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Agricultural irrigation uses 83% of water consumed in the United States. Large amounts of water transported to farms are wasted annually because of inefficient delivery systems which seep water. Findings/Conclusions: The seepage problem exists throughout the West and causes a loss of water for beneficial purposes. Federal projects supply water to only about one-fifth of the total irrigated western lands and, therefore, cooperation among State, local and Federal agencies is necessary to lessen seepage. In 1975, the Bureau of Reclamation reported a loss of 2,600 billion gallons of water during delivery, primarily through seepage. Federal agency programs related to this problem are not specifically designed or administered to effectively deal with it. Since the Department of the Interior accounts for 90% of Federal financial involvement in projects involving irrigation, it should take the lead in promoting better management practices in this area. A program for improved water conveyance systems should be designed to: improve the accuracy of reported seepage data; consider overall basinwide effects of conveyance system improvements, including more definitive criteria for selecting the systems to improve; and identify and resolve institutional and legal constraints hampering improvements to water conveyance systems. Recommendations: The Secretary of the Interior should take the lead in identifying all aspects of the water conveyance system problem and devising a comprehensive action program to improve system efficiency. The Department should direct the interagency task force which is being established to consider solutions to inefficient irrigation practices to also consider solutions to inefficient conveyance systems, including the development of

coordinated Federal, State, and local objectives, policies, and action plans. (Author/HTW)

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REPORT TO THE CONGRESS

*BY THE COMPTROLLER GENERAL
OF THE UNITED STATES*

More And Better Uses Could Be Made Of Billions Of Gal- lons Of Water By Improving Irrigation Delivery Systems

Departments of Agriculture and the Interior

Billions of gallons of water seep from inefficient irrigation delivery systems in the western States. By reducing such seepage, more water could be available for crop irrigation, energy development, environment improvement, and recreation.

No Federal agency has taken a leadership role in identifying all aspects of the problem or recommending a comprehensive action program. Because it accounts for about 90 percent of the Federal funds involved in projects that include irrigation delivery systems, the Department of the Interior should assume such a role.



COMPTROLLER GENERAL OF THE UNITED STATES
WASHINGTON, D.C. 20548

B-114885

To the President of the Senate and the
Speaker of the House of Representatives

Available water supplies can be used more efficiently by reducing seepage losses from canals and laterals--water conveyance systems. This report discusses opportunities to administer better the Federal programs providing the funds for water conveyance system improvements and the benefits to be derived.

We made the review to identify needed improvements in the Federal effort to promote more efficient use of our available water resources. The review was made pursuant to the Budget and Accounting Act, 1921 (31 U.S.C. 53), and the Accounting and Auditing Act of 1950 (31 U.S.C. 67).

We are sending copies of this report to the Director, Office of Management and Budget; the Secretaries of the Interior and Agriculture; and the Administrator, Environmental Protection Agency.

A handwritten signature in black ink, appearing to read "Thomas B. Stauch".

Comptroller General
of the United States

COMPTROLLER GENERAL'S
REPORT TO THE CONGRESS

MORE AND BETTER USES COULD
BE MADE OF BILLIONS OF
GALLONS OF WATER BY IMPROVING
IRRIGATION DELIVERY SYSTEMS
Departments of Agriculture
and the Interior

D I G E S T

Conserving the Nation's water supply is becoming increasingly important. To better use current supplies, seepage losses from irrigation conveyance systems should be reduced.

Several reports and studies (see pp. 7 to 12) highlighted the importance of the seepage problem and identified potential, beneficial uses for water saved through improving conveyance systems. GAO believes that further analyses are needed to identify and determine the overall basinwide effects of system improvements and areas where additional Federal participation would promote the national interest.

The seepage problem exists throughout the West. Federal projects supply water to only about one-fifth of the total irrigated western lands; consequently, State, local, and Federal agencies must work cooperatively to lessen seepage. The Department of the Interior accounts for about 90 percent of the Federal financial involvement in projects that include irrigation delivery systems and should take the lead in promoting efficient water conservation and management practices.

If the seepage problem receives inadequate attention, conveyance improvements will continue to be uneven and erratic and with little consideration given to which systems should be improved or the effect improvements could have on overall basin planning and conserving the Nation's water supplies.

Water seeping from conveyance systems may be lost to beneficial use in many areas by being consumed by nonagricultural vegetation, flowing into deep underground aquifers from which

pumping may be economically impracticable, flowing into the ocean, or evaporating into the atmosphere. Excess seepage contributes also to water quality problems, causes waterlogged lands, or denies farms sufficient water when most needed. Lining canals and laterals with concrete or asphalt or using pipe to transport the water reduces much seepage.

Federal agencies have an interest in promoting more efficient conveyance systems. In 1975, for example, Federal projects delivered 28.1 million acre-feet or 9,139 billion gallons of water to irrigate over 9 million acres producing crops worth over \$4 billion. However, the Bureau of Reclamation, Department of the Interior, reported that during delivery, 8.1 million acre-feet or 2,600 billion gallons were primarily lost through seepage.

Several Department of the Interior and Agriculture programs address seepage problems, but they are not specifically designed or administered to comprehensively and coordinatively reduce seepages.

These are some of the reasons that demonstrate the need for a coordinated Federal, State, and local program to improve water conveyance systems. Such a program should be designed to

- improve the accuracy of reported seepage data (see p. 14);
- consider overall basinwide effects of conveyance system improvements, including more definitive criteria for selecting the systems to improve (see p. 18); and
- identify and resolve institutional and legal constraints hampering improvements to water conveyance systems (see p. 22).

GAO pointed out recently 1/ that less than half

1/Report to the Congress entitled "Better Federal Coordination Needed to Promote More Efficient Farm Irrigation," (RED-76-116, June 22, 1976).

of the water delivered to farms for irrigation is actually used by the crops. The report recommended that the Secretaries of the Interior and Agriculture and the Administrator of the Environmental Protection Agency coordinatively seek to improve the efficiency of farm irrigation in the West.

The Under Secretary of the Interior advised GAO that his Department was working with the Department of Agriculture and the Environmental Protection Agency in organizing a task force to review the problems and recommend Federal objectives, policies, actions, and agency roles. He said that the Department was attempting to involve State agency and irrigators' association representatives and others in the task force.

Such a program would be ideally arranged to expand its objectives to consider also the problems of and solutions to inefficient conveyance systems.

RECOMMENDATIONS TO THE SECRETARY OF THE INTERIOR

GAO recommends that the Secretary of the Interior take the lead in identifying all aspects of the water conveyance system problem and devising a comprehensive action program to improve the efficiency of water conveyance systems. The Department should direct the interagency task force being established to consider solutions to inefficient farm irrigation practices to consider also solutions to inefficient conveyance systems, including the development of coordinated Federal, State, and local objectives, policies, and action plans. (See pp. 26 to 27.)

AGENCY COMMENTS

The Departments of the Interior and Agriculture agreed with the thrust of GAO's report. (See apps. I and II.) The Interior Department stated that GAO highlighted the benefits of reducing seepage but not the potential, adverse effects, such as interfering with downstream water rights, reducing the recharge to aquifers, and eliminating wildlife habitats.

GAO agreed that all potential effects should be considered when addressing the recommendations. (See pp. 12 and 18.)

The Interior Department stated further that identifying all aspects of irrigation water conveyance system problems and developing a comprehensive action program to address those problems present excellent opportunities for it and other concerned Federal agencies to contribute to conserving and efficiently using the Nation's water resources. The Department stated that GAO's recommendations represent a sound and logical approach toward development of effective Federal policy and action plans to improve the efficiency of water use in the irrigation industry.

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ABBREVIATIONS

ACP Agricultural Conservation Program

ASCS Agricultural Stabilization and Conservation Service

GAO General Accounting Office

SCS Soil Conservation Service

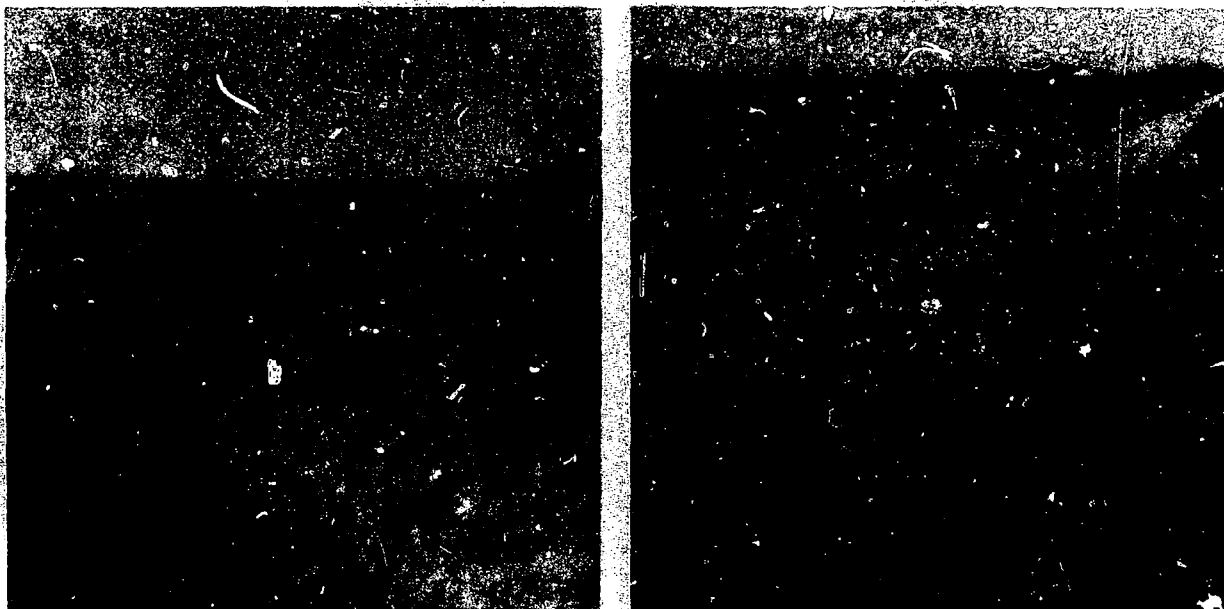
CHAPTER 1

INTRODUCTION

As the demand for the Nation's fresh water supplies increases, so does the need for conservation practices. Agricultural irrigation uses the largest amount of water consumed in the United States--about 83 percent. However, in transporting water to the farms, enormous amounts are wasted annually because of inefficient irrigation delivery systems 1/ which seep water. (See photographs below.)

