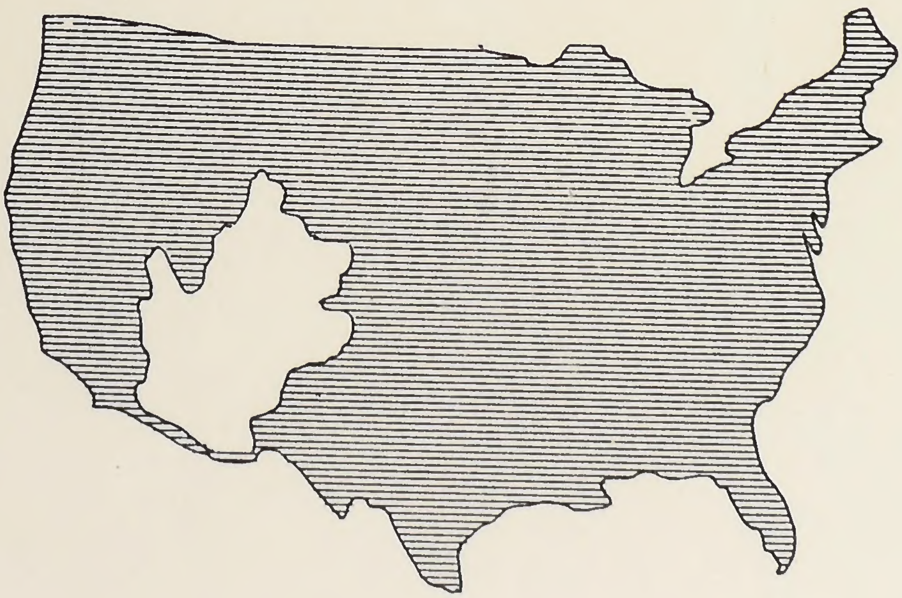
1986

Joint Evaluation of Salinity Control Programs in the



Colorado River Basin

1986 JOINT EVALUATION OF SALINITY CONTROL PROGRAMS IN THE COLORADO RIVER BASIN

November 1986

Prepared by

Colorado River Water Quality Office
Bureau of Reclamation

and the
USDA Salinity Control Coordinating Committee
U. S. Department of Agriculture

in Cooperation With
Bureau of Land Management,
Geological Survey, Fish and Wildlife Service,
and the Environmental Protection Agency

FOREWORD

This report is a combined DOI-USDA effort which consolidates two different reports. DOI efforts are summarized in the Bureau of Reclamation 1986 Evaluation Report required by the Commissioner of Reclamation as a management document used in the (MBO) Management By Objectives program management. The USDA report is the Annual Report on the Colorado River Salinity Control Program, published as a separate document prior to 1985. This combined report reflects upon the efforts by DOI and USDA to more fully coordinate and integrate the respective salinity control programs authorized in P. L. 98-569, amendments to the Colorado River Basin Salinity Control Act of 1974 (P. L. 93-320). Data shown reflects accomplishments to January 1, 1986.

Nothing in this report is intended to interpret the provisions of the Colorado River Compact (45 Stat. 1057), the Upper Colorado River Basin Compact (63 Stat. 31), the Water Treaty of 1944 with the United Mexican States (Treaty Series 994, 59 Stat. 1219), the decree entered by the Supreme Court of the United States in Arizona vs. California, et al. (376 U.S. 340), the Boulder Canyon Project Act (45 Stat. 1057), the Boulder Canyon Project Adjustment Act (54 Stat. 774; 43 U.S. Code 618a), the Colorado River Storage Project Act (70 Stat. 105; 43 U.S. Code 620), or the Colorado River Basin Project Act (82 Stat. 885; 43 U.S. Code 1501).

PREFACE

This report is a combined multi-agency report which consolidates two different reports. USBR efforts are summarized in the Bureau of Reclamation 1990 Evaluation Report required by the Commissioner of Reclamation as a management document that is the USBR Management by Objectives program requirement. The USDA report is the annual report of the Colorado River Salinity Control Program, published as a separate document prior to 1989. This combined report reflects upon the efforts of the past year to more fully coordinate and integrate the cooperative salinity control programs authorized in P. L. 93-320, amendments to the Colorado River Basin Salinity Control Act of 1974 (P. L. 98-569). Data given reflects accomplishments to January 1, 1990.

Nothing in this report is intended to interpret the provisions of the Colorado River Compact (45 Stat. 1057), the Upper Colorado River Basin Compact (63 Stat. 31), the Water Treaty of 1944 with the United Mexican States (Treaty Series 994, 59 Stat. 1219), the decree entered by the Supreme Court of the United States in Arizona vs. California, et al. (376 U.S. 340), the Boulder Canyon Project Act (45 Stat. 1057), the Boulder Canyon Project Adjustment Act (54 Stat. 774; 43 U.S. Code 618a), the Colorado River Storage Project Act (70 Stat. 105; 43 U.S. Code 620), or the Colorado River Basin Project Act (82 Stat. 885; 43 U.S. Code 1501).

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FINDINGS AND RECOMMENDATIONS

The findings and recommendations briefly summarized here are the result of a joint evaluation conducted by the Department of the Interior and the Department of Agriculture. The findings are presented as a program management tool to accomplish salinity control objectives at minimum cost. This approach to long-term, programwide interagency analysis is helpful to Federal program managers when weighing budget and program decisions each year.

The 1986 evaluation was prepared using data adjusted to more accurately compare the program information of the two departments. All costs (January 1986) and interest or discount rates (8 5/8 percent) have been adjusted to the same base. Repayment from the Lower Colorado River Basin Development Fund was based on the current 10 5/8 percent interest rate.

The base condition for the CRSS (Colorado River Simulation System) computer model evaluation assumes no funds expended on salinity control beyond those already spent on Grand Valley, Meeker Dome, Uinta Basin, and Las Vegas Wash. These projects, or portions thereof, are currently removing approximately 126,800 tons of salt annually from the river system. Projections of future salinity conditions used the average of 15 sequences of historical hydrology (1906-1983) as a data base and current (1986) Bureau of Reclamation depletion projections (similar to the Forum's moderate depletion level).

The salinity at Imperial Dam is projected to reach about 963 mg/L by the year 2010. Using the salinity projections at Imperial Dam, salt load reductions required to reduce projected TDS (total dissolved solids) levels to the numeric criteria level of 879 mg/L were estimated to be 1,090,000 tons per year by the year 2010 and are referred to as the program objective. Because of hydrologic fluctuations in the Colorado River Basin, the salt load reduction objective would be met at least 50 percent of the time in the future.

In confirming the effectiveness of the recommended plan to fully satisfy salt load reduction objectives and program goals, salinity projections at Imperial Dam, with and without additional program controls, are shown in figure 1. Figure 1 provides an historical perspective in addition to the numeric standard and the projections at Imperial Dam. It is readily apparent that with or without the recommended controls, the salinity at Imperial Dam is expected to increase significantly over the next eight years.

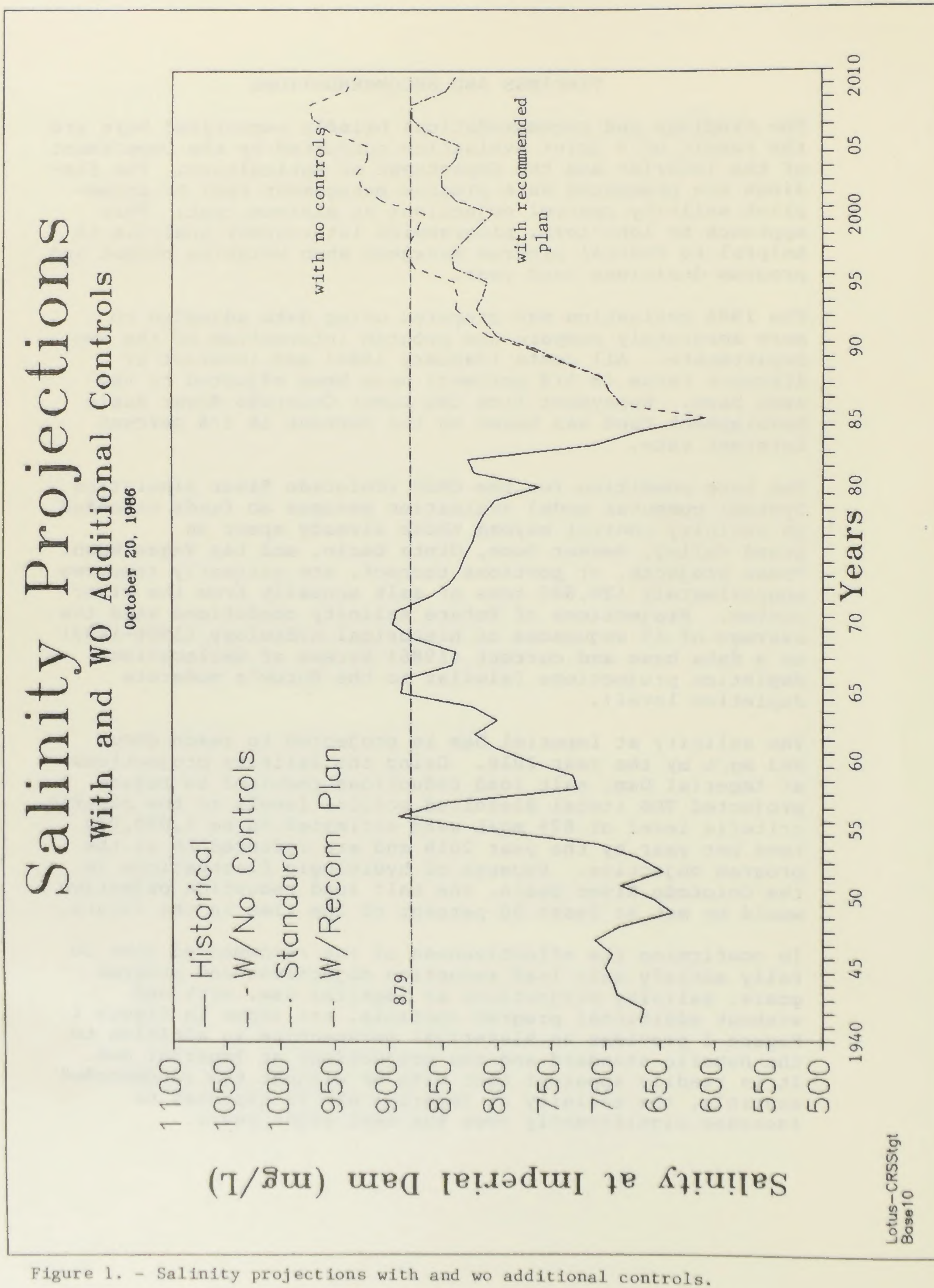

Figure 1. - Salinity projections with and wo additional controls.

In looking to the future, the salinity impacts of the recommended plan can be compared with the no action/no control scenario. In the near term, due to long construction periods and natural lag times in the river system, the potential reduction of salinity is not significant. The real program payoff appears after 1995 when the recommended plan maintains the TDS at Imperial Dam below the standard to the year 2010. Any long-term program capability in terms of maintaining of salinity below the standard also provides some cushion or insurance, should any individual project fail to reduce salt loading as planned.

The least cost investment computer model developed by Reclamation and Colorado State University was used to evaluate project investment levels. This model initially determines the optimal combination of projects and construction timing to meet salt load reduction goals at minimum investment levels. The investment level, modified to meet program needs and continuity, results in an investment level for the selected schedule of $498 million. (See figure 2.)

The model is driven by the overall cost of the total construction and implementation schedule. Cost-effectiveness ($/ton) is an important factor in selecting the projects to implement (as directed in Public Law 98-569), but it is not the only consideration in the development of an implementation schedule. The basinwide program must consider the uncertainties of implementation in the technical, social, political, institutional, and legal arenas. Local concerns and needs, management of irrigation systems, and regional impacts are involved in the final selection of an implementation schedule.

The analysis is based on current data. Annual review is required to update project data, review the program objectives to determine if they deviate significantly, and confirm the validity that the investment level of approximately $498 million will satisfy the program objectives. As evidenced by past program activities, long lead times are required for project planning and implementation, and construction costs continue to increase. To minimize program costs and to avoid increased inflation expenses program planning, implementation schedules, and funding levels should be consistent with the recommended plan. Construction should not be delayed because high flows for the past few years have temporarily lowered salinity levels in the system. Any delay would impact program continuity and

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Bar186-Nov. 20, 1986                                           Recommended Plan - $498 million 1/
                                                                 1.091 Million Ton Reduction
              Description                                                  Years

                                         1985  1986  1987  1988  1989  1990  1991  1992  1993  1994  1995  1996  1997  1998  1999  2000  2001  2002  2003  2004

Grand Valley Stage II                 2/ zzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzz

Paradox                                  zzzzzzzzzzzzzzzzzzzzzzzzzzzzzz

Dolores                               3/ |---------------------|zzzzzzzzzzzzzzzzzzz

Lower Gunnison Winter Water                   |----------|zzzzzzzzzzzzzzzzzzz

Las Vegas Wash - Whitney                 |----|zzzzzzzzzzzzzzzzzz

Uinta Stage I                                             |----------------|zzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzz

Lower Virgin                                              |-----------------------|zzzzzzzzzzzzzzzzzz

Price-San Rafael (coordinated)  4/                        |----------------|zzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzz

Grand Valley - USDA                      zzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzz

Uinta - USDA                             zzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzz

Lower Gunnison 1 - USDA                                   |----|zzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzz

Lower Gunnison 2 - Montrose - USDA                                    |----|zzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzz

Lower Gunnison 2 - Delta - USDA                                       |----|zzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzz

Lower Gunnison 3 - USDA                                                      |----|zzzzzzzzzzzzzzzzzz

Moapa Valley - USDA                                             |----------|zzzzzzzzzzzzzzzzzz

McElmo Creek - USDA                                       |----------------|zzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzz

Big Sandy - USDA                                          |----|zzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzz
```

1/ Information based on 1986 data tables.

2/ Z's zzzzzz designate construction activities.

3/ Lines |-----| designate advance planning activities for Reclamation and technical assistance activities for USDA.

4/ Currently not included in USDA Schedule.

Note: Units not included:	Reclamation:	USDA:	Completed Units:
*Data not available	Grand Valley II, Balance	Virgin Valley	Meeker Dome
	Lower Gunnison I, Balance	Mancos Valley	Grand Valley Stage I
	*Lower Gunnison North Fork	*Palo Verde Irrig. Dist.	Las Vegas Wash - Pittman
	Las Vegas Wash Stage II		
	*Uinta Stage II		
	Dirty Devil River		
	*Palo Verde Irrig. Dist.		
	*Big Sandy		
	*San Juan		
	Sinbad Valley		
	Glenwood-Dotsero Springs		

Figure 2. - Recommended Plan

cause serious interruption to the long-term irrigation improvement and onfarm projects, as well as result in future unrealistic funding requests from Congress.

Major Findings

- The recommended plan will fully satisfy the salt load reduction objective (1.09 million tons per year by 2010) and the program goal of maintaining salinity below 879 mg/L at Imperial Dam.

- Total construction cost for the program is now projected to be about $498 million, or $72 million less than the $570 million projected in 1985, which is significantly less than previous estimates ($1.9 billion in 1983).

- In order for the recommended plan to meet the program objective and goals, it is imperative that construction of most of the projects under the plan be initiated no later than 1991.

- In order to meet the program needs beyond the next decade, to minimize Lower Basin interest costs and maintain program continuity, construction of several new projects needs to be initiated in the next 4 years. The $498 million investment level appears to best satisfy the remaining long-term requirements at least investment cost.

- To meet salt load reduction objectives, it is necessary to have a mix of both USDA and Interior projects.

- Repayment analysis of the Lower Colorado River Basin Fund shows that sufficient funds are available to cover all costs (capital, O&M, interest, and 3.8 percent inflation) for the $498 million cost of the recommended plan.

- Continued close Federal and State coordination among Interior, USDA, the Interagency Committee, the Forum, and the Advisory Council is critical to continued effective management of the program.

- To keep the project implementation schedule on track, the evaluation will need to be reviewed annually for the next several years to allow for inclusion of newly formulated, more cost-effective projects and changes in technology.

Management Recommendations

- Continue to refine the determination of salt load reduction objectives for future program analysis.

- Continue analysis of project construction schedules for possible modifications to allow other cost-effective projects to be started earlier.

- DOI and USDA should support the $498 million investment level for program planning and budgeting purposes. Figure 2 represents the 1986 recommended implementation schedule.

- Continue program evaluation annually to improve on investment, repayment, and uncertainty analysis.

- Continue to work toward early implementation of the USDA Colorado River Salinity Control Program in coordination with DOI.

- Support direct USDA-Reclamation coordination effort by maintaining a USDA Basin Coordinator in Reclamation's Colorado River Water Quality Office.

- Continue technical policy and coordination committees.

- Continue cooperation among the Federal agencies, the Forum, and Advisory Council.

BACKGROUND

This report provides the basis for continuing evaluation of the Title II portion of salinity control programs in the Colorado River Basin. It is intended to serve as a comprehensive financial/management level analysis of all Federal and State salinity control efforts in the basin. This annual evaluation is provided as a management tool to ensure that the program is being carried out in the most cost-effective manner in accordance with legislative requirements and current program schedules. The Title I portion of the salinity control program downstream from Imperial Dam is also briefly summarized.

Colorado River Basin

The Colorado River Basin encompasses portions of seven states. The river flows over 1,400 miles from its mainstem headwaters in Colorado. It joins with major tributaries from Wyoming, Utah, and New Mexico, flows through the Grand Canyon, provides state boundaries for Nevada, Arizona, and California, flows through the Republic of Mexico, and terminates in the Gulf of California.

The Colorado River provides municipal and industrial water supplies for over 18 million people and irrigation water to over 1,000,000 acres. The river, however, carries about 9 million tons of salt annually past Hoover Dam. Projections indicate salinity levels increasing beyond numeric standards if controls are not implemented, even though recent high flows have flushed the major reservoirs. The result has been significantly lowered salinity levels at Imperial Dam--from an annual average of 826 mg/L in 1982, to 607 mg/L (provisional) in 1985.

Colorado River Water Quality Improvement Program

The CRWQIP (Colorado River Water Quality Improvement Program) was initiated as a general investigation program by Reclamation (Bureau of Reclamation) in 1971. See figure 3. The general goals and objectives governing salinity control in the basin have been established by two key pieces of Federal legislation: The Federal Water Pollution Control Act as amended, Public Law 92-500, currently known as the Clean Water Act; and the Colorado River Basin Salinity Control Act of 1974 as amended, Public Law 93-320.

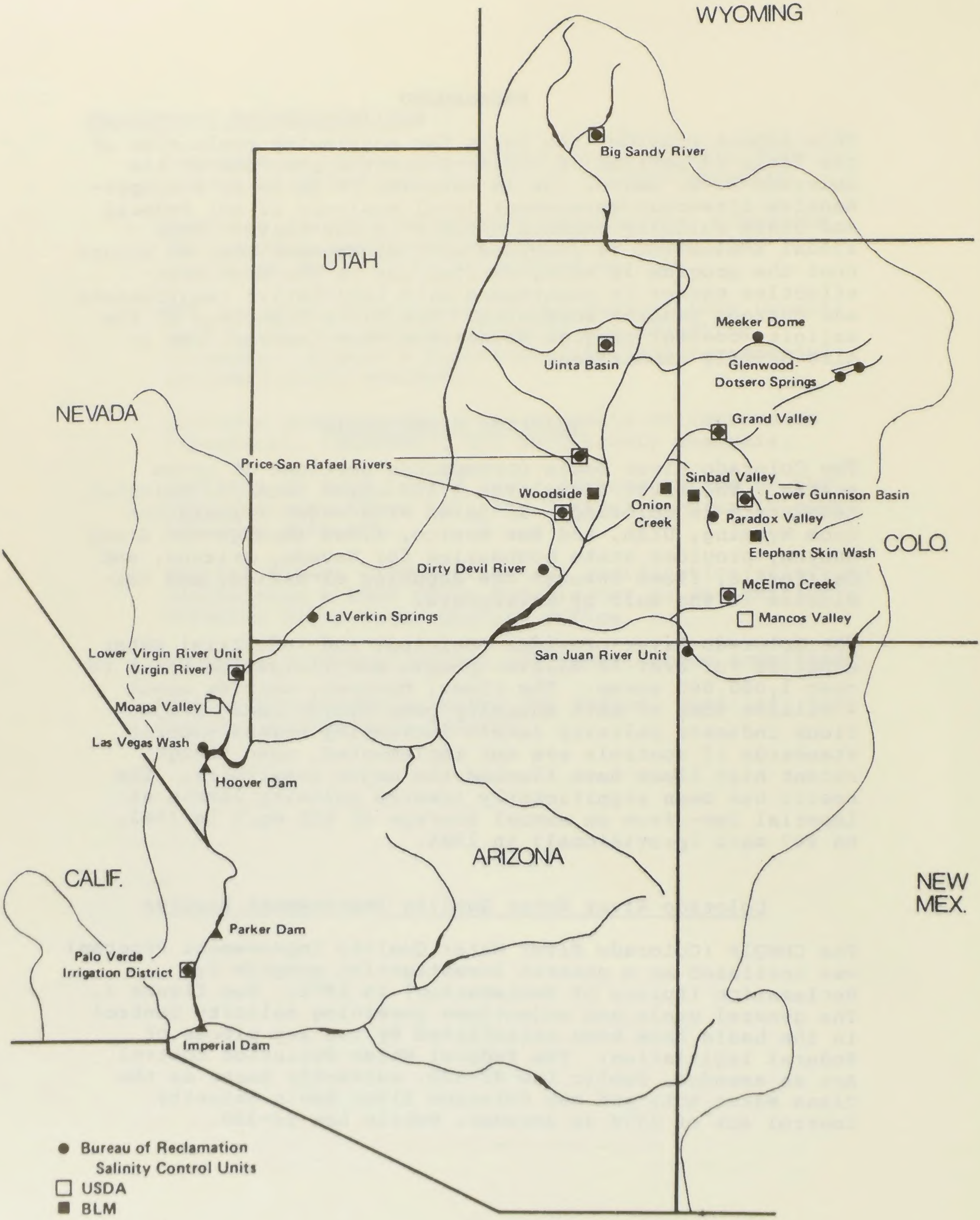

Figure 3. - Colorado River Water Quality Improvement Program.

Public Law 92-500 provides for water quality standards for receiving waters, and Public Law 93-320 authorized construction of four salinity control units and studies of twelve additional units.

In Public Law 93-320, the Secretary of the Interior was directed to implement the salinity control policy adopted on April 26-27, 1972, for the Colorado River in the "Conclusions and Recommendations" published in the Proceedings of the Reconvened Seventh Session of the Conference in the Matter of Pollution of the Interstate Waters of the Colorado River and Its Tributaries in the States of California, Colorado, Utah, Arizona, Nevada, New Mexico, and Wyoming.

> A salinity policy was adopted for the Colorado River system that would have as its objective the maintenance of salinity concentrations at or below levels presently found in the lower main stem. In implementing the salinity policy objective for the Colorado River system, the salinity problem must be treated as a basinwide problem that needs to be solved to maintain Lower Basin water salinity at or below present levels while the Upper Basin continues to develop its compact-apportioned waters.

This policy was approved by the EPA (Enviromental Protection Agency) on June 9, 1972. The Administrator of the EPA and the Secretary of Agriculture were directed to cooperate and coordinate their activities with the Secretary of the Interior to effectively carry out the objectives of the program.

Public Law 98-569 was signed into law on October 30, 1984, and amends Public Law 93-320. This legislation modifies the original salinity control program by authorizing construction of additional units and directs the Secretary of Agriculture to establish a major voluntary onfarm cooperative salinity control program.

Participants

Reclamation was delegated the coordinating role for the Secretary of the Interior; and the Chief, Colorado River Water Quality Office, was appointed the designated salinity control liaison officer for Interior. As liaison officer, he coordinates the overall salinity control program with USDA (Department of Agriculture), EPA, the Colorado River Basin Salinity Control Advisory Council, and the Forum (Colorado River Basin Salinity Control Forum).

The FWS (Fish and Wildlife Service) activities are important to the implementation and progress of the CRWQIP. FWS provides guidance for replacing fish and wildlife habitat values potentially lost primarily through canal and lateral lining and onfarm programs.

The USGS (Geological Survey) Water Resources Division operates and maintains a network of 22 streamflow and water quality stations in the Colorado River drainage basin that are used in salinity program analysis. In addition to maintaining this hydrologic data network, the USGS has been conducting studies which analyze the time variations in salinity and define man's influence on salinity. These studies will be completed by the end of FY 1986 with reports available early in FY 1987.

The BLM (Bureau of Land Management) has identified several salinity source areas on public lands. Effective management of these areas, which may include land treatment, is currently being considered.

USDA involvement is provided primarily by the ASCS (Agricultural Conservation and Stabilization Service) and the SCS (Soil Conservation Service). Working through the USDA Salinity Control Coordinating Committee and the Director of Land Treatment Program Division as the designated USDA salinity control liaison officer, ASCS and SCS provide major program management leadership and overall program coordination with Reclamation. However, USDA agencies and Title II onfarm salinity control programs are funded and implemented separately from Reclamation programs.

Currently, USDA implementation efforts are administered under existing program authorities since line item funding has not been authorized as of January 1986. Financial assistance and landowner cost-share funding are being provided through specific appropriation language for the ACP (Agricultural Conservation Program) within the ASCS. SCS funding for technical assistance and monitoring are not specifically appropriated; therefore, the agency must rely upon the existing CTA (Conservation Technical Assistance) support to implement onfarm salinity control measures.

The ARS (Agricultural Research Service), the Cooperative State Research Service, and the Extension Service also play a vital role in the salinity control program. The ARS conducts research on irrigation water and soil management, water delivery system design, and operational practices. The Extension Service carries out educational programs to advise irrigators on water, soil, and crop management in saline areas.

The major EPA programs dealing with salinity control (Water Quality Standards, Water Quality Management Planning, and NPDES permits) are the responsibility of the States. EPA maintains oversight and/or approval responsibilities for these programs.

The Colorado River Basin Salinity Control Advisory Council was established by Public Law 93-320. The Advisory Council is composed of up to three representatives appointed by the Governor of each Basin State. It receives reports from the various Federal agencies working on the salinity control program and makes recommendations to the Secretaries of the DOI (Department of the Interior) and USDA and the Administrator of the EPA on the progress of implementation of the salinity control program.

The Colorado River Basin Salinity Control Forum was established in 1973 as a mechanism for interstate cooperation and to develop and adopt water quality standards for salinity, including numeric criteria, on the Colorado River. The standards were published in 1975 and were based on the objective of maintaining salinity concentrations at or below the 1972 levels found in the lower main stem while allowing the Basin States to continue to develop their compact-apportioned waters. The Forum is composed of up to three representatives appointed by the Governor of each of the Basin States.

The seven Colorado River Basin States--Arizona, California, Colorado, Nevada, New Mexico, Utah, and Wyoming--have an important role in the salinity control effort. They are responsible for the control of the discharge of TDS (total dissolved solids) from point discharges through the NPDES permit program. California, Colorado, Nevada, and Wyoming have authority to issue all types of NPDES permits; New Mexico and Arizona prepare permits and forward them to EPA for issuance; and Utah issues its minor industrial permits while EPA handles the major industrial permits.

The States have primary responsibility for the adoption and enforcement of water quality standards. The numeric criteria established at Hoover Dam, Parker Dam, and Imperial Dam are 723 mg/L, 747 mg/L, and 879 mg/L, respectively. In addition to NPDES permits, the States have developed water quality management plans to conform with the requirements of Section 208 of the Clean Water Act.

Status of Implementing Public Law 98-569

The 98th Congress passed H. R. 2790 that amends Public Law 93-320, the Colorado River Basin Salinity Control Act. The President signed the bill on October 30, 1984, and the legislative initiative became Public Law 98-569. The following comments provide a status of activities directed toward implementing the new legislation:

- Preconstruction activities are underway in the salinity control units newly authorized for construction by the Department of the Interior: Winter Water portion of Stage I of the Lower Gunnison Basin Unit, Colorado, and the McElmo Creek Unit as a part of the Dolores Participating Project, Colorado;

- Since the USDA portion of the Colorado River Basin salinity control program has not yet been funded, the Secretary of Agriculture continues to use existing authorities to carry out the onfarm program.

- The Secretary of Agriculture will submit a report on the onfarm program to the Congress by January 1, 1988, and every five years thereafter;

- BLM is continuing to work on its comprehensive salinity control program. A draft report describing the program is scheduled to be completed by January 1987.

- Current studies are investigating industrial water use for disposal of saline and brackish waters;

- Reclamation plans to undertake advance planning on the Sinbad Valley Unit, Colorado, in 1989, if funding permits;

- The investment schedules are reviewed annually to make certain the Lower Basin Development Fund can repay its share of the investment and operation and maintenance costs.

SUMMARY OF AGENCY AND UNIT ACTIVITIES

Title I

Title I of the Colorado River Basin Salinity Control Act, Public Law 93-320, authorized the Secretary of the Interior 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. Title I enables the United States to comply with its obligation under the agreement with Mexico of August 30, 1973 (Minute No. 242 of the International Boundary and Water Commission, United States and Mexico), which was concluded pursuant to the Treaty of February 3, 1944 (TS 994).

Title I features of the Colorado River Basin Salinity Control Project are measures below Imperial Dam. They include the Coachella Canal Unit, the Protective and Regulatory Pumping Unit, and the Desalting Complex Unit. Together, these units will salvage over a third of a million acre-feet of water a year.

The Coachella Canal Unit, which provides for concrete lining the first 49 miles of the canal, is essentially completed, except for some fish and wildlife mitigation features. Program costs for this feature were $47,900,000. Up to 132,000 acre-feet of water will be saved per year. Operation and maintenance of this canal remain with the Coachella Valley Irrigation District.

Twenty-one wells of the 35-well Protective and Regulatory Pumping Unit have been completed and are operable. The remaining 14 have been deferred until water supply needs make construction necessary. High flows in the Colorado River over the past few years have meant little or no operation of the completed wells. About $19,500,000 of a programmed $31,700,00 have been spent to date. By agreement with Mexico, a maximum of 160,000 acre-feet per year will be withdrawn by this well field.

Work is continuing on the keystone of Title I, the Desalting Complex Unit. Contracts for the desalting equipment have been awarded, and all major structures except the desalting building have been completed. The last major contract, the $35,419,195 Pretreatment Completion Contract, is well underway. Two key flag dates are as follows:

1. Completion and start-up of the main pretreatment system - mid-1987. We estimate about 18 months to fully shake down this equipment.

2. Completion of the desalting building and equipment installation - 1988 and 1989.

The design capacity of the plant is 96 Mgal/d, although only 73 Mgal/d is initially being built. Depending on the progress of the programs to reduce irrigation return flows (the feedwater for the plant), more capacity can be added if needed. The total program cost for the Desalting Complex Unit, which includes the Yuma Desalting Plant, is $347,800,000. At 73 Mgal/d, the desalting plant will salvage up to 80,000 acre-feet of water per year.

At this time, Title I overall is about 60 percent complete, based on a present expenditure of $265,500,000. With the award of the completion contract, the last major milestone was passed and we can see the end of this large and complex project.

USDA's involvement in Title I relates specifically to onfarm treatments and water management improvements in the WMIDD (Wellton-Mohawk Irrigation and Drainage District) in Yuma, Arizona. Any reduction of drainage return flows would reduce the demands and costs of operating the desalting plant. By improving irrigation efficiencies, a reduction of deep percolation into ground water reduces the amount of drainage return flows leaving the 65,000 acre District.

The Wellton-Mohawk onfarm Federal cost-sharing program was fully funded by Reclamation. Under authority of a BR-SCS Title I Memorandum of Agreement (December 1974), Reclamation reimbursed SCS for cost-sharing and technical assistance provided to individual participants through long-term contracts. The initial program for 23,800 acres was expanded during the annual renewal of the agreement in 1984 to 48,000 acres.

This last renewal provided that all SCS contracting would be completed by September 30, 1985, and that all water management and salinity control land treatment practices would be installed by December 31, 1985.

In 1985, 55 contracts were developed and signed covering 4,519 acres. Practices applied included 31 miles of ditch lining, 4,822 acres of laser land leveling, and 787 structures for water control and measurement.

The SCS designed irrigation systems and assisted farmers in their installation to reduce irrigation return flow. As of January 30, 1986, 366 contracts had been developed for assistance on 48,195 acres, which exceeds the project goals.

Since implementation of the Colorado River salinity program began in 1975, the irrigation return flows have been reduced about half or approximately 100,000 acre-feet. This has been accomplished through the installation of over 1,386,000 ft. (262.6 miles) of concrete ditch linings, 44,724 acres of land leveling, and 10,635 water control structures in addition to a concerted effort to obtain irrigation water management (IWM) on all 48,195 planned acres. There remains 112 active contracts covering 13,541 acres for which additional IWM activity will be carried out by the Wellton Field Office staff.

All construction work has been completed and all payment applications and final status reviews have been submitted during this final year of implementation. Federal costs were $2,426,879 while local individual farmer cost was $808,960. To date Federal cost for installation of all facilities has been $18,209,268.

Title II Programs

Bureau of Reclamation

In addition to construction of three units and planning activities on 12 units, Reclamation is carrying out research programs utilizing expertise in the Engineering and Research Center on such activities as solar salt gradient ponds, ion exchange softening, and use of saline water for powerplant cooling. Further descriptions of the research activities are in another section of this report.

Bureau of Land Management

The present salinity efforts of the Bureau of Land Management (BLM) have concentrated on the identifications and recommendations for control of significant saline source areas on public lands. BLM has developed a resource management planning system that is multiple-use oriented, but emphasizes solutions to specific issues.

Passage of amendments to the Colorado River Basin Salinity Control Act in 1984 required BLM to develop a comprehensive salinity control program, and to report to Congress and the Colorado River Basin Salinity Control Advisory Council concerning this program. Utilizing the planning system, saline source areas and management options for control of these sources are being identified. Watershed activity plans addressing salinity and implementation actions will be conducted as funds permit.

The watershed practices that may be effective in salinity control include gully plugs, contour furrowings, pitting, ripping, retention and detention structures, and the implementation of allotment and habitat management plans. The cost of these watershed treatments within Grand Valley, Colorado, as estimated by the Soil Conservation Service, is approximately $30-40 per ton of salt removed. BLM feels that these salinity control projects, with secondary benefits to erosion and flood control, water supply for livestock and wildlife, and/or improved forage production, are consistent with the multiple-use philosophy of BLM. Reports identifying potential salinity control areas have been completed for eastern Utah and the Montrose, Craig, and Grand Junction Districts in Colorado.

Several activity plans have been completed in the States of Colorado, Utah, and Wyoming. Portions of these plans have been implemented, with one, Elephant Skin Wash in Colorado, being fully implemented in 1985. This verification project is designed to prevent approximately 600 tons of salt from reaching the Colorado River annually at a cost of $29 per ton.

In addition to nonpoint-source salinity control, BLM has also implemented point-source control measures. Point-source control measures include the plugging of abandoned oil and gas wells. The condition of two plugged saline flowing wells in the Piceance Creek Basin were monitored in 1985. These wells originally had a flow rate of 90 gpm with dissolved solid concentration of 30,000 mg/L. This is equal to approximately 5,000 tons of salt a year. The plugs are still in place with no seepage to the creek.

Geological Survey

Determination of the overall goals and accomplishments of the salinity control program relies heavily on streamflow and dissolved-solids data from key sampling stations in the Colorado River Basin. Since 1984, the U.S. Geological Survey has been analyzing the available data in order to develop a consistent, accurate data base for salinity studies in the basin. This analysis has included consolidating historical records and studies, extending the historical record for certain stations, and generating a natural record of dissolved-solids discharge which would have occurred if no water-resource development existed in the basin. The natural record was required specifically for prediction of future salinity using the U.S. Bureau of Reclamation's river-basin operations model, CRSS.

Specific objectives of the data-analysis project were:

1. Generate annual and monthly loads and concentrations of dissolved solids and the major constituents for all stations with adequate record;

2. Determine source areas of dissolved solids;

3. Determine trends in streamflow, dissolved solids, and the major constituents;

4. Identify causes of trends whenever possible;

5. Develop a method for calculating natural salt load at the key Reclamation input points for CRSS; and

6. Develop a technique based on hydrologic, hydraulic, and statistical principles to estimate complete monthly and annual dissolved solids load data sets for the period 1941-83, at 12 of the 20 stations in the Colorado River basin which have varying lengths of record.

Department of Agriculture

The passage of Public Law 98-569 provides a separate authority for implementing a basinwide USDA onfarm program. Funds, however, have not yet been appropriated for the program. Until then, as prescribed by the provisions of Title II of Public Law 93-320, USDA will continue to use existing program authorities.

Planning. - Within USDA, planning activities are a responsibility of the SCS. Once irrigated agricultural salt source areas have been identified, SCS undertakes salinity control studies and investigations to determine the extent and severity of salt source loadings. These studies and investigations are conducted under the river basin authorities of Section 6 of Public Law 83-566, Watershed Protection and Flood Prevention Act. These studies are fully coordinated with Reclamation activities and serve as the basis for detailed project implementation plans.

In 1985, only a minimal planning effort was undertaken due to limited funding. The two reports released in 1985 were the Mancos Valley, published in September 1984, and the Colorado River Indian Reservation, published in May 1985.

Implementation. - Current implementation activities are concentrated in the Uinta Basin, Utah, and the Grand Valley, Colorado. Implementation of the USDA onfarm program is the responsibility of the ASCS and SCS. Currently, USDA is relying on the existing program authorities and funding for project implementation. The ACP (Agricultural Conservation Program) of ASCS is providing special cost-share funding for water management and salinity control practices. SCS is using funds allocated through their ongoing CTA (Conservation Technical Assistance) program to provide the necessary technical support staff to plan and implement the water management and salinity control practices.

The current implementation schedule is controlled by annual appropriation funding levels. While USDA developed a modified implementation schedule in 1982, funding has only supported the two ongoing projects. Other project implementation starts are scheduled to be phased in over a period of years as program funding levels increase.

A new implementation schedule was formulated as a result of new legislation, closer coordination with Reclamation, and inputs from the Basin States. The new implementation schedule is based upon projected salt load reduction needs, cost-effectiveness analysis, the likelihood of Federal funding, and Basin Fund repayment capability.

Monitoring and Evaluation. - Monitoring and evaluation (M&E) of the accomplishments of USDA actions in salinity control has a threefold objective. First and most important is to develop information about actual (rather than planned) onfarm effects that have occurred in the area. This information will enable farmers to make informed choices about voluntary implementation of salinity control practices. The information includes cost of practices, changes in water use, labor use, and other farm inputs, and finally, observed changes in crop yield and potential changes in net farm income. The second purpose is to enable SCS to confirm or correct the data used to plan salinity control projects to do a more reliable job of planning other projects. The final purpose is to collect data to be used to evaluate the overall effectiveness and efficiency of USDA salinity control activities from a program standpoint.

Although continuing to be hampered by shortage of staff and funding, SCS M&E activities have moved ahead sharply during fiscal year 1985. In the Grand Valley Unit in Colorado, 16 automated irrigation M&E sites are now operational, and full-season irrigation data have been collected on 13 fields. Development of the software to process this M&E data proved to be a much larger task than initially estimated. Significant progress was made toward developing the needed software, but additional programming time will be required.

On the Uinta Basin Unit in Utah, ground water tubes have been installed on 15 farms and efforts will begin to monitor ground water levels using neutron probes. Water inflow and outflow measurements on these farms will be combined with data from six potential evapotranspiration sites to measure deep percolation. The SCS staff is also working with Cooperative Extension in Utah to establish and monitor progress in irrigation water management on four farms.

A plan of study for the economics M&E effort was developed and approved for the Grand Valley Unit and a worksheet to collect farm operations data was developed, field tested, and is ready for the staff to begin collecting data regarding the onfarm effect of salinity reduction activities.

Wildlife habitat M&E efforts have been strongly pushed during FY 1985. Baseline wildlife habitat conditions have been established for 30 additional sites in the Uinta Unit, bringing the total sites evaluated to 60. Microcomputer programs have also been developed to calculate a habitat suitability index (HSI) for six species for each of the sites. These programs will enable the ready comparison of site habitat condition over time. On the Grand Valley Unit, a Wildlife M&E Annual Report for FY 1984 was prepared. The report gives preliminary data regarding changes that have occurred in wildlife habitat since the inception of the project.

Extension Education. - Information and educational support activities for the CRWQIP have been provided through the USDA Federal Extension Service and the State CES (Cooperative Extension Service) agencies. Like ASCS and SCS, the Extension Service and the State CES agencies have relied on existing authorities and funding mechanisms to provide the extension education support. Existing extension staffs such as Extension Agents and Extension Irrigation Water Management Specialists have provided some general levels of limited education support. These include newsletters, water management workshops, and other educational efforts as a part of their ongoing extension education programs.

A special full-time irrigation extension agent in Grand Valley was the most significant extension education support in recent years. Lack of funding caused termination of the position in 1985. This sort of extension education support could play a valuable and important role in project visibility, local understanding, and local acceptance.

Research and Demonstration. - Research and demonstration activities continue to be important to the development of new technologies and improvement of water management practices for control of soil and water salinity. The ARS provides national leadership for salinity related research and demonstration activities. In addition, the Cooperative State Research Service (CSRS) and State Agricultural Experiment Stations (SAES) provide the leadership and conduct research funded from Federal and State sources.

Agricultural Research Service. - The majority of the ARS salinity activities are conducted at the U.S. Salinity Laboratory in Riverside, California; the U.S. Water Conservation Laboratory in Phoenix, Arizona; the Agricultural Engineering Research Center in Ft. Collins, Colorado; and the Snake River Conservation Research Center at Kimberly, Idaho.

Environmental Protection Agency

EPA has responsibility for approving revisions to water quality standards and approved the triennial reviews adopted by several states based on the 1984 Forum standards review. EPA continues to encourage the Basin States to develop and implement state salinity control strategies.

The Forum and EPA policy encouraging the use of poorer quality water or saline water for industrial purposes is being supported primarily through NEPA (National Environmental Policy Act) review responsibilities. Also, through the NEPA review process, EPA urges the identification of potential salinity impacts as required by the Council on Environmental Quality regulations (40 CFR Parts 1500-1508) for implementing NEPA. For example, EPA has commented on potential salinity impacts in reviewing environmental statements for grazing and land management, recreational developments, mining, timber harvesting, oil development, and water development projects.

EPA continues to work with Reclamation on the underground injection control requirements for the Paradox Valley.

Title II Units

Big Sandy River Unit (Reclamation and USDA)

The Big Sandy River Unit is located in southwestern Wyoming, in Sweetwater County. The Big Sandy River begins in the Wind River Mountains where the water quality is good. Below Big Sandy Dam, the river is diverted to irrigate the Eden Project. Return flows from the irrigated area and small stream tributaries make up the flows of the lower Big Sandy River.

Drilling investigations have shown that the shallow aquifers near the river are the source of saline seeps. Saline seeps and springs below the Eden Project contribute an estimated 116,000 tons of salt. Along with other tributaries, a total of approximately 164,000 tons of salt is contributed annually to the Green River. Test well pumping indicates that the saline water could be intercepted before seeping into the river.

Additional studies were undertaken in the off-farm portion of the irrigated area of the Eden Project. Studies showed that lining some currently unlined canals in the Eden Project area could be a cost-effective solution to reducing salt in the Big Sandy River. The SCS completed a separate on-farm salinity control draft report in early calendar year 1986. The report recommends converting the existing gravity irrigation systems to low-head sprinkler irrigation systems. A combination of a lined delivery system and an onfarm sprinkler irrigation system could possibly achieve maximum benefits.

Ongoing studies are focused on the selective lining alternative. Field verification of canal seepage rates were completed in the summer of 1986. Results will help determine the cost effectiveness and will be documented in a plan formulation working document in early 1987. The State of Wyoming has been involved in the study from the beginning and has provided information, guidance, and funds. It has also supported further funding for advance planning activities.

A low pressure sprinkler system alternative appears to be cost effective for the 15,000 acre irrigation salt source area if supplemental, low interest loans and cost sharing at the 70 percent level were obtained. The State of Wyoming supports this USDA low pressure sprinkler alternative and has requested SCS to proceed with development of a selected plan.

The State of Wyoming has also requested Reclamation to refine the salt and water budget related to selected lining of canals and laterals in the Eden-Farson area. Planning will be targeted toward selected lining of unlined segments of the canal and lateral system.

The combination of improved off-farm delivery systems and onfarm irrigation efficiency allows SCS to recommend low pressure sprinkler systems for onfarm salinity program elements.

Blue Springs Unit (Reclamation)

The Blue Springs Unit area is located on the Little Colorado River within the Navajo Indian Reservation in north-central Arizona. The springs contribute an average of 160,000 acre-feet per year which have a collective salinity of 2,500 mg/L and a total salt load of about 550,000 tons per year.

A full-scale feasibility study of the project is not planned due to the high capital cost of building the project and environmental problems resulting from the significant historical and religious value of the area to the Hopi Indians.

Colorado River Indian Reservation Unit (Reclamation and USDA)

The Colorado River Indian Reservation has a total of 268,850 acres located in the lower Colorado River Basin below Parker Dam in northern Yuma County, Arizona, and the eastern part of the San Bernadino and Riverside Counties, California.

The purpose of Reclamation's Colorado River Indian Reservation Unit investigation was to formulate a plan to reduce the salt loading to the Colorado River from irrigation on the reservation. An analysis of the diversions to and drainage from the reservation indicated that the reservation did not make a net salt contribution to the river. Consequently the investigation was terminated, and a Concluding Report was released in October 1979 to present the studies performed.

A Cooperative River Basin Study has been completed by USDA on the Colorado River Indian Reservation. Data available from this study support the hypothesis that a minimal amount of salt is picked up on the Reservation and that long-term benefits of better irrigation systems and practices appear to have a relatively small effect on downstream salinity. The final USDA report on the study, Water Conservation and Resource Development, Colorado River Indian Reservation, which did not identify a recommended plan, was recently published and distributed under authority of Section 6 of the Watershed Protection and Flood Prevention Act (Public Law 83-566).

Dirty Devil River Unit (Reclamation)

The Dirty Devil River Unit is located in Emery and Wayne Counties in southern Utah. The study area includes the

Muddy Creek, Fremont River, Dirty Devil River, and the tributaries of Muddy Creek, Salt Wash, and South Salt Wash. The Dirty Devil River drainage contributes approximately 150,000 tons each year to the Colorado River. The Muddy Creek contributes the most salt, an average of 86,000 tons of salt annually. No significant sources of salt or potential alternatives were identified on the Fremont River or its tributaries. Approximately 28 percent of the Muddy Creek salt load, 24,200 tons per year, comes from springs in Hanksville Salt Wash and Emery South Salt Wash.

The unit would be designed to reduce the salinity of the Dirty Devil and Colorado Rivers by collecting saline spring water in Hanksville Salt Wash and Emery South Salt Wash and disposing of it by deep-well injection. Collection would be accomplished by pumping surface and alluvial water from shallow wells. This water would be filtered and chemically stabilized, after which it would be injected into deeply buried geologic formation, the Coconino Sandstone, where it would be stored indefinitely, isolated from any fresh-water aquifer now in use. This means of disposal would reduce the salt contribution to the Colorado River by 20,900 tons annually. The only alternative to the recommended plan is no action.

The Preliminary Findings Report was completed in 1983, the Plan Formulation Working Document in 1984, and the Field Draft Planning Report/Environmental Compliance Document in 1985. The field review was completed in May 1986, and the Draft Planning Report/Environmental Compliance Document was sent to Washington and the E&R Center in July 1986.

Since the State of Utah will not grant a water right for the unit because deep-well injection is not considered a beneficial use of water, the unit will not continue into advance planning.

Glenwood-Dotsero Springs Unit (Reclamation)

The Glenwood-Dotsero Springs Unit is located along the Colorado River in Eagle, Garfield, and Mesa Counties in west-central Colorado. Combined discharges annually contribute approximately 25,000 acre-feet of water containing about 440,000 tons of salt, mostly sodium chloride. About half of the salt contribution comes from 20 surface springs. Twelve of these springs are clustered near the town of Glenwood Springs, and eight are grouped about 2.5 miles downstream from Dotsero. The remainder of the salt enters through springs in the stream gravels, diffuse seeps, and to a small extent, surface runoff. Several of the springs in

Glenwood Springs have been developed for bathing and therapeutic purposes.

The recommended plan consists of collecting both surface and subsurface salt water at Dotsero, transporting it in a gravity flow pressure line to Glenwood Springs where additional surface and subsurface salt water would be collected and added to the Dotsero salt water. The water would then be piped through a gravity pressure line to evaporation ponds at the Colorado-Utah border.

The current plan is not as cost effective as other units being implemented and, under Colorado water law, evaporation is not considered a beneficial use of water. A planning report concluding the study was completed in February 1986. Other alternatives are being considered which involve a beneficial use of the saline water.

Grand Valley Unit (Reclamation and USDA)

The Grand Valley Unit is located in western Mesa County in west-central Colorado. For the most part, the unit area includes the entire irrigated portion of the Grand Valley consisting of about 71,000 acres and involving about 200 miles of canals and about 500 miles of laterals.

The Grand Valley is estimated to contribute an average of about 580,000 tons of salt annually to the Colorado River. Most of these salts are leached from the soil and underlying Mancos Formation by ground water that receives its recharge from canal, lateral, and on-farm seepage.

In May 1983, the recommended plan was selected for Stage Two. The plan provides for replacing existing open earth laterals with buried pipe and lining three reaches of the Government Highline Canal with membrane liners. Construction of the west end of the canal is scheduled to begin in the fall of 1986 and construction of the west end portion of the Government Highline Canal laterals is scheduled to begin in fiscal year 1988. The remaining lateral systems will be implemented approximately in order of cost effectiveness, with construction concluding about the year 2005. The supplement to the definite plan report and the final environmental impact statement was filed with the Environmental Protection Agency May 23, 1986.

USDA's onfarm and off-farm lateral improvements in Stage One and Stage Two Grand Valley have been accomplished primarily through the annual practice cost-share provision of the ASCS's ACP program. Onfarm pipeline and ditch lining installed during calendar year 1985 was 135,944 feet and 18,148 feet respectively. Total onfarm pipeline and ditch lining accomplishments thus far are approximately 141 miles of pipelines and 41 miles of ditch lining. Combined, these accomplishments represent about 27 percent of the total Grand Valley project goal.

