Report to the Congress
THE YUMA DESALTING PLANT AND OTHER ACTIONS TO ADDRESS ALTERNATIVES
Colorado River Basin Salinity Control Act, Title I
August 2005

EXECUTIVE SUMMARY

Background

The Mexican Water Treaty of 1944 requires the United States to annually deliver 1.5 million acre-feet of Colorado River water to Mexico, absent Treaty surplus or shortage conditions. Subsequent to 1944, the quality of that water became a contentious issue, particularly after the Wellton-Mohawk Irrigation and Drainage District began discharging saline groundwater (and return flows) to the Colorado River above Morelos Dam, Mexico's primary diversion point. After Mexico protested the resulting high salinity in Colorado River water delivered to them, the United States began a process to address Mexico's concerns. That process culminated in passage of the Colorado River Basin Salinity Control Act of June 24, 1974, Public Law 93-320 (hereinafter the "Salinity Control Act"). The Salinity Control Act anticipated redirecting the brackish Wellton-Mohawk Irrigation and Drainage District drainage water from the Colorado River (where it had been counted as part of Mexico's treaty allotment) to the Cienega de Santa Clara (Cienega) in Mexico (where it is not counted as part of the treaty amount), replacing those flows for an "interim period" with water saved from lining 49 miles of the Coachella Canal, and ultimately recovering the bypass flows by operation of the Yuma Desalting Plant (Plant) when the "interim period" is over. The Bypass Drain, which discharges Wellton-Mohawk drainage flow into the Cienega, and the Coachella Canal lining have been constructed and are in operation. The Plant has been constructed, but has never operated at full capacity. During a 9-month period in 1992/1993 it operated at one-third capacity. See Figure 1 for a map of features constructed under the Salinity Control Act.

Increases in water demand in each of the three lower Basin states has intensified the need for more efficient water management of the Colorado River system. This, coupled with the effects of a prolonged drought over the entire Colorado River Basin, has increased interest in replacing and/or recovering bypass flows to Mexico in order to conserve storage in the Colorado River reservoirs.

Operation of the Plant as originally authorized under the Salinity Control Act would recover some, but not all, of the bypass flow. Depending upon final operational efficiency, about 75 percent of the Bypass Drain flow would become Plant product water at a good enough quality to be delivered to Mexico and counted as part of Mexico's Treaty allocation, while 25 percent would be high salinity Plant reject discharge that would still be bypassed and would have to be replaced in accordance with the Salinity

Control Act. Costs for Plant start-up and operation, however, would require a significant investment. Congressional authorization in Section 104 of the Salinity Control Act that authorizes the Secretary to meet "the international settlement objectives" with Mexico "at the lowest overall cost to the United States" provides the statutory basis for seeking cost saving opportunities.

There are also other issues that have been raised regarding Plant operations. For example, flows in the Bypass Drain, averaging over 100,000 acre-feet a year since 1977, have enhanced a 14,000-acre wetland when discharged to a depression in Mexico that previously contained perhaps 500 acres of marsh and open water. This wetland, the Cienega de Santa Clara, is an area that now provides habitat for endangered species and migratory birds and is currently supported primarily by bypass flows.

Status of the Yuma Desalting Plant—Since the short, partial-capacity operation in 1992 and 1993, the Plant has been maintained in a "ready-reserve" status. Preventative maintenance is performed and repairs are made so that the Plant's condition does not decline. A number of technical design deficiencies were identified both during the limited operation in the 1990s and in subsequent studies. While six of the 18 identified deficiencies have been resolved, the remaining 12 would need to be addressed prior to Plant operation. In addition to correcting the design deficiencies, all mechanical and electrical equipment would require testing and, as needed, repair prior to Plant start-up. Instrumentation would require testing and calibration and a new set of reverse osmosis membranes would be required. While no determination of environmental compliance requirements has been made, there may be some environmental activities necessary prior to Plant operation.

Costs Associated With the Yuma Desalting Plant—Maintaining the current "ready-reserve" status costs approximately $4.4 million a year. Full operation of the Plant would require correcting all design deficiencies, purchase of additional membranes, and testing and repair of equipment. Correction of all remaining design deficiencies is estimated to take four years at a cost of about $15,000,000. Purchase of membranes would cost an estimated $9,000,000 and additional equipment required for start-up cost is estimated at $2,200,000. Total start-up costs for full capacity operation, then, are estimated at about $26,200,000 over a four-year period, not counting any environmental costs. A significant area of cost uncertainty is related to the aluminum bronze piping that was used extensively throughout the Plant, but that has been shown to have some problems under certain operational conditions. An in-depth assessment is currently underway and, depending upon the results of that assessment, costs in addition to those given here could be required to replace the piping.