Although water seeping from conveyance systems may return to a river or fill a groundwater aquifer for later use, it may also be lost to intended beneficial use in the area by

- being consumed by nonagricultural vegetation,
- flowing into deep underground aquifers from which pumping may be economically impracticable,.



UNLINED CONVEYANCE SYSTEMS WHICH SEEP WATER.

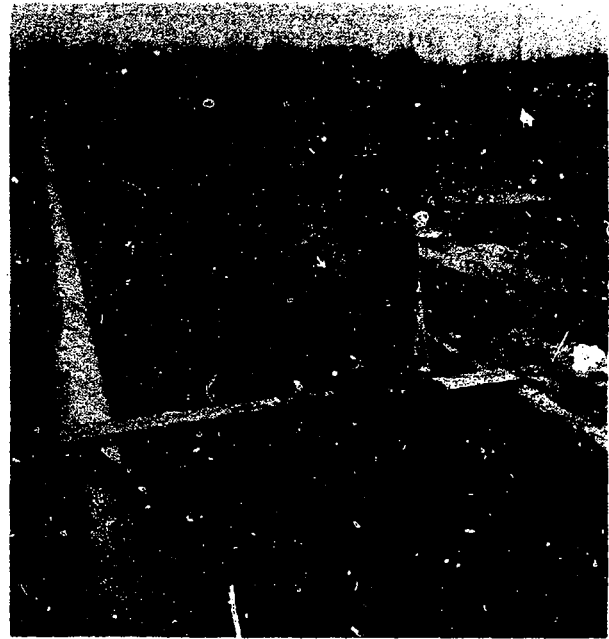
1/Water conveyance efficiency is the ratio of the volume of water delivered to the point of use by a conveyance system to the volume of water introduced into the conveyance system at the supply source.

--flowing into the ocean, or

--evaporating into the atmosphere.

Excess seepage can also deny farmers an adequate supply of water when it is needed. Sometimes, the seepage may collect in low-lying areas and waterlog the land, which reduces crop production or completely withdraws it from production. In some cases, even if the water returns to the river, it may be degraded in quality by picking up salts and other minerals when passing through the soil.

Experience has shown that seepage can be reduced greatly by transporting the water through closed pipe; lining the canals or laterals with a hard surface material, such as asphalt or concrete (see photographs below); or using compacted earth to line canals or laterals.



**CONCRETE-LINED CONVEYANCE
SYSTEMS GREATLY REDUCE
WATER LOSS.**

The benefits of a lined or piped water distribution system extend beyond water conservation. For example, a lined or piped system in most cases is less expensive to clean and maintain, and it reduces the canal and lateral bank erosion which could cause the system to fail. Also, replacing open canals or laterals with pipe reduces or eliminates right-of-way costs, makes land that was previously occupied by open systems available for production, and eliminates the hazard of drownings.

FEDERAL INVOLVEMENT IN AGRICULTURAL WATER DELIVERY SYSTEMS

Several Federal agencies have a primary interest in promoting more efficient agricultural water delivery. They include the Bureau of Reclamation of the Department of the Interior and several Department of Agriculture agencies, such as the Soil Conservation Service (SCS) and the Agricultural Stabilization and Conservation Service (ASCS).

The Bureau's role

The Reclamation Act of 1902 (43 U.S.C. 391), authorized the Secretary of the Interior to construct, operate, and maintain works for the storage, diversion, and development of waters to reclaim arid and semiarid lands in the western United States. ^{1/} The Bureau carries out these functions by planning, constructing, operating, and maintaining facilities to store and deliver water for irrigation.

Water storage and distribution facilities operating in 1975, including those constructed by others but operated with Bureau projects, included 326 storage reservoirs, 14,323 miles of canals, 897 miles of pipelines, 227 miles of tunnels, and 34,294 miles of laterals. According to the Bureau, water delivered through these facilities was used to irrigate 9,309,000 acres of farmland producing crops worth over \$4 billion.

Most of the newer water conveyance facilities that the Bureau constructed are lined or constructed with buried pipe. Older reclamation projects constructed in the early 1900s generally are unlined. Of the 14,323 miles of canals operating on Bureau projects, 12,189 miles or 85 percent are

^{1/}These States are Arizona, California, Colorado, Idaho, Kansas, Montana, Nebraska, Nevada, New Mexico, North Dakota, Oklahoma, Oregon, South Dakota, Texas, Utah, Washington, and Wyoming.

unlined. For the 34,294 miles of laterals, 23,352 miles or 68 percent are unlined.

The Bureau estimated that in delivering in 1975 27.4 million acre-feet 1/ of water from Federal projects to farmers for irrigation, 8.1 million acre-feet or 2,600 billion gallons were lost primarily through seepage. The canals and laterals that seeped most of the reported losses were primarily older, unlined systems. Lining and pipes were omitted from earlier project designs because, at that time, they were uneconomical.

Since 1967, however, the Bureau has been operating under a policy which provides that all conveyance systems on new projects will be lined or placed in pipe to conserve water and secure other benefits, unless an unlined waterway is recommended for such reasons as costs exceeding benefits. To decide the method, material, and type of lining for a new project, an analysis is made of costs and benefits by comparing future project conditions with and without pipe or lining. In areas where irrigable lands exceed the available water supply or where more valuable uses exist for the conserved water, canal linings or pipe are generally justified.

The Bureau provides also funds to rehabilitate existing conveyance systems through loan programs authorized by the Rehabilitation and Betterment Act of 1949 (43 U.S.C. 504), as amended, 2/ the Small Reclamation Projects Acts of 1956 (43 U.S.C. 422a et seq.), as amended, and the Distribution System Loans Act of July 4, 1955 (43 U.S.C. 421b), as amended.

For water conveyance systems, these programs provide funds to repair, replace, or improve irrigation structures and systems that have become so obsolete the cost of the work exceeds the entity's funds, except as a long-term obligation. Loans under the acts may be used, among other things, to line or replace with pipe irrigation conveyance systems. The Bureau set the maximum repayment period on the loans at 40 years. Under the Rehabilitation and Betterment Act of 1949 the size of loans or the number of loans any one

1/One acre-foot of water is the amount required to cover 1 acre of land to a depth of 1 foot, equaling 325,851 gallons.

2/Loans under this act are interest free, except when applied to the rehabilitation of projects built under the Small Reclamation Projects Act of 1956.

organization can receive are limited only by the user's ability to repay them. However, under the Small Reclamation Projects Act of 1956 any number of loans can be obtained, but the combined total loan is limited to the lesser of two-thirds of the estimated total project cost or \$15 million (Jan. 1971 base), plus any increases because of changes in the Bureau's composite construction cost index.

As of September 1975, 34 irrigation projects received Rehabilitation and Betterment Act loans amounting to \$55 million, and as of January 1976, the Bureau granted loans totaling about \$160 million to 64 projects under the Small Reclamation Projects Act of 1956. However, a breakdown was not readily available of the amounts spent for agricultural conveyance system lining or piping in relation to other work that can be funded under the programs.

Rehabilitation and Betterment Act loans are available to projects constructed or managed by the Bureau, but loans granted under the Small Reclamation Projects Act of 1956 are available to any licensed organization within the 17 western States which under Federal reclamation laws is eligible to contract with the United States.

Department of Agriculture's role

The seepage problem is prevalent not only on Federal projects but throughout the West. Consequently, other Federal agencies, such as the SCS and the ASCS, administer grant, loan, and cost-sharing programs which can improve the efficiency of conveyance systems. The Agriculture Department told us that the Agricultural Research Service does research on irrigation and the Farmers Home Administration makes loans for irrigation development. Irrigation system improvements can be funded on a 50/50 cost-sharing basis through the SCS's Resource Conservation and Development program, Great Plains Conservation Program, or the Small Watershed Program (Public Law 83-566). Resource Conservation and Development projects are sponsored by conservation districts, local governments, and other public bodies to advance economic development and enhance the environment in multicounty areas. Small Watershed projects coordinate conservation measures on private and public land with dams and other structures to, among other things, reduce floods and provide a water supply and irrigation distribution systems appurtenances.

Although these program funds can be used for canal lining and piping, Agriculture Department officials said that a very small part are obtained for those purposes. Information was not readily available on the actual amounts.

The Agricultural Conservation Program (ACP) administered by ASCS offers, among other things, cost-sharing for water conservation practices, including canal and lateral rehabilitation work. The grants are made to individuals who volunteer to participate in the program. Generally, cost-sharing assistance involves 50 to 75 percent of the cost of performing the improvement and cannot exceed \$10,000 each year for each person. Funds for implementing conservation measures each program year are allocated to ASCS State committees on the basis of the conservation needs of farmlands in the various States and as determined by the Secretary of Agriculture.

Although program funds can be used for conveyance rehabilitation, during 1971-75 less than 7 percent of ACP appropriations were spent for that purpose. Data was not readily available, however, to identify the actual amount spent to line and pipe conveyance systems.

SCOPE OF REVIEW

We reviewed Bureau policies, procedures, and practices for promoting better use of existing water supplies through the improved efficiency of conveyance systems. We examined also reports and correspondence and interviewed Bureau and water user organization officials. We made this review primarily at Bureau headquarters in Washington, D.C., and the Engineering and Research Center in Denver, Colorado. We made the review also at Bureau regional offices and selected projects in Denver, Colorado; Amarillo, Texas; Boise, Idaho; and Billings, Montana.

We discussed Agriculture Department programs concerned with improving the efficiency of conveyance systems with officials of that Department. The comments of the Departments of the Interior and Agriculture were considered in finalizing this report.

CHAPTER 2

INEFFICIENT IRRIGATION CONVEYANCE SYSTEMS--

WHAT PREVIOUS STUDIES DISCLOSED

Various Federal agency and commission studies disclosed the great amounts of seepage occurring mainly in the western States because of inefficient irrigation conveyance systems. Reduced seepage could make available more water for such beneficial uses as agricultural irrigation, energy development, environment improvement, and recreation.

The studies recommended that the problem be addressed, by among other things, obtaining more accurate and comprehensive information on seepage and improving the efficiency of irrigation conveyance systems. However, as discussed in chapter 3, no Federal agency has taken the lead in implementing a comprehensive action program to include these recommendations in administering Federal programs designed to improve the efficiency of the conveyance systems.