USDA's off-farm lateral improvements for calendar year 1985 consisted of 18,717 feet of pipeline improvements and 2,956 feet of ditch lining. Cumulative off-farm lateral accomplishments for the project are 37.1 miles of pipelines and 11.4 miles of ditch lining, representing 25.5 percent of USDA's overall project goals.

USDA's onfarm seepage or deep percolation reductions from all treatments to date are estimated to be 4,159 acre-feet per year for an average salt load reduction of 20,675 tons per year. Off-farm lateral seepage reductions from all treatments to date are 2,281 acre-feet per year for 11,470 tons of salt load reductions per year. Total seepage/deep percolation reductions are 6,439 acre-feet through calendar year 1985 for a 32,145 tons per year salt load reduction from USDA activities in both Stage One and Stage Two.

La Verkin Springs Unit (Reclamation)

During the past 20 years the La Verkin Springs Project has been studied extensively with several reports being produced. The latest, a Preliminary Findings Report recommending the study be discontinued because of poor cost effectiveness, was submitted to the Office of the Commissioner in January 1984. The Salinity Control Forum and the Office of the Commissioner have concurred with the recommendation. The Preliminary Findings Report recommending discontinuance of the study was released in August 1984.

Las Vegas Wash Unit (Reclamation)

Las Vegas Wash (Wash) is a natural drainage channel providing the only surface water outlet for the entire 2,193 square miles of Las Vegas Valley. A drainage area of 1,586 square miles directly contributes to the Wash which conveys storm runoff and waste water to Las Vegas Bay, an arm of Lake Mead.

One alternative salinity control strategy would be to prevent seepage of waste water and minor storm runoff by placing it in a bypass channel running parallel to the Wash for about 4 miles, circumventing salt deposits in the Wash alluvium. The bypass channel has been viewed by some local entities as being in conflict with nutrient and toxics control and wildlife habitat improvement objectives. A consensus of local support for the bypass channel does not appear obtainable while waste water treatment issues remain unresolved.

The seepage prevention strategy for salinity control is being studied in the Pittman Verification Program. Once-through cooling water is now diverted from unlined ditches into a pipeline. Several new wells in the Pittman area are being used to monitor ground water levels and quality. The curtailment of seepage from the unlined ditches is expected to cause a drop in ground water levels resulting in reduced saline ground water inflow to the Wash. The ground water monitoring is planned to continue through fiscal year 1987. A long-term reduction of 7,000 tons per year is expected to be realized from the diversion to the pipeline.

A plan is being developed for a second program to test another alternative strategy for salinity control. Ground water flow reduction may be accomplished by the development of a ground water detention basin system. Each detention basin would be formed by a peripheral slurry trench/wall. One large basin and several small basins would be constructed near the Whitney area (now part of East Las Vegas) to verify the feasibility of this strategy. If a detention basin system appears feasible after 2 years of monitoring, additional large basins may be built. The construction of ground water basins may accomplish the equivalent salinity reduction expected from the bypass channel for the same cost and less local opposition.

Lower Gunnison Basin Unit (Reclamation and USDA)

The Lower Gunnison Basin Unit is located in the Uncompahgre Valley in west-central Colorado. The study area consists of lands irrigated by the Uncompahgre Project along the lower reaches of the Uncompahgre River in Delta and Montrose Counties. The area which encompasses the communities of Delta, Montrose, and Olathe are principally agricultural and agribusiness is of primary importance to the local economy.

The recommended plan of development for the Lower Gunnison Basin Unit consists of (1) elimination of winter water flows in the irrigation system, with replacement through the domestic water delivery system, and (2) concrete lining five separate Uncompahgre Project canal systems east of the Uncompahgre River.

The winter water replacement program would eliminate seepage from canals and laterals during the winter months. At the same time, it would allow more efficient livestock watering during winter with no resultant salinity impacts. The program could reduce annual salt loading from the study area by about 80,000 tons. Advance planning on the winter water replacement program is expected to be completed in 1987. Because the lining of the canals and laterals is less cost effective than other salinity control measures in other units, advance planning on this portion of the plan will be conducted after more cost-effective measures have been implemented.

The 1981 SCS onfarm report outlines an implementation plan that is compatible with the Reclamation plan. Four cost-effective subareas have been identified for high priority implementation.

Lower Gunnison Basin Unit, North Fork Area (Reclamation)

The Lower Gunnison Basin Unit-North Fork Area, is located in west-central Colorado on the Gunnison River in Delta County. The Gunnison River is tributary to the Colorado River. The unit area is bounded on the north by Grand Mesa National Forest, on the east by Gunnison National Forest, and on the south and west by the Gunnison River. Major communities in the study area include Cedaredge, Crawford, Hotchkiss, and Paonia.

The study area includes about 67,750 acres of irrigated land which includes farms, ranches, and orchards. A large portion of the study area is undeveloped land composed of soils derived from the Mancos Formation.

Preliminary salinity control concepts to be considered for this study include selectively lining canals and laterals and providing piped winter stock water rather than operating canals and laterals year-round. Other concepts will be considered as the investigation proceeds.

Water quality and quantity monitoring in surface streams is underway. A contract for aerial photography was completed during the fall of 1984 providing information for environmental, hydrosalinity, and engineering studies. A synoptic river survey will be conducted and a river budget completed during the summer of 1986. This data will aid in identifying the highly saline areas within the study area for more detailed study.

Lower Virgin River Unit (Reclamation)

This unit is located along the Lower Virgin River in northeastern Clark County, Nevada, and northwestern Mohave County, Arizona. The unit includes natural saline ground water averaging 2,400 to 3,400 mg/L along the Virgin River between Riverside and Lake Mead.

Since November 1981, the State of Nevada and a power company have been interested in developing the saline ground waters of the Virgin River as a source for powerplant cooling water. In January 1984, the Bureau of Reclamation reinitiated the Virgin River Unit Study to determine if a new water supply and salinity control project could be constructed on the Virgin River. The project needs to locate up to 50,000 acre-feet of saline water that can be used as powerplant cooling water.

Mancos Valley Unit (USDA)

This unit has met the prerequisite for construction and is awaiting funding. The Mancos Valley unit is a 9,200 acre irrigated area along the Mancos River, a tributary to the San Juan River. The report, Irrigation Improvements for Mancos Valley, was completed in 1985.

The recommended implementation plan includes 3,200 acres of sprinkler systems and other water management/salinity control treatment on about 5,500 total acres. About 17 miles of canal and lateral lining would combine many old earthen laterals. Total salt load reductions are estimated to be 8,800 tons per year with about 7,700 tons resulting from lateral improvements. About 57 landowners and 15 lateral companies or groups of landowners would be involved.

McElmo Creek Unit - Dolores Project (Reclamation and USDA)

The McElmo Creek Basin is located in southwestern Colorado and covers approximately 720 square miles. About 150 square miles of the basin, mostly in the east, are agricultural land. Early studies in the area show that salt loading results from both irrigation sources and diffuse sources, with irrigation being the main contributor.

Through a Multiple Objective Planning Process and Public Involvement Program, several alternatives were proposed to reduce salinity. The Reclamation recommended plan is to line three sections of Montezuma Valley Irrigation Company canals--two on the Lone Pine Lateral and one on the Upper Hermana Lateral--and to install laterals from the proposed

Towaoc-Highline Canal (a Dolores Project feature) to serve the Rocky Ford Ditch Service area. The Rocky Ford Ditch would then be abandoned as part of the plan, and its flows would be combined into the proposed Towaoc-Highline Canal. The plan will reduce ground water seepage from canals by 4,060 acre-feet a year and reduce the amount of salt returned to McElmo Creek.

Portions of the McElmo Creek Unit have been authorized for construction as part of the Dolores Project, a participating project of the Colorado River Storage Project. Included are seepage control from the Towaoc-Highline Combined Canal, Rocky Ford laterals, Lone Pine Lateral, and the Upper Hermana Lateral.

The McElmo Creek USDA salinity control report was published in 1983. The recommended implementation plans call for treatment of about 19,700 acres with sprinkler irrigation systems (10,400 acres gravity and 9,300 acres pumped) and about 270 miles of onfarm ditch and lateral lining.

By combining the DOI Dolores Project and the McElmo Creek salinity project, the more efficient gravity pressure sprinkler systems can be installed to an additional 9,000 acres over the original USDA implementation plan. The DOI and USDA projects are fully compatible; however, a fully coordinated effort has been initiated so the design and implementation of DOI delivery and distribution systems complement the design and installation of onfarm systems. A reevaluation of the USDA implementation schedule is underway to allow for coordinated onfarm and off-farm planning.

Meeker Dome Unit (Reclamation)

Meeker Dome, the site of several abandoned oil and gas exploratory wells, is a local anticlinal uplift in northwestern Colorado, 3 miles east of the town of Meeker and on the right bank of the White River.

During verification studies, the abandoned Scott, James, and Marland oil wells were cleaned and plugged. At the end of fiscal year 1985, monitoring of seeps and wells was terminated. Water levels in the observation wells had stabilized and springs and seeps remained dry or filled with standing water indicating the well plugs remained intact. The estimated cost effectiveness of this 19,000 tons reduction is $14 per ton. A planning report concluding the Meeker Dome Unit study was published July 1985.

Moapa Valley Unit (USDA)

The project covers a 5,000 acre irrigated area on Muddy River upstream of Lake Mead. The project includes installation of 17 miles of underground piped delivery system, onfarm water management, and salinity control practices. By reducing overirrigation and excessive deep percolation, it is estimated average annual salt load reductions to the Colorado River system will be 19,200 tons. This unit has met the prerequisite for construction and is awaiting funding. SCS published its report on Moapa Valley in February 1981.

Palo Verde Irrigation District (Reclamation and USDA)

The Palo Verde Irrigation District is a privately developed district located in Riverside and Imperial Counties, California. Water for irrigation is diverted from the Colorado River at the Palo Verde Diversion Dam and is conveyed through 295 miles of main canals and laterals to serve approximately 91,400 acres of irrigated land within the district. The irrigation return flows are collected in a 153-mile drainage system and returned to the Colorado River; however, the return flows are located below many of the areas impacted by salinity and would not have the full benefits of an upstream project.

An analysis based on 1974 operational data indicated that the 914,000 acre-feet diverted contained 945,000 tons of salt and that 467,000 acre-feet of return flows to the river contained 1,097,000 tons of salt. The difference of 152,000 tons of salt was the net discharge to the river. For analysis the district was divided into seven subareas, which were found to vary greatly in their salt discharge.

The subarea with the greatest discharge by a substantial margin is the Palo Verde subarea in the southwestern part of the district which discharged 144,000 tons. This subarea was found to be underlain by a sizable body of saline ground water that is gradually being flushed out by percolating irrigation leaching water and canal seepage. The ground water aquifer subject to flushing contains an estimated 6.65 million tons of salt, which is expected to be flushed out gradually by deep percolation of irrigation water.

The rate of salt discharged is theoretically proportional to the amount of subsurface drainage, so an improvement in water use efficiency would result in a reduction in annual salt discharge. The present on-farm irrigation efficiency in the Palo Verde subarea is estimated to be approximately

42 percent. The unlined water distribution system also contributes seepage to the ground water system.

In 1985, SCS and Reclamation formulated a joint plan of study. SCS will provide Reclamation with onfarm, onsite evaluations and analyses relative to irrigation efficiencies, deep percolation, and prospects for improved onfarm management. The USDA portion of the evaluation, however, has not yet been funded pending the outcome of Reclamation's Phase I work. Reclamation completed the shallow well drilling for the verification program in May 1985 and is sampling the test wells.

During 1987, Reclamation activities will complete Phase I work in developing hydrosalinity analysis for the Palo Verde Irrigation District Unit to determine the movements of ground water and source of salt loadings. The study will provide information for Reclamation, USDA, and the Palo Verde Irrigation District to determine salinity control program components and the need for further studies.

<u>Paradox Valley Unit (Reclamation)</u>

Paradox Valley, a collapsed salt anticline, is a northwest-southeast trending valley 3 to 5 miles wide in southwestern Colorado. Geologic investigations in the Colorado Plateau have established the existence of a series of five major northwest-southeast trending salt anticlines (elongated swells), about 100 miles long. Paradox Valley lies along the axis of one of these salt anticlines and was formed from erosion of faulted and uplifted sandstone and shale formations above a residual gypsum cap overlying about 14,000 feet of pure salt and salt-rich shale. The Dolores River remained in its ancient streambed as the uplift and erosion of the valley developed.

Ground water comes into contact with the top of the salt formation where it becomes nearly saturated with sodium chloride and surfaces in the Dolores River channel in Paradox Valley. Studies conducted by the Bureau of Reclamation have indicated that the river picks up over 205,000 tons of salt annually as it passes through the valley.

The ongoing testing program consists of verification and refinement of controlling brine inflow to the river, design data collection for future facilities, and drilling and testing an injection well. Reclamation is using outside consultants for its technical assistance on deep well injection. A test injection well will be constructed to determine characteristics of the disposal formation. Based on these characteristics, the required number and location of disposal wells will be determined, well design will be completed, and required surface facilities will be determined. After analyzing the total required facilities and projected operation, maintenance, and replacement costs, a final decision on whether or not to use deep well brine disposal will be made.

The injection well will be drilled and tested in 1987. When positive test results are obtained, the original Definite Plan Report will be amended, and the National Environmental Policy Act (NEPA) requirements will be fulfilled. The constructing of permanent facilities will then follow the approval of the amended plan. Construction should be completed by 1989.

Conditional water rights were obtained from the State of Colorado, and the State has approved pumping and well testing as stipulated in existing well permits. Reclamation will apply for permanent water rights when an actual beneficial use, the improvement of water quality in the Dolores River for downstream water users, is achieved.

Price-San Rafael Rivers Unit (Reclamation and USDA)

The Price-San Rafael Rivers Unit is located in east-central Utah, 120 miles southeast of Salt Lake City, encompassing Carbon and Emery Counties. U.S. Highway 50 is a major north-south road in the area passing through Price and Green River, Utah. Both the Price and San Rafael Rivers drain into the Colorado River via the Green River.

The Irrigation Systems Improvement Alternative had been selected as the preferred plan. The plan was to consist of two components--lining canals with the highest amount of leakage and lining stockwater ponds to improve winter watering practices. However, field verification tests conducted during November 1984 indicated that the canal seepage is not as great as expected. Consequently, the canal lining component of the plan was deleted.

Reclamation and SCS are looking at new combined alternatives that would include placement of laterals in pipe and a combination of the laterals with the gravity sprinkler irrigation systems. SCS and Reclamation are evaluating potential for a joint and fully coordinated salinity project which may result in SCS-BR reports on two subareas.

USDA has participated in public meetings to discuss onfarm salinity program and has kept the local sponsors informed on opportunities for funding and technical assistance.

<u>Saline Water Use and Disposal Opportunities Unit (Reclamation)</u>

<u>Powerplant Cooling</u>. - Installation of a test loop for saline water cooling has been completed at the Etiwanda Power Plant near Ontario, California. The selected hardware will be evaluated under actual field conditions to verify technical performance and operation. A parallel study of the economic impacts of the test loop and selected hardware is also underway. The economic study is tailored after previous studies completed at Hunter and Jim Bridger powerplants. An earlier contract study of saline water use in Jim Bridger Power Plant found that by using side-stream softeners and disposal ponds, about 8,000 acre-feet per year of Big Sandy River water could be used. Total in-plant costs were about $70 per ton. However, when the costs of well construction features and pipeline costs were included, the total increased to between $146 to $152 per ton. These costs were not competitive with other salinity control units.

A letter of agreement for cost sharing the hardware study has been extended to December 1986. Cost sharing for the program is provided by Reclamation, EPA, State of California, Sephton Water Technology, Pacific Gas and Electric, and Southern California Edison.

Under an existing Basic Agreement with Consultant Jack Laughlin, a final study contract is examining the technical and economic feasibility of using Lower Virgin River Water at the proposed 1000 MW Harry Allen Power Plant near Las Vegas, Nevada. The study will establish the in-plant costs of using brackish water from the Lower Virgin River as compared to alternative supplies. Opportunities for cost sharing further studies and construction of a water supply system for the proposed (1995) powerplant will be pursued with Nevada Power Company. Test results from the Etiwanda study will be incorporated into the process concepts proposed for the Harry Allen Plant.

<u>Aquaculture</u>. - International Bio Resources, Inc. and Denver Engineering Corporation completed a contract study for the use of a Salt Tolerant Emergent Plant (STEP) process to beneficially use, concentrate, and dispose of saline water. Economics of the STEP process were applied to the Glenwood-Dotsero Springs Unit. Although unit costs under $100/ton were claimed in the study, technical issues related

to production rate, evaporation rate, forage value, etc., could not be addressed due to lack of field experience. Moreover, remaining questions related to "beneficial use" and water rights of Glenwood Springs, coupled with lack of government funding for continued research, have halted the study effort.

San Juan River Unit (Reclamation)

The San Juan River Unit investigations began in November 1985 with the objectives of locating salt sources and identifying control methods. The study area includes the entire 23,000 square mile watershed from its headwaters in south-central Colorado to its mouth at Lake Powell. The drainage contributes approximately one million tons of salt annually to the Colorado River Basin. Early reconnaissance shows significant salt loading in the river between Shiprock, New Mexico, and the Four Corners. At Bluff, Utah, the annual flow of 2,047,000 acre-feet of water contains 1,165,000 tons of salt. About 18 percent of this salt loading occurs between Shiprock and Bluff but only 7 percent of the water is added in this reach.

The study area was broken into about 20 sub-watersheds and geographic areas. Since November 1985, water quality sampling and flow measurements throughout these subbasins have been made to gain an understanding of salinity mechanisms. The study area covers many thousands of square miles of natural resource lands as well as agricultural, municipal and industrial areas which may contribute controllable salt. Most of the natural source of salt is contributed by surface runoff and ground water discharge from the Nacimiento Formation and Mancos Shale. Many thousands of acres of vegetation, along the streams and washes, worsen the conditions by concentrating the salts. Irrigation projects, coal-fired powerplants, surface mining operations, oil & gas fields, and refinery operations also contribute to the salinity problems.

On the Hammond Project, Navajo Indian Irrigation Project (NIIP), and the Hogback Irrigation Project (also a Navajo Indian project) are the principal irrigation sources of salt in the basin. Preliminary canal seepage and drainage investigations have been made on the Hammond Project and justify the need for more detailed testing. Historic flow and water quality data from subsurface drains show that the irrigated area contributes about 18,500 tons salinity annually. The NIIP irrigated area has recently started discharging water above 3000 mg/L, mostly in the Gallegos and Ojo Amarillo Washes. These are both wide and deep sandy washes and the drainage water could be collected in them if disposal or industrial-use alternatives appear feasible.

The Hogback Project contributes heavy salt loading but the mechanisms have not yet been explored. Ground water accruing to the San Juan alluvium in this vicinity shows salinity concentrations of over 15,000 mg/L. Other manmade salt contributions include abandoned gas or oil wells which have developed leaks at the wellhead, coolant discharges from powerplants, and waste water from a petroleum refinery.

As the information in this early stage of investigation is gathered, potential solutions are being developed. Costs for lining the canals in the area are being estimated, methods of controlling the salt discharge from those areas north of the river are being identified and potential industrial users will be contacted. Environmental and other planning considerations, such as water rights, are being evaluated. The conclusions from this appraisal of the basin will be made by the fall of 1986.

If at least one cost-effective and acceptable alternative can be identified, the study will continue toward identifying the best plans for reducing salinity in the basin. A Planning and Environmental Document is scheduled for the fall of 1989.

<u>Sinbad Valley Unit (BLM and Reclamation)</u>

The Sinbad Valley Unit is located in western Colorado, south of the town of Gateway. Salt Creek drains Sinbad Valley and has been identified as a point source of saline ground water contributing an estimated 5,000 to 8,000 tons per year of salts to the Colorado River system. Saline ground water discharge from the Paradox member of the Hermosa Formation and overlying alluvium in Sinbad Valley is responsible for high concentrations of dissolved solids, primarily sodium and chloride, in Salt Creek. This ground water is discharged through a series of springs and seeps near the mouth of Sinbad Valley.

The BLM initiated a feasibility report for the interception and disposal of these saline waters during fiscal year 1982 and prepared a report on Sinbad Valley in April 1983. This report recommended that lead responsibility and funding be assumed by Reclamation.

Six appraisal level alternatives for the Sinbad Valley Salinity Study were developed. The cost effectiveness of the three most attractive alternatives ranged from $65 to

$69 per ton reduction. Before a preferred alternative can be selected, an environmental assessment needs to be completed. Sewemup Mesa, located immediately east of Sinbad Valley, is a wilderness study area and is also proposed as an Outstanding Natural Area in the Resource Management Plan. The area has high visual sensitivity, both onsite and along a powerline alignment, and has Peregrine falcons nesting in it.

The Sinbad Valley feasibility study indicates that additional information is needed before final selection can be made among the various alternatives. First, additional discharge and conductivity measurements are required to define salt loads of high flows. Second, onsite evaporation data are needed to further refine the sizing of evaporation ponds. A pan evaporation station should be established and operated in Sinbad Valley for at least one year. Third, the abandoned wildcat well, No. 1, Sinbad Unit, should be evaluated for injection suitability. Other questions which need to be resolved include water rights and the compatibility of the project with existing land uses.

<u>Uinta Basin Unit (Reclamation and USDA)</u>

The Uinta Basin Unit is located in northeastern Utah. The unit area includes portions of Duchesne and Uintah Counties and is situated between the Uinta Mountains on the north and the Tavaputs Plateau on the south. The principal communities within the area are Duchesne, Roosevelt, and Vernal.

<u>Phase I</u>. - Uinta Basin Unit alternatives which were evaluated include lining irrigation canals and laterals to reduce seepage losses and thus reduce the salt load carried to the Colorado River; collecting saline water and disposing of it through deep-well injection, evaporation ponds, or a desalting plant; using saline water for energy development, transportation of coal through a coal-slurry pipeline, or cooling purposes at a local powerplant; and the retirement from irrigation of high-salt-contributing lands. As determined by the Bureau of Reclamation's four tests of viability (completeness, effectiveness, efficiency, and acceptability), the only viable alternative is canal lining.

Under the canal-lining alternative, 55.5 miles of the total of about 240 miles of canals and laterals in the Uinta Basin would be lined with concrete. Project implementation would reduce the salt load to the Colorado River by an estimated 21,000 to 30,000 tons per year and reduce canal seepage by about 16,800 acre-feet per year, of which about 4,600 acre-feet could be used to reduce irrigation shortages.

An integrated planning report/draft environmental impact statement on the unit has been prepared and was released to to the public on April 25, 1986. The final document is scheduled to be completed and filed with the Environmental Protection Agency in March 1987. Design-data collection and other advance-planning activities are scheduled to begin in October 1987. Construction of the unit is scheduled to begin in fiscal year 1990.

Phase II. - Uinta Basin Unit Phase II alternatives which will be evaluated include:

1. A joint Bureau of Reclamation-Soil Conservation Service program of lining canals and laterals in conjunction with onfarm irrigation system improvements;

2. Lining canals and laterals not considered under the phase I study;

3. "Combining-and-lining," that is, eliminating a canal by transferring its water to another canal which would be lined;

4. Eliminating winter water now diverted through canal systems;

5. Retiring high-salt-contributing lands from irrigation; and

6. Using saline water for industrial purposes.

A draft plan of study is being prepared and is scheduled to be completed and approved in September 1986. Planning activities are scheduled to begin in October 1986, with a "preliminary findings" report prepared by November 1987.

To date, over eighty percent of the Uinta Basin USDA onfarm and supportive off-farm salinity control improvements have been implemented through the use of LTA's (Long Term Agreements). More than ninety percent of the participants who entered into LTA's have done so through pooling arrangements whereby two or more participants develop mutually beneficial plans. A major emphasis has been placed on comprehensive planning and LTA preparation. Participants are assisted in implementing a well-balanced improvement program of structural and management practices that address salinity reduction and wildlife habitat enhancement.

In calendar year 1985, 70 LTA's were authorized for implementation. These agreements, when completed, will minimize salt loading impacts from 3,368 acres of irrigated cropland and 4,500 linear feet of off-farm irrigation system laterals. In addition to practices in LTA's, 55 annual practices were installed which partially treated 1,485 acres of irrigated cropland.

At the of end 1985, salinity program participants had achieved irrigation water management on 18,000 acres and reduced salt loading to the Colorado River by an estimated 15,447 tons. Treatment of 23,169 linear feet of off-farm laterals has reduced salt loading by an additional 3,711 tons. Overall, average annual salt reduction to date has been 19,158 tons. Approximately 26 percent of project funds have been obligated and approximately 19 percent of projected salt load reduction benefits have been achieved.

Virgin Valley Unit (USDA)

The area consists of about 5,000 acres of irrigated land owned by about 50 individuals. Four irrigation companies or districts would also be involved with improvements of about 6 miles of off-farm canal and lateral improvement. Deep percolation reduction is estimated to be 19,000 acre-feet per year and salt load reductions are estimated to be 37,200 tons per year.

While the Virgin Valley is independent of any Reclamation salinity control project, the downstream impacts on Reclamation's Lower Virgin River Unit are to be evaluated by Reclamation and SCS collectively. Otherwise, this unit has met the prerequisite for construction and is awaiting funding. The Virgin Valley report was published in March 1982.

State NPDES Salinity Discharge Permitting

The States of the Colorado River Basin, the Federal Executive Department, and Congress have adopted the policy that the salinity of the lower main stem of the Colorado River shall be maintained at or below the flow-weighted average values found during 1972 while the Basin States continue to develop their compact-apportioned water. The flow-weighted averages are referred to as numeric criteria at three downstream stations--below Hoover Dam, below Parker Dam, and at Imperial Dam. The numeric criteria for those three stations are 723 mg/L, 747 mg/L, and 879 mg/L, respectively.

Although the numeric criteria have not been exceeded since the Forum adopted its policy, it is anticipated that without salinity control measures, as the States continue to develop their compact-apportioned water supply, the criteria will be exceeded. Therefore, the seven States, working collectively within the auspices of the Colorado River Basin Salinity Control Forum, have from time-to-time adopted additional policies to help facilitate the control of the salinity in the Basin. In 1977, the Forum adopted the "Policy for Implementation of Colorado River Salinity Standards Through the NPDES Permit Program." The policy deals with both industrial and municipal discharges to the river system. With respect to effluent limitations for industrial discharges the stated objective is no-salt return to the river wherever practicable. The policy with respect to municipal discharges is that the incremental increase in salinity shall be 400 mg/L or less than the average salinity of the intake water supply. This policy is being implemented through the NPDES permit program.

In 1980 the Forum adopted a policy encouraging the use of brackish and/or saline waters for industrial purposes. This use of saline waters by industry combined with the "no-salt" discharge policy will reduce the salt load to the river system.

In October 1982, the Forum adopted a policy concerning intercepted ground waters. The 1982 policy more clearly defines those aspects dealing with intercepted ground waters addressed under the 1977 policy. The NPDES permit program is used to facilitate the 1977 and 1982 policies. There is a separate NPDES permit program in each of the States, with authority derived from the Federal Clean Water Act, Public Law 92-500. A brief status report as to the program in each of the States follows.

Arizona. - The authority for issuing NPDES permits has not been delegated to the State and still resides in the Region IX office of EPA. Currently, the State prepares the permits, solicits public comments and involvement, and forwards a final draft of proposed permits to EPA for signature and issuance. For waters tributary to the Colorado River above Imperial Dam, there are three industrial discharge permits now issued by the State of Arizona. There are also 31 municipalities or quasi-public NPDES permittees in the watersheds of Arizona above Imperial Dam.

California. - California has authority to issue NPDES permits. In recent years there have been no applications for industrial discharge permits in the Colorado River drainage in California. Only one municipality in the drainage area has been reissued a municipal discharge permit in recent years. This permit is consistent with Forum policy.

Colorado. - Colorado has the authority to issue NPDES permits. There are 333 permits in the Colorado River Basin portion of the State. Most of these are for minor municipal or industrial facilities. Of these 333 permits, 13 are major or significant industrial permits, and 21 are major or significant municipal permits.

All new or reissued permits have been brought into compliance with the Water Quality Control Commission's regulation for implementation of the Colorado River salinity standards. This is being accomplished through the discharge permit program. Action of particular note in the past year include requirements that three major municipal dischargers demonstrate the non-practicability of preventing a greater than 400 mg/L increase in salinity in their wastewater systems, and amendment of all industrial permits which lacked salinity monitoring requirements.

Nevada. - The authority to issue NPDES permits has been delegated to the State of Nevada. The industrial discharges into water tributary to the Colorado River in the State of Nevada are located in the Las Vegas Wash area. Permits have been issued to industrial companies at Henderson and strategies of piping and ponding discharge waters are being implemented. Nevada has also issued permits that prohibit Nevada Power Company from discharging brackish waters from its two generation stations in the drainage. Two of the three major municipalities in the Las Vegas Wash area have been issued discharge permits that are in keeping with the Forum policy. The third major municipality in the area, the city of Las Vegas, has been involved in lengthy discussions, negotiations, and litigation concerning the terms of its discharge permit. When the permit is reissued, the State will ensure that the requirements of the Forum discharge permit policy are fully implemented.

New Mexico. - Authority for issuing permits has not been granted to the State of New Mexico, and the program is being administered by EPA, Region VI. EPA is following the discharge permit policy of the Forum. There are currently 17 industrial, 10 federal, and 6 municipal discharge permits issued in the State of New Mexico within the Colorado River drainage. Some permits are not in compliance with Forum policy due to monitoring requirements, although corrective measures are being taken. Many expired permits are currently under administrative extension by EPA. New permits will require compliance with Forum policy as they are reissued.

Utah. - Major industrial permits are drafted by EPA, and minor industrial permits are drafted by the State of Utah.

EPA maintains the authority for the issuance of the permits, but all permits are reviewed by the State for compliance with Forum policy. There are 72 NPDES permits in effect for industrial discharges in the State of Utah in the Colorado River drainage. There are also 31 municipal permits in the State in that drainage. Twenty-one of these municipal facilities provide total containment. Since 1977 and the enactment of the Forum policy, all reissuance of discharge permits has been in compliance with the Forum policy.

Wyoming. - The State of Wyoming has the authority to issue NPDES permits and the State follows the Forum policy in the issuance of these permits. The State is giving particular attention to the discharges from the Pacific Power and Light Company Jim Bridger Powerplant located in Sweetwater County. That plant is currently operating under a conditional discharge permit; it is anticipated that with the installation of air pollution control devices over the period of the next 6 years, water discharge will be eliminated from that plant. Wyoming has issued 13 municipal permits for discharges to tributaries of the Colorado River. These 5-year permits are for relatively small discharges and are reissued in compliance with the policy of the Forum when they reach their expiration dates.

SALINITY RESEARCH

U.S. Department of Interior - Salinity Research

Through funding and direction by the Bureau of Reclamation, the USGS has become more involved in several aspects contributing to the analysis of the Colorado River Salinity Control Program. These include: the gathering of basic data, extending data records, automating the analysis of data using new computer techniques, documenting the methods and results, and helping to identify and quantify sources of salt loading.

Beyond investigating potential salinity control units, Reclamation has also contracted to review the economic impacts of salinity.

Characteristics and Trends in Dissolved Solids in the Upper Colorado River Basin [Liebermann, Choquette, and Bell]

This study evaluates historical water use in relation to dissolved solids concentration in the Upper Colorado River Basin. The report also identifies sources of dissolved solids loads, trends, and concentrations. Annual and monthly dissolved solids were estimated for 70 streamflow gaging stations using regression techniques. Major dissolved constituents also were estimated. Nonparametric trend analysis was used to determine long term trends resulting from major interventions upstream.

The major changes in streamflow and dissolved solids in the Upper Colorado River Basin, during the period of record, have been caused by the construction of Lake Powell.

Controlled outflows and mixing of seasonal inflows stored in the reservoir have greatly reduced the seasonal and annual variability in discharge and dissolved solids concentrations and loads. In general, other trend detected at stations are of a local nature, and do not reflect basinwide changes.

More detailed results will be available later in a USGS Open File Report (not yet published).

Estimation of Natural Dissolved-Solids Discharge in The Upper Colorado River Basin [David K. Mueller and Lisa L. Osen]

A statistical method was developed to estimate monthly natural dissolved-solids discharge at selected sites in the Upper Colorado River Basin. Natural dissolved-solids discharge was defined as the rate of inorganic-solute flow past a specific site that would have occurred if there had been no water-resources development in the basin upstream from the site. The method used weighted least-squares regression to fit a model of dissolved-solids discharge as a function of streamflow and several variables representing development. After the model had been calibrated for an individual station, the development variables were removed, leaving the relation between dissolved-solids discharge and streamflow for conditions of no upstream development. Natural dissolved-solids discharge was calculated using this relation and estimates of natural streamflow provided by Reclamation.

Limitations of the method included a lack of data to verify the natural dissolved-solids discharge estimates and to adequately represent all the effects of development. However, model statistics indicated a good fit to historical data. Also, mean annual natural dissolved-solids discharge values were approximately equal to mass-balance estimates.

Some additional items included in the report are also of interest. The natural (pre-development) annual salt load for the Colorado River at Lees Ferry, Arizona, was estimated in the study to be 5.3 million tons per year. The average salt load from 1941 to 1983 was 7.7 million tons per year. Apparently development is responsible for an increase in salinity of approximately 2.4 million tons per year. Or in other terms, the effect of development has caused salinity at Lees Ferry to increase from an average of 250 mg/L to 551 mg/L.

It was also noted in the report that the effect of Lake Powell reduced the monthly variation in salinity below Glen Canyon Dam from 299 mg/L to 72 mg/L. The annual variation was similarly reduced from 106 mg/L to 42 mg/L.

