available to the United States and Mexico by maximizing the recovery of WMID irrigation drainage, which will minimize the use of water from upstream storage to make treaty deliveries to Mexico. This, in turn, will minimize water lost to the Basin States.

A permanent source of replacement water for the YDP reject stream has not yet been found, primarily because the United States has no entitlement to Colorado River water. Reclamation is continuing work to resolve this problem. For example, Reclamation is investigating proposals (1) to replace riparian salt cedar along the lower Colorado River with vegetation with lower water demands and greater habitat and recreational values and (2) to create additional storage on the lower Colorado River to capture flows that otherwise would be lost to Mexico as excess deliveries.

Building the YDP has contributed to the knowledge base of the desalting industry. The desalting industry will continue to benefit from the research and testing performed in support of the YDP.

Future Activities

Reclamation has developed an action plan to (1) review and evaluate the long-term power source for the YDP and the PRPU to ensure that power is purchased at least cost; (2) complete YDP startup work; (3) reduce WMID irrigation drainage pumping; (4) reduce YDP operation and maintenance costs; (5) secure a source of replacement water for the reject stream; and (6) further advance desalting research and development. Implementing the action plan is subject to change based on future developments and budget priorities.
Chapter I

Introduction

Purpose

This document updates the status of the Title I program of the Colorado River Basin Salinity Control Act (Title I)—as authorized by Public Law 93-320 and amended by Public Law 96-336 (appendix A)—and sets forth an action plan for future activities. This document reviews the history and provisions of Title I; provides an update on its major works; summarizes construction and operation, maintenance, replacement, and energy costs (OMR&E); and evaluates the ability of Title I to support its objectives. This document also satisfies the Title I portions of a September 1990 agreement between the Bureau of Reclamation (Reclamation) and the Office of Inspector General (OIG). The agreement was reached to resolve the recommendations contained in a 1989 OIG survey audit report on the Colorado River Basin Salinity Control Program.

In its report, OIG expressed concern about (1) the ability of the Title I program to meet its objective of providing Mexico with Colorado River water that meets negotiated salinity standards without depriving the Colorado River Basin States (Basin States) of any of their apportioned water, (2) replacement of the reject stream from the Yuma Desalting Plant (YDP), (3) increases in projected YDP operating and capital costs, and (4) alternative means of complying with Title I salinity requirements. OIG also recommended that Reclamation “provide Congress additional information upon which to judge the reasonability and desirability of continuing with the Title I program in its current context.” The portions of the audit report concerning the Title II program of the Colorado River Basin Salinity Control Act were addressed in Quality of Water, Colorado River Basin, Progress Report No. 15, a biennial report to the Congress released in June 1991. (See page 56, “State and Local Cooperators.”)

Scope

Public Law 93-320 seeks, through a program of works in the Colorado River Basin, to control the salinity of water delivered to users in the United States and Mexico. Title I authorizes salinity control projects downstream from Imperial Dam, the last Colorado River diversion structure in the United States. (See frontispiece map.) The Title II program authorizes salinity control projects upstream from Imperial Dam.

Specifically, Title I allows the United States to comply with its obligations under Minute No. 242 of the International Boundary and Water Commission (Minute No. 242). Minute No. 242 is an extension of the 1944 water treaty with Mexico to address the salinity of Colorado River water delivered to Mexico and to satisfy the concerns of the seven Basin States of Arizona, California, Colorado, Nevada, New Mexico, Utah, and Wyoming. (See appendix B.) In enacting Title I, Congress also sought to advance desalting technologies through construction and operation of the YDP.
Previous Title I Reports


- Colorado River Basin Salinity Control Project, Title I Division, Desalting Complex Unit, Arizona, Definite Plan Report, July 1976, United States Department of the Interior, Bureau of Reclamation.

- Colorado River Basin Salinity Control Project, Title I Division, Desalting Complex Unit, Arizona, Status Report, April 1977, United States Department of the Interior, Bureau of Reclamation.

- Colorado River Basin Salinity Control Project, Title I Division, Desalting Complex Unit, Sizing Study, Yuma Desalting Plant,Arizona, Interim Report, June 1977, Bureau of Reclamation, Lower Colorado Region.


- Colorado River Basin Salinity Control Project, Title I Division, Coachella Canal Unit, Definite Plan Report, June 1978, United States Department of the Interior, Bureau of Reclamation.


Chapter II

Title I History and Provisions

Title I History

In 1944, the United States and Mexico signed a treaty requiring the United States to deliver 1.5 million acre-feet of Colorado River water to Mexico annually. The treaty did not address the salinity of the delivered water.

In 1961, the salinity of the delivery to Mexico increased sharply from a range of about 700 to 920 parts per million (ppm) to about 1,340 ppm total dissolved solids (TDS). In some months, the salinity exceeded 2,500 ppm.\(^1\)

The increased salinity was caused by (1) the discharge to the Colorado River of saline irrigation drainage pumped from newly constructed wells in the Wellton-Mohawk Irrigation and Drainage District (WMIDD) in Arizona; (2) a reduction in excess Colorado River flows to Mexico, resulting from the construction and closure of Glen Canyon Dam; and (3) construction of Painted Rock Dam, which significantly reduced the less saline Gila River floodflows to the Colorado River below Imperial Dam.

In November 1961, Mexico filed a formal protest with the United States, claiming that the increased salinity was damaging crops in the Mexicali Valley, a violation of international law. In response, the United States began modifying WMIDD irrigation drainage pumping and river operations in 1963 and 1964. In 1965, the United States reached its first salinity agreement with Mexico, Minute No. 218 of the International Boundary and Water Commission (a 5-year agreement that was later extended 2 years). Minute No. 218 authorized the construction and operation of the Main Outlet Drain Extension (MODE), which allowed WMIDD irrigation drainage to be discharged either above or below Morelos Dam, Mexico’s principal diversion structure. (See frontispiece map.)

After the MODE was constructed, about 40,000 acre-feet of irrigation drainage was bypassed (discharged below Morelos Dam) each year. The bypassed waters, which were not considered part of Mexico’s treaty deliveries, were substituted with waters from upstream storage. By the end of 1971, these bypass operations and a gradual improvement in the salinity of WMIDD irrigation drainage reduced the average annual salinity of Mexico’s deliveries to about 1,245 ppm. Monthly averages varied from 1,150 ppm to almost 1,500 ppm.

To maintain salinity below about 1,240 ppm, Mexico later asked the United States to bypass an additional 40,000 to 75,000 acre-feet of WMIDD irrigation drainage each year. The additional amount bypassed was considered part of Mexico’s treaty deliveries. The resulting average annual salinity of the treaty deliveries was reduced to about 1,160 ppm, but only by reducing Mexico’s usable deliveries.

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\(^1\) Salinity refers to the salt content of solutions containing dissolved mineral salts, generally measured as total dissolved solids in parts per million.
Mexico continued to press its case, and in June 1972, Mexico’s President Echeverria and President Nixon met to discuss a solution to the salinity problem. The initial result was Minute No. 241 of the International Boundary and Water Commission, which allowed 118,000 acre-feet of WMIDDD irrigation drainage to be bypassed without charge to treaty deliveries. These bypassed waters were substituted with waters from upstream storage and from wells on the Yuma Mesa in southwestern Arizona.

Then, in August 1972, President Nixon assigned former Attorney General Herbert Brownell to find a “permanent, definitive, and just” solution to the salinity problem. Brownell, assisted by a Federal interagency task force, studied the problem. Negotiations with Mexico proceeded with the concurrent consultation of the seven Basin States, acting through the Committee of Fourteen (an advisory group consisting of two representatives from each State).

After studying several solutions to the problem (appendix C), Brownell issued a report in December 1972 that, among other things, recommended (1) constructing a desalting plant to treat WMIDDD irrigation drainage and (2) allowing for a specified differential between the salinity of the waters arriving at Imperial Dam and the salinity of the waters delivered to Mexico upstream from Morelos Dam. The President approved the recommendations, and the Secretary of the Interior (Secretary) was directed to prepare legislation seeking authorization for the design and construction of a desalting plant.

However, before lending support to any agreement with Mexico, the Basin States required assurances that the United States would:

- Ensure that water users, landowners, and governments in the Basin States would not bear the economic and water costs of fulfilling such an agreement.
- Take some action to protect ground-water resources along the Southerly International Land Boundary with Mexico.
- Assume responsibility for replacing water bypassed as desalting plant reject stream.
- Develop a complementary program to reduce the overall salinity of the Colorado River.
- Acknowledge its responsibility to proceed with augmenting supplies of the Colorado River Basin, as directed by Congress in the Colorado River Basin Project Act.

Appendix D contains the Basin States July 20, 1973, letter to the President outlining their concerns. The United States commitments to satisfy these concerns are reflected in Minute No. 242 and in Public Law 93-320, Minute No. 242’s implementing legislation.

On August 30, 1973, Presidents Nixon and Echeverria approved Brownell’s recommended solution to the salinity problem in the form of Minute No. 242. The minute contains the following major provisions:

- The average annual salinity of Colorado River water delivered upstream from Morelos Dam (approximately 1,360,000 acre-feet) would not exceed the average annual salinity of water arriving at Imperial Dam by more than 115 ppm plus or minus 30 ppm (United States count). This value is known as the salinity differential.
- In partial satisfaction of Mexico’s 1.5-million-acre-foot entitlement, the United States would continue to deliver about 140,000 acre-feet of water annually to Mexico across the Southerly International Land Boundary near the Colorado River.
San Luis, Arizona, and in the Limitrophe Division of the Colorado River (that section of the Colorado River between the Northerly and Southerly International Boundaries). The salinity of this delivery would be substantially the same as the waters customarily delivered there.

- The United States would build a Bypass Drain extending the MODE to carry the YDP reject stream and bypassed irrigation drainage to the Southerly International Boundary and pay Mexico to build an additional extension through Mexico to the Santa Clara Slough, upstream from the Gulf of California. (See frontispiece map.)

- The United States and Mexico would limit ground-water pumping within 5 miles on each side of the Southerly International Land Boundary near San Luis to 160,000 acre-feet annually.

- The United States and Mexico would consult each other before developing surface- or ground-water resources in the border area that might adversely affect the other country.

- Measures required to implement this resolution would be undertaken and completed as soon as practicable, and the United States would seek prompt funding for construction of the works needed to fulfill the agreement.

**Title I Provisions**

Public Law 93-320 was passed on June 24, 1974, to enable the United States to comply with its obligations under Minute No. 242 without depriving the Basin States of any of their apportioned water (Title I program) and to authorize projects to control the salinity of the water delivered to users in the United States (Title II program).

Section 101(b)(1) of Public Law 93-320 authorized (1) construction, operation, and maintenance of a desalting plant to remove salts from WMIDD irrigation drainage; (2) construction of the necessary appurtenant works; (3) construction of the Bypass Drain from Morelos Dam to the Santa Clara Slough to dispose of reject stream from the desalting plant and other bypassed water; (4) replacement of the metal flume in the existing MODE with a concrete siphon; (5) reduction of WMIDD irrigation drainage by improving irrigation efficiencies and acquiring irrigation district lands; (6) acquisition of lands in Painted Rock Reservoir, as necessary, for flood control (the Painted Rock Reservoir land acquisition program was not completed because the United States determined that sufficient storage capacity exists to operate the reservoir in accordance with its obligations under Minute No. 242); and (7) construction, operation, and maintenance of all associated facilities including roads, railroad spur, and transmission lines.

Section 101(b)(2) specified the initial plant characteristics and stated that “the power supply for the desalting complex will not diminish the supply of power to preference customers from the Federal power systems operated by the Secretary,” and that “all costs associated with the desalting complex shall be nonreimbursable except as provided in sections 101(f)(1) and 101(h).”

Section 102(a) authorized concrete lining of the first 49 miles of the Coachella Canal of the Boulder Canyon Project, California. For an interim period, the United States has use of an amount of water equal to that conserved by lining the canal (about 132,000 acre-feet per year). The conserved water provides a source of replacement water for WMIDD irrigation drainage bypassed to meet the salinity differential.

Also, as defined in section 102(a), the interim period of use began when canal lining was completed in 1982 and
In enacting Title I, the Congress also sought to advance United States desalting technologies through construction and operation of the desalting plant.

Herbert Brownell stated in his report on the salinity problem:

The plant itself would materially assist in the development of desalting technology. The information and experience gathered through it would be of value in solving salinity problems predicted to occur in the future elsewhere in the United States and Mexico.

Also, the benefit of the technical knowledge gained by building the YDP was specifically mentioned as a reason for supporting Public Law 93-320 by Representatives Harold T. Johnson of California, Morris K. Udall of Arizona, Paul W. Cronin of Massachusetts, and David Towell of Nevada during debate in the House of Representatives on June 11, 1974.

Public Law 96-336, enacted on September 4, 1980, amended Public Law 93-320 by adding provisions about (1) the power source for the YDP and the PRPU and (2) the mitigation of fish and wildlife habitat losses and by increasing the appropriations ceiling. These amendments are discussed in chapter III.
Chapter III

Title I Works and Capital Costs

Yuma Desalting Plant

The YDP, the central feature of the works authorized by Title I, is located on a 60-acre tract of land 6 miles west of Yuma, Arizona. (See photograph 1.)

Design Considerations

Process Selection

Public Law 93-320 stipulated that the YDP use an advanced, commercially available desalting process. As a result, applicable technologies were narrowed to (1) distillation processes and (2) ionic processes (ion exchange, electrodialysis, and reverse osmosis). Electrodialysis and reverse osmosis processes were selected for further testing because of their projected lower overall costs. Both processes use semi-permeable membranes to remove ionic constituents from the water.

