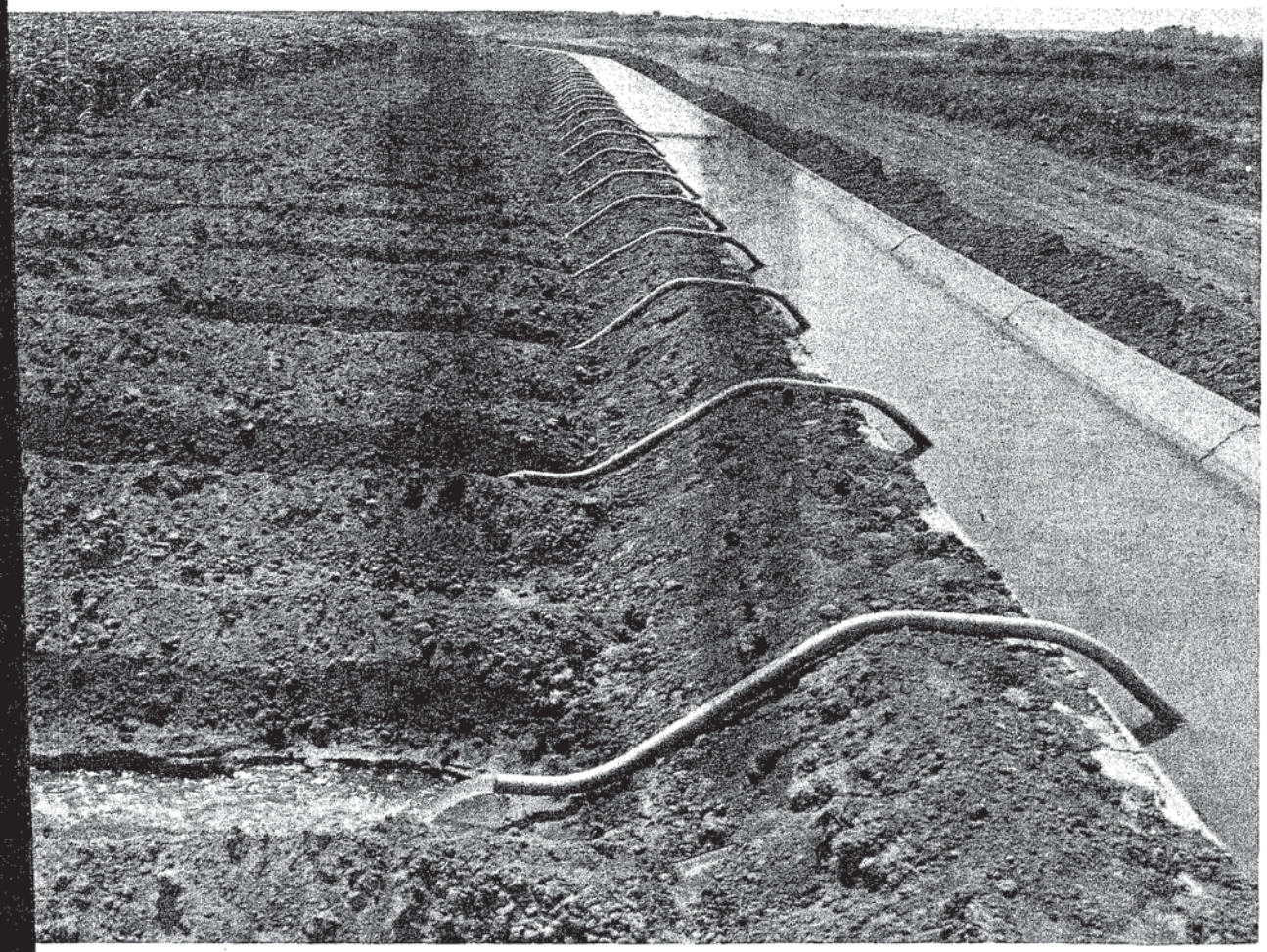
ON-FARM PROGRAM for SALINITY CONTROL

FINAL REPORT OF THE GRAND VALLEY SALINITY STUDY



Prepared by
SOIL CONSERVATION SERVICE
Assisted by
AGRICULTURAL RESEARCH SERVICE
of the
U. S. DEPARTMENT OF AGRICULTURE

