MEETING THE REQUIREMENTS OF THE MEXICAN TREATY

and the

COLORADO RIVER BASIN SALINITY CONTROL ACT

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by
Ival V. Goslin

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Legislation

Don Lane asked me to discuss with you the progress being made in meeting the requirements of the Mexican Water Treaty which were assumed by the United States as part of the Colorado River Basin Project Act of 1968. This Act provided for further development of the water resources of the Colorado River Basin, including construction of the Central Arizona Project and a number of projects in the Upper Colorado River Basin. The Act also provided that for a period of ten years from the date of the Act (September 30, 1968) the Secretary of the Interior shall not undertake reconnaissance studies of any plan for the importation of water into the Colorado River Basin from any other natural river drainage basin lying outside the States of Arizona, California, Colorado, New Mexico, and those portions of Nevada, Utah, and Wyoming which are in the natural drainage basin of the Colorado River.

Congress also declared that satisfaction of the requirements of the Mexican Water Treaty would be the first obligation of any water augmentation project.

Related legislation is contained in Public Law 93-320, the Colorado River Basin Salinity Control Act. This legislation authorized under Title I, along with other facilities, a desalting plant at Yuma, Arizona to desalt drain water from the Wellton-Mohawk division of the Gila project solely for the benefit of Mexico.

Title II authorized a salinity control program upstream from Imperial Dam designed to maintain the salinity level at Imperial at or below the average level reached in 1972. Measures for control include facilities to reduce the seepage of irrigation water from irrigated lands, and collection and disposition of saline ground water from natural sources.

Accomplishments

I regret to say that except for initial construction work on the Central Arizona Project, not a great deal (except planning and replanning) during the past eight years has been accomplished under the Colorado River Basin Project Act. Construction has not been started on any of the authorized projects in the Upper Basin States. We have drawn a blank on near-term water supply augmentation. Weather modification offers some promise, both technically and economically as a means of augmentation, but the attendant social, legal, and environmental problems have been monumental. A major demonstration project is needed to assure the technology and to verify the estimated cost of about $5 per acre-foot, while work continues on the institutional factors. In my judgment, any positive benefits from weather modification are years away, and may not be attainable as a reliable means for augmentation of the Colorado River's water supply.

The other sources of augmentation studied include the desalting of geothermal brines and sea and brackish water. High costs are associated with these currently unproven techniques. The geothermal resource may possess the
potential for developing power along with high quality water. The Bureau of Reclamation is currently evaluating the geothermal resources of the East Mesa in Imperial Valley in California.

The objective of its development program is to provide the necessary information to permit design, construction, operation and maintenance of economically and technically efficient desalting systems utilizing geothermal fluids. Items which have been identified as important in the evaluation studies include a system to produce and collect geothermal fluid, desalting performance and a brine disposal system. Thinking is in terms of membrane reverse osmosis and electrodialysis processes for geothermal fluids with a salinity of about 4,000 ppm. A multi-stage flash unit and a vertical tube evaporator are presently being tested for fluids in the 25,000 ppm salinity concentration range.

The Bureau of Reclamation appears relatively confident regarding the capability of the distillation process to desalt geothermal fluids. A determination of the practicability and economics of the development of geothermal resources for water supply augmentation will require much time, effort, and money, and certainly has its physical limitations.

I personally believe substantial results from this source are years away.

Water Supply

Colorado River water is used and reused several times during its 1,400-mile journey from the Continental Divide to the Mexican boundary. It furnishes irrigation water to over 1.5 million acres in the Upper Basin and about 1 million acres in the Lower Basin. Approximately 5.8 million acre-feet of transmountain diversions (almost half the total consumed) serve people outside the basin in California, Colorado, New Mexico, and Utah with domestic and irrigation water supplies. In the lower river reaches, 10,000,000 people obtain part or all of their domestic supplies from the river. Even the City of Tijuana, Mexico uses Colorado River water through an emergency connection with San Diego.

The long-term average annual virgin flow of the Colorado River at Lee Ferry, Arizona is less than 15 million acre-feet. Present consumptive use including deliveries to Mexico totals about 12.0 maf with 3.7 maf being used in the Upper Basin and 8.3 maf in the Lower Basin. Total water going to Mexico presently approximates 1.7 maf which is made up of 1.5 maf of treaty deliveries and 200,000 acre-feet of drainwater, to be bypassed until a desalting plant begins operations.