IMPORTANCE OF THE SEEPAGE PROBLEM

Some National Water Commission (established in 1968 to review national water resources problems) studies highlighted the importance of seepage losses from agricultural water conveyance systems. In a June 1976 study entitled "Crop Consumptive Irrigation Requirements and Irrigation Efficiency Coefficients for the United States," the Agriculture Department estimated that 20 to 25 percent of the water diverted from streams or reservoirs for agriculture does not reach the farms. The Department estimated that of 195 million acre-feet of water diverted in 1975 for irrigation, about 42 million were lost through seepage from inefficient conveyance systems. Of the 42 million acre-feet, about 24 million were reported as consumptively lost to such nonagricultural vegetation as weeds. The report also pointed out that although some of the remaining seepage may return to originating streams or rivers, it may be polluted by sediment and salts picked up in returning to the water supply.

An April 1975 Interior Department report entitled "West-wide Study Report on Critical Water Problems Facing The Eleven Western States," stated that seepage from inefficient conveyance facilities for 11 of the 17 western States 1/

1/Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming.

totaled about 32 million acre-feet, with about 17 million lost to consumption by nonagricultural vegetation, nonrecoverable deep percolation, evaporation, and wildlife habitat.

A National Water Commission report in 1973 entitled "Water Policies For The Future," addressed also the importance of seepage losses. The report, a composite of 64 studies by universities, research organizations, consultant firms, and individual experts, stated that one means of making more efficient use of our available water supplies would be to reduce seepage losses from agricultural water conveyance systems. Although no quantified data on seepage losses was presented, the report concluded that much water could be saved through its efficient use in irrigation.

BENEFITS OF AN IMPROVED CONVEYANCE SYSTEM

Potential, identified uses for the water being wasted as seepage from inefficient irrigation conveyance systems include agricultural irrigation, energy development, environment improvement, and recreation.

Irrigated agriculture

In the June 1976 report on irrigation requirements and efficiency, the Agriculture Department estimated that 46 million acres of cropland would require irrigation by 2000, a 4-million-acre increase over 1975.

The report stated that to irrigate these 4 million acres, more water will be needed, and in many areas new water supplies are not available. Moreover, agricultural irrigation must compete with other needs for water, such as producing energy, preserving instream flows for visual quality and fish and wildlife, and providing streamflow to dilute pollutants. The report concluded that in many areas irrigators will have to concentrate more on water conservation practices to help meet future needs.

The Agriculture Department stated further that if programs providing higher water use efficiency, including improved irrigation conveyance systems, could be implemented, the total 1975 irrigation withdrawals of 195 million acre-feet of water could be reduced by 48 million acre-feet annually and still provide for the 4-million-acre projected increase in irrigated land. The Department estimated that to accomplish this higher water use efficiency, seepage from inefficient irrigation conveyance systems must be reduced from the current 42 million to 17 million acre-feet annually by 2000.

The 1975 Interior Department report agreed also with the Agriculture Department study concerning the need for the improved efficiency of conveyance systems. The report disclosed that about 5.5 million acres of irrigated farmland within the 11 western States are currently affected by annual or seasonal water shortages. The report stated also that in a number of irrigated areas, conservation measures and better water management practices would greatly reduce shortages. In other areas with highly regulated water supplies, such improvements would permit the supply to be stretched to serve more land.

Energy development

Interior Department studies show that the development of large low-sulfur coal reserves and rich oil shale deposits will have a major impact on future western State water needs. The studies state that increased water requirements will result not only from mining and processing these energy minerals but also from associated population growth of the areas. Expected energy development from fossil fuel, particularly in the Colorado River Basin and Rocky Mountain area, will increase burdens on already limited water supplies. According to the Interior Department's 1975 study, an additional 1 million acre-feet of water from the Colorado River Basin alone will be required by 1985 to meet the growth of energy development in that area. The report states that the additional water will have to be obtained by developing new water sources or using more efficiently existing water supplies.

According to the report, in 1972, hydroelectric power production provided almost one-half of the generating capacity in the 11 western States. The report concluded that hydroelectric power production can increase by installing more power-producing equipment at existing projects. These additions will likely involve changes in operating existing storage systems, along with increased water needs. Better water management through more efficient conveyance systems could provide more water for producing hydroelectric power.

Recreation and environment improvements

The benefits of saving water through more efficient conveyance systems include having more water to take out of the stream or reservoir and reducing diversions by leaving water in the system.

Water pollution from increased salt buildup in the surface waters of the West is becoming increasingly serious, especially in the Colorado River Basin. According to the

Interior Department's 1975 report, one primary cause of rising salt levels is the passage of additional mineral salts into the streams from agricultural return flows. If not consumed, seepage from conveyance systems also flows through the ground, picking up salts and returning them to the stream. Therefore, reducing these seepage losses may reduce the return flows and consequently reduce the volume of salts and other pollutants returning to the stream.

Excess diversion of water from streams and reservoirs can adversely affect fish and other aquatic life. If a stream has an insufficient amount of water, for example, heat from the sun can rapidly raise the water temperature and encourage undesirable plant growth, which reduces oxygen levels and makes the water uninhabitable for certain aquatic life.

Another potential benefit of more efficient conveyance systems would be increased recreational opportunities. Water savings can maintain adequate streamflows, which improves fishing opportunities, and maintain reservoir water levels for recreation throughout the year.

In 1975 a record 64.7 million days of public recreational use was reported at Bureau of Reclamation reservoirs alone. This figure reflects a long-term trend of increased recreational activity at Bureau reservoirs. Even though some recreational opportunities are normally available at the end of the irrigation season when the water is at its lowest level, the low water level detracts from the aesthetics of the reservoir. For this reason, a higher reservoir water level--resulting from improved conveyance systems and reduced diversion--could improve recreational opportunities.

RECOMMENDATIONS OF PREVIOUS STUDIES

National Water Commission and Department of the Interior and Agriculture studies highlighted the importance of the seepage problem, identified potential beneficial uses for the water saved, and recommended actions to adequately address the problem.

The Commission suggested in a 1973 report that one way to use more efficiently available water supplies was reducing seepage losses by improving water conveyance systems. Other recommendations include the following.

- " * * * The States in water-short regions should enforce existing laws to limit water use to beneficial need and thus prevent wasteful application of water and unreasonable transmission losses.

- "The appropriation States should quantify 'beneficial need' and 'reasonable efficiency' for particular areas in order to reduce water waste.
- "States in water-short areas should adopt doctrines and procedures to encourage voluntary actions to improve efficiency of water use.
- "Water supply projects should not be authorized by the Congress until evaluations are made with respect to the efficiency of use of presently developed supplies in proposed project areas, and until a report is made on the prospects and desirability of satisfying existing shortages in any particular area by water-savings practices in lieu of further project development. * * *

The Interior Department's report pointed out that several studies have shown that opportunities exist for improving the use of water in agricultural irrigation. Concerning the efficiency of irrigation, the report stated that although current data is preliminary and needs refinement, it does show that the efficiency of irrigation can be greatly improved if conveyance systems are improved.

The report specifically suggested that agricultural water user districts and farmers who irrigate will need to use the best available assistance and technology to modernize their conveyance systems. The report suggested also the need for (1) action programs to be accelerated by the Federal Government to improve the efficiency of irrigation and (2) Federal assistance programs to systematically inventory the extent of water conservation problems in agricultural irrigation.

The Agriculture Department report recommended also accelerating irrigation system and water management improvements, using the best practical technology available.

- - - -

Although several reports and studies highlighted the importance of the seepage problem and identified potential beneficial uses for water saved through improving conveyance systems, we found that further analyses are needed to identify and measure the (1) overall effects of improvements on selected river basins, (2) potential national benefits, and (3) the areas where additional Federal input would be warranted.

AGENCY COMMENTS AND OUR EVALUATION

The Inter. - Department stated that the potential benefits of reducing seepage are highlighted in this report but not the potential, adverse effects, such as interfering with downstream water rights, reducing the recharge to aquifers, and eliminating wildlife habitat. (See app. II.)

We agree that beneficial and adverse effects should be considered in determining the need for reducing seepage losses, and as discussed on page 18, we believe that consideration should be given to the overall effects in determining the potential net benefits to a basin or the Nation.

CHAPTER 3

NEED FOR A COMPREHENSIVE ACTION

PROGRAM TO IMPROVE WATER CONVEYANCE SYSTEMS

As discussed in chapter 2, Federal agency and commission studies have shown that large quantities of water seep primarily in the western States from inefficient irrigation canals and laterals. In addition, the water saved by reducing such seepage could result in such potential benefits as more water for agricultural irrigation, energy development, environment improvement, and recreation. Although the studies identified the need to address the seepage problem as well as the need for more accurate and comprehensive information on seepage and improving the efficiency of water conveyance systems, no Federal agency has taken the lead in identifying all aspects of the problem, evaluating the effectiveness of existing programs, and recommending a comprehensive action program appropriate for the Federal Government to implement.

Department of the Interior and Agriculture agencies concerned with the seepage problem have directed their grant and loan programs to finance improvements in water conveyance systems. These programs are not specifically designed or administered, however, to comprehensively and coordinatively address the problem. For example, Bureau of Reclamation loans are approved primarily on the basis of the applicant's ability to repay them. They are granted to individual projects, with little consideration given to the overall effects on a basin of proposed conveyance system improvements and without definitive criteria on which systems should be improved to provide the greatest national benefit in terms of conserving water.

The Bureau expressed concern about the adequacy of its programs for encouraging conveyance system improvements. A 1973 preliminary report by a Bureau study team entitled "Policy for Lining or Placing Canals or Laterals in Pipe," concluded that justification requirements for lining or piping new projects are more stringent than requirements for rehabilitation projects. Also, the report stated that current Bureau policies for lining or piping are ineffective because of their inconsistent application. The report stated that requirements for lining and piping under the rehabilitation programs do not require economic justification--assessing the overall economic value of the improvement based on the potential use of the water saved. Rather, under these programs the borrower need only demonstrate the ability to repay construction costs within the repayment period allowed by the particular act.

The preliminary report noted the need for effective policies and practices in dealing with the problems of excess seepage. The report concluded, among other things, that

- criteria was not developed to evaluate all the benefits and adverse effects of lining programs,
- reliable practices were needed to determine methods of assessing seepage losses, and
- research on data collection programs was needed to determine the degree of piping and lining programs' achievements.

At the time of our review, no actions had been taken on the inadequacies identified in the preliminary report.