From 1974 to 1978, a variety of electrodialysis and reverse osmosis processes were tested at the Yuma Desalting Test Facility (YDTF). (See chapter V, “Desalting Research and Development.”) The primary objectives of the testing were (1) to provide data for Reclamation and the manufacturers on desalting equipment, (2) to provide information for evaluating

Photograph 1.—Yuma Desalting Plant complex.
proposed YDP desalting equipment, and (3) to test pretreatment systems.

After mid-1978, testing focused on obtaining final design data for the pretreatment process and proof-testing the selected desalting equipment. All testing work was completed in 1982.

Sizing and Performance

Public Law 93-320 authorized construction of a desalting plant with a 128-million-gallon-per-day (MGD) capacity. However, a 1977\(^1\) sizing study recommended construction of a 96-MGD plant with the "operational characteristics for a reverse osmosis desalting process...capable of recovering 70 percent of the plant feed water." The report stated that while the actual desalting plant might not be built with the same processes, it would have to perform in substantially the same way.

Using the criteria established in the 1977 study, contracts specifying a total treatment capacity of about 96 MGD were awarded to two manufacturers of reverse osmosis desalting equipment.

However, by 1979, the WMIDD irrigation drainage reduction program was proving so successful that irrigation drainage was projected to be reduced eventually to 108,000 acre-feet per year. As a result, the required capacity of the desalting plant was reduced to 72.4 MGD, and a new plan was developed based on the premise of staged plant construction. That is, the 96-MGD design was completed, but specific increments of capacity (solids contact reactors [SCR's], filters, and associated equipment) in construction were deleted. This approach was less costly than redesigning the plant.

Description of the YDP and Desalting Process

The YDP is divided into two distinct systems: (1) the partial lime-softening pretreatment system and (2) the reverse osmosis desalting system.

WMIDD irrigation drainage (feed water) will be diverted from the MODE to grit sedimentation basins where settleable solids and biomass will be removed. The water will then be pumped to three SCR's. A single-unit, partial lime-softening pretreatment process will remove calcium, bicarbonates, iron, and manganese and reduce suspended solids. Under normal operation, the pretreatment process will use about 100 tons of lime and produce about 360 tons of calcium carbonate sludge byproduct per day. The byproduct will be piped to sludge disposal ponds.

From the SCR's, the water will flow by gravity to dual media filters (anthracite over sand), which will provide the final clarification. From the filters, the water will flow to a clear well. Then the water will be pumped to the reverse osmosis desalting equipment, the heart of the desalting plant. (See photograph 2.)

Hydranautics Water Systems provided reverse osmosis desalting equipment capable of producing 22.4 MGD of desalted water. This equipment consists of "pressure vessels" that are 8 inches in diameter and 20 feet long. Fluid Systems Corporation

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\(^{1}\) Colorado River Basin Salinity Control Project, Title I Division, Desalting Complex Unit, Sizing Study, Yuma Desalting Plant, Arizona, Interim Report, June 1977, Lower Colorado Region, Bureau of Reclamation.
provided pressure vessels to produce the remaining 50 MGD of desalted water. These vessels, 12 inches in diameter and 20 feet long, are the largest in the industry.

Each pressure vessel will contain spiral-wound, semipermeable membranes. These membranes, through the process known as reverse osmosis, will remove dissolved materials (mostly mineral salts) from the pretreated water.

The YDP is sized to accommodate about 108,000 acre-feet of irrigation drainage per year, with a salinity of about 2,900 to 3,200 ppm. When operated at full capacity, about 98,000 acre-feet of saline irrigation drainage will be fed into the plant, producing about 68,500 acre-feet of desalted water (product water) with a salinity of about 250 to 300 ppm and about 29,500 acre-feet of reject stream with a salinity of about 9,400 ppm.

The product water will be blended with about 10,000 acre-feet of untreated irrigation drainage. This blended water will be returned to the Colorado River, mixed with other river water, and then delivered to Mexico at the Northerly International Boundary, upstream from Morelos Dam. (See figure 1.)

The reject, or concentrate, stream from the YDP will first flow through an energy recovery system and then to the Bypass Drain, where it will be combined with excess untreated WMIDD irrigation drainage (if any) and conveyed to Santa Clara Slough.

Year-to-year operations will vary according to river conditions and the volume and quality of WMIDD irrigation drainage to be recovered. During years of surplus water conditions on the Colorado River, the YDP will be placed in standby status. Otherwise, these variations will be reflected in minor
fluctuations in power and chemical requirements and in the amount of untreated irrigation drainage blended with product water and returned to the river for delivery to Mexico.

Power Source

Early Studies

Public Law 96-336 required an analysis of alternative power sources (capacity and energy) for Title I works, including a possible agreement with the Republic of Mexico to supply enough power to operate the YDP and the PRPU and their associated facilities. These works require a total of 27 megawatts of capacity: the YDP requires 22 megawatts of capacity in a full-load daily operation, as currently constructed, and the PRPU requires a maximum of 5 megawatts of capacity.

Reclamation contacted public and private utilities in the Southwest to determine the types of power resources available. Several options were considered, including:

Unit Contingent Power - The United States would purchase a specified percentage of the output from a specific generating station.

Firm Power Contracts - The utility would serve the YDP and the PRPU as a commercial wholesale load.

The United States also considered purchasing power from the Comision Federal de Electricidad in Mexico City. However, at the time of the study, Reclamation determined that the power systems between Mexico and the United States could not be synchronized to provide reliable electric service.

Current Power Arrangement

These studies were completed in the late 1980's. Since then, Reclamation has entered into two interagency agreements with Western Area Power Administration (Western). The term of these agreements extends to September 30, 2021, unless terminated by Reclamation upon a 2-year notice.

Under the first agreement, Pacific Northwest-Southwest Intertie and the Parker-Davis Transmission Systems provide firm transmission capacity. Under the second agreement, Western, at Reclamation's request, purchases power and energy at the least possible cost from the spot market to operate the YDP and PRPU. Currently, the composite average cost of this power is 21 to 22 mills per kilowatt-hour. Western makes most of these purchases from the Western Systems Power Pool, of which Western is a member.

While these arrangements meet current power needs at a reasonable cost, future spot market costs could be higher than other arrangements. Western is currently increasing firm transmission rates, which will affect the cost of power for the YDP and PRPU. The rate increase could be substantial and may be effective as early as October 1992. Currently, each Federal project has its own transmission rate. Western is also considering integrating these projects into a one-rate, joint-use transmission system.

Ongoing Studies

Several new developments have occurred in the power market since Reclamation completed its studies in the late 1980's:

- Several utilities in the Southwest have encountered financial problems and may be more willing to negotiate long-term contracts at a lower or more attractive price.

- In the last 5 years, private utilities in the Southwest have interconnected with the Comision Federal de Electricidad to
exchange power. While Mexican power resources are not plentiful, new generation capability may be available in the future that could meet the needs of the YDP and PRPU. Interconnected private utilities are pursuing additional interconnections with Mexico to purchase, sell, and exchange power.

- Utilities in the Southwest are forming consortiums to construct or modify existing power generation and transmission facilities to minimize environmental concerns, increase power system reliability, control costs, and create a more versatile power market.

Reclamation will study these new developments and reexamine some previous studies for comparison with the current power arrangement with Western. Specifically, Reclamation is investigating, either as a sole buyer or as a member of a consortium:

- Purchasing contractual power assets of financially troubled utilities, such as a generating capacity entitlement, and exchanging power with other utilities that have generation entitlements.

- Purchasing physical power assets such as a share of a generating plant near Yuma.

Reclamation will also investigate:

- Using surplus power from Reclamation's entitlement from the Navajo Generating Station near Page, Arizona. (Surplus power is power that exceeds the requirements of the Central Arizona Project.)

- Selling, purchasing, and exchanging power to and from Mexico as a member of a consortium that is connected to the Comision Federal de Electricidad and interconnected with the Federal power system. Or, as a sole buyer, purchasing power from Mexico on a long-term basis and negotiating transmission with private utilities.

- New power marketing possibilities as a result of the addition of two, new 500-kilovolt interconnections into Navajo Westwing and McCullough Substations.

- Resurveying all interconnected utilities with the Federal power system for least-cost firm power purchases and transmission to the YDP and PRPU.

- Energy conservation opportunities such as installing modern pumps and motors at pumping stations in the Yuma area.

In summary, Reclamation has secured power for the YDP and PRPU until the year 2021. Reclamation believes this arrangement is the least-cost alternative for now and the near future. However, Reclamation will periodically evaluate new technical and system developments and reexamine past studies to ensure that the YDP and the PRPU continue to receive the required power at the lowest possible cost. Reclamation is currently reevaluating the power market and expects to have a written analysis completed by the end of calendar year 1992.

**Status**

Construction of the facilities essential to operating the YDP is complete. Activities scheduled for the future include construction of additional sludge disposal ponds, as needed, and a pilot program to test the feasibility of recalcining.

Startup work began in December 1991; currently, the pressure vessels are being loaded with membranes. The YDP is expected to be operated at one-third capacity (producing 22.4 MGD of desalted water) by August 1, 1992. Most of this desalted water will be blended with untreated irrigation drainage and returned to the Colorado River for delivery to Mexico. The YDP is scheduled to operate at this
capacity through fiscal year 1986, as appropriations allow. (Budgets for 1994-96 are preliminary and will compete with other program needs.) Also see figure 5.

WMIDD Irrigation Drainage Reduction Program

This program, authorized by section 101(b) of Public Law 93-320, has reduced WMIDD irrigation drainage pumping and, thus, the required size of the YDP by removing some high-water-use lands from irrigation and by increasing irrigation efficiencies.

Acreage Reduction Program

Under this program, WMIDD irrigable lands were reduced from 75,000 to 65,000 acres. About 6,200 acres of land were purchased from 85 landowners. The remaining 3,800 acres were Federal lands from which irrigable status was withdrawn. Approximately 4,600 of the irrigable acres purchased were in crop production. As a result of the land purchases, deep percolation was reduced by about 29,800 acre-feet per year. This program was completed in 1978.

In addition to the Title I measures described above, the Salt River Pima Maricopa Indian Community Water Rights Settlement Act of 1988, executed in 1991, reduced WMIDD irrigated lands by an additional 2,125 acres and reduced WMIDD maximum contractual consumptive use from 300,000 to 275,000 acre-feet per year.

Wellton-Mohawk Irrigation Efficiency Improvement Program

Several entities cooperated on this program, including the WMIDD and its farmers, several Government agencies (Reclamation, Soil Conservation Service [SCS], and the Agricultural Research Service), and the University of Arizona Cooperative Extension Service. Individual measures are discussed in the following sections.

Onfarm Improvements Program

The objective of this program was to increase onfarm irrigation efficiencies by improving onfarm irrigation systems and management practices. SCS provided design, installation, and management assistance for approximately 48,000 acres of land. Significant accomplishments included lining 263 miles of onfarm canals; leveling 44,415 acres of land; making soil improvements on more than 3,000 acres; and installing 10 drip irrigation systems and 10,600 onfarm water-control and measurement structures. The Federal Government contributed 75 percent of the costs; farm cooperators contributed the other 25 percent.

Irrigation Management Services Program

Reclamation provided technical assistance through the Irrigation Management Services (IMS) program, which, in turn, provided onfarm, field-by-field irrigation scheduling assistance. From 1977 through 1986, irrigation scheduling information was furnished for about 49,000 acres of crops each year.

Reclamation provided technical expertise, training, and funding for the program. The WMIDD provided one district employee and office facilities at the district. Reclamation funding for the IMS program ended in 1987.

Research and Demonstration Program

Six projects were funded under this program, which provided information on cultural practices, equipment, and economic considerations that could lead to improved irrigation efficiencies. Projects included monitoring soil salinity, studying emitter
clogging in trickle irrigation systems, managing pressure irrigation systems for citrus crops, managing dead-level irrigation, automating surface irrigation, and evaluating alternative irrigation systems. All projects were completed by 1980.

**Education and Information Program**

The objectives of this program, conducted by the University of Arizona Cooperative Extension Service, were (1) to provide liaison among the various irrigation efficiency programs and (2) to educate and encourage growers to adopt recommended techniques and practices. Program information was provided through publications, television, and radio. With grower cooperation, field trials were held to demonstrate water management benefits, and field days were conducted on topics such as automated irrigation systems, irrigation scheduling and efficiency, and crop consumptive use.

**Federal Cost Share**

Table 1 shows the Federal cost share of the WMIDD irrigation drainage reduction program.

**Results**

Before the program was initiated, WMIDD irrigation efficiency was 56 percent. While the program was active, overall WMIDD irrigation efficiencies exceeded 72 percent, the level estimated to reduce irrigation drainage to 108,000 acre-feet per year. An overall peak irrigation efficiency of 77 percent was reached in 1985, and irrigation drainage dropped from 220,000 acre-feet to a low of 118,500 acre-feet per year.

<table>
<thead>
<tr>
<th>Table 1.—Federal cost share WMIDD irrigation drainage reduction program</th>
</tr>
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<tbody>
<tr>
<td>Soil Conservation Service</td>
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<tr>
<td>Technical assistance</td>
</tr>
<tr>
<td>Onfarm improvements</td>
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<tr>
<td>Agricultural Research Service</td>
</tr>
<tr>
<td>Research and demonstrations</td>
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<tr>
<td>Bureau of Reclamation</td>
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<tr>
<td>Acreage reduction program</td>
</tr>
<tr>
<td>Irrigation Management Service</td>
</tr>
<tr>
<td>Education on irrigation efficiency</td>
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<tr>
<td>Technical Field Committee activities</td>
</tr>
<tr>
<td>Administrative costs</td>
</tr>
<tr>
<td>Total cost of WMIDD irrigation drainage reduction program</td>
</tr>
</tbody>
</table>

While the program demonstrated an overall positive effect, a cause-and-effect relationship for individual measures has never been established.²

**Status**

All permanent measures implemented by the WMIDD are still in use, although no active Federal program is currently in operation. Total crop acres have remained relatively stable since the early 1970's because more acreage is double-cropped than when the program was initiated. Irrigation efficiency has declined to about 60 percent and is continuing to decrease.