December 1977

GRAND VALLEY WATER USERS' ASSOCIATION
GRAND VALLEY PROJECT, COLORADO
500 South Tenth Street
GRAND JUNCTION, COLORADO 81501

December 15, 1977

Robert Halstead
State Conservationist

Dear Mr. Halstead:

The Grand Valley Water Users' Association and the Orchard Mesa Irrigation District are divisions of the Grand Valley Project which provides irrigation water for some 40,000 acres of land here in the Grand Valley of western Colorado.

In addition to the "systems improvement" phase of the Grand Valley Salinity Control Program, the Grand Valley Project has supported the "on farm" phase of said program through its formative stages and continues to support and endorse it as proposed for implementation at this time.

Sincerely yours,

G. W. Klapwyk

G. W. Klapwyk
Manager

GWK:cd

Mesa Soil Conservation Distric
WENDELL LARSEN
GATEWAY, COLO. 81522

December 5, 1977

Robert G. Halstead
State Conservationist
Soil Conservation Service
P.O. Box 17107
Denver, Colorado 80217

Dear Sir:

The Board of Supervisors of the Mesa Soil Conservation District gives full support to the Plan of Implementation of the Salinity Control Project. Our Long Range Plan as well as our Annual Plan gives a high priority to this program.

We wish the decision makers at the Washington level would support the projects submitted from the "grass roots levels". These projects are more practical and more likely to succeed than those written at the higher levels.

We see this program as an opportunity to get "conservation on the land". Your interest and support in achieving full funding for this project would be appreciated.

Sincerely,

Wendell Larsen

Wendell Larsen
Chairman, Mesa SCD

RICHARD D. LAMM
Governor

DEPARTMENT OF NATURAL RESOURCES
COLORADO WATER CONSERVATION BOARD
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1313 SHERMAN STREET
DENVER, COLORADO 80203

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Deputy Director

TELEPHONE
(303) 839-3441

December 15, 1977

Mr. Robert Halstead
State Conservationist
P.O. Box 17107
Denver, CO 80217

Dear Sir:

I have reviewed the Grand Valley Salinity Study Draft Report and wish to express my whole-hearted support for alternative four as being a most effective means of salt reduction to the Colorado River.

The Colorado Water Conservation Board, as you know, is vitaly interested in increased water use efficiency as a means to salinity reduction. It is essential to match this system to the farm in order to achieve good water use. An example of this is application of drip irrigation to orchards where a 70% decrease in water use can be effected and still increase productivity. For this reason alternatives one and two should not be considered.

Our real concern though is the failure of soil conservation service to secure funding for this project. Public Law 93-320 of June 24, 1974 directed: "The Secretary of Agriculture to cooperate in the construction of on-farm system measures through programs available to that Department."

It has been some four years now since that directive; so why not give this program top priority for 1979.