In addition to the Plant start-up costs, significant costs are required for Plant operation and maintenance. Current estimates indicate a range of between $23.6 and $28.8 million in annual costs for full capacity operations. These operational costs alone, without including the capital investment for construction or start-up, are equivalent to a unit cost range of $307 to $482 per acre-foot of water returned to the Colorado River. While operation at less than full capacity would result in less operation and maintenance cost,

the unit cost of water would go up because the reduction in cost is not proportional to the reduction in water production.

Alternatives For Bypass Flow Replacement or Recovery
The Plant start-up expense, time required to prepare the Plant for operation, the high cost of Plant operation, and the potential for impacts of Plant operation on the Cienega led Reclamation and others to look for interim or supplemental methods of recovering or replacing the bypass flows.

For example, Reclamation has proposed a two-year demonstration of the concept of forbearance. Under this concept, in exchange for cash payment, holders of contracts for Colorado River water could agree to temporarily fallow a certain portion of land and not divert water that would normally be used for irrigation on that land for the limited time period of the agreement. It is estimated that water obtained through forbearance agreements could be obtained at costs in the $60 to $150 an acre-foot range.

Other concepts for replacing bypass flows include using local groundwater for Plant feedwater and either returning the product to the Colorado River or delivering it to local communities for domestic use, developing additional regulatory storage on the lower Colorado River to reduce or eliminate excess flows to Mexico, augmenting Colorado River flow by various methods, water exchanges, paying water users for implementing extraordinary water conservation measures, or seeking opportunities for cooperative activities with Mexico that would address bypass flow issues. More study would be required on these concepts to evaluate cost, legal, institutional, environmental, administrative, and other factors.

Next Steps
In order to identify the best approach for recovery or replacement of bypass flows at the lowest possible cost, Reclamation plans to:

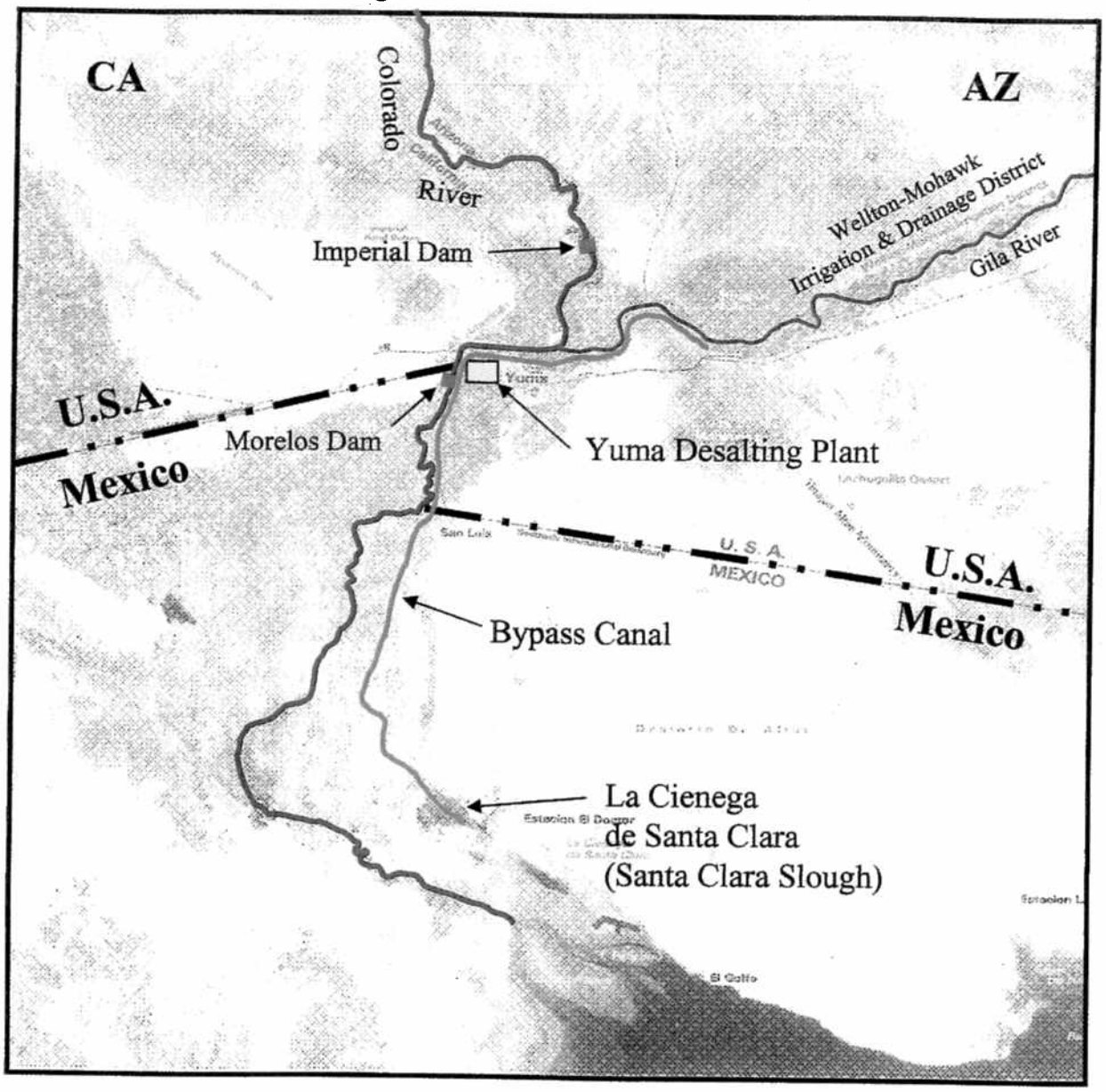
1. Begin a public process for identifying and evaluating options for replacing or recovering bypass flow to Mexico.