Salinity Loading in Las Vegas Wash

During FY 1986, the Bureau of Reclamation and the Geological Survey developed a cooperative investigation with the major purpose to determine whether proposed engineering plans aimed at reducing salt loading to the Las Vegas Wash near Henderson are feasible and effective. One plan proposes building a detention basin which includes a dike and slurry wall (vertically through the aquifer) which they predict will capture and retard saline ground-water flow from entering the wash. The hypothesis is that the saline water behind the slurry wall and dike will stratify leaving fresher water at the surface which will flow out of the detention basin and into the wash. Ultimately, Reclamation plans on building a series of 14 detention basins along the wash if it is determined that these basins are effective measures in reducing the total salt content entering Lake Mead. The second part of the plan has already been completed by the Bureau and consists of a pipeline which carries cooling water from three chemical plants directly to the wash nearly 3/4 of a mile down gradient. Originally, the cooling water entered an unlined channel where it is infiltrated into the gypsum rich alluvium in this part of Las Vegas Valley.

The objectives are to determine whether these two measures are feasible and effective means to reduce salt loading to the Las Vegas Wash and ultimately Lake Mead. After sufficient data have been collected, SUTRA will be used as the primary tool to meet our objectives. SUTRA is a two-dimensional single-species solute transport model which can handle density dependent flow. After accurately identifying the flow system in these areas, various scenarios will be tested as how to best model the transport of salts. Further geochemical studies are still needed to define the processes involved.

The study is currently in the data collection stage. About 120 wells in the two areas have been used to obtain water levels, water-quality samples, and aquifer parameters needed to understand the system. More drilling and well installation is planned to help to understand more fully the hydrologic and geochemical processes that influence this complex setting.

Estimation of Salinity Loads, Lower Colorado River

International Treaty agreements between the United States and Mexico provide for the control of the quantity and quality of the waters of the Colorado River entering Mexico. The Colorado River Basin Salinity Control Act as amended in 1984 (Public Law 98-569) provides the Departments of the Interior and Agriculture the authority to implement salinity controls in the basin. These controls insure compliance with standards that have been established and accepted by the basin States for selected locations on the Colorado River main stem.

Salinity concentrations in the Colorado River are associated with water use, agriculture, municipal and industrial development, trans-basin diversions, and natural sources. To fulfill management responsibilities, the Bureau of Reclamation must determine the degree to which the various sources of salinity impact river quality as well as the effectiveness of alternate salinity control technologies. A tool in the management of the River is a data base of sufficient duration that will allow for projections of flows and salinities to some point in the future.

The objective of this study is to develop a data base of monthly discharges and salt loads for the calendar year period 1935 to current year, or as appropriate, for selected sites on the Colorado River from Imperial Dam to the Southerly International boundary. This includes estimating monthly salt loads and monthly flow data wherever data are missing and documenting procedures.

To fulfill the objectives, the following approach will be used:

1. Determine the availability and completeness of flow records and water quality records at 10-11 stations below Imperial Dam;

2. Enter data into a computerized data base;

3. Utilize appropriate statistical programs to develop techniques to fill in missing periods of record for flow and salinity;

4. Prepare an Open-File report summarizing the techniques used to estimate salinity loads, and

5. Furnish a review copy to Reclmation by Fall 1986.

Economic Update to Salinity Impacts

While the concept of cost-effectiveness generally supports project selection and order of implementation, the determination of the overall economic benefits due to program implementation remains an important aspect. Estimates of economic benefits are addressed formally in planning reports and are frequently used in public documents.

A preliminary analysis of economic impacts of salinity was initiated in 1974, resulting in a 1980 report entitled Economic Impacts on Agricultural, Municipal, and Industrial Users by Messrs. Kleinman and Brown. Since this earlier work, there have been many changes in water use, treatment, equipment costs, etc., that affect present and future salinity damage levels.

A contract study was initiated in June 1986 to provide a better estimate of present and future salinity damages under various water use scenarios and economic conditions. The study will focus primarily on the municipal and industrial water use sectors in the Lower Basin. The study contractor, Milliken-Chapman Research Group, Littleton, Colorado, will submit a final report to Reclamation by January 1987.

U.S. Department of Agriculture - Salinity Research

The Department of Agriculture, through the Agricultural Research Service, continues to provide the Salinity Control Program with valuable basic research. Some of their studies are summarized below.

Isotope Determination of Water Sources

Existing methodology to determine sources of return flow and salt loading requires prohibitively time consuming and expensive studies of water and salt fluxes on and off individual fields and determination of hydrologic gradients and flow rates. An alternative methodology with relatively low costs involves use of stable isotopes as well as the chemical compositions of surface and ground waters. In the Grand Valley, the isotopic differences between local ground water (as measured in the upland areas) and the Colorado River water used for irrigation are sufficiently large to enable estimating the relative contributions from these two sources Water samples were taken in the winter from all the washes in Grand Valley.

Since there were no irrigation flows nor surface flows from upland areas, the flow in the washes should represent the composition of the ground water recharging into the Colorado River. This isotopic composition of the washes was very uniform, indicating that approximately 85 percent of the return flows are drainage waters from irrigation and only 15 percent from non-irrigated recharge. Analysis of well waters revealed that the most saline waters had smaller contributions of irrigation water than did the more dilute waters. The salt contribution in return flows due to irrigation is thus less than the contribution of irrigation to return flow volumes. The contribution of on-farm deep percolation could not be accurately separated from canal and lateral seepage based on stable isotopes and solution composition. Based on these procedures, it is estimated that these processes contribute roughly equal volumes of water to the subsurface.

Soil Salinity Monitoring Instrumentation

A limiting factor in evaluating the salinity status of soils and the maintenance of a productive irrigated agriculture is the availability of practical methods of measuring soil salinity on a large area basis. Developmental work is continuing on the field use of time-domain reflectometry (TDR) for the simultaneous measurement of soil water content and electrical conductivity over identical sampling volumes. Experimental work has shown that a small correction factor is needed for the theoretically derived attenuation coefficient. Successful electrode insertion and measuring techniques have been developed and used for field sampling of water content and salinity. Contractual work on measuring the soil dielectric constant (water content) with a 4-probe electrode configuration is in progress.

Irrigation With Saline Water

Reuse of drain water for irrigation would reduce the volume of brackish water returned to the Colorado River. A strategy has been developed to reuse this water while maintaining a suitable agricultural water supply and crop production. Using this management strategy, drainage water is substituted for irrigation water when irrigating certain crops in a tolerant growth stage. The salt buildup resulting from irrigating salt tolerant crops with drainage water is subsequently alleviated by irrigating salt-sensitive crops with low salinity water. Since previous reports, cantaloupes were grown without loss of yield in successive crop-rotation fields for the second time, concluding the repeat of the two year rotation of wheat-sugarbeets-melons in which 75 percent of the irrigation needs of wheat and sugar beets were supplied with 3,500 mg/L drainage water. Alfalfa was grown for a year (six cuttings) without yield loss, concluding a four-year rotation of cotton-cotton-wheat-alfalfa, in which substantial brackish water was used to irrigate cotton.

Computer Mapping of Irrigated Areas

Salinity maps are needed to assess the extent, nature, and severity of salinity problems. These maps can serve as a basis for planning, monitoring, and managing salinity in irrigated lands. The developed technique includes instrumental measurement techniques and a computerized geographic information system.

A 15 square-mile irrigated area was sampled on an approximately 1/8 mile grid basis. The desired sampling point was located using a LORAN system. At each point soil salinity was measured using electromagnetic instruments, a wide spacing 4-probe electrical resistivity array, and a vertical 4-probe array; and water content was determined using time-domain reflectometry. Surface soil samples were taken for laboratory analysis of water content and salinity. Evaluation of this data will enable development of a suitable instrumental procedure for large scale salinity mapping. The salinity information will be input to an appropriate computerized geographic information system. This system will be developed to allow for overlay, as well as single parameter mapping and to make statistical evaluations of spatial relations among the mapped attributes such as cropping patterns, depth and salinity of ground water, soil type, and irrigation management. This information will be evaluated for its suitability for salinity assessment, prognosis, and inventorying.

Canal Delivery Systems

For irrigated agriculture to respond to changing markets, new crops and new practices to reduce salt loading, a flexible irrigation delivery system is required. Such flexibility exists on farms that obtain water from wells, but not on most existing canal delivery systems.

Detailed monitoring of lateral canals has begun in the Wellton-Mohawk Irrigation and Drainage District and the Imperial Irrigation District. Inflows, outflows, and water levels are being precisely measured to provide a data base from which the effects of system management and structures on flow transients and delivery uniformities can be studied.

The Wellton-Mohawk Irrigation and Drainage District (WMIDD), located along the Gila River east of Yuma in southwestern Arizona, provides water to about 50,000 acres of farmland. Water is ordered with three days notice for any duration and standard deliveries of 15 cfs (with 20-25 cfs more common), and ditchriders are on 24-hour call. A cooperative agreement was reached with the WMIDD to study canal operations, principally through the detailed monitoring of flow along two lateral canals, one near the upstream end of the district where main canal levels and flow should be reasonably stable, and the other near the downstream end where main canal flows vary widely.

The Imperial Irrigation District (IID) provides water to 500,000 acres of farmland in the Imperial Valley. Water is ordered from IID with three days notice for 24-hour durations, standard deliveries of 11 cfs, (but less can be requested) and the ditchriders work 8-hour shifts. A monitoring project similar to that in WMIDD has been initiated in IID to compare the differences in scale and operating procedures. This project dovetails very well with an ongoing IID conservation project aimed at reducing tailwater losses. Under cooperative arrangement with IID, the ARS principal responsibility will be data analysis, while IID will install the monitoring equipment and collect most of the data.

Dual-Acting Controlled Leak Control Scheme

There are basically four existing techniques for regulating flow rates into canal laterals:

1. Manual control of gates or valve openings,

2. Neyrtec or Neyrpic constant-discharge modules,

3. Manual or mechanically operated movable weirs, and

4. Automatic downstream local control structures in conjunction with weirs or flumes.

The controlled-leak or Denaidean system, used on several Arizona and California canals, consists of a loosely housed large float or "piston" connected by cable or lever to the gate to be controlled. The "piston" is actuated by a skimming weir placed at the level to be controlled. The resulting water level is used to fill the piston chamber and works against a lead from the chamber bottom through an orifice opening. Thus, a rising controlled water level will cause "piston" movement, and consequently gate movement, to bring the controlled surface back to the limited-spill level. The limitations on this system are that the skimming weir mechanism is rather cumbersome and costly to construct in an adjustable mode and control levels achieved are on the order of 210.1 foot.

A new controlled-leak mechanism has been developed to eliminate these problems and to increase the control accuracy. The new system is called the Dual-Acting Controlled Leak system in that the "piston" chamber inflow and outflow are manipulated by the deviation in the controlled water surface, instead of just the weir inflow rate on previous versions. Water for the piston float chamber is obtained from any pressure source, usually the high water behind the gate to be operated. This pressure source is modulated to and from the piston/float chamber through two float-operated valves placed to sense the controlled water surface. The valves are plumbed to work from the same water surface, one feeding pressure flow to the piston/float chamber and the other leaking water from the chamber. The mechanism is small enough to be easily adjusted to any flow level and sensitive enough to control the water surface to 21 3mm (1/8 inch).

Canal Control Schemes

Accurate measurement of flow rates and hydraulic heads that drive a system are required to assure accurate flow rates at a canal branch as incoming flow rates change. A computer program is being developed to assess the sensitivity of branching structures to inaccurate flow or hydraulic head measurements.

Variability of Infiltration Rates

Two recirculating infiltrometers were used during the 1985 irrigation season in the Grand Valley of western Colorado to evaluate the effects of tillage methods on intake and to quantify infiltration variability on a given field. Infiltration parameters have been calculated for three major Grand Valley soils, based on data from inflow-outflow measurements. For a typical opportunity time, intake was commonly twice as high for non-wheel as for wheel track furrows. Variation between nearby wheel track furrows for a single irrigation was sometimes more than two-fold while variation from early to late season was five- or six-fold.

High Water Table Effects on Irrigation Water Requirements

Weighing lysimeters containing water tables of varying depth and salinity were used to determine effects of these conditions on irrigation requirements of spring wheat. Poor wheat growth surrounding the lysimeters limits the validity of the first year's data. Measurements on spring wheat will be continued for two more years. Prior years' studies on corn indicated that irrigation applications could be reduced about two-thirds for a water table depth of 60-cm and about one-third for a 105-cm water table depth for values of ground water salinity up to 6 deciSiemens per meter, the highest tested.

Improving Irrigation Systems

Salt loading results from excessive deep percolation caused by applying excessive water and from nonuniform distribution of water. Accurate application of the desired amount of water is essential to reduce deep percolation which generally requires some form of automation of surface irrigation systems. Excess application usually occurs at the upper end of fields during the first irrigation after plowing. Minimum tillage or recompaction of furrows can enable applying light, uniform water applications.

Two additional cablegation systems were installed in the Grand Valley in Colorado bringing the total number of systems there to seven. All seven systems were used for all irrigations, and the operators were pleased with their performance. A two-day cablegation training course was given to Colorado SCS personnel, including several working in the Grand Valley.

Two cablegation systems in the Grand Valley were evaluated for the total 1985 season. Both farmers applied water an average of every 10-11 days after July 1, the normal interval for the area. Net application depths varied from 27 mm to 60 mm with a seasonal total of 390 mm (15 in) on one field, and from 62 mm to 140 mm with a seasonal total of 770 mm (30 in) on the other field. Corn consumptive use for the area was about 570 mm with about 100 mm of that provided by precipitation. One farmer deep percolated very little water and may have stressed portions of his field, while the other deep percolated about 300 mm or 25 percent of his gross application and 40 percent of his net application. Thirty-two percent and 40 percent of the gross applications ran off the two fields, respectively.

Due to the relatively low base infiltration rates (2-3 mm/h) of the fields and the higher initial inflow rates cablegation provides, water distribution down the furrows, calculated from measured intake opportunity times and base infiltration rates, was good with no more than 15 percent more water applied to the top of the field than the bottom, even during the initial irrigation.

Four cablegation systems in Grand Valley, two in southern Idaho, and several in western Nebraska have been evaluated over the last two years. These evaluations show that cablegation systems can be, and often are, operated to irrigate efficiently. However, poor performance, primarily in the form of excessive application and runoff, has been observed, due primarily to the farmer not monitoring and adjusting his system to the varying soil conditions.

Improving Furrow Infiltration Uniformity

Furrow-to-furrow infiltration variability was measured on five fields in the Grand Valley. The infiltration coefficient of variation ranged from 21 percent to 44 percent and averaged 29 percent. On four of the five fields, one or two of every three furrows infiltrated at significantly higher rates than the remaining furrow(s), due to tractor wheel compaction during cultivation and planting. Unpacked or soft furrows infiltrated an average of 46 percent more water. This implies that, if the packed furrows received the desired amount of water, 46 percent of that applied to the soft furrows or 15 percent of the net application to the field (assuming one-third of the furrows are soft) will deep percolate just due to wheel compaction. Elimination of wheel packing differences will reduce the furrow-to-furrow infiltration variance by 30-50 percent. Both random and tillage-caused infiltration variability will result in significant deep percolation, even when net water applications are not greater than the available soil moisture storage capacity.

Techniques such as furrow compaction and flow interruption (surge) can be applied to decrease infiltration rates, while organic matter incorporation and furrow chiseling can be used to increase infiltration. During 1985, these factors were studied in the Grand Valley on both Youngston fine sandy loam (Colorado State University Fruit Research Center) and Billings clay (Roy Hood Farm, 1049 22nd Road) soils.

Wheel packing reduced intake rates in the two loam soils by 35 percent and the wheel packing effect decreases but persists throughout the season. Packing only a portion of the irrigated furrows was a primary factor causing infiltration variability. Packing, or avoiding packing of all irrigated furrows, would eliminate the primary source of nonuniform water distribution from furrow to furrow. Irrigating only packed furrows during the first irrigation permits lighter, more uniform water application. Moist compaction is a highly effective means of reducing infiltration on both Grand Junction soils.

Flow interruption reduced infiltration rates 20-40 percent on the two loam soils during the first irrigation after spring tillage. The reduction was only 10-15 percent for the remainder of the year on the Youngston soil. Flow interruption had no effect on infiltration into the Billings clay.

Furrow chiseling increased infiltration into the Billings clay by 25 percent only on the first irrigation with no residual effects. On both loams, chiseling greatly increased initial infiltration rates and slowed advance times during the first irrigation following chiseling. On the Youngston soil, the infiltration remains higher in the non-wheel furrow than in wheel-packed furrows throughout the irrigation season. The chiseled furrows were repacked by tractor wheels during cultivation between the first and succeeding irrigations. Furrow chiseling can be an effective way to increase initial infiltration. Because sustained infiltration rates are not greatly changed, the distribution uniformity would not be greatly affected.

On the Youngston soil, the high manure applications increased the cumulative infiltration about 25 percent mainly through a 100 percent increase in the sustained rate. The manure effects may have been limited by soil compaction due to driving loaded manure spreaders and incorporation equipment on the moist soil in the spring.

Universities - Salinity Research

Reuse of Blowdown Water for Irrigation

Research by Utah State University scientists in cooperation with Utah Power and Light since 1977 relates to the use of wastewater from the coal-fired powerplant at Huntington, Utah. Crops have been grown for 8 years and soil salinity has been monitored. Wastewater was applied by specialized line-source equipment at various rates. The saline water from the powerplant is about ten times saltier than the normal "creek" irrigation water. The build-up of total salts was sufficient to cause some minor yield depressions. Tests made in 1985 definitely show the major detrimental effect found was boron toxicity, which was highly dependent on the crop.

The forage crops tested showed no yield depression due to these boron rates but potato yields were decreased to 20 percent of normal. The susceptibility of crops was found to be (from high to low susceptibility) potatoes, corn, barley, wheat, alfalfa, wheatgrass. A model of water-boron-crop-irrigation-yield has been developed and is in the process of being tested against field data.

Carbonate Chemistry and Mineralogy

A University of California-Davis study of factors influencing carbonate chemistry and mineralogy in salt affected soils was carried out over a 3-year period. Plots were designed to provide delivery of variable quantities of irrigation water and salts through parallel line-source sprinklers. The plots were cropped to sorghum during summer seasons and to wheat during winter and early spring. Soil solutions and soil gases were collected periodically to study seasonal and diurnal periods, varying temperature, moisture, and salinity regimes on cropped and noncropped conditions. Data applied to a water equilibrium model showed that soil solutions at all profiles were supersaturated with calcite.

Fifteen subsurface drains on 23 acres of irrigated agricultural land established by Nevada Agricultural Experiment Station scientists in salinity research at Fallon, Nevada, were sampled in 27 consecutive weeks. The time period and spacing variabilities of electrical conductivity, temperature, ph, dissolved oxygen, and nitrate nitrogen were evaluated using time series and geostatistical analyses. Optimum spacings for subsurface drains were compared with the resulting information. Models were established that can be used for forecasting future temporal and spatial values and for determining the transfer function to provide a way to relate water management plans with water quality control.

An improved experimental setup is in use at the University of California-Davis to study dissolution kinetics of carbonate minerals in aqueous systems. Dissolution studies were carried out to determine the influence of different surface areas. The same experimental setup was used to study the dissolution kinetics of gypsum and phosphogypsum. Understanding dissolution chemistry of minerals will help develop practices to minimize contributions to salinity in Basin streams.

1986 SALINITY PROGRAM EVALUATION

USDA/Reclamation Program Coordination

The USDA Basin Coordinator position established in 1985 of FY 1985 to assist in carrying out the Colorado River salinity program is performing as planned. The position is responsible for coordination and evaluation of USDA salinity control activities in the Basin. The Coordinator, headquartered at the Bureau of Reclamation's Colorado River Water Quality Office in Denver, Colorado, is the primary point of contact with the Bureau of Reclamation and USDA agencies. He is also responsible for providing salinity control program assistance for the seven Basin State Conservationists of SCS; Director, West National Technical Center); and other Federal, State, and local entities and organizations.

In response to concerns raised by the Colorado River Basin Salinity Control Forum and the mandate contained in the amendatory legislation for the Colorado River Salinity Control Program, the Department of the Interior and the Department of Agriculture formed a TPCC (Technical Policy Coordination Committee) in 1985 to improve coordination of the salinity control programs. The committee is comprised of representatives of the Bureau of Reclamation and the Soil Conservation Service.

Issues addressed and resolved by the TPCC during the past year:

1. Developed a common methodology to assess a project prioritization schedule for the salinity control program.

2. Agreed to combine Department of Agriculture and Department of the Interior programs where the combined effort results in greater overall cost-effectiveness than the individual programs.

3. Agreed on joint interagency reporting process.

4. Coordinated the basinwide and individual project monitoring and evaluation plans.

5. Coordinated Reclamation off-farm planning, design, and implementation with SCS planning, design, and implementation of onfarm systems improvement.

6. Agreed on a joint salt load reporting process in the Grand Valley.

ACP vs CRSC Program Staffing and Funding

Since 1979, USDA implementation of the Grand Valley and Uinta Basin Units has been accomplished using funds reprogramed from other USDA program activities--specifically, ACP funds from ASCS for cost sharing and conservation operations funds from SCS for technical assistance. Public Law 98-569 provides for direct funding of the onfarm salinity program, including the continuing Grand Valley and Uinta Basin Units. The continued use of existing program authorities has resulted in a significant and growing disparity between the amount of cost-share dollars and technical assistance dollars available to carry out this program. Direct line item funding in each of these areas would resolve this problem.

Evaluation Process

The agreed upon process used for this 1986 evaluation consists of three steps: basic data and program inputs, evaluation and analysis, and verification and review. The three steps, in turn, are composed of individual components which further describe the complete process as shown in figure 4.

The basic data components reflect DOI and USDA coordinated input of basic data on individual projects used in the evaluation process. Other program input components include the facts, figures, and values provided in the basic data that are used in the least cost investment model, including project data, projected depletions, and the salt load reduction objective.

Under evaluation and analysis, investment schedules necessary to achieve the program salt load reductions are developed, evaluated, and analyzed. The investment levels are then checked against the basin fund repayment capability. The proposed schedule is subsequently verified using the CRSS program and, when verified, it becomes the recommended implementation schedule. Following internal review and review by the Interagency Committee and the Forum Work Group (the technical support team of the Forum), the Forum and the Advisory Council reviewed the report as the final step in preparing this 1986 evaluation.

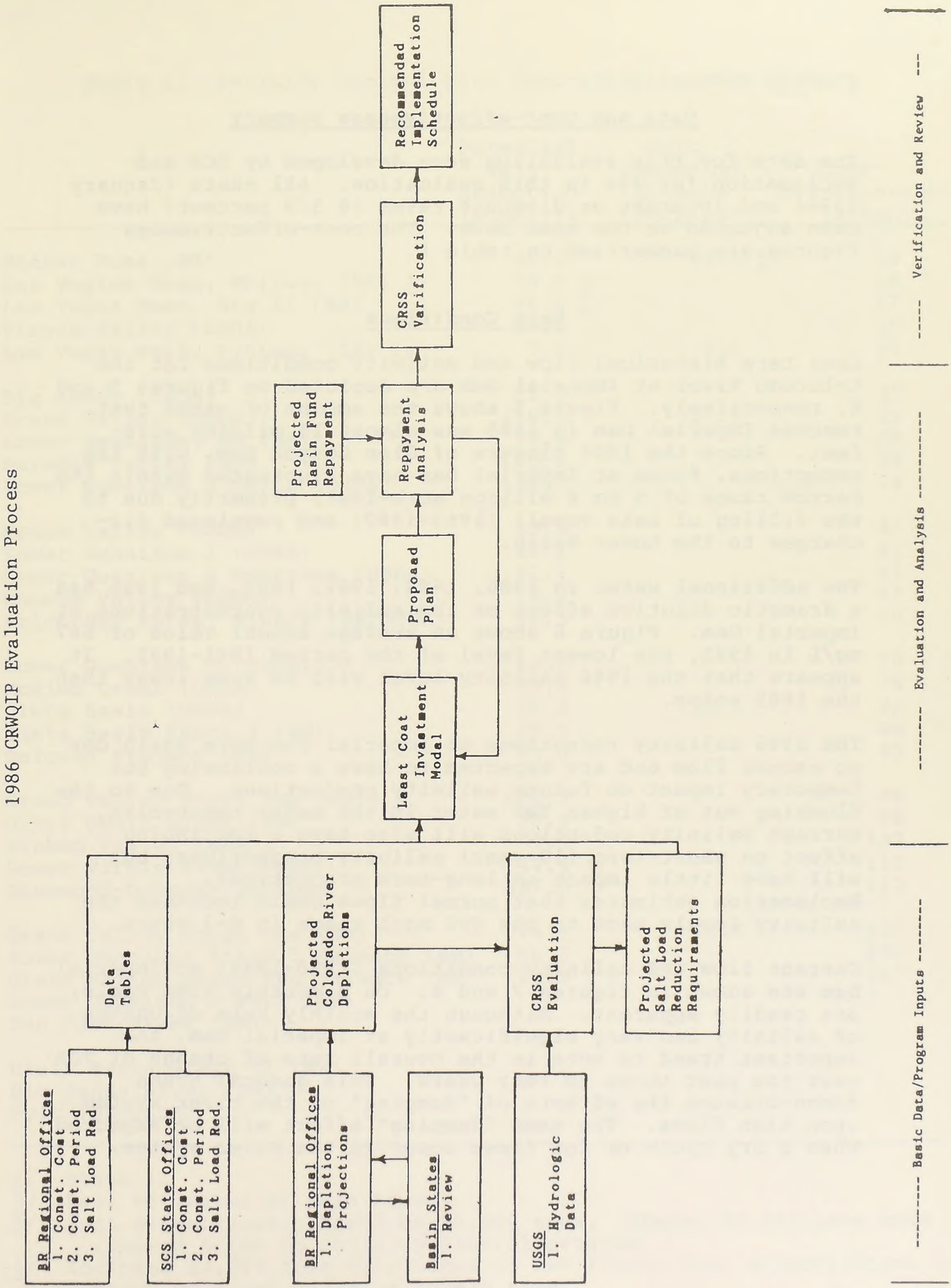

Figure 4. - 1986 CRWQIP Evaluation Process.

Data and Cost-effectiveness Summary

The data for this evaluation were developed by SCS and Reclamation for use in this evaluation. All costs (January 1986) and interest or discount rates (8 5/8 percent) have been adjusted to the same base. The cost-effectiveness figures are summarized on table 1.

Base Conditions

Long term historical flow and salinity conditions for the Colorado River at Imperial Dam are depicted on figures 5 and 6, respectively. Figure 5 shows the amount of water that reached Imperial Dam in 1985 was almost 15 million acre-feet. Since the 1966 closure of Glen Canyon Dam, with few exceptions, flows at Imperial Dam have fluctuated within the narrow range of 5 to 6 million acre-feet, primarily due to the filling of Lake Powell (1963-1980) and regulated discharges to the Lower Basin.

The additional water in 1980, 1983, 1984, 1985, and 1986 had a dramatic dilution effect on the salinity concentrations at Imperial Dam. Figure 6 shows an average annual value of 607 mg/L in 1985, the lowest level of the period 1941-1985. It appears that the 1986 salinity level will be even lower than the 1985 value.

The 1986 salinity reductions at Imperial Dam were again due to excess flow and are expected to have a continuing but temporary impact on future salinity projections. Due to the flushing out of higher TDS water in the major reservoirs, current salinity reductions will also have a continuing effect on short-term (10-year) salinity projections, but will have little impact on long-term projections. Reclamation estimates that normal flows could increase the salinity levels back to the 800 mg/L range in 6-7 years.

Current flow and salinity conditions (1980-1985) at Imperial Dam are shown in figures 7 and 8. On a monthly time scale, are readily apparent. Although the monthly rate of change of salinity can vary significantly at Imperial Dam, the important trend to note is the overall rate of change of TDS over the past three to four years. This general trend demon-strates the effects of "damping" of the river system upon high flows. The same "damping" effect will be expected when a dry cycle or low flows occur in the river system.

Table 1. Salinity Control Unit Cost-effectiveness Summary

	Potential Salt Reduction (kton/yr)	Salt Reduction to Date (kton/yr)	Cost-effectiveness ($/ton)
Meeker Dome (BR)	48.0	48.0 3/	14
Las Vegtas Wash, Whitney (BR) 1/	10.0 2/		16
Las Vegas Wash, Stg II (BR)	66.0 2/		17
Virgin Valley (USDA)	37.2		20
Las Vegas Wash, Pittman (BR) 1/	7.0	7.0	24
Big Sandy (USDA)	52.9		25
Grand Valley (USDA)	230.0	27.3	25
Lower Gunnison, WW (BR)	78.5		28
Paradox Valley (BR)	180.0		38
Lower Gunnison 2 Delta (USDA)	104.7		39
Moapa Valley (USDA)	19.5		41
Lower Gunnison 1 (USDA)	82.1		61
Lower Gunnison 2 Montrose (USDA)	81.7		65
Mancos Valley (USDA)	8.8		67
Price-San Rafael Rivers (BR/USDA)	52.3		70
Lower Gunnison 3 (USDA)	12.0		70
McElmo Creek (USDA)	38.0		78
Uinta Basin (USDA)	98.2	15.6	82
Uinta Basin Stage I (BR)	25.5		88
Dolores Project (BR)	23.0		95
Grand Valley Stage Two (BR)	120.3		96
Dirty Devil River (BR)	20.9		98
Sinbad Valley (BLM)	7.5		102
Lower Virgin River (BR)	44.4 4/		113
Glenwood-Dotsero Springs	287.0		117
Grand Valley Stage One (BR)	24.0	21.9	121
Lower Gunnison Stage I Balance (BR)	66.3		190
Grand Valley Stage Two Balance (BR)	23.2		307
Lower Gunnison N Fork (BR)			
San Juan River (BR)			
Uinta Basin Stage II (BR)			
Big Sandy River (BR)			
PVID (BR/USDA)			

1/ Stage I.
2/ Best estimates at this time.
3/ Cost effectiveness based on 19,000 tons. Almost 29,000 tons were removed prior to salinity control program.
4/ Includes 24,000 tons attributed to AWT flows; cost effectiveness is based on a reduction of 20,400 tons.

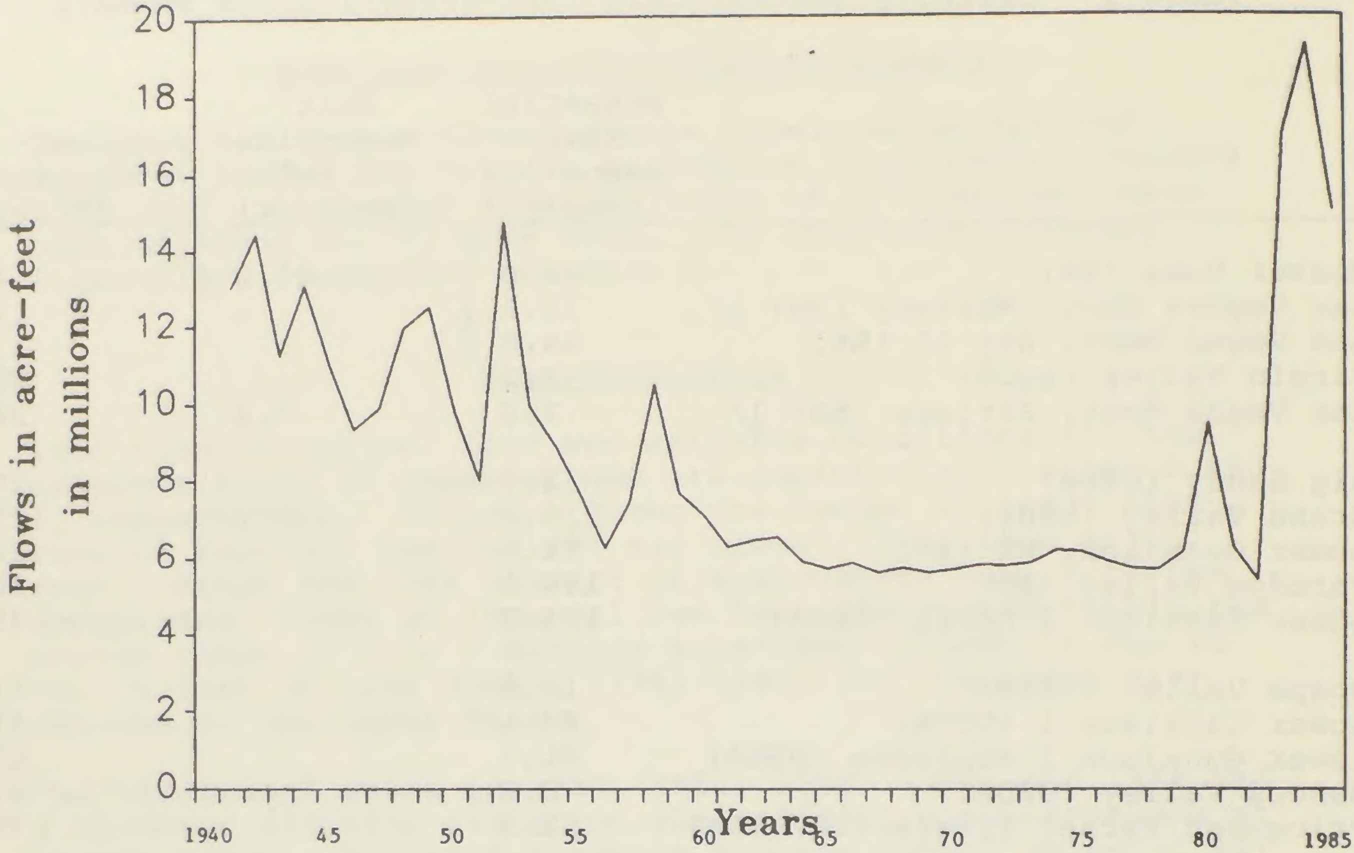

Figure 5. - Historical flows at Imperial Dam.

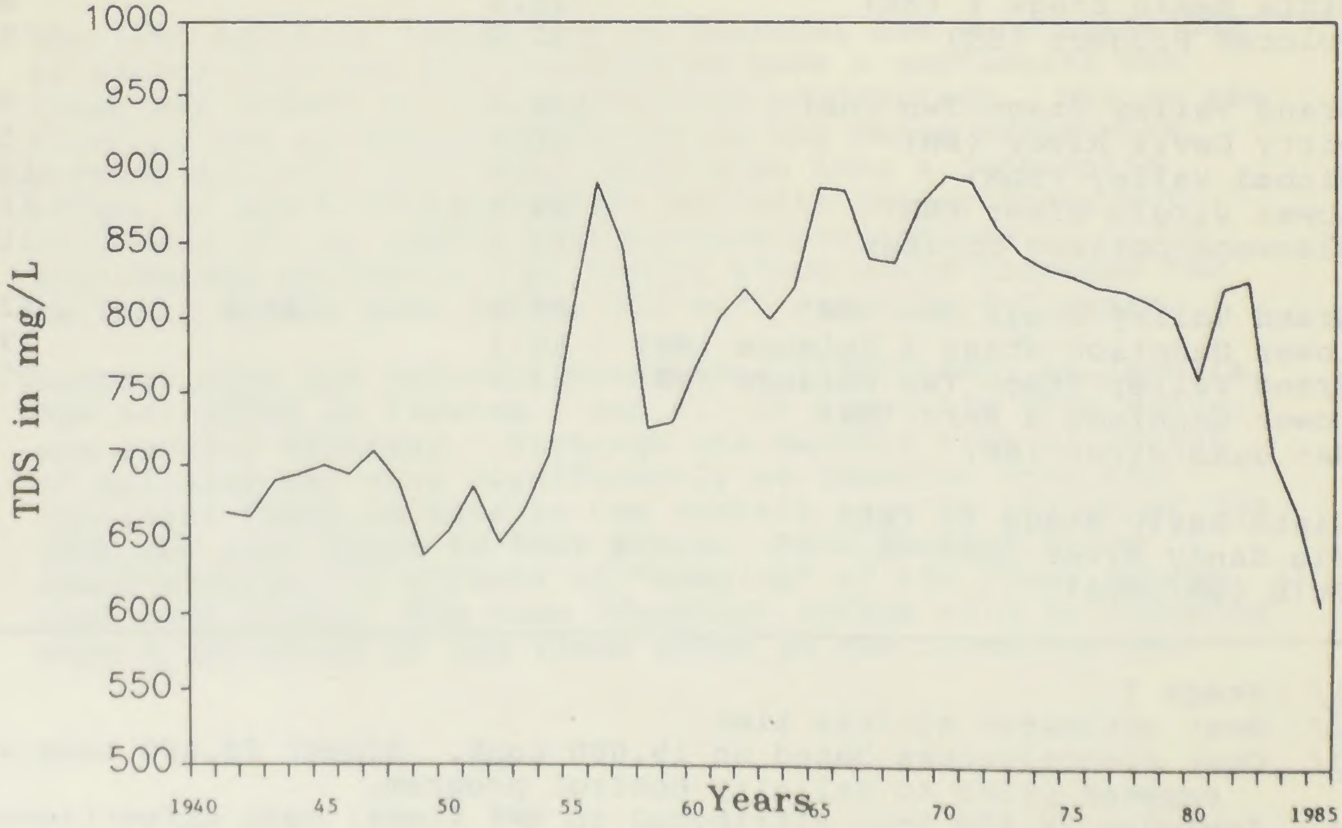

Figure 6. - Historical salinity levels at Imperial Dam, flow-weighted average annual estimates.

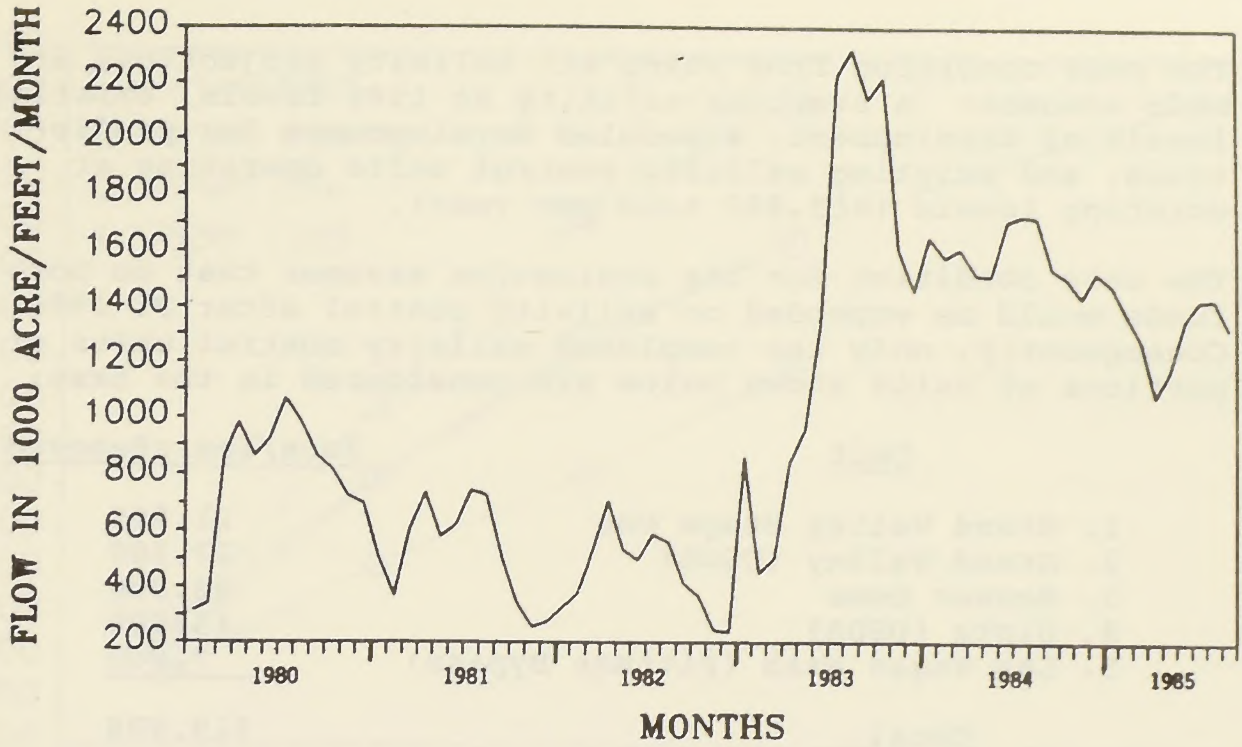

Figure 7. - Current flows at Imperial Dam; all figures based on monthly mean averages.

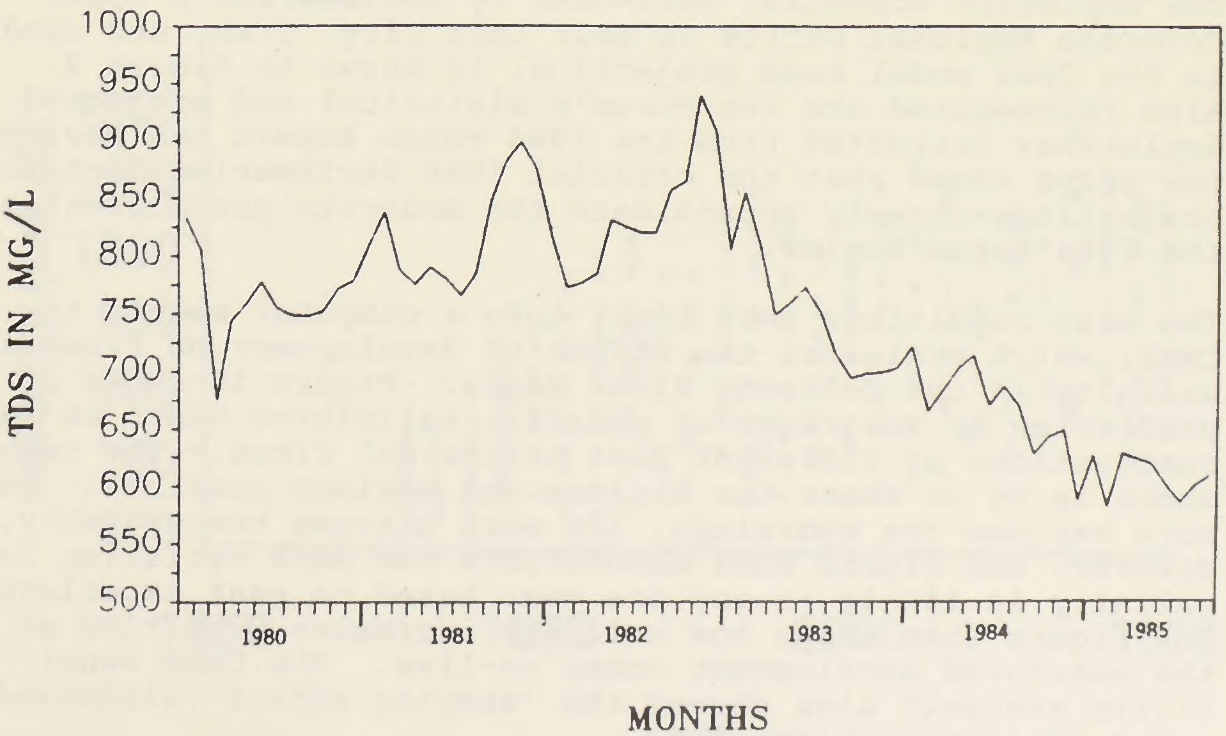

Figure 8. Current salinity at Imperial Dam; all figures based on monthly mean averages.

The base condition from which all salinity projections are made assumes: a starting salinity at 1986 levels, existing levels of development, scheduled developments for predictions, and existing salinity control units operating at existing levels (119,800 tons per year).

The base condition for the evaluation assumes that no more funds would be expended on salinity control after FY 1986. Consequently, only the completed salinity control units or portions of units shown below are considered in the base:

Unit	Tons/YearsRemoved
1. Grand Valley Stage One	21,900
2. Grand Valley (USDA)	27,300
3. Meeker Dome	48,000
4. Uinta (USDA)	15,600
5. Las Vegas Wash (Pittman Bypass)	7,000
Total	119,800

BLM well plugging reducing 7,000 tons annually of salt loading was not entered into the CRSS computations because information was not available by river reach. Total reduction is 126,800 tons; but CRSS analysis used 119,800 tons.

The depletion schedule, estimated by Reclamation's Upper Colorado Regional Office in Salt Lake City, Utah, and used in the CRSS model base projection, is shown in figure 9. Also represented are the Forum's historical and projected depletions extracted from the 1984 Forum Report and Review. The graph shows that the official 1986 Reclamation depletion projections closely approximate the moderate projection in the 1984 Forum Review.

The base conditions were input into a computer model, the CRSS, which evaluates the effect of development on flows and salinity in the Colorado River Basin. Figure 10 shows a prediction of the range of possible salinities based on 15 combinations of different past historical flows. The range shown is by no means the minimum and maximum possible. The more extreme the hydrology, the more extreme the salinity. However, the figure does demonstrate how much variation in salinity is likely in any one year based on past experience. The figure also shows how salinity increases with time as the scheduled development comes on-line. The CRSS sensitivity analysis also showed the "damping effect" discussed under "Base Conditions."

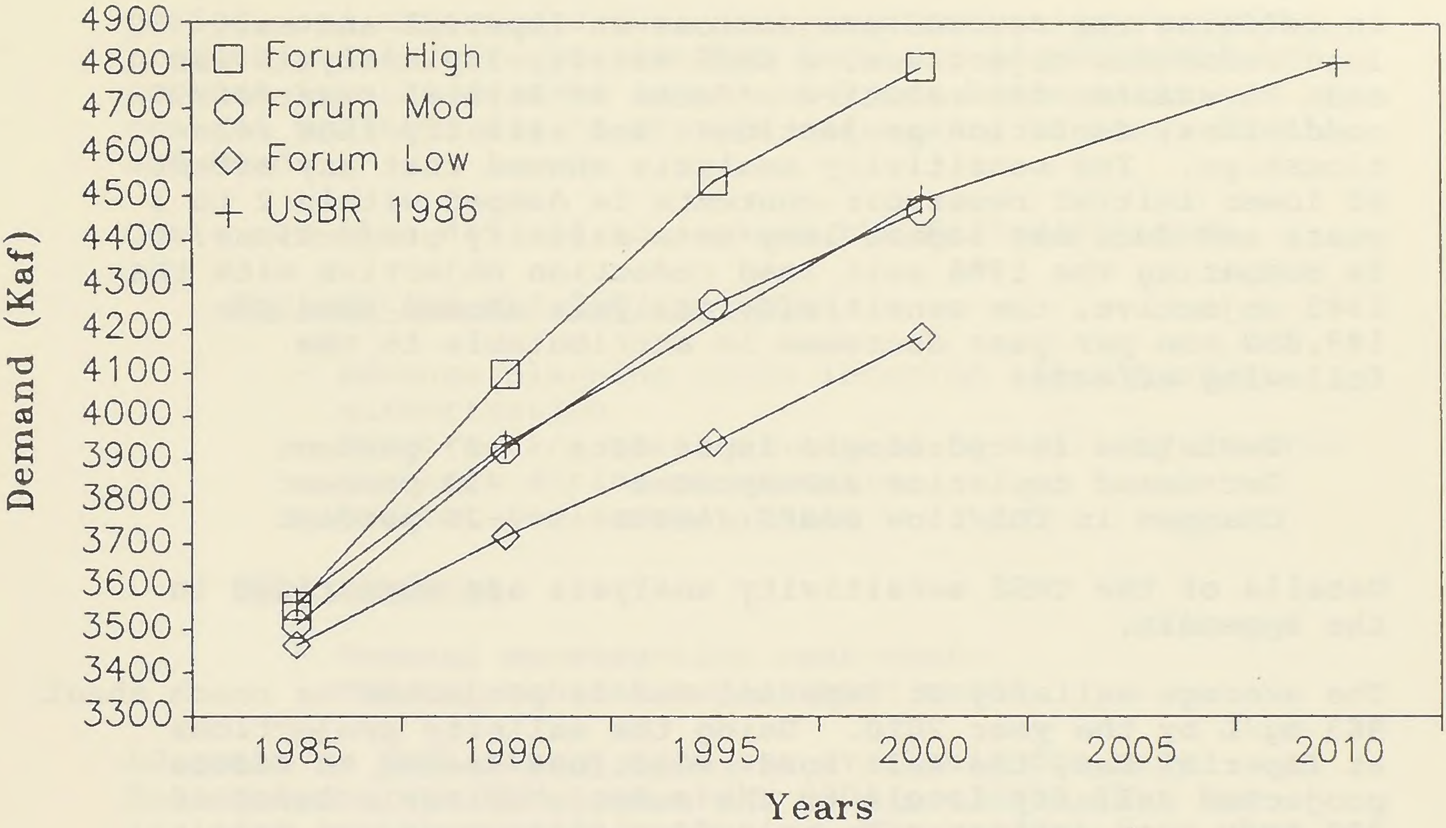

Figure 9. - Comparison of Upper Basin depletion projections.

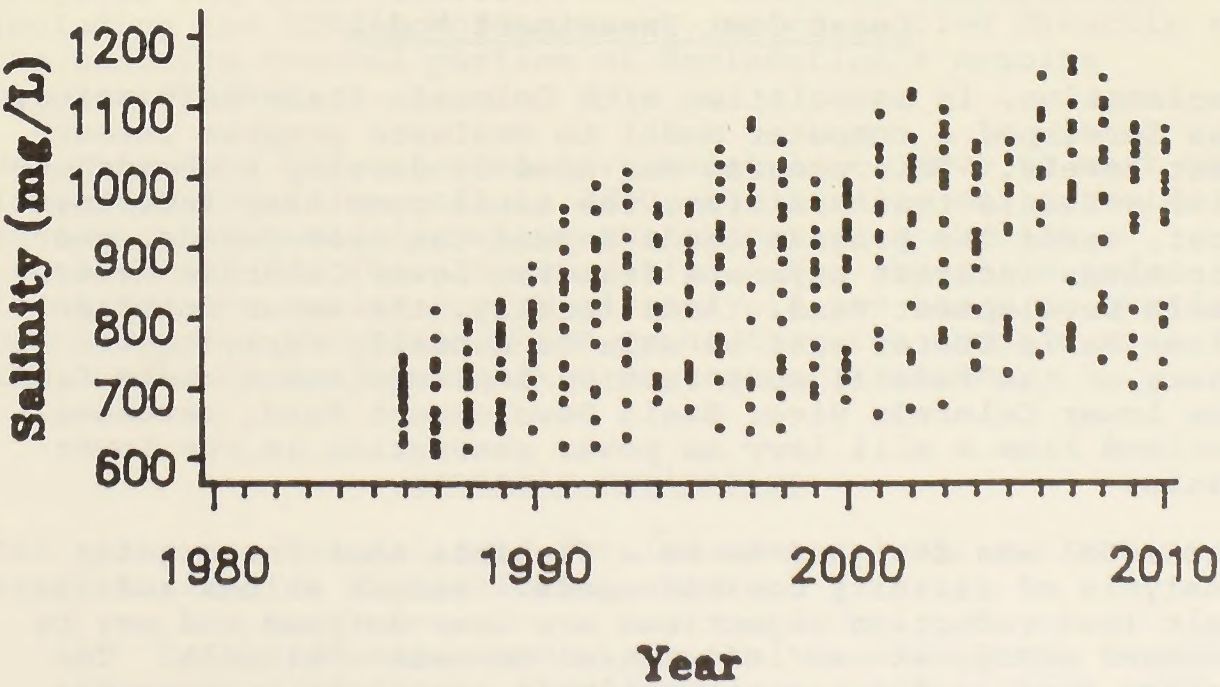

Figure 10. - Salinity projections at Imperial Dam without further controls.

In defining the new TDS projections at Imperial and salt load reduction objectives, a CRSS sensitivity analysis was made to examine the relative effects of initial reservoir conditions, depletion projections, and salinity flow relationships. The sensitivity analysis showed that any effect of lower initial reservoir contents is damped within 2 to 3 years and does not impact long-term salinity projections. In comparing the 1986 salt load reduction objective with the 1985 objective, the sensitivity analysis showed that the 189,000 ton per year decrease is attributable to the following effects:

Revisions in hydrologic input data	-47 percent
Decreased depletion assumptions	-33 percent
Changes in TDS/flow coefficients	-20 percent

Details of the CRSS sensitivity analysis are summarized in the Appendix.

The average salinity at Imperial Dam is projected to reach about 963 mg/L by the year 2010. Using the salinity projections at Imperial Dam, the salt load reductions needed to reduce projected salinity levels to the numeric criteria level of 879 mg/L were estimated to be 1.09 million tons per year by the year 2010. The required salt load reductions are in addition to that already removed and are referred to as the program objective.

Least Cost Investment Model

Reclamation, in association with Colorado State University, has developed a computer model to evaluate program investment levels. This program was used to develop a comprehensive schedule that minimizes the total remaining investment cost, meets the program needs beyond the next decade, and minimizes interest payments from the Lower Colorado River Basin Development Fund. Additionally, the Lower Colorado River Basin States must be able to annually repay their share of the Federal construction/implementation costs from the Lower Colorado River Basin Development Fund, revenues derived from a mill levy on power generation in the Lower Basin.

The model was designed to be a flexible tool for ongoing analysis of salinity control needs. Budget values and the salt load reduction objectives are user-defined and may be changed easily as new information becomes available. The values used in the present analysis are given in Appendix Table C-1. Other data required by the model are total period, and expected annual salt load reduction for each project. A 4-year lag time has been set in the model to account for the delayed impact of Upper Basin salinity control projects due to storage and mixing in Lakes Powell and Mead.

Costs are also defined to include the following items:

Reclamation and BLM projects

- Advance planning costs incurred after project authorization
- Construction costs allocated to salinity control
- Interest during construction
- Habitat replacement costs

USDA projects

- Federal construction cost-share
- Federal habitat replacement costs.

Adequate or preliminary data are available for nine Reclamation, one BLM, and eight USDA projects that are included in the present analysis. The project data used in the least cost investment model are displayed in Appendix C-2. Some of these projects were split in sections and some were given fixed construction-start dates. The "fixed starts" would cost approximately $348 million to complete. These projects are under construction or awaiting construction, including the USDA'S McElmo Creek, which is tied directly to the salinity control portion of Reclamation's ongoing Dolores Project.

Not only does the selected investment level have to meet the long-term reduction goal in 2010, but it also must provide assurance of remaining above the objective reduction requirements for the interim period. The objective reductions for the entire period of analysis are based on average hydrology for the basin which means that the numeric criteria will be met at least 50 percent of the time.

Scenario Evaluation

The basic process followed for investment level evaluation is summarized in the following steps:

1. Establish base conditions for the CRSS model considering pre-1986 basin hydrology, current depletion estimates, and completed salinity control projects.

2. Develop a salt load reduction objective to the year 2010 (see table 2) reflecting base conditions with no other salinity control activity under future conditions.

3. Identify DOI/USDA fixed construction starts that satisfy current authorizations and other physical and institutional constraints.

4. Use the least cost investment model to initially generate the optimal combination of projects and construction timing that meet the objective salt load reduction to the year 2010 at the least overall cost.

5. Adjust construction starts to meet the objective in all years and to complete the projects that were initially selected by no later than 2009.

6. Delete and/or trade off projects considering institutional constraints without regard to cost constraints while still meeting the objective.

7. Check for program continuity to see if the plan makes sense with respect to authorization, funding, and proposed construction schedule.

8. Compare total investment costs and annual costs of the schedule generated under the least cost investment model against repayment capacity of the Lower Basin Development Funds.

9. Select the investment level schedule that satisfies repayment capacity, minimum investment, and salt load reduction requirements.

10. Run a CRSS verification to see if the proposed construction schedule would meet the salt load reduction objective.

After modifications for program continuity were made to the investment level selected by the computer, the resulting investment level was determined to be $498 million. The "fixed start" projects remain as those projects that are "fixed" in terms of current program commitments/constraints for construction or implementation.

The recommended plan is shown in figure 11 at an investment of $498 million. This schedule is subject to change in future years as better data are developed. Figure 12 shows annual funding requirements for Reclamation's construction program and USDA's cost-share requirements and indicates that the program funding requirements are spread over the life of the program.

Table 2. Salt Load Reduction Targets Used in the Least Cost Investment Model

YEAR	SALT LOAD REDUCTION TARGET (kTon) 1/
1986	0
1987	0
1988	0
1989	0
1990	0
1991	0
1992	88
1993	113
1994	143
1995	181
1996	227
1997	280
1998	342
1999	412
2000	488
2001	567
2002	648
2003	727
2004	801
2005	869
2006	930
2007	982
2008	1025
2009	1061
2010	1091

1/ Targets were computed for Imperial Dam and shifted forward 4 years to allow project impacts to completely pass through Lakes Powell and Mead.

