

Salinity Control Planning in the Colorado River System
by
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INTRODUCTION

The increase of salinity in the Colorado River is a basinwide problem that imposes significant economic impacts on water users in the U.S. and Mexico. In the lower reaches of the river, these total damages to U.S. water users are now estimated to be about \$53 million per year. If no salinity control measures are taken, the damages are projected to increase to about \$124 million per year by the year 2000. The overriding issue on the Colorado River, however, involves not only the continued decline of water quality but also the expected inadequacy of water supply to meet future demand for river water, particularly to support energy resource development.

This paper discusses the physical, legal, economic, and institutional aspects of the salinity problem and proposed actions to mesh salinity control with a total water management plan for the Basin. A general strategy is presented for planning under the Colorado River Water Quality Improvement Program. Recent legislative action is also discussed which establishes control plans to improve the water quality delivered to Mexico as well as Upper Basin water users.

THE COLORADO RIVER BASIN

The Colorado River is one of the most highly regulated and institutionally constrained rivers in the world. It's watershed encompasses more than 242,000 square miles, draining parts of seven states and Mexico. The river main stem extends more than 1,400 miles, from the Rocky Mountains to the Gulf of California in Mexico. The river and its principal tributaries serve as a source of water supply for irrigating nearly a million acres of land and supplying the municipal and industrial needs of nearly 12,000,000 people.

In hydrologic terms, the annual basin runoff can be highly variable with some 24 million acre-feet at Lee Ferry in 1917 and the lowest being only 5.6 million acre-feet in 1934. Recent runoff data, however, shows an annual average yield of about 14 to 15 million acre-feet. Major facilities such as Imperial Dam, Parker Dam, Davis Dam, Hoover Dam, and Glen Canyon Dam have effectively regulated the river and provided storage capacity for flood control and reliable water supply.

Salt has been in the river long before the influences of man were felt. Journals of the early explorers such as John Wesley Powell

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describe the location and quality of naturally occurring saline water. Other man-induced salinity contributions have added to natural levels, bringing the matter to the level of international and interstate importance. Thus, as river salinity increases and water use approaches usable water supply, the Colorado River continues to be the object of conflict in legislatures, in the courts, and around conference tables.

THE SALINITY PROBLEM

Colorado River salinity comes from several primary sources. Nearly half of the salinity concentration in Lake Mead can be attributed to natural sources. These natural sources include mineral springs and salt dissolved by precipitation moving through and over geologic marine shales and other salty soils before reaching the river. Return flows from irrigation account for approximately 37 percent of the salinity, reservoir evaporation for some 12 percent, basin exports for 3 percent, and municipal and industrial uses of 1 percent.

These sources raise the salinity of the river considerably as it flows to the Gulf of California. At the headwaters, the average salinity of Colorado River water is less than 50 milligrams per liter (mg/l). The salinity increases progressively until at Imperial Dam it now averages about 865 mg/l under present modified conditions ^{1/}. Under Table 1, both historic and modified salinity conditions are shown for the 1941-1970 period. Bureau of Reclamation projections of future salinity levels without a control program suggest that values of 1,160 mg/l or more will occur at Imperial Dam by the year 2000. Other agencies have projected higher projected salinity increases for the river, Table 2. If these projected salinity levels are allowed to occur, agriculture in the Lower Basin will be further threatened and the quality of municipal and industrial deliveries will be impaired.

In overall terms, the increase in dissolved mineral concentration in the river generally results from the processes of salt loading and salt concentration. Salt loading or salt pickup refers to the amount of salt added to the river from any natural or man-made sources and occurs normally through mineral weathering and irrigation return flows. Salt concentration is a process that results from the reduction of dilution water which in turn increases the concentration of the remaining dissolved solids in solution. Thus, evapotranspiration, reservoir evaporation, and exports or other consumptive use of water all result in a salt concentration effect on the river.

^{1/} Present modified refers to historic conditions (1941-1970) modified to reflect all upstream, existing projects in operation for the full period.

TABLE 1. - HISTORIC AND PRESENT MODIFIED
 QUALITY OF WATER
 COLORADO RIVER - AVERAGE VALUES 1941-1970

<u>Location</u>	<u>Concentration (mg/l)</u>	
	<u>Historic</u>	<u>Modified*</u>
Glenwood Springs, Colorado	271	310
Cameo, Colorado	406	443
Cisco, Utah	613	662
Lees Ferry, Arizona	556	615
Grand Canyon, Arizona	617	680
Hoover Dam, Arizona-Nevada	690	760
Imperial Dam, Arizona-California	757	865

*See footnote 1. for definition

TABLE 2. - PROJECTED CONCENTRATIONS
OF TOTAL DISSOLVED SOLIDS (mg/l) AT IMPERIAL DAM

(Average annual values)

