CHAPTER 4 – CENTRAL ARIZONA SALINITY ECONOMIC ASSESSMENT MODEL

INTRODUCTION

Managing the salts imported with CAP and Salt River waters into central Arizona and mitigating the salt imbalance in the region has economic benefits to society. However, if steps to manage salinity are not implemented, at some point the economies and groundwater resources of affected communities will be adversely impacted beyond current levels.

The high salinity levels of imported CAP and Salt River waters cause economic impacts to residential, commercial, industrial, and agricultural sectors. The general population must pay for more frequent replacement of water-using household appliances and elective home water softeners and other treatments. The high-tech industry bears increased costs to remove salts from the water used in manufacturing. Farmers lose income as a result of reduced crop yields and increased operational costs, and are forced each year to procure additional water to leach salts out of the root zone from the previous year's irrigation. And in the long run, continuing to import waters high in salinity will continue to degrade the groundwater, which will exacerbate these problems. The CASS Technical Committee worked to quantify the economic impacts brought about by salinity in the water that is imported into central Arizona.

In the late 1980s, USBR developed a computer model to assess the economic impacts of Colorado River salinity on the entire Lower Colorado River Basin. The model produced an initial estimate of damages on a regional basis. The Metropolitan Water District (MWD) of Southern California, in cooperation with USBR, updated that model for a salinity management study of southern California conducted in the late 1990s. This update of the model was done to better understand the economic impacts of salinity in MWD's water delivery area. MWD improved the model by focusing only on their delivery area and included knowledge specific to their local water systems and salinity problems. The Technical Committee, building on what MWD had accomplished, revised the model further by only focusing on central Arizona and incorporating factors inherent in or common to central Arizona. One of those factors, was accounting for the importation of salts from the Salt, Verde, and Gila Rivers, in addition to the salts imported with Colorado River water into central Arizona.

The data on water use and water quality in central Arizona was much more detailed and accurate than previous projections made with the model. The model calculates salinity impacts to five sectors of society: (1) residential, (2) commercial, (3) industrial, (4) agricultural, and (5) water utilities. For the residential sector, the impact of salinity is calculated in terms of reduced useful life of household appliances such as water heaters, evaporative coolers, faucets, garbage disposals, clothes washers, and dishwashers. Also calculated for residential consumers are "avoidance costs," such as buying bottled water and installing and maintaining water softening systems. Costs to the commercial sector are similar to those considered for residential users, but include impacts related to non-industrial sized cooling towers. Industrial sector impacts include costs associated with demineralizing and softening water used in manufacturing processes, costs of maintaining industrial cooling towers, and costs associated with treating boiler feed water. Agricultural costs fall into two primary categories: loss of income due to reduced crop yields and the cost of water to leach the salts out of the crop root zone. Water utilities' costs are calculated based on the lowered useful life of water treatment facilities when processing high-salinity water.

The baseline data used in the analysis represented a typical Arizona year of water use and water quality in Arizona. The reasoning for using a “typical year” was that currently Arizona is in a drought. The Technical Committee did not want to use the latest water year data because the Salt and Verde Rivers are delivering much lower amounts of water and have much greater salinity concentrations. The Technical Committee concluded that these factors would skew the results, so a “typical year” was created. The typical year uses population numbers from the 2000 census and water consumption rates derived from that year. But the water supply values are from either averages or medians of the Colorado, Gila, Salt, and Verde Rivers. Average water supply numbers were adjusted to match the demands for the year 2000. Water quality, including groundwater quality, is an average TDS value expressed in mg/L. The data was collected from ADWR, ADEQ, USGS, SRP, CAWCD, the City of Phoenix, and many other local sources. Because the salinity level of the consumed water was the most important analytical factor, water was tracked by source, not by legal owner. For example, SRP may have delivered CAP water to its customers, but for purposes of this model the water was considered CAP water, not SRP water.