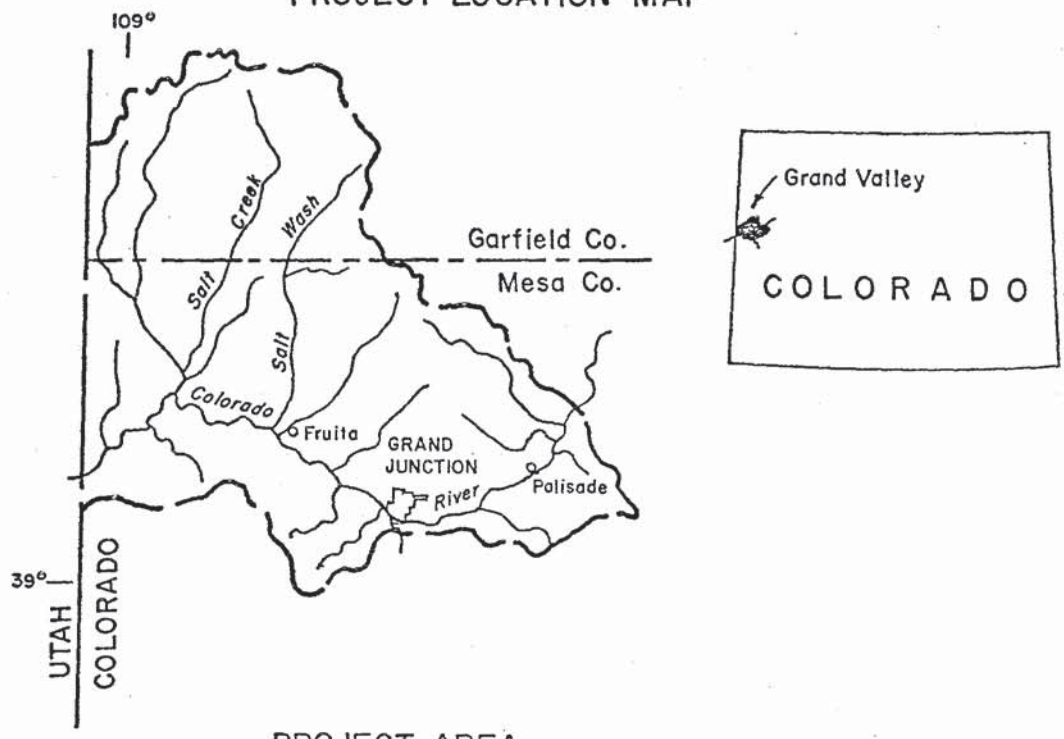
Sincerely,

T. J. Longley, P.E.
Sup. Engr. Colo. Water Cons. Board
Sec. Grand Valley Salinity Coord. Comm.

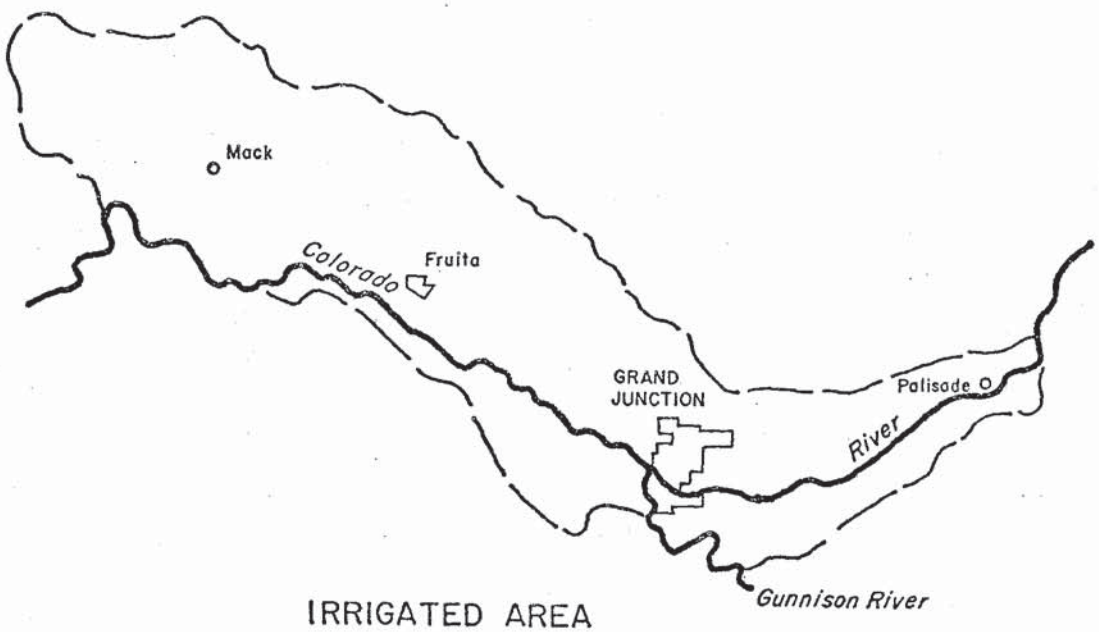
TJL/dw

GRAND VALLEY SALINITY STUDY

PROJECT LOCATION MAP



PROJECT AREA



IRRIGATED AREA

SUMMARY

Overall objectives of the U. S. Department of Agriculture's participation in the Grand Valley Salinity Control Studies are to determine:

1. The contribution of salt loading from irrigated and related upland areas; and

2. The opportunity for reducing salt loading through improvements on irrigated farmland and reducing erosion and sediment delivery from privately owned upland areas.