Source	Year				
	1980	2000	2010	2020	2030
EPA	1060	-	1220	-	-
CRBC	1070	1340	-	-	1390
WRC	1260	1290	-	1350	-
USBR	930	1160	-	-	-

EPA: Environmental Protection Agency, 1972

CRBC: Colorado River Board of California, 1970

WRC: Water Resources Council (Lower Colorado Region Comprehensive Framework Study), 1971

USBR: Bureau of Reclamation, 1973

Salinity also affects future development of Upper Basin water resources. While Lower Basin development is nearly completed, considerable Upper Basin development remains possible. Further development primarily through salt concentrating effects may lead to even higher salinity levels in the Lower Basin. Advance planning and reformulation of future Upper Basin irrigation projects as well as minimizing consumptive use and return from energy development projects such as oil shale and coal gasification will be required.

As such, high salinity levels not only affect planning for future water supplies but is also a present problem that can be measured in direct economic terms. According to preliminary studies by the Bureau of Reclamation [1] water users in the lower reaches of the Colorado River are now incurring total damages estimated to be about \$53 million per year. Projected increases to \$124 million per year by the year 2000 are expected if water resource development continues and no salinity reduction measures are instituted. The studies also indicated a most likely expected detrimental value of \$230,000 per mg/l annually with a possible range from \$194,000 to \$395,000 per mg/l increase in salinity at Imperial Dam. The damages are expressed in economic terms reflecting agricultural, municipal, and industrial uses in the Lower Basin. There is no salinity problem per se in the Upper Basin; however, the Upper Basin will be the principal source of future salinity increases if additional water resources development continues as planned.

INSTITUTIONAL ASPECTS

The salinity problem in the Colorado River has been the object of intensive study and investigations for several years [2] [3] [4]. Surveys of salinity sources and various control measures have been pursued by the Bureau of Reclamation, U.S. Geological Survey, Environmental Protection Agency and its predecessors, Water Resources Council, Colorado River Board of California, and several universities.

The 1972 Joint Federal-State Enforcement Conference on the matter of Pollution of Interstate Waters of the Colorado River and its tributaries initiated new efforts to establish an overall, coordinated salinity control policy for the river [4]. The seven basin state conferees and Federal representatives concluded that such a policy would have as its objective the maintenance of salinity concentrations at or below levels presently found in the lower main stem. This control activity was to be done generally as outlined in a program report prepared by the Bureau of Reclamation as based on their prior studies and those of the EPA, Colorado River Board of California and others [5]. The conferees recognized the need for the states to continue development of their compact apportioned waters and that temporary rises in salinity might occur until the

control program becomes effective. This recommended action then was to substitute for the establishment of a salinity standard. With the enactment of Public Law 92-500 the Federal Water Pollution Control Act as amended, salinity standards will now be required to be set on the Colorado River.

Other institutional matter emphasizing the need for basinwide salinity control planning is a recent agreement (Minute 242 of the International Boundary of Water Commission) with Mexico in an effort to find a permanent, definitive, and just solution to the international salinity problem with Mexico. Under the agreement, water delivered to Mexico shall have an overage annual salinity of no more than 115 mg/l (plus or minus 30 mg/l) over the average annual salinity of waters arriving at Imperial Dam. This new, international requirement is to become effective upon the authorization of Federal funds to construct the Colorado River International Salinity Control Project consisting of a desalting plant and other works necessary to achieve the stated salinity differential [6].

Finally, H.R. 12165, recently introduced before the Congress and now enacted as Public Law 93-320 (The Colorado River Basin Salinity Control Act) sets in motion Federal action and funding for basinwide control. The act authorizes construction of the desalting plant and associated works for the Colorado River International Salinity Control Project (Title I) and authorizes early construction of some Upper Basin control units under the Colorado River Water Quality Improvement Program (Title II).

COLORADO RIVER WATER QUALITY IMPROVEMENT PROGRAM

There is no one solution to the complex problem of salinity control for the Colorado River. Salinity control planning strategy is generally focused on identifying the key elements of a matrix of solutions that will eventually lead to a comprehensive plan of management of the basin's water resources. Included within the matrix or solution mix are potential technological measures which can be applied to the following major categories: (1) Point Sources, (2) Natural Diffuse Sources, (3) Irrigation Sources, (4) River System Management, and (5) Dilution. The classes and the techniques involved in each are presented in outline form below:

I. Point sources

1. Desalt
2. Divert/Evaporate
3. Divert/Special Use
4. Plug Wells
5. Deep Injection

II. Natural Diffuse Sources

1. Collect/Desalt
2. Collect/Evaporate
3. Collect/Special Use
4. Watershed Management
 - a. Vegetative conversions
 - b. Forest management
 - c. Structural measures
 - d. Water harvesting
 - e. Reduced sediment production
5. Phreatophyte Control
 - a. Control of spread
 - b. Replacement vegetation
 - c. Antitranspirants

III. Irrigation Sources

1. Improved on-farm irrigation use
 - a. Irrigation scheduling
 - b. Improved farm irrigation systems
 - (1) Pipes and lining
 - (2) Automation
 - (3) Advanced systems
2. Improved water conveyance systems
 - a. Pipes, lining
3. Ground water management
 - a. Water table control (drainage)
 - b. Selective pumping
 - c. Ground water recharge
4. Return-flow management
 - a. Collect/desalt
 - b. Collect/special use
5. Evaporation suppression

IV. River System Management

1. Alteration - time pattern of streamflow
2. Alteration - time pattern of saline discharges

V. Dilution

1. Augmentation

- a. Weather modification
- b. Geothermal resources
- c. Desalting
- d. Wastewater reclamation
- e. Conservation practices

2. Importation

Other options involving institutional changes, imposition of "no development or restricted development policies" through establishment of highly restrictive water quality standards, and other non-structural methodologies are under evaluation.

Under the 10-year, Colorado River Water Quality Improvement Program (CRWQIP) depicted in Figure I, several near-term elements of the matrix have been under intensive study. In short, the CRWQIP will perform reconnaissance or feasibility studies on a total of 17 Point, Diffuse, and Irrigation sources. Related program activities and support studies involve development of a mathematical model of the Colorado River, economic analysis of water quality, analysis of legal and institutional constraints, and investigations of desalting systems.

Heavy program emphasis is being placed on those activities most likely to achieve water quality improvement at least cost. Thus, Irrigation source control with close integration of on-farm irrigation water scheduling and management with accompanying water delivery systems improvement is expected to reduce salt loadings with minimum capital investment for new structures. Following the full operational establishment of the irrigation scheduling activity, water users would be expected to operate the program.

The Colorado River carries a salinity burden of about 10 million tons annually. If the salinity is to be kept near present levels in the lower main stem as recommended by the basin states, then about 2.5 million tons per year will need to be removed from the river each year. This target level may be regarded as the physical objective of a salinity control plan. Thus, each control unit envisioned under the CRWQIP plus other measures will be needed to meet this physical objective of salinity control.

Under the CRWQIP, examples of point sources include La Verkin Springs and Crystal Geyser in Utah, Blue Springs, and Littlefield Springs in Arizona, and Dotsero Springs, Glenwood Springs, and Paradox Valley in Colorado. Examples of diffuse sources are the Price, San Rafael, and Dirty Devil Rivers in Utah, McElmo Creek in Colorado, and Big Sandy River in Wyoming. Major salt loadings to the Colorado River from irrigated areas are contributed by the Grand Valley in Colorado, the Colorado River Indian Reservation in California and Arizona, the