```
Bar186-Nov. 20, 1986                          Recommended Plan - $498 million 1/
                                                1.091 Million Ton Reduction
           Description                                    Years

                                        1985  1986  1987  1988  1989  1990  1991  1992  1993  1994  1995  1996  1997  1998  1999  2000  2001  2002  2003  2004

* Grand Valley Stage II              2/ zzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzz
* Paradox                               zzzzzzzzzzzzzzzzzzzzzzzzzzzzz
* Dolores                            3/ ¦----------------------¦zzzzzzzzzzzzzzzzzz
* Lower Gunnison Winter Water                 ¦----------¦zzzzzzzzzzzzzzzzzz
* Las Vegas Wash - Whitney              ¦----¦zzzzzzzzzzzzzzzzzz
  Uinta Stage I                                     ¦----------------¦zzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzz
  Lower Virgin                                      ¦---------------------¦zzzzzzzzzzzzzzzzzz
  Price-San Rafael (coordinated)  4/                ¦----------------¦zzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzz
* Grand Valley - USDA                   zzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzz
* Uinta - USDA                           zzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzz
  Lower Gunnison 1 - USDA                           ¦----¦zzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzz
  Lower Gunnison 2 - Montrose - USDA                            ¦----¦zzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzz
  Lower Gunnison 2 - Delta - USDA                               ¦----¦zzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzz
  Lower Gunnison 3 - USDA                                             ¦----¦zzzzzzzzzzzzzzzzzz
  Moapa Valley - USDA                                     ¦----------¦zzzzzzzzzzzzzzzzzz
* McElmo Creek - USDA                               ¦----------------¦zzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzz
  Big Sandy - USDA                                  ¦----¦zzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzzz
```

1/ Information based on 1986 data tables.

2/ Z's zzzzzz designate construction activities.

3/ Lines ¦-----¦ designate advance planning activities for Reclamation and technical assistance activities for USDA.

4/ Currently not included in USDA Schedule.

* Fixed starts

Note: Units not included:	Reclamation:	USDA:	Completed Units:
*Data not available	Grand Valley II, Balance	Virgin Valley	Meeker Dome
	Lower Gunnison I, Balance	Mancos Valley	Grand Valley Stage I
	*Lower Gunnison North Fork	*Palo Verde Irrig. Dist.	Las Vegas Wash - Pittman
	Las Vegas Wash Stage II		
	*Uinta Stage II		
	Dirty Devil River		
	*Palo Verde Irrig. Dist.		
	*Big Sandy		
	*San Juan		
	Sinbad Valley		
	Glenwood-Dotsero Springs		

Figure 11. Recommended plan with remaining investment of $498 million.

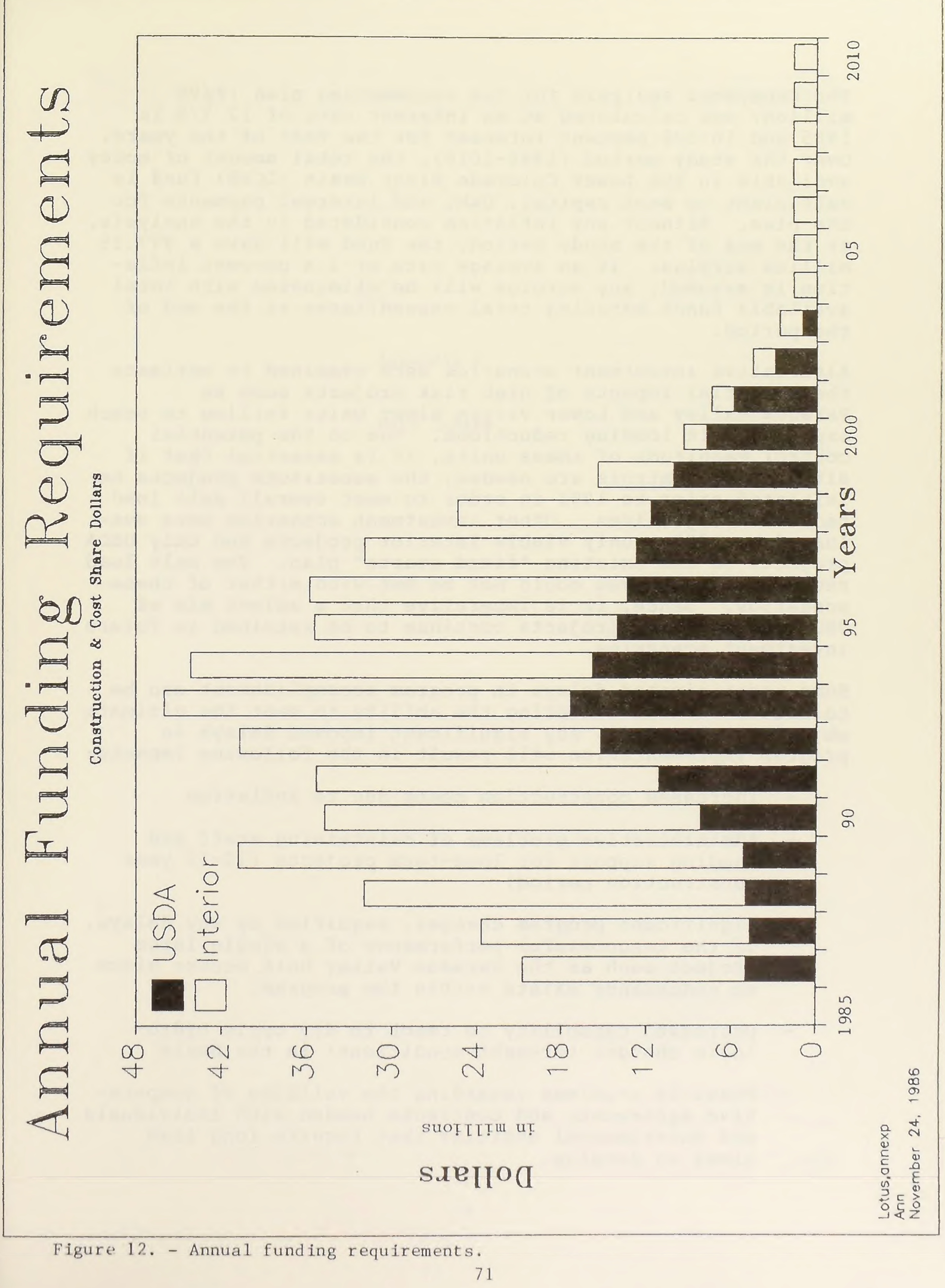

Figure 12. - Annual funding requirements.

The repayment analysis for the recommended plan ($498 million) was calculated at an interest rate of 12 3/8 in 1985 and 10 5/8 percent interest for the rest of the years. Over the study period (1986-2010), the total amount of money available in the Lower Colorado River Basin (LCRB) fund is sufficient to meet capital, O&M, and interest payments for the plan. Without any inflation considered in the analysis, at the end of the study period, the fund will have a $77.25 million surplus. If an average rate of 3.8 percent inflation is assumed, any surplus will be eliminated with total available funds matching total expenditures at the end of the period.

Alternative investment scenarios were examined to estimate the potential impacts of high risk projects such as Paradox Valley and Lower Virgin River Units failing to reach expected salt loading reductions. Due to the potential control magnitude of these units, it is essential that if alternative controls are needed, the substitute projects be initiated prior to 1992 in order to meet overall salt load reduction objectives. Other investment scenarios were evaluated by adding only viable Interior projects and only USDA projects to the existing "fixed starts" plan. The salt load reduction objectives could not be met with either of these scenarios. Hence, it is imperative that a select mix of USDA and Interior projects continue to be retained in future investment scenarios.

Some unanticipated delays in program accomplishment can be tolerated without hindering the ability to meet the ultimate objective. However, any significant imposed delays in program implementation will result in the following impacts:

- Increased construction costs due to inflation
- Administrative problems of maintaining staff and funding support for long-term projects (10-15 year construction period)
- Significant program changes, magnified by any delays, if the unsuccessful performance of a single large project such as the Paradox Valley Unit occurs since no redundancy exists within the program.
- Decreased capability to react to dry cycle hydrologic changes (drought conditions) in the Basin
- Possible problems regarding the validity of cooperative agreements and contracts needed with individuals and governmental entities that require long lead times to develop.

Appendix A

Data Tables

	USBR Sinbad Valley COLORADO	BR Meeker Dome COLORADO	BR Grand Valley Stage One COLORADO
Date of Estimate:	1/82	Completed	Completed
Interest Rate:	7.63		
Estimate Adjustment for 1/86:	106.76%		
1/86 Interest Rate	8.63		
IDC Adjustment for 1/86:	13.11%		
Project Area			
1. Irrigated Area (total acres)			6,000
2. Potential Participants:			
a. Individuals (number)			
b. Groups (number)			
3. Canals (total miles)			
4. Laterals (total miles)			
5. Point Sources (number)	1	3	
6. Other			
Salt Load Contribution			
1. On-farm (tons/year)			
2. Canals (tons/year)			
3. Laterals (tons/year)			
4. Point Sources (tons/year)	8,938	57,000	
5. Other (tons/year)			
Implementation Plan			
1. Construction Start (year)	1991		1980
2. Construction Period (years)	3		3
3. Expected Participants:			
a. Individuals (number)			
b. Groups (number)			
4. On-farm Practices:			
a. Treated Area (acres)			
b. Land Leveling (acres)			
c. Sprinkler Systems (acres)			
d. Farm Ditches/Pipelines (miles)			
5. Canal Lining (miles)			6.70
6. Lateral Lining (miles)			
7. Pipe Laterals (miles)			29.7
8. Winter Water Systems (miles)			
9. Collection Features (type)	low dam		
10. Delivery Systems (type)	pipeline		
11. Disposal Facilities (type)	deep well inj	well plugs	
12. Habitat Replacement (acres)			
Salt Load Reduction			
1. To date:			
a. On-farm (tons/year)			
b. Canals (tons/year)			21,900
c. Laterals (tons/year)			
d. Point Sources (tons/year)		19,000	
e. Other (tons/year)			
2. Potential/Balance:			
a. On-farm (tons/year)			
b. Canals (tons/year)			
c. Laterals (tons/year)			
d. Point Sources (tons/year)	7,470		
e. Other (tons/year)			
Data Source:	9/82 BLM Rpt	7/85 Clc Rpt	1986 EIS

	BLM Sinbad Valley	BR Meeker Dome	BR Grand Valley Stage One
	COLORADO	COLORADO	COLORADO
Economic and Financial Analyses			
Department of the Interior:			
1. Plan Formulation Costs		3,118,000	
2. Nonsalinity Planning Costs			
3. Advance Planning Costs:			
a. Prior to Authorization			25,000
b. After Authorization	500,000		
4. Nonsalinity Design Costs			
5. Salinity Const. Costs To Date			27,744,000
6. Balance Salinity Const. Costs	7,143,095		
7. Nonsalinity Construction Costs			
8. Habitat Replacement Costs			
9. Salinity IDC:			
a. Economic	307,909		1,112,000
b. Financial			
10. Nonsalinity IDC			
a. Economic			
b. Financial			
11. Salinity OM&R Costs w/o Power	53,378		104,000
12. Nonsalinity OM&R w/o Power			8,000
13. Economic Cost of Power			
14. Financial Cost of Power	9,288		
15. Salinity M & E Costs			
16. Nonsalinity M & E Costs			
Department of Agriculture:			
1. Technical Assistance Costs			
2. M & E Costs			
3. Information and Education Costs			
4. Federal Cost-share Obligations			
5. Federal Const. Cost-share To Date			
6. Balance Federal Const. Cost-share			
7. Local Construction Cost-share			
8. Percent Federal Cost-share:			
9. Federal Habitat Costs			
10. Local Habitat Costs			
11. Other Local Costs			
12. Local O&M Costs			
13. Annual Value of Replacement Costs			
14. Federal IDC			
Cost Effectiveness:			
1. Total Salinity Construction Costs	7,143,095	3,118,000	27,744,000
2. Advance Planning Costs	500,000		
3. Habitat Replacement Costs			
4. IDC (Economic)	307,909		1,112,000
5. Investment Cost	7,951,003	3,118,000	28,856,000
6. Annual Equivalent Investment Costs	696,905	273,293	2,529,228
7. Annual Salinity OM&R Costs	53,378		104000
8. Annual Economic Cost of Power	9,288		
9. Annual M & E Costs			
10. Annual Habitat OM&R Costs			8000
11. Annual Salinity Costs	759,572	273,293	2,641,228
12. Tons of Salt Removed Annually	7,470	19,000	21,900
13. Cost Effectiveness - $/ton	102	14	121

	BR Grand Valley Stage Two	BR Grand Valley Stage Two Balance	USDA Grand Valley
	COLORADO	COLORADO	COLORADO
Date of Estimate:	1/84	1/84	10/79
Interest Rate:	8.13%	8.13%	7.08%
Estimate Adjustment for 1/86:	101.94%	101.94%	
1\86 Interest Rate	8.63%	8.63%	8.63%
IDC Adjustment for 1/86:	6.15%	6.15%	
Project Area			
1. Irrigated Area (total acres)	45,270	8,730	66,000
2. Potential Participants:			
a. Individuals (number)			920
b. Groups (number)			250
3. Canals (total miles)			
4. Laterals (total miles)			190
5. Point Sources (number)			
6. Other			
Salt Load Contribution			
1. On-farm (tons/year)			300,000
2. Canals (tons/year)			
3. Laterals (tons/year)			100,000
4. Point Sources (tons/year)			
5. Other (tons/year)			
Implementation Plan			
1. Construction Start (year)	1986	1996	1979
2. Construction Period (years)	14	9	23
3. Expected Participants:			
a. Individuals (number)			920
b. Groups (number)			250
4. On-farm Practices:			
a. Treated Area (acres)			53,000
b. Land Leveling (acres)			16,900
c. Sprinkler Systems (acres)			800
d. Farm Ditches/Pipelines (miles)			1,790
5. Canal Lining (miles)	31.86	6.14	
6. Lateral Lining (miles)	258.20	49.80	15
7. Pipe Laterals (miles)			175
8. Winter Water Systems (miles)			
9. Collection Features (type)			
10. Delivery Systems (type)			
11. Disposal Facilities (type)			
12. Habitat Replacement (acres)			1,200
Salt Load Reduction			
1. To date:			
a. On-farm (tons/year)			17,000
b. Canals (tons/year)			
c. Laterals (tons/year)			10,300
d. Point Sources (tons/year)			
e. Other (tons/year)			
2. Potential/Balance:			
a. On-farm (tons/year)			113,000
b. Canals (tons/year)	8,222	17,900	
c. Laterals (tons/year)	108,078	5,300	89,700
d. Point Sources (tons/year)			
e. Other (tons/year)			
Data Source:	2/85 Supp DPR	2/85 Supp DPR	SCS/CO

	BR Grand Valley Stage Two	BR Grand Valley Stage Two Balance	USDA Grand Valley
	COLORADO	COLORADO	COLORADO
Economic and Financial Analyses			
Department of the Interior:			
1. Plan Formulation Costs	170,002	104,998	
2. Nonsalinity Planning Costs			
3. Advance Planning Costs:			
a. Prior to Authorization			
b. After Authorization			
4. Nonsalinity Design Costs			
5. Salinity Const. Costs To Date			
6. Balance Salinity Const. Costs	121,040,138	74,757,540	
7. Nonsalinity Construction Costs			
8. Habitat Replacement Costs			
9. Salinity IDC:			
a. Economic	5,188,064	3,204,283	
b. Financial			
10. Nonsalinity IDC			
a. Economic			
b. Financial			
11. Salinity OM&R Costs w/o Power	403,039	251,522	
12. Nonsalinity OM&R w/o Power	48,152	27,146	
13. Economic Cost of Power			
14. Financial Cost of Power			
15. Salinity M & E Costs			
16. Nonsalinity M & E Costs			
Department of Agriculture:			
1. Technical Assistance Costs			19,482,000
2. M & E Costs			3,297,000
3. Information and Education Costs			1,618,000
4. Federal Cost-share Obligations			35,900,000
5. Federal Const. Cost-share To Date			7,870,000
6. Balance Federal Const. Cost-share			28,030,000
7. Local Construction Cost-share			15,371,000
8. Percent Federal Cost-share:			70
9. Federal Habitat Costs			
10. Local Habitat Costs			
11. Other Local Costs			
12. Local O&M Costs			513,000
13. Annual Value of Replacement Costs			568,000
14. Federal IDC			
Cost Effectiveness:			
1. Total Salinity Construction Costs	121,040,138	74,757,540	57,000,000
2. Advance Planning Costs	0	0	
3. Habitat Replacement Costs	0	0	0
4. IDC (Economic)	5,188,064	3,204,283	0
5. Investment Cost	126,228,202	77,961,823	57,000,000
6. Annual Equivalent Investment Costs	11,063,902	6,833,354	4,996,050
7. Annual Salinity OM&R Costs	403,039	251,522	568,000
8. Annual Economic Cost of Power			
9. Annual M & E Costs			288,982
10. Annual Habitat OM&R Costs	48,152	27,146	
11. Annual Salinity Costs	11,515,093	7,112,021	5,853,032
12. Tons of Salt Removed Annually	116,300	23,200	230,000
13. Cost Effectiveness - $/ton	99	307	25

	BR Paradox	BR Lower Gunnison Stage One Winter Water	BR Lower Gunnison Stage One Deferred
	COLORADO	COLORADO	COLORADO
Date of Estimate:	10/85	1/86	1/85
Interest Rate:	8.63%	8.63%	8.63%
Estimate Adjustment for 1/86:	100.00%	100.00%	101.28%
1\86 Interest Rate	8.63%	8.63%	8.63%
IDC Adjustment for 1/86:	0.00%	0.00%	0.00%
Project Area			
1. Irrigated Area (total acres)			
2. Potential Participants:			
a. Individuals (number)			
b. Groups (number)			
3. Canals (total miles)			
4. Laterals (total miles)			
5. Point Sources (number)			
6. Other			
Salt Load Contribution			
1. On-farm (tons/year)			
2. Canals (tons/year)			
3. Laterals (tons/year)			
4. Point Sources (tons/year)	205,000		
5. Other (tons/year)		78,550	
Implementation Plan			
1. Construction Start (year)	1986	1988	1990
2. Construction Period (years)	4	3	6
3. Expected Participants:			
a. Individuals (number)			
b. Groups (number)			
4. On-farm Practices:			
a. Treated Area (acres)			
b. Land Leveling (acres)			
c. Sprinkler Systems (acres)			
d. Farm Ditches/Pipelines (miles)			
5. Canal Lining (miles)			58.90
6. Lateral Lining (miles)			195.40
7. Pipe Laterals (miles)			
8. Winter Water Systems (miles)			
9. Collection Features (type)	shallow wells		
10. Delivery Systems (type)	pipeline		
11. Disposal Facilities (type)	deep well inj		
12. Habitat Replacement (acres)			2,100
Salt Load Reduction			
1. To date:			
a. On-farm (tons/year)			
b. Canals (tons/year)			
c. Laterals (tons/year)			
d. Point Sources (tons/year)			
e. Other (tons/year)			
2. Potential/Balance:			
a. On-farm (tons/year)			
b. Canals (tons/year)			
c. Laterals (tons/year)			
d. Point Sources (tons/year)	180,000	78,550	66,300
e. Other (tons/year)			
Data Source:	MPO/PF-65	Interim Update	1/84 FR/FES

	BR Paradox	BR Lower Gunnison Stage One Winter Water	BR Lower Gunnison Stage One Deferred
	COLORADO	COLORADO	COLORADO
Economic and Financial Analyses			
Department of the Interior:			
1. Plan Formulation Costs			
2. Nonsalinity Planning Costs			
3. Advance Planning Costs:			
a. Prior to Authorization			
b. After Authorization			
4. Nonsalinity Design Costs			
5. Salinity Const. Costs To Date	13,308,721		
6. Balance Salinity Const. Costs	49,189,928	17,682,000	143,887,359
7. Nonsalinity Construction Costs			
8. Habitat Replacement Costs			
9. Salinity IDC:			
a. Economic			
b. Financial			
10. Nonsalinity IDC			
a. Economic			
b. Financial			
11. Salinity OM&R Costs w/o Power	300,000	620,000	
12. Nonsalinity OM&R w/o Power			
13. Economic Cost of Power	1,005,000		
14. Financial Cost of Power	156,000		
15. Salinity M & E Costs			
16. Nonsalinity M & E Costs			
Department of Agriculture:			
1. Technical Assistance Costs			
2. M & E Costs			
3. Information and Education Costs			
4. Federal Cost-share Obligations			
5. Federal Const. Cost-share To Date			
6. Balance Federal Const. Cost-share			
7. Local Construction Cost-share			
8. Percent Federal Cost-share:			
9. Federal Habitat Costs			
10. Local Habitat Costs			
11. Other Local Costs			
12. Local O&M Costs			
13. Annual Value of Replacement Costs			
14. Federal IDC			
Cost Effectiveness:			
1. Total Salinity Construction Costs	62,498,649	17,682,000	143,887,359
2. Advance Planning Costs			
3. Habitat Replacement Costs			
4. IDC (Economic)			
5. Investment Costs	62,498,649	17,682,000	143,887,359
6. Annual Equivalent Investment Costs	5,478,007	1,549,827	12,611,727
7. Annual Salinity OM&R Costs	300,000	620,000	
8. Annual Economic Cost of Power	1,005,000		
9. Annual M & E Costs			
10. Annual Habitat OM&R Costs			
11. Annual Salinity Costs	6,783,007	2,169,827	12,611,727
12. Tons of Salt Removed Annually	180,000	78,550	66,300
13. Cost Effectiveness - $/ton	38	28	190

	BR Lower Gunnison North Fork COLORADO	USDA Lower Gunnison 1 COLORADO	USDA Lower Gunnison 2 Montrose COLORADO
Date of Estimate:		7/80	7/80
Interest Rate:		0.00%	7.38%
Estimate Adjustment for 1/86:			
1\86 Interest Rate		8.63%	8.63%
IDC Adjustment for 1/86:			0
Project Area			
1. Irrigated Area (total acres)		22,609	32,460
2. Potential Participants:		215	
a. Individuals (number)		22	310
b. Groups (number)		50	30
3. Canals (total miles)		46	70
4. Laterals (total miles)		0	13
5. Point Sources (number)		0	0
6. Other			0
Salt Load Contribution			
1. On-farm (tons/year)		66,000	76,000
2. Canals (tons/year)		41,400	37,800
3. Laterals (tons/year)		11,400	2,900
4. Point Sources (tons/year)		0	0
5. Other (tons/year)		0	0
Implementation Plan			
1. Construction Start (year)	1990	1989	1991
2. Construction Period (years)	8	16	18
3. Expected Participants:			
a. Individuals (number)		220	230
b. Groups (number)		15	15
4. On-farm Practices:			
a. Treated Area (acres)		20,400	26,000
b. Land Leveling (acres)		8,400	12,000
c. Sprinkler Systems (acres)		2,600	3,700
d. Farm Ditches/Pipelines (miles)		305	440
5. Canal Lining (miles)		40.00	56.00
6. Lateral Lining (miles)		9	3
7. Pipe Laterals (miles)		28	8
8. Winter Water Systems (miles)		0	0
9. Collection Features (type)		0	0
10. Delivery Systems (type)		0	0
11. Disposal Facilities (type)		0	0
12. Habitat Replacement (acres)		950	1,300
Salt Load Reduction			
1. To date:			
a. On-farm (tons/year)		0	0
b. Canals (tons/year)		0	0
c. Laterals (tons/year)		0	0
d. Point Sources (tons/year)		0	0
e. Other (tons/year)		0	0
2. Potential/Balance:			
a. On-farm (tons/year)		38,700	48,300
b. Canals (tons/year)		34,000	31,000
c. Laterals (tons/year)		9,400	2,400
d. Point Sources (tons/year)		0	0
e. Other (tons/year)		0	0
Data Source:		SCS/CO	SCS/CO

	BR Lower Gunnison North Fork	USDA Lower Gunnison 1	USDA Lower Gunnison 2 Montrose
	COLORADO	COLORADO	COLORADO
Economic and Financial Analyses			
Department of the Interior:			
1. Plan Formulation Costs			
2. Nonsalinity Planning Costs			
3. Advance Planning Costs:			
a. Prior to Authorization			
b. After Authorization			
4. Nonsalinity Design Costs			
5. Salinity Const. Costs To Date			
6. Balance Salinity Const. Costs			
7. Nonsalinity Construction Costs			
8. Habitat Replacement Costs			
9. Salinity IDC:			
a. Economic			
b. Financial			
10. Nonsalinity IDC			
a. Economic			
b. Financial			
11. Salinity OM&R Costs w/o Power			
12. Nonsalinity OM&R w/o Power			
13. Economic Cost of Power			
14. Financial Cost of Power			
15. Salinity M & E Costs			
16. Nonsalinity M & E Costs			
Department of Agriculture:			
1. Technical Assistance Costs		16,682,000	17,703,000
2. M & E Costs		2,184,000	2,496,000
3. Information and Education Costs		1,600,000	1,800,000
4. Federal Cost-share Obligations		30,730,100	32,611,000
5. Federal Const. Cost-share To Date		0	0
6. Balance Federal Const. Cost-share		30,730,100	32,611,000
7. Local Construction Cost-share		13,170,000	13,976,000
8. Percent Federal Cost-share:		70	70
9. Federal Habitat Costs		0	0
10. Local Habitat Costs		0	0
11. Other Local Costs		0	0
12. Local O&M Costs		439,000	466,000
13. Annual Value of Replacement Costs		486,000	516,000
14. Federal IDC		0	0
Cost Effectiveness:			
1. Total Salinity Construction Costs		49,012,100	52,114,000
2. Advance Planning Costs		0	0
3. Habitat Replacement Costs		0	0
4. IDC (Economic)		0	0
5. Subtotal Investment		49,012,100	52,114,000
6. Annual Equivalent Investment Costs		4,295,911	4,567,792
7. Annual Salinity OM&R Costs		486,000	516,000
8. Annual Economic Cost of Power		0	
9. Annual M & E Costs		191,428	218,774
10. Annual Habitat OM&R Costs		0	0
11. Annual Salinity Costs		4,973,338	5,302,567
12. Tons of Salt Removed Annually		82,100	81,700
13. Cost Effectiveness		61	65

	USDA Lower Gunnison 2 Delta	USDA Lower Gunnison 3	BR Dolores
	COLORADO	COLORADO	COLORADO
Date of Estimate:	7/80	7/80	10/85
Interest Rate:	7.38%	7.38%	8.63%
Estimate Adjustment for 1/86:			100.00%
1\86 Interest Rate	8.63%	8.63%	8.63%
IDC Adjustment for 1/86:	0	0	0.00%
Project Area			
1. Irrigated Area (total acres)	26,667	62,366	
2. Potential Participants:			
a. Individuals (number)	255	595	
b. Groups (number)	25	60	
3. Canals (total miles)	88	0	
4. Laterals (total miles)	23	0	
5. Point Sources (number)	0	0	
6. Other	0	0	
Salt Load Contribution			
1. On-farm (tons/year)	97,000	32,000	
2. Canals (tons/year)	47,100	0	
3. Laterals (tons/year)	5,300	0	
4. Point Sources (tons/year)	0	0	
5. Other (tons/year)	0	0	
Implementation Plan			
1. Construction Start (year)	1991	1992	1989
2. Construction Period (years)	13	3	3
3. Expected Participants:			
a. Individuals (number)	200	450	
b. Groups (number)	15	30	
4. On-farm Practices:			
a. Treated Area (acres)	21,300	50,000	
b. Land Leveling (acres)	9,900	23,200	
c. Sprinkler Systems (acres)	3,100	0	
d. Farm Ditches/Pipelines (miles)	360	0	
5. Canal Lining (miles)	70	0	
6. Lateral Lining (miles)	4	0	
7. Pipe Laterals (miles)	14	0	
8. Winter Water Systems (miles)	0	0	
9. Collection Features (type)	0	0	
10. Delivery Systems (type)	0	0	
11. Disposal Facilities (type)	0	0	
12. Habitat Replacement (acres)	1,100	500	
Salt Load Reduction			
1. To date:			
a. On-farm (tons/year)	0	0	
b. Canals (tons/year)	0	0	
c. Laterals (tons/year)	0	0	
d. Point Sources (tons/year)	0	0	
e. Other (tons/year)	0	0	
2. Potential/Balance:			
a. On-farm (tons/year)	61,600	12,000	
b. Canals (tons/year)	38,700	0	23,000
c. Laterals (tons/year)	4,400	0	
d. Point Sources (tons/year)	0	0	
e. Other (tons/year)	0	0	

1/ Deferred pending identification of beneficial use of water

Data Source:	SCS/CO	SCS/CO	PF-65

	USDA Lower Gunnison 2 Delta	USDA Lower Gunnison 3	BR Dolores
	COLORADO	COLORADO	COLORADO
Economic and Financial Analyses			
Department of the Interior:			
1. Plan Formulation Costs			
2. Nonsalinity Planning Costs			
3. Advance Planning Costs:			
a. Prior to Authorization			
b. After Authorization			
4. Nonsalinity Design Costs			
5. Salinity Const. Costs To Date			
6. Balance Salinity Const. Costs			25,040,000
7. Nonsalinity Construction Costs			
8. Habitat Replacement Costs			
9. Salinity IDC:			
a. Economic			
b. Financial			
10. Nonsalinity IDC			
a. Economic			
b. Financial			
11. Salinity OM&R Costs w/o Power			
12. Nonsalinity OM&R w/o Power			
13. Economic Cost of Power			
14. Financial Cost of Power			
15. Salinity M & E Costs			
16. Nonsalinity M & E Costs			
Department of Agriculture:			
1. Technical Assistance Costs	13,860,000	2,787,000	
2. M & E Costs	1,716,000	468,000	
3. Information and Education Costs	1,200,000	300,000	
4. Federal Cost-share Obligations	25,532,000	5,135,000	
5. Federal Const. Cost-share To Date	0	0	
6. Balance Federal Const. Cost-share	25,532,000	5,135,000	
7. Local Construction Cost-share	10,934,000	2,200,000	
8. Percent Federal Cost-share:	70	70	
9. Federal Habitat Costs	0	0	
10. Local Habitat Costs	0	0	
11. Other Local Costs	0	0	
12. Local O&M Costs	365,000	73,000	
13. Annual Value of Replacement Costs	404,000	81,000	
14. Federal IDC	0	0	
Cost Effectiveness:			
1. Total Salinity Construction Costs	40,592,000	8,222,000	25,040,000
2. Advance Planning Costs	0	0	
3. Habitat Replacement Costs	0	(	
4. IDC (Economic)	0	0	
5. Subtotal Investment	40,592,000	8,222,000	25,040,000
6. Annual Equivalent Investment Costs	3,557,889	720,658	2,194,756
7. Annual Salinity OM&R Costs	404,000	81,000	
8. Annual Economic Cost of Power	0	0	
9. Annual M & E Costs	150,407	41,020	
10. Annual Habitat OM&R Costs	0	0	
11. Annual Salinity Costs	4,112,296	842,679	2,194,756
12. Tons of Salt Removed Annually	104,700	12,000	23,000
13. Cost Effectiveness	39	70	95

	USDA McElmo	BR Glen Dot	USDA Mancos
	COLORADO	COLORADO	COLORADO
Date of Estimate:	7/81	1/83	1/83
Interest Rate:	7.63%	8.63%	7.88%
Estimate Adjustment for 1/86:		104.64%	
1\86 Interest Rate	8.63%	8.63%	8.63%
IDC Adjustment for 1/86:		0.00%	
Project Area			
1. Irrigated Area (total acres)	29,100		9,200
2. Potential Participants:			
a. Individuals (number)	342		95
b. Groups (number)			34
3. Canals (total miles)			104
4. Laterals (total miles)	235		
5. Point Sources (number)			
6. Other			
Salt Load Contribution			
1. On-farm (tons/year)	51,000		13,000
2. Canals (tons/year)			10,000
3. Laterals (tons/year)	9,000		
4. Point Sources (tons/year)		429,000	
5. Other (tons/year)			
Implementation Plan			
1. Construction Start (year)	1991	1/	1994
2. Construction Period (years)	7	3	4
3. Expected Participants:			
a. Individuals (number)	238		57
b. Groups (number)			15
4. On-farm Practices:			
a. Treated Area (acres)	19,700		5,500
b. Land Leveling (acres)			
c. Sprinkler Systems (acres)	19,700		3,200
d. Farm Ditches/Pipelines (miles)	33		
5. Canal Lining (miles)			17
6. Lateral Lining (miles)			
7. Pipe Laterals (miles)	235		
8. Winter Water Systems (miles)			
9. Collection Features (type)		sp boxes & wells	
10. Delivery Systems (type)		pipeline	
11. Disposal Facilities (type)		evap ponds	
12. Habitat Replacement (acres)			
Salt Load Reduction			
1. To date:			
a. On-farm (tons/year)			
b. Canals (tons/year)			
c. Laterals (tons/year)			
d. Point Sources (tons/year)			
e. Other (tons/year)			
2. Potential/Balance:			
a. On-farm (tons/year)	29,000		1,100
b. Canals (tons/year)			7,700
c. Laterals (tons/year)	9,000		
d. Point Sources (tons/year)		287,000	
e. Other (tons/year)			

1/ Deferred pending identification of beneficial use of water

Data Source:	SCS/CO		SCS/CO

	USDA McElmo COLORADO	BR Glen Dot COLORADO	USDA Mancos COLORADO
Economic and Financial Analyses			
Department of the Interior:			
1. Plan Formulation Costs			
2. Nonsalinity Planning Costs			
3. Advance Planning Costs:			
a. Prior to Authorization			
b. After Authorization			
4. Nonsalinity Design Costs			
5. Salinity Const. Costs To Date			
6. Balance Salinity Const. Costs		323,512,848	
7. Nonsalinity Construction Costs			
8. Habitat Replacement Costs			
9. Salinity IDC:			
a. Economic		18,310,212	
b. Financial			
10. Nonsalinity IDC			
a. Economic			
b. Financial			
11. Salinity OM&R Costs w/o Power		2,743,550	
12. Nonsalinity OM&R w/o Power			
13. Economic Cost of Power			
14. Financial Cost of Power		849,642	
15. Salinity M & E Costs			
16. Nonsalinity M & E Costs			
Department of Agriculture:			
1. Technical Assistance Costs	10,486,000		2,230,000
2. M & E Costs	1,065,000		51,000
3. Information and Education Costs	1,029,000		152,000
4. Federal Cost-share Obligations	17,937,000		3,521,000
5. Federal Const. Cost-share To Date	0		0
6. Balance Federal Const. Cost-share	17,937,000		3,521,000
7. Local Construction Cost-share	9,658,000		2,347,000
8. Percent Federal Cost-share:	65		60
9. Federal Habitat Costs	0		0
10. Local Habitat Costs	0		0
11. Other Local Costs	0		0
12. Local O&M Costs	276,000		59,000
13. Annual Value of Replacement Costs	306,000		65,000
14. Federal IDC	0		0
Cost Effectiveness:			
1. Total Salinity Construction Costs	29,452,000	323,512,848	5,903,000
2. Advance Planning Costs	0		0
3. Habitat Replacement Costs	0		0
4. IDC (Economic)	0	18,310,212	0
5. Subtotal Investment	29,452,000	341,823,060	5,903,000
6. Annual Equivalent Investment Costs	2,581,468	29,960,791	517,398
7. Annual Salinity OM&R Costs	306,000	2,743,550	65,000
8. Annual Economic Cost of Power	0	849,642	0
9. Annual M & E Costs	93,347		4,470
10. Annual Habitat OM&R Costs	0		
11. Annual Salinity Costs	2,980,815	33,553,983	586,868
12. Tons of Salt Removed Annually	38,000	287,000	8,800
13. Cost Effectiveness	78	117	67

	BR Lower Virgin 1/ 2/	USDA Virgin Valley	USDA Moapa
	NEVADA	NEVADA	NEVADA
Date of Estimate:	1/86	7/80	7/80
Interest Rate:	8.63%	7.38%	7.38%
Estimate Adjustment for 1/86:	100.00%		
1\86 Interest Rate	8.63%	8.63%	8.63%
IDC Adjustment for 1/86:	0.00%		
Project Area			
1. Irrigated Area (total acres)		4,625	4,982
2. Potential Participants:			
a. Individuals (number)		45	70
b. Groups (number)		4	1
3. Canals (total miles)		15.70	70.00
4. Laterals (total miles)			
5. Point Sources (number)			
6. Other			
Salt Load Contribution			
1. On-farm (tons/year)		47,200	20,300
2. Canals (tons/year)		8,200	1,050
3. Laterals (tons/year)			
4. Point Sources (tons/year)	359,000		
5. Other (tons/year)			2,000
Implementation Plan			
1. Construction Start (year)	1995	1995	1990
2. Construction Period (years)	3	3	4
3. Expected Participants:			
a. Individuals (number)		45	70
b. Groups (number)		4	1
4. On-farm Practices:			
a. Treated Area (acres)		3,525	4,982
b. Land Leveling (acres)			
c. Sprinkler Systems (acres)			
d. Farm Ditches/Pipelines (miles)		27	14.30
5. Canal Lining (miles)		6.40	0.27
6. Lateral Lining (miles)			
7. Pipe Laterals (miles)			17.00
8. Winter Water Systems (miles)			
9. Collection Features (type)			