Based on our review, we believe that there is a need for a comprehensive action program specifically designed to effectively deal with inefficient water conveyance systems. Such a program should be designed to (1) improve the accuracy of reported seepage data, (2) consider adequately the overall basinwide effects of system improvements, including more definitive criteria for selecting systems to be improved, and (3) identify and resolve institutional and legal constraints hampering improvements to water conveyance systems.

NEED TO IMPROVE THE RELIABILITY OF REPORTED SEEPAGE DATA

Improvements are needed in the accuracy of reported seepage data to assist the Government in taking the more active role needed to increase the efficiency of conveyance systems.

As discussed previously, most water seepage from conveyance systems is in the western States. The Bureau's 1975 annual report entitled "Water and Land Resource Accomplishments," includes information on the utilization of water releases for each of the 165 Bureau projects in the 17 western States. The report shows that about 8.1 million acre-feet of water was lost primarily through seepage from conveyance systems on Bureau projects. The following table shows, by major river basin, Bureau projects reporting most of the seepage and the percent such seepage was of the total water diverted.

<u>Basin</u>	<u>Acre-feet of seepage</u>	<u>Percent of total diverted</u>
Missouri River:		
Buford Trenton, North Dakota	6,149	35
Mirage-Flats, Nebraska	6,821	46
Buffalo Rapids, Montana	42,478	55
Lower Yellowstone, Montana/North Dakota	57,985	21
North Platte, Wyoming/Nebraska	542,380	43
Milk River, Montana	151,967	59
Columbia River:		
Crescent Lake, Oregon	32,830	49
Arnold, Oregon	8,590	38
Missoula Valley, Montana	710	24
Umatilla, Oregon	60,335	30
Minidoka Palisades, Idaho/ Wyoming	1,457,949	24
Boise, Idaho/Oregon	784,655	35
Columbia Basin, Washington	676,320	23
Yakima, Washington	520,832	24
Sacramento River:		
Orlando, California	45,066	37
Colorado River:		
Salt River, Arizona	526,177	39
Grand Valley, Colorado	59,661	18
Rio Grande River:		
Rio Grande, New Mexico/Texas	273,301	39
Middle Rio Grande, New Mexico	121,360	24
Klamath River:		
Klamath, California/Oregon	<u>265,473</u>	28
Total	<u>5,641,039</u>	

The Bureau's annual report is developed in part from information furnished by its regional offices in a "Monthly Water Distribution Report." The report summarizes water disposition according to the following classifications: diverted from streams and reservoirs, main canal wastes and losses, deliveries to laterals, lateral wastes and losses, nonirrigation deliveries, and farm deliveries. The information reported for each project is obtained initially from the individual irrigation districts within each project.

Reported seepage figures could be an excellent means of identifying conveyance systems incurring high seepage and having the potential need for improvements. However, we found that seepage figures are sometimes inaccurate and not used by Bureau headquarters or field offices to identify those systems.

In analyzing reported seepage data from the Yakima, North Platte, and Rio Grand projects, we found that different methods and devices were used to measure seepage. Bureau officials told us that some of the measuring devices were highly accurate; however, some instruments, if not used at proper intervals and under proper conditions, provided unreliable estimates of the amount of water lost through seepage. Other irrigation districts we visited had not installed measuring devices in the canals and laterals, and as a result reported seepage figures were estimated. One irrigation district used outdated measuring devices that, according to Bureau officials, were not placed properly for providing accurate seepage data.

Irrigation districts we reviewed reported seepage up to 56 percent. In some cases districts that reported no seepage had unlined canals, making the possibility of no seepage, according to Bureau personnel, very unlikely. In other cases we found that districts reported only estimated water losses.

The Yakima project will serve to illustrate some of the inaccurate and incomplete seepage-loss information reported.

Overall, Bureau project water-loss figures were compiled from the water distribution reports prepared by the six irrigation divisions in the Yakima project. Only one manager was sure that his irrigation division reported accurate seepage-loss information. We found that inaccurate seepage-loss data was compiled by the remaining five irrigation divisions for several reasons.

Two division managers told us that not all water delivered to farmers was measured and recorded. In one division, deliveries for about 4,000 of the 13,000 irrigated acres were not measured. The other division did not know how much water was lost through operational spills and seepage from canals or laterals.

For the third division, we found that the figures were compiled by the local Bureau office and sent to headquarters without the input or knowledge of the division. Based on

the division manager's comments the reported losses were incorrect. The manager estimated the main canal losses were overstated by about 90,000 acre-feet and questioned the lateral losses because the division has never measured and recorded the delivery of water from the laterals to the farms.

According to a fourth division representative, the figures prepared and reported to the Bureau were compiled from actual data by only one of the seven districts in the division. He said that the remaining six districts lacked the staffpower to measure and record seepage or water delivered to farmers.

Canal and lateral losses were measured and recorded in the fifth division, but the division did not distinguish between operational spills and seepage losses. On the basis of reconstructed figures, without wastewater, the actual seepage loss for canals was considerably less than the report showed.

Project and Bureau officials with whom we discussed the matter of reporting seepage data said it was general knowledge that the figures were inaccurate and not used by management. Moreover, little effort was being made by the Bureau to obtain better reporting. The Bureau acknowledges, however, large seepage losses. Bureau personnel agreed further that reliable seepage-loss information could be a valuable tool for identifying conveyance systems needing repair and measuring the results of improvement programs.

AGENCY COMMENTS AND OUR EVALUATION

The Interior Department stated that they concur fully in the need for a comprehensive program to deal with inefficient water conveyance systems (see app. II). They stated also that they have attempted and will continue to increase the coverage and accuracy of reported seepage data. The Department believes that more definitive criteria for selecting systems to be improved and attention to basinwide effects will naturally follow the improvement of basic data.

According to the Department, the Bureau seepage figures we used on page 15 are only partially accurate. Although the Bureau reported the figures for seepage, the Interior Department said that they include certain operational losses and other types of losses not associated with conveyance systems for six of the projects listed: Mirage Flats, Nebraska; Buffalo Rapids, Montana; Milk River, Montana; Crescent Lake, Oregon; Umatilla, Oregon; and Boise, Idaho/Oregon. Thus the corresponding values for seepage as a

percentage of total diversions do not reflect the actual situation for these projects.

Also, the Department pointed out that the overall percentage of seepage losses for Bureau projects is 21 percent and that the projects listed on page 15 are not representative of all Bureau projects. We believe that losses of 21 percent justify increased attention to this problem.

We believe that the Interior Department should continue efforts to improve the seepage data. Reasonably accurate data is necessary in developing a comprehensive program to effectively deal with inefficient water conveyance systems.

NEED TO IDENTIFY AND RESOLVE PROBLEMS HAMPERING IMPROVEMENTS TO WATER CONVEYANCE SYSTEMS

e found that some irrigation districts were not applying for conveyance system improvement loans and that several problems contributed to this situation. Also, the Bureau lacked adequate programs for identifying conveyance system problems, measuring their importance, and devising solutions for them. The problems we identified were concerned with the inadequate consideration of potential benefits of system improvements in establishing loan repayment terms and with institutional and legal constraints, such as water allocation agreements and interstate compacts.

Inadequate consideration of overall effects in establishing loan repayment terms and selecting projects for improvement

Bureau representatives told us that irrigation districts are responsible for deciding needed system improvements and how they will meet repayment terms established by the Bureau. Bureau guidelines state that actions initiated toward securing conveyance improvements can be made by the Bureau or at the request of irrigators. However, we found that Bureau offices generally wait for irrigators to initiate actions for obtaining loans for conveyance improvements. In one project area, some irrigation districts initiated actions to improve their conveyance systems, while other districts took no action.

On the Bureau's North Platte project, for example, two districts took the lead in obtaining funds for conveyance improvements, while two others did not. Managers of the districts that have not improved their systems expressed concern about the high cost of improvements. However, they said that they have not recently studied the costs and benefits of such improvements and have received no assistance or encouragement from the Bureau to do so.

Potential, national benefits could result from conveyance system improvements in the area served by the North Platte project in Wyoming and Nebraska. Although we found no evidence that coal development in this area is being restricted because of a lack of water, energy mineral developers may increase demands for water in the future. For example, we were told that a large Texas-based energy company is planning to construct a coal gasification plant in Wyoming that will require about 5,000 acre-feet of water annually. The North Platte project reported seepage losses of about 542,000 acre-feet of water annually, or 43 percent of the project's total water supply.

In an area known for its potential for coal development, the Lower Yellowstone project in Montana and North Dakota reported annual seepage losses of about 58,000 acre-feet, or 21 percent of the project's total water supply.

We also identified three irrigation districts (Sunnyside, Roza, and Grandview) within the Yakima project in Washington that considered making conveyance improvements which would have provided more water for agriculture. District officials told us that they later decided against such improvements because they considered the loan repayment terms established by the Bureau unduly harsh; they felt they could not meet the requirements.

In all three cases, the proposed improvements were discussed with the Bureau, but field investigations were not made and reports on the proposed improvement not prepared. However, the Bureau did determine the repayment ability of each district.

The Roza district proposed an \$8 million rehabilitation program that the Bureau determined could be repaid in about 10 years. The Sunnyside program was estimated to cost about \$500,000, and the Bureau estimated the district's repayment capability at \$1 million annually. The Grandview district proposal was estimated to cost \$560,000, and the Bureau estimated that repayment would take about 8 years.

The Roza and Sunnyside irrigation district managers told us that they believed that the repayment schedules the Bureau made were unrealistic in that crop values were overstated and farm expenses understated. Consequently, neither the districts nor the Bureau pursued the matter further. The Interior Department advised us that irrigators object to any programs that increase their costs and subject them to additional risks when their direct economic benefits cannot be readily perceived.

The potential advantages of conveyance system improvements in two of the three districts are discussed below.

Sunnyside Irrigation District

Sunnyside reported 23,276 acre-feet of water seepage losses in 1974.

The Sunnyside manager told us that of the 62,831 acres irrigated, about 18,000 receive water under a limited-water-supply contract. Under the contract, the users are entitled to 2.62 acre-feet of water for each acre of land. The district's remaining 44,831 acres are irrigated under a full-water-supply contract, which allows users 3 to 5 acre-feet of water for each acre of land depending on the land classification.

The Sunnyside manager said that he believed that water saved by conveyance system improvements could be used to replace the limited-water-supply contracts with a full-water-supply contracts. To bring the limited-supply users under a full supply would require about 1 acre-foot for each acre, or a total of 18,000 acre-feet. He estimated that the additional 1 acre-foot of water would be worth about \$3.60, or about \$64,800 annually.