2. Maintain the Plant in a "ready-reserve" status and continue correcting design deficiencies.

3. Initiate a demonstration program to determine the viability of paying holders of Colorado River water delivery contracts to temporarily forbear use of water.

It is anticipated that the outcome of one, or a combination, of these items will lead to an action that will meet the competing needs associated with bypass flows to Mexico.

Figure 1. Yuma Desalting Plant and Associated Features



REPORT PURPOSE

On several occasions Congress has requested that Reclamation provide information on the Yuma Desalting Plant. In the most recent request, the Conference Report which accompanied the Fiscal Year 2004 Energy and Water Appropriations Act (P.L. 108-137) states that in light of current water supply concerns on the Colorado River the Bureau of Reclamation is directed:

> ". . . . to expedite its modifications of the plant and accomplish state of the art operation, and accelerate the permitting and environmental compliance activities needed for operation of the plant. The Bureau of Reclamation is directed to report to the House and Senate Committee on Appropriations on the status of those activities within 180 days of enactment of this Act." (H. Rep. No. 108-357, at 118-19 (2003)).

While this report is transmitted to Congress in response to that request, it is an informational status report and does not represent any formal findings or conclusions on behalf of the Department of the Interior regarding operation of the Yuma Desalting Plant, or the precise costs associated with achieving "state of the art operation" of the Plant.

Concerns with the impact of Plant operation on both the Federal budget and the environment have created an interest in consideration of possible alternatives to operation of the Plant as envisioned in its authorizing legislation. Using the results of a local *ad hoc* group that addressed these issues, as well as other sources, a number of conceptual possibilities have been identified. This report is one component of a process to document these possibilities and provide information on Plant status. While this report is not intended to go into any detail on these possibilities, it presents the conceptual ideas and provides a strategy for more detailed consideration. Future reports will document results of further studies and additional work on the Plant.

BACKGROUND

The Mexican Water Treaty of February 3, 1944 requires delivery of 1.5 million acre-feet of water per year to Mexico from the Colorado River (absent treaty surplus or treaty shortage conditions), but it contained no quality requirements for that water. The salinity level of water delivered to Mexico was similar to water delivered to the United States users in the lower reaches of the River until the late 1950s when the Wellton-Mohawk Irrigation and Drainage District began discharging drainage water to the Colorado River. By using the Gila River for conveyance, this water was discharged into the Colorado River between Imperial Dam—the point of diversion for United States users—and Morelos Dam—the primary point of diversion for users in Mexico. As a result of the high salinity levels contained in this drainage water, in combination with a reduction in excess Colorado River flows Mexico had received prior to 1961, Mexico claimed agricultural damages and in November 1961 lodged a formal protest with the United States.

In response to Mexico's protest, the United States undertook practical measures relative to Wellton-Mohawk drainage and Colorado River management that reduced the salinity of waters reaching Mexico. To establish a permanent level of salinity of water delivered to Mexico, Minute No. 242 of the Treaty of 1944 was negotiated and executed by the United States and Mexico Sections of the International Boundary and Water Commission in 1973. Minute No. 242 specifies that water delivered to Mexico be no greater than 115 parts per million, plus or minus 30 parts per million, over the average annual salinity concentration of the Colorado River water at Imperial Dam. Among other provisions, the Salinity Control Act authorized the construction of facilities near Yuma, Arizona that would allow treatment of saline return flows from Wellton-Mohawk, enabling such flows to be delivered to Mexico within the agreed-upon salinity levels.

One of the facilities authorized by the Salinity Control Act was a Bypass Drain (Figure 1) that could be used to transport either untreated drainage water from the Wellton-Mohawk Irrigation and Drainage District or concentrated wastewater from the Plant's desalting process (reject stream) to the Cienega de Santa Clara (Cienega). Bypassing Wellton-Mohawk drainage water (i.e., not returning the drainage water to the Colorado River, but discharging it to the Cienega in Mexico) currently allows the United States to meet the Minute No. 242 salinity requirements. In accordance with Minute 242, water discharged to the Cienega has not been counted as part of the annual treaty deliveries to Mexico.