No Colorado River water has reached the Gulf of California since about 1960, and no appreciable amount of excess water has been delivered to Mexico for about 15 years. The difference between the runoff and consumptive use has been stored in Lake Mead and Lake Powell since the gates were closed at Glen Canyon Dam in November, 1963. There are now about 40 maf of water stored in these two reservoirs.
The Central Arizona Project is now under construction and is expected to be completed about 1985. The diversions to Central Arizona combined with increased use from other projects in the basin will result in demands on the river that will exceed the long-term dependable supply. The water accumulating in storage over many years (perhaps for a period amounting to a quarter of a century) will be drawn down to meet the demands.

About the year 2000, the Upper Basin will be approaching the limit of the available supply assumed for it by the Bureau of Reclamation, if energy demands develop as projected. If the Bureau's assumption was to prevail, but only after an anticipated court battle, the Upper Basin will be short about 20 percent of its 7.5 million acre-feet per year of consumptive use of water apportioned to it by the Colorado River Compact of 1922. The Compact also allotted 7.5 million acre-feet annually to the Lower Basin, with the stipulation that 75,000,000 acre-feet be delivered by the Upper Basin each ten years.

It is quite obvious that with 15 maf allotted to United States users and 1.5 maf to Mexico from a river system with less than 15 maf that someone is going to be short.

You may be interested in a couple of comparative facts with reference to your river system and ours. For instance, the Columbia river system, after serving parts of seven States and Canada, spills about 12 times as much water into the Pacific Ocean as the total water supply of the Colorado River, if man had never removed a drop from it in his efforts also to serve parts of seven States and Mexico.

The Columbia has at least three times as much salt load (total dissolved solids) as the Colorado River. During the past 10 years the 9 million tons average annual salt load of the Colorado River has caused an average salinity at Imperial Dam near Yuma, Arizona of 760 parts per million. If this same amount of salt could be injected into the Columbia River below Portland, Oregon, its concentration would still be only about 153 ppm total dissolved solids.

Progress on Salinity Control Act

Title I. I would also like to discuss with you the progress being made under the Colorado River Basin Salinity Control Act. Title I, or the programs downstream from Imperial Dam, include a 104 MGD desalting complex at Yuma, a Bypass Drain for salty return flow from Arizona's Wellton-Mohawk Project, a cooperative program to improve irrigation efficiency, irrigation system improvements, acquisition of 10,000 acres of Wellton-Mohawk Project lands, lining of 49 miles of the Coachella Canal, and protective pumping of ground water within five miles of the United States-Mexico boundary.

No construction is underway on the desalting plant. Testing of osmotic membranes is in progress a few miles away at a test facility and a request for proposals has gone out to a number of membrane manufacturers. The desalting plant will be so large that no single manufacturer has capability for providing the membranes.
Construction of 35 miles of bypass drain in Mexico is well ahead of schedule and bids are in on the United States' portion.

The drain will transport Wellton-Mohawk drain water, which caused the salt problem with Mexico, to the Santa Clara Slough 51 miles distant near the Gulf of California until the desalting plant is complete. After that it will carry reject brine from the desalting plant. The program to improve irrigation efficiency is progressing with 30 percent of the Wellton-Mohawk farms now participating. It is hoped that this program will help decrease the amount of water to be desalted. The total Wellton-Mohawk acreage is being reduced by land purchases to also help reduce the volume of water to be desalted.

Forty-nine miles of the Coachella Canal are being lined. The saving of 132,000 acre-feet of water seepage is supposed to offset the losses of Wellton-Mohawk drainage water and reject brine bypassed to the Gulf of California.

The Salinity Control Act also provides for the pumping of 160,000 acre-feet of water on the Yuma Mesa within five miles of the Mexican Border. This so-called "protective pumping" is for the purpose of matching an equal amount of water now being pumped by Mexico immediately across the border and which Mexico refuses to have counted as part of the treaty water. The ground water gradient is toward Mexico. Continued pumping by Mexico would deplete the U.S. groundwater supply. The U.S. "protective pumping" will decrease that possibility.

The total estimated cost of Title I facilities as shown in the F.Y. 1977 budget is about $270 million as compared with an estimated $155 million when the project was authorized in 1974. The Bypass Drain has gone from the original estimated cost of $15.7 million to about $33 million. The Coachella Canal lining originally estimated at $21,450,000 is expected to go much higher. The "protective pumping" authorized at $34,000,000 will undoubtedly be a lot higher.