The Sunnyside manager estimated that there are also about 5,000 acres outside of the district boundaries that could be brought into the district if additional water were available as a result of conveyance system improvements. These lands are not presently irrigated, and therefore an irrigation system would need to be constructed.

He explained further that to bring new lands into the district, the entire district would have to be reevaluated to assure that all lands receive sufficient water.

Roza Irrigation District

Roza reported 118,985 acre-feet of water seepage losses in 1974.

Roza has a total of 72,511 acres classified as irrigable land. In 1974, 68,262 acres were irrigated. The Roza district manager explained that all irrigable lands are entitled to a full water supply and that the district could supply the water if requested. Therefore, water savings would not benefit irrigable lands; however, water savings could be directed toward lands classified as nonirrigable but actually farmed.

The Roza manager stated that the district sells excess water annually to nonwater-right lands--lands classified as nonirrigable but actually farmed. For the past few years, the district sold about 30,000 acre-feet annually to nonwater-right lands. This excess water supplements the farmers' present water supply. This excess water enables farmers to have a fair crop year, but when the district does not have the excess water to sell, farmers virtually lose their crops.

The district manager explained that excess water acts as insurance for those nonirrigable lands. In addition, these lands could be reclassified as irrigable.

Another possible use for saved water would be adding lands to the district. The Roza manager estimated that with the water saved through conveyance improvements, 2,000 to 2,500 more acres could be brought into the district. Presently, this land is not irrigated but could be highly productive orchards if supplied water.

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Although there is a potential beneficial use for water saved by conveyance system improvements in irrigation districts served by the Bureau's Yakima project, the Bureau would have to perform further analyses to identify and measure all potential benefits and adverse effects to justify the need for additional Federal involvement in improving conveyance systems.

Bureau officials said that they do not maintain an inventory or data base of water resource projects with the potential of benefiting from conveyance improvements. They said that irrigation districts are responsible for deciding what improvements are needed and how they will meet repayment terms established by the Bureau.

We believe that the Bureau should broaden its view of its responsibility and in some cases should encourage the irrigation districts to make appropriate cost/benefit analyses of conveyance system improvements. In addition, when system improvements would promote the national interest--by increased agriculture, energy development, environment improvement, and recreation and without causing net adverse effects--we believe that the Bureau should take appropriate actions to establish loan repayment terms that encourage irrigation districts to apply for such loans. The Bureau should consider whether additional legislative authority is needed to provide such encouragement.

Institutional and legal constraints

Water allocation formulas in years of shortages, interstate water allocation decrees, and water rights and laws can present problems which discourage irrigation districts from requesting conveyance improvement loans. On the Bureau's North Platte project and the Rio Grande project, for example, water is allocated to insure that each irrigation district receives the same amount. The Rio Grande project always uses this system while the North Platte project uses it during years when water is short. Under this system an irrigation district that improves its conveyance systems must share the increased water supply with other irrigation districts in the project, even though the cost of improvements are not shared. For example, of the 45,000 acre-feet of water that can be saved annually by conveyance improvements to the El Paso County Water Improvement District No. 1, Rio Grande project, over half of the water would be available to another adjacent district not sharing in improvement costs.

The Northport Irrigation District received water from the North Platte project but did not line its conveyance system. On the basis of the North Platte water allocation formula, if Northport lined its conveyance system, it would be entitled to only 7 percent of the water saved during a year water was short because the savings would have to be shared with other irrigation districts receiving water from the North Platte project.

In addition, a 1945 Supreme Court decree apportioned part of the river supply between Colorado, Wyoming, and Nebraska. However, the decree does not state whether irrigators who save or manage water better upstream have full use of all water saved. Bureau personnel said that if the saved water was used for consumptive purposes upstream and resulted in less water being available to downstream users, irrigators in Nebraska could reopen the decree.

Bureau officials said that at the time of the Supreme Court decree, the conveyance systems on one upstream Wyoming irrigation district were unlined. That district later lined or placed in pipe large sections of its conveyance systems. One purpose of the conveyance improvement program was to reduce high losses when transporting water, supplement existing water supplies, and increase district crop values. Our review of Bureau project records disclosed that as a result of improving its conveyance system, the district reduced water transportation losses and was able to change crop patterns from barley and oats to more profitable beans and sugar beet crops, which consume more water. Bureau

officials said that irrigators further downstream now receive less water than before the upstream conveyance system was lined.

Bureau officials told us that because of the upstream conveyance improvement in Wyoming and the consequent decrease in water supplied to downstream users in Nebraska, the interstate compact may be reopened and water apportionments reallocated, which could deny upstream irrigators the use of the water saved from improved conveyance systems. This reallocation could reduce the consumptive use of water by Wyoming irrigators to the amount used before the conveyance system improvement program. Bureau officials said that other area irrigation districts realize that the compact could be reopened and many benefits of the lining program negated. Therefore, they are hesitant to encourage conveyance system lining within their districts.

Bureau officials said that this situation is not an isolated case. Because of State water rights laws, interstate compacts, and changes in upstream users' water consumption, downstream water users and water users holding junior water rights can be adversely affected by conveyance system improvements.

In the Rio Grande River Basin, for example, increased water usage on the Rio Grande project because of conveyance improvements left less water for downstream users in Hudspeth County, Texas. We were told that agricultural lands were withdrawn from production because the quantity and quality of water needed to raise crops was no longer available.

The Hudspeth County Conservation and the Reclamation District, No. 1 lack primary water rights and must rely on return flows from upstream water users. A Bureau official said that Hudspeth County soil is very fertile and most county areas are more fertile than areas upstream that are receiving high quality irrigation water. Therefore, if increased water consumption by upstream crops results from conveyance improvements, as stated in the proposal for the Bureau improvement loans, much of the more fertile land downstream may be withdrawn from production.

Hudspeth County water problems may worsen in the future. Irrigation districts north of Hudspeth County have started lining their systems or are formalizing lining plans. The El Paso County Water Improvement District No. 1, for example, began in 1971 a lining program which should be completed by 1981. Also, the Elephant Butte Irrigation District north

of El Paso was finalizing a plan to line most of the district. Fully lined systems in the El Paso and Elephant Butte areas may reduce further the amount of water available to the Hudspeth County area.

We believe that the Bureau should study the overall effects of and constraints to improving conveyance systems to reduce water seepage and when a basin's or national potential benefits are sufficient, devise improvement programs. Such programs could consider means for encouraging necessary improvements, such as equitable cost-sharing arrangements, and recommendations for legislation, if needed, to overcome problems hampering the efficient use of the Nation's water resources.

AGENCY COMMENTS

The Departments of the Interior and Agriculture agreed that institutional and legal constraints are major factors blocking conveyance system improvements. The Agriculture Department believes that some basinwide authority and State or Federal funding would be needed to implement a successful program of system improvements under present legal constraints. The Interior Department believes that action is required by the States to make needed changes in water rights laws and interstate compacts. However, they believed the changes will be slow in coming.

CHAPTER 4

CONCLUSIONS AND RECOMMENDATIONS

Conserving our Nation's water supply is becoming increasingly important. One way to conserve and make better use of existing water supplies is the potential for reducing seepage losses from irrigation water conveyance systems. Although several reports and studies highlighted the importance of the seepage problem and identified potential beneficial uses for water saved through improving conveyance systems, we found that further analyses are needed to identify and measure the overall basinwide effects of improvements on selected systems and the areas where additional Federal involvement would promote the national interest.

Because the seepage problem exists throughout the West and Federal projects supply water to only about one-fifth of the total irrigated lands there, it is evident that Federal, State, and local agencies must work cooperatively to lessen the problem. However, we believe that the Department of the Interior, which accounts for about 90 percent of the Federal financial involvement in projects that include irrigation delivery systems, should assume a leadership role in promoting efficient water conservation and management practices. If seepage receives inadequate attention, conveyance improvements will continue to be uneven and erratic and with little consideration given to which systems should be improved or the impact improvements could have on overall basin planning and conserving the Nation's water supplies.

Several Department of the Interior and Agriculture programs are concerned with seepage problems, but they are not specifically designed or administered to comprehensively and coordinatively address the problem.

On the basis of our review, we believe that a coordinated Federal, State, and local program is needed to improve water conveyance systems. Such a program should be designed to (1) improve the accuracy of reported water seepage data, (2) consider overall basinwide effects of conveyance system improvements, including more definitive criteria for selecting systems to improve, and (3) identify and resolve institutional and legal constraints hampering improvements to water conveyance systems.

In a previous report ^{1/} we pointed out that less than half of the water delivered to farms for irrigation is actually used by the crops. We recommended that the Secretaries of the Interior and Agriculture and the Administrator of the Environmental Protection Agency coordinatively seek to improve the efficiency of farm irrigation.

In a September 24, 1976, letter, the Under Secretary of the Interior commented on our previous report and advised us that the Interior Department was working with the Agriculture Department and the Environmental Protection Agency in organizing an interagency task force to review inefficient irrigation problems in the western States and recommend appropriate Federal objectives, policies, actions, and agency roles. Also, he stated that the Interior Department was seeking ways to involve State agency and irrigators' association representatives and others in the task force.

We believe that this task force would be ideally arranged to expand its objectives to consider also the problems of and solutions to inefficient conveyance systems.

RECOMMENDATIONS TO THE SECRETARY OF THE INTERIOR

We recommend that the Secretary of the Interior take the lead in identifying all aspects of the water conveyance system problem and devising a comprehensive action program to improve the efficiency of water conveyance systems. Also, the Department should encourage the interagency task force being established to consider solutions to inefficient farm irrigation practices to consider also solutions to inefficient conveyance systems, including the development of coordinated Federal objectives, policies, and action plans.

In developing a comprehensive action plan, we recommend that the Secretary:

- Identify and make needed improvements in conveyance system water-loss data to insure that management has reasonably accurate information.
- Maintain an inventory or data base of projects or conveyance facilities having from an overall area or basinwide viewpoint the best potential of benefiting

^{1/}Report to the Congress entitled "Better Federal Coordination Needed to Promote More Efficient Farm Irrigation," (RED-76-116, June 22, 1976).

from improvements. This data base should identify and measure such matters as the value or use for the water saved and overall, potential effects of the improvements.