Another facility authorized by the Salinity Control Act was the Yuma Desalting Plant. The Plant was designed to reduce the salinity of the Wellton-Mohawk drainage water so that approximately 71,000 to 85,000 acre-feet of the average amount of 109,000 acre-feet per year of drainage water could be included as a portion of the 1,500,000 acre-feet per year Mexican treaty allocation without violating the salinity standards of Minute 242. Completed in 1991, the Plant only operated for a 9-month period in 1992 and 1993 at one-third of its full 73 million gallons per day capacity.

Through 2003, the water supply impacts of the bypassed water have been offset by the use of water saved by lining the first 49 miles of the Coachella Canal, another project authorized by the Salinity Control Act. Section 102(a) of the Salinity Control Act provides that this water supply offset ends the first year that the Secretary delivers less mainstem Colorado River water to California than requested by California agencies under contracts made pursuant to section 5 of the Boulder Canyon Project Act.

Section 101(c) of the Salinity Control Act provides that the "replacement of the reject stream from the desalting plant" and bypass water is "recognized as a national obligation, as provided in section 202 of the Colorado River Basin Project Act." Section 202 of the Colorado River Basin Project Act specifically linked this "national obligation" to augmentation of the Colorado River, which has not yet occurred. Congress further provided in section 101(c) of the Salinity Control Act that: "Measures found necessary to replace the reject stream from the desalting plant, Colorado River waters used for the mitigation of fish and wildlife habitat losses, and any Wellton-Mohawk drainage bypassed to the Santa Clara Slough [Cienega] to accomplish essential operations may be

undertaken independently of the national obligation set forth in section 202 of the Colorado River Basin Project Act." Section 104 of the Salinity Control Act provides that "the Secretary is authorized to provide for modifications of the projects authorized by this title to the extent [s]he determines appropriate for purposes of meeting the international settlement of this title at the lowest overall cost to the United States."

Currently, water bypassed to the Cienega requires releases of a like amount of system water from Colorado River storage. Full use of each of the three Lower Basin States' Colorado River apportionments (along with full use by Mexico of its Treaty apportionment) coupled with the recent period of drought in the Colorado River watershed is heightening concerns among the Basin States about the effects of the continued bypass on water storage, because a reduction in storage increases the risk of future shortages.

As pointed out earlier, the Colorado River Basin Salinity Control Act of June 24, 1974, Public Law 93-320, provided the Secretary of the Interior with certain authorities to control the salinity of the Colorado River. Title I of the Salinity Control Act authorized actions "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 242 of the International Boundary and Water Commission, United States and Mexico)." Salinity Control Act of 1974 at § 101(a). Under authorization of the Act, the Bureau of Reclamation constructed a Bypass Drain, the Yuma Desalting Plant (Plant), and other associated facilities, as shown in Figure 1.

For a 9-month period in 1992 and 1993, Reclamation operated the Plant in order to determine whether it would perform as designed. The Plant was operated at one-third capacity, but the test was cut short before full operation was achieved because flood flows on the Gila River damaged the intake canal. The Plant has not been operated since. Salinity control obligations have subsequently been met by using the Bypass Drain to convey saline agricultural drainage water to the Cienega, a topographical depression just north of the Gulf of California in Mexico, rather than discharging it to the Colorado River. Increasing water demands in the Colorado River Basin have raised concerns over the continued discharge of water to Mexico in addition to the delivery of 1,500,000 acre-feet released annually under the Treaty of 1944. These concerns involve both discharges to the Cienega and operational over-deliveries on the main stem of the Colorado River. Prolonged and severe drought in the Colorado River basin has further exacerbated concerns. These concerns have contributed to renewed interest in proceeding with Plant operation as a way of recovering a large portion of the water that is now being bypassed to Mexico (approximately 109,000 acre-feet annually, although this number is highly variable, based on actual farming and water management operations).

High projected costs of Plant operation and potential environmental impacts at the Cienega, however, have created concerns about Plant operation and a desire to seek other ways of recovery or replacement of the bypass flow.

CURRENT STATUS OF THE YUMA DESALTING PLANT

Current Maintenance

Subsequent to the short, partial-capacity operation in 1992 and 1993, the Plant has been maintained in a "ready-reserve" status. In this status, preventative maintenance is performed and any needed repairs are made so that the Plant's condition does not decline. It costs approximately $4.4 million per year to maintain this status.