INVESTIGATION SCHEDULE **COLORADO RIVER WATER QUALITY IMPROVEMENT PROGRAM**

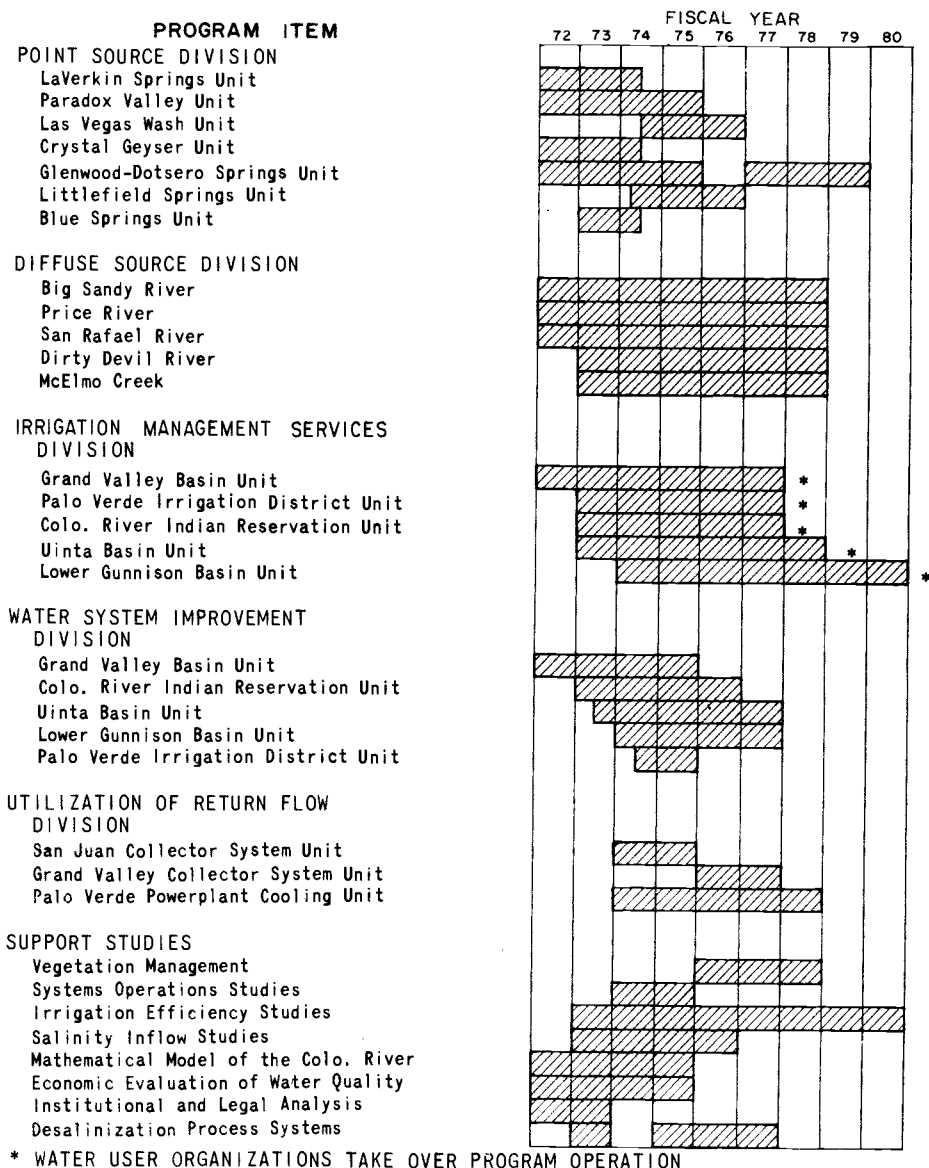


FIGURE 1

lower Gunnison in Colorado, the Uinta Basin in Utah, and the Palo Verde Irrigation District in California. The locations of these study areas are shown in Figure 2.

Based on prior studies several projects were selected for early investigation. These included Paradox Valley, Colorado; Grand Valley, Colorado; Crystal Geyser, Utah; Las Vegas Wash, Nevada; and La Verkin Springs, Utah. Currently, investigations on these units are completed, nearing completion, or are highly advanced. Public Law 93-320 includes all of these for early construction with the exception of La Verkin Springs.