- Use the data base in determining which projects should be encouraged to make conveyance improvements and manage loan funds available for that purpose accordingly.
- Identify problems or reasons why irrigation districts with the potential to conserve or better manage water resources do not improve their conveyance facilities. When necessary, irrigation districts should be encouraged to make appropriate cost/benefit analyses of conveyance system improvements. If these improvements would benefit a district or river basin or promote national efforts to conserve water, appropriate actions should be taken to establish Federal loan repayment terms which encourage such improvements or suggest alternative funding.
- Devise and recommend to the Congress programs for obtaining needed improvements when the potential benefits to the basin or Nation are sufficient but present programs are not likely to result in such improvements. Such programs may consider equitable cost-sharing arrangements and recommendations for additional legislation, if needed, to insure the efficient use of our Nation's water resources.

Because a comprehensive action program to improve the efficiency of conveyance systems probably will require the cooperation and involvement of other Federal agencies, State and local governments, and irrigators' organizations, we recommend that the Secretary identify and include representatives of such agencies, governments, and organizations in any task force established to identify and find solutions to the problem of inefficient water conveyance systems.

AGENCY COMMENTS AND OUR EVALUATION

The Departments of the Interior and Agriculture agreed with the thrust of our report. (See apps. I and II.) The Agriculture Department said, however, that they should have the leadership role in improving irrigation conveyance systems. Although Interior accounts for about 90 percent of the Federal financial involvement in projects that include irrigation delivery systems, this 90 percent involves only about 20 percent of the Nation's irrigated lands. Federal input to the other 80 percent is predominantly through the Agriculture Department. Even though Agriculture Department

programs can affect 80 percent of irrigated lands, we believe that the Interior Department is the proper agency to assume a leadership role because it accounts for most Federal funds expended. The Agriculture Department primarily provides on-farm technical assistance.

The Interior Department fully concurred with the conclusions and recommendations presented in this report and stated that the recommendations represent a sound and logical approach toward development of effective Federal policy and action plans to increase the efficiency of water use in the irrigation industry. (See app. II.) In addition, the Interior Department informed us that the interagency task force referred to in their September 24, 1976, letter (see p. 26) had been established. This task force will examine ways to improve the efficiency of irrigation and consider solutions to inefficient irrigation water conveyance systems.

The task force held its first meeting on June 16, 1977, and the minutes of that meeting showed that the representatives of the agencies involved (Departments of the Interior and Agriculture and the Environmental Protection Agency) agreed that the Bureau of Reclamation would be the lead agency in the task force study.



DEPARTMENT OF AGRICULTURE
OFFICE OF THE SECRETARY
WASHINGTON, D. C. 20250

JUN 9 1977

Mr. Henry Eschwege
Director
Resources and Economic
Development Division
General Accounting Office
Washington, D.C. 20548

Dear Mr. Eschwege:

We concur with the thrust of the draft report entitled "More Productive Use Could be Made of Billions of Gallons of Water if Irrigation Delivery Systems Were Improved." There is a need to have more efficient water delivery systems. The Department of Agriculture (USDA) has increased its activities in promoting better onfarm water use and in providing assistance on water conservation to individuals and local organizations. Our comments on the enclosed draft include the views of the Agricultural Stabilization and Conservation Service (ASCS) and the Soil Conservation Service (SCS).

We appreciate the opportunity to review and comment on the draft of the report.

Sincerely,

A handwritten signature in cursive script that reads "M. Rupert Cutler".

M. Rupert Cutler
Assistant Secretary

Enclosure

Comments on GAO Report on Irrigation Delivery Systems

Cover Summary - 1. The justification for giving Departmental leadership to the Department of the Interior (USDI) is that it is responsible for 90% of the federally financed irrigation projects. However, this involves only about 20% of the Nation's irrigated land. Federal input to the other 80% is predominantly through the U.S. Department of Agriculture (USDA). USDA has the legislative authority and has historically handled onfarm irrigation assistance on Federal, State, and privately developed projects. USDA also provides both technical and financial assistance to groups of landowners and to irrigation associations for improvement of off-farm distribution systems. It would seem that USDI's leadership role should be limited to off-farm losses within their Federal projects and the USDA be responsible for the balance.

2. The highlight of the figure, 70% lost to seepage from irrigation canals is misleading. This may be true in isolated instances but an average figure would better represent the case. Data provided by the Soil Conservation Service (SCS) to the Water Resources Council (WRC) for the National Water Assessment, which is referred to in the draft, indicates that the average off-farm loss is about 22% and the onfarm loss, which includes some ditch losses, at about 37%. This results in a 59% loss of which 47% is recovered in return flows.

Digest - Page i, paragraph 1, sentence 2, states enormous quantities are wasted. Nationwide, the net loss is only 12% when the 47% return-flow is considered. We believe the expression "enormous quantities wasted" is an overstatement of fact.

Page ii, paragraph 2, last sentence, states that one of the benefits of reduced seepage is "enhanced environmental" opportunities. Environmental groups have been active to prevent elimination of wet areas developed from ditch losses on the basis that the resulting vegetation is essential to the environment.

Page iii, paragraphs 1, 2, and 3 - The comment given on the Cover Summary applies here. USDI has been responsible for developing about 20% of the irrigation in the United States, and has not had responsibility for onfarm development. We do not concur that USDI is in a position to assume leadership role in devising a program. USDA has more expertise and capability of identifying and developing solutions to onfarm irrigation efficiency problems.

Page iv, 3rd line - What does the "which projects" refer to -- all projects or to USDI projects? Under present authorities, we question USDI's capabilities to "encourage" all irrigation districts to make the proposed studies.

Page iv, lines 13, 14, and 15 - Can existing Federal loan payment terms be changed? If not, the recommendation generally involves new work and possible Federal cost sharing for improving existing works both for USDI projects and other irrigation projects. In the latter, USDA becomes deeply involved.

Chapter 1

- page 1, paragraph 1, lines 6 through 9 stated "enormous amounts are wasted." Again, we point out that the amount lost and not recoverable for beneficial use is about 12 percent.
- page 2, lines 4 and 5 - Environmentalists do not consider seepage water consumed by weeds and other nonagricultural plants lost to beneficial use because these areas provide cover, food, and other ecosystem benefits.
- page 4, paragraph 2 - This paragraph overlooks the activities of the Agricultural Research Service (ARS) in carrying out irrigation research and the Farmers Home Administration (FmHA) in making loans for irrigation development.
- page 5, paragraph 3 - Again, the expression "lost through seepage" is misleading. A significant portion is lost only to the immediate area. Much of it returns to the system further downstream and, even though reduced in quality, is reused.
- page 8, line 2 - "grant and loan programs." - Change to grant, loan, and cost-sharing programs. Add Great Plains Conservation Program (GPCP) to line 5.

The RC&D program and small watershed projects are utilized to improve agriculture water management which is much more inclusive in scope than the expression "irrigation system improvements."

FmHA administers loan programs which can impact on system efficiencies.

Change lines 10 and 11 to read ...structural measures to reduce floods, provide water supply, control erosion, provide drainage, control drainage, control sedimentation, and provide irrigation distribution systems with appurtenances.

Page 9, line 2 - The program per person limitation under pooling agreements is \$10,000 per year as authorized by law. Reorganization of irrigation systems under ACP frequently involves pooling agreements.

Page 9, first full paragraph - Should more ACP funds have been spent for irrigation rehabilitation practices? We would like to point out that a previous GAO report was critical of ACP expenditures for irrigation practices.

Chapter 2

- page 14, paragraph 1 - Add "In some other areas, the problem is a lack of storage, such that during certain periods there may be insufficient water even with highly efficient distribution systems."

- page 16, paragraphs 1 and 2 - Will not water rights laws have to be changed before diversions will change significantly, thereby leaving more water in streams?
- page 17 - The report should define beneficial use. Most state laws refer to beneficial use, not beneficial need.

Chapter 3

- page 34, first full paragraph - This implies that land may be reclassified. If it had been classed properly at the beginning, reclassification would not be needed.
- page 35-38 - The institutional legal constraints are major factors in acceptance of programs to improve irrigation efficiencies. The right to use the water saved is subject to state laws and interstate compacts. The benefits thus may be greater offsite than onsite. This discourages actions by individuals or irrigation districts. Some basinwide authority, State or Federal funding, would be needed to implement a successful program of system improvements under present legal constraints.

Chapter 4

- page 39, paragraph 2 - Does one-third the total acreage refer to irrigation in the 17 Eastern States or to the U.S. total? The Bureau of Reclamation (BR) report "Water and Land Resource Accomplishments" indicates that they supply water to about 20% of the irrigated acreage of the U.S.
- In the same paragraph, the statement that USDI accounts for 90% of Federal involvement is in error. They provide 90% of the Federal financial involvement which includes major reservoir construction. Federal involvement in providing technical assistance to irrigators and irrigation districts is mainly through USDA programs. Nearly all Federal assistance to 80% of the irrigated areas comes through USDA programs.
- USDI's leadership role should be for water conveyance on Federal projects.
- page 40, paragraph 1 - The current programs being carried out jointly by USDA and USDI for salinity control are vitally concerned about seepage and provide an example of how the seepage problem could be handled.
- page 40, paragraph 3, states that over half the water delivered to farms for irrigation is wasted. This is not correct. Again, the SCS report to WRC shows only 12% actually lost since the remainder is return flow which is available for reuse.

Final Comments - 1. We concur in the need for more direct and comprehensive action. Overall, the objective of the report is good.

2. The report oversimplifies a very complex situation and is not completely accurate. For example: savings of water are exaggerated by stating savings on a project-by-project basis where much of the water reported as lost returns to the system for use by others. However, this should not detract from the importance of pursuing water conservation programs. We fully support and encourage this effort.

3. Leadership role by USDI is not fully justified.

4. A better understanding of the relationship of the problem to water rights laws, water pricing and environmental considerations is needed.



United States Department of the Interior

OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20240

JUN 2 1977

Mr. Henry Eschwege
Director
Community and Economic
Development Division
General Accounting Office
Washington, D.C. 20548

Dear Mr. Eschwege:

Your letter of May 3, 1977, asked for our comments on your draft report entitled "More Productive Use Could Be Made of Billions of Gallons of Water if Irrigation Delivery Systems Were Improved." In addition, we were requested to report on the status of the interagency task force that is being established to consider solutions to the problems of inefficient irrigation practices.

The draft report recommends that the Department of the Interior take a leadership role in identifying all aspects of the water conveyance system problem and in developing a comprehensive program to improve conveyance systems efficiencies. The Department is advised to use the interagency task force that is being established to consider irrigation efficiencies to consider also solutions to inefficient conveyance systems, including the development of joint Federal objectives, policies, and action plans.

In addition, it is recommended that the Secretary of the Interior: (a) identify and take actions to improve the data collected on water losses from conveyance systems; (b) maintain a data base on projects or conveyance systems and consider basin-wide effects in selecting projects according to potential benefit from improvements; (c) use the data base to determine which projects should be encouraged to make improvements and to manage available funds; (d) determine the reasons irrigation districts are not improving their conveyance systems, encourage them to make appropriate cost-benefit studies of improvements, and take action to establish Federal loan repayment terms which encourage improvements or suggest alternative funding possibilities; (e) develop and recommend programs to the Congress for obtaining needed improvements where they are not likely to be



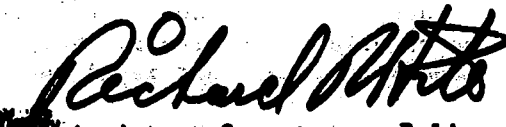
made under existing programs; and (f) identify and include representatives of other Federal agencies, State and local governments, and irrigators' organizations in any task force established to find solutions to the problem of inefficient water conveyance systems.

Although we do not agree on some details of the supporting analyses, we fully endorse those recommendations. In our opinion, the identification of all aspects of irrigation water conveyance system problems and the development of a comprehensive action program to address those problems represent excellent opportunities for the Department of the Interior and other Federal agencies concerned to contribute to conservation and efficient use of the Nation's water resources. The recommendations represent a sound and logical approach toward development of effective Federal policy and action plans to increase water use efficiency in the irrigation industry.

We are enclosing specific comments on details of the report for your consideration. Our review revealed several general areas which we believe should receive more attention. These include: (a) identification of actual benefits and beneficiaries of seepage reduction; (b) adverse effects; (c) costs, legal and institutional arrangements (especially water rights and water allocation arrangements), and other factors which discourage improvements; and (d) economic justification and financing of improvements. We believe there should be more recognition of these aspects in the DIGEST section of the report.

We agree that the Department needs to place more emphasis on the interagency task force that is being established to examine ways of improving irrigation efficiencies and to develop recommendations regarding Federal objectives, policies, agency roles, and action programs. We regret that the press of other business has prevented us from diligently pursuing this study. Task force representatives designated by the Departments of Agriculture and the Interior and the Environmental Protection Agency will meet on June 16, 1977, to get the study underway. We accept your recommendation that the task force consider solutions to inefficient irrigation water conveyance systems in addition to inefficient farm irrigation practices. Thus, we expect that a comprehensive examination of all aspects of irrigation systems and operations will be undertaken.

Sincerely,


Assistant Secretary - Policy, Budget,
and Administration

Enclosure

Enclosure

DEPARTMENT OF THE INTERIOR SPECIFIC COMMENTS ON THE GENERAL
ACCOUNTING OFFICE DRAFT REPORT TO THE CONGRESS, "MORE PRODUCTIVE
USE COULD BE MADE OF BILLIONS OF GALLONS OF WATER IF IRRIGATION
DELIVERY SYSTEMS WERE IMPROVED"

1. Report title--We recommend revision. The title used for the draft report appears to be designed to inflict maximum embarrassment on the irrigation industry and Federal agencies concerned with irrigation. The title associates huge savings with unspecified improvements of undetermined feasibility. If a unit of volume has to be indicated, we suggest that acre-feet be used instead of gallons which is a rather unconventional unit for the irrigation industry but results in huge numbers.

2. COVER SUMMARY--This section also borders on sensationalism.

It is stated in the summary, on page 1 (last sentence) and on page 19 (first sentence), that seepage from irrigation canals is ". . . in some cases as high as 70 percent of the water diverted." The way the statistic is used in the report suggests that extremely low conveyance efficiency is a common occurrence on Bureau of Reclamation projects, which is not the case. The 70 percent seepage value apparently is based on the information presented for the Milk River Project on page 23. This project, like many in the West, does not have measurement devices which provide accurate estimates of seepage from waterways. The project's best estimate of total transportation losses from conveyance systems, as reported in 1974, was 72 percent of the amount diverted. This includes operational spills, including bypasses for downstream rights, as well as seepage. We expect that the actual seepage loss was closer to 50 percent. (See comment 19.)

This section also indicates the report's apparent presumption that "seepage" is the only important component of water losses or inefficient operation of irrigation water delivery systems. Some definition or explanation should be presented for "seepage" and "inefficient irrigation canals" as used in the report.

Potential benefits from reducing seepage are highlighted but nothing is said about potential adverse effects (e.g.; interference with downstream water rights, reducing the recharge to aquifers, and elimination of wildlife habitat). Neither are constraints such as costs and their incidence and legal and institutional factors mentioned.

3. DIGEST--Pages i and ii have problems similar to those indicated in comments 1 and 2. There is considerable use of the terms "inefficient irrigation conveyance systems" and "seepage" without prior definition. Also, there are no indications of which parts of irrigation projects or systems are affected or being considered.

The first full sentence on page 11 indicates that 8.6 million acre-feet of seepage losses were involved in the delivery of 27.4 million acre-feet of water to over 9 million irrigated acres on Federal projects in 1974. Not all of this so-called seepage can be considered a "loss" because a large portion returns to surface streams or to ground-water aquifers where it is available for reuse.

Furthermore, all of the cited 8.6 million acre-feet was not actual seepage. Presumably, these statistics were taken from the Bureau of Reclamation report "Federal Reclamation Projects - Water and Land Resource Accomplishments - 1974" which actually reported total transportation losses of 8.6 million acre-feet (page 263). For many of the projects listed in the report, transportation losses include operational spills and other losses as well as seepage. While we agree that this situation supports the conclusion that better basic data are needed, to equate total transportation losses for all Reclamation projects to seepage results in considerable overstatement of actual seepage losses. This error is repeated on pages 5 (last paragraph) and 22 (2d paragraph).

Adverse effects, costs, and other constraints on reducing the water losses are ignored even though there is considerable discussion of these aspects on pages 35-38. The DIGEST fails to indicate that there are aspects of the problem that are within the jurisdiction or responsibility of State and local interests.

Regarding the second full sentence on page 11, the Department of the Interior does not administer any grant programs for improving conveyance systems.

4. Page 1, first paragraph, last sentence--As indicated in comment 2, the statements regarding seepage losses "of up to 70 percent of the water diverted" are erroneous and misleading.

5. Page 3, last 2 lines--We suggest replacement of "or in some cases by compacting the earth in the canal or lateral" with "or by using compacted earth lining."

6. Page 4, first paragraph, second sentence--Lining canals and laterals does not significantly reduce the need to install expensive drainage systems. Drainage systems are installed mainly to take care of the deep percolation from irrigation and, at most, the first drain out from the canal is increased in size if there is canal seepage. Otherwise, drainage system requirements are not affected.

Page 4, first paragraph--This discussion is really part of a benefit-cost analysis for open vs. pipe system alternatives. The case for pipe is presented, but there are no arguments against pipe (i.e., costs). Pipe systems also more energy intensive. While advantages of lined

and pipe systems are indicated, adverse effects are ignored. (See comment 2.)

It is difficult to place dollar values on the kinds of benefits discussed on page 4 so they can be justified. The high costs of lined and pipe systems need to be given some emphasis to give the reader perspective regarding the problem of justification.

7. Page 5--Literature references or other documentation should be indicated for the statistics and other information presented.

8. Page 5, paragraph 2--It should be pointed out that it is very difficult to obtain economic justification for the costlier lined and pipe systems for many projects currently being planned.

9. Page 5, paragraph 3--It is indicated that in delivering 27.4 million acre-feet of irrigation water on Federal projects in 1974, 8.6 million acre-feet were "lost through seepage." Actually, 8.6 million acre-feet were reported as transportation losses with deliveries of 27.4 million acre-feet to farmers. (See comment 3.)

10. Page 5, last sentence--Lining and pipe were not omitted from earlier projects to "reduce costs and because, at the time, there was little concern about water conservation and future basin-wide water needs." They simply could not be economically justified under the criteria that existed at the time the early systems were designed. As indicated in comment 8, it is often difficult to economically justify the more costly lined and pipe systems for irrigation projects being planned today.

11. Page 6--The first sentence reads: "Since 1967, however, the Bureau of Reclamation has been operating under a policy which provides that all conveyance systems on new projects will be lined or placed in pipe in order to conserve water and secure other benefits, unless there are reasons for recommending an unlined waterway." This could be misleading. Costs vs. identifiable benefits remain the compelling reason.

12. Page 6, third paragraph--The Rehabilitation and Betterment Act of 1949 and the Small Reclamation Projects Act of 1956 have been amended several times. More complete citations would read: ". . . the Rehabilitation and Betterment Program as authorized by the Act of October 7, 1949 (63 Stat. 724), as amended on March 3, 1950 (64 Stat. 11), and on October 3, 1975 (89 Stat. 485); and ". . . the Small Reclamation Projects Act of 1956 (70 Stat. 1044), as amended June 5, 1957 (71 Stat. 48), September 2, 1966 (80 Stat. 376), November 24, 1971 (85 Stat. 488), and December 27, 1975 (89 Stat. 1050).

The report has neglected to mention the Distribution System Loans Act of July 4, 1955 (69 Stat. 244), as amended on May 14, 1956 (70 Stat. 155), and on October 13, 1972 (86 Stat. 804). Pursuant to this act, irrigation districts or other public agencies whose distribution and drainage systems have been authorized for construction under the Federal Reclamation laws, or where non-federally constructed distribution systems convey Federal project water under

water service contracts and are covered by Reclamation law, may obtain loans to construct those systems in lieu of having them constructed by the Secretary of the Interior. Unlike the R&B Program, the Distribution System Loan Act permits construction of facilities to serve new lands.

13. Page 7--Second full sentence reads: "The size of loans or the number of loans any one organization can obtain are not limited under the Rehabilitation and Betterment Act." Contrary to what this suggests, the total advance of funds cannot exceed the water users' ability to pay.

14. Page 10, first paragraph--Regarding the potential use of "saved water" in other beneficial uses, this would be contingent on local legal and institutional arrangements (water rights). (See comment 21.)

15. Pages 12-13--Regarding the Department of Agriculture's estimate that there will be an additional 4 million acres of irrigated cropland by 2000, we suggest that the underlying assumptions for this projection be indicated. If withdrawal requirements for the existing irrigated acreage could be reduced by 48 million acre-feet annually, the increase in the irrigated area could be much larger than the 4 million acres that are projected.

16. Page 15, first paragraph--The last sentence is somewhat misleading. Except for the effect of the seepage losses that are consumptively used, seepage control would not add to the total flow of water in a river system. It could have significant influence on the timing of flows.

Page 15 (2d paragraph) and page 16 (2d paragraph)--Many western streams are overappropriated. In such cases, water "savings" from seepage control would not be available for maintaining streamflows because they would be captured by junior rights holders.

17. Page 19, first sentence--Regarding the assertion that seepage losses may be as high as 70 percent of the water diverted, see comment 2.

18. Page 21, paragraph 2--We concur fully in these conclusions concerning the need for a comprehensive program to deal with inefficient water conveyance systems. We have made attempts in the past and will continue to increase the coverage and accuracy of reported seepage data. More definitive criteria for selecting systems to be improved and attention to basin-wide effects will follow naturally with improvement of basic data. Resolution of institutional and legal constraints hampering improvements will be a slow process because of the involvement of States' water rights laws and interstate river compacts. (See comment 21.)

19. Page 23, listing of 1974 seepage volumes and percentages for selected Bureau of Reclamation projects--Operational spills and other

losses are erroneously included in the values given for "acre-feet of seepage" for six of the listed projects: Mirage Flats, Nebraska; Buffalo Rapids, Montana; Milk River, Montana; Crescent Lake, Oregon; Umatilla, Oregon; and Boise, Idaho-Oregon. Thus the corresponding values for seepage as a percentage of the total diversion are also incorrect. It may be best to delete these projects since there is no way to tell what portion of the reported losses are operational spills, bypasses, etc., instead of seepage. (See comment 2 regarding use throughout the report of the erroneous seepage percentage indicated for the Milk River Project.)

A quick analysis of the 1974 data presented on page 23 shows that, with all considered, seepage losses from Bureau of Reclamation projects are not as excessive as pictured. As indicated above, the seepage losses given for six of the projects actually represent bypasses, spills, and other transportation losses in addition to seepage. Thus their seepage losses and percentages are overstated. If it were assumed that all values quoted are accurate, the listed projects account for 38 percent of the total acreage served by Reclamation projects and 69 percent of the total seepage losses. This leaves projects amounting to 62 percent of the irrigated area accounting for 31 percent of the seepage. Put in another way, the listed projects have an overall conveyance loss rate of 29 percent (based on total losses and diversions for the listed projects) and the remaining Reclamation projects have but a 13 percent loss rate. Thus the listed projects are hardly representative. The conveyance system seepage loss for all Reclamation projects is 21 percent based on the data presented on page 23.

Reclamation's 1975 annual report, "Water and Land Resources Accomplishments," is now available. We suggest that updated actual seepage loss data be obtained from that report and its supporting data for a more representative set of projects.

20. Page 29, paragraph 1--Institutional and legal constraints (i.e. water rights, water allocation agreements, and interstate compacts) are not just "potential" problems hampering improvements to water conveyance systems. Instead, they are real, existing, and a fact of life.

21. Pages 29-35, discussion of "Inadequate consideration of overall effects in establishing loan repayment terms and selecting projects for improvement."

In the last full paragraph on page 29 and the first sentence on page 35, it is indicated that the Bureau of Reclamation views its responsibility as "to guide, review, and approve programs proposed by the districts but not to encourage the idea of conveyance improvements." On page 29, it is stated that it has not been Bureau of Reclamation practice "to encourage applications for improvement loans." These statements are inaccurate. Irrigation district managers are informed about conveyance systems deficiencies during biannual Review of Maintenance examinations

conducted by Bureau of Reclamation representatives. The need for irrigation systems improvement and sources of funds (R&B Loan Program and Small Reclamation Projects Loan Program) are well known by officials of water users' organizations as a result of presentations and discussions led by Bureau of Reclamation representatives at periodic meetings of regional and national organizations of irrigators and other water users. Special information pamphlets on the loan programs have been prepared and distributed to encourage loan applications. Contrary to what is implied in the second paragraph on page 29, most Reclamation regional representatives encourage loan applications and technical assistance is made available to irrigation districts in preparing applications.

The first sentence in the first full paragraph on page 30 implies that whether irrigation districts take action to improve their systems depends solely on the Bureau of Reclamation initiating the action. This is inaccurate. Information subsequently presented in the same paragraph indicates that the "high cost" of improvements is probably a more important determining factor.

We fail to see the point of the last paragraph on page 30 and the first paragraph on page 31. To compare a 5,000 acre-foot water requirement for a coal gasification plant with alleged seepage losses of 600,500 acre-feet is similar to comparing apples and elephants. It is obvious that seepage losses from irrigation systems are not constraining energy development in the North Platte Project and Lower Yellowstone Project areas.

Regarding the discussions of loan repayment terms on pages 31 and 32, it is important to understand that the Bureau of Reclamation does not establish the basic repayment requirements; instead they are established by Federal statute and administration policy. It also should be understood that the loan repayment terms proposed by the Bureau of Reclamation are not necessarily "unduly harsh" simply because district officials said they were. The situations discussed are hardly consistent with such a conclusion; e.g., a district with a repayment capability of \$1 million per year objects to a \$500,000 (total cost) improvement program. A more valid conclusion would be that irrigators object to any program that increases their costs and subjects them to additional risks when their direct economic benefits cannot be readily perceived.

The discussion in the last paragraph on page 32 would be enhanced by inclusion of additional information, e.g., total costs of needed improvements, cost per acre-foot of water "saved," etc.

The first full paragraph on page 35 states "appropriate action should be taken by the Bureau to establish loan repayment terms which encourage irrigation districts to apply for such loans; such as providing for

longer repayment periods." As previously indicated, the Bureau of Reclamation does not have this discretion. Basic repayment requirements are established by Federal statute and administration policy.

21. Pages 35-38, "Institutional and legal constraints."

Along with rehabilitation costs, water rights implications are among the major deterrents to improvement of irrigation water delivery systems in many areas as illustrated by the situations described in this section of the report. Constraints related to water rights and water allocation arrangements should be recognized in the COVER SUMMARY and DIGEST sections of the report.

In some cases, irrigation districts that improve their water delivery systems may not obtain commensurate benefits because provisions in States' water rights laws and/or longstanding local water allocation arrangements obligate them to share any water savings with other districts. Irrigators with junior rights may capture the entire water savings. Thus systems improvements may benefit water users who do not share the costs.

As indicated earlier in the report, the less efficient water delivery systems are generally found on the older projects. Irrigation districts associated with these projects have senior water rights and tend to have adequate water supplies even in water short years. There is relatively little incentive for such districts to make improvements to reduce seepage losses.

In cases where the so-called water "savings" from seepage reduction are used in the districts making the improvements, the water supplies of downstream irrigators may be interrupted. In many areas, the seepage losses and resulting return flows from upstream irrigation systems are important components of downstream districts' water supplies. Irrigation districts which take action to reduce seepage, with the intent to use the "saved" water internally, may be subject to legal action by downstream water users.

While we do not minimize the necessity of resolving these issues, the complexities involved should be recognized. Actions would be required by State legislatures and executives to make the required changes in State water rights laws and interstate compacts. In some cases, court actions may be required to resolve local water rights issues and provide an equitable basis for water systems improvement programs. We agree that the Department of the Interior should take a lead role in demonstrating the need and determining means of accomplishing the necessary reform.

22. Page 39, second paragraph, second sentence--Federal projects supply water to about one-fifth of the irrigated acreage in the West instead of the indicated one-third.

23. Page 40, third paragraph--An earlier GAO report (RED-76-116, June 22, 1976) is cited and it is stated that GAO pointed out in that report "that over half the water delivered to farms for irrigation is wasted through overwatering" We object to the characterization of all on-farm water losses as "waste." Aside from the obvious impracticability of attaining 100 percent farm irrigation efficiencies and the need for water applications in excess of crop consumptive use to maintain salinity control, the greater portion of delivered irrigation water that is not productively or consumptively used on individual farms replenishes ground-water supplies and produces surface return flows that are used in irrigation and for other purposes downstream. The referenced assertion is misleading because it does not recognize that cumulative use of water in river basins may be highly efficient. Measurements of individual and average farm irrigation efficiencies do not adequately characterize the overall situation.

24. Pages 39-43, Chapter 4, CONCLUSIONS AND RECOMMENDATIONS.

We fully endorse the conclusions and recommendations presented in the report even though we disagree with many details of the preceding analysis. The problem of water delivery system efficiency has been worked on by the Bureau of Reclamation for many years. Unfortunately, the commitment of adequate resources, authority, and personnel to resolve the problem has not been possible. It appears that there now may be an opportunity to merge the resources, experience, and expertise of the Bureau of Reclamation and other Federal agencies to address in a comprehensive and coordinated manner all areas in which water use efficiency needs to be improved. We believe the recommendations made in the report represent a sound and logical approach toward development of effective Federal policy and action plans to increase water use efficiency in the irrigation industry.

PRINCIPAL OFFICIALS RESPONSIBLE FOR
THE ACTIVITIES DISCUSSED IN THIS REPORT

Tenure of office
From To

DEPARTMENT OF THE INTERIOR

SECRETARY OF THE INTERIOR:

Cecil D. Andrus	Jan. 1977	Present
Thomas S. Kleppe	Oct. 1975	Jan. 1977
Stanley K. Hathaway	June 1975	Oct. 1975
Kent Frizzell (acting)	May 1975	June 1975
Rogers C. B. Morton	Jan. 1971	May 1975
Fred J. Russell (acting)	Dec. 1970	Jan. 1971
Walter J. Hickel	Jan. 1969	Nov. 1970

COMMISSIONER OF THE BUREAU OF
RECLAMATION:

R. Keith Higginson	Apr. 1977	Present
Donald Anderson (acting)	Feb. 1977	Apr. 1977
Gilbert Stamm (note a)	Apr. 1973	Feb. 1977
Ellis L. Armstrong	Nov. 1969	Apr. 1973

DEPARTMENT OF AGRICULTURE

SECRETARY OF AGRICULTURE:

Bob Bergland	Jan. 1977	Present
John Knebel (acting)	Oct. 1976	Jan. 1977
Earl L. Butz	Dec. 1971	Oct. 1976
Clifford M. Hardin	Jan. 1969	Nov. 1971
Orville L. Freeman	Jan. 1961	Jan. 1969

a/Served as Acting Commissioner from April to May 1973.