ECONOMIC EVALUATION of WATER CONSERVATION PRACTICES

by

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The Senate Select Committee on National Water Resources recently concluded that by 1980 the number one resource shortage of the nation will be fresh water. The U.S. Geological Survey has estimated that by 1980, the daily requirement for the nation will be 600 billion gallons of water; this will have to be obtained from the 4,300 billion gallons of rainfall that falls daily on an average on the United States.

The daily increasing requirements are due to the increasing population, plus the increasing rate at which we are using water in our daily lives. In the arid Southwest, of course, the problem is most serious. While in cities like Tucson, water is thrown around like it were only money, the problem is real to the rancher who has to haul water when his stock pond dries up, or to the irrigator as he watches his groundwater levels drop consistently.

To provide the required water supplies, development and conservation practices will have to be established. The feasibility of providing water by these development and conservation practices for the various uses needs to be economically evaluated.

**ECONOMIC EVALUATION**

By noting the value of water in Arizona for various uses in Table 1, one can determine the economic feasibility of the following development and conservation practices.
### APPRAOCHATE VALUE of WATER in ARIZONA in DOLLARS PER ACRE-FOOT

<table>
<thead>
<tr>
<th>Category</th>
<th>Ave.</th>
<th>Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domestic</td>
<td>100</td>
<td>?</td>
</tr>
<tr>
<td>Industry</td>
<td>75</td>
<td>Produces income worth 500 to 750</td>
</tr>
<tr>
<td>Mining</td>
<td>40</td>
<td>Produces minerals worth 3,000</td>
</tr>
<tr>
<td>Pulp</td>
<td>-</td>
<td>Produces paper worth 3,300</td>
</tr>
<tr>
<td>Livestock</td>
<td>300</td>
<td>Produces beef worth 10,000</td>
</tr>
<tr>
<td>Irrigation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wheat</td>
<td>-</td>
<td>10</td>
</tr>
<tr>
<td>S.S. Cotton &amp; Veg.</td>
<td>-</td>
<td>20</td>
</tr>
<tr>
<td>L.S. Cotton</td>
<td>-</td>
<td>22</td>
</tr>
<tr>
<td>Citrus</td>
<td>-</td>
<td>25</td>
</tr>
<tr>
<td>Recreation</td>
<td>1000/acre of water surface</td>
<td></td>
</tr>
</tbody>
</table>

**Weather Modification**

Weather modification is in the research stage, but indications are that, if the techniques for example for seeding the clouds to increase the total amount of rainfall over an area are perfected, the cost-benefit ratio would be very favorable.
Deminerlization of Saline Water

The chief aim of this research program is to reduce the conversion cost from the present approximate 350 dollars per acre-foot of treated water to a cost which more nearly compares with the prevailing price of about 100 dollars per acre-foot (30 cents per 1000 gallons) of domestic water at the tap.

An important factor when considering deminerlization of saline water is the cost of lifting and transporting the water from sea level to the point of use.

Artificial Groundwater Recharge

One of the most critical problems in the Southwest today is the diminishing groundwater supply. The average yearly overdraft on the groundwater reserves in Arizona alone is approximately three million acre-feet. Artificial recharge takes flood waters that are normally lost by evaporation and transpiration by non-beneficial plants and places it in the underground reservoir. However, any successful program of artificial recharge must include consideration and asso- ciation of many factors, such as methods of desilting, relative chemical quality of recharge water and native groundwater, algae and bacteria control, and air-plugging of aquifer.

Cost of artificial recharge ranges from approximately 40 dollars per acre-foot using injection wells, to almost nothing where spreading is technically feasible. Research is underway in an effort to develop methods of treatment for well injection where costs will total about
five dollars per acre-foot of water recharged. A factor when considering artificial recharge is the cost of back pumping when the water is to be utilized.

**Evaporation Suppression**

Evaporation from reservoirs and stock tanks results in large losses of water in the Southwest. The total yearly evaporation loss from free water surfaces in the 11 Western States is estimated at 11 million acre-feet; the loss from Lake Mead alone averages about 750,000 acre-feet yearly.

Chemicals like hexadecanol, which form monomolecular films, are applied to water surfaces to reduce evaporation. Savings in water of about 65 per cent are being obtained when the chemical is used on water in pans having a diameter of about four feet. Savings of about 25 per cent are being obtained from stock tanks up to two acres in surface area. However, any successful program of evaporation suppression must include consideration and resolution of many factors, such as methods for detecting the film on the surface, technique of application, how to prevent microbiological attrition, and effect on the thermal balance of the body of water.

Cost of evaporation suppression in field tests to date range from approximately 60 dollars per acre-foot of water saved at 2500-acre Lake Hefner, Oklahoma, in trials by the Bureau of Reclamation, to 10 dollars per acre-foot in about 100-acre lakes in Australia.
Watershed Management

Since only a small part of the water that falls as precipitation in the Southwest is effectively used, research is being conducted in watershed management to determine if eradication of non-beneficial plants will increase timber, forage, and water, and, if so, the economics of the operation. Almost one million dollars is being spent in Arizona alone in cooperative studies involving the University of Arizona, Arizona