Irrigation drainage pumping has increased to about 145,000 acre-feet per year and diversion rates are increasing because of several factors, including some changes from permanent to vegetable crops.

Reclamation continues to investigate the causes of increased irrigation drainage pumping. In cooperation with the WMIDD, SCS, and others, Reclamation will explore a program of irrigation efficiency improvement measures or other measures, with a goal of permanently reducing irrigation drainage pumping to 108,000 acre-feet or less per year.

Reclamation's future activities are outlined below. (Also see figure 5.)

- Continue discussions among project and regional offices concerning increased irrigation drainage.
  - Identify possible causes.
  - Define reduction goal.
  - Identify potential institutional or legal authority.
  - Identify funding options.
- Meet with WMIDD, SCS, and other interested Federal agencies.
  - Develop program goals.
  - Identify roles and commitments for all involved agencies.
  - Discuss potential activities of all agencies involved.
  - Discuss implementation schedule.
  - Discuss monitoring requirements.
  - Identify specific Federal authorities and limitations.
  - Identify additional staff required and sources of funding.
  - Develop monitoring plan.

- Complete implementation schedule.
- Execute letter of agreement defining responsibilities of all agencies involved.
- Fully implement irrigation drainage reduction program.

**Coachella Canal Lining**

As authorized by section 102(a) of Public Law 93-320, the first 49 miles of the Coachella Canal were concrete lined to reduce seepage and, for an interim period, to provide a source of replacement water for bypassed WMIDD irrigation drainage. The lined section conserves an estimated 132,000 acre-feet of water per year. The canal originates as a diversion from the All-American Canal at a turnout point near the Mexican border and runs generally northwest for about 123 miles. (See frontispiece map.) It provides irrigation water for 67,000 acres of land in the Coachella Valley.

Shortly after the Coachella Canal was completed in 1948, seepage losses became apparent in the first 86 miles of unlined canal. The most severe seepage occurred in the first 49 miles of the canal, which traversed the coarse, sandy soils of the Imperial East Mesa in California. An estimated 141,000 acre-feet of Colorado River water was lost each year in this section.

The Coachella Valley Water District (CVWD) operates and maintains the new lined canal. Canal-lining costs are to be repaid by the CVWD over a 40-year period on an interest-free basis. However, the payments are waived for the interim period when the United States has use of the conserved water. (See chapter II, "Title I Provisions.")
Protective and Regulatory Pumping Unit

Section 103(a) of Public Law 93-320 authorized the construction, operation, and maintenance of the PRPU to manage and conserve United States ground water for the benefit of the United States and for delivery to Mexico. The PRPU is located in a 5-mile-wide zone along the Southerly International Boundary between Arizona and Mexico. (See frontispiece map.)

The PRPU was developed to intercept part of the ground-water underflow that moves southward from the Yuma Mesa in the United States into Mexico. Before the PRPU was constructed, this underflow was increasing because of ground-water pumping in the Sonora Mesa Well Field, immediately south of the Southerly International Land Boundary in Mexico. The Basin States expressed their concern about the pumping in their July 1973 letter to the President.

Currently, 21 of the planned full complement of 35 wells and associated conveyance and energy facilities have been constructed. The wells are connected by a 15.3-mile pipeline and open concrete-lined canal that carries water by gravity across the Southerly International Land Boundary.

With 35 wells, the PRPU would be capable of producing about 160,000 acre-feet of water per year. Ultimately, approximately 125,000 acre-feet of water from the PRPU, combined with 15,000 acre-feet of water from wasteways and drains in the Yuma Valley, would furnish 140,000 acre-feet of Mexico's 1.5-million-acre-foot annual entitlement. The water will be delivered at the Southerly International Land Boundary near San Luis, Arizona. Currently, water from wasteways and drains in the Yuma Valley exceeds 15,000 acre-feet per year.

Should these wasteway and drain flows diminish in the future, wells will be added to the PRPU, as needed, to ensure that approximately 140,000 acre-feet can be delivered at the Southerly International Land Boundary at all times.

Additionally, as authorized by Title I, approximately 23,500 acres of private, State, and State-leased lands have been acquired within the 5-mile zone. The purpose of these acquisitions is to limit development and thus limit United States ground-water pumping to 160,000 acre-feet per year, as required by Minute No. 242. Acquisitions were completed in 1984.

Fish and Wildlife Mitigation Measures

Public Law 93-320, as amended by Public Law 96-336, authorized mitigation of fish and wildlife habitat losses attributable to Title I projects, including:

- Loss of wetlands and seep areas along the Coachella Canal caused by concrete lining.

- Deer drownings in the concrete-lined section of the Coachella Canal.

- Reduction in agricultural acreage in the WMIID.

- Loss of surface water in the Colorado River below Morelos Dam caused by conveying WMIID irrigation drainage in the Bypass Drain to the Santa Clara Slough.

Several measures were implemented to mitigate these impacts:

- A water well for wildlife use is being constructed near Tacna, Arizona.

- An old borrow pit near Fortuna Wash and the Gila River east of Yuma, Arizona, was deepened to improve habitat for fish.
Aquatic improvements were made to Mittry Lake (located on the Colorado River between Laguna and Imperial Dams), including fish stocking and fishing dikes. Also, open water areas were created within a marsh at the lake to improve habitat for waterfowl and other species. Areas surrounding the lake were revegetated.

Mumme Farm, 1,200 acres of land in the Gila River floodplain near Gillespie Dam, was purchased to provide a wildlife management area. Much of the area will be planted for wildlife feed; the remainder will be planted with cottonwood, willow trees, and other native vegetation.

About 140 acres of Reclamation-acquired lands in the Welton area have been revegetated with mesquite and other plants desirable for wildlife.

Open areas of water have been created on Finney Lake, located in California’s Imperial Wildlife Area.

Nineteen water devices have been constructed on lands adjacent to the Coachella Canal. Each device, consisting of a windmill and a storage tank, produces drinking water for wildlife and maintains some vegetation.

In California, several tracts of land containing unique wildlife habitats have been purchased for public ownership.

**Title I Capital Costs**

The original appropriations ceiling for all Title I works was $155.5 million, based on April 1973 prices. Public Law 96-336 included provisions to increase the Title I appropriations ceiling to $356.4 million because of additions to the YDP (a more complicated pretreatment system and a lime recovery system), the expansion of the irrigation efficiency improvement program, and design changes in the Coachella Canal lining program. See table 2 for Title I capital costs.

Approximately $390 million was allotted for Title I works through fiscal year 1992; $9 million has been requested for 1993; and $52 million will be required after 1993 to complete the Title I program.

The October 1992 Title I authorized appropriations ceiling, adjusted using the construction cost index, is $472.8 million, adequate to fund the program as proposed.
Table 2.—Capital costs: Colorado River Basin Salinity Control Project, Title I

<table>
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<tr>
<th>Title I features</th>
<th>Project cost estimates</th>
<th>Actual costs through fiscal year 1991</th>
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<td>April 1973 price level</td>
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<td>October 1992 price level</td>
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<tr>
<td>108 MGD capacity</td>
<td>72.4 MGD capacity</td>
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<td>Desalting complex unit:</td>
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<td>Subtotal</td>
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<td>Coachella Canal Unit</td>
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<td>Fish and wildlife mitigation measures</td>
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Chapter IV

Cost of Desalted Water and the YDP Cost Reduction Program

Cost of Desalted Water

YDP product water is expected to have a total cost of about $699 per acre-foot. If about 10,000 acre-feet of untreated irrigation drainage is blended with the product water and discharged to the river for delivery to Mexico, the cost of the total water recovered is about $610 per acre-foot. These costs are based on full-capacity operation, a 50-year amortization period, and an interest rate of 5-5/8 percent. (See table 3.)

Industry-wide, typical total desalting costs (capital cost plus operation and maintenance costs) range from about $1.00 to about $2.50 per 1,000 gallons, or $325 to $812 per acre-foot. The amortization period and interest rate used are not available.

In 1988, The Metropolitan Water District of Southern California (MWD) prepared a report on the cost of desalting water utilizing available technology. The report documented desalting costs at 22 desalination plants:

- Ten plants used reverse osmosis to treat brackish ground water.
- Four plants used reverse osmosis to demineralize municipal secondary effluent and agricultural drainage water.
- Three plants used electrodialysis to treat surface and ground water.
- Five plants used reverse osmosis or multiple-effect thermal distillation to desalt seawater.

Total desalting costs for these plants were developed and compared. Unit costs for plant construction were based on a 20-year amortization period and an interest rate of 8-7/8 percent (the prevailing United States Treasury Department rate for July 1987). All operating and maintenance costs reflect actual 1986-87 data. According to the results, the cost of desalting brackish water in southern California ranges from $350 to $2,250 per acre-foot. These costs vary considerably site-to-site and depend on the size of the facility and specific pretreatment requirements. The report recommends that MWD use a range of $350 to $750 per acre-foot for general cost estimating.

Assuming full-capacity operation and applying the same amortization period and interest rate used in the MWD report, YDP desalted water costs $886 per acre-foot to produce. The recovery of irrigation

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Table 3.—Cost of desalted water (October 1992 prices)
Yuma Desalting Plant

<table>
<thead>
<tr>
<th>Plant data</th>
<th></th>
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</thead>
<tbody>
<tr>
<td>Installed capacity</td>
<td>72.4 million gallons per day</td>
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<tr>
<td>Product water</td>
<td>68,500 acre-feet per year</td>
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<tr>
<td>Blended water(^1)</td>
<td>78,500 acre-feet per year</td>
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<table>
<thead>
<tr>
<th>Plant cost</th>
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<tbody>
<tr>
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<td>Annual equivalent capital cost(^2)</td>
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<tr>
<td>Annual OMR&amp;E costs</td>
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<tr>
<td>Total annual equivalent cost</td>
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<table>
<thead>
<tr>
<th>Unit cost of desalting water</th>
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<tr>
<td>Investment cost per daily gallon of installed capacity</td>
<td>$3.65</td>
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<tr>
<td>Annual operating cost per 1,000 gallons of:(^3)</td>
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<tr>
<td>Product water</td>
<td>$1.43</td>
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<tr>
<td>Blended water</td>
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<tr>
<td>Total annual equivalent unit cost of desalting 68,500 acre-feet of irrigation drainage (product water):</td>
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<tr>
<td>Per acre-foot(^4)</td>
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<tr>
<td>Per 1,000 gallons</td>
<td>$2.15</td>
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<tr>
<td>Total annual equivalent unit cost of delivering 78,500 acre-feet of blended water to the Colorado River:</td>
<td>$610.00</td>
</tr>
<tr>
<td>Per acre-foot</td>
<td>$1.87</td>
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<tr>
<td>Per 1,000 gallons</td>
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</tbody>
</table>

\(^1\) Blended water is the combination of product water, blend flow during normal operation of the desalting plant, and transient flows during plant startup and shutdown.

\(^2\) Fifty-year period of analysis and interest rate of 5-5/8 percent (factor of 0.060148).

\(^3\) One acre-foot equals 325,880 gallons.

\(^4\) Based on operation at full capacity.
drainage costs about $773 per acre-foot. These costs are within the range provided in the MWD report. However, the cost of YDP product water is greater than the range recommended for general cost estimating for several unique reasons:

- To reduce life-cycle costs, the YDP was designed for a 50-year life expectancy. This design required more durable, higher cost equipment and materials such as aluminum bronze piping, gravity backwash filters, and concrete vessels.

- The feed water, WMIDD irrigation drainage, is conveyed to the YDP in an 80-mile-long open drain exposed to windborn sand and runoff, which creates a high suspended solids loading. This debris is difficult to remove and requires extensive pretreatment facilities.

- The drain is exposed to intensive direct sunlight, which encourages the growth of aquatic weeds and algae that become part of the feed water. As a result, additional pretreatment facilities are needed to remove this biomass. Introducing the White Amur (grass carp) into the MOD/MODE could control the biomass (this fish effectively controls aquatic vegetation). However, the Arizona Department of Game and Fish has restricted stocking of the grass carp in the Yuma area within 1 mile of the lower Colorado River. This option will be explored in the future if the department changes its position on the 1-mile restriction.

- For esthetic reasons, a significant portion of the YDP's piping and equipment were located underground, at increased cost.

- Design work was completed on a "piece-meal" basis over a 15-year period to reduce the impact on the annual budget. As a result, overhead composed a larger than usual portion of the total design cost.

- Construction work was completed over a 10-year period (1) to reduce the impact on the annual budget, (2) to ensure plant completion coincided with actual need, (3) to allow construction to follow the design work, and (4) to allow the completion of higher priority Reclamation work such as the Central Arizona and the Central Utah Projects. As a result, overhead costs increased, coordination between construction contracts was made more difficult and expensive, and multiple contracts were required, eliminating the discounts associated with larger procurements.

Annual YDP Operations Costs

As shown in table 4, full-capacity operation of the YDP under long-term operating conditions will cost about $32 million per year. Table 4 also shows estimated fiscal year 1993 operation and maintenance costs for a range of operating scenarios.