The Grand Valley contributes about 600,000 to 700,000 tons of salt annually to the Colorado River. Most of the salt is leached from the soil and the underlying Mancos shale, and carried to the river by deep percolation from irrigation and by seepage from the irrigation delivery system. Of this amount on-farm irrigation practices and systems contribute about 300,000 tons while runoff and erosion from upland areas adds an additional 80,000 tons.

The plan selected for implementation can be effective in reducing the annual salt load from irrigated farmland by 130,000 tons at a total cost of $21,050,000; an additional 4,000 tons of salt can be eliminated by improvements on privately owned range and grazed woodlands at a cost of $2,570,000. Treatment of publicly owned range and grazed woodland also is needed to achieve significant reductions in sediment and salt originating from upland diffused sources.

The total effect of the selected plan is an estimated salt load reduction of 130,000 tons (rounded) at a cost of $23,620,000. Technical assistance during the 10-year implementation period is estimated to cost $378,000 annually including $178,000 for continuing the present program for irrigation research. The landowners' cost for operation and maintenance of the improved system is estimated at $400,000 annually.

The selected plan is comprised of individual conservation plans to be implemented by farmers and ranchers on land under their ownership or control. The plan can be implemented by the U. S. Department of Agriculture through authority of PL-46. However, implementation at 75 percent federal cost share requires annual funding of $2,120,000 for 10 years, including technical assistance, a level that greatly exceeds all previous funding. The annual funding needed from private landowners is $790,000 including costs for operation and maintenance. Long-term contracts with individual landowners is recommended in order to achieve full implementation of the plan within ten years.

The selected plan includes recommendations for management in addition to physical improvements. Management practices necessary for control of irrigation water include the size of streamflow, the number of irrigations, and the duration and frequency of each irrigation. Because of

:he wide variation in daily meteorological conditions recommendations :or frequency of irrigation are left to the Bureau of Reclamation's Irrigation Management Services program as the recommended scientific approach, or to the experience and judgement of the individual farm operator. Three management practices share equal importance in reducing runoff, erosion, and sedimentation from the grazed non-irrigated uplands. These are the number of grazing animals, the season of grazing, and the duration of grazing.

Four types of improvements have been identified as needed for existing on-farm irrigation systems. Ditch lining or pipelines with necessary measuring devices and control structures will reduce ditch seepage and improve on-farm water management. Land leveling adapts the field to the use of lined ditches or gated pipes and enhances uniform application of irrigation water. Subsurface drains for existing open drains can improve field shapes and the layout of irrigation systems. Changing where applicable to drip or sprinkler methods of irrigation will increase irrigation efficiency and reduce the potential for salt load pickup.

The need for three types of physical improvements for the grazed non-irrigated areas has been determined. Seeding with brush control and fencing will improve vegetative cover. Stockwater development and distribution systems will enhance site control for grazing, and erosion control dams, gully plugs and grazingland mechanical treatment are positive means of reducing erosion by holding storm water on the ground.

The Grand Valley study area reaches into Mesa and Garfield Counties in western Colorado, and consists of 839,000 acres of grazed non-irrigated uplands and 126,000 acres in the valley. Of the grazed uplands, 175,000 acres (21 percent) are in private ownership and 664,000 acres (79 percent) are publicly owned. Although the Grand Valley covers 126,000 acres, only 66,000 acres make up the irrigated farmland and about 6,000 acres are not cultivated in any one year.

Soils in the valley are typical of desert soils -- they are low in organic matter, high in weatherable minerals and associated salts, and are chemically similar to the geologic materials from which they were derived. One-third of the area is affected by accumulations of salts or alkali, and sodium is the most prevalent soluble salt.