The model calculates the economic impacts due to a change in the salinity of water in the five sectors of society previously discussed. For example, in a typical year the TDS in CAP water is 650 mg/L, and in SRP water is 475 mg/L, these salinity levels are used as the baseline. Those values are derived from the 30 year average TDS for CAP which is 649 mg/L, rounded to 650 mg/L and the 20 year weighted average of the Salt and Verde Rivers which is 475 mg/L. When the salinity level increases or decreases, the model calculates the economic impacts between the baseline salinity level and the new salinity level. As the salinity levels increase the resulting information can be graphed. The curve of the graph shows the annual impacts to society as salinity levels change from the baseline (Figure 4-1).

Three separate analyses using the model were performed to assess the economic impacts due to changes in salinity of imported waters. The analyses examined: (1) improvement and degradation of the Colorado River water imported via the CAP, (2) improvement and degradation of the Salt and Verde River water imported via the SRP system, and (3) a combination of (1) and (2). The groundwater salinity level remained the same in all three analyses. Salinity in effluent was calculated as the average TDS of the consumed water in the area, including both imported and groundwater, plus 300 mg/L TDS to reflect the input of salts by society. The model then used a weighted average TDS of imported waters, groundwater, and effluent in proportion to their use to produce the salinity economic impact calculations.

In the first analysis, CAP water was changed by 100 mg/L TDS increments from a starting point of 650 mg/L TDS (25-year average of Colorado River). All other waters were held constant except for effluent, which varies with the salinity of the other waters in the area as explained above. As shown in Figure 4-1, an increase or decrease of 100 mg/L TDS of CAP water results in just under a $15 million annual impact to society. All values are in 2002 dollars the year the analysis was done.

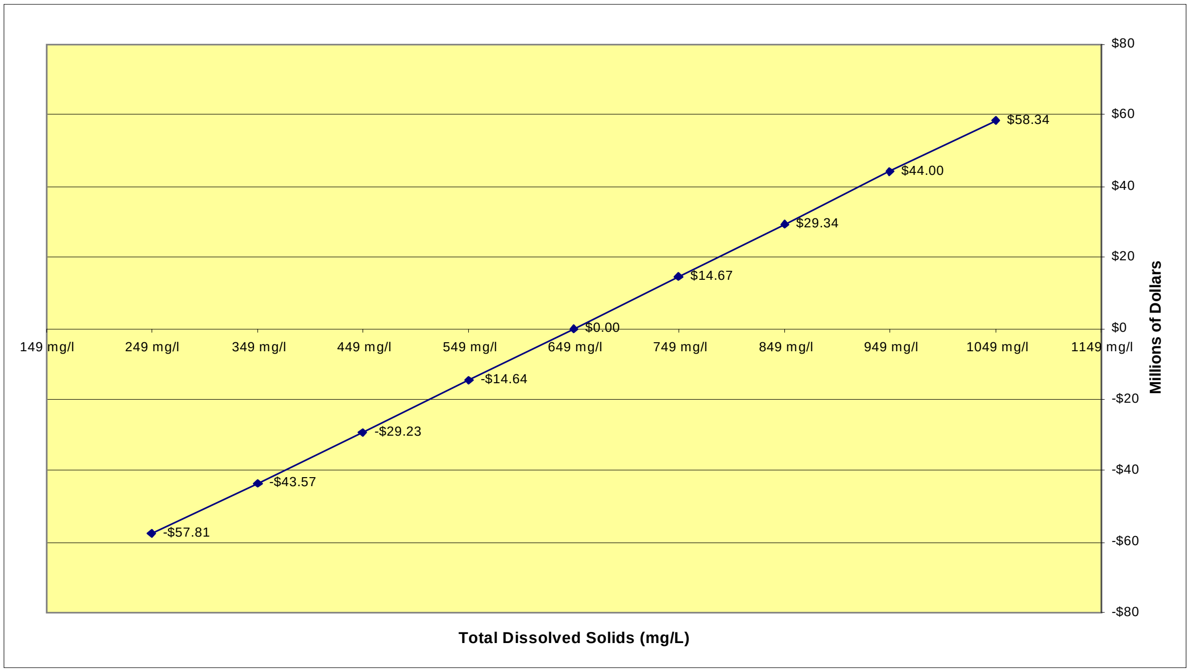

Figure 4-1. Annual Costs Due to Changes in Salinity of CAP Water (Colorado River)

Figure 4-1 demonstrates that the economic impacts of increasing salinity in CAP water are nearly linear. At two points—when the weighted average TDS was so high that it was no longer considered potable and when the weighted average TDS was so low that the water would be extremely aggressive—would the economic impacts diverge from the nearly linear results. Neither one of those conditions are feasible within the range of anticipated salinity of CAP water. (Aggressive water is water that is soft and acidic and can corrode plumbing, piping, and appliances.)