In addition, transitional years will occur between full operation and standby (and vice versa). Projected costs for any given year depend on what occurred the previous year as well as what is planned for the following year. This creates a wide range of possible operating costs; figure 2 illustrates one possibility. The first year after full operation in a transition to standby would include overhead and nonroutine maintenance costs. Nonroutine maintenance includes work scheduled to be performed during standby; otherwise, plant shutdown would be required.

After a period of standby, and assuming that full operation will resume at the beginning of the next calendar year, startup costs will be incurred in the calendar year before the year operation begins. Startup costs will include increases in chemical, power, and personnel costs. After a period of standby, about 3 months of pretreatment and desalting equipment startup will be required before full operation can occur at the beginning of the year. Annual maintenance contracts and administrative
### Table 4.—Yuma Desalting Plant Operation and maintenance costs (1988 costs in millions of dollars)

<table>
<thead>
<tr>
<th>Description</th>
<th>Mothball</th>
<th>Standby</th>
<th>One-third operation</th>
<th>Full operation</th>
<th>Future full operation</th>
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<tbody>
<tr>
<td>Noncontract costs</td>
<td>$3.5</td>
<td>$3.5</td>
<td>$3.5</td>
<td>$3.5</td>
<td>$3.5</td>
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<tr>
<td>Service contracts</td>
<td>5.6</td>
<td>5.6</td>
<td>5.6</td>
<td>5.6</td>
<td>5.6</td>
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<tr>
<td>Equipment replacement and modification</td>
<td>0.0</td>
<td>1.0</td>
<td>1.8</td>
<td>3.1</td>
<td>2.0</td>
</tr>
<tr>
<td>Membranes</td>
<td>1.2</td>
<td>2.6</td>
<td>2.6</td>
<td>2.6</td>
<td>6.0</td>
</tr>
<tr>
<td>Power and chemicals</td>
<td>0.8</td>
<td>0.8</td>
<td>0.7</td>
<td>10.9</td>
<td>10.9</td>
</tr>
<tr>
<td>Sludge disposal</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>1.0</td>
<td>3.0</td>
</tr>
<tr>
<td><strong>Total O&amp;M</strong></td>
<td><strong>$9.9</strong></td>
<td><strong>$10.9</strong></td>
<td><strong>$14.6</strong></td>
<td><strong>$23.1</strong></td>
<td><strong>$32.0</strong></td>
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<tr>
<td><strong>Total</strong></td>
<td><strong>$12.5</strong></td>
<td><strong>$13.5</strong></td>
<td><strong>$17.2</strong></td>
<td><strong>$25.7</strong></td>
<td><strong>$32.0</strong></td>
</tr>
</tbody>
</table>

1 Not considered O&M costs; considered capital costs through 1994.

![Figure 2.—Variations in annual typical YDP operating costs.](image-url)
personnel expenses would be reduced only slightly by an extended period of standby.

Reclamation began projecting YDP operating costs in the mid-1970’s. Early cost estimates were based on a nominal 108-MGD plant, the minimum capacity originally considered necessary to meet objectives. For a 108-MGD plant, operation, maintenance, replacement, and energy costs were estimated to be $11.7 million at October 1975 prices. Using October 1975 prices and the same assumptions for membrane replacement and power costs, reducing the capacity of the YDP to 72.4 MGD would have reduced estimated OMR&E costs by $2.1 million. If refined membrane replacement and power costs are considered, the estimated October 1975 OMR&E costs for a 72.4-MGD plant would have been $14.4 million.

From October 1975 through October 1991, the OMR&E cost estimate increased by the addition of $2.7 million for construction of sludge disposal ponds (which previously had been considered capital costs), $0.5 million for other replacement costs (which previously had been underestimated), $1.8 million for contractor operation of the YDP, as well as for updated costs for administrative and engineering support and research and development programs, and $13.4 million for inflation. Estimated energy costs decreased by $800,000. As a result of these factors, the OMR&E cost estimate at October 1992 prices is $32 million.

YDP Cost Reduction Program

The Yuma Projects Office, responsible for YDP operation and maintenance, is pursuing an aggressive OMR&E cost reduction program. Some of these projects, described in the following sections, will also help advance United States desalting technologies. All cost savings are based on full-capacity operation of the YDP (72.4-MGD production).

Increased Membrane Life

Techniques to reduce fouling and to increase the expected 3-year life of desalting membranes are being investigated. The accumulation of solids on the membranes and fouling by micro-organisms are two of the known major contributors to shortened membrane life. Determining how these contributors shorten membrane life and making appropriate adjustments will reduce costs. Extending membrane life by 1 year could save $1.5 million annually.

Equipment Monitoring

A program to monitor the performance and reliability of YDP equipment and components will be implemented. More reliable or cost-effective equipment, where needed, will be investigated.

New Technologies

Some new desalting technologies may be applicable to the YDP. If implemented, they could improve efficiencies and reduce costs. For example, new water treatment facilities are being developed to meet high water-quality requirements for the electronics industry, steam generating, and food processing, as well as for agriculture. Agricultural requirements include removing specific contaminants such as excessive selenium, pesticides, and herbicides.

New Pretreatment Processes

Improved pretreatment processes with the potential to reduce costs for chemicals or equipment and membrane replacement are
being investigated. New and innovative techniques are being developed to remove grit, clays, colloids, and scaling constituents from the feed water. As promising techniques are developed, pilot studies will be conducted to determine if these new techniques will reduce costs.

Desalted Water Marketing

The city of Yuma has investigated purchasing water treated by the YDP (desalted irrigation drainage and/or Colorado River water treated by the pretreatment system only) to help meet its increasing need for potable water. Joint technical evaluations by Reclamation and the city have been completed, but the city has decided to meet short-term needs by expanding its own water treatment facilities. In the future, however, the city will pursue purchasing YDP-treated water. Discussions with Reclamation are continuing.

If the city purchases YDP-treated water in the future, it could avoid the high cost of expanding its own water treatment facilities, and the United States could benefit by cost-sharing YDP operation and maintenance costs. The salinity and the quantity of the water delivered to Mexico would not be affected by such an agreement.

Sludge Marketing

Reclamation is investigating the possibility of marketing YDP waste calcium carbonate sludge. However, even if the sludge were given away, up to $2.7 million in disposal costs could be saved per year.

New Membrane Technologies

Investigation of lower pressure and higher recovery membranes is planned. As new membranes are developed, Reclamation will determine if the membranes are suitable for the YDP. Low-pressure membranes, although more expensive, could reduce electrical power requirements from 22 to 15 megawatts for an annual cost savings of about $1.5 million. These membranes may also increase recovery of irrigation drainage, thereby reducing the volume of the reject stream. However, changes in pretreatment would be required to allow use of low-pressure membranes and to substantially increase recovery, which may offset overall cost savings.

Technical Review

Reclamation plans to develop a board of consultants, or technical review committee, to review and recommend improvements to the YDP and its operations. The committee, expected to consist of experts from the desalting industry (public and private), academia, and others, will review all aspects of the YDP and recommend modifications to increase efficiencies, reduce costs, and improve the overall operation of the YDP, Test Plant (formally called the Test Train), and cost reduction program.

Recalcining and Cogeneration

Recalcining is a technique to recycle the waste calcium carbonate sludge that forms in the pretreatment system. The present design provides for all of the sludge to be piped to disposal ponds.

In recalcining, the sludge would be heated in a kiln to produce calcium oxide (lime), which would be reused in the pretreatment system. Therefore, the amount of new chemicals required and the amount of sludge that must be disposed of would be greatly reduced. Reclamation will investigate the compatibility of recycled lime with the pretreatment system.
In cogeneration, electricity for the YDP would be produced by a natural gas turbine generator. Waste heat from the turbine would be used for part of the recalcining process. These two processes could reduce costs for new chemicals and power by up to $2 million per year.

maintenance costs. The program has already produced results. For example, high maintenance equipment has been replaced with lower maintenance, more reliable equipment as a result of the monitoring program described above.

Implementation

Implementing this program will significantly reduce YDP operation and
Chapter V

Ability of Title I to Support Program Objectives

This chapter discusses the ability of Title I to support its primary objective of providing Mexico with Colorado River water that meets negotiated salinity standards without depriving the Basin States of any of their apportioned water. It also discusses the ability of Title I to advance desalting technologies.

Supporting the Primary Objective Before Completion of the YDP

The United States has complied with the salinity differential since 1974. That is, the average annual salinity of the water delivered to Mexico at the Northerly International Boundary, upstream from Morelos Dam, has not exceeded the average annual salinity of the water arriving at Imperial Dam by more than 115 ppm plus or minus 30 ppm (maximum of 145 ppm). Figure 3 shows the annual flow-weighted salinity at Imperial Dam from 1973 through 1991. Figure 4 shows the annual salinity differential for the same period (the salinity at the Northerly International Boundary less the salinity at Imperial Dam).

The United States has complied with the salinity differential through the temporary measures of bypassing all WMIDD irrigation drainage to the Santa Clara Slough, substituting good quality water from upstream storage for treaty deliveries to Mexico, and, for an interim period that began in 1982, claiming as replacement the water conserved by lining the Coachella Canal.

As stated previously, under Public Law 93-320, the replacement of irrigation drainage bypassed to meet the salinity differential is recognized as a national obligation. The United States has secured interim use of 132,000 acre-feet per year of replacement water by lining the Coachella Canal. However, the United States has not secured water to replace the amount bypassed in excess of 132,000 acre-feet per year, which totaled 5,900, 6,000, and 13,000 acre-feet in calendar years 1989, 1990, and 1991, respectively. Over the past 10 years, the amount of irrigation drainage bypassed has ranged from a high of 192,000 to a low of 118,500 acre-feet per year.

Supporting the Primary Objective in the Future With the YDP

Under present conditions, the YDP, if operated at full capacity, would be able to recover more than half of the WMIDD irrigation drainage. Until the interim period ends, the water conserved by the lining the Coachella Canal will be sufficient to replace the reject stream and any bypassed WMIDD irrigation drainage required for essential operations, even if the YDP is operated at one-third capacity (22.4-MGD production).

1 Except at such times when there existed surplus water for the Colorado River under the terms of the 1944 water treaty with Mexico.
Figure 3.—Annual flow-weighted salinity at Imperial Dam.

Figure 4.—Annual salinity differential: Northerly International Boundary - Imperial Dam.
In the future, if WMIDD irrigation drainage pumping is permanently reduced to 108,000 acre-feet per year (the volume the YDP is sized to accommodate) and the YDP is operated at full capacity, no untreated irrigation drainage will be bypassed except when there are no surplus flows to Mexico and the salinity of the river is very low (about 600 ppm at Imperial Dam, a very rare event). Should this occur, some WMIDD irrigation drainage would be bypassed to the Santa Clara Slough. The actual volume bypassed would correspond directly to the volume of irrigation drainage pumped.

The YDP will conserve water by maximizing the recovery of WMIDD irrigation drainage for treaty deliveries to Mexico.

**Previous Replacement Water Studies**

Section 101(c) of Public Law 93-320 directed the Secretary to identify feasible measures to adequately replace water lost through the reject stream and bypassing WMIDD irrigation drainage. The law limited the source of the replacement water to Arizona, California, Colorado, New Mexico, and those portions of Nevada, Utah, and Wyoming within the natural drainage basin of the Colorado River. Reclamation identified eight possible measures:

1. **Yuma Mesa Division Entitlement Exchange**—proposal to use an unused portion of the division’s irrigation entitlement for a specified period.

2. **Alamo River Desalting Facility**—proposal to desalt water from the Alamo River in California’s Imperial Valley.

3. **San Onofre Desalting Facility**—proposal to desalt ocean water on the southern California coast.

4. **High recovery at the Yuma Desalting Plant**—proposal to add a high-recovery unit to the plant, thereby decreasing the volume of reject stream.

5. **All American Canal Well Field**—proposal to intercept canal seepage and ground water through well-field pumping south of the canal.

6. **Butler Valley Well Field**—proposal to withdraw ground water from a large aquifer underlying Butler Valley in west-central Arizona.

7. **Protective and Regulatory Pumping Unit**—proposal to use the well fields to pump ground water not currently needed for delivery to Mexico or for use in the United States.

8. **All American Canal Relocation**—proposal to line a segment of the existing unlined canal to salvage seepage water.

As required by Public Law 93-320, these possibilities were presented in a report submitted to the Congress in June 1980, *Colorado River Basin Salinity Control Project, Title I Division, Reject Stream Replacement Study, California-Arizona.*

To date, a permanent source of replacement water has not been found because of two primary legal and institutional constraints:

- All Colorado River water is apportioned; the United States has no entitlement to this water.

- No Colorado River water user has expressed an interest in substituting an alternative water use for an existing Colorado River water use.

Despite these constraints, Reclamation has pursued, and continues to pursue, sources of replacement water and measures to reduce loss of water to the Basin States.
For example, one result of the WMIDD irrigation drainage reduction program was to reduce the volume of the YDP reject stream from about 40,000 to about 29,500 acre-feet per year by reducing the volume of the irrigation drainage. The installed capacity of the YDP was subsequently reduced from 96 MGD to 72.4 MGD. Therefore, the reject stream volume has been permanently reduced by 25 percent.

Ongoing Replacement Water Studies

Currently, Reclamation is studying ways to increase YDP efficiencies to further reduce the volume of the reject stream. These studies are an integral part of the YDP cost reduction program discussed in chapter IV. The new membrane technologies program would contribute most directly toward increased efficiencies.

To obtain a source of replacement water for the YDP reject stream, Reclamation is investigating a proposal to remove riparian salt cedar along the lower Colorado River and replace it with vegetation with lower water demands. This plan would reduce nonbeneficial consumptive water use along the river while simultaneously improving wildlife habitat and recreation values.