POINT SOURCES

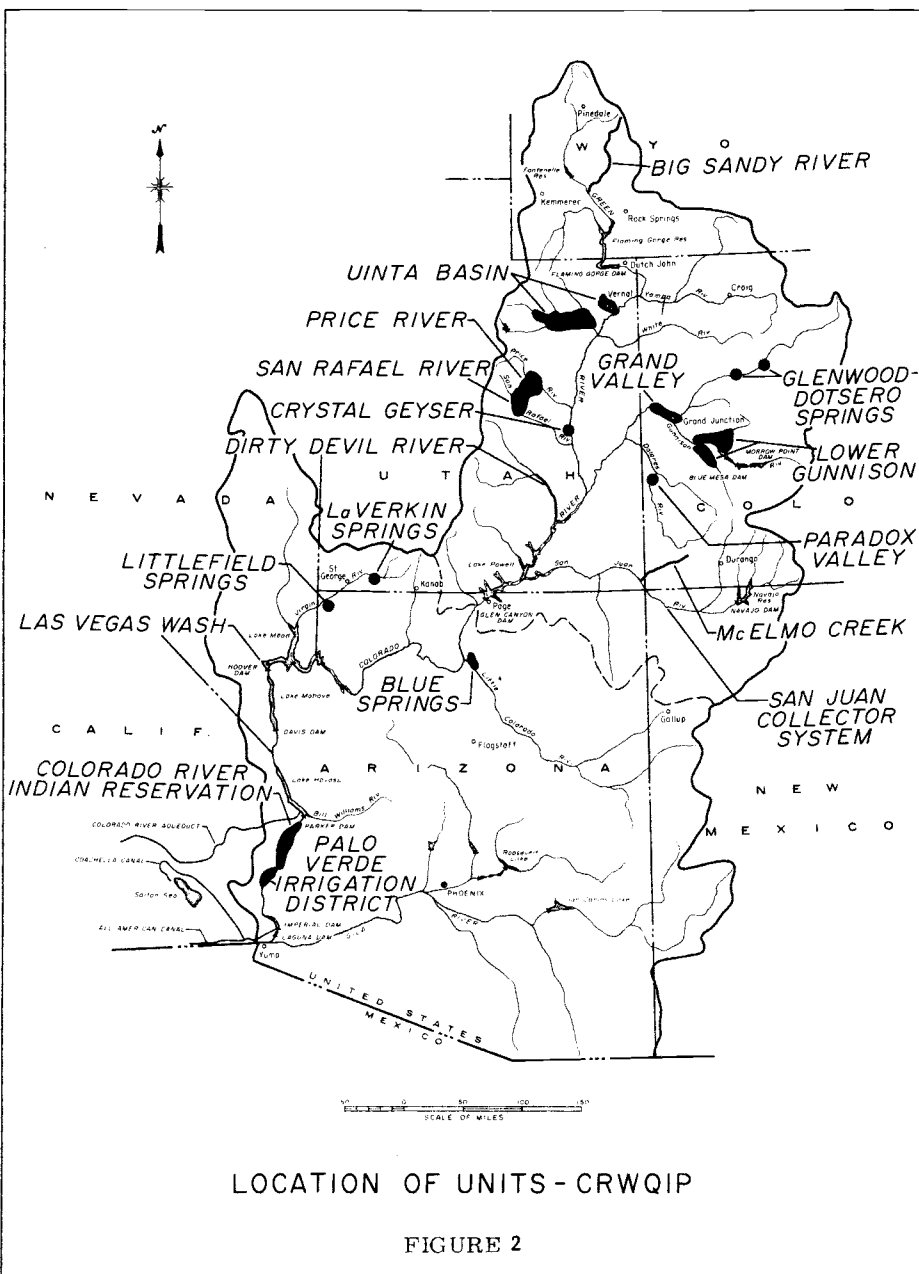
Paradox Valley is estimated to contribute about 200,000 tons of salt per year to the Dolores River in southwestern Colorado. A control project might reduce this contribution about 180,000 tons per year. The valley sits over a salt dome and test wells in the area have recorded discharges of 270,000 mg/l. Based on data developed at this time, the control plan is to lower the fresh water/brine interface by pumping wells along the Dolores River to prevent the brine from entering the river. The planning is not completed but our preliminary estimate is that construction would cost about \$16 million.

In the Grand Valley area of western Colorado, there are about 76,000 irrigated acres. The salt contributed by the area is 400,000 tons annually. Planned control measures include irrigation management services and irrigation systems improvement.

Irrigation scheduling was started in 1972 on about 1,000 acres. In 1972 the scheduling program was expanded to 7,200 acres. The program involves advising farmers when to irrigate and how much water to apply. Early results indicate that higher efficiencies are being obtained along with increased crop yields.

An investigation is also underway to determine the best methods of increasing water delivery efficiency. The combination of system improvement and irrigation scheduling and management could result in a reduction of about 200,000 tons of total dissolved solids to the Colorado River. Preliminary estimates of this alternative control plan suggest that the system improvements would cost about \$59 million.

Crystal Geyser, an abandoned oil well, located just south of Green River, Utah, contributes 200 acre-feet of water and 3,000 tons of salt to the Green River annually. The basic plan of control is



to build a wall or dike around the points of eruption to collect the discharges and then convey the water by pipeline to an evaporation pond. The preliminary estimates for controlling the salinity by this plan is one-half million dollars.

Las Vegas Wash serves as a surface drain for all domestic, municipal, and industrial wastewaters from Las Vegas Valley. The average annual discharge from the wash to Lake Mead is about 38,000 acre-feet, which carries approximately 208,000 tons of dissolved solids.

The plan of development would collect ground-water flows at a natural "barrier" with a grouted curtain wall and a series of perforated pipes. The collected discharges would be pumped to a nearby solar evaporation pond for disposal. Man-made surface flows in the wash would be diverted and conveyed around the ground-water collection site. It is estimated that the Las Vegas Wash control could remove 138,000 tons of salt per year from the Colorado River System.

The La Verkin Springs are located in a 1,800-foot-long reach of the Tempweap Canyon of the Virgin River in southwestern Utah. The springs discharge about 8,300 acre-feet of water and 109,000 tons of salt each year. A feasibility study shows 103,000 tons of this salt could be removed annually.

The plan of development at La Verkin Springs calls for the construction of a diversion dam upstream from the springs to divert the normal riverflows around the area of the springs. A control dam would be located just below the springs to form a pool from which the springs' flows would be pumped to a desalting plant.

The product water from the desalting plant would be returned to the Virgin River through a pipeline. Another pipeline would be used to pump the brine from the plant to a evaporation pond formed by diking a natural depression nearby. This desalting alternative is estimated to cost about \$20 million.