Table 4-1 shows the costs incurred by different sectors of society within the study area from the same analysis that produced Figure 4-1. The portion of the table shown reflects the annual cost increase to water users due to an increase of salinity of the Colorado River water from 650 mg/L to 750 mg/L. The majority of the impacts occur in the Phoenix metropolitan area. All values are in 2002 dollars the year the analysis.

Table 4-1. Costs of Increased Salinity in CAP Water

TDS = 750 mg/L	Residential	Commercial	Industrial	Agriculture	Utilities	Total
Phoenix Metro Area	$6,430,921	$1,948,078	$2,400,992	$1,673,841	$342,928	$12,796,761
Gila River Indian Community	$8,935	$2,179	$0	$82,548	$0	$93,662
Harquahala Basin	$2,091	$407	$0	$426,859	$0	$429,358
Tucson Metro Area	$0	$0	$0	$2,402	$0	$2,402
Pinal Study Area	$310,298	$58,830	$95,476	$887,154	$0	$1,351,758
Gila Bend Basin	$0	$0	$0	$0	$0	$0
Total	$6,752,245	$2,009,495	$2,496,469	$3,072,805	$342,928	$14,673,941

For several obvious reasons, the Phoenix metropolitan area experiences the highest impacts in this analysis: this study area has the most residents, uses the most water, and has greatest number of industrial consumers (industrial water processing costs are high). Conversely, Tucson has very minimal impacts because they are not at this time directly using CAP water, except for a relatively small amount for crop irrigation. However, Tucson is currently using a blend of CAP water and groundwater, and the composition of the blended water will eventually approximate the composition of CAP water unless additional steps are taken to control salinity. Because the large-scale introduction of CAP water has only recently begun in Tucson, the "typical year" for Tucson will likely occur around 2015. Continued use of CAP water in the Tucson metropolitan area will cause the impacts in that area to increase. Table 4-1 is only a small portion of the data output. The complete data output is included as Technical Appendix J.

Figure 4-2 shows the economic impacts due to change increments of 100 mg/L TDS in Salt River and Verde River water delivered by SRP, starting from a baseline of 475 mg/L TDS (25-year weighted average of the Salt and Verde Rivers). The graph indicates that the economic impact is slightly above $15 million for each increase or decrease of 100 mg/L TDS. Again, the economic impact of change of salinity concentration in the Salt and Verde Rivers is nearly linear. All of these impacts occur in the Phoenix metropolitan area because it is the only area where SRP water is used.