Independent Assessment of Requirements for Operation

During the Plant's limited operation in the early 1990s, a number of technical deficiencies were identified. Since then, additional problems have emerged that would require correction prior to full Plant operation. In 2002, Reclamation commissioned an independent assessment to document the state of Plant readiness, identify design deficiencies, detail remedial action that would have to be taken prior to restarting the Plant, provide current cost estimates for the restart, and update estimates for the ongoing cost to operate the Plant. The Yuma Desalting Plant Readiness Assessment Report was delivered to Reclamation in September 2002. As part of a continuing process to keep information current, Reclamation recently contracted with the consulting group that worked on the original Readiness Assessment Report to update the assessment. That update was documented in an April 2004 report.

Key findings from the 2002 Yuma Desalting Plant Readiness Assessment included:

- While the Plant did run at partial capacity in 1992-93, it never achieved a fully operational status. Numerous design deficiencies have been identified that would have to be addressed prior to Plant operation.

- At the time of shutdown in 1993, engineers were still engaged in identifying and resolving design deficiencies. This creates a level of uncertainty about whether additional design problems might be identified once the plant runs again for some period of time.

- Both bringing the Plant to operational status and ongoing Plant operation would require significant financial expenditures.

In order to bring the Plant up to full operational status, the 2002 Readiness Assessment Report indicated that attention would have to be given to three major areas of interest:

- **Environmental Process**. The 2002 Report identifies certain environmental permitting activities and cost estimates for completion of such activities. For example, the 2002 Report identifies activities related to the Clean Water Act and the National Environmental Policy Act and includes an estimate that such activities would take two years and cost $1,600,000 to complete (see also Table 1, below). The report notes that "since the time the plant last operated, the nature and focus of environmental oversight has changed considerably." Presumably, this refers, in part, to environmental litigation over the past decade on certain

lower Colorado River activities and the increased attention to issues associated with the Colorado River Delta in Mexico. Likewise, the 2004 House Report requiring preparation of this report to Congress also referred to "environmental compliance activities needed for operation of the plant." As of the date of this report to Congress, neither the Department of the Interior nor Reclamation has made any final determinations of what further environmental compliance activities, if any, are required prior to restarting the Plant. In light of this position, references to permits and environmental impact studies identified in the Readiness Assessment Report (and similar references shown in Table 1 below) are presented here for informational purposes only. With respect to "environmental compliance" on Plant operations, it is important to note that there is not a consensus among the various interested stakeholder groups on what level, if any, of environmental analysis is required prior to plant operation. In recent years, particular focus of many non-governmental groups has been directed at potential impacts of Plant operation on wetlands habitat in the Cienega de Santa Clara in Mexico. The emergence of habitat in the Cienega has been linked to bypass flows during past decades. It is presumed that, absent other arrangements, this area would be impacted if the bypass flow is processed by the Plant and returned to the Colorado River.

- **Equipment Startup Costs**: In order to reactivate the Plant, all mechanical and electrical equipment, such as valves and pumps, would require testing and, as needed, repair. Wear parts, such as packing and belts, would have to be reinstalled on equipment. Instrumentation would require testing and calibration. A new set of reverse osmosis membranes would also be required. While there are sufficient membranes on site to support one-third capacity operations for a short time, additional membranes would be required to reach and sustain full capacity operations. This task is estimated to take four years to complete at an estimated cost of $11.2 million, of which over $9 million would be required for membranes.

- **Design Deficiencies**: Of the 18 deficiencies identified in the 2002 assessment report or thereafter, six have been remedied and twelve still require resolution—seven of them prior to commencing one-third capacity operations. Correcting all known deficiencies is estimated to require four years and cost an estimated $15,014,000. It must be recognized, however, that as each deficiency moves through its project life cycle from scoping and preliminary estimating to design, specification, and construction, cost estimates could change to reflect adjustments to deficiency remediation requirements.

Table 1 illustrates the current estimates regarding tasks and costs required for reaching full capacity Plant operation by the end of four years. In this projection, one-third capacity operation would be achieved by the end of the second year and two-thirds capacity operation by the end of the third year.

Operational Expense

In addition to the identified one-time Plant start up costs shown in Table 1, significant funding would also be required for actual Plant operations and maintenance. An estimated cost range was developed due to uncertainties in some operational factors, such as membrane efficiency and Plant reliability. Current estimates show a range of between $23.6 and $28.8 million in annual recurring costs to operate and maintain the Plant for full capacity operations, once the Plant is restarted. This range of operational costs is equivalent to a unit cost range of $307 to $482 per acre-foot of water returned to the Colorado River. The estimated range of costs for one-third capacity operations is $12.9 to $16.5 million per year, or $428 to $684 per acre-foot. For two-thirds capacity

Table 1. Estimated Costs and Timeframe for Yuma Desalting Plant Startup Once a Decision is Made to Begin Operation