The Littlefield Springs discharge along the south side of the Virgin River about a mile upstream from Littlefield, Arizona. These springs have a combined outflow of about 10 cfs and contribute about 30,000 tons of dissolved solids to the river system annually.

The Glenwood-Dotsero group of 18 springs discharge to the Colorado River at opposite ends of Glenwood Canyon in northwestern Colorado. These springs, many of which issue warm water, are estimated to contribute 25,000 acre-feet of water and 500,000 tons of salt to the river annually. After considering alternative methods, the geology involved, the present commercial resort uses of water, and the potential loss of water, it has been concluded that some type of desalting will provide the most desirable solution.

Blue Springs rise in the Little Colorado River about 13 miles upstream from that river's confluence with the Colorado River. The springs are the largest point source of salinity in the entire system, with an output of 220 cfs and 550,000 tons of salt per year.

Investigations of a control program for Blue Springs are not encouraging to date. The comparatively large flow, the scenic setting in the river's deep canyon, and the special ethnic value to the local Indians are complicating factors. A report summarizing control alternatives will soon be completed and will serve as a basis for deciding whether additional investigations are warranted.

DIFFUSE SOURCES

In the category of diffuse sources being investigated, Big Sandy River in Wyoming contributes approximately 180,000 tons of dissolved solids annually to the Green River. Most of this salt enters the Big Sandy from numerous seeps in a particular reach of the river. It is estimated that about 80,000 tons could be removed by treatment of the more saline flows when the stream discharge is low. Because of the low winter temperatures in the region, it may be possible to apply natural freezing methods to treat the water. Water would be pumped from the Big Sandy River, sprinkled to produce ice piles, and then separated by natural freezing and thawing. A pilot plant is currently in operation to test this concept.

McElmo Creek is tributary to the San Juan River near the Colorado-Utah State line. Although the creek's drainage area is only 350 square miles, the salt loading is estimated to be 115,000 tons per year, of which about 40,000 tons could be removed by selective withdrawal and evaporation or desalting.

The Price, San Rafael, and Dirty Devil Rivers originate in the mountains of the Wasatch and Aquarius Plateaus and are tributary to the Green and Colorado Rivers in east-central Utah. The estimated total dissolved solids contributed by the Price, San Rafael, and Dirty Devil Rivers are 240,000, 190,000, and 200,000 tons, respectively.

The estimated annual removal of salt by proposed control programs is 100,000 tons on the Price River and 80,000 tons each for the San Rafael and Dirty Devil Rivers. The tentative plan for control of these sources is to selectively remove the higher concentrated flows and evaporate or desalt them.

IRRIGATION SOURCES

Major program emphasis for control of irrigation sources is placed on improved irrigation management through an Irrigation Management Service (IMS) and improved control of waterflow in canals, laterals, and drainage systems through a System Improvements (SI) program. Basically, the IMS program is a nonstructural management technique for increasing irrigation water efficiency and reducing salt loading. [7] [8]

Major benefits derived from IMS irrigation scheduling include increased yields, water savings, reduced leaching of soils, and reduced drainage requirements.

The SI program, on the other hand, involves a structural water management tool for improving water delivery conveyances and thus reducing drainage and seepage salinity pickup. The lining of canals and laterals would result in decreased deep percolation losses, thus reducing water contact with highly saline soils, shales, and saline ground waters.

For efficient salinity control, particularly to meet a wide range of local conditions, both the IMS and SI programs must be considered under an integrated program. At present, based on available data, it is difficult to separate the relative effects of each program. Consequently, both schemes are considered as operating together for field evaluation and feasibility studies.

UTILIZATION OF RETURN FLOWS

Another means of reducing salinity contribution is the utilization of irrigation return flows and natural flows for beneficial consumptive uses such as thermal powerplant cooling, coal gasification, and oil shale development.

One such source is return flows of the Palo Verde Irrigation District, which is located downstream from Parker Dam. Diverting a portion of the saline flows of the Palo Verde outfall drain and using these waters to supply a nuclear powerplant in the California desert would reduce the salinity of the Colorado for the water users downstream.

Another irrigation source is the Grand Valley, located in west-central Colorado at the confluence of the Colorado and Gunnison Rivers. One of the most promising uses of saline waters from this area could be in oil shale development. Thermal powerplant cooling and coal conversion are other possible uses.

A third source of saline water includes natural waters and irrigation return flows in the San Juan Basin in Colorado and New Mexico. This saline water could also be used in developing coal and oil shale in the Upper Colorado River Basin.

There are several supporting studies for the salinity investigations. One study has been completed which quantifies the impact of increased salinity on the multiple river uses. An institutional and legal review is nearing completion and a report of the findings is being prepared. Two computerized water quality models of the Colorado River System have been developed.