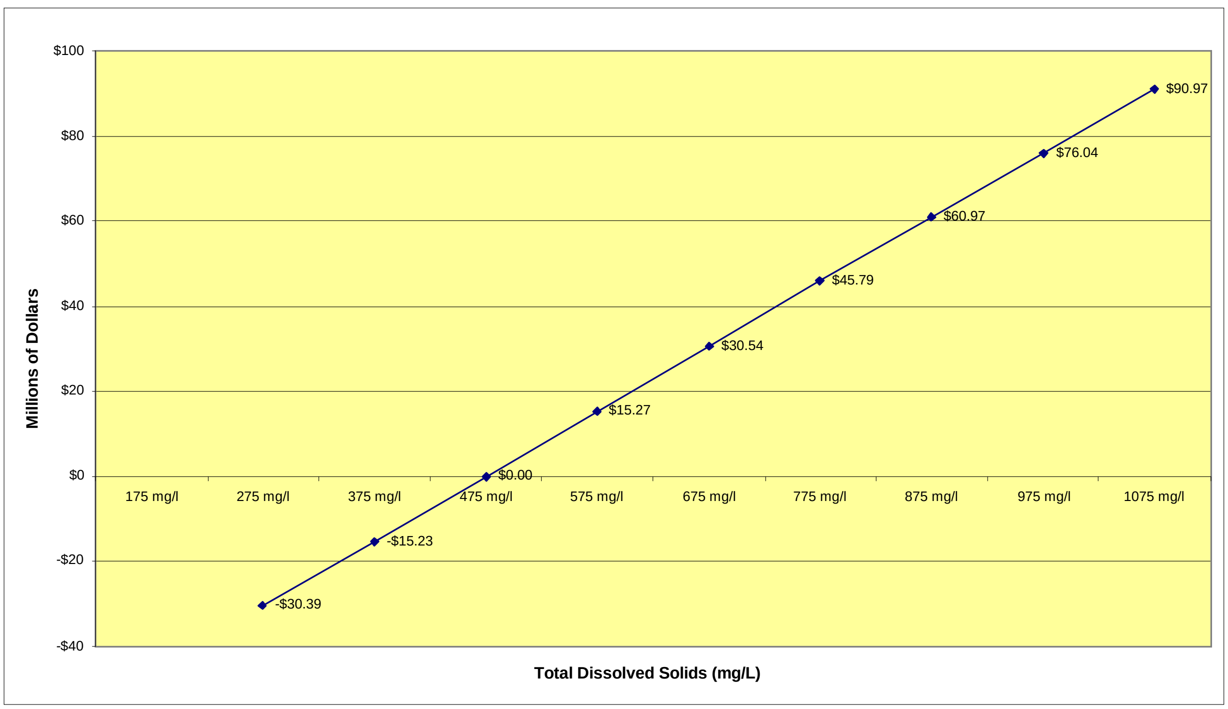

Figure 4-2. Annual Costs Due to Changes in Salinity of SRP Water (Salt and Verde Rivers)

The economic impacts of salinity changes in CAP and SRP water are calculated at approximately $15 million per incremental change in salinity of 100 mg/L. However, it is coincidental that these impacts are similar. More CAP water than SRP water is used on an annual basis, but proportionally more CAP water is used for agriculture and recharge. The similarity in overall economic impact of high salinity in these water sources may be attributed to the differing use characteristics.

Figure 4-3 depicts changes in salinity of 100 mg/L TDS in the combination of both the CAP and the SRP waters. As might be expected, the economic impacts are approximately twice the value, at nearly $30 million for every 100 mg/L of change in salinity concentration.