10. Delivery Systems (type)	42 mi. pipeline	open lined	pipeline
11. Disposal Facilities (type)			
12. Habitat Replacement (acres)		2,040	2,814
Salt Load Reduction			
1. To date:			
a. On-farm (tons/year)			
b. Canals (tons/year)			
c. Laterals (tons/year)			
d. Point Sources (tons/year)			
e. Other (tons/year)			
2. Potential/Balance:			
a. On-farm (tons/year)		30,407	17,395
b. Canals (tons/year)		6,800	1,835
c. Laterals (tons/year)			
d. Point Sources (tons/year)	20,100		
e. Other (tons/year)			270
Data Source:	LCR 3/86	SCS/NV	SCS/NV

1/ Assumes 50% allocation of costs to water supply.
2/ Based on gross tons removed at 2400 mg/L. Assuming that w/o project water source is AWT plant a 1,300 mg/L reduction would occur without the project. Using a net reduction of 900 mg/L, the cost effectiveness could exceed $200/ton.

		BR Lower Virgin	USDA Virgin Valley	USDA Moapa
		NEVADA	NEVADA	NEVADA
	Economic and Financial Analyses			
	Department of the Interior:			
1.	Plan Formulation Costs			
2.	Nonsalinity Planning Costs			
3.	Advance Planning Costs:			
	a. Prior to Authorization			
	b. After Authorization			
4.	Nonsalinity Design Costs			
5.	Salinity Const. Costs To Date			
6.	Balance Salinity Const. Costs	19,600,000		
7.	Nonsalinity Construction Costs			
8.	Habitat Replacement Costs			
9.	Salinity IDC:			
	a. Economic			
	b. Financial			
10.	Nonsalinity IDC			
	a. Economic			
	b. Financial			
11.	Salinity OM&R Costs w/o Power	341,550		
12.	Nonsalinity OM&R w/o Power			
13.	Economic Cost of Power			
14.	Financial Cost of Power			
15.	Salinity M & E Costs			
16.	Nonsalinity M & E Costs			
	Department of Agriculture:			
1.	Technical Assistance Costs		2,056,300	2,170,500
2.	M & E Costs		323,000	388,000
3.	Information and Education Costs		200,000	275,000
4.	Federal Cost-share Obligations		4,455,300	5,064,600
5.	Federal Const. Cost-share To Date		0	0
6.	Balance Federal Const. Cost-share		4,455,300	5,064,600
7.	Local Construction Cost-share		2,399,000	2,170,500
8.	Percent Federal Cost-share:		65	70
9.	Federal Habitat Costs		16,400	125,100
10.	Local Habitat Costs		8,900	53,600
11.	Other Local Costs		0	0
12.	Local O&M Costs		62,200	359,600
13.	Annual Value of Replacement Costs		138,400	96,390
14.	Federal IDC		0	0
	Cost Effectiveness:			
1.	Total Salinity Construction Costs	19,600,000	6,711,600	7,510,100
2.	Advance Planning Costs		0	0
3.	Habitat Replacement Costs		16,40	125,100
4.	IDC (Economic)	0	0	0
5.	Subtotal Investment	19,600,000	6,728,000	7,635,200
6.	Annual Equivalent Investment Costs	2,200,000	589,709	669,225
7.	Annual Salinity OM&R Costs		138,400	96,390
8.	Annual Economic Cost of Power	0	0	0
9.	Annual M & E Costs		28,311	34,008
10.	Annual Habitat OM&R Costs			
11.	Annual Salinity Costs		756,420	799,623
12.	Tons of Salt Removed Annually	20,100	37,207	19,500
13.	Cost Effectiveness	113	20	41

	BR Las Vegas Wash Stage I Pittman NEVADA	BR Las Vegas Wash Stage I Whitney NEVADA	BR Las Vegas Wash Stage II NEVADA
Date of Estimate:	Complete		
Interest Rate:			
Estimate Adjustment for 1/86:			
1\86 Interest Rate			
IDC Adjustment for 1/86:			
Project Area			
1. Irrigated Area (total acres)			
2. Potential Participants:			
a. Individuals (number)			
b. Groups (number)			
3. Canals (total miles)			
4. Laterals (total miles)			
5. Point Sources (number)			
6. Other			
Salt Load Contribution			
1. On-farm (tons/year)			
2. Canals (tons/year)			
3. Laterals (tons/year)			
4. Point Sources (tons/year)			
5. Other (tons/year)			
Implementation Plan			
1. Construction Start (year)	1984	1986	1992
2. Construction Period (years)	1	1	10
3. Expected Participants:			
a. Individuals (number)			
b. Groups (number)			
4. On-farm Practices:			
a. Treated Area (acres)			
b. Land Leveling (acres)			
c. Sprinkler Systems (acres)			
d. Farm Ditches/Pipelines (miles)			
5. Canal Lining (miles)			
6. Lateral Lining (miles)			
7. Pipe Laterals (miles)			
8. Winter Water Systems (miles)			
9. Collection Features (type)			
10. Delivery Systems (type)			
11. Disposal Facilities (type)			
12. Habitat Replacement (acres)			
Salt Load Reduction			
1. To date:			
a. On-farm (tons/year)			
b. Canals (tons/year)			
c. Laterals (tons/year)			
d. Point Sources (tons/year)	7,000		
e. Other (tons/year)			
2. Potential/Balance:			
a. On-farm (tons/year)			
b. Canals (tons/year)			
c. Laterals (tons/year)			
d. Point Sources (tons/year)		1,000	66,000
e. Other (tons/year)			
Data Source:	CRWQO	CRWQO	CRWQO

	BR Las Vegas Wash Stage I Pittman NEVADA	BR Las Vegas Wash Stage I Whitney NEVADA	BR Las Vegas Wash Stage II NEVADA
Economic and Financial Analyses			
Department of the Interior:			
1. Plan Formulation Costs			
2. Nonsalinity Planning Costs			
3. Advance Planning Costs:			
a. Prior to Authorization			
b. After Authorization			
4. Nonsalinity Design Costs			
5. Salinity Const. Costs To Date	1,381,800		
6. Balance Salinity Const. Costs		1,400,000	9,609,565
7. Nonsalinity Construction Costs			
8. Habitat Replacement Costs			
9. Salinity IDC:			
a. Economic			
b. Financial			
10. Nonsalinity IDC			
a. Economic			
b. Financial			
11. Salinity OM&R Costs w/o Power	50,000	75,000	300,000
12. Nonsalinity OM&R w/o Power			
13. Economic Cost of Power			
14. Financial Cost of Power			
15. Salinity M & E Costs			
16. Nonsalinity M & E Costs			
Department of Agriculture:			
1. Technical Assistance Costs			
2. M & E Costs			
3. Information and Education Costs			
4. Federal Cost-share Obligations			
5. Federal Const. Cost-share To Date			
6. Balance Federal Const. Cost-share			
7. Local Construction Cost-share			
8. Percent Federal Cost-share:			
9. Federal Habitat Costs			
10. Local Habitat Costs			
11. Other Local Costs			
12. Local O&M Costs			
13. Annual Value of Replacement Costs			
14. Federal IDC			
Cost Effectiveness:			
1. Total Salinity Construction Costs	1,381,800	1,400,000	9,609,565
2. Advance Planning Costs			
3. Habitat Replacement Costs			
4. IDC (Economic)			
5. Subtotal Investment	1,381,800	1,400,000	9,609,565
6. Annual Equivalent Investment Costs	121,115	122,710	842,278
7. Annual Salinity OM&R Costs	50,000	75,000	300,000
8. Annual Economic Cost of Power			
9. Annual M & E Costs			
10. Annual Habitat OM&R Costs			
11. Annual Salinity Costs	171,115	197,710	1,142,278
12. Tons of Salt Removed Annually	7,000	1,000	66,000
13. Cost Effectiveness	24	198	17

	BR San Juan NEW MEXICO	BR Uinta Stage One UTAH	BR Uinta Stage Two UTAH
Date of Estimate:		1/85	
Interest Rate:		8.38%	
Estimate Adjustment for 1/86:		101.28%	
1\86 Interest Rate		8.63%	
IDC Adjustment for 1/86:		2.98%	
Project Area			
1. Irrigated Area (total acres)		97,447	
2. Potential Participants:			
a. Individuals (number)			
b. Groups (number)			
3. Canals (total miles)			
4. Laterals (total miles)			
5. Point Sources (number)			
6. Other			
Salt Load Contribution			
1. On-farm (tons/year)			
2. Canals (tons/year)			
3. Laterals (tons/year)			
4. Point Sources (tons/year)			
5. Other (tons/year)		450,000	
Implementation Plan			
1. Construction Start (year)		1991	
2. Construction Period (years)		8	
3. Expected Participants:			
a. Individuals (number)			
b. Groups (number)			
4. On-farm Practices:			
a. Treated Area (acres)			
b. Land Leveling (acres)			
c. Sprinkler Systems (acres)			
d. Farm Ditches/Pipelines (miles)			
5. Canal Lining (miles)		43.90	
6. Lateral Lining (miles)		11.60	
7. Pipe Laterals (miles)			
8. Winter Water Systems (miles)			
9. Collection Features (type)			
10. Delivery Systems (type)			
11. Disposal Facilities (type)			
12. Habitat Replacement (acres)			
Salt Load Reduction			
1. To date:			
a. On-farm (tons/year)			
b. Canals (tons/year)			
c. Laterals (tons/year)			
d. Point Sources (tons/year)			
e. Other (tons/year)			
2. Potential/Balance:			
a. On-farm (tons/year)			
b. Canals (tons/year)		25,500	
c. Laterals (tons/year)			
d. Point Sources (tons/year)			
e. Other (tons/year)			
Data Source:		4/86 PR/EIS	

	BR San Juan NEW MEXICO	BR Uinta Stage One UTAH	BR Uinta Stage Two UTAH
Economic and Financial Analyses			
Department of the Interior:			
1. Plan Formulation Costs		2,500,000	
2. Nonsalinity Planning Costs			
3. Advance Planning Costs:			
a. Prior to Authorization		1,200,000	
b. After Authorization			
4. Nonsalinity Design Costs			
5. Salinity Const. Costs To Date			
6. Balance Salinity Const. Costs		21,552,000	
7. Nonsalinity Construction Costs			
8. Habitat Replacement Costs		1,000,000	
9. Salinity IDC:			
a. Economic			
b. Financial			
10. Nonsalinity IDC			
a. Economic			
b. Financial			
11. Salinity OM&R Costs w/o Power		157,000	
12. Nonsalinity OM&R w/o Power		7,300	
13. Economic Cost of Power			
14. Financial Cost of Power			
15. Salinity M & E Costs			
16. Nonsalinity M & E Costs			
Department of Agriculture:			
1. Technical Assistance Costs			
2. M & E Costs			
3. Information and Education Costs			
4. Federal Cost-share Obligations			
5. Federal Const. Cost-share To Date			
6. Balance Federal Const. Cost-share			
7. Local Construction Cost-share			
8. Percent Federal Cost-share:			
9. Federal Habitat Costs			
10. Local Habitat Costs			
11. Other Local Costs			
12. Local O&M Costs			
13. Annual Value of Replacement Costs			
14. Federal IDC			
Cost Effectiveness:			
1. Total Salinity Construction Costs		21,552,000	
2. Advance Planning Costs		1,200,000	
3. Habitat Replacement Costs		1,000,000	
4. IDC (Economic)			
5. Subtotal Investment		23,752,000	
6. Annual Equivalent Investment Costs		2,081,863	
7. Annual Salinity OM&R Costs		157,000	
8. Annual Economic Cost of Power			
9. Annual M & E Costs			
10. Annual Habitat OM&R Costs		7,300	
11. Annual Salinity Costs		2,246,963	
12. Tons of Salt Removed Annually		25,500	
13. Cost Effectiveness		88	

	USDA Uinte 1/	BR/USDA Price-Sn Rfael	USDA Price-Sn Rfael
	UTAH	UTAH	UTAH
Date of Estimate:	?/??	1/86	
Interest Rate:	6.63%	8.88%	
Estimate Adjustment for 1/86:		100.00%	
1\86 Interest Rate	8.63%	8.63%	
IDC Adjustment for 1/86:		-2.76%	
Project Area			
1. Irrigated Area (total acres)	205,000		
2. Potential Participants:			
a. Individuals (number)	1,300		
b. Groups (number)	250		
3. Canals (total miles)	576		
4. Laterals (total miles)	859		
5. Point Sources (number)			
6. Other			
Salt Load Contribution			
1. On-farm (tons/year)	175,000		
2. Canals (tons/year)	25,000		
3. Laterals (tons/year)	20,000		
4. Point Sources (tons/year)	45,000		
5. Other (tons/year)	235,000		
Implementation Plan			
1. Construction Start (year)	1980	1991	
2. Construction Period (years)	24	?	
3. Expected Participants:			
a. Individuals (number)	800		
b. Groups (number)	150		
4. On-farm Practices:			
a. Treated Area (acres)	128,100		
b. Land Leveling (acres)	42,800		
c. Sprinkler Systems (acres)	79,400		
d. Farm Ditches/Pipelines (miles)	1,540		
5. Canal Lining (miles)			
6. Lateral Lining (miles)			
7. Pipe Laterals (miles)	306		
8. Winter Water Systems (miles)			
9. Collection Features (type)			
10. Delivery Systems (type)	Pipeline		
11. Disposal Facilities (type)			
12. Habitat Replacement (acres)	4,500		
Salt Load Reduction			
1. To date:			
a. On-farm (tons/year)	12,900		
b. Canals (tons/year)			
c. Laterals (tons/year)	2,700		
d. Point Sources (tons/year)			
e. Other (tons/year)			
2. Potential/Balance:			
a. On-farm (tons/year)	69,400		
b. Canals (tons/year)			
c. Laterals (tons/year)	13,200		
d. Point Sources (tons/year)			
e. Other (tons/year)		52,322	

1/ Revised to reflect current studies

Data Source:	SCS/UT	3-86 Jt Rpt/Forum	

	USDA Uinta UTAH	BR Price-Sn Rfael UTAH	USDA Price-Sn Rfael UTAH
Economic and Financial Analyses			
Department of the Interior:			
1. Plan Formulation Costs			
2. Nonsalinity Planning Costs			
3. Advance Planning Costs:			
a. Prior to Authorization			
b. After Authorization			
4. Nonsalinity Design Costs			
5. Salinity Const. Costs To Date			
6. Balance Salinity Const. Costs		28,300,000	
7. Nonsalinity Construction Costs			
8. Habitat Replacement Costs		110,962	
9. Salinity IDC:			
a. Economic		2,511,625	
b. Financial			
10. Nonsalinity IDC			
a. Economic			
b. Financial			
11. Salinity OM&R Costs w/o Power		0	
12. Nonsalinity OM&R w/o Power			
13. Economic Cost of Power			
14. Financial Cost of Power			
15. Salinity M & E Costs			
16. Nonsalinity M & E Costs			
Department of Agriculture:			
1. Technical Assistance Costs	16,709,000		
2. M & E Costs	2,922,000		
3. Information and Education Costs	684,000		
4. Federal Cost-share Obligations	59,351,000	6,538,000	
5. Federal Const. Cost-share To Date	10,073,562	0	
6. Balance Federal Const. Cost-share	49,277,438	6,538,000	
7. Local Construction Cost-share	25,436,310	2,802,000	
8. Percent Federal Cost-share:	70		
9. Federal Habitat Costs	441,300	30,644	
10. Local Habitat Costs	225,000		
11. Other Local Costs	685,000		
12. Local O&M Costs	3,121,000	177,460	
13. Annual Value of Replacement Costs	1,014,000		
14. Federal IDC	0		
Cost Effectiveness:			
1. Total Salinity Construction Costs	76,744,000	34,838,000	
2. Advance Planning Costs	0		
3. Habitat Replacement Costs	441,300		
4. IDC (Economic)	0	2,511,625	
5. Subtotal Investment	77,185,300	37,349,625	
6. Annual Equivalent Investment Costs	6,765,292	3,273,695	
7. Annual Salinity OM&R Costs	1,014,000	177,460	
8. Annual Economic Cost of Power	0		
9. Annual M & E Costs	256,113		
10. Annual Habitat OM&R Costs	0	141,606	
11. Annual Salinity Costs	8,035,405	3,592,761	
12. Tons of Salt Removed Annually	98,200	52,322	
13. Cost Effectiveness	82	69	

	BR Dirty Devil	BR Big Sandy	USDA Big Sandy 1/
	UTAH	WYOMING	WYOMING
Date of Estimate:	1/85		10/84
Interest Rate:	8.63%		7.00%
Estimate Adjustment for 1/86:	101.28%		
1\86 Interest Rate	8.63%		8.63%
IDC Adjustment for 1/86:	0.00%		
Project Area			
1. Irrigated Area (total acres)			15,700
2. Potential Participants:			
a. Individuals (number)			84
b. Groups (number)			9
3. Canals (total miles)			
4. Laterals (total miles)			
5. Point Sources (number)			
6. Other			
Salt Load Contribution			
1. On-farm (tons/year)			90,100
2. Canals (tons/year)			
3. Laterals (tons/year)			
4. Point Sources (tons/year)		164,000	
5. Other (tons/year)	150,000		24,300
Implementation Plan			
1. Construction Start (year)	1991		1989
2. Construction Period (years)	3		7
3. Expected Participants:			
a. Individuals (number)			84
b. Groups (number)			9
4. On-farm Practices:			
a. Treated Area (acres)			15,700
b. Land Leveling (acres)			2,500
c. Sprinkler Systems (acres)			11,000
d. Farm Ditches/Pipelines (miles)			146
5. Canal Lining (miles)			
6. Lateral Lining (miles)			
7. Pipe Laterals (miles)			
8. Winter Water Systems (miles)			
9. Collection Features (type)	shallow wells		
10. Delivery Systems (type)	15000 ft pipeln		
11. Disposal Facilities (type)	injection wells		
12. Habitat Replacement (acres)			1,290
Salt Load Reduction			
1. To date:			
a. On-farm (tons/year)			
b. Canals (tons/year)			
c. Laterals (tons/year)			
d. Point Sources (tons/year)			
e. Other (tons/year)			
2. Potential/Balance:			
a. On-farm (tons/year)			52,900
b. Canals (tons/year)			
c. Laterals (tons/year)			
d. Point Sources (tons/year)			
e. Other (tons/year)	20,900		

1/ Subject to low pressure sprinkler plan revisions

Data Source:	3/86 Draft PR		SCS/WY

	BR Dirty Devil	BR Big Sandy	USDA Big Sandy
	UTAH	WYOMING	WYOMING
Economic and Financial Analyses			
Department of the Interior:			
1. Plan Formulation Costs	3,241,026		
2. Nonsalinity Planning Costs			
3. Advance Planning Costs:			
a. Prior to Authorization	962,179		
b. After Authorization			
4. Nonsalinity Design Costs			
5. Salinity Const. Costs To Date			
6. Balance Salinity Const. Costs	10,938,462		
7. Nonsalinity Construction Costs			
8. Habitat Replacement Costs			
9. Salinity IDC:			
a. Economic	1,616,462		
b. Financial			
10. Nonsalinity IDC			
a. Economic			
b. Financial			
11. Salinity OM&R Costs w/o Power	490,205		
12. Nonsalinity OM&R w/o Power			
13. Economic Cost of Power	371,705		
14. Financial Cost of Power	103,308		
15. Salinity M & E Costs			
16. Nonsalinity M & E Costs			
Department of Agriculture:			
1. Technical Assistance Costs			2,179,600
2. M & E Costs			500,000
3. Information and Education Costs			450,000
4. Federal Cost-share Obligations			7,437,500
5. Federal Const. Cost-share To Date			0
6. Balance Federal Const. Cost-share			7,437,500
7. Local Construction Cost-share			3,187,400
8. Percent Federal Cost-share:			70
9. Federal Habitat Costs			721,800
10. Local Habitat Costs			417,300
11. Other Local Costs			2,298,700
12. Local O&M Costs			315,900
13. Annual Value of Replacement Costs			339,000
14. Federal IDC			0
Cost Effectiveness:			
1. Total Salinity Construction Costs	10,938,462		10,067,100
2. Advance Planning Costs	962,179		0
3. Habitat Replacement Costs			721,800
4. IDC (Economic)	1,616,462		0
5. Subtotal Investment	13,517,103		10,788,900
6. Annual Equivalent Investment Costs	1,184,774		945,647
7. Annual Salinity OM&R Costs	490,205		339,000
8. Annual Economic Cost of Power	371,705		0
9. Annual M & E Costs			43,825
10. Annual Habitat OM&R Costs			0
11. Annual Salinity Costs	2,046,684		1,328,472
12. Tons of Salt Removed Annually	20,900		52,900
13. Cost Effectiveness	98		25

Appendix B

Salt Reduction Objective Estimation

SALT LOAD REDUCTION TARGET ESTIMATION

Salt load reduction required to maintain the Lower Basin standards was estimated using a 3-step procedure.

1. A 15-trace CRSS simulation was made using the Reclamation demand data base (given in Progress Report 12) and initialized at 1985 conditions. Existing and ongoing salinity control project salt load reductions were included as shown in Table B-1. The simulation period was 1986-2040.

2. CRSS output was used to compute the salt load reduction required to reduce the TDS at Imperial Dam to the standard (879 mg/L). This was done using the future-effects equation for projects above Parker Dam:

$$\Delta TDS = \left[Q_{BP} \frac{L_{AP} - \Delta L}{Q_{AP}} - L_{BP} \right] \frac{k}{Q_I}$$

where:
- ΔTDS = change in TDS (mg/L) at Imperial Dam
- Q_{BP} = discharge (kac. ft) below Parker Dam
- L_{AP} = salt load (kton) above Parker Dam
- ΔL = change in salt load above Parker Dam
- Q_{AP} = adjusted discharge above Parker Dam
- L_{BP} = salt load below Parker Dam
- k = conversion from ton/ac.ft to mg/L = 735.46
- Q_I = discharge at Imperial Dam

The difference between the predicted TDS at Imperial Dam (TDS_I) and the standard was substituted for TDS and the equation was solved for L:

$$\Delta L = L_{AP} - \frac{Q_{AP}}{Q_{BP}} \left[\frac{Q_I \, (TDS_I - 879)}{735.46} + L_{BP} \right]$$

The required salt load reduction, ΔL, was then evaluated for each year of the simulation period using CRSS output values for L_{AP}, Q_{AP}, Q_{BP}, L_{BP}, Q_I, and TDS_I. These values and resultant values are displayed in Table B-2.

3. Computed reductions (ΔL) exhibited significant scatter (Figure 9, main report) due to oscillations due to the 5 year increments on which the CRSS output was based. Therefore, a smooth curve was fit through the

data. The best fit was achieved using a logistic growth curve of the form:

$$y = \frac{a}{1 + \exp(b-cx)}$$

The coefficients were evaluated using non-linear, least - squares regression with the SPSS (Statistical Package for the Social Sciences) Marquardt method (Robinson, B; 1984; SPSS Program NONLINEAR - Nonlinear Regression; Manual 433, Vogleback Computing Center, Northwestern University). The computed reductions were regressed against sequential year numbers, with year one corresponding to 1996, the first year in which the standard was exceeded. The resultant best fit target values are given in Table B-2 and plotted on Figure B-1.

Table B-1. - Salt Load Reduction from Existing Salinity Control Projects

Project	Reduction (kTon/yr)
Reclamation	
Grand Valley, Stage I	21.9
Meeker Dome	48.0 1/
Las Vegas Wash, Pittman Bypass	7.0
USDA	
Grand Valley	27.3
Uinta Basin	15.6

1/ Cost-effectiveness is based on 19,000 tons.

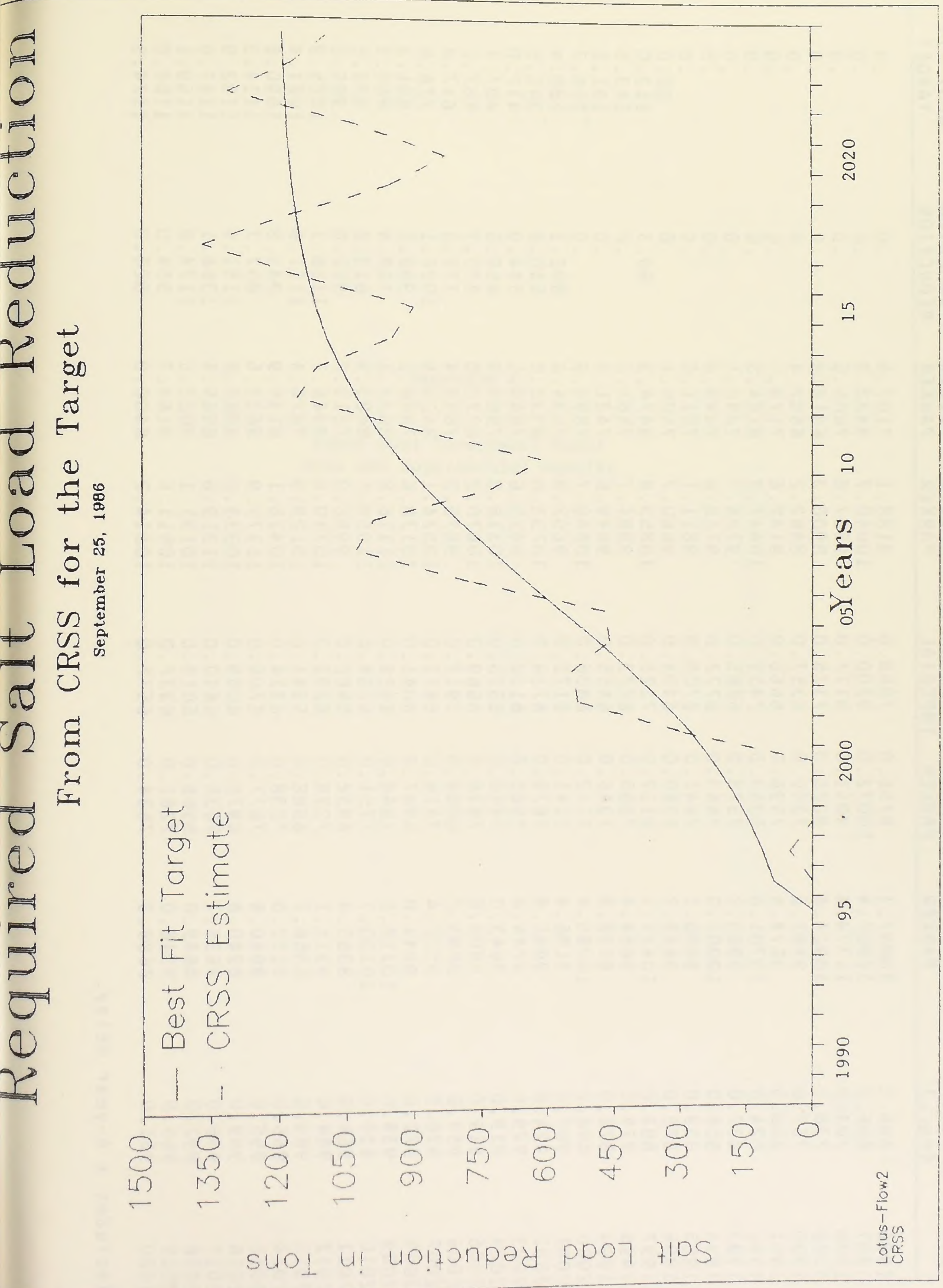

Figure B-1. - Required salt reduction from CRSS for the target objective.

Table B-2. CRSS Results and Salt Load Reduction Targets at Imperial Dam

YEAR	TDS AT IMPERIAL (mg/L)	-----DISCHARGE (KACFT)----- ABOVE PARKER	BELOW PARKER	AT IMPERIAL	-----SALT LOAD (KTON)----- ABOVE PARKER	BELOW PARKER	COMPUTED REDUCTION	BEST FIT TARGET
1986	686.0	10087.1	8756.0	7858.0	8188.1	7107.6	.0	.0
1987	696.0	12007.4	10072.0	9200.0	10040.7	8422.3	.0	.0
1988	704.0	11374.4	9051.0	8177.0	9557.8	7605.5	.0	.0
1989	738.0	10324.6	8026.0	7175.0	8900.3	6918.8	.0	.0
1990	767.0	9487.2	7290.0	6357.0	8462.2	6502.4	.0	.0
1991	808.0	9674.9	7596.0	6660.0	9142.6	7178.1	.0	.0
1992	824.0	10701.8	8363.0	7452.0	10447.8	8164.5	.0	.0
1993	837.0	9963.2	7578.0	6665.0	9726.7	7398.1	.0	.0
1994	836.0	10007.0	7663.0	6772.0	9728.6	7449.8	.0	.0
1995	839.0	9980.1	7641.0	6708.0	9811.1	7511.5	.0	.0
1996	875.0	9448.2	7340.0	6404.0	9660.7	7505.1	.0	88.0
1997	883.0	10421.1	8137.0	7225.0	10853.8	8474.9	50.3	113.0
1998	879.0	9654.4	7385.0	6473.0	9884.7	7561.1	.0	143.5
1999	872.0	9538.8	7346.0	6455.0	9649.6	7431.3	.0	181.2
2000	866.0	10090.4	7772.0	6806.0	10248.7	7893.9	.0	226.7
2001	907.0	9186.4	7141.0	6172.0	9692.8	7534.6	302.3	280.4
2002	924.0	9891.8	7679.0	6734.0	10733.0	8332.0	530.8	342.5
2003	929.0	9244.8	7103.0	6158.0	9955.6	7649.1	544.9	412.0
2004	919.0	9643.0	7448.0	6525.0	10318.8	7969.9	459.5	487.7
2005	919.0	9908.5	7635.0	6669.0	10670.2	8222.0	470.7	567.2
2006	954.0	8893.2	6886.0	5917.0	9879.2	7649.4	779.3	647.9
2007	970.0	9522.4	7416.0	6471.0	10824.1	8429.8	1028.1	726.8
2008	972.0	9041.0	6987.0	6041.0	10178.6	7866.1	988.5	801.3
2009	939.0	10118.5	7848.0	6925.0	11116.5	8622.1	728.4	869.3
2010	930.0	10103.7	7751.0	6784.0	11059.1	8483.9	613.2	929.6
2011	966.0	8865.4	6932.0	5962.0	9992.9	7813.7	902.0	981.5
2012	984.0	9315.1	7239.0	6293.0	10740.5	8346.7	1156.1	1025.3
2013	986.0	8858.7	6888.0	5941.0	10129.9	7876.4	1111.6	1061.4
2014	965.0	9272.0	7238.0	6314.0	10426.1	8138.9	945.8	1090.8
2015	955.0	9940.6	7677.0	6709.0	11177.9	8632.5	897.7	1114.3
2016	989.0	8940.8	6979.0	6009.0	10333.2	8065.9	1151.4	1132.9
2017	998.0	9635.7	7635.0	6690.0	11319.8	8969.4	1366.1	1147.6
2018	992.0	8849.0	6966.0	6019.0	10191.1	8022.5	1174.8	1159.1
2019	965.0	9348.0	7261.0	6337.0	10511.5	8164.7	954.0	1168.0
2020	951.0	9699.3	7534.0	6572.0	10814.2	8400.0	828.3	1174.9

Includes a 4-year delay.

Appendix C

Least Cost Investment Model Data and Supplemental Results

Table C - 1. Maximum Budget and Salt Load Reduction Targets Used in the Budget Constraint Model 1/

YEAR	MAXIMUM COST TARGET 2/ (Millions of Dollars) ANNUAL	CUMULATIVE	SALT LOAD REDUCTION TARGET (kTon) 3/
1986	20	20	0
1987	20	40	0
1988	30	70	0
1989	40	110	0
1990	50	150	0
1991	50	190	0
1992	50	230	88
1993	50	270	113
1994	50	310	143
1995	50	350	181
1996	50	390	227
1997	50	430	280
1998	50	470	342
1999	50	510	412
2000	50	550	488
2001	50	590	567
2002	50	630	648
2003	50	670	727
2004	50	710	801
2005	50	750	869
2006	50	790	930
2007	50	830	982
2008	50	870	1025
2009	50	870	1061
2010	50	870	1091

1/ All minimum budget targets were zero.

2/ The two columns are independent - $50 million is the annual maximum but cumulative totals do not allow a full $50 million to be added each year.

3/ Targets were computed for Imperial Dam and shifted forward 4 years to allow project impacts to completely pass through Lakes Powell and Mead.

Table C-2 Project Data Used in the Least Cost Investment Model

PROJECT	SALINITY COST (millions of dollars) CONSTRUCTION (Total remaining)	CM&R (Annual)	CONSTRUCTION PERIOD (Years)	FIXED START (Year)	SALT LOAD REDUCTION (kton)	DELAYED IMPACT 1/
Reclamation						
Grand Valley, Stage II	126.2	0.05	14	1986 2/	116.3	
Grand Valley, balance	74.8	0.25	9		23.2	
Paradox Valley	49.5	0.30	4	1986 2/	180.0	yes
Dolores	25.0	0.00	3	1989	23.0	
Lower Gunnison, Winter Water	17.7	0.62	3	1987	78.6	
Lower Gunnison, Stage I balance	143.9	0.00	6		66.3	
Las Vegas Wash, Whitney	1.4	0.08	1	1986	1.0	
Las Vegas Wash, remaining area	9.6	0.30	10		66.0	
Uinta Basin, Stage I	22.6	0.00	8		25.5	
Dirty Devil	10.9	0.49	3		20.9	yes
Price-San Rafael	37.3	0.00	5		52.3	
Lower Virgin	19.6	0.34	2		44.4 4/	yes
BLM						
Sinbad Valley	7.1	0.06	3		7.5	yes
USDA						
Grand Valley	28.0	0.00	16	1986 2/	202.7	
Uinta Basin	49.7	0.00	18	1986 2/	82.6	
Lower Gunnison 1 5/	21.5	0.00	12		57.5	
Lower Gunnison 2 - Montrose 5/	22.8	0.00	12		57.2	
Lower Gunnison 2 - Delta 5/	17.9	0.00	9		73.3	
Lower Gunnison 3 5/	3.6	0.00	3		8.4	
Moapa Valley 5/	3.6	0.00	4		13.7	
Virgin Valley 5/	2.9	0.00	3		24.2	
McElmo Creek 5/	11.7	0.00	7	1992 3/	24.7	
Mancos Valley 5/	2.8	0.00	3		7.0	
Big Sandy	8.2	0.00	7		52.9	

1/ Projects with delayed impacts must be completely built before any salt load reduction occurs.
2/ Ongoing projects - remaining cost, construction period and salt load reduction are given.
3/ McElmo will start the year following completion of Dolores.
4/ Includes 24,000 tons that would be attributed to AWT flows which would be used for Harry Allen.
5/ Reflects current projected program accomplishment based on reduced participation.

Table C-3

Data Table Summary for 1986 Least Cost Analysis — CHECKI/November 21, 1986

Project	Remaining Investment Costs ($1,000,000's)	O&M Costs ($1,000,000's) Annual O&M Costs	Financial Cost of Power	Years	Remaining O&M Costs
Grand Valley Stage I	0.0	0.01		24	0.24
Grand Valley Stage II	126.2	0.05		11	0.55
Las Vegas Wash - Pittman -	0.0	0.05		25	1.25
Las Vegas Wash - Whitney -	1.4	0.08		22	1.76
Paradox Valley Unit	49.5	0.30	0.16	21	9.66
Grand Valley USDA	28.0				0.00
Uinta USDA	49.7				0.00
Lower Gunnison - Winter Water -	17.7	0.62		20	12.40
Lower Gunnison 1 USDA	21.5				0.00
Lower Gunnison 2 Montrose USDA	22.8				0.00
Lower Gunnison 2 Delta USDA	17.9				0.00
Lower Gunnison 3 USDA	3.6				0.00
Dolores - Salinity Control -	25.0				0.00
McElmo Creek USDA	11.7				0.00
Big Sandy USDA	8.2				0.00
Moapa Valley USDA	3.6				0.00
Unita Stage I	22.6	0.00		12	0.00
Price-San Rafael (Combined)	37.3				0.00
Lower Virgin	19.6	0.34		16	5.44
	466.3	1.45	0.16		31.30
					466.30
Total Remaining Program Costs:					497.60

Appendix D

Repayment Analysis

Repayment Analysis

The basin fund revenues used in this analysis are the numbers provided by Western Area Power Administration in 1986. Payments have been deducted for Hoover deficiencies and annual amortization of presently authorized projects. The result is revenue available annually for the balance of projects required to meet salt load reduction targets. Table D-1 shows the repayment dollars available.

Tables D-2 and D-3 show the repayment dollars needed and the repayment capability of the Basin States for the $498 million investment level without and with inflation costs added.

For purposes of basin fund repayment analysis, the USDA costs for technical assistance, education, and monitoring and evaluation are excluded. However, these Federal costs are costs of implementation and are considered in the computed cost-effectiveness values.

Table D-1
Colorado River Basin Salinity Control Program
Available Revenue in LCRBD Fund
For S.752 Programs
($1,000's)

Year	Hoover Revenue Available	Plus Parker-Davis Revenue Available	Less Hoover Deficiency Payments	Less Presently Authorized Amortization	Equals Total Revenue Available
1987	3,770	0	0	0	3,770
1988	10,304	0	1,556	0	8,749
1989	9,458	0	1,556	266	7,636
1990	9,336	0	1,556	311	7,469
1991	9,168	0	1,556	1,342	6;271
1992	9,451	0	1,556	1,342	6,553
1993	9,120	0	1,556	1,342	6,222
1994	9,120	0	1,556	1,342	6,222
1995	9,120	0	1,556	1,342	6,222
1996	9,120	0	1,556	1,342	6,222
1997	9,120	0	1,556	1,342	6,222
1998	9,355	0	1,556	1,342	6,457
1999	9,132	0	1,556	1,342	6,234
2000	9,252	0	1,556	1,342	6,354
2001	8,964	0	1,556	1,342	6,066
2002	8,917	0	1,556	1,342	6,020
2003	9,033	0	1,556	1,342	6,135
2004	8,858	0	1,556	1,342	5,961
2005	8,942	879	1,556	1,342	6,923
2006	8,921	2,637	0	1,342	10,217
2007	8,881	2,637	0	1,342	10,176
2008	8,670	2,637	0	1,342	9,965
2009	8,828	2,637	0	1,342	10,123
2010	8,779	2,637	0	1,342	10,075
TOTAL	213,618	14,066	28,000	27,417	172,267

CRWQIP RECOMMENDED PLAN - NOVEMBER 1986/BASE1986 $498 Million Alternative - 0.038097 Inflation Rate Repayment Interest Rates - 1985 @ 0.12375, 1986 through 2010 @ 0.10625

CRWQIP Data Table November 14, 1986

B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE
$ in 1,000's P.L.93-320 Units	Total Investment Costs	Investment and O&M Costs	Total thru 1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Grand Valley Stage I	28,856	29,105	28,856			9	9	9	10	10	10	11	11	12	12	13	13	14	14	15	15	16	16	17	18	18	19	20	20
Grand Valley Stage II	174,560	175,695		3,950	2,621	5,441	9,085	13,193	12,174	14,210	13,119	13,619	15,985	14,677	17,140	15,816	16,419	6,392	84	88	91	94	98	102	106	110	114	118	123
Grand Valley - Balance -	0	0																											
Crystal Geyser	0	0																											
Las Vegas Wash - Pittman -	1,382	3,539	1,382	50	52	54	56	58	60	63	65	67	70	73	75	78	81	84	88	91	94	98	102	106	110	114	118	123	127
Las Vegas Wash - Whitney -	1,513	4,431			392	603	517	87	98	94	97	101	105	109	113	117	122	127	131	136	142	147	153	158	164	171	177	184	191
Las Vegas Wash Stage II	0	0													0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Paradox Valley Unit	69,962	87,174	13,390	2,350	13,358	14,400	14,395	12,069	550	571	592	615	638	663	688	714	741	770	799	829	861	894	928	963	1,000	1,038	1,078	1,119	1,161