GENERAL RESEARCH

Research has been conducted in on-farm irrigation efficiencies, desalting by natural freezing, economics of water quality, and modeling for predicting the salt and nutrient loading. At Grand Valley a unique field experiment is being conducted by the Agricultural Research Service in cooperation with the Bureau of Reclamation. Here, very high irrigation efficiencies are being attained with the objective of precipitating nonharmful salts in the soil. In this way the salt loading from irrigation would be reduced. However, this technique, even if successful, would take many years to implement.

Control of the point, diffuse, and irrigation sources, excluding Blue Springs, would provide a reduction of 1.6 million tons annually with a concentration reduction of about 200 mg/l at Imperial Dam under conditions of development anticipated by the year 2000. Other corollary elements needing study within the solution matrix include: Improvements in management of the river system, improvements in irrigation efficiency beyond those currently contemplated from the IMS programs, formulating new water projects to minimize the salt loading, enhancing salt precipitation phenomena in large reservoirs, salinity control on watersheds, reducing evapotranspiration through treatment and management of vegetation, and the perfection of such concepts as weather modification, sea water desalting, development of geothermal resources, and desalting at the points of diversions to meet quality requirements of the intended uses.

PROGRAM IMPACT

When integrated into an overall basin management plan, salinity control can preclude the damaging increases anticipated from continuing economic growth in the basin. The projected reduction requirements that need to be attained through CRWQIP and basin management are shown in Table 3 for expected salinity loads during 1980, 1990, and the year 2000.

Table 3
ESTIMATED SALINITY REDUCTIONS
Colorado River at Imperial Dam

Mg/l

	1970	1980	1990	2000
Estimated salinity level <u>a/</u> Anticipated range <u>c/</u>	865 (795 - 935)	930 (855 - 1005)	1115 (995 - 1235)	1160 b/ (1035 - 1285)
Estimated salinity reductions				
Potential source controls	-	(-39)	(-130)	(-130)
Other possible reductions from practices such as vegetation management, desalting, and weather modification	-	(-26)	(-120)	(-165)
Total estimated reduction		(-65)	-250	-295
Estimated salinity level with possible control programs Range	865 (795 - 935)	865 (795 - 935)	865 (795 - 935)	865 (795 - 935)

a/ No salinity control programs.

b/ Construction of all Federal and private water resource developments. If Upper Basin develops the full 5.8 million acre-feet estimated to be available, then salinity could increase to 1,260 ± 140 mg/l.

c/ Based on one standard deviation for period of record.

COLORADO RIVER INTERNATIONAL SALINITY CONTROL PROJECT

Implementation of the CRWQIP will do much to improve the quality of the Colorado River water. However, as the waters reach the southern boundary of the basin, the salinity levels will still be high. Measures under another effort called the Colorado River International Salinity Control Project (Title I of Public Law 93-320) are therefore being planned to assure water of suitable quality in deliveries made to Mexico under the 1944 treaty.

The delivery of treaty waters to Mexico began in 1950, with the completion of Morelos Dam, Mexico's major diversion structure. A decade later, two events occurred to make water quality a serious issue between the two countries. In 1961, drainage flows from the Wellton-Mohawk Irrigation and Drainage District, initially averaging about 6,000 parts per million, began discharging into the Colorado River above Morelos Dam. Two years later, excess flows which Mexico had received in the past nearly came to an end as storage began behind Glen Canyon Dam in Lake Powell. The effect of these developments was to increase the salinity of the Colorado River waters made available to Mexico at the Northerly International Boundary from an annual average of about 800 parts per million to nearly 1,500 parts per million in 1962.

On June 17, 1972, the Presidents of the United States and Mexico culminated more than 10 years of negotiations and interim agreements with a joint committee in which President Nixon assured President Echevarria of his desire for a definitive, equitable, and just solution to the problem.

Final agreement was reached with Mexico on August 30, 1973, when Minute 242 was signed in Mexico City. The Minute is entitled Permanent and Definitive Solution to the International Problem of the Salinity of the Colorado River.

The agreement provides that the annual average salinity of the Mexican deliveries be no more than 115 parts per million plus or minus 30 parts per gallon greater than that of Colorado River waters which arrive at Imperial Dam. Until the necessary measures under a permanent solution are completed, the United States will have to bypass all of the Wellton-Mohawk drainage to meet this requirement. This will be replaced by an equivalent flow of 175,000 to 220,000 acre-feet per year.

As a permanent solution, the method most acceptable to the United States for maintaining the differential of 115 parts per million is to modify the Wellton-Mohawk drainage waters. This modification would involve improving irrigation efficiencies, regulating flood

flows, and constructing a desalting complex. Lining the first 49 miles of the Coachella Canal will save 132,000 acre-feet per year of water now lost to seepage which can replace the bypassed water.