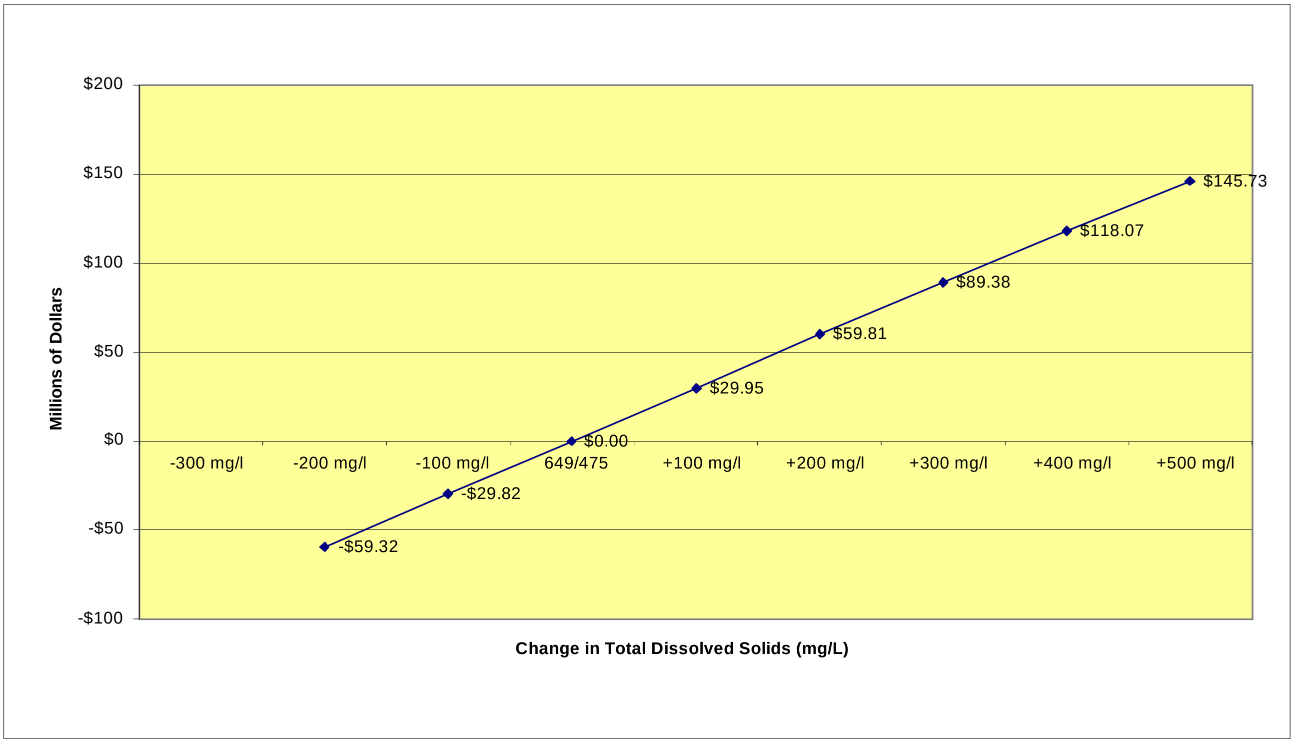

Figure 4-3. Annual Costs Due to Changes in Salinity of SRP and CAP Waters

Another way of assessing the annual impacts is to compare the current salinity concentration to EPA's secondary MCL standard of 500 mg/L TDS. The 30-year average TDS of Colorado River water is 650 mg/L at the entrance of the CAP at Lake Havasu. If CAP water delivered to users met the secondary MCL, the estimated savings to central Arizona users is calculated to be about $22 million annually. These savings would be in the form of extended life of residential water appliances, larger crop yields, less water used to leach salts from the soil, and reduced costs to businesses and industry for such things as cooling tower maintenance and treatment of water used in manufacturing processes. The annual Gross Domestic Product (GDP) for Maricopa County is approximately $93.6 billion. The economic burden of using high-TDS water is assessed at approximately 0.02 percent of the GDP. These costs are spread throughout society, with the majority of the costs allocated to individual homeowners. If these annual costs were equally divided among the citizens of Maricopa County, each person would pay about $7.10 per year.

The model does not, and cannot, include all the economic ramifications of importing high-salinity water into central Arizona. Other economic impacts not considered in the model include abandoning wells due to high TDS in the groundwater and the costs of importing additional water because of poor quality groundwater. Increased maintenance costs at private golf courses and other non-municipal recreational areas are also not included in the model. While the costs of additional water used by farmers to flush salts from the root zone are considered, the higher payroll expenses associated with salinity management are not. The model is a not a fully comprehensive tool, but it does provide a working concept of the magnitude of the costs associated with high salinity, and some conclusions can be reached from the modeling work. One is that if the SRP and the CAP water quality were improved by 100 mg/L, the savings to central Arizona would amount to approximately $30 million per year. Residents incur about 45 percent of the cost impacts, but industrial, commercial, and agricultural users are also impacted. Another conclusion drawn from the model analysis is that there is not a particular “break point” at which the economic impacts rapidly improve or degrade. Rather, the results indicate that the impacts associated with salinity follow a linear path. There is no “magic” range of water quality to shoot for that will dramatically reduce the economic impacts to society.

And finally, it is important to notice, as shown in Table 4-1, that the vast majority of economic impacts projected by the model occur in the Phoenix metropolitan area. As previously stated, this not just a function of the high salinity CAP water, but a combination of CAP and SRP water coupled with the largest concentration of population and industrial water use in the state.

Technical Appendix J provides more detail on the economic assessment model.