Studies of this proposal are being conducted in two phases. Phase I was initiated in June 1989, and a draft report was completed in June 1990. The report documented existing conditions and the factors affecting salt cedar removal and revegetation and included sample feasibility analysis plans.

Phase II has three objectives: (1) to develop a 20-year revegetation management plan, (2) to develop a financial analysis testing the feasibility of using the saved water to replace the reject stream, and (3) to develop a management structure to implement a management plan. The 20-year management plan will be developed by initiating a programmatic environmental assessment/environmental impact statement (EA/EIS). Coordination with the lower Basin States will continue to ensure their acceptance and support. (Also see figure 5.)

Preliminary studies indicate that water savings of 1.0 to 1.5 acre-feet per acre are possible. To replace 29,500 acre-feet per year of reject stream, about 20,000 acres of salt cedar would need to be replaced.

As a fiscal year 1994 planning start, Reclamation is also investigating a proposal to create storage on the lower Colorado River to capture water ordered, but not diverted, and regulatory waste that would otherwise be lost to Mexico as excess deliveries. Preliminary work is currently funded with Environmental and Interagency Coordination Activities and Yuma Area Projects operation and maintenance funds. The source of funding for future work has not yet been determined.

Supporting the Primary Objective in the Future Without the YDP

No permanent approach to complying with the obligations of Minute No. 242, other than operating the YDP, is under active consideration. If the YDP is not operated, Reclamation would continue to bypass all WMIDD irrigation drainage and substitute water from upstream storage for treaty deliveries to Mexico. After the United States loses use of the water conserved by lining the Coachella Canal, it will have a significantly reduced ability to replace this bypass. Should the United States secure water to replace the reject stream, that amount of water would be available to replace bypassed WMIDD irrigation...
drainage. Otherwise, the United States would have no means of replacing any bypassed drainage.

Additionally, if the YDP is not operated and the salinity of the river is very low, Reclamation could be required to bypass all WMLDD irrigation drainage, plus a portion of the irrigation drainage from the South Gila Drainage Pump Outlet Channels (located between Imperial and Morelos Dams).

Effect on Relations With Mexico

If the United States decides not to operate the YDP, Mexico could view this as unwillingness to comply with Minute No. 242, which was created as the permanent and definitive solution to the salinity problem. Relations with Mexico could be further strained over the salinity differential to be maintained in the future. While Minute No. 242 provides for an average annual differential of 115 ppm plus or minus 30 ppm, the United States is under pressure to maintain the differential at 115 ppm at all times. To conserve water for use in the United States, the Basin States could urge a differential closer to 145 ppm (115 ppm plus 30 ppm).

Advancing Desalting Technologies

In support of the YDP, Reclamation has actively pursued desalting research and development and technology transfer. This work will serve to advance desalting technologies as well to increase YDP efficiencies and reduce operating costs.

Previous Research and Development

Significant programs carried out at the Yuma Desalting Test Facility in the 1970’s and early 1980’s included (1) developing suitable pretreatment for the desalting units, (2) testing proposed desalting equipment, (3) developing a research program with desalting equipment manufacturers to develop larger scale equipment than previously available, and (4) proof-testing desalting equipment chosen for the YDP. (See chapter III, “Design Considerations.”)

The pretreatment program quickly demonstrated the difficulty in making the feed water (a surface water supply) suitable for the desalting units. Numerous commercial water clarification processes were tested before a partial lime-softening process was selected.

Before Reclamation issued a request for proposal for desalting equipment, potential suppliers were allowed to test reverse osmosis and electrodialysis equipment on pretreated water at the YDTP. (See chapter III, “Process Selection.”) Most of the major manufacturers provided one or more desalting systems for the initial testing. All systems tested exhibited some technical problems or weaknesses. Some problems and weaknesses were correctable; others were too severe and the process or equipment was abandoned, redesigned, or replaced. Each manufacturer performed as much testing as desired within the initial test period, and test data from each unit were collected and made available during the testing.

Individual manufacturers also carried out a program to develop larger scale equipment for the YDP, which led to the development of the 8- and 12-inch-diameter pressure vessels that will be used in the YDP. These vessels are now available for domestic and world desalting markets.

Proof tests were performed on full-scale vessels provided by successful offerors. These tests led to improvements in the
equipment offered to and ultimately accepted by the Government.

After testing was completed at the YDTF, research was moved to Reclamation's chemical engineering pilot plant laboratory in Denver and to the newly constructed YDP Test Train (currently called the Test Plant). Most of the continuing pretreatment research was conducted at the Test Train because of the availability of process water and actual YDP feed water.

The use of surface water as the feed water focused research on problems of national interest to the desalting industry. Studies performed included using polymer additions to improve water clarity, testing the ability of cellulose-consuming bacteria to survive the pretreatment process, optimizing clarification and sludge concentration to ensure pumpable sludge, and changing disinfection processes to reduce or eliminate the production of trihalomethanes. These studies have broad application because they provide a basis for research in treating other water sources.

Reclamation engineers and scientists, working with membrane manufacturers, have helped improve the quality of the membrane supplied and have been instrumental in switching to environmentally acceptable chemical products for membrane storage and cleaning. Reclamation also has identified environmentally acceptable processes for neutralizing chemical biocides.

Desalting equipment manufacturers have adopted new approaches developed to monitor desalting unit performance in the YDP. These approaches included detailed autopsy procedures for damaged membranes, use of a newly developed and patented plugging factor monitor, and on-line instrumentation for real-time monitoring of unit performance.

Ongoing Research and Development

During construction, research and development focused on solving problems specific to the YDP, including biomass and grit removal, chemical feed and piping failures, dual media filter performance, and membrane degradation. Needed modifications and changes will be completed in 1992.

Reclamation will continue to develop research and development programs. This effort, which includes the cost reduction program discussed in chapter IV, may not only reduce operating costs but may also increase the efficiency of the YDP and thereby minimize waste and conserve materials and energy. (Some waste materials are hazardous and should be minimized for economic as well as for health, safety, and environmental reasons.) Reclamation is pursuing the following research and development activities:

- Continue national and international technology exchange program.
- Identify alternative biocide.
- Perform clean water test for control comparison with normal and test operations.
- Form professional board to review research and development needs and accomplishments.
- Demonstrate membrane storage technology.
- Perform membrane fouling investigation.
- Investigate catalyzed chlorine attack on membranes.
- Identify and adopt new measurement techniques.
- Optimize YDP pretreatment.
Develop surrogate water quality measurements.

Develop innovative disposal techniques for all effluents, including sludge and reject stream.

Advance recovery of treatment chemicals and treatment byproducts.

Develop techniques to minimize byproducts and waste.

Investigate techniques to increase recovery of the reject stream.

Investigate uses for the reject stream.

The research and development program complements the Denver Office’s new desalting technologies program. Many desalting technologies program tasks have been identified through the research and development program or will use the research and development program's findings and developments. For example, the results of the membrane degradation studies provided direction for the membrane development program, and the approaches used in the “clean water test” were used to evaluate and troubleshoot membrane and pretreatment performance. In turn, results from the desalting technologies program will contribute to YDP operations and practices.

To monitor and review the desalting technologies program in Denver, an ad hoc professional board will be created. The board, which will consist of experts from the Government, academia, and desalting industry, will meet regularly to help develop, monitor, evaluate, and identify required changes in program direction.

Technology Transfer

Reclamation has actively pursued desalting technology transfer by sharing problems, experiences, and solutions with the desalting industry through cooperative studies, sponsored tests, technical papers and presentations, and other technology transfer forums.

For example, Reclamation sponsored a workshop in October 1989 entitled “Emerging Desalting and Water Treatment Technologies,” which brought together desalting experts from across the Nation. The workshop recommendations focused on the need to reduce the reject stream for environmental as well as operational purposes.

Reclamation also cosponsored with the National Water Supply Improvement Association a workshop on research needs. The workshop was held as part of the International Desalination Association’s World Congress in August 1991. More than 100 United States and international desalting experts participated. The results of the workshop were used to prepare a report entitled Research Needs for Upgrading Sub-standard Water Supplies.

The YDP continues to maintain a high profile in the desalting industry, as evidenced by the visits from desalting engineers and water managers from more than 20 countries.

Research efforts are guided by the staffs at Reclamation’s Yuma Projects, Regional, and Denver Offices and by the YDP contractor. These staffs represent a major Government resource in desalting technology and serve as a reference and referral source for the public.
Chapter VI

Conclusion

Need For and Benefits of the YDP

The United States must operate the YDP to meet the salinity differential and to minimize the bypass of WMIDD irrigation drainage.

The YDP will (1) conserve water and (2) maximize the beneficial use of Colorado River water available to the United States and Mexico by maximizing the recovery of WMIDD irrigation drainage, which will minimize the use of water from upstream storage to make treaty deliveries to Mexico. This, in turn, will minimize water lost to the Basin States.

A permanent source of replacement water for the YDP reject stream has not yet been found, primarily because the United States has no entitlement to Colorado River water. Reclamation is continuing work to resolve this problem, including investigating proposals (1) to replace riparian salt ceder along the lower Colorado River with vegetation with lower water demands and greater habitat and recreational values and (2) to create additional storage on the lower Colorado River to capture flows that otherwise would be lost to Mexico as excess deliveries.

Building the YDP has contributed to the knowledge base of the desalting industry. The desalting industry will continue to benefit from the research and testing programs performed in support of the YDP.

Future Activities

Reclamation has developed the following action plan to (1) review and evaluate the long-term power source for the YDP and the PRPU to ensure that power is purchased at least cost; (2) complete YDP startup work; (3) reduce WMIDD irrigation drainage pumping; (4) reduce YDP operation and maintenance costs; (5) secure a source of replacement water for the reject stream; and (6) further advance desalting research and development. Implementing this action plan is subject to change based on future developments and budget priorities.

Power Source for the YDP and the PRPU

- Periodically review and evaluate alternative power sources and prepare report for least-cost power source for the YDP and PRPU.
- Continue energy conservation measures.
- Continue to use existing power source or select new source and implement conservation measures.

YDP Startup Schedule

- Form technical review committee to evaluate plant operations and recommend modifications.
- Load membranes.
• Operate at 22.4-MGD production through fiscal year 1996, as appropriations allow. (Budgets for 1994-96 are preliminary and will compete with other program needs.)

WMIDD Irrigation Drainage Reduction Program

• Continue to evaluate possible causes of increased irrigation drainage pumping and identify potential sources of program funding.

• Meet with WMIDD, SCS, and other interested Federal agencies to discuss program goals, participation and roles, constraints, monitoring, and sources of funding.

• Complete implementation schedule.

• Execute letter of agreement defining responsibilities of all agencies involved.

• Implement irrigation drainage reduction program.

YDP Cost Reduction Program

• Continue research to increase membrane life.

• Monitor equipment for reliability and replace as needed.

• Apply new technologies as available and appropriate.

• Investigate new pretreatment processes.

• Market desalted water.

• Market sludge.

• Investigate new membrane technologies.

• Evaluate (technical review committee) plant operations and recommend plant modifications.

• Recalcine sludge.

Reject Stream Replacement

Vegetation Management Study

• Perform water use analysis and prepare decision report.

• Complete 20-year management plan and prepare draft and final Phase II reports.

• Create funding and management structure.

• Perform site suitability analysis.

• Perform salt cedar biological control.

• Perform environmental analyses and prepare draft and final environmental assessments/environmental impact statements.

Lower Colorado River Storage Investigation

• Prepare interim report.

• Prepare planning report/draft environmental assessment.

• Select and implement a preferred plan.

Research and Development Program

• Continue national and international technology exchange program.

• Identify alternative biocide.

• Perform clean water test for control comparison with normal and test operations.
• Form professional board to review research and development needs and accomplishments.

• Demonstrate membrane storage technology.

• Perform membrane fouling investigation.

• Investigate catalyzed chlorine attack on membranes.

• Identify and adopt new measurement techniques.

• Optimize YDP pretreatment.

• Develop surrogate water quality measurements.

• Develop innovative disposal techniques for all effluents, including sludge and reject stream.

• Advance recovery of treatment chemicals and treatment byproducts.

• Develop techniques to minimize byproducts and waste.

• Investigate techniques to increase recovery of the reject stream.

• Investigate uses for the reject stream.
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<td>Periodically review and evaluate alternative power sources and prepare report for low-cost power options for the YDP and PRPU. Continue energy conservation measures. Continue to use existing power source or select new source and implement conservation measures.</td>
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<td>Continue to evaluate possible sources of increased irrigation drainage pumping and identify potential sources of program funding. Meet with WMWD, SCS, and other interested Federal agencies to discuss program goals, participation, roles, constraints, monitoring, and sources of funding. Complete implemention schedule. Execute letter of agreement defining responsibilities of all agencies involved. Implement irrigation drainage reduction program.</td>
<td>$60,000</td>
<td>$100,000</td>
<td>$250,000</td>
<td>$750,000</td>
<td>$1,000,000</td>
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<td>Continue research to increase membrane life. Monitor equipment for reliability and replace as needed. Apply new technologies as available and appropriate. Investigate new pretreatment processes. Market desalinated water. Market sludge. Investigate new membrane technologies. Evaluate (technical review committee) plant operations and recommend plant modifications. Reclaim sludge.</td>
<td>$300,000</td>
<td>$700,000</td>
<td>$500,000</td>
<td>$500,000</td>
<td>$500,000</td>
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<td>Perform water use analyses and prepare decision report. Complete 20-year management plan and prepare draft and final Phase II reports. Create funding and management structure. Perform site suitability analyses. Perform salin odar biological control. Perform environmental analyses and prepare draft and final environmental assessments/environmental impact statements. ADDITIONAL STORAGE ON LOWER COLORADO RIVER</td>
<td>$185,000</td>
<td>$282,000</td>
<td>$80,000</td>
<td>$50,000</td>
<td>$250,000</td>
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<tr>
<td>Continue national and international technology exchange program. Identify alternative broods. Perform clean water test for control comparison with normal and test operations. Form professional board to review research and development needs and accomplishments. Demonstrate membrane storage technology. Perform salinity leaching investigation. Investigate catalyzed chlorine attack on membranes. Identify and adopt new measurement techniques. Optimize YDP pretreatment. Develop surrogate water quality measurements. Develop innovative disposal techniques for all effluents, including sludge and reject stream. Advance recovery of treatment chemicals and treatment byproducts. Develop techniques to minimize byproducts and waste. Investigate techniques to increase recovery of the reject stream. Investigate uses for the reject stream.</td>
<td>$800,000</td>
<td>$500,000</td>
<td>$1,000,000</td>
<td>$1,000,000</td>
<td>$1,000,000</td>
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1. Budgets for 1994-95 are preliminary and will compete with other program needs.
2. If operated at 72.6-MGD production level, estimated funding requirements would be $32 million.