In 1975 the population of Grand Valley was about 62,000, up 13.8 percent from 1970, and is projected to be 90,000 by the year 1990. Percapita income for Mesa County was $3,409 in 1972 compared with $4,006 for the state. Farm population for Mesa County totaled 3,898 in 1970 down 42.7 percent from 1960. In 1974 352 farms had sales between $2,500 and $9,999; 145 had sales between $10,000 and $19,999 and 269 had sales over $20,000. Grand Valley contains about 65 percent of the irrigated crop land in Mesa County but the value of farm product sales amounts to about 75 percent of the total for the county.

Landowners in the valley are actively applying conservation land treatment. Some treatment is applied by individuals on land under their control while other practices are implemented by groups of landowners for mutual benefit. Application of land treatment is expected to continue whether or not an accelerated program for salinity control is forthcoming. Projections indicate that about one-fourth of the improvement recommended for salinity control may be installed during the next 10-year period.

Currently agricultural land is being converted to residential and urban uses at the rate of about 800 acres per year. Without extensive development of oil shale it is estimated that an additional 8,800 acres of agricultural land will be converted to residential and urban uses during the next ten years; extensive oil shale development could raise the estimate to 9,700 acres. With these projections there would be about 57,000 acres of land remaining in irrigated agricultural use after 10 years. Exercising existing zoning authority could control the pattern of new developments, preserve the better agricultural lands, and maybe reduce the acreage converted to urban uses.

Four alternative plans were developed that satisfy objectives of the study. Each plan has two parts; one part addresses recommended management practices, the other discusses needed structural measures. Each plan assumes only 80 percent of the measures identified as being needed will be implemented. Formulation of the plan was oriented toward the primary objective of reducing salt load pickup by improving irrigation efficiency in the cultivated area and by improving watershed conditions on privately owned land in the diffused source area.

INTRODUCTION

This section presents the study objectives and discusses general salinity problems of the Colorado River before dealing specifically with the problem of salt loading attributed to the Grand Valley. The authority for USDA participation in the study and a discussion of coordination between agencies participating in salinity studies in the valley are identified in this section.

STUDY OBJECTIVES

The overall objectives of the U. S. Department of Agriculture's participation in the salinity control studies in Grand Valley are to: (1) determine the contribution of salt loading from the irrigated and related upland areas, and (2) determine the opportunity for reducing salt loading through improvements on irrigated farms and reducing erosion and sediment delivery from the privately owned upland areas.

USDA activities include determining the contribution of salt, sediment, and water into and through the irrigated area from the privately owned upland watershed (diffuse area); and also focused on evaluating the present condition of on-farm irrigation systems and management practices to determine what could be done to improve present conditions and practices to reduce salt loading. These activities were directed toward finding answers to three questions:

1. What is the magnitude of on-farm improvement needs? On-farm irrigation improvements include ditch lining or pipelines with appropriate water control structures, on-farm water measuring devices, land leveling, field drains and improved irrigation management. Revegetation of rangeland and control of grazing livestock will be needed to reduce runoff that contributes to erosion of salt laden soils.

2. What are the total installation costs and annual levels of funding required for program implementation?

3. What will be the effect on salinity contributions to the Colorado River? Beneficial effects will be achieved through reducing tailwater runoff, deep percolation, and ditch seepage from irrigation with an increase in irrigation efficiency, and from reducing runoff and erosion from the upland watershed. Reduced return flow to the Colorado River is translated into expected reduction in salt loading.

PROBLEMS

Historical - Salinity ultimately becomes a major problem in many irrigated areas. In irrigated areas with high saline soils, such as the Grand Valley in west central Colorado, salinity has been a problem since irrigation water was first delivered. Irrigated land in the valley and the diffused source areas with highly saline soils and subsoils are large contributors of saline return flows. In recent years salinity concentrations in the Lower Colorado River have adversely affected irrigated crop production and other uses. This problem is especially severe for water delivered to California, Arizona, and Mexico.

The Colorado River system naturally carries a large load of salts (dissolved solids) and suspended sediment. Depletions in streamflow resulting from transbasin diversions, and for irrigation, municipal and industrial uses has significantly reduced the supply of water available for dilution of salt loads in the lower river system. Future development of water by Upper Basin states will further reduce the water available for dilution, and in some cases the development projects will themselves increase salt loadings in the river system.