Subtotal P.L.93-320 Units:	276,201	300,023	43,628	6,350	16,423	20,507	24,861	25,417	12,884	14,955	13,885	14,413	16,730	15,533	18,029	16,739	17,376	7,306	1,116	1,159	1,203	1,249	1,296	1,346	1,397	1,450	1,506	1,563	1,623
Cumulative Subtotal:			43,628	49,978	66,401	86,908	111,769	137,186	150,070	165,025	178,909	193,323	210,053	225,585	243,614	260,353	277,729	285,115	286,231	287,390	288,593	289,842	291,138	292,484	293,881	295,332	296,837	298,400	300,023
LCRB Fund Share																													
Grand Valley Stage I						124	125	125	125	125	125	125	125	125	125	125	125	126	126	126	126	126	126	126	126	127	127	127	127
Grand Valley Stage II																			760	761	761	762	763	764	764	765	766	767	768
Grand Valley - Balance -																													
Las Vegas Wash - Pittman -				16	17	17	18	18	19	19	20	20	21	21	22	23	23	24	24	25	26	27	27	28	29	30	31	32	33
Las Vegas Wash - Whitney -								25	26	26	27	28	29	30	30	31	32	33	34	35	37	38	39	40	41	43	44	46	47
Las Vegas Wash Stage II																									0	0	0	0	0
Paradox Valley Unit									414	419	423	428	433	438	444	449	455	461	467	474	480	487	495	502	510	518	526	535	544
Subtotal - LCRB Fund Share				16	17	142	142	168	583	589	595	601	608	614	621	628	636	644	1,411	1,420	1,430	1,440	1,450	1,460	1,471	1,482	1,494	1,506	1,519
P.L.98-569 Units																													
Grand Valley USDA	46,345	46,345	6,000	1,870	2,037	1,812	2,195	1,953	2,365	2,105	2,549	2,646	2,355	2,852	2,537	3,073	3,190	2,839	2,947	1,020									
Uinta USDA	81,042	81,042	6,689	3,305	3,097	3,215	3,337	2,887	3,596	3,733	3,876	4,023	4,176	3,613	4,501	4,672	4,850	5,035	5,227	5,426	3,755	1,949							
Lower Gunnison - Winter Water -	43,244	43,244					5,341	8,214	7,035	776	805	836	868	901	935	971	1,008	1,046	1,086	1,128	1,171	1,215	1,262	1,310	1,360	1,411	1,465	1,521	1,579
Lower Gunnison Stage 1	0	0																											
Lower Gunnison - North Fork -	0	0																											
Lower Gunnison 1 USDA	31,215	31,215						500	1,556	2,692	2,515	2,901	3,012	3,126	3,245	3,032	3,497	3,631	1,508										
Lower Gunnison 2 Montrose USDA	35,698	35,698								571	1,779	3,079	2,876	3,310	3,444	3,575	3,712	3,460	4,000	4,152	1,724								
Lower Gunnison 2 Delta USDA	26,264	26,264								895	2,322	3,133	3,503	3,377	3,505	3,639	3,778	2,112											
Lower Gunnison 3 USDA	4,861	4,861									1,261	1,939	1,661																
Dolores - Salinity Control -	30,260	30,260						7,851	12,075	10,341																			
McElmo Creek USDA	16,463	16,463								875	2,424	2,673	2,612	2,881	2,990	2,089													
Big Sandy USDA	10,691	10,691						569	1,574	1,736	1,696	1,871	1,942	1,304															
Virgin Valley USDA	0	0																											
Moapa Valley USDA	4,651	4,651							788	1,318	1,369	1,176																	
Price USDA	0	0																											
Mancos Valley USDA	0	0																											
Palo Verde Irrig District USDA	0	0																											
Subtotal P.L.98-569 Units	330,742	330,742	12,689	5,255	5,134	5,027	10,873	21,973	28,909	25,043	20,596	24,278	23,005	21,372	21,159	20,972	20,035	18,130	14,767	11,725	6,650	3,164	1,262	1,310	1,360	1,411	1,465	1,521	1,579
Cumulative Subtotal:			12,689	17,944	23,077	28,104	38,977	60,951	89,940	114,983	135,579	159,857	182,861	204,233	225,392	246,364	266,399	284,529	299,296	311,021	317,671	320,835	322,097	323,407	324,766	326,177	327,643	329,163	330,742
Subtotal - LCRB Fund Share						1,282	2,773	5,603	7,392	6,386	5,252	6,191	5,866	5,450	5,396	5,348	5,109	4,623	3,766	2,990	1,696	887	322	334	347	360	374	388	403
Remaining Units																													
Sinbad Valley (BLM)	0	0																											
Uinta Stage 1	32,492	32,503								1,411	3,809	4,258	4,736	4,916	4,764	5,298	3,300	6	6	7	7	7	7	8	8	8	9	9	9
Uinta Stage II	0	0																											
Dirty Devil	0	0																											
Price-San Rafael (Combined)	52,741	52,741								2,805	7,764	8,563	8,367	9,220	9,580	6,435													
Lower Virgin	1,547	37,174									6,875	10,573	9,055	496	515	535	555	576	598	621	645	669	695	721	749	777	807	838	870
Palo Verde Irrigation District	0	0																											
Big Sandy	0	0																											
San Juan River	0	0																											
Subtotal Remaining Units	86,780	122,497								4,216	18,448	23,395	22,158	14,641	14,859	12,268	3,855	583	605	628	652	677	702	729	757	786	816	847	879
Cumulative Subtotal:										4,216	22,663	46,058	68,216	82,857	97,716	109,984	113,839	114,422	115,026	115,654	116,306	116,982	117,685	118,414	119,171	119,956	120,772	121,619	122,497
Subtotal - LCRB Fund Share										1,075	4,704	5,966	5,650	3,733	3,789	3,128	983	149	154	160	166	173	179	186	193	200	208	216	224
TOTAL - ALL UNITS	693,803	753,263	56,317	11,605	21,556	25,534	35,734	47,391	41,873	44,214	52,928	62,086	61,892	51,545	54,046	49,978	41,267	26,098	16,488	13,512	8,505	5,090	3,260	3,395	3,513	3,647	3,786	3,931	4,080
CUMULATIVE TOTAL:			56,317	67,922	89,478	115,012	150,746	198,137	240,010	284,224	337,152	399,238	461,130	512,676	566,722	616,700	657,967	684,065	700,553	714,065	722,570	727,660	730,920	734,305	737,818	741,465	745,252	749,182	753,263
TOTAL - LCRB Fund Share				16	17	1,424	2,915	5,771	7,975	8,050	10,551	12,758	12,124	9,797	9,806	9,104	6,728	5,415	5,331	4,571	3,292	2,419	1,950	1,980	2,011	2,043	2,076	2,110	2,146
LCRB Funds				0	0	3,770	8,749	7,636	7,469	6,271	6,553	6,222	6,222	6,222	6,222	6,222	6,457	6,234	6,354	6,066	6,020	6,135	5,961	6,923	10,217	10,176	9,965	10,123	10,075
Balance				(16)	(17)	2,347	5,834	1,865	(506)	(1,779)	(3,998)	(6,535)	(5,902)	(3,575)	(3,583)	(2,882)	(270)	819	1,023	1,496	2,728	3,716	4,010	4,943	8,206	8,133	7,890	8,013	7,929
Previous Balance				0	(19)	(39)	2,307	8,141	10,006	9,500	7,721	3,723	(3,111)	(9,970)	(14,984)	(20,540)	(25,911)	(28,963)	(31,134)	(33,311)	(35,196)	(35,917)	(35,623)	(34,971)	(33,210)	(27,670)	(21,612)	(15,181)	(7,929)
Balance				(16)	(35)	2,307	8,141	10,006	9,500	7,721	3,723	(2,812)	(9,012)	(13,545)	(18,567)	(23,422)	(26,181)	(28,144)	(30,112)	(31,815)	(32,468)	(32,201)	(31,612)	(30,028)	(25,012)	(19,537)	(13,723)	(7,167)	0
Interest Component				(2)	(4)	0	0	0	0	0	0	(299)	(958)	(1,439)	(1,973)	(2,489)	(2,782)	(2,990)	(3,199)	(3,380)	(3,450)	(3,421)	(3,359)	(3,190)	(2,658)	(2,076)	(1,458)	(762)	0
TOTAL - Balance				(19)	(39)	2,307	8,141	10,006	9,500	7,721	3,723	(3,111)	(9,970)	(14,984)	(20,540)	(25,911)	(28,963)	(31,134)	(33,311)	(35,196)	(35,917)	(35,623)	(34,971)	(33,210)	(27,670)	(21,612)	(15,181)	(7,929)	0

CRWDIP RECOMMENDED PLAN - NOVEMBER 1986/BASE1986 — $498 Million Alternative - Without Inflation — Repayment Interest Rates - 1985 @ 0.12375, 1986 through 2010 @ 0.10625

$ in 1,000's — CRWDIP Data Table — November 14, 1986

B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
P.L.93-320 Units	Total Investment Costs	Investment and O&M Costs	Total thru 1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Grand Valley Stage I	20,856	29,040	20,856			8	8	8	8	8	8	8	8	8
Grand Valley Stage II	130,170	130,700		3,950	2,525	5,849	8,836	11,361	10,098	11,361	10,098	10,098	11,361	10,098
Grand Valley - Balance -	0	0												
Crystal Geyser	0	0												
Las Vegas Wash - Pittman -	1,302	2,602	1,302	50	50	50	50	50	50	50	50	50	50	50
Las Vegas Wash - Whitney -	1,400	3,050			378	560	462	75	75	75	75	75	75	75
Las Vegas Wash Stage II	0	0												
Paradox Valley Unit	65,230	74,806	13,390	2,350	12,867	13,362	12,867	10,393	456	456	456	456	456	456
Subtotal P.L.93-320 Units:	227,046	240,294	43,628	6,350	15,820	19,029	22,223	21,886	10,687	11,950	10,687	10,687	11,950	10,687
Cumulative Subtotal:			43,628	49,978	65,798	84,820	107,851	128,937	139,625	151,574	162,261	172,949	184,898	195,585
LCRB Fund Share														
Grand Valley Stage I						124	124	124	124	124	124	124	124	124
Grand Valley Stage II														
Grand Valley - Balance -														
Las Vegas Wash - Pittman -				16	16	16	16	16	16	16	16	16	16	16
Las Vegas Wash - Whitney -								22	22	22	22	22	22	22
Las Vegas Wash Stage II														
Paradox Valley Unit									374	374	374	374	374	374
Subtotal - LCRB Fund Share				16	16	141	141	163	537	537	537	537	537	537
P.L.98-569 Units														
Grand Valley USDA	35,980	35,980	6,000	1,870	1,962	1,682	1,962	1,682	1,962	1,682	1,962	1,962	1,602	1,962
Uinta USDA	59,792	59,792	6,689	3,385	2,903	2,903	2,903	2,406	2,903	2,903	2,903	2,903	2,903	2,406
Lower Gunnison - Winter Water -	17,682	30,002					4,774	7,073	5,835	620	620	620	620	620
Lower Gunnison Stage I	0	0												
Lower Gunnison - North Fork -	0	0												
Lower Gunnison 1 USDA	21,511	21,511						430	1,291	2,151	1,936	2,151	2,151	2,151
Lower Gunnison 2 Montrose USDA	22,820	22,820								457	1,370	2,283	2,054	2,283
Lower Gunnison 2 Delta USDA	17,072	17,072								715	1,707	2,323	2,582	2,323
Lower Gunnison 3 USDA	3,595	3,595									971	1,430	1,186	
Dolores - Salinity Control -	25,040	25,040						6,761	10,016	8,263				
McElmo Creek USDA	11,659	11,659								700	1,865	1,902	1,865	1,902
Big Sandy USDA	8,159	8,159						490	1,305	1,387	1,305	1,387	1,387	898
Virgin Valley USDA	0	0												
Moapa Valley USDA	3,633	3,633							654	1,054	1,054	872		
Price USDA	0	0												
Mancos Valley USDA	0	0												
Palo Verde Irrig District USDA	0	0												
Subtotal P.L.98-569 Units	227,671	240,071	12,689	5,255	4,945	4,665	9,719	18,921	24,046	20,011	15,853	18,001	16,431	14,705
Cumulative Subtotal:			12,689	17,944	22,889	27,554	37,273	56,194	80,241	100,251	116,104	134,106	150,537	165,242
Subtotal - LCRB Fund Share						1,190	2,470	4,825	6,132	5,103	4,043	4,590	4,190	3,750
Remaining Units														
Sinbad Valley (BLM)	0	0												
Uinta Stage I	22,552	22,595								1,120	2,932	3,157	3,383	3,383
Uinta Stage II	0	0												
Dirty Devil	0	0												
Price-San Rafael (Combined)	37,350	37,350								2,241	5,976	6,349	5,976	6,349
Lower Virgin	19,600	25,065									5,292	7,840	6,468	342
Palo Verde Irrigation District	0	0												
Big Sandy	0	0												
San Juan River	0	0												
Subtotal Remaining Units	79,502	85,010								3,369	14,200	17,347	15,827	10,074
Cumulative Subtotal:										3,369	17,568	34,915	50,742	60,816
Subtotal - LCRB Fund Share										859	3,621	4,423	4,836	2,569
TOTAL - ALL UNITS	534,219	565,375	56,317	11,605	20,765	23,694	31,943	40,808	34,734	35,329	40,740	46,035	44,208	35,466
CUMULATIVE TOTAL:			56,317	67,922	88,687	112,381	144,324	185,132	219,865	255,194	295,934	341,969	386,177	421,643
TOTAL - LCRB Fund Share			0	16	16	1,330	2,619	4,988	6,669	6,499	8,200	9,551	8,763	6,855
LCRB Funds			0	0	0	3,770	8,749	7,636	7,469	6,271	6,553	6,222	6,222	6,222
Balance			0	(16)	(16)	2,440	6,129	2,648	800	(228)	(1,647)	(3,328)	(2,540)	(633)
Previous Balance			0	0	(19)	(39)	2,401	8,531	11,179	11,980	11,752	10,105	6,777	4,236
Balance			0	(16)	(35)	2,401	8,531	11,179	11,980	11,752	10,105	6,777	4,236	3,603
Interest Component			0	(2)	(4)	0	0	0	0	0	0	0	0	0
TOTAL - Balance			0	(19)	(39)	2,401	8,531	11,179	11,980	11,752	10,105	6,777	4,236	3,603

B	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE
P.L.93-320 Units	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Grand Valley Stage I	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
Grand Valley Stage II	11,361	10,098	10,098	3,787	48	48	48	48	48	48	48	48	48	48	48
Grand Valley - Balance -															
Crystal Geyser															
Las Vegas Wash - Pittman -	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
Las Vegas Wash - Whitney -	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75
Las Vegas Wash Stage II															
Paradox Valley Unit	456	456	456	456	456	456	456	456	456	456	456	456	456	456	456
Subtotal P.L.93-320 Units:	11,950	10,687	10,687	4,376	637	637	637	637	637	637	637	637	637	637	637
Cumulative Subtotal:	207,535	218,222	228,909	233,285	233,922	234,560	235,197	235,834	236,471	237,108	237,745	238,383	239,020	239,657	240,294
LCRB Fund Share															
Grand Valley Stage I	124	124	124	124	124	124	124	124	124	124	124	124	124	124	124
Grand Valley Stage II					563	563	563	563	563	563	563	563	563	563	563
Grand Valley - Balance -															
Las Vegas Wash - Pittman -	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16
Las Vegas Wash - Whitney -	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22
Las Vegas Wash Stage II															
Paradox Valley Unit	374	374	374	374	374	374	374	374	374	374	374	374	374	374	374
Subtotal - LCRB Fund Share	537	537	537	537	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,100
P.L.98-569 Units															
Grand Valley USDA	1,682	1,962	1,962	1,682	1,682	561									
Uinta USDA	2,903	2,903	2,903	2,903	2,903	2,903	1,909	994							
Lower Gunnison - Winter Water -	620	620	620	620	620	620	620	620	620	620	620	620	620	620	620
Lower Gunnison Stage I															
Lower Gunnison - North Fork -															
Lower Gunnison 1 USDA	2,151	1,936	2,151	2,151	860										
Lower Gunnison 2 Montrose USDA	2,283	2,283	2,283	2,054	2,283	2,283	913								
Lower Gunnison 2 Delta USDA	2,323	2,323	2,323	1,251											
Lower Gunnison 3 USDA															
Dolores - Salinity Control -															
McElmo Creek USDA	1,902	1,282													
Big Sandy USDA															
Virgin Valley USDA															
Moapa Valley USDA															
Price USDA															
Mancos Valley USDA															
Palo Verde Irrig District USDA															
Subtotal P.L.98-569 Units	14,024	13,390	12,323	10,742	8,428	6,446	3,522	1,614	620	620	620	620	620	620	620
Cumulative Subtotal:	179,266	192,656	204,979	215,720	224,148	230,595	234,117	235,731	236,351	236,971	237,591	238,211	238,831	239,451	240,071
Subtotal - LCRB Fund Share	3,576	3,414	3,142	2,739	2,149	1,644	898	412	158	158	158	158	158	158	158
Remaining Units															
Sinbad Valley (BLM)															
Uinta Stage I	3,157	3,383	2,030	4	4	4	4	4	4	4	4	4	4	4	4
Uinta Stage II															
Dirty Devil															
Price-San Rafael (Combined)	6,349	4,108													
Lower Virgin	342	342	342	342	342	342	342	342	342	342	342	342	342	342	342
Palo Verde Irrigation District															
Big Sandy															
San Juan River															
Subtotal Remaining Units	9,848	7,833	2,371	345	345	345	345	345	345	345	345	345	345	345	345
Cumulative Subtotal:	70,664	78,497	80,868	81,213	81,558	81,903	82,248	82,594	82,939	83,284	83,629	83,974	84,319	84,664	85,010
Subtotal - LCRB Fund Share	2,511	1,997	605	88	88	88	88	88	88	88	88	88	88	88	88
TOTAL - ALL UNITS	35,822	31,918	25,381	15,463	9,410	7,429	4,504	2,597	1,602	1,602	1,602	1,602	1,602	1,602	1,602
CUMULATIVE TOTAL:	457,465	489,375	514,756	530,219	539,629	547,058	551,562	554,159	555,761	557,363	558,966	560,568	562,170	563,772	565,375
TOTAL - LCRB Fund Share	6,624	5,949	4,284	3,364	3,338	2,832	2,086	1,600	1,346	1,346	1,346	1,346	1,346	1,346	1,346
LCRB Funds	6,222	6,222	6,457	6,234	6,354	6,066	6,028	6,135	5,961	6,923	10,217	10,176	9,965	10,123	10,075
Balance	(402)	274	2,174	2,870	3,016	3,234	3,933	4,535	4,614	5,577	8,870	8,830	8,619	8,777	8,729
Previous Balance	3,603	3,201	3,475	5,648	8,519	11,535	14,769	18,703	23,238	27,852	33,429	42,299	51,129	59,747	68,524
Balance	3,201	3,475	5,648	8,519	11,535	14,769	18,703	23,238	27,852	33,429	42,299	51,129	59,747	68,524	77,253
Interest Component	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL - Balance	3,201	3,475	5,648	8,519	11,535	14,769	18,703	23,238	27,852	33,429	42,299	51,129	59,747	68,524	77,253

Table D-4

Data Table Summary for 1986 Repayment Analysis CHECK/November 21, 1986

	Investment Costs						O&M Costs				
Project	Construction Costs	IDC	Habitat Costs	Investment Costs	Cost Share Adjustment	Remaining Investment Costs	Annual Replacement Costs	Annual O&M Costs	Financial Cost of Power	Years	Remaining O&M Costs
GV Stage 1				0	1.00	0	104,000	8,000		24	192,000
GV Stage II	121,040,138	5,188,064		126,228,202	1.00	126,228,202	403,039	48,152		11	529,672
LVW Pittman				0	1.00	0		50,000		25	1,250,000
LVW Whitney	1,400,000			1,400,000	1.00	1,400,000		75,000		22	1,650,000
Paradox	49,489,928			49,489,928	1.00	49,489,928		300,000	156,000	21	9,576,000
GV USDA	28,030,000			28,030,000	1.00	28,030,000					0
Uinta USDA	49,277,438		441,300	49,718,738	1.00	49,718,738					0
LG WW	17,682,000			17,682,000	1.00	17,682,000		620,000		20	12,400,000
LG1 USDA	30,730,100			30,730,100	0.70	21,511,070					0
LG2 Mont. USDA	32,611,000			32,611,000	0.70	22,827,700					0
LG2 Delta USDA	25,532,000			25,532,000	0.70	17,872,400					0
LG3 USDA	5,135,000			5,135,000	0.70	3,594,500					0
Dolores	25,040,000			25,040,000	1.00	25,040,000					0
McElmo USDA	17,937,000			17,937,000	0.65	11,659,050					0
BS USDA	7,437,500		721,800	8,159,300	1.00	8,159,300					0
Moapa USDA	5,064,600		125,100	5,189,700	0.70	3,632,790					0
Unita 1	21,552,000		1,000,000	22,552,000	1.00	22,552,000	161,500	3,600		12	43,200
P-SL Comb.	34,838,000	2,511,625		37,349,625	1.00	37,349,625					0
LV	19,600,000			19,600,000	1.00	19,600,000		341,550		16	5,464,800
	492,396,704	7,699,689	2,288,200	502,384,593		466,347,303	668,539	1,446,302	156,000		31,105,672
											466,347,303
								Total Remaining Program Costs:			497,452,975

Appendix E

Changes in the 1986 Evaluation Process
and
Recommended Plan

EVL86
November 20, 1986

Changes in the
1986 Evaluation Process

1. Modify USDA Data Table project costs, salt load reductions, and construction periods used in the Least Cost Investment Model to their Federal cost share percentages with the exception of Big Sandy, Grand Valley, and Uinta which shall be 85, 80, and 60 percent, respectively, as presently shown in the Data Tables. Use 80 percent for Mancos Valley, rather than the planned cost share shown in the Data Tables.

2. Use BR Data Table project costs, salt load reductions, and construction periods in the Least Cost Investment Model.

3. Establish an analytical process, using best available methodology to project salt load reduction goals through the year 2010, to establish the overall salt load reduction objective for the program. This objective would be used to develop a basinwide salinity control plan for inclusion in the 1986 Evaluation Report.

4. Use 1985 fixed start array in the Least Cost Investment Model.

5. Start USDA Big Sandy in 1989 in the Least Cost Investment Model.

6. Revise the Data Tables for BR's Grand Valley II and Lower Virgin Units, the BR/SCS combined Price-San Rafael Unit, and reduce BR's LVW Whitney to 1-Kton SLR and use updated costs to be provided by LC Region.

7. Include the following projects only as last priorities in the Least Cost Investment Model:
    a. USDA - Virgin Valley
    b. BR - Lower Gunnison II
    c. BR - Las Vegas Wash II

8. Do not include the following projects in the Least Cost Investment Model analysis:
    a. BR - Grand Valley Deferred
    b. BR - Glenwood-Dotsero Springs
    c. BR - Weather Modification

P30 YEAR	1 Grand Valley II	2	3 Paradox	4 Dolores	5 LC winter water	6	7	8 LVW Whitney	9	10 Uinta I	11	12	13 Price-San Rafael (coordinated)	14 Lower Virgin	15	16	17	18	19 Grand Valley	20 Uinta	21 Lower Gunnison 1	22 LG 2, Montrose	23 LG 2, Delta	24 LG 3	25 Moapa	26	27 McElmo	28	29	30	31 Big Sandy	SALT RED	SALT TRGT	COST
1986	.02	.00	.26	.00	.00	.00	.00	.27	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.07	.06	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	0.	0.	20.1
1987	.06	.00	.53	.00	.00	.00	.00	.67	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.13	.12	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	20.	0.	44.1
1988	.13	.00	.79	.00	.27	.00	.00	***	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.20	.18	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	44.	0.	76.6
1989	.22	.00	***	.27	.67	.00	.00	***	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.26	.23	.02	.00	.00	.00	.00	.00	.00	.00	.00	.00	.06	93.	0.	117.1
1990	.30	.00	***	.67	***	.00	.00	***	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.33	.29	.08	.00	.00	.00	.18	.00	.00	.00	.00	.00	.22	342.	0.	152.0
1991	.39	.00	***	***	***	.00	.00	***	.00	.05	.00	.00	.06	.00	.00	.00	.00	.00	.39	.35	.18	.02	.04	.00	.47	.00	.06	.00	.00	.00	.39	420.	0.	186.4
1992	.47	.00	***	***	***	.00	.00	***	.00	.18	.00	.00	.22	.27	.00	.00	.00	.00	.46	.41	.27	.08	.14	.27	.76	.00	.22	.00	.00	.00	.55	483.	88.	227.9
1993	.55	.00	***	***	***	.00	.00	***	.00	.32	.00	.00	.39	.67	.00	.00	.00	.00	.53	.47	.37	.18	.27	.67	***	.00	.39	.00	.00	.00	.72	559.	113.	273.9
1994	.64	.00	***	***	***	.00	.00	***	.00	.47	.00	.00	.55	***	.00	.00	.00	.00	.59	.53	.47	.27	.41	***	***	.00	.55	.00	.00	.00	.89	640.	143.	317.7
1995	.72	.00	***	***	***	.00	.00	***	.00	.62	.00	.00	.72	***	.00	.00	.00	.00	.66	.58	.57	.37	.54	***	***	.00	.72	.00	.00	.00	***	761.	181.	353.7
1996	.81	.00	***	***	***	.00	.00	***	.00	.76	.00	.00	.89	***	.00	.00	.00	.00	.72	.64	.67	.47	.67	***	***	.00	.89	.00	.00	.00	***	832.	227.	388.8
1997	.89	.00	***	***	***	.00	.00	***	.00	.91	.00	.00	***	***	.00	.00	.00	.00	.79	.70	.76	.57	.80	***	***	.00	***	.00	.00	.00	***	898.	280.	421.0
1998	.97	.00	***	***	***	.00	.00	***	.00	***	.00	.00	***	***	.00	.00	.00	.00	.86	.76	.86	.67	.93	***	***	.00	***	.00	.00	.00	***	959.	342.	446.0
1999	***	.00	***	***	***	.00	.00	***	.00	***	.00	.00	***	***	.00	.00	.00	.00	.92	.82	.96	.76	***	***	***	.00	***	.00	.00	.00	***	1009.	412.	461.6
2000	***	.00	***	***	***	.00	.00	***	.00	***	.00	.00	***	***	.00	.00	.00	.00	.98	.88	***	.86	***	***	***	.00	***	.00	.00	.00	***	1047.	488.	470.8
2001	***	.00	***	***	***	.00	.00	***	.00	***	.00	.00	***	***	.00	.00	.00	.00	***	.94	***	.96	***	***	***	.00	***	.00	.00	.00	***	1072.	567.	478.0
2002	***	.00	***	***	***	.00	.00	***	.00	***	.00	.00	***	***	.00	.00	.00	.00	***	.98	***	***	***	***	***	.00	***	.00	.00	.00	***	1086.	648.	482.9
2003	***	.00	***	***	***	.00	.00	***	.00	***	.00	.00	***	***	.00	.00	.00	.00	***	***	***	***	***	***	***	.00	***	.00	.00	.00	***	1093.	727.	485.3
2004	***	.00	***	***	***	.00	.00	***	.00	***	.00	.00	***	***	.00	.00	.00	.00	***	***	***	***	***	***	***	.00	***	.00	.00	.00	***	1094.	801.	486.8
2005	***	.00	***	***	***	.00	.00	***	.00	***	.00	.00	***	***	.00	.00	.00	.00	***	***	***	***	***	***	***	.00	***	.00	.00	.00	***	1094.	869.	488.4
2006	***	.00	***	***	***	.00	.00	***	.00	***	.00	.00	***	***	.00	.00	.00	.00	***	***	***	***	***	***	***	.00	***	.00	.00	.00	***	1094.	930.	489.9
2007	***	.00	***	***	***	.00	.00	***	.00	***	.00	.00	***	***	.00	.00	.00	.00	***	***	***	***	***	***	***	.00	***	.00	.00	.00	***	1094.	982.	491.5
2008	***	.00	***	***	***	.00	.00	***	.00	***	.00	.00	***	***	.00	.00	.00	.00	***	***	***	***	***	***	***	.00	***	.00	.00	.00	***	1094.	1025.	493.0
2009	***	.00	***	***	***	.00	.00	***	.00	***	.00	.00	***	***	.00	.00	.00	.00	***	***	***	***	***	***	***	.00	***	.00	.00	.00	***	1094.	1061.	494.6
2010	***	.00	***	***	***	.00	.00	***	.00	***	.00	.00	***	***	.00	.00	.00	.00	***	***	***	***	***	***	***	.00	***	.00	.00	.00	***	1094.	1091.	496.1

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+Grand Valley Stage I O&M	0.24
+Las Vegas Wash, Pittman O&M	1.25
Total Remaining Program Costs	497.59
Use	497.6

Recommended plan output from Least Cost Investment Model with O&M added from completed projects.

USDA Implementation Schedule

PRELIMINARY USDA SCHEDULE - AUGUST 1986 USDA III (1986 Evaluation Report) Without Inflation

$ in 1,000		Cost Eff #	Total Federal Costs	Total thru 1985	1988 JULY 29, 1986	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Grand Valley,Co.	Cost Share	25	35,900	7,070	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	30								
c/s rate 70/30	IA		19,452	4,270	950	950	950	950	950	950	950	950	950	950	950	950	950	950	950	950	12						
An.T.Reduct-230,000	A&E		3,297	723	160	160	160	160	160	160	160	160	160	160	160	160	160	160	160	160	14						
	Inf.&Ed.		1,018		100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	10						
Sub Tot IA,A&E			22,779	4,993	1,110	1,110	1,110	1,110	1,110	1,110	1,110	1,110	1,110	1,110	1,110	1,110	1,110	1,110	1,110	1,110	26	0	0	0	0	0	0
No. Personnel for IA,A&E					29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	1	0	0	0	0	0	0
Uinta,Ut	Cost Share	82	59,351	10,674	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	2,000	3,000	3,000	3,000	3,000	3,000	3,000	1,277						
c/s rate 70/30	IA		16,709	2,625	726	726	726	726	726	726	726	726	726	726	726	726	726	726	726	726	726	726	16				
An.T.Reduct-98,200	A&E		2,922	634	123	123	123	123	123	123	123	122	123	133	123	133	133	123	123	123	123	123	14				
	Inf.&Ed.		664		38	38	38	38	38	38	38	38	38	38	38	33	36	38	38	38	38	38					
Sub Tot IA,A&E			19,631	4,319	849	849	849	849	849	849	849	845	849	849	849	849	843	849	849	849	849	849	30	0	0	0	0
No. Personnel for IA,A&E					23	22	22	22	22	22	22	23	22	23	22	22	22	22	22	22	23	22	1	0	0	0	0
McElmo Creek,Co	Cost Share	75	11,659					1,000	2,000	2,000	2,000	2,000	2,000	659													
c/s rate 65/35	IA		5,562		45	45	304	608	608	608	608	608	608	608	608	304											
An.T.Reduct-24,760	A&E		912		76	76	76	76	76	76	76	76	76	76	76	76											
	Inf.&Ed.		660			60	60	60	60	60	60	60	60	60	60	60											
Sub Tot IA,A&E			6,474		121	121	380	684	684	684	684	684	684	684	684	380	0	0	0	0	0	0	0	0	0	0	0
No. Personnel for IA,A&E					3	2	10	10	10	10	10	10	10	10	10	10	2	0	0	0	0	0	0	0	0	0	0
Lower Gun #1,Co.	Cost Share	59	21,511				1,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	511									
c/s rate 70/30	IA		10,032			152	380	760	760	760	760	760	760	760	760	760	760	760	760	380							
An.T.Reduct-57,470	A&E		1,520		95	95	95	95	95	95	95	95	95	95	95	95	95	95	95	95							
	Inf.&Ed.		1,450			50	100	100	100	100	100	100	100	100	100	100	100	100	100	100							
Sub Tot IA,A&E			11,552		95	247	475	855	855	855	855	855	855	855	855	855	855	855	855	475	0	0	0	0	0	0	0
No. Personnel for IA,A&E					2	7	13	23	23	22	23	23	23	23	23	23	23	23	23	13	0	0	0	0	0	0	0
Moapa Valley,Nv.	Cost Share	41	3,539					1,000	2,000	539																	
c/s rate 70/30	IA		1,355			25	123	266	266	266	266	133															
An.T.Reduct-13,650	A&E		270			60	35	35	35	35	35	35															
	Inf.&Ed.		275			40	40	40	40	40	40	40															
Sub Tot IA,A&E			1,625	0	0	85	160	361	301	301	301	160	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
No. Personnel for IA,A&E					0	2	4	8	8	8	8	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Big Sandy,Wy	Cost Share	25	7,438			600	1,300	1,500	1,500	1,350	1,200	288															
c/s rate 70/30	IA		2,140		76	190	228	304	304	228	228	228	114	114	114	52											
An.T.Reduct-52,900	A&E		500		60	60	60	60	60	60	60	60	60	60	60	60											
	Inf.&Ed.		450		50	40	40	40	40	40	40	40	40	40	40												
Sub Tot IA,A&E			2,606	0	116	250	268	344	344	262	268	268	154	154	154	92	0	0	0	0	0	0	0	0	0	0	0
No. Personnel for IA,A&E					3	7	7	9	9	7	7	7	4	4	4	2	0	0	0	0	0	0	0	0	0	0	0
Lower Gun #2(NCO),Co.	Cost Share	63	22,828					1,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	1,828								
c/s rate 70/30	IA		10,412				152	380	760	760	760	760	760	760	760	760	760	760	760	760	760						
An.T.Reduct-57,190	A&E		2,240				200	140	140	140	140	140	140	140	140	140	140	140	140	100	140						
	Inf.&Ed.		1,450				50	100	100	100	100	100	100	100	100	100	100	100	100	100	100						
Sub Tot IA,A&E			12,652	0	0	0	432	520	900	900	900	900	900	900	900	900	900	900	900	900	900	0	0	0	0	0	0
No. Personnel for IA,A&E					0	0	11	14	24	24	24	24	24	24	24	24	24	24	24	24	24	0	0	0	0	0	0
Lower Gun #2(BCO),Co.	Cost Share	40	17,872					1,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	872									
c/s rate 70/30	IA		9,366				462	742	742	742	742	742	742	742	742	742	742	742	742								
An.T.Reduct-73290	A&E		1,708				244	122	122	122	122	122	122	122	122	122	122	122	122								
	Inf.&Ed.		1,210				90	90	90	90	90	90	90	90	90	90	90	90	36								
Sub Tot IA,A&E			10,476	0	0	0	706	864	864	864	864	864	864	864	864	864	864	864	864	0	0	0	0	0	0	0	0
No. Personnel for IA,A&E					0	0	19	23	23	23	23	23	23	23	23	23	23	23	23	0	0	0	0	0	0	0	0
Lower Gunnison #2,Co.	Cost Share	69	2,595						1,000	2,000	595																
c/s rate 70/30	IA		1,550					30	380	380	380	190	190														
An.T.Reduct-8,400	A&E		468					156	78	78	78	78															
	Inf.&Ed.		300						100	100	100																
Sub Tot IA,A&E			2,026	0	0	0	0	194	458	458	458	268	190	0	0	0	0	0	0	0	0	0	0	0	0	0	0
No. Personnel for IA,A&E					0	0	0	5	12	12	12	7	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mancos Valley,Co -	Cost Share	58	2,017								1,000	1,000	017														
c/s rate 60/40	IA		1,026							152	190	190	190	152	152												
An.T.Reduct-7,040	A&E		51						4	7	0	0	0	0	0												
	Inf.&Ed.		152							26	26	26	26	26	22												
Sub Tot IA,A&E			1,077	0	0	0	0	0	4	159	190	190	190	160	160	0	0	0	0	0	0	0	0	0	0	0	0
No. Personnel for IA,A&E					0	0	0	0	0	4	5	5	5	4	4	0	0	0	0	0	0	0	0	0	0	0	0
Virgin Valley,Nv.	Cost Share	21	2,096									1,000	1,000	817													
c/s rate 65/35	IA		1,292								760	114	114	114	114	76											
An.T.Reduct-24,185	A&E		282							72	42	42	42	42	21	21											
	Inf.&Ed.		200							35	33	33	33	23	33												
Sub Tot IA,A&E			1,574	0	0	0	0	0	0	72	802	156	156	156	135	97	0	0	0	0	0	0	0	0	0	0	0
No. Personnel for IA,A&E					0	0	0	0	0	3	21	4	4	4	4	3	0	0	0	0	0	0	0	0	0	0	0
Total Cost Share			109,686	17,944	3,000	5,600	7,000	12,500	17,500	16,889	15,795	15,288	14,017	12,476	11,000	11,000	9,872	7,511	4,828	3,000	1,277	0	0	0	0	0	0