Figure 5.—Action Plan for Future Title I Activities.
APPENDIXES
COLORADO RIVER BASIN SALINITY CONTROL ACT
PUBLIC LAW 93–322; 88 STAT. 266
For Legislative History of Act, see p. 3327
[H. R. 13185]
An Act to authorize the construction, operation, and maintenance of certain works in the Colorado River Basin to control the salinity of water delivered to users in the United States and Mexico.
Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That:
This Act may be cited as the “Colorado River Basin Salinity Control Act”.
TITLE I—PROGRAMS DOWNSTREAM FROM IMPERIAL DAM
Sec. 101. (a) The Secretary of the Interior, hereinafter referred to as the “Secretary”, is authorized and directed to proceed with a program of works of improvement for the enhancement and protection of the quality of water available in the Colorado River for use in the United States and the Republic of Mexico, and to enable the United States to comply with its obligations under the agreement with Mexico of August 30, 1973 (Minute No. 242 of the International Boundary and Water Commission, United States and Mexico), concluded pursuant to the Treaty of February 3, 1944 (TS 994), in accordance with the provisions of this Act.
(b)(1) The Secretary is authorized to construct, operate, and maintain a desalting complex, including (1) a desalting plant to reduce the salinity of drain water from the Wellton-Mohawk division of the Gila project, Arizona—hereinafter referred to as the division), including a pretreatment plant for settling, softening, and filtration of the drain water to be desalted; (2) the necessary appurtenant works including the intake pumping plant system, product pipeline, power transmission facilities, and permanent operating facilities; (3) the necessary extension in the United States and Mexico of the existing bypass drain to carry the reject stream from the desalting plant and other drainage waters to the Santa Clara Slough in Mexico, with the part in Mexico, subject to arrangements made pursuant to section 101(d); (4) replacement of the metal flume in the existing main outlet drain extension with a concrete siphon; (5) reduction of the quantity of irrigation return flows through acquisition of lands to reduce the size of the division, and irrigation efficiency improvements to minimize return flows; (6) acquire on behalf of the United States such lands or interest in lands in the Painted Rock Reservoir as may be necessary to operate the project in accordance with the obligations of Minute No. 242, and (7) all associated facilities including roads, railroad spur, and transmission lines.
(2) The desalting plant shall be designed to treat approximately one hundred and twenty-nine million gallons a day of drain water using advanced technology commercially available. The plant shall effect recovery initially of not less than 70 per centum of the drain water as product water, and shall effect reduction of not less than 90 per centum of the dissolved solids in the feed water. The Secretary shall use sources of electric power supply for the desalting complex that will not diminish the supply of power to preference customers from Federal power systems operated by the Secretary. All costs associated with the desalting plant shall be nonreimbursable.

APPENDIX A

Colorado River Basin Salinity Control Act.
43 USC 1571 note.

U.S. and Mexico, water quality improvement.
43USC 1571.

TIAS 7708.
59 Stat.

Desalting complex construction and maintenance

Desalting plant treatment capacity.

Nonreimbursable
(c) Replacement of the reject stream from the desalting plant and of any Wellton-Mohawk drainage water bypassed to the Santa Clara Slough to accomplish essential operation except at such times when there exists surplus water of the Colorado River under the terms of the Mexican Water Treaty of 1944, is recognized as a national obligation as provided in section 202 of the Colorado River Basin Project Act (82 Stat. 885). Studies to identify feasible measures to provide adequate replacement water shall be completed not later than June 30, 1980. Said studies shall be limited to potential sources within the States of Arizona, California, Colorado, New Mexico, and those portions of Nevada, Utah, and Wyoming which are within the natural drainage basin of the Colorado River. Measures found necessary to replace the reject stream from the desalting plant and any Wellton-Mohawk drainage bypassed to the Santa Clara Slough to accomplish essential operations may be undertaken independently of the national obligation set forth in section 202 of the Colorado River Basin Project Act.

(d) The Secretary is hereby authorized to advance funds to the United States section, International Boundary and Water Commission (IBWC), for construction, operation, and maintenance by Mexico pursuant to Minute No. 242 of that portion of the bypass drain within Mexico. Such funds shall be transferred to an appropriate Mexican agency, under arrangements to be concluded by the IBWC providing for the construction, operation, and maintenance of such facility by Mexico.

(e) Any desalted water not needed for the purposes of this title may be exchanged at prices and under terms and conditions satisfactory to the Secretary and the proceeds therefrom shall be deposited in the General Fund of the Treasury. The city of Yuma, Arizona, shall have first right of refusal to any such water.

(f) For the purpose of reducing the return flows from the division to one hundred and seventy-five thousand acre-feet or less, annually, the Secretary is authorized to:

1. Accelerate the cooperative program of Irrigation Management Services with the Wellton-Mohawk Irrigation and Drainage District, hereinafter referred to as the district, for the purpose of improving irrigation efficiency. The district shall bear its share of the cost of such program as determined by the Secretary.

2. Acquire, by purchase or through eminent domain or exchange, to the extent determined by him to be appropriate, lands or interests in lands to reduce the existing seventy-five thousand developed and undeveloped irrigable acres authorized by the Act of July 30, 1947 (61 Stat. 628), known as the Gila Reauthorization Act. The initial reduction in irrigable acreage shall be limited to approximately ten thousand acres. If the Secretary determines that the irrigable acreage of the division must be reduced below sixty-five thousand acres of irrigable lands to carry out the purpose of this section, the Secretary is authorized, with the consent of the district, to acquire additional lands, as may be deemed by him to be appropriate.
June 24  COLORADO RIVER BASIN CONTROL  P.L. 93–320

(g) The Secretary is authorized to dispose of the acquired lands and interests therein on terms and conditions satisfactory to him and meeting the objective of this Act.

(h) The Secretary is authorized, either in conjunction with or in lieu of land acquisition, to assist water users in the division in installing system improvements, such as ditch lining, change of field layouts, automatic equipment, sprinkler systems and bubbler systems, as a means of increasing irrigation efficiencies: Provided, however, That all costs associated with the improvements authorized herein and allocated to the water users on the basis of benefits received, as determined by the Secretary, shall be reimbursed to the United States in amounts and on terms and conditions satisfactory to the Secretary.

(i) The Secretary is authorized to amend the contract between the United States and the district dated March 4, 1952, as amended, to provide that—

1. the portion of the existing repayment obligation owing to the United States allocable to irrigable acreage eliminated from the division for the purposes of this title, as determined by the Secretary, shall be nonreimbursable; and

2. if deemed appropriate by the Secretary, the district shall be given credit against its outstanding repayment obligation to offset any increase in operation and maintenance assessments per acre which may result from the district's decreased operation and maintenance base, all as determined by the Secretary.

(j) The Secretary is authorized to acquire through the Corps of Engineers for title to, or other necessary interests in, additional lands above the Painted Rock Dam in Arizona that are required for the temporary storage capacity needed to permit operation of the dam and reservoir in times of serious flooding in accordance with the obligations of the United States under Minute No. 242. No funds shall be expended for acquisition of land or interests therein until it is finally determined by a Federal court of competent jurisdiction that the Corps of Engineers presently lacks legal authority to use said lands for this purpose. Nothing contained in this title nor any action taken pursuant to it shall be deemed to be a recognition or admission of any obligation to the owners of such land on the part of the United States or a limitation or deficiency in the rights or powers of the United States with respect to such lands or the operation of the reservoir.

(k) To the extent desirable to carry out sections 101(f)(1) and 101(h), the Secretary may transfer funds to the Secretary of Agriculture as may be required for technical assistance to farmers, conduct of research and demonstrations, and such related investigations as are required to achieve higher on-farm irrigation efficiencies.

(l) All cost associated with the desalting complex shall be nonreimbursable except as provided in sections 101(f) and 101(h).

Sec. 102. (a) To assist in meeting salinity control objectives of Minute No. 242 during an interim period, the Secretary is authorized to construct a new concrete-lined canal or, to line the presently unlined portion of the Coachella Canal of the Boulder Canyon project, California, from station 2 plus 26 to the beginning of siphon numbered 7, a length of approximately forty-nine miles. The United States shall be entitled to temporary use of a quantity of water, for

APPENDIX A

Acquired lands, disposal.

System improvements, installation assistance.

Costs, reimbursement to U.S.

Contract amendment.

Land acquisition for stoppage.

TIAS 7708.

Transfer of funds.

Nonreimbursable costs.

Canal or canal lining, construction.
43 USC 1572.
June 24    COLORADO RIVER BASIN CONTROL   P.L. 93-320

the purpose of meeting the salinity control objectives of Minute No. 242, during an interim period, equal to the quantity of water conserved by constructing or lining the said canal. The interim period shall commence on completion of construction or lining said canal and shall end the first year that the Secretary delivers main stream Colorado River water to California in an amount less than the sum of the quantities requested by (1) the California agencies under contracts made pursuant to section 5 of the Boulder Canyon Project Act (45 Stat. 1057), and (2) Federal establishments to meet their water rights acquired in California in accordance with the Supreme Court decree in Arizona against California (376 U.S. 340).

(b) The charges for total construction shall be repayable without interest in equal annual installments over a period of forty years beginning in the year following completion of construction: Provided, That, repayment shall be prorated between the United States and the Coachella Valley County Water District, and the Secretary is authorized to enter into a repayment contract with Coachella Valley County Water District for that purpose. Such contract shall provide that annual repayment installments shall be nonreimbursable during the interim period, defined in section 102(a) of this title and shall provide that after the interim period, said annual repayment installments or portions thereof, shall be paid by Coachella Valley County Water District.

(c) The Secretary is authorized to acquire by purchase, eminent domain, or exchange private lands or interests therein, as may be determined by him to be appropriate, within the Imperial Irrigation District on the Imperial East Mesa which receive, or which have been granted rights to receive, water from Imperial Irrigation District's capacity in the Coachella Canal. Costs of such acquisitions shall be nonreimbursable and the Secretary shall return such lands to the public domain. The United States shall not acquire any water rights by reason of this land acquisition.

(d) The Secretary is authorized to credit Imperial Irrigation District against its final payments for certain outstanding construction charges payable to the United States on account of capacity to be relinquished in the Coachella Canal as a result of the canal lining program, all as determined by the Secretary: Provided, That, relinquishment of capacity shall not affect the established basis for allocating operation and maintenance costs of the main All-American Canal to existing contractors.

(e) The Secretary is authorized and directed to cede the following land to the Cocopah Tribe of Indians, subject to rights-of-way for existing levees, to be held in trust by the United States for the Cocopah Tribe of Indians:

Township 9 south, range 25 west of the Gila and Salt River meridian, Arizona;
Section 25: Lots 18, 19, 20, 21, 22, and 23;
Section 26: Lots 1, 12, 13, 14, and 15;
Section 27: Lot 3: and all accretion to the above described lands.

The Secretary is authorized and directed to construct three bridges, one of which shall be capable of accommodating heavy vehicular traffic, over the portion of the bypass drain which crosses the reservation of the Cocopah Tribe of Indians. The transfer of lands to the Cocopah Indian Reservation and the construction of bridges

APPENDIX A

43 USC 6174
Repayment
Repayment contract.

Private lands, acquisition.

Imperial Irrigation District, construction charges, credit.

Cocopah Tribe of Indians, transfer of lands by U.S.

Bridges, construction.
across the bypass drain shall constitute full and complete payment to said tribe for the rights-of-way required for construction of the bypass drain and electrical transmission lines for works authorized by this title.

Sec. 103. (a) The Secretary is authorized to:

(1) Construct, operate, and maintain, consistent with Minute No. 242, well fields capable of furnishing approximately one hundred and sixty thousand acre-feet of water per year for use in the United States and for delivery to Mexico in satisfaction of the 1944 Mexican Water Treaty.

(2) Acquire by purchase, eminent domain, or exchange, to the extent determined by him to be appropriate, approximately twenty-three thousand five hundred acres of lands or interests therein within approximately five miles of the Mexican border on the Yuma Mesa: Provided, however, That any such lands which are presently owned by the State of Arizona may be acquired or exchanged for Federal lands.

(3) Any lands removed from the jurisdiction of the Yuma Mesa Irrigation and Drainage District pursuant to clause (2) of this subsection which were available for use under the Gila Reauthorization Act (61 Stat. 628), shall be replaced with like lands within or adjacent to the Yuma Mesa division of the project. In the development of these substituted lands or any other lands within the Gila project, the Secretary may provide for full utilization of the Gila Gravity Main Canal in addition to contracted capacities.