	Year 1	Year 2	Year 3	Year 4	Total
Environmental Process	**700,000**	**900,000**			**1,600,000**
Equipment Startup Costs (including new membranes)	**600,000**	**3,600,000**	**3,500,000**	**3,500,000**	**11,200,000**
Design Deficiencies Remaining					
- Replace high pressure pumps	862,500	862,500	1,500,000	1,535,000	
- Construct third sludge disposal stage				4,170,000	
- Replace control block valves & actuators	830,000	830,000			
- Replace plant ammonia system			900,000		
- Replace failed piping	375,000	375,000			
- Replace plant silt density index equipment			330,000		
- Replace silt density index equipment in Water Quality Improvement Center			270,000		
- Install blend system	130,000	130,000			
- Upgrade plant air system	112,000	112,000			
- Install chlorine containment system	450,000	450,000			
- Access and repair solids contact reactor				390,000	
- Upgrade plant chlorination system				400,000	
Total Design Deficiencies	**2,759,500**	**2,759,500**	**3,000,000**	**6,495,000**	**15,014,000**
Total Start-Up Costs[1]	**4,059,500**	**7,259,500**	**6,500,000**	**9,995,000**	**27,814,000**

[1] In addition to start-up costs, recurring operation and maintenance costs are estimated at $23.6 to $28.8 million annually.

operations, the estimated range is $19.8 to $24.6 million annually, or $323 to $506 per acre-foot. It should be noted that these unit costs reflect operation cost only and do not include amortization of capital expenditure for construction or start-up.

Operation and maintenance costs include estimated funding required for equipment renewal and replacement of components as they wear out during Plant operations. Estimating these costs was challenging, due to uncertainty inherent in projected Plant operations. The Plant is the largest of its kind in the world and has only operated at partial capacity for nine months since its completion 12 years ago.

The largest single uncertainty associated with the plant is its aluminum bronze piping. Estimates developed in 2002 and 2003 predict an average 10-year remaining service life for those components. However, estimates vary widely for individual pipe segments throughout the Plant, depending on the specific conditions to which each pipe segment is exposed. Several of the design deficiencies include this piping issue, but addressing the design deficiencies would not completely eliminate the issue. An in-depth technical assessment of the Plant's aluminum bronze piping is underway and scheduled for completion in calendar year 2005. Depending upon the outcome of that assessment, costs could be significant and those increased costs are not currently included in any of the estimates presented in this report.

Reclamation Action to Prepare Plant for Operation

Over the past several years, Reclamation has been engaged in addressing the design deficiencies, as well as maintaining the Plant in a readiness state. Six of the 18 deficiencies identified since 2002 have been resolved at a cost of about $760,000. An additional $867,000 has been spent since fiscal year 2003 to partially address the remaining design deficiencies.

In addition to Reclamation's work associated with design deficiencies, the Plant maintenance program has improved markedly since October 2002. On-site Plant quality assurance activities have increased and continue to be improved, as documented in the 2004 assessment report. Reclamation has provided increasing expenditures for maintenance activities associated with Plant readiness.

ADDITIONAL OPERATIONAL CONSIDERATIONS

Operation of the Plant would not result in recovering all of the bypass water. The reverse osmosis process used in the Plant would recover between approximately 71,000 and 85,000 acre-feet per year of the total 109,000 acre-feet per year that on average arrives at the Plant and is currently being bypassed. The remaining approximately 24,000 to 38,000 acre-feet per year comes out of the Plant process as "reject" water. It is anticipated that this "reject" water, at a salinity of about 11,000 mg/l[1], would be added to

[1] The Bypass Drain currently conveys Wellton-Mohawk drainage flow, which has a salinity concentration of about 3,000 mg/l. As a comparison, ocean water has a salinity of about 35,000 mg/l and Colorado River water at Imperial Dam has a salinity of 700 – 800 mg/l.

other flow in the Bypass Drain and would not be counted as part of Mexico's 1,500,000 acre-feet per year Treaty amount. Section 101(c) of the Salinity Control Act provides that replacement of this water is a national obligation as provided in section 202 of the Colorado River Basin Project Act of 1968. As noted previously, Section 202 of the Colorado River Basin Project Act linked this "national obligation" to augmentation of the Colorado River, which has not yet occurred. With the Plant in full operation, a source of "replacement" (or "make-up") water would have to be found for the reject stream in order to minimize or eliminate impacts on Colorado River system storage.

Even with a fully operational Plant, a supplemental source of water is required to accommodate scheduled maintenance and unscheduled down times and to serve as a source of replacement for the "reject" stream. During times when the Plant is not fully operational, drainage flows from Wellton-Mohawk would bypass the Plant and, consistent with current practice, would presumably not be counted as part of Mexico's Treaty obligation.

Supplemental sources of water that could be used to make up for Plant "reject", as well as during periods of Plant down time, may be found among the possibilities cited below.

