Limiting Salt Loading to the Colorado River

Jack Barnett *– Colorado River Salinity Control Forum*

Controlling the salt that is carried by the Colorado River has been an intriguing and unusual challenge, bringing to the forefront many political, technical, and economic issues. Despite no previous record of salinity control efforts—much less salinity control *successes*—on any major river system in history, the U.S. Congress took a bold step in 1974, addressing the growing salinity problem by passing the Colorado River Basin Salinity Control Act (SCA), requiring cost-effective salinity control on the river.

Prior to this, Congress had passed the Federal Water Pollution Control Act of 1972 (amended in 1977), commonly known as the Clean Water Act, which, among other things, required Arizona, California, Colorado, Nevada, New Mexico, Utah, and Wyoming to set water quality standards on the Colorado River. Enforcement of the Clean Water Act was to be administered by the U.S. Environmental Protection Agency. The new SCA addressed both water quality commitments that had been made to Mexico and requirements within the United States.

The Players

The lead federal agency to implement the Colorado Salinity Control Program (formed through the SCA) was the Department of the Interior, mainly the Bureau of Reclamation. The Secretary of Agriculture was to also play a role, and eventually six other federal agencies became involved. Issues with Mexico were to be addressed by the State Department through the International Boundary and Water Commission (IBWC). The states, seeking to focus their involvement, created their own organization, the Colorado River Basin Salinity Control Forum, to which each of the seven governors were invited to appoint up to three members. In many ways, the forum's goals parallel the mission of the federal agencies.