(b) The cost of work provided for in this section, including delivery of water to Mexico, shall be nonreimbursable; except to the extent that the waters furnished are used in the United States.

Sec. 104. The Secretary is authorized to provide for modifications of the projects authorized by this title to the extent he determines appropriate for purposes of meeting the international settlement objective of this title at the lowest overall cost to the United States. No funds for any such modification shall be expended until the expiration of sixty days after the proposed modification has been submitted to the appropriate committees of the Congress, unless the Congress approves an earlier date by concurrent resolution. The Secretary shall notify the Governors of the Colorado River Basin States of such modifications.

Sec. 105. The Secretary is hereby authorized to enter into contracts that he deems necessary to carry out the provisions of this title in advance of the appropriation of funds therefor.

Sec. 106. In carrying out the provisions of this title, the Secretary shall consult and cooperate with the Secretary of State, the Administrator of the Environmental Protection Agency, the Secretary of Agriculture, and other affected Federal, State, and local agencies.

Sec. 107. Nothing in this Act shall be deemed to modify the National Environmental Policy Act of 1969, the Federal Water Pollution Control Act, as amended, or, except as expressly stated herein, the provisions of any other Federal law.
Sec. 108. There is hereby authorized to be appropriated the sum of $121,500,000 for the construction of the works and accomplishment of the purposes authorized in sections 101 and 102, and $34,900,000 to accomplish the purposes of section 103, based on April 1973 prices, plus or minus such amounts as may be justified by reason of ordinary fluctuations in construction costs involved therein, and such sums as may be required to operate and maintain such works and to provide for such modifications as may be made pursuant to section 104. There is further authorized to be appropriated such sums as may be necessary to pay condemnation awards in excess of appraised values and to cover costs required in connection with the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 (Public Law 90-646).
AMEND COLORADO RIVER BASIN SALINITY CONTROL ACT; AMEND SMALL RECLAMATION PROJECTS ACT

An act to increase the appropriations ceiling for title I of the Colorado River Basin Salinity Control Act (the Act of June 24, 1974; 88 Stat. 256), to increase the appropriations authorization for the Small Reclamation Projects Act of 1956 (70 Stat. 1044), and for other purposes. (Act of September 4, 1980, Public Law 96-336, 94 Stat. 1065)

[The Act of June 24, 1974 (hereafter referred to as the “Act”), is hereby amended as follows:

Sec. 1. [Nonreimbursability of desalting plant costs—Authorize use of Navajo Station power and energy for desalting—Precondition of alternate sources of supply analysis—Authorization of future purchases of supplemental power and energy,]—Section 101(b)(2) is amended, by inserting “(A)” after “(2)”, by deleting the last sentence of the paragraph, and by adding thereafter the following:

“(B) The Secretary is authorized to use electrical power and energy available from the Navajo Generating Station which is in excess of the Central Arizona Project pumping requirements for the purpose of supplying power and energy requirements of the desalting plant and protective pumping well field constructed pursuant to title I of the Act: Provided, That revenues credited to the Lower Colorado River Basin Development Fund shall not be diminished below those amounts which would have accrued had the power been marketed at the rate determined by the Secretary of Energy for the sale of power from the Navajo Generating Station to utilities and public entities, as a result of the use of power and energy for the desalting, protective pumping works, and other uses authorized by law, and that power and energy from the Navajo Generating Station shall be used first to meet the pumping requirements of the Central Arizona Project and after those needs have been met, for the desalting and protective pumping facilities constructed pursuant to title I of the Act, and finally for other uses: Provided further, That prior to obtaining power from the Navajo Generating Station under the authority of this subsection, the Secretary shall complete an analysis of alternative sources of supply, including but not limited to the possibility of developing an agreement with the Republic of Mexico whereby the United States (or a non-Federal entity) would enter into contractual arrangements with Mexico for a sufficient supply of power to operate the desalting plant, the regulatory pumping fields and appurtenant facilities.

“(C) Effective October 1, 1979, and to such extent and in such amounts as are provided in advance in appropriation Acts, the Secretary of the Interior is authorized to purchase supplemental power and energy as required for the purposes of supplying the power and energy requirements of the desalting plant and protective pumping well field.”. (94 Stat. 1065; 43 U.S.C. § 1571(b))
September 4, 1980

COLORADO RIVER BASIN SALINITY CONTROL

EXPLANATORY NOTE


Sec. 2. [Waters used for mitigation of habitat losses.]—Section 101(c) is amended by inserting "", Colorado River waters used for the mitigation of fish and wildlife habitat losses" after "from the desalting plant" in two places. (94 Stat. 1063; 43 U.S.C. § 1571(c))

Sec. 3. [Contract terms for water delivery from well field for municipal, industrial, or irrigation purposes—Acreage limitations not applicable to private lands.]—Section 109(a) of the Act is amended by adding a new subsection (4) as follows:

"(4) Effective October 1, 1979, and to such extent and in such amounts as are provided in advance in appropriation Acts, enter into contracts under the terms and conditions of the Act of June 17, 1902 (43 U.S.C. 371 et. seq.) as amended and supplemented for the delivery of water from said well field to entities within the United States for municipal and industrial or irrigation purposes: Provided, That such contracts for municipal and industrial purposes shall contain terms and conditions as substantially provided in section 9(c)(1) of the Reclamation Project Act of 1939, and that contracts for replacement irrigation water supplies to prevent damage to existing water users on privately developed lands include water charges no greater than if such water users had continued to pump their own wells without the United States lowering the water table and that the acreage limitation and related provisions of the Reclamation Law will not be applicable to such privately developed lands: Provided further, That no contract shall be entered which will impair the ability of the United States to continue to deliver to Mexico on the land boundary at San Luis and in the Limonite Section of the Colorado River downstream from Morelos Dam approximately one hundred and forty thousand acre-feet annually, consistent with the terms contained in Minute No. 242 of the IBWC." (94 Stat. 1064; 43 U.S.C. § 1573(a))

EXPLANATORY NOTE

Reference in the Text. Section 9(c)(1) of the Reclamation Project Act of 1939 (53 Stat. 1187, 1194; 43 U.S.C. § 485h(c)), referred to in the text, specifies the repayment provisions for fixed obligation contracts to furnish water for municipal water supply or miscellaneous purposes. The 1939 Act appears in Volume I at page 634.

Sec. 4. [Disposal of lands and facilities—Revenues credited to Treasury General Fund.]—A new section 106 shall be added to the Act, as follows, and succeeding sections shall be numbered accordingly:

"Sec. 106. The Secretary is hereby authorized to administer and dispose of lands and interests in lands acquired, and facilities constructed under this title, and revenues received in connection with this authority shall be credited to the general fund of the Treasury." (94 Stat. 1064; 49 U.S.C. § 1576)
APPENDIX A

September 4, 1980

3202   COLORADO RIVER BASIN SALINITY CONTROL

Sec. 5. [Increased authorization of appropriations—Implement improved desalinization techniques into plant design.].—Section 108 of the Act is changed to section 109 and effective October 1, 1979, is amended by striking the first sentence and inserting in lieu thereof: "There is hereby authorized to be appropriated the sum of $356,400,000 for the construction of the works and accomplishment of the purposes authorized in sections 101, 102, 103, and 110, of which $3,579,000 is authorized for mitigation of fish and wildlife losses associated with replacement of the Coachella Canal in California, and $6,960,000 is authorized for mitigation of fish and wildlife losses associated with the Desalting Complex Unit and the Protective and Regulatory Pumping Unit in Arizona, based on January 1979, prices plus or minus such amounts as may be justified by reason of ordinary fluctuation in construction costs involved therein, and such sums as may be required to operate and maintain such works and to provide for such modifications as may be made pursuant to section 104. In order to provide for the utilization of significant improvements in desalinization technologies which may have been developed since the Bureau's evaluation, the Secretary is directed to evaluate such cost effective improvements and implement such improved designs into the plant operations when the evaluation indicates that cost savings will result: Provided, however, That no more than five percent of the amount authorized to be appropriated is used for these purposes.'." (94 Stat. 1064; 43 U.S.C. § 1579)

Sec. 6. [Authorization of measures to mitigate loss of fish and wildlife habitat—Costs nonreimbursable.].—A new section 110 shall be added to the Act, as follows:

"Sec. 110. Effective October 1, 1979, and to such extent and in such amounts as are provided in advance in appropriate Acts, in order to provide measures determined by the Secretary of the Interior to be appropriate to mitigate loss of fish and wildlife habitat associated with other measures taken under this title:

"(a) The Secretary is authorized to—

"(1) acquire lands by purchase, eminent domain, or exchange;

"(2) dispose of land, facilities, and equipment;

"(3) construct, operate, maintain, and make replacements of facilities: Provided, however, That no funds will be provided for operation, maintenance, or replacement of non-Federal facilities.

"(b) All costs authorized by this section are nonreimbursable.". (94 Stat. 1065; 43 U.S.C. § 1579)

Sec. 7. [Definitions—Navajo Generating Station—Terms defined in Colorado River Compact.].—A new section 111 shall be added to the Act, as follows:

"Sec. 111. As used in this title:

"(a) Navajo Generating Station means—

"(1) the United States entitlement to a portion of the output of power and energy from the Navajo Generating Station, Page, Arizona, pursuant to United States participation in that generating station;"
SMALL RECLAMATION PROJECTS ACT  3203

"(2) in the event that said United States entitlement is integrated with other generating facilities, then Navajo Generating Station means that amount of power and energy from the integrated system which is attributable to the United States Navajo entitlement;

"(3) when the Navajo Generating Station is replaced at the end of its useful life or an alternative resource is established, then Navajo Generating Station means an amount of power and energy equivalent to the present United States entitlement from Navajo, from the replacement resource.

"(b) All terms used herein that are defined in the Colorado River Compact shall have the meanings therein defined.". (94 Stat. 1065; 43 U.S.C. § 1580)

Sec. 8. [Increase in appropriations authorized for Small Reclamation Projects Act—No interest on repayment of sums for portion of project providing benefits to U.S. facility.]—The Small Reclamation Projects Act of 1956 (70 Stat. 1044) as amended, is further amended as follows:

(a) Effective October 1, 1980, section 10, as amended, is further amended by deleting "$400,000,000" and inserting in lieu thereof the amount of "$600,000,000". (94 Stat. 1065; 43 U.S.C. § 422)

(b) Subsection (c) of section 5, as amended, is further amended by adding the following: "Except that portion of said allocation attributable to furnishing benefits to a facility operated by an agency of the United States, which portion shall bear no interest;". (94 Stat. 1065; 43 U.S.C. § 422c)

EXPLANATORY NOTES

Editor's Note. Annotations. Annotations of opinions relating to the Colorado River Basin Salinity Control Act are found under the Act of June 24, 1974 in Volume IV. Annotations of opinions relating to the Small Reclamation Projects Act are found in Volume I at pages 1352, 1356 and 1358, and in Supplement I under "August 6, 1956—Small Reclamation Projects Act."

INTERNATIONAL BOUNDARY AND WATER COMMISSION
UNITED STATES AND MEXICO

Mexico, D.F.,
August 30, 1973

MINUTE NO. 242

PERMANENT AND DEFINITIVE SOLUTION TO THE INTERNATIONAL PROBLEM
OF THE SALINITY OF THE COLORADO RIVER.

The Commission met at the Secretariat of Foreign Relations, at
Mexico, D.F., at 5:00 p.m. on August 30, 1973, pursuant to the instructions
received by the two Commissioners from their respective Governments, in order
to incorporate in a Minute of the Commission the joint recommendations which
were made to their respective Presidents by the Special Representative of
President Richard Nixon, Ambassador Herbert Brownell, and the Secretary of
Foreign Relations of Mexico, Lic. Emilio O. Rabasa, and which have been
approved by the Presidents, for a permanent and definitive solution of the
international problem of the salinity of the Colorado River, resulting from
the negotiations which they, and their technical and juridical advisers, held
in June, July and August of 1973, in compliance with the references to this
matter contained in the Joint Communiqué of Presidents Richard Nixon and Luis
Echeverria of June 17, 1972.

Accordingly, the Commission submits for the approval of the two
Governments the following

RESOLUTION:

1. Referring to the annual volume of Colorado River waters
   guaranteed to Mexico under the Treaty of 1944, of
   1,500,000 acre-feet (1,850,234,000 cubic meters):
   
   a) The United States shall adopt measures to assure that not
      earlier than January 1, 1974, and no later than July 1, 1974,
      the approximately 1,360,000 acre-feet (1,677,545,000 cubic
      meters) delivered to Mexico upstream of Morelos Dam, have an
      annual average salinity of no more than 115 p.p.m. ± 30 p.p.m.
      U.S. count (121 p.p.m. ± 30 p.p.m. Mexican count) over the
      annual average salinity of Colorado River waters which
      arrive at Imperial Dam, with the understanding that any
      waters that may be delivered to Mexico under the Treaty of
      1944 by means of the All American Canal shall be considered as
      having been delivered upstream of Morelos Dam for the purpose
      of computing this salinity.
   
   b) The United States will continue to deliver to Mexico on the
      land boundary at San Luis and in the limitrophe section of
      the Colorado River downstream from Morelos Dam approximately
      140,000 acre-feet (172,689,000 cubic meters) annually with a
      salinity substantially the same as that of the waters
      customarily delivered there.
   
   c) Any decrease in deliveries under point 1 (b) will be made up
      by an equal increase in deliveries under point 1 (a).
   
   d) Any other substantial changes in the aforementioned volumes
      of water at the stated locations must be agreed to by the
      commission.
e) Implementation of the measures referred to in point 1 (a) above is subject to the requirement in point 10 of the authorization of the necessary works.