POSSIBLE ALTERNATIVES FOR BYPASS FLOW REPLACEMENT OR RECOVERY

For many years, there has been a recognition that natural flow in the Colorado River may not be enough to meet the demands on the Colorado River system. Ideas for increasing flow were either never attempted or results were unfavorable. In those days the threat of shortages was theoretical—everyone was getting all the water they needed and reservoirs were full or filling. Today, full usage in the lower Colorado River Basin and the recent period of multi-year drought has brought recognition that allowing the bypass flows to continue to be lost may not be in the best interest of those that rely on the waters of the Colorado River Basin.

But where once it was assumed that these conditions would initiate the startup of the Plant to recover those flows, current financial and environmental conditions now make that problematic. The anticipated Plant startup expense, the time required to modify and prepare the Plant for full operation, the high cost of Plant operation, and the potential for international concern with altering the bypass flow to the Cienega are some of the reasons why some groups have looked at alternative methods of recovering or replacing bypass flows.

Recognizing the significance of the issues involved in beginning Plant operation, Sid Wilson, General Manager of the Central Arizona Water Conservation District, recently organized an *ad hoc* group of people representing various interests in the lower Colorado River to try to identify multiple possibilities for addressing the problem. Primary considerations the group used to formulate alternatives were minimizing the risk of shortage to Colorado River water users in the Lower Basin; minimizing cost; minimizing

environmental impacts, particularly at the Cienega; and compliance with treaties, laws, and contracts. The group published the results of their work in "Balancing Water Needs on the Lower Colorado River: Recommendations of the Yuma Desalting Plant/Cienega de Santa Clara Workgroup", April 22, 2005.

The following list of possible alternatives comes from a variety of sources, including the work of the Workgroup. Most are conceptual in nature; no detailed analyses of operation, cost, or impacts have been made. So, additional study and, at least in one case, demonstration will be necessary before they can be recommended for implementation. They may, however, hold promise to meet the requirements set by the Workgroup.

Forbearance

Forbearance, as a method of replacing the bypass flow, is an idea that has never been tested. While the concept seems rather straightforward, there are a number of administrative details that would have to be developed and agreed upon before it could be considered a viable potential alternative.

Currently, about 5 million acre-feet of water per year is delivered to agricultural users in the two states of Arizona and California alone. Water conservation or land fallowing agreements to temporarily forbear irrigation that would yield approximately two percent of that amount would provide adequate water to replace the full amount of water being bypassed into Mexico.

Because of the extremely large flow available to work from, implementation of temporary voluntary forbearance agreements with farmers or water districts may be one of the most promising methods of providing replacement water as an alternative to operation of the Plant. Under this approach, Reclamation would pay a district to voluntarily forbear a portion of its approved annual projected use of Colorado River water for a year, thereby leaving the water in the Colorado River system storage in Lake Mead. This water, then, would be considered as a "replacement" for the water bypassed to Mexico.

Policy would be developed that considers local effects, addresses establishment of the quantity of water that had been forgone, identifies eligibility requirements, and protects holders of lower priority rights on the Colorado River in the United States.

It is anticipated that about 20,000 acres would have to be fallowed in order to fully offset water bypassed to the Cienega. As noted above, this constitutes less than two percent of the total irrigated acreage on the lower Colorado River.

Based on previous water transfer arrangements and a recent solicitation of water through a demonstration program, it is estimated that water obtained with forbearance agreements can be acquired at costs in the range of $60 to $150 an acre-foot, for an estimated total annual cost ranging from approximately $6.5 million to $16 million.

Groundwater
Local irrigation districts estimate that an additional 90,000 acre-feet could be pumped every year from the local groundwater without causing any adverse impacts. In addition, groundwater in the vicinity of the Mexican border has a hydraulic gradient sloping toward Mexico due, in part, it is believed, to high rates of groundwater pumping in Mexico. This results in significant amounts of water flowing underground from the United States into Mexico that is not counted as part of Mexico's treaty deliveries. Additional groundwater pumping in the Yuma area, then, would recover some of the water now going to Mexico and would contribute to the current efforts to keep groundwater elevations from rising too high.

Depending upon its quality and use, at least a portion of the recovered groundwater could be returned directly to the Colorado River to be used as replacement for bypass water, or the Plant could be used to treat the water so it could be provided to local (including Mexican) municipalities for domestic use. Use of this treated water would significantly improve the quality of water municipalities deliver to customers, providing a benefit that could result in repayment of some of the costs.

In order to pursue this possibility, additional technical work would be required, particularly in the area of aquifer characterization and model verification. It would take several years to collect the appropriate data and develop predictions of anticipated pumping results that have the concurrence of all the stakeholders. Costs, including wells/pumps/motors, energy, conveyance, and maintenance, would be relatively inexpensive on an acre-foot basis. However, cost would be significantly higher if groundwater was treated by the Plant and delivered to local municipalities for domestic use.