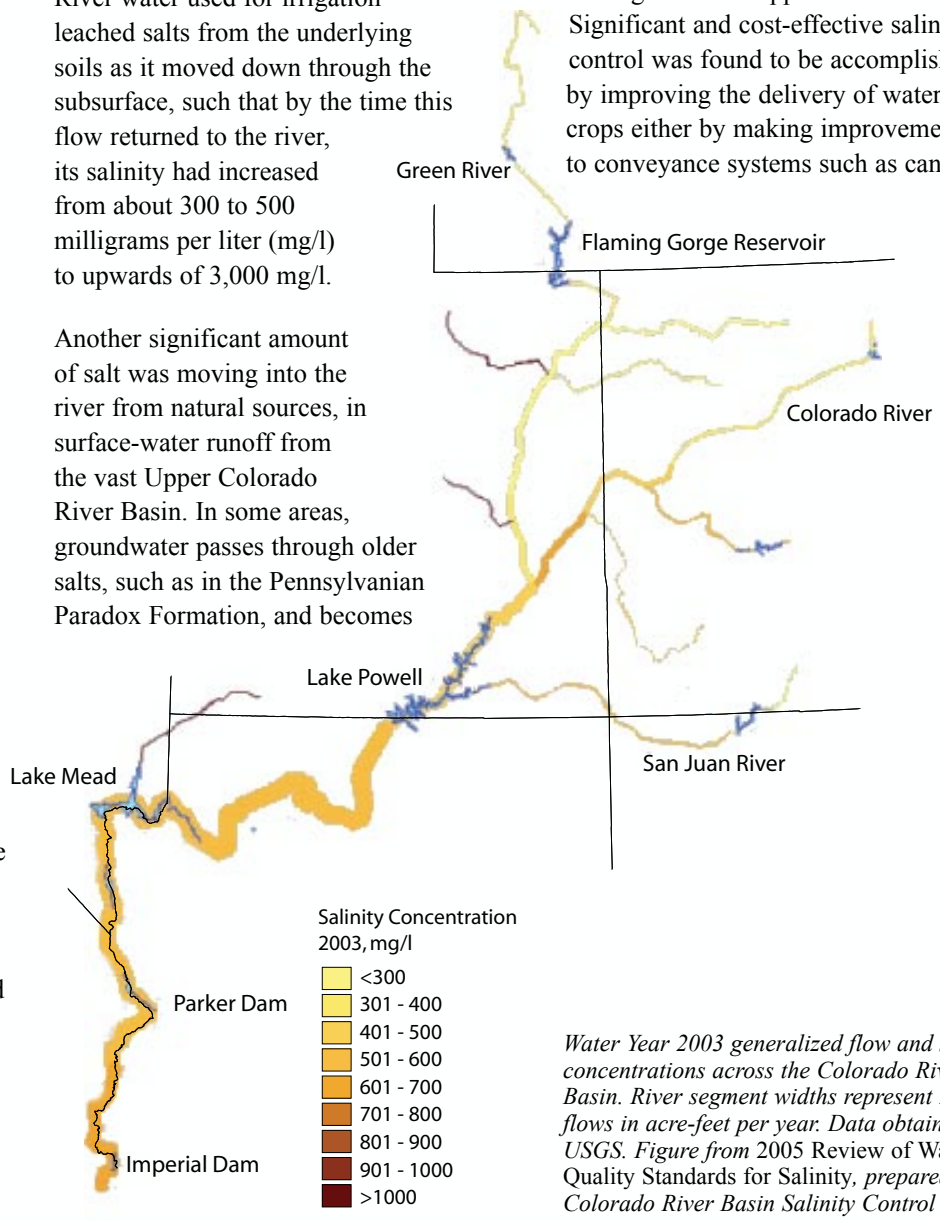
Identifying the Sources

When the SCA was signed by President Nixon, how to control salt loading of the Colorado—or any major river system—was poorly understood. What *was* known was that the salt load from the Upper Basin into Lake Powell each year totaled about 8 million tons, inflicting economic damages on water users in the Lower Basin. The salt was coming from geologic formations deposited under marine conditions, particularly the Jurassic Mancos shale, but human activity exacerbated the problem. Colorado River water used for irrigation leached salts from the underlying soils as it moved down through the subsurface, such that by the time this flow returned to the river, its salinity had increased from about 300 to 500 milligrams per liter (mg/l) to upwards of 3,000 mg/l.

Another significant amount of salt was moving into the river from natural sources, in surface-water runoff from the vast Upper Colorado River Basin. In some areas, groundwater passes through older salts, such as in the Pennsylvanian Paradox Formation, and becomes very concentrated brine. Where such groundwater migrates upward and discharges as springs, these point sources provide additional natural loading.

Control Efforts

In the first decade following passage of the SCA, much effort was spent in investigation and planning. The SCA was subsequently changed to bring the Natural Resources Conservation Service (NRCS), one of the federal agencies involved, into a more active role. The SCA was also modified to require cost sharing from the Upper and Lower basins. Significant and cost-effective salinity control was found to be accomplished by improving the delivery of water to crops either by making improvements to conveyance systems such as canals or



Water Year 2003 generalized flow and salinity concentrations across the Colorado River Basin. River segment widths represent 2003 flows in acre-feet per year. Data obtained from USGS. Figure from 2005 Review of Water Quality Standards for Salinity, *prepared by the Colorado River Basin Salinity Control Forum.*

by making changes to on-field irrigation, such as converting to sprinklers. This approach—reducing human-caused loading by return flows—has been the main thrust of the program. But an important additional activity is being carried out by Reclamation in the Paradox Valley of Colorado, where the deep-sourced saturated brines that were flowing into the Dolores River have now been cut off by shallow collection wells and injected into deep limestone formations.

Over $45 million is now being spent each year on salinity management in the Colorado River Basin, funded by Reclamation, NRCS, the basin states' cost-sharing program, and local irrigation participants. The salt load to Lake Powell has dropped to around 7 million tons annually, with a corresponding reduction in total dissolved solids to Lower Basin users of about 125 mg/l.

The Costs of Salinity

Recent computer model runs by Reclamation indicate that salinity levels are unlikely to return to 1972 levels in the foreseeable future. More important is the issue of downstream economic damages. Reclamation has created an economic model that evaluates the impacts of the salt in the water, focusing on quantified damages. For example, crop production is reduced when salinity levels are higher. Household water appliances in homes may clog or corrode sooner, reducing the life of the appliance. Treatment costs of water for municipal use are greater. Consider that in the United States, Colorado River water is used to irrigate 4.4 million acres and to serve water to 33 million people. Reclamation's model indicates that current quantifiable damages are $376 million a year. For each mg/l in salt reduction, the quantified damages are reduced by $1.4 million. Hence, with the current estimated reduction of 125 mg/l since 1974, the yearly damage reduction is approximately $175 million.

Other damages from salinity are known to occur but are difficult to quantify, such as when imported Colorado River water is used more than once. If the TDS of reclaimed water is not low enough for the second use, then expensive treatments such as desalination must be implemented or an additional water source obtained. Groundwater once suitable for use may become impacted by decades of infiltration of imported high-TDS surface water, introducing the need for desalination.

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For Lower Basin agriculture, the costs of having to grow more salt-tolerant crops rather than crops of higher economic value are not currently captured in the economic model. Unquantified damages such as these may be very large, perhaps at least as significant as the quantified damages.

The improvement of water delivery systems in the Upper Colorado River Basin has had a positive economic impact. Efficient delivery systems allow more water to be held in storage. Sprinkler systems require less water than rough furrow irrigation, less labor, and often less fertilizer; sometimes they result in greater production. These economic benefits have not been quantified.

The Colorado River Basin Salinity Control program has made great strides in salinity management of a major river system through successful cooperation among federal, state, and local interests. Salinity impacts to Mexican river water deliveries, although not quantified, also have been reduced, water quality treaty commitments have been met, and salinity control has been very cost-effective. However, much more work can be done to further reduce downstream damages in the United States and Mexico. Additional data, study, and analysis will increase understanding of the hydrosalinity of the Colorado River and can lead to more accurate accounting and implementation of the most cost-effective control options in the future.

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