2. The life of Minute No. 241 shall be terminated upon approval of the present Minute. From September 1, 1973, until the provisions of point 1 (a) become effective, the United States shall discharge to the Colorado River downstream from Morelos Dam volumes of drainage waters from the Wellton-Mohawk District at the annual rate of 118,000 acre-feet (145,551,000 cubic meters) and substitute therefor an equal volume of other waters to be discharged to the Colorado River above Morelos Dam; and pursuant to the decision of President Echeverria expressed in the Joint Communique of June 17, 1972, the United States shall discharge to the Colorado River downstream from Morelos Dam the drainage waters of the Wellton-Mohawk District that do not form a part of the understanding that this remaining volume will not be replaced by substitution waters. The Commission shall continue to account for the drainage waters discharged below Morelos Dam as part of those described in the provisions of Article 10 of the Water Treaty of February 3, 1944.

3. As a part of the measures referred to in point 1 (a), the United States shall extend in its territory the concrete-lined Wellton-Mohawk bypass drain from Morelos Dam to the Arizona-Sonora international boundary, and operate and maintain the portions of the Wellton-Mohawk bypass drain located in the United States.

4. To complete the drain referred to in point 3, Mexico, through the Commission and at the expense of the United States, shall construct, operate and maintain an extension of the concrete-lined bypass drain from the Arizona-Sonora international boundary to the Santa Clara Slough of a capacity of 353 cubic feet (10 cubic meters) per second. Mexico shall permit the United States to discharge through this drain to the Santa Clara Slough all or a portion of the Wellton-Mohawk drainage waters, the volumes of brine from such desalting operations in the United States as are carried out to implement the Resolution of this Minute, and any other volumes of brine which Mexico may agree to accept. It is understood that no radioactive material or nuclear wastes shall be discharged through this drain, and that the United States shall acquire no right to navigation, servitude or easement by reason of the existence of the drain, nor other legal rights, except as expressly provided in this point.

5. Pending the conclusion by the Governments of the United States and Mexico of a comprehensive agreement on groundwater in the border areas, each country shall limit pumping of groundwaters in its territory within five miles (eight kilometers) of the Arizona-Sonora boundary near San Luis to 160,000 acre-feet (197,358,000 cubic meters) annually.

6. With the objective of avoiding future problems, the United States and Mexico shall consult with each other prior to undertaking any new development of either the surface or the groundwater resources, or undertaking substantial modifications of present developments, in its own territory in the border area that might adversely affect the other country.

7. The United States will support efforts by Mexico to obtain appropriate financing on favorable terms for the improvement and rehabilitation of the Mexicali Valley. The United States will also provide non-reimbursable assistance on a basis mutually acceptable to both countries exclusively for those aspects of the
Mexican rehabilitation program of the Mexicali Valley relating to the salinity problem, including tile drainage. In order to comply with the above mentioned purposes, both countries will undertake negotiations as soon as possible.

8. The United States and Mexico shall recognize the undertakings and understandings contained in this Resolution as constituting the permanent and definitive solution of the salinity problem referred to in the Joint Communique of President Richard Nixon and President Luis Echeverria dated June 17, 1972.

9. The measures required to implement this Resolution shall be undertaken and completed at the earliest practical date.

10. This Minute is subject to the express approval of both Governments by exchange of Notes. It shall enter into force upon such approval; provided, however, that the provisions which are dependent for their implementation on the construction of works or on other measures which require expenditure of funds by the United States, shall become effective upon the notification by the United States to Mexico of the authorization by the United States Congress of said funds, which will be sought promptly.

Thereupon, the meeting adjourned.

Commissioner of the United States
Commissioner of Mexico
Secretary of the United States Section
Secretary of the Mexican Section
Note: The following list of possible solutions to the salinity problem was summarized from a report developed as a part of a presentation to the Governor's Commission on the Arizona Environment on March 31 and April 1, 1978. The report is entitled, "Colorado River Basin Salinity Control Project Status Report United States Department of the Interior Bureau of Reclamation Lower Colorado Region Governor's Commission on Arizona Environment Ad Hoc Committee on Water Salinity March 31-April 1, 1978 Mesa, Arizona."

Summary of Principal Options Considered

In the course of Mr. Brownell's investigation, numerous possible solutions to the salinity problem were considered, ranging from projects with immediate practicability to projects whose feasibility had not been fully demonstrated. It was felt that some of these options could be employed individually or in combination with others and, indeed, Mr. Brownell's report recommended an approach to the negotiations with Mexico that would combine several techniques. It was also visualized that any new agreement that might be negotiated with Mexico would include, among other things, some undertaking by the United States to deliver Colorado River water to Mexico above Morelos Dam with a prescribed annual average of salinity greater than the salinity of the Colorado River waters that arrive at Imperial Dam. Within this frame of reference, it would be the responsibility of the United States, by and large, to decide how it might fulfill any new obligations.

The principal solutions that were considered are summarized as follows:

1. Desalting Plant

Nine cases were considered in which a desalting plant might be employed to contribute to a long-term decrease in the salinity of the waters delivered to Mexico. The principal distinguishing features of the various desalting options relate to the locations, size, and capacities of the plants considered. In most of these cases, desalting all or part of the drainage from the Wellton-Mohawk Irrigation and Drainage District was considered. This stems from the basic premise that the high saline content of the drainage from the Wellton-Mohawk Irrigation District was the occasion and the singular most important factor in the eyes of Mexico in raising the salinity of the waters reaching Mexico during the 1960's. However, for purpose of comparison, several more ambitious and more costly desalting schemes also were reviewed, including two postulated plants for desalting seawater that would be located near the Mexican and California coasts, respectively, as well as plants that would
theoretically desalt the entire flows of the Colorado River, all of the drainage from the Palo Verde Irrigation District, or geothermal brines for augmentation of the Colorado River.

In general terms, all of the desalting plant options had the distinct advantage of conserving water resources and, as such, they held a special appeal for the Colorado River Basin states, given the scarcity of water in the general region. However, in all cases, desalting plants presented the special problem of arranging for a suitable disposal of the brine that is produced as a necessary part of the operation. Accordingly, various forms of brine disposal were analyzed from an environmental as well as economic standpoint and, on balancing the options, it appeared that disposal with Mexican consent via a drain to the Santa Clara Slough would be the most attractive alternative.

2. High Quality Substitute Water

Five cases were considered in which higher quality waters would be substituted for Wellton-Mohawk return flows. In all cases, Colorado River waters were the substitute supply, either directly or as available, due to water saving measures, including canal lining and exchange agreements. In most of these cases, the permanence of the solution became questionable as projections of future development were made and compared with allocations.

3. Changes in Operation of the Wellton-Mohawk District

Two cases considered partial and complete shutdown of the Wellton-Mohawk Irrigation and Drainage District. This would remove the impact of the drainage flows on the river salinity, but had serious financial, environmental, and human impacts.

4. Other Measures

Other cases considered included water quality controls above Imperial Dam, more efficient irrigation practices, flow augmentation, and even limiting future development in the Colorado River Basin. For the most part, legal and institutional problems posed serious doubt as to the practicality or permanence of most of these schemes.

5. Conclusion

It was recommended that a negotiated rather than an adjudicated solution be sought to the salinity problem with Mexico. The differences among legal and technical experts are so deep on a variety of questions relating to the problem that
resorting to adjudication would delay a solution for a prolonged period.

It was concluded from the results of the systematic and detailed study which the Task Force gave to the salinity problem that a permanent solution to the problem could not be achieved immediately or without significant costs in water or money or both. In a potentially over-allocated basin, solutions requiring significant expenditures of water were considered less favorable, and the Basin States advised that they would not accept any solution involving permanent loss of Colorado River Basin water resources. It was, and is, recognized that permanent bypass of Wellton-Mohawk (and some other) returns, made up by substitution of additional mainstream waters, would allow resolution of the salinity problem. However, this substitution would reduce extant supplies. The task force concluded that resolution of the Mexico salinity problem was a national obligation, to be borne by the Nation as a whole rather than by any specific segment. Therefore, the solution should involve the expenditure of funds rather than water, limiting the direct impact on the Basin States.
July 20, 1973

The President
The White House
Washington, D.C.

Dear Mr. President:

At your direction, the United States is currently seeking a bi-national agreement to end the long-standing dispute between ourselves and the Republic of Mexico over the salinity of the Colorado River.

While we generally applaud these proceedings and have every wish for their successful conclusion, we are seriously concerned that some of the possible terms of such an agreement could be quite detrimental to the basic water interests of the seven states in which the Colorado River Water Basin lies. We are particularly concerned that the negotiations may be conducted in a climate of urgency to accommodate domestic political considerations in Mexico relating to the salinity issue. In this atmosphere, we are fearful that concessions detrimental to the Colorado River Basin states might be made without the knowledge and consent of these states and their elected representatives.

Specifically, there are several key issues to which we hope Ambassador Brownell and his group will devote special efforts in order to protect the vital water interests of our states. These include, but are not limited to, the following:

1. We feel it essential that any agreement take into account Mexico's battery of wells near the Border which can pump and drain 160,000 acre feet of water per year from underground aquifers on the United States side of the international boundary. This water must be credited to the United States as deliveries under the Treaty with Mexico. If the Mexican pumping continues without proper credit for the United States, we must insist on some action, such as equal pumping on our side of the border, to protect our rights.
2. It would be impractical and counterproductive to adopt a fixed numerical differential in salinity levels between Imperial Dam, in California, and Morelos Dam, in Mexico. The objective sought can and should be achieved by other methods.

3. Any salinity control program for the lower Colorado River must go hand-in-hand with a complementary program to reduce the over-all salinity of the river, so that waters reaching Southwestern population centers will be of acceptable quality in the decades to come.

4. Since the United States-Mexico disagreement is one of long-standing between national governments, assurances must be given that the economic and water costs of fulfilling any agreement with Mexico shall not be borne by the water users, land owners, or the governments of the states of the Colorado River Basin. Also, the Federal Government should assume responsibility for the replacement of water consumed as desalting plant brine, removed from the Colorado River system by any canal which by-passes and discharges it outside the system, without credit therefor under the Treaty with Mexico.

5. The Treaty with Mexico was silent on the quality of water to be delivered. This was by design, and not by accident. Any agreement made which would be aimed at setting quality standards must make it clear that it comes as a result of a desire to be a good neighbor, and not from any legal or moral obligation.

6. There must be clear recognition of the rights of the Colorado River Basin states to continue to develop their water resources within the constraints of the "law of the River." We feel that it is time that the Federal Government also acknowledge its responsibility to proceed with augmentation of supplies of the Colorado River Basin, as directed by the Congress in the Colorado River Project Act, in an amount at least equal to the water deliveries to Mexico under the Treaty. We also feel that it is essential for the Government to proceed with the development of water projects previously authorized by Congress.
We respectfully request an appointment with you personally, so that we may discuss this matter in greater depth and answer any questions you may care to ask. We will make ourselves available, at your pleasure.

Yours Sincerely,

/s/ 
John J. Rhodes, M.C.

/s/ 
Paul J. Rannin, U.S.S.

/s/ 
John B. Conlan, M.C.

/s/ 
Morris K. Udall, M.C.

/s/ 
Sam Steiger, M.C.

/s/ 
Del Clawson, M.C.

/s/ 
Carlos J. Moorhead, M.C.

/s/ 
Andrew J. Hinshaw, M.C.

/s/ 
James P. Johnson, M.C.

/s/ 
Donald G. Brotzman, M.C.

/s/ 
Gunn McKay, M.C.

/s/ 
Frank E. Moss, U.S.S.

/s/ 
Barry Goldwater, U.S.S.

/s/ 
Gale W. McGee, U.S.S.

/s/ 
Frank E. Evans, M.C.

/s/ 
Jerry L. Pettis, M.C.

/s/ 
Harold Runnels, M.C.

/s/ 
Chet Holifield, M.C.

/s/ 
William L. Armstrong, M.C.

/s/ 
Harold T. Johnson, M.C.
The President
July 20, 1973

/s/ David Powell, M.C.

/s/ Don Clausen, M.C.

/s/ Charles H. Wilson, M.C.

/s/ Floyd K. Haskell, U.S.S.

/s/ Bob Wilson, M.C.

/s/ Barry Goldwater, Jr., M.C.

/s/ Richard T. Hanna, M.C.

/s/ John H. Rousselot, M.C.

/s/ Craig Hosmer, M.C.

/s/ Victor V. Veysey, M.C.

/s/ William M. Ketchum, M.C.

/s/ Peter V. Domenici, U.S.S.

/s/ Clifford P. Hansen, U.S.S.

/s/ Wallace F. Bennett, U.S.S.

/s/ Peter H. Dominick, U.S.S.

/s/ Joseph M. Montoya, U.S.S.

/s/ Clair W. Burgener, M.C.

/s/ Charles E. Wiggins, M.C.

/s/ Manuel Lujan, Jr., M.C.

/s/ Yvonne Brathwaite Burke, M.C.

/s/ Lionel Van Deerlin, M.C.

/s/ Wayne Owens, M.C.

/s/ Alphonzo Bell, M.C.

/s/ Patricia Schroeder, M.C.

/s/ Glenn M. Anderson, M.C.

/s/ Frank E. Evans, M.C.

/s/ Teno Roncalio, M.C.
President
July 20, 1973

/s/
John V. Tunney, U.S.S.

/s/
Howard H. Cannon, U.S.S.

/s/
Alan Cranston, U.S.S.

/s/
Alan Bible, U.S.S.

/s/
Floyd K. Haskell, U.S.S.