Recognition of the water quality problem in the region has caused a number of studies to be made since about 1960. The Colorado River Basin Water Quality Control Project was established in 1960 by the Division of Water Supply and Pollution Control, U. S. Public Health Service (predecessor to the Federal Water Quality Administration). Their studies produced a series of reports on "The Mineral Quality Problem in the Colorado River Basin" by the Environmental Protection Agency (1971). Salinity in the Colorado River is also documented by the U. S. Bureau of Reclamation (1972 and 1974) Status Reports - Colorado River Water Quality Improvement Program, and U. S. Geological Survey Professional Paper 441, "Water Resources of the Upper Colorado River Basin - Technical Report," by Iorns and others (1965).

The Federal Water Pollution Control Act Amendments of 1972, PL 92-500, in Section 303 require adoption of water quality standards applicable to interstate waters. The Act's objective is "to restore and maintain the chemical, physical, and biological integrity of the Nation's waters" (Section 101), and the administrator is required, in cooperation with other Federal, State, and local agencies, "to develop comprehensive programs for preventing, reducing, or eliminating the pollution of navigable waters and ground waters" (Section 102[a]). Pursuant to that requirement, the Environmental Protection Agency on December 18, 1974, issued a regulation requiring states of the Colorado River Basin to adopt water quality standards for salinity, consisting of numeric criteria and a plan of implementation for salinity control. The standards, submitted for approval to the Environmental Protection Agency before October 18, 1975, are to be reviewed at 3-year intervals and modified, if appropriate.

Consistent with the regulation, the recommended flow-weighted average annual numeric salinity criteria for three locations in the lower main stem of the Colorado River System are:

	Salinity in mg/l
Below Hoover Dam	723
Below Parker Dam	747
Imperial Dam	879

The plan of implementation comprises a number of federal and non-federal projects and measures to maintain the flow-weighted average annual salinity in the lower main stem at or below the recommended numeric criteria through 1990, as the Basin States continue to develop their compact-apportioned waters. The principal components of the plan are as follows:

1. Prompt construction and operation of the initial four salinity control units (includes Grand Valley Unit) authorized by Title II of PL 93-320, the Colorado River Basin Salinity Control Act.

2. Construction of the 12 other units listed in Title II of PL 92-320 or their equivalent after receipt of favorable planning reports.

3. The placing of effluent limitations, principally under the NPDES permit program provided for in Section 402 of PL 92-500 on industrial discharges.

4. The reformulation of previously authorized, but unconstructed, federal water projects to reduce the salt loading effect.

5. Use of saline water for industrial purposes whenever practical, programs by water users to cope with the river's high salinity, studies of means to minimize salinity in municipal discharges, and studies of future possible salinity control programs.

Because many natural and man-made factors affect the river's salinity, the actual salinity will vary above and below recommended numeric criteria. However, under assumptions of streamflow equivalent to the long-term average, a reasonable rate of increase in water depletions and full implementation of needed salinity control measures, the average salinity can be maintained at or below 1972 levels during the study period of the next 15 years.

Federal regulations provide for temporary increases above the 1972 levels if control measures are included in the plan. Should water development projects be completed before control measures are identified or brought on line, temporary increases above the criteria could result and these increases will be in conformance with the regulation. With completion of control projects, those now in the plan or those to be added subsequently, salinity would return to or below the criteria level.

PROBLEMS IN THE GRAND VALLEY

Analysis of water quality data by the U. S. Geological Survey (USGS) indicate that the Grand Valley contributes about 600,000 to 700,000 tons of salt annually to the Colorado River. Most of these salts are thought to be leached from the soil and underlying Mancos Shale and carried into the river by deep percolation from irrigation and seepage from water delivery and tailwater collection systems.

Both natural runoff and irrigation contribute to the problem, either by salt concentration or by salt loading. Salt concentration is caused by removal of water from the river system through consumptive use by irrigated crops and phreatophytes. As water is consumed through evaporation and transpiration, its mineral constituents remain in the ground water. Salt loading occurs as ground water dissolves subsurface minerals while flowing back to the Colorado River. Although both processes are at work in the Grand Valley, salt loading is the major cause of the salinity increase.