Excess Flows to Mexico
Flows to Mexico in excess of their orders occasionally occur because there are times when water delivery orders in the United States are reduced after releases have already been made past the last control point. Additional regulation on the lower end of the Colorado River would eliminate or greatly reduce these excess flows to Mexico.

While the volume of excess flows to Mexico varies greatly, depending upon hydrologic conditions, the long-term annual average is greater than 50,000 acre feet. Construction of physical works necessary to control and salvage these flows, could allow this water to be used as bypass flow replacement. Preliminary studies of the construction of regulating reservoirs for control of excess flow to Mexico indicate that costs of salvaged water could be less than $100 an acre-foot.

Other Possibilities
Other concepts that have been suggested include importation of water into the Colorado River basin through water exchanges, implementing advanced irrigation techniques to conserve water, weather modification, vegetation management, and negotiations with Mexico. Ideas presented in this section are for information only; much more study would have to go into how they would work and at what cost. Some may also have legal,

institutional, environmental, authority, and administrative issues that could make their implementation complex.

A brief explanation of these possibilities is provided below.

- An example of exchanges would be the possibility of Reclamation paying for, and participating in, coordinated use of supply projects and/or options in areas experiencing high water supply years and exchanging those waters for Colorado River water.

- Reclamation could pay farmers or water districts to implement advanced, extraordinary irrigation techniques that result in water savings. These savings could then be used as replacement for bypass flows. Increasing irrigation efficiencies through installation of system improvements, such as ditch lining, automated control equipment, sprinkler systems, bubbler systems, regulatory storage, and spill interception are some examples of techniques that could be considered.

- The Colorado River Basin Project Act of 1968, particularly Sec. 202 and Sec. 306, authorized the study and implementation of measures to augment and salvage Colorado River flows. While some investigation was made into possibilities for augmentation of the Colorado River through vegetation management and weather modification, no projects were ever implemented and no augmentation has occurred.

Finally, there may be opportunities for bi-national actions that could be implemented in cooperation with Mexico that resolve some of the issues with bypass flows. The International Boundary and Water Commission and Department of State would need to participate in the pursuit of those opportunities. One of the possibilities that could be considered would be the improvement and re-configuration of drainage facilities in the San Luis or Mexicali valleys so that agricultural drainage water could be delivered to the Cienega in place of flow in the Bypass Drain. No specific proposals for improvements or configuration have been considered, so no costs have been estimated.

NEXT STEPS

The topic of bypass flows has created calls for various types of action that may be in tension with one-another. Some call for the operation of the Plant in order to recover most of the bypass water. Others point out the impacts to the Cienega that could occur if the Plant is operated. In addition, Congress recognized the importance of the cost of recovering the bypass flow by including language in The Salinity Control Act that encourages the consideration of modifications of projects authorized by the Act in order to provide the "lowest overall cost to the United States". In order to try to accommodate each of these considerations, Reclamation plans to take action on three different fronts.

- Reclamation will continue to maintain the Plant in a "ready-reserve" status and correct design deficiencies as funds become available. With adequate funding (at

levels shown in this report), the Yuma Desalting Plant could be ready for long-term operation within 4 to 5 years.

- Recognizing the unique character of the forbearance concept and its sensitivity among the water community in the Lower Basin, Reclamation plans to conduct a two-year demonstration analysis of this concept. Under this demonstration program, land fallowing is the only method of generating water that could be offered for forbearance. During this period, the process, effectiveness, and acceptability of a longer term forbearance program will be tested and analyzed. At the completion of the two-year demonstration period, Reclamation will summarize the results of the program and consult on the program's effectiveness with appropriate state agencies, water entitlement holders, and other interested parties in the Lower Basin states. The program can then be terminated, expanded, or adjusted, as appropriate.

- Building upon the activities of the *ad hoc* Workgroup and others, Reclamation plans to initiate a public process for compiling ideas, identifying concerns, and completing the evaluation and analysis of bypass flow replacement or recovery possibilities. While a number of possibilities for meeting the needs of the lower Colorado River already exist, as shown earlier in this report, there may be others that provide the desired result, or existing ideas could be adjusted to be even better at meeting the requirements. This effort will culminate in the documentation of all ideas for alternative solutions, concerns along the lower Colorado River and how those concerns are address in the alternatives, technical data and analyses of that data, evaluation of all the possibilities, and conclusion as to which possibilities might best resolve the issue of bypass flow to Mexico.

Reclamation's current management approach, then, utilizes available funding to proceed with the exploration of options to replace the bypass water while, at the same time, maintaining the Plant's condition and improving the readiness of the Plant to operate.