Improved irrigation efficiencies on the Wellton-Mohawk Project will reduce the quantity of water requiring treatment by the desalting complex.

Presently, a study effort is underway by an interagency technical field committee to apply extensive measures to significantly improve irrigation efficiency of the Wellton-Mohawk Irrigation and Drainage District. The measures under study include canal and lateral lining, land leveling, gravity and pressure system improvements, and improved water management through the Irrigation Management Services (IMS) program.

Gila River flood flows would be regulated by limiting flood releases from Painted Rock Reservoir, a Corps of Engineers facility. Limiting these flows, which would otherwise raise the ground-water level, reduces drainage well pumping requirements.

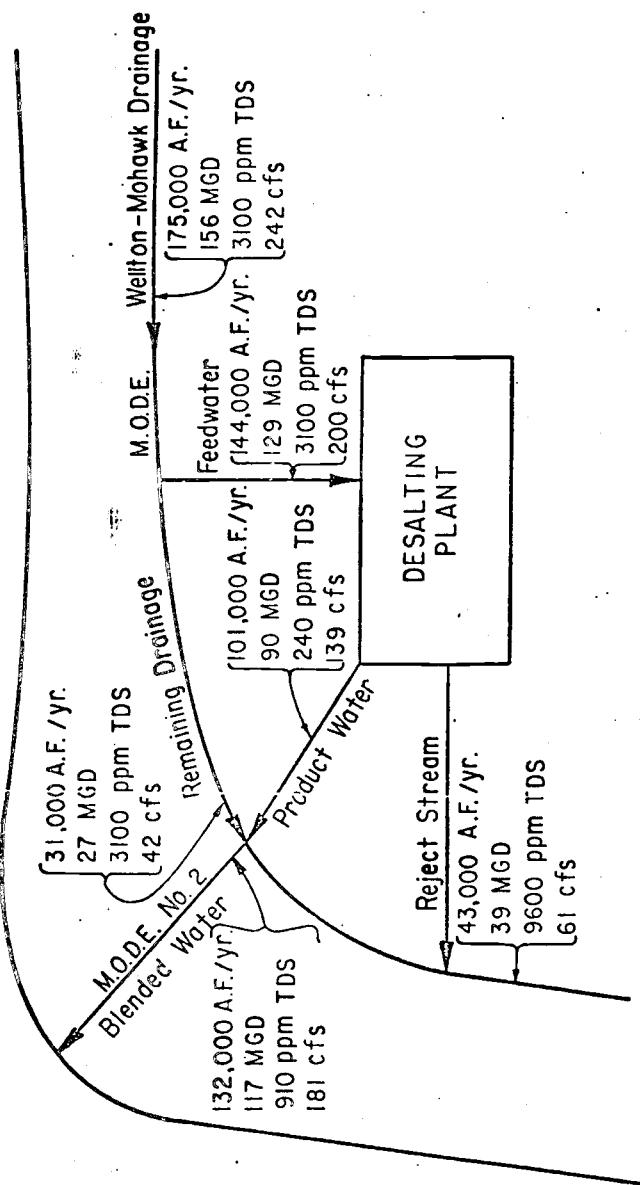
The proposed desalting complex will receive flows from 106 drainage wells on the Wellton-Mohawk Project. The annual flows of the wells is expected to be 175,000 acre-feet. The complex would result in the return to the river of 132,000 acre-feet of 910 parts per million water per year. Reject water from the desalting plant, totaling 43,000 acre-feet per year, will be conveyed to the Santa Clara Slough. This is illustrated in Figure 3. A number of assumptions are involved in deriving these values and they may change as detailed planning is completed.

The total cost of the International Salinity Control Project is \$119 million, based on April 1973 cost indexes. Assuming prompt authorization and funding, the project is scheduled for completion by late 1979.

SUMMARY

Two major efforts now under study, The Colorado River Water Quality Improvement Program and the Colorado River International Salinity Control Project, will assure the continued, full utility of Colorado River water to U.S. users and Mexico. However, more extensive development of the Basin's vast natural resources puts new emphasis on total resources management through improved water and land use planning to conserve a most precious western resource - water.

COLORADO RIVER



A.F./yr. = Acre Feet/yr.
 MGD = Million Gallons per Day
 ppm TDS = parts per million total dissolved solids
 M.O.D.E. = Main Outlet Drain Extension
 cfs = Cubic Feet per Second

COLORADO RIVER INTERNATIONAL SALINITY CONTROL PROJECT PLAN OF DEVELOPMENT FLOW DIAGRAM NORMAL OPERATION - 90% PLANT FACTOR

FIGURE 3

SEPTEMBER 1973

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