Total IA			78,974	7,898	1,797	2,888	3,335	4,774	5,496	5,572	6,370	5,601	5,154	4,926	4,926	4,370	3,938	3,938	3,938	2,016	1,498	726	16	0	0	0	0
Total A&E			13,372	1,417	494	574	1,053	947	873	940	919	919	886	886	785	777	640	640	640	518	277	122	14	0	0	0	0
Total Inf. & Ed.			8,439	0	188	328	518	568	668	729	727	627	587	587	583	488	428	428	368	338	156	38	0	0	0	0	0
Grand Total (Fed. Dollars)		48	290,391	27,286	7,479	8,590	11,906	18,789	24,537	24,130	23,811	22,238	21,364	18,798	17,294	16,638	14,878	12,517	9,804	6,672	3,288	887	30	0	0	0	0
Grand Total IA,A&E			92,546	9,212	2,391	2,663	4,388	5,721	6,369	6,520	7,289	6,320	5,960	5,732	5,711	5,147	4,578	4,578	4,578	3,334	1,775	849	30	0	0	0	0
Total Personnel for IA,A&E (SCS)					60	76	115	151	168	172	192	166	157	151	150	132	122	120	120	88	47	23	1	0	0	0	0
By States: Az.					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ca.					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Co.					38	29	82	113	128	133	133	128	126	128	128	108	100	98	98	68	24	0	0	0	0	0	0
NM.					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nv.					0	3	4	0	0	10	29	9	4	4	4	3	0	0	0	0	0	0	0	0	0	0	0
Ut.					23	23	23	22	22	22	22	22	22	22	22	22	22	22	23	23	22	22	1	0	0	0	0
Wy.					3	7	7	9	9	7	7	7	4	4	4	3	0	0	0	0	0	0	0	0	0	0	0

Construction and Cost-Share
Annual Required Expenditures
1986 Evaluation Report

Years	DOI	USDA	Total
1986	15,820	4,945	20,765
1987	19,029	4,665	23,694
1988	26,997	4,945	31,942
1989	35,720	5,088	40,808
1990	26,538	8,195	34,733
1991	24,201	11,128	35,329
1992	25,507	15,233	40,740
1993	28,654	17,381	46,035
1994	28,396	15,811	44,207
1995	21,381	14,085	35,466
1996	22,418	13,404	35,822
1997	19,140	12,770	31,910
1998	13,678	11,703	25,381
1999	5,341	10,122	15,463
2000	1,602	7,808	9,410
2001	1,602	5,826	7,428
2002	1,602	2,902	4,504
2003	1,602	994	2,596
2004	1,602		1,602
2005	1,602		1,602
2006	1,602		1,602
2007	1,602		1,602
2008	1,602		1,602
2009	1,602		1,602
2010	1,602		1,602

Appendix F

CRSS Sensitivity Analysis Summary

Colorado River Salinity Reduction Targets

Plots of Targets and Nonlinear Regressions

Introduction

The USBR (U.S. Bureau of Reclamation) annually reevaluates the CRWQIP (Colorado River Water Quality Improvement Program), in cooperation with the USDA (U.S. Department of Agriculture). The annual review is based on computer simulations of salinity in the Colorado River based on projections of future development. The process is fully described in USBR-USDA (1985), which should be consulted for details.

The 1986 review of the CRWQIP was conducted during June based on the results obtained from CRSS (Colorado River Simulation System) in May. The results indicated that approximately 300k tons less salt than was indicated in 1985 (USBR-USDA, 1985) would have to be removed annually from the Colorado River by year 2010 to maintain the standard at Imperial (879 mg/L TDS (total dissolved solids)). This investigation was undertaken to determine the cause of the 300k-ton difference between 1985 and 1986 projections.

During the 1986 review it was noted that there was a significant change in the depletion schedules between 1985 and 1986. The difference in the projected depletions was primarily due to a delay in the development of oil shale reserves in the Upper Basin and an anticipated delay in the construction of water development projects by Reclamation. Since the depletion schedules were based in part on information provided by the States, they were requested to reevaluate their information. On the basis of updated data (hereinafter referenced as the June 1986 depletion schedule), CRSS was rerun. The resulting target was 1,099k tons which was still 182k tons less than the 1985 target of 1,281k tons. It was also noted that the 1986 CRSS results also could result from other differences between the two evaluations. The CRSS differences included a different set of coefficients for computing natural salinity (Mueller and Osen, in prep.) and different initial reservoir salinities. Due to these differences and a request from the Forum Work Group to evaluate the effects of having Lakes Mead and Powell at maximum reservoir levels, a sensitivity analysis was undertaken to evaluate the individual effects of each of these factors on the resulting salinity reduction target.

Methods

The initial CRSS sensitivity analysis was performed by comparing various modifications (cases) of input data and starting conditions to a base case. The base case was defined by the following conditions:

1. Depletions were held constant at the 1986 level, as defined by the June 1986 depletion schedule;

2. Initial reservoir salinities were defined by the January 1, 1986, values, i.e., Powell at 500 mg/L and Mead at 575 mg/L;

3. Initial reservoir contents were set at the January 1, 1986, levels, i.e., Powell at 22,993k acre-ft and Mead at 23,720k acre-ft;

4. Salinity coefficients consist of those in the updated 1986 hydrology file (Mueller and Osen, in prep.)

The cases that were evaluated are defined by the following modifications:

Case 1 - variable future depletions using the June 1986 depletion schedule;

Case 2 - raise initial reservoir salinities; i.e., set Powell and Mead at 550 and 750 mg/L, respectively;

Case 3 - decrease initial reservoir contents by 2M acre-ft, i.e., set Powell and Mead at 20,993k and 21,720k acre-ft, respectively;

Case 4 - use 1985 salinity coefficients (pre-USGS (Mueller and Osen, in prep.));

Case 5 - variable future depletions using the October 1985 depletion schedule.

CRSS runs were made as usual for target computation, 15 traces incremented by 5 years. The averages over the traces for the 55-year period 1986 through 2040 were entered into the salt reduction target program. The resulting targets were smoothed using SPSS program regression (Cohen et al., 1984); specifically, the distribution of targets over time were fit to a 4th degree polynomial regression equation (Kim and Kohout, 1975). The results were compared using the Wilcoxon Matched-Pairs Ranked-Signs Test (Hull and Nie, 1981).

After a discussion of the results of the first sensitivity analysis, it was decided to undertake a second sensitivity analysis to evaluate the major differences between the 1985 and 1986 CRSS runs. In the second sensitivity analysis, the Base Case was based on the following:

1. Initial conditions were set as for the 1986 CRWQIP evaluation.

2. The pre-Mueller and Osen (in prep.) salinity coefficients were used.

3. The October 1985 depletion schedule was used.

The three cases to be compared to the base included:

1. Use of the June 1986 depletion schedule;

2. Use of the Mueller and Osen (in prep.) salinity coefficients;

3. Use of both the June 1986 depletion schedule and revised salinity coefficients.

Number 3 was undertaken to evaluate the addivity of the differences. In addition, the second analysis was to be based on the more standard techniques for smoothing the targets. This includes a fit to a logistic growth model as described in Odum (1971). The fit is made using the SPSS nonlinear regression procedure (Robinson, 1984). As above, the results were compared using the Wilcoxon Matched-Pairs Test.

Results

Sensitivity Analysis Number 1

The results of the first sensitivity analysis are summarized in table 1. With the exception of the targets for cases 1 and 5, both of which are based on increasing depletion schedules, the targets are negative, and thus are not truly targets. In the case of negative values, the "targets" represent the amount of salt that could be added before the standard at Imperial is reached. Because the first sensitivity analysis yielded a preponderance of negative numbers, polynomial regressions were used to smooth the data; the nonlinear regression procedure cannot handle negative numbers.

The poorest fit to the 4th degree polynomial regression that was used to smooth the data is exhibited by case 2, the higher initial reservoir salinity. The poor fit is a reflection of the absence of the increase in salinity that occurs over the first 10 years in all other cases. The increase is due to the return of the system to an average condition. The current wet period has produced low salinity by dilution due to the greater than average water yield throughout the basin over the last several years. For comparative purposes, plots of the targets and the polynomial regressions appear in appendix A. The absence of the early dilute condition is evident in the plots.

Case 3, the low initial reservoir contents, is the only one that does not yield significantly greater targets than the base case. The difference in the Upper Basin target for year 2010 is only 22k tons greater than the base. The overall Z (Wilcoxon Test) is less than 1, which indicates no statistically significant difference between the base case and case 3 targets.

The next largest difference from the base case is exhibited by case 4, the effect of the new salinity coefficients. The difference in the 2010 target is 188k tons. This is slightly greater than the total difference between the 1985 target and the one developed for the July 1986 Forum Work Group meeting. As indicated above, the total difference at that time between the 1985 and 1986 targets was 182k tons. Without considering any differences in depletion schedules, case 4 yielded a difference that was as great as the total difference between the 1985 and 1986 targets.

The effect of depletion schedules can be determined by subtracting the case 1 target from that for case 5. This yields a difference of 101k tons. When added to the difference due to the coefficients (case 4), the total is 289k tons; this is over 100k tons greater than the difference in the 1985 and 1986 targets. The reason for this was not discovered until the second sensitivity analysis was undertaken.

At the USBR-USDA coordination meeting during May when the initial 1986 targets were discussed, it was noted that the year 2020 was an extreme low point in the distribution of targets over time (see appendix A - year 35 equates to 2020). Following that meeting the effects of the period of record used in the derivation of the nonlinear regression were evaluated. The July target referenced above was based on an ending year of 2023, which brought the targets following the 2020 low back to the approximate midpoint of the 5-year CRSS cycle. The difference in the 2020 and 2023 regressions in estimating the Upper Basin 2010 target was 45k tons (1,054 vs. 1,099k tons). Thus, of the 101k-ton increase in the target between May and July, 56k tons were due to the reevaluation of the depletion schedule and 45k tons were due to the elimination of the extreme low at the ending year of the period used to derive the regression. In deriving the 1985 target, the year 2020 would have been equivalent to 2021 in the 1986 analysis. Thus, the final year used in computing the 1985 targets would not have affected the regression to the degree that it has in computing the 1986 targets. This can be illustrated by backing off the period to 2019; doing so yields a 2010 target of 1047 or a value similar to what was obtained by extending the period to 2023.

Sensitivity Analysis Number 2

The results of the second sensitivity analysis are summarized in table 2; plots of the individual targets and fitted regressions appear in appendix B. Table 2 also shows the effects of the different periods used to generate the target regression and includes two different runs for analysis 2. Run 1 of analysis 2 yields results that are similar to those for analysis 1, where case 4 (equivalent to case 1 in table 2) showed 188k tons, and the difference between cases 1 and 5 (equivalent to case 2 in table 2) was 101k tons (table 1). The equivalent differences in the two analyses are: case 2 (table 2) with 4 (table 1) between 181 and 196k tons, depending on the period used to compute the regression; and case 1 (table 2) with the case 1 and case 5 (table 1) difference, yielding differences ranging from 62 to 80k tons (table 2). However, in entering the data to compute the targets for case 2 (table 2), it was noticed that the discharge data were different from the previous two cases. Differences in discharge are expected due to the use of different depletion schedules but not from a simple change in the coefficients used to estimate salinity from discharge. Therefore, a review of the hydrology data bases was undertaken.

A second CRSS run using the same criteria as above for sensitivity analysis 2 was also made. These results also appear in table 2 and are labelled run 2. The most noteworthy difference is the decline in the effect of the salinity coefficients from somewhere in the range of 181 to 196 for case 2 (table 2) to about 48k tons (table 2 - see case 2, run 2). A review of the first sensitivity analysis indicated that the differences in discharge also appeared in that run, and the 188k ton difference attributed to the update to the salinity coefficients was in reality due to input of different hydrology data bases in making the runs.

Table 2 presents the results for each case and each run. These results can be used to compare the influence of (1) different depletion schedules and salinity/discharge coefficients for each case to its respective base case, and (2) compare the effect of different hydrology data bases across runs. Table 2 also shows each run and case as it is affected by different ending years used in deriving the regression. Although it is not shown in the table, the results of Wilcoxon Matched-Pairs, Signed-Ranks Tests (Z) on the target distributions for the different ending years all show highly significant differences (probability of a greater Z less than 0.01). In other words, by way of example, the regressions for the base cases for the periods ending in 2019, 2020 and 2023 all yield significantly different results.

Table 3 presents a breakdown of the individual changes that have been identified as having occurred between the computation of the 1985 targets and the present (lines 1-4). Also presented is a further breakdown of differences between May and July 1986, when the initial review of the depletion schedules was undertaken. The targets presented in table 3 are mostly based on the period through 2019 and are not directly comparable to any of the targets generated for use in the general evaluation of the Salinity Control Program. They should, however, be based on the same period as the 1985 target and be directly comparable with it.

On the basis of table 3, the largest difference appears to be due to differences in the hydrology data bases used in making the CRSS computer runs. As near as can be determined at least three different hydrology data bases were used during the sensitivity analysis. These include the two that appear in run 1 of analysis 2 (table 2). The difference between these two can be shown for all periods appearing in table 2 by the difference between the base and case 2 for run 1 less the effect of the salinity coefficients from case 3 of run 2. Corrections were made to the hydrology data base between runs 1 and 2 making the third data base. As near as can be determined, the data bases used in run 1 were last modified in February 1985 for the base case and case 1 and in late 1985, when the USGS salinity coefficents were being entered, for cases 2 and 3. The corrections between run 1 and run 2 effected a further reduction in the target of about 7-8,000 tons. Since it was impossible to recreate the 1985 CRSS output to generate the target, it appears that there was an additional data base in use when the 1985 target was computed. However, it cannot be located or identified at this time.

At the time the initial or May 1986 target was computed, the feeling was that the update to the depletion schedule effected the disparity between the 1985 and 1986 targets, i.e., 1,281 vs. 998k tons. The actual effect of the depletion schedule update was about 99k tons; this is the sum of lines 3 and 7, table 3. This was reduced to 77k tons following the reevaluation of their respective depletion schedules by the member States during early June 1986.

Coincident with the review of the depletion schedules, an evaluation of the effect of the 2020 salinity low was undertaken. The correction for that also affected the target by extending the regression input data through 2023. The equivalent effect of backing off 1 year is shown in table 3, line 6, and it amounts to 27k tons.

In summary, the difference between the salinity reduction targets computed during June of 1985 and May of 1986, which totaled 283k tons, can be attributed to a variety of factors. The main one includes several changes to the hydrology data base. Two changes that have been identified are replacement of provisional USGS discharge data with final values and changes to evapotranspiration rates of phreatophytes in the Lower Colorado Basin. The second major difference is attributable to the update to the depletion schedule. Lesser differences were caused by the use of better salinity coefficents and the inclusion of an atypical year as an ending coordinate in the target regression. The effect of these differences vary with respect to each other and further vary due to the final set of paired data points used to derive the target regression.

In initially discussing table 3, it was noted that the targets presented in the table were not comparable to targets used in evaluating the CRWQIP. With certain minor adjustments, the table 3 data can be put on an equivalent basis to the current target. The adjustment involves a surrogate for extending the period used in computing the 1985 target from a period of record through 2020 to one through 2040. The necessary adjustments can be made in different ways. Two examples are shown in tables 4 and 5.

Table 4 shows adjustments made based on the effects as derived from regressions based on the period 1995 through 2019. The adjustment shows that the differences are not strictly additive based on the 1995 through 2019 regressions (table 4, line 11). This is also illustrated by data presented in table 2. For the 1995 through 2019 regressions (table 2, run 2), the sum of the individual differences of cases 1 and 2 is 77 + 44k tons = 124k tons. When the two effects (depletions and salinity coefficients) were combined into a single CRSS run, the resulting regression yielded a difference from the base case of 120k tons (table 2, run 2, case 3), or once again a difference amounting to 4k tons between the effects individually as opposed to their combined effect.

Table 4 again presents the individual differences attributable to changes in hydrologic input data, the deletion schedule, and the salinity discharge coefficients as used in CRSS for computing the 1985 target and the current target. The total difference computed from the individual targets from sensitivity analysis 2 is 238k tons of salt (table 4, line 10). The difference between the 1985 target and the current target is only 190k tons (table 4, line 4). If an adjustment is made based on the difference between the equivalent regressions (run 2, case 3) for the periods 1995 through 2019 and 1995 through 2040, the totals are approximately equal (table 4, line 11), as described above. Since the differences can now be related to a common base, percentages of the total difference can be computed for each of the individual changes to CRSS. These are also shown in table 4 (lines 12, 13, and 14). These show that almost half of the total difference from the 1985 target can be attributed to changes in the hydrologic data base with the remainder due to updates to depletions and salinity coefficients; the latter amount to about 30 and 20 percent of the total, respectively.

Table 5 presents a similar set of computations as table 4. Table 5 shows the adjustment and conversion to percentages based on the regressions derived using the period 1995 through 2040. The resulting percentages (table 5, lines 12, 13, and 14) are essentially the same (within rounding error) as those from table 4. However, the regressions derived from the longer period (1995-2040) yield individual differences from the base that sum to the collective effect of updated depletions and salinity coefficients. The percentages shown in table 5 are those that appear in the elsewhere in this Evaluation Report.

References

Cohen, Claude, Wayne Helm and James Tuccy. 1984. SPSS REGRESSION Reference. SPSS No. 414. Vogelback Computing Center, Northwestern University, Evanston, IL, 22 p.

Hull, C. Hadlai and Norman H. Nie. 1981. SPSS Update 7-9: New Procedures and Facilities for Releases 7-9. McGraw-Hill Book Co., New York, NY, 402 p.

Kim, Jae-On and Frand J. Kohout, 1975. Special Topics in General Linear Models. In: SPSS - Statistical Package for the Social Sciences, 2d Ed., Norman H. Nie, et al. (eds.) McGraw-Hill Book Co., New York, NY, pp 368-397.

Mueller, David K. and Lisa L. Osen. In prep. Estimation of Natural Dissolved Soilds Discharge in the Upper Colorado River Basin. U.S. Geological Survey, Water Resources Division, Denver, CO. 86 p + Tables + Figures.

Odum, Eugene P. 1971. Fundamentals of Ecology. W. B. Saunders, Philadelphia, PA, 574 p.

Robinson, Barry. 1984. SPSS Subprogram NONLINEAR-Nonlinear Regression. Vogelback Computing Center, Northwestern University, Evanston, IL, 28 p.

U.S. Bureau of Reclamation - U.S. Department of Agriculture. 1985. 1985 Joint Evaluation of Salinity Control Programs in the Colorado River Basin. USBR-USDA, Denver, CO.

Table 1: Results of CRSS Sensitivity
Analysis No. 1: Comparison of Targets by Case

Case	Median Target (k tons TDS)	Target in 2010 (k tons TDS)	Difference From Base (k tons)	R^2 (Target on Year)	Wilcoxon Test Z (with Base)	Wilcoxon Test Prob. > |Z|
Base	-575	-572	-	0.874	-	-
1	970	991	1563 1/	0.970	-6.45	<0.0001
2	-569	-521	51	0.305	-2.31	0.021
3	-575	-550	22	0.814	-0.96	0.335
4	-386	-384	188	0.884	-6.45	<0.0001
5	1080	1092	1664 1/	0.971	-6.44	<0.0001

1/ Difference due to alternative depletion schedule is 101k tons.

Table 2: Results of Sensitivity Analysis
No 2 - Comparison of Results by Run
and by Case

Period	Run	Case	Median Target (k tons)	Target in 2010 (k tons)	Difference from Base (k tons)	Wilcoxon Test Z (with Base)	Wilcoxon Test Prob. > |Z| (n = 26)
1995-2040	1	Base	1376	1360	-	-	-
		1	1339	1287	73	4.46	<0.0005
		2	1190	1179	181	4.46	<0.0005
		3	1167	1098	262	4.46	<0.0005
	2	Base	1230	1218	-	-	-
		1	1205	1139	79	3.70	<0.0005
		2	1180	1170	48	4.46	<0.0005
		3	1159	1091	127	4.23	<0.0005
1995-2020	1	Base	1173	1295	-	-	-
		1	1013	1216	79	4.46	<0.0005
		2	1007	1102	193	4.46	<0.0005
		3	886	1028	267	4.46	<0.0005
	2	Base	1041	1141	-	-	-
		1	928	1064	77	4.38	<0.0005
		2	998	1093	48	4.46	<0.0005
		3	880	1020	121	4.46	<0.0005
1995-2023	1	Base	1175	1307	-	-	<0.0005
		1	1002	1245	62	4.46	<0.0005
		2	1010	1119	188	4.46	<0.0005
		3	875	1060	247	4.46	<0.0005
	2	Base	1043	1158	-	-	-
		1	919	1095	63	4.25	<0.0005
		2	1001	1110	48	4.46	<0.0005
		3	869	1052	106	4.41	<0.0005
1995-2019	1	Base	1177	1324	-	-	-
		1	1004	1244	80	4.46	<0.0005
		2	1010	1128	196	4.46	<0.0005
		3	879	1054	257	4.46	<0.0005
	2	Base	1044	1167	-	-	-
		1	993	1090	77	4.36	<0.0005
		2	1002	1120	47	4.46	<0.0005
		3	873	1047	120	4.46	<0.0005

Table 3: Summary of Differences Between the 1985 Salinity Reduction Target and Estimates from Sensitivity Analysis 2: Regressions Through 2019

Basis for Target	Target in 2010 (k tons)	Difference From Preceding Target (or base)	Total
1. 1985 Evaluation Report	1281	--	
2. Base Case, Run 2	1167	1281-1167 = 114	
3. Case 1 (1986 Depletion Schedule)	1090	1167-1090 = 77	
4. Case 2 (USGS Salinity Coefficients)	1120	1167-1120 = 47	
Current Total	--	--	238
5. Case 3 (Current Depletions and Salinity Coefficients)	1047	--	
6. Case 3 - Period Through 2020	1020	1047-1020 = 27	
7. May 1986 Target	998	1020-998 = 22	
Total Due to Initial Depletion Review and Year 2020 Low	--	--	49
Total Difference	283	--	287

TABLE 4: CONVERSION OF DIFFERENCES USING REGRESSIONS BASED ON THE PERIOD 1995-2019: PERCENT CHANGE DUE TO MODIFICATIONS TO CRSS BETWEEN MAY 1985 AND JUNE 1986

	Source of Target or Effect	Target (k tons)	Source of Effect (Columns 5 & 6)	Effect: Salt Load (k tons)	Net Effect (Percent)
1.	1985 Target	1281	-		
2.	Current (1986) Target	1091	-		
3.	2019 Regression Target	1047	-		
4.	Effect of Regression	-	1091 - 1047 =	44	
5.	1985 T 1986 Change	-	1281 - 1091 =	190	
6.	Adjusted Total	-	190 + 44 =	234	
7.	Effect of Changes to Hydrologic Input Data	-	Table 3, Line 2 =	114	
8.	Effect of Changes to Depletion Schedule	-	Table 3, Line 3 =	77	
9.	Effect of Coefficients	-	114 + 77 + 47 =	238	
11.	Non-Additivity	-	238 - 234 =	4	
12.	Hydrologic Input Data	-	(114/238) · 100 =		48
13.	Depletion Schedule	-	(77/238) · 100 =		32
14.	Salinity Coefficients	-	(47/238) · 100 =		20

TABLE 5: CONVERSION OF DIFFERENCES USING REGRESSIONS BASED ON THE PERIOD 1995 THROUGH 2040: PERCENT CHANGE DUE TO MODIFICATIONS TO CRSS BETWEEN MAY 1985 AND JUNE 1986

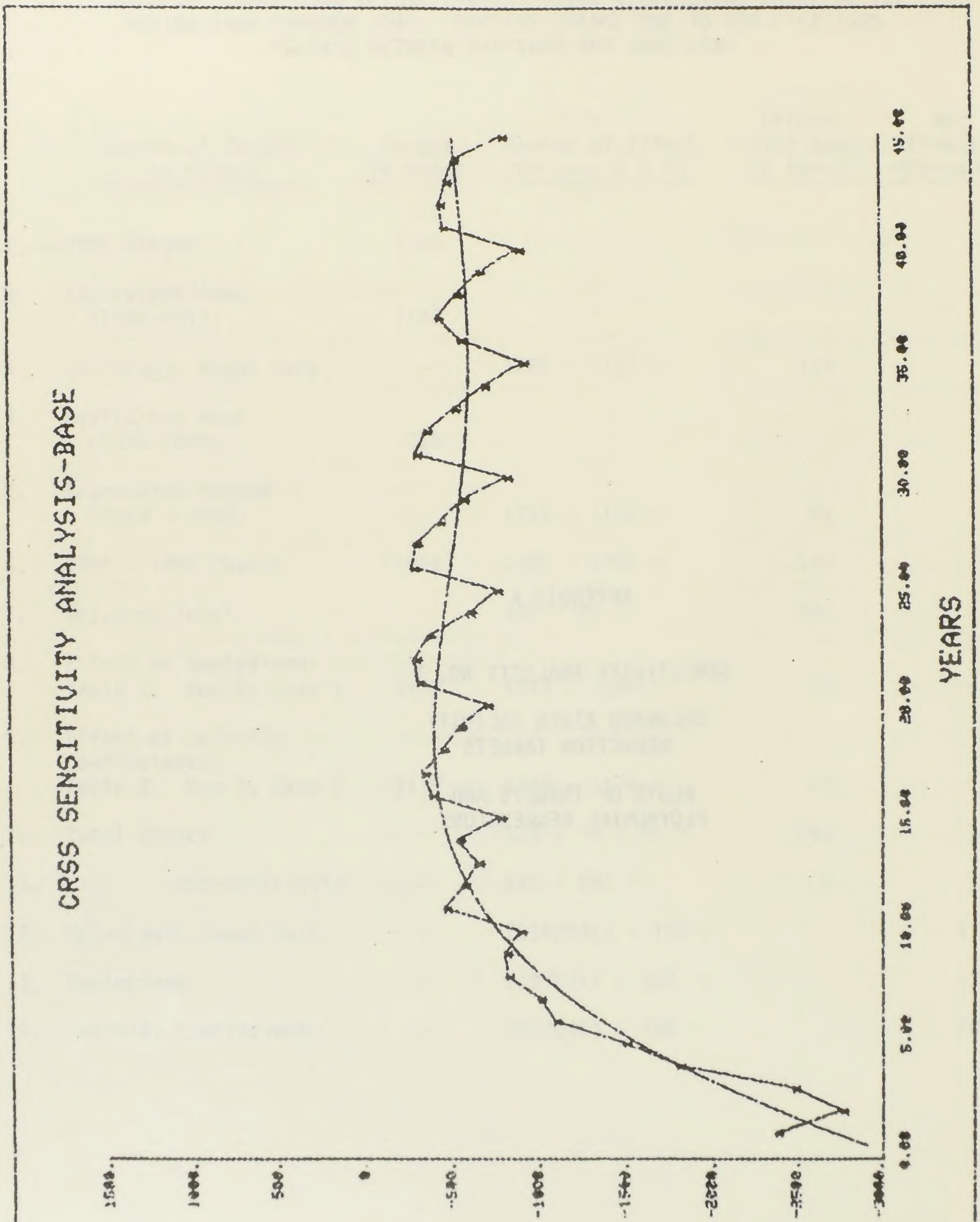
	Source of Target or Effect	Target (k tons)	Source of Effect (Columns 5 & 6)	Effect: Salt Load (k tons)	Net Effect (Percent)
1.	1985 Target	1281	-		
2.	Equivalent Base (1995-2019)	1167			
3.	Hydrologic Input Data	-	1281 - 1167 =	114	
4.	Equivalent Base (1995-2040)	1218			
5.	Regression Period (2019 → 2040)	-	1218 - 1167 =	51	
6.	1985 → 1986 Change	(1091)	1281 - 1091 =	190	
7.	Adjusted Total	-	190 + 51 =	241	
8.	Effect of Depletions: Table 2: Run 2, Case 1	1139	1218 - 1139 =	79	
9.	Effect of Salinity Coefficients: Table 2: Run 2, Case 2	1170	1218 - 1170 =	48	
10.	Total Effect	-	114 + 79 + 48 =	241	
11.	Non-additivity	-	241 - 241 =	0	
12.	Hydrologic Input Data	-	(114/241) · 100 =		47
13.	Depletions	-	(79/241) · 100 =		33
14.	Salinity Coefficients	-	(48/241) · 100 =		20

APPENDIX A

SENSITIVITY ANALYSIS NO. 1

COLORADO RIVER SALINITY
REDUCTION TARGETS

PLOTS OF TARGETS AND
PLOYNOMIAL REGRESSIONS


CRSS SENSITIVITY ANALYSIS-BASE
YEARS
SALT TARGET - KTONS
1500.
1000.
500.
0
-500.
-1000.
-1500.
-2000.
-2500.
-3000.
0.00
5.00
10.00
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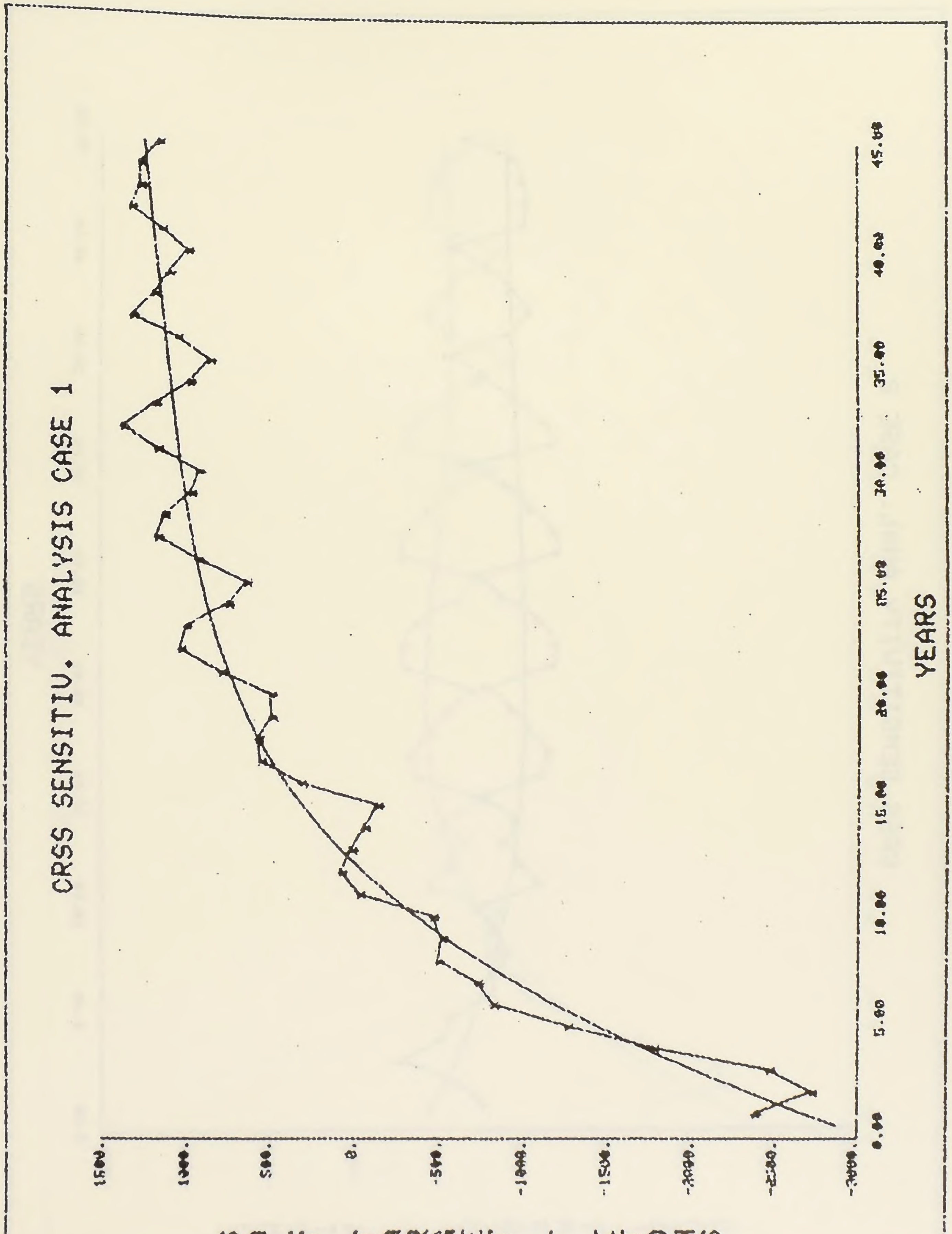
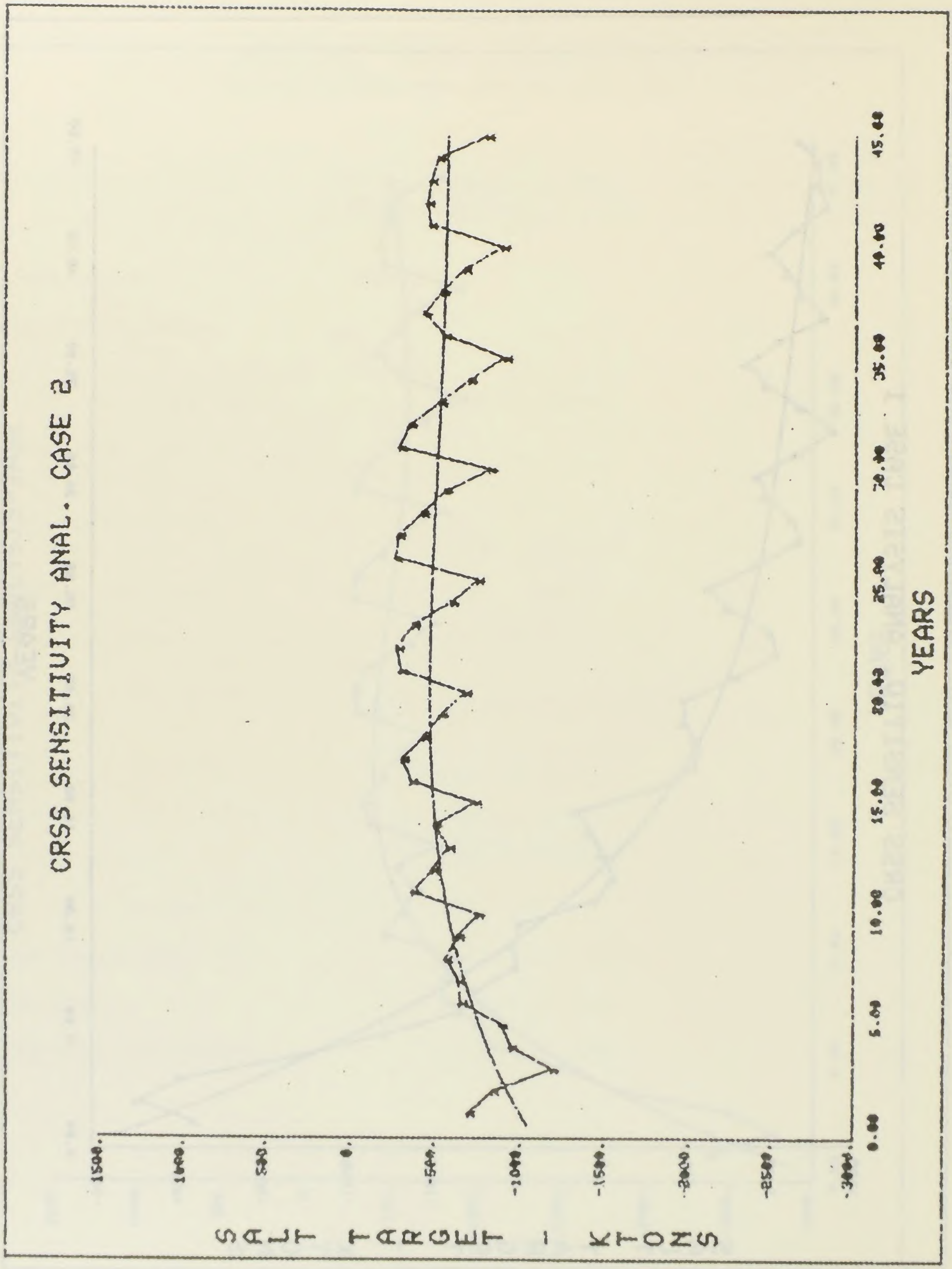
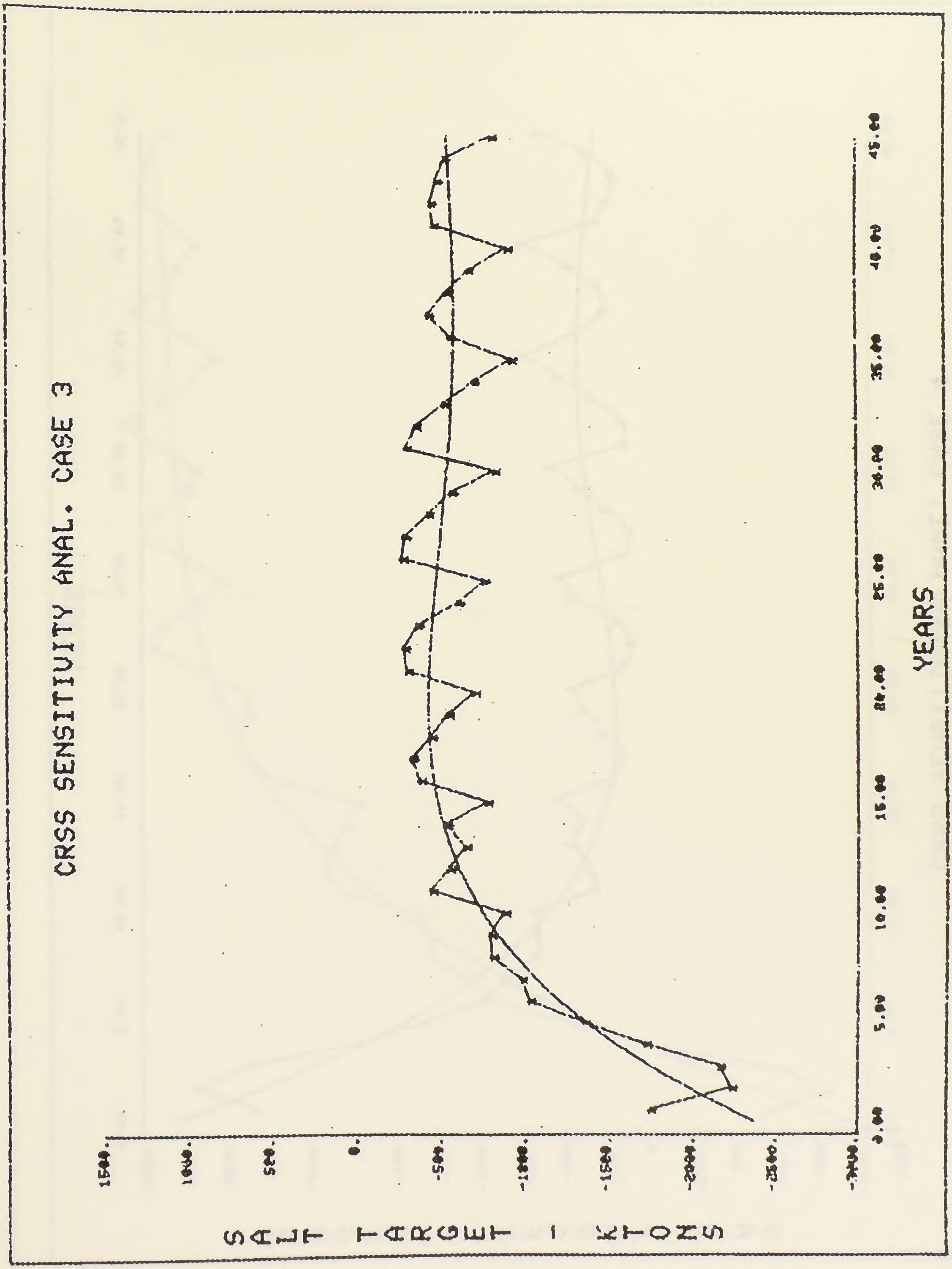
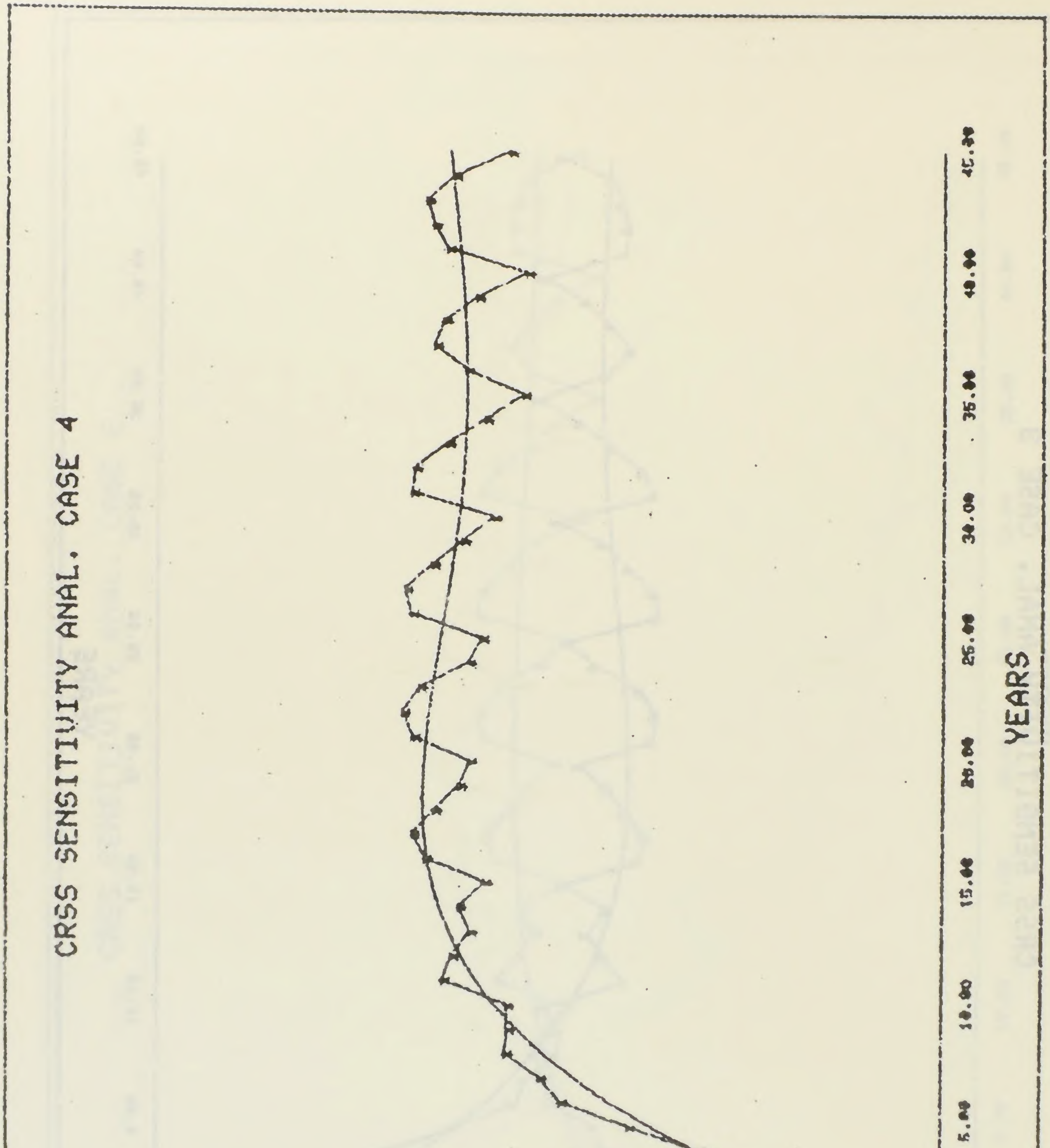
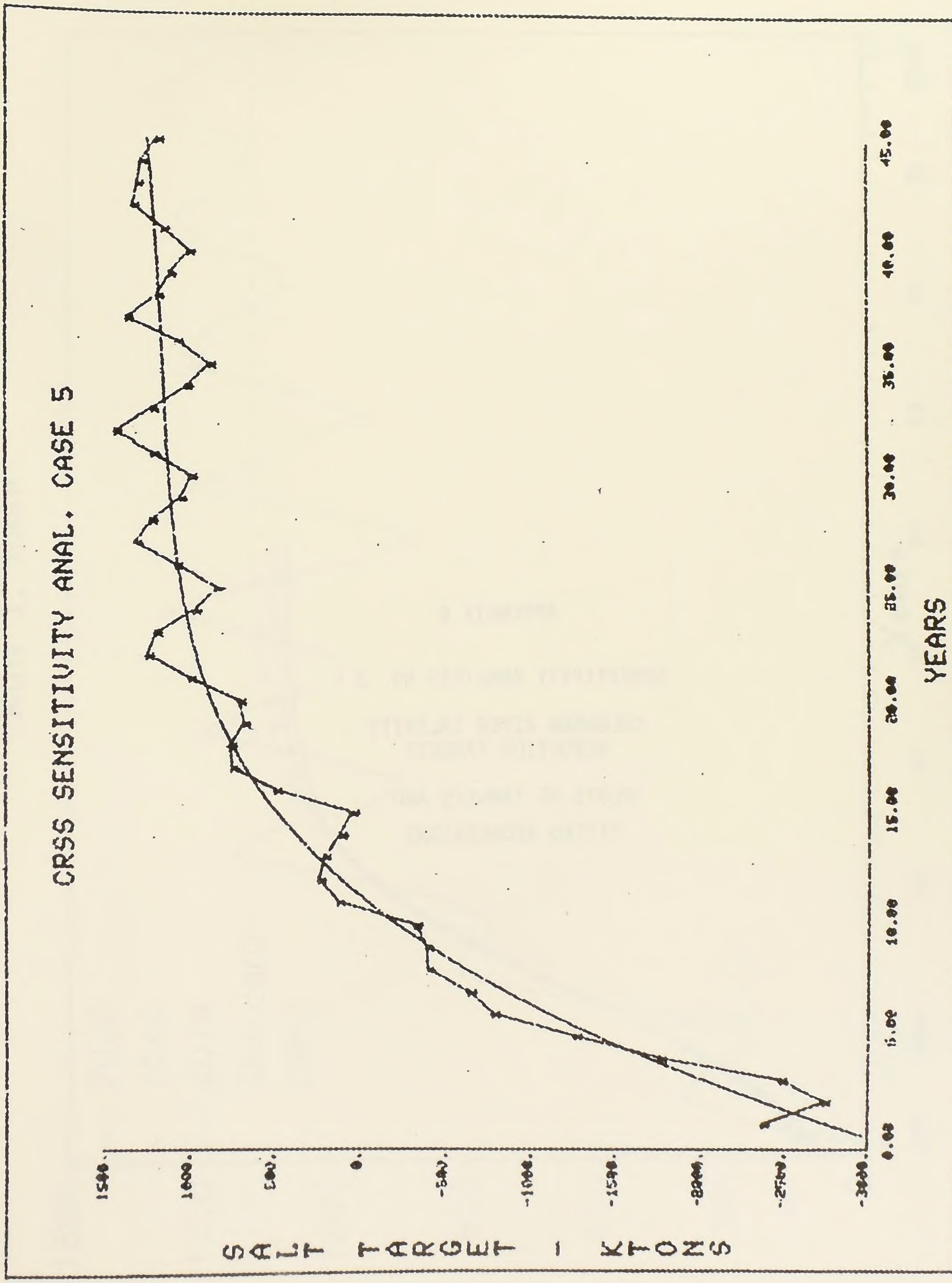
25.00
30.00
35.00
40.00
45.00


CRSS SENSITIV. ANALYSIS CASE 1
SALT TARGET - KTONS
YEARS
1500.
1000.
500.
0.
-500.
-1000.
-1500.
-2000.
-2500.
-3000.
0.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
40.00
45.00


CRSS SENSITIVITY ANAL. CASE 2
SALT TARGET - KTONS
YEARS
1500.
1000.
500.
0.
-500.
-1000.
-1500.
-2000.
-2500.
-3000.
0.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
40.00
45.00


CRSS SENSITIVITY ANAL. CASE 3
SALT TARGET - KTONS
YEARS


CRSS SENSITIVITY ANAL. CASE 4
YEARS
SALT TARGET - KTONS
1500.
1000.
500.
0.
-500.
-1000.
-1500.
-2000.
-2500.
-3000.
0.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
40.00
45.00



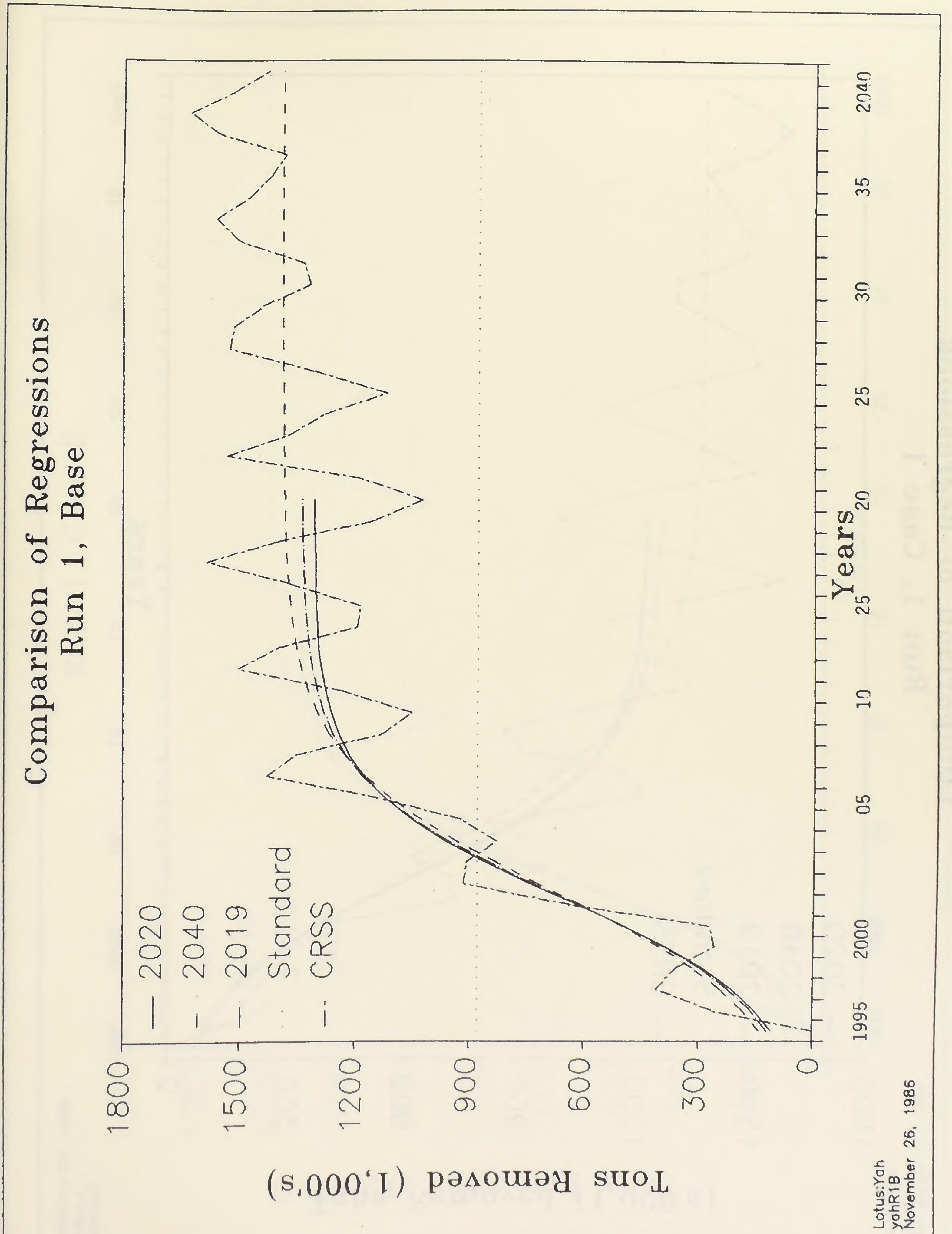
CRSS SENSITIVITY ANAL. CASE 5
YEARS
SALT TARGET - KTONS

APPENDIX B

SENSITIVITY ANALYSIS NO. 2

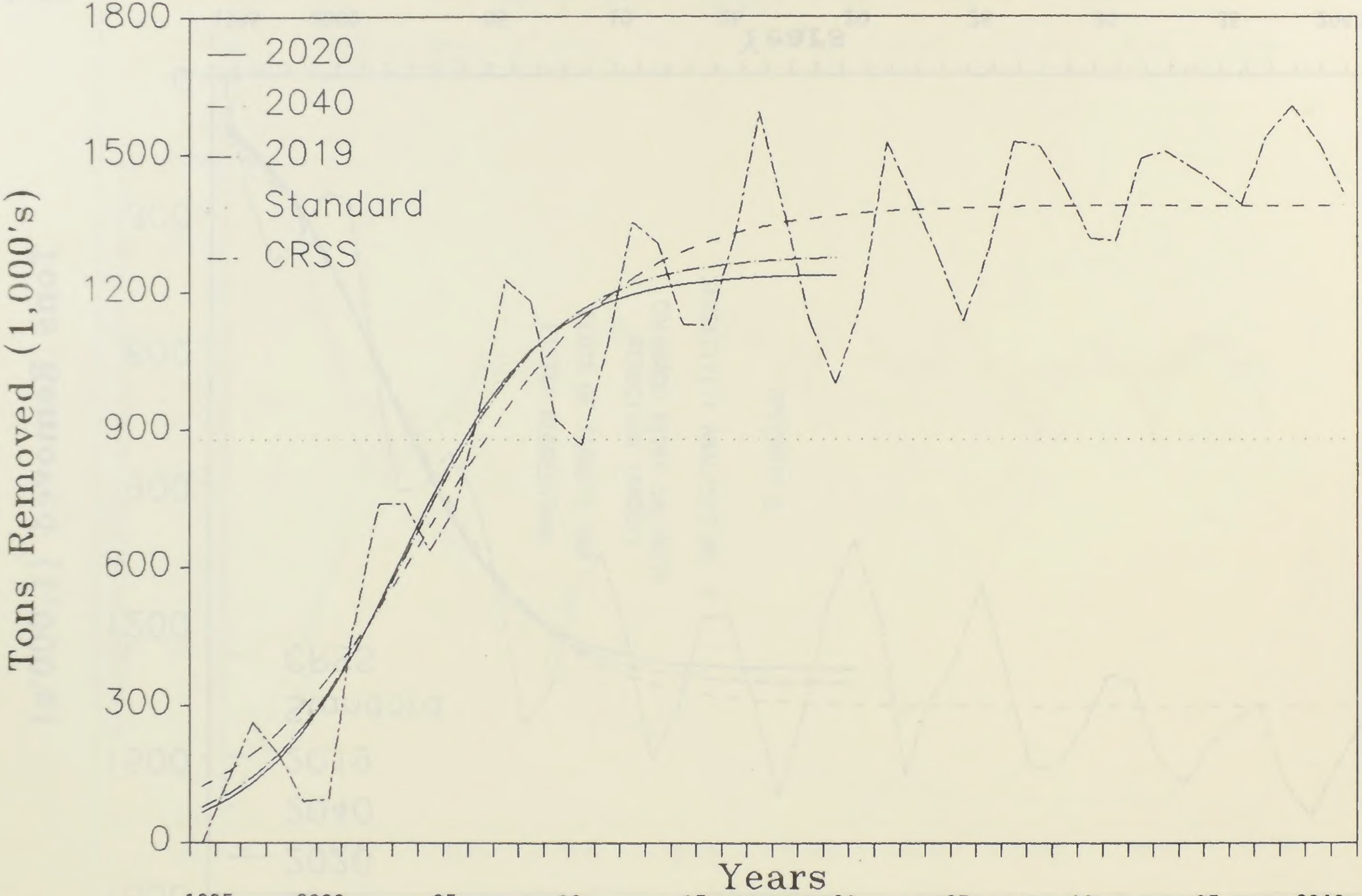
COLORADO RIVER SALINITY
REDUCTION TARGETS

PLOTS OF TARGETS AND
FITTED REGRESSIONS

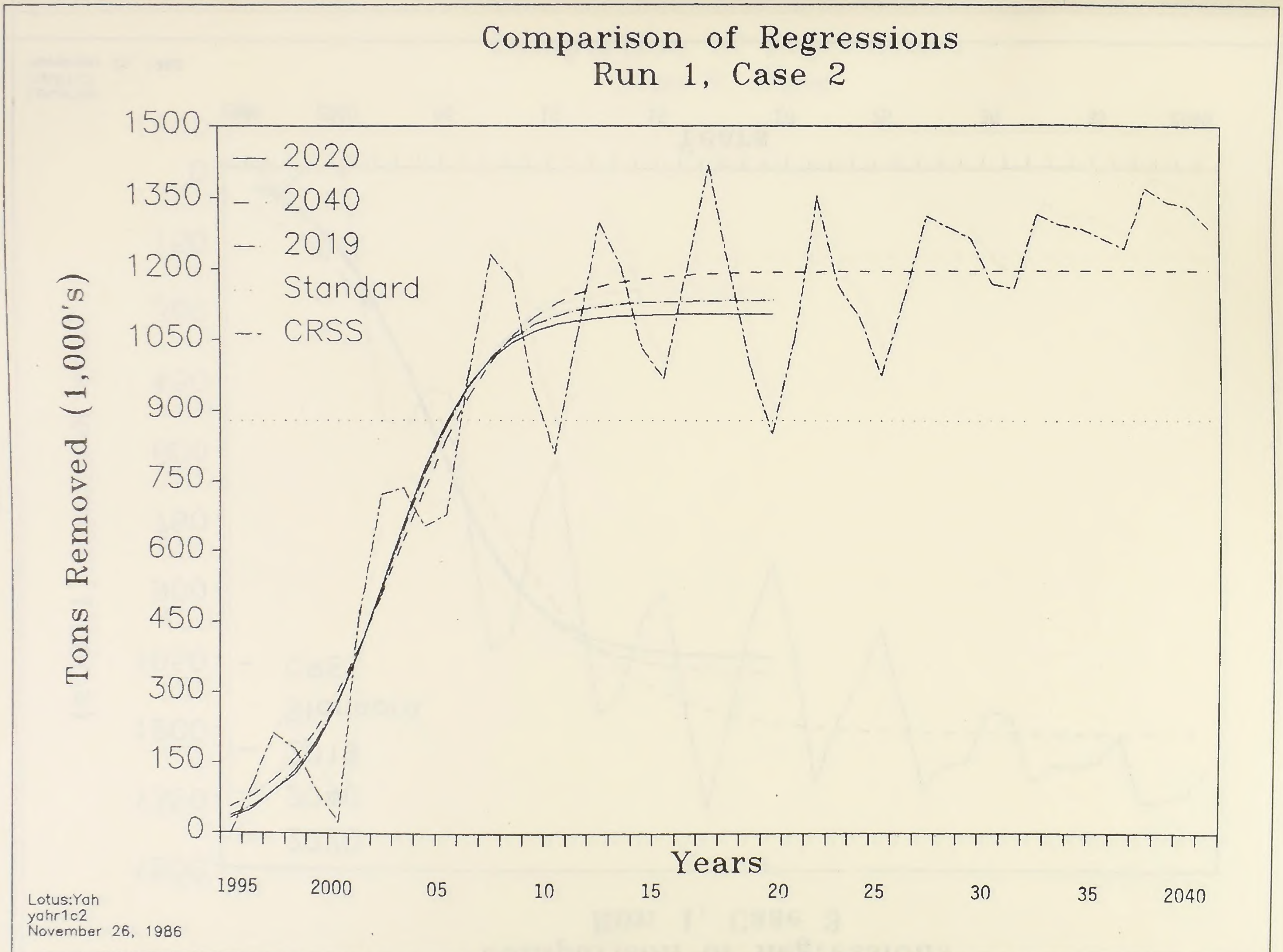


Comparison of Regressions
Run 1, Base
Tons Removed (1,000's)
1800
1500
1200
900
600
300
0
2020
2040
2019
Standard
CRSS
1995
2000
05
10
15
20
25
30
35
2040
Years
Lotus:Yah
yahR1B
November 26, 1986

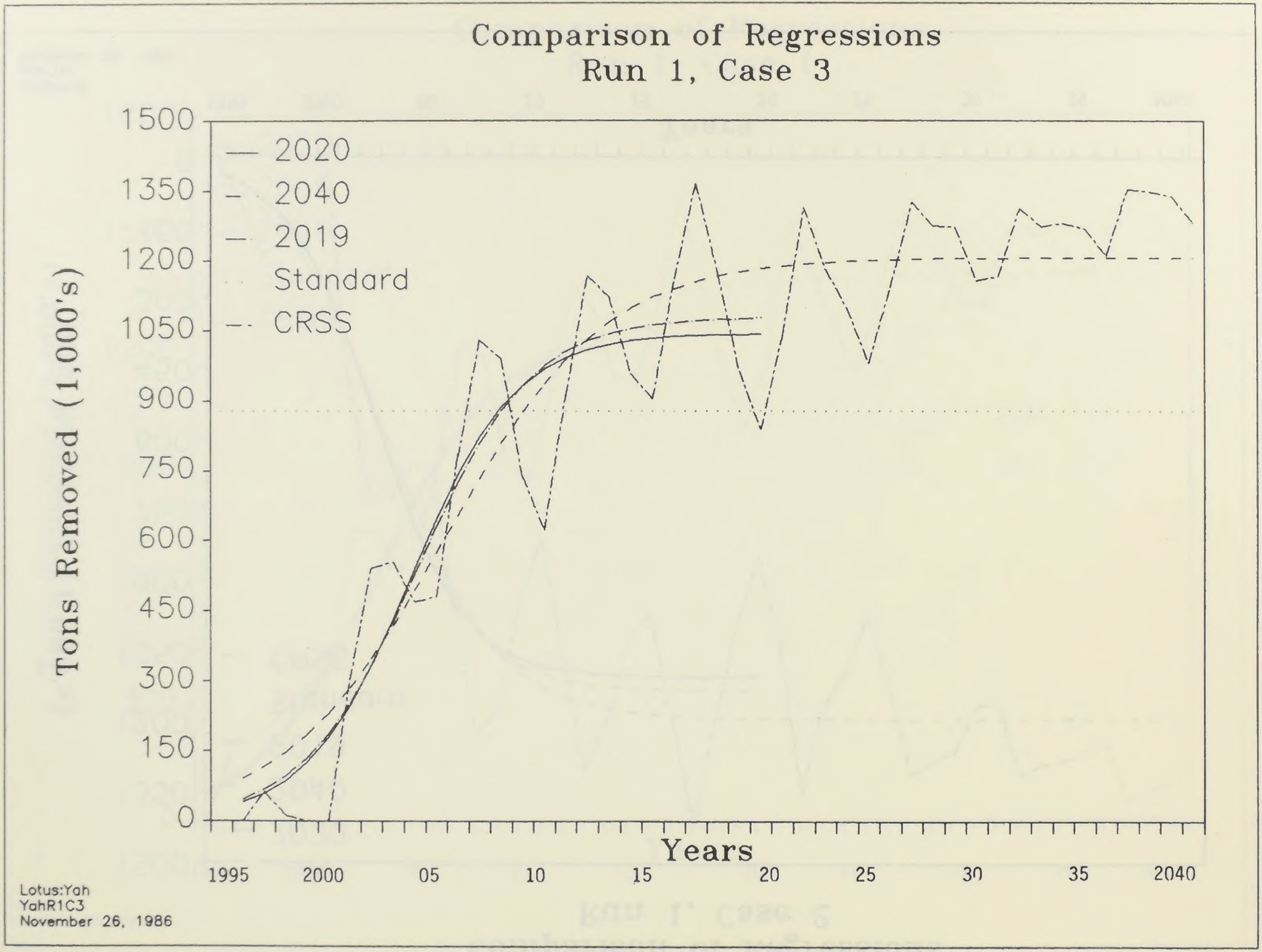
Comparison of Regressions
Run 1, Case 1

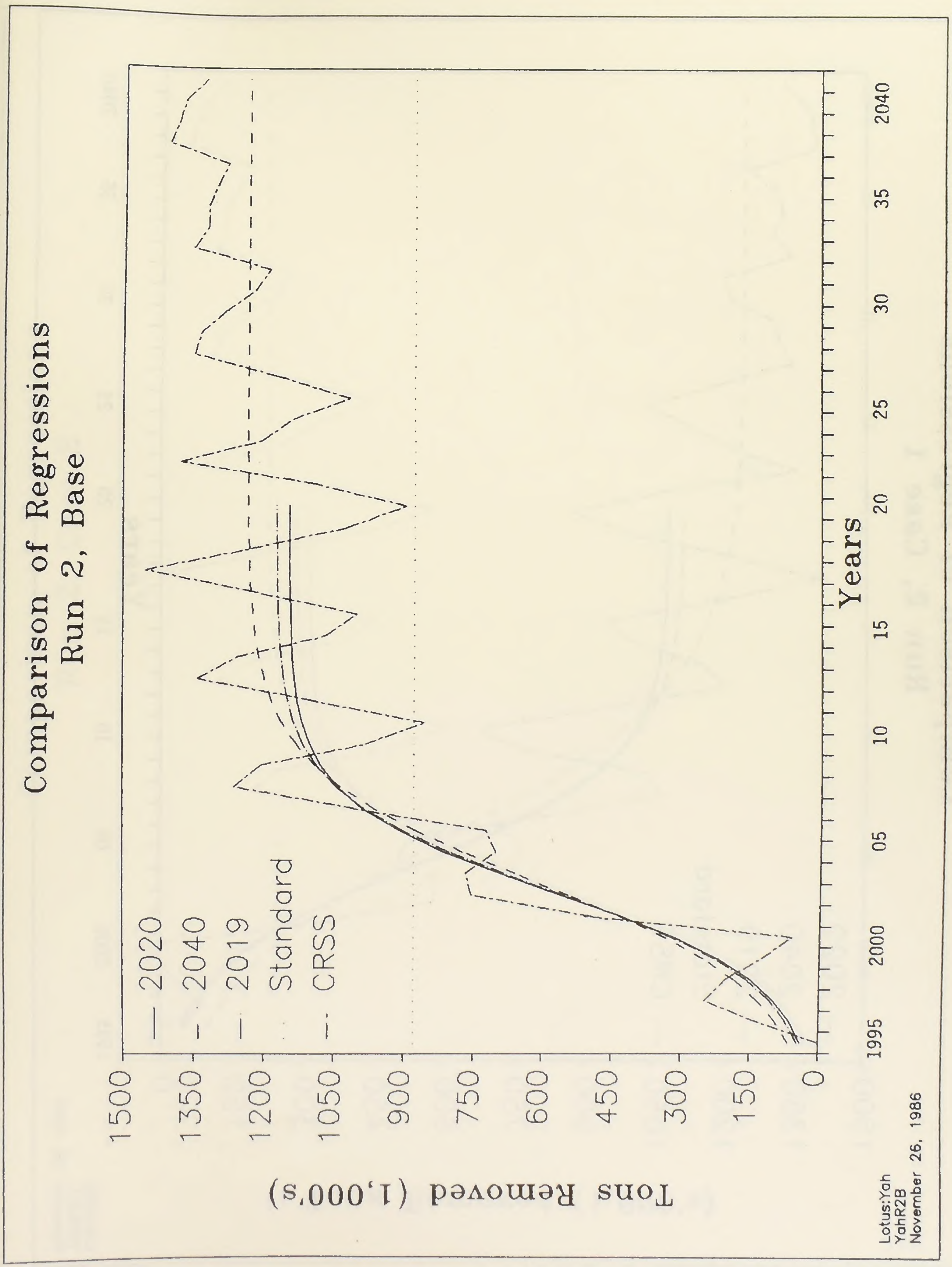


Lotus:Yah
yahR1C1
November 26, 1986

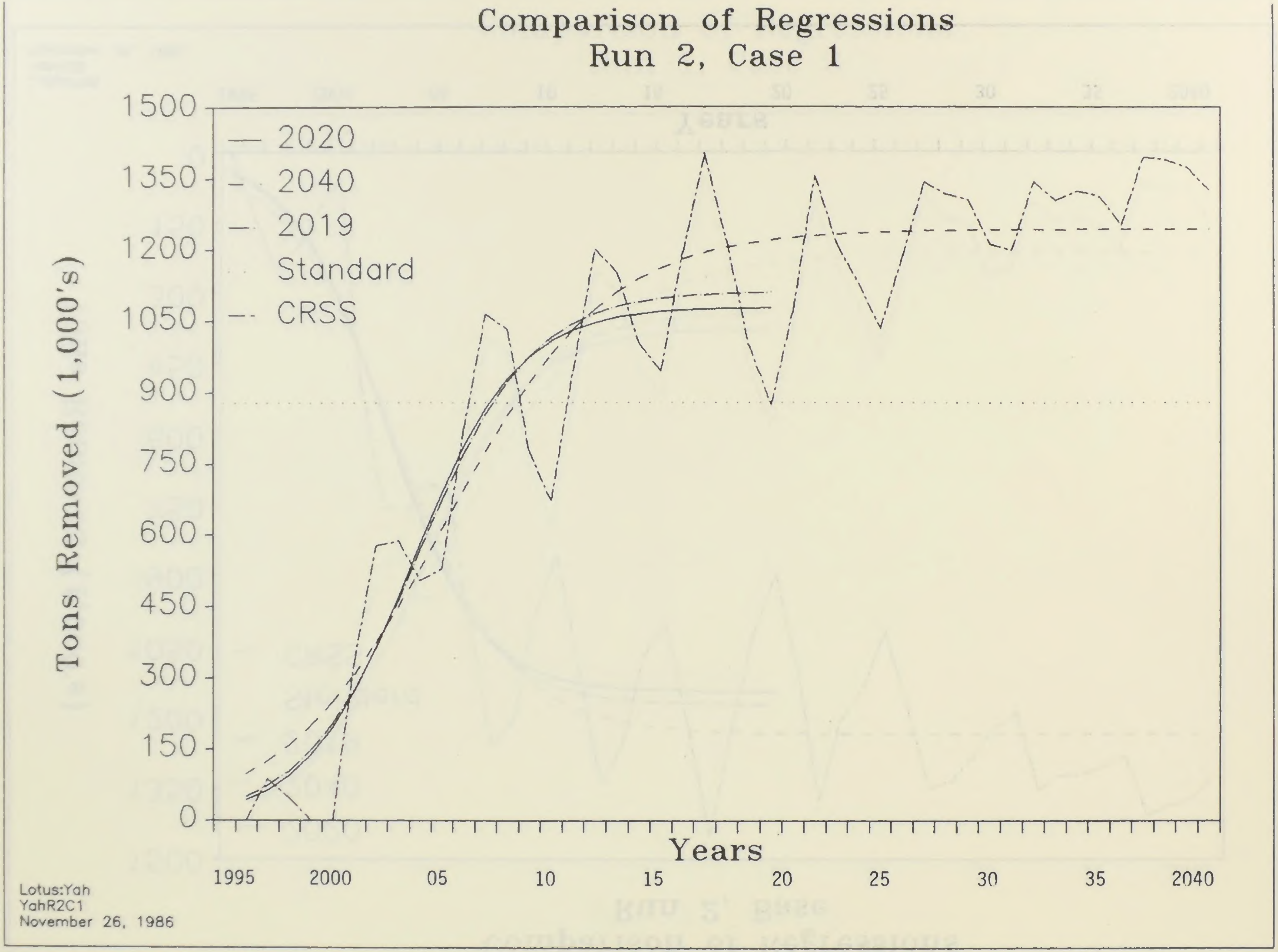


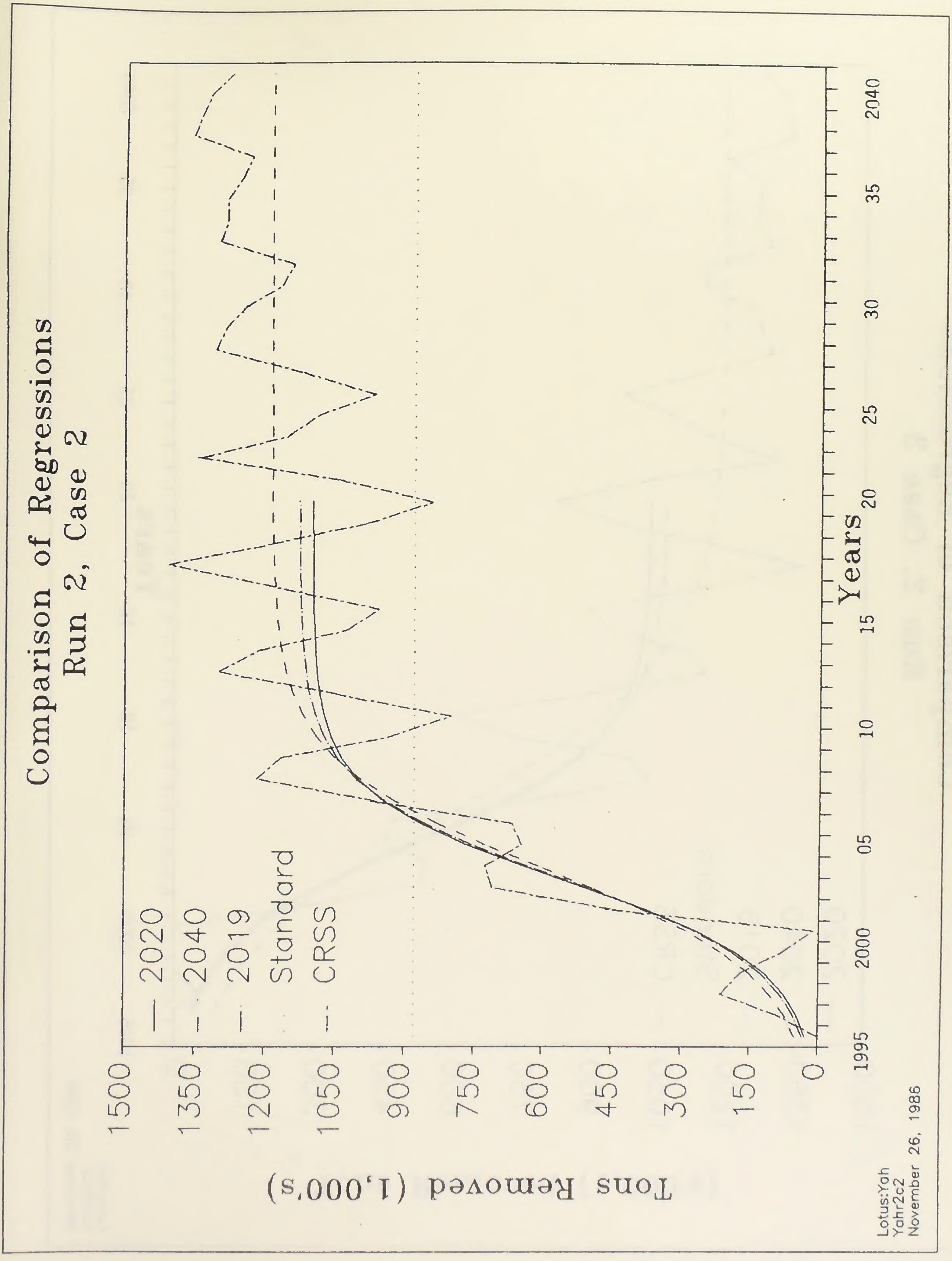
Comparison of Regressions
Run 1, Case 2
Tons Removed (1,000's)
1500
1350
1200
1050
900
750
600
450
300
150
0
2020
2040
2019
Standard
CRSS
Years
1995
2000
05
10
15
20
25
30
35
2040
Lotus:Yah
yahr1c2
November 26, 1986

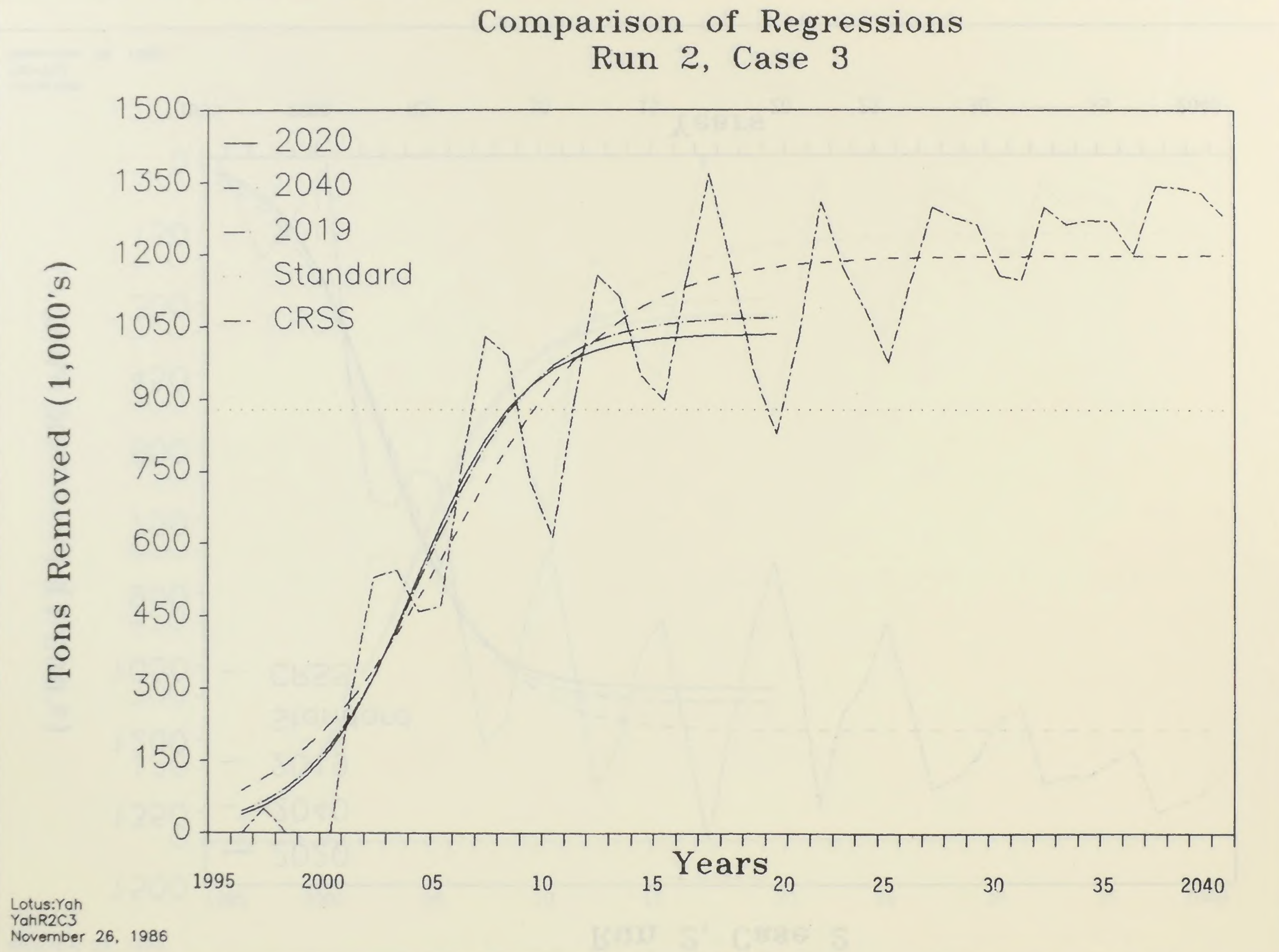

Comparison of Regressions
Run 1, Case 3
Tons Removed (1,000's)
1500
1350
1200
1050
900
750
600
450
300
150
0
2020
2040
2019
Standard
CRSS
Years
1995
2000
05
10
15
20
25
30
35
2040
Lotus:Yah
YahR1C3
November 26, 1986



Comparison of Regressions
Run 2, Base
Tons Removed (1,000's)
1500
1350
1200
1050
900
750
600
450
300
150
0
Years
1995
2000
05
10
15
20
25
30
35
2040
2020
2040
2019
Standard
CRSS
Lotus:Yah
YahR2B
November 26, 1986


Comparison of Regressions
Run 2, Case 1
Tons Removed (1,000's)
1500
1350
1200
1050
900
750
600
450
300
150
0
2020
2040
2019
Standard
CRSS
Years
1995
2000
05
10
15
20
25
30
35
2040
Lotus:Yah
YahR2C1
November 26, 1986


Comparison of Regressions
Run 2, Case 2
2020
2040
2019
Standard
CRSS
Tons Removed (1,000's)
1500
1350
1200
1050
900
750
600
450
300
150
0
1995
2000
05
10
15
20
25
30
35
2040
Years
Lotus:Yah
Yahr2c2
November 26, 1986


Comparison of Regressions
Run 2, Case 3
Tons Removed (1,000's)
1500
1350
1200
1050
900
750
600
450
300
150
0
2020
2040
2019
Standard
CRSS
Years
1995
2000
05
10
15
20
25
30
35
2040
Lotus:Yah
YahR2C3
November 26, 1986