Ground water return flows from the irrigated area to the Colorado River contain as much salt now as they did at the inception of irrigation and it is assumed this will continue because excess water dissolves salt from the Mancos Shale formation. Two conditions substantiate this conclusion: (1) water quality information on the artesian ground water aquifer collected at several well sites by the U. S. Department of Agriculture in 1915; Agricultural Research Service-Soil Conservation Service Project in 1951, and Agricultural Research Service in 1973, to 1975, indicate no change in water quality of the aquifer. Hydrostatic pressures toward the Colorado River rule out the river as a source of water to the aquifer; (2) diversions to the irrigated area since installation of Government Highline Canal in 1917 are essentially unchanged. Situations indicate that salt loading by subsurface return flows to the Colorado River from irrigated areas have been relatively constant over this 60-year period.

Erosion from the upland watershed also contributes sediment and salt to the Colorado River. Sheet, rill, gully and streambank erosion results in 2.9 million tons of sediment with about 80,000 tons of salt being added to river annually.

AUTHORITY

On November 16, 1973, the Colorado Water Conservation Board requested assistance from the Soil Conservation Service, under authority of Section 6 of Public Law 566, to make feasibility studies of possible improvements for on-farm irrigation systems and improvements in the upland watershed condition for the purpose of controlling saline return flows to the Colorado River from Grand Valley.

Public Law 93-320 (88 Stat. 266) dated June 24, 1974, entitled "Colorado River Basin Salinity Control Act" authorized the U. S. Department of Agriculture in cooperation with the Department of the Interior and the Environmental Protection Agency to develop a salinity control plan for the Grand Valley Unit. Title II, Section 202(2) of the Act specifically directs; (a) the Secretary of the Interior to ". . . enter into agreements with the Secretary of Agriculture to develop a unified control plan for the Grand Valley Unit," and (b) the Secretary of Agriculture ". . . to cooperate in the planning and construction of on-farm system measures under programs available to that department." Section 203(b)(1) directs the Secretary of Interior ". . . in the investigation, planning, construction, and implementation of any salinity control unit involving control of salinity from irrigation sources, to cooperate with the Secretary of Agriculture in carrying out research and demonstration projects and in implementing on-the-farm improvements and farm management practices and programs which will further the objective of this title; . . ." To establish a cooperative program for effective execution of the salinity control measures called for in the act, a Memorandum of Understanding effective November 27, 1974, was entered into by the Department of the Interior and the Department of Agriculture. A Memorandum of Agreement, effective March 27, 1975, was entered into between the Bureau of Reclamation and the Soil Conservation Service to implement the specific cooperative activities called for under Title II of the Colorado River Basin Salinity Control Act.

COORDINATION

Coordination of USDA activities with state and other federal agencies was accomplished through the Grand Valley Salinity Coordinating Committee. This committee has members from the following agencies and organizations: Bureau of Reclamation, U. S. Geological Survey (Water Resources Division), Environmental Protection Agency, Bureau of Land Management, Colorado State University, Soil Conservation Service, Agricultural Research Service, Colorado Water Conservation Board, Grand Valley Irrigation Company, Grand Junction Drainage District, Colorado River Water Conservation District, Grand Junction Chamber of Commerce, Grand Valley Project, Mesa County Soil Conservation District, and Grand Valley Irrigation Association.

Studies conducted by the Soil Conservation Service field office included a farm by farm inventory which had the support and cooperation of 2,200 landowners who provided information on their irrigation systems and practices.

The Soil Conservation Service inventoried on-farm irrigation systems and determined improvement needs, costs and impacts. The Bureau of Reclamation inventoried the off-farm canal and lateral system and determined improvement opportunities. Close coordination of the studies were required, so that the total system can be operated compatibly and efficiently.

The Agricultural Research Service, Bureau of Land Management, Colorado State University, and Colorado Water Conservation Board are conducting or have carried out research and demonstration programs in the valley and their results along with results from monitoring the system provide a valuable data base to establish present conditions and expected results with improved irrigation efficiency.