The final cost for the benefit of Mexico will be over $300 million. This figure does not cover all uncertainties connected with the desalting complex. Nor does it include a mention of anticipated annual O&M costs of $22 - $25 million in perpetuity that will be saddled to the backs of your children and grandchildren.

Title II. Of more immediate concern to the Colorado River Basin is the Title II portion of the Salinity Control Act which authorized salinity control measures upstream from Imperial Dam for the benefit of United States citizens.

Three salinity control units will soon be under construction. The Paradox Valley Unit in Montrose County, Colorado is designed to collect and evaporate saline groundwater which is now flowing into the Dolores River. Let me say at this point that salinity control is a very difficult process. The more we get into it the more problems are uncovered. The collection and evaporation of the saline groundwater in Paradox Valley were expected to be uncomplicated without any particular problems. Hydrogen-sulphide gas has now been encountered in well-drilling operations, which corrodes the pumps
and even defies a sulphur stripping process that was designed to eliminate it. Also, a satisfactory well field has not been delineated.

I'm not sure what the next step is. The Paradox Valley Unit, if workable, is to withhold about 200,000 tons of salt annually from the Colorado River system at an estimated cost of $21,100,000 with O & M at $451,000 per year.

The Grand Valley Unit in Colorado is designed to reduce the seepage of water from irrigated lands into the ground water and thence into the Colorado River. The lining of canals and laterals is included. Also, a primary objective is to improve irrigation efficiencies by limiting application of irrigation water. Cost of the Grand Valley Unit will be about $80-$100 million.

The Las Vegas Wash Unit will consist of facilities for collection and disposition of saline ground water of Las Vegas Wash. The Wash is a natural channel discharging to Lake Mead with an average flow of 50 c.f.s. and a weighted average salinity of 4,000 ppm. It is planned to reduce the present 200,000 tons of salt now going to Lake Mead by 138,000 tons. The salinity of the Colorado River will be reduced by 10 ppm at Hoover Dam and 13 ppm at Imperial Dam, if the scheme works. The proposed plan includes a saline water interception facility, a desalting plant, evaporation lake and a by-pass system for surface flows. The total cost is estimated to be $32,005,000, with O & M costs of $303,000 annually.

Two of the major costs associated with membrane desalting are:
1. the pretreatment costs to prepare the feedwater for the membranes and
2. disposal of the brine water from the plant.

These costs are of major significance for the Mexican Treaty desalting plant and for the Las Vegas Wash plant also.

Thirteen other salinity sources are being investigated for inclusion in the program at a later date. We classify these in three categories:
1. irrigation sources;
2. point sources; and
3. diffuse sources. The first could entail a single irrigation project or a number of irrigation projects in a given drainage basin. Examples are the Palo Verde Irrigation District in California and the Lower Gunnison Basin in Colorado. Examples of point sources are the LaVerkin Springs in Utah and the Glenwood-Dotsero Springs in Colorado. These are natural sources. Diffuse sources include Big Sandy River in Wyoming, McElmo Creek in Colorado, and San Rafael River in Utah. These are also natural sources of salinity.

Dealing with irrigation sources involves rehabilitating irrigation systems and improving irrigation efficiency. The point sources can best be controlled by collection and evaporation, or, in some cases, by collection, desalting and evaporation of waters with high salt concentrations.

The diffuse sources are more difficult and will be costly to control. Involved is the collection of saline water on a selective basis during low-flow high-salinity periods - then diversion to ponds and evaporation.
We have already been in the game long enough to have learned that salinity control involves important institutional factors. The first one being, "whose water is evaporated?" On a water-short river system with the use of the water resource allocated by interstate compacts and a major court decree, this question is of paramount importance.

Salinity control is plagued with environmental problems, too. Environmentalists don't like the idea of making saline water fit for human consumption, or for food production, because the process modifies the environment for such insignificant life forms as the spiny dace or woundfin--small fish found downstream from the 10,000 ppm waters of LaVerkin Springs that pollute the Virgin River and Lake Mead--or for some bird that lives in the millions of acres of salt cedars that could be removed with the saving of hundreds of thousands of acre-feet of water annually coupled with a decrease in concentration of salts in the stream.

In the Colorado River Basin we are trying everything. For instance, natural freezing to desalt the saline flows in the Big Sandy River has been attempted. Sprinklers were used to spray water into the air where it freezes and falls forming an ice pile. The ice crystals which separate are almost pure water. The unfrozen brine contains nearly all the salt. The main difficulties with this process were the freezing of the sprinkler nozzles and collecting the brine and fresh water separately.

The cost of the various salinity control units is being handled in a unique manner. In recognition of Federal responsibility for the Colorado River as an interstate stream and for international comity with Mexico, Federal ownership of the lands of the Colorado River Basin from which most of the dissolved solids originate, and the policy embodied in the Federal Water Pollution Control Act Amendments of 1972, 75 percent of the total costs of construction, operation, maintenance, and replacement are considered nonreimbursable. The remaining 25 percent are allocated between the Upper Colorado River Basin Fund and the Lower Colorado River Basin Development Fund, with the stipulation that not more than 15 percent of the reimbursable 25 percent be allocated to the Upper Colorado Basin Fund since very few benefits accrue to the Upper Basin.

The total cost of the Title II measures is still too uncertain to make a reasonable estimate. The first four authorized units were estimated to cost about $125 million in 1974.

**Water for Energy**

The pending nationwide shortage of energy coupled with the large reserves of coal, gas, and oil shale resources available in the Colorado River Basin are certain to increase water use within the basin. Water will be used for cooling in thermal electric power plants, for oil shale processing, for coal gasification, for coal slurry transportation, and for nuclear power plant cooling.

It is expected that sufficient water will be available from the Colorado River through the year 2000 to provide for the increased consumptive use required for new energy production, as well as for present uses.
These new uses will tend to increase salinity in the river, depending on the nature, size, and location of each facility. One exception would be San Diego Gas and Electric Sun Desert Plant which will use high salinity drain water for cooling, thereby reducing the salinity of the river.

The rate of development is difficult to predict, but with sufficient urgency it is conceivable that energy resources could be developed at a pace that would increase salinity levels above the standards set under the Federal Water Pollution Control Act Amendments of 1972 at Hoover, Parker, and Imperial Dams, even with the salinity control measures in effect. In that event, augmentation will be necessary for salinity control purposes even before it is needed for water supply purposes.

Total Water Management

In the Colorado River Basin the limited water supply, the water quality (salinity) problem, the national need to develop the vast energy resources, and increasing population pressures, are all complexly but inextricably interrelated. For this reason we have directed our attention to a concept of "total water management"; whatever that is. I say "whatever that is" because I understand that a regional office of the Bureau of Reclamation was asked by its Washington Office to define "total water management" which was done in 13 pages. Further, that Washington objected to 13 pages as being too long, saying that one to two pages would be sufficient, but when that Washington Office finished rewriting the definition the document required 29 pages. Maybe that is a self definition of Washington efficiency instead.

To me "total water management" simply means developing and operating the available water resource within the river basin in a manner to efficiently obtain all of the benefits possible for mankind from the resource. Among these benefits I would include those of both a physical nature, such as water supply, food and shelter, energy production, etc.; and those of a social nature including aesthetics, environmental protection and enhancement. Maybe you could elaborate for 29 pages on the subjects of benefits and impacts.

Undoubtedly "total water management" will include many facets. Reservoir operations, salinity control, hydro-energy production, environmental considerations, water distribution, adjustments in water-use priorities, and others will have to be efficiently intermeshed in the overall picture.

I mention this concept to you because I want you to realize that we in the Colorado River Basin are seriously doing everything we can to wisely and effectively utilize in the future every single drop of water within our own river system. We are considering water supply augmentation also, but again from within our own basin from such sources as geothermal and weather modification possibilities.
Summary and Conclusions

Progress has been very slow in augmenting the Colorado River to meet the requirements of the Mexican Treaty which were assumed by the United States as part of the Colorado River Basin Project Act. Positive, reliable results from weather modification and geothermal fluid desalting appear to be years away.

A more pressing problem for the Colorado River Basin is the prospect of increasing salinity in the portion of the basin below Hoover Dam. This problem is being dealt with below Imperial Dam by construction of a desalting complex to improve the salinity of water going to Mexico and above Imperial Dam by measures designed to hold salinity at 1972 levels or below.

New energy developments will further deplete water supplies in the Colorado River Basin. Present supplies are expected to be sufficient to meet the foreseeable demands for energy along with present uses to about the year 2000.

Increased salinity due to increased use of water may be a problem of greater magnitude than the remaining decreasing supply. It may be necessary to augment the Colorado River to maintain the prescribed salinity levels even before the supply runs out. This would be true especially if the salinity control measures now being studied fail to perform at the expected level.

Total water management has become the order of the day with salinity control being only one facet of it.

Ideas that any of you may generate for a practicable solution to our problems will be greatly appreciated. Our record indicates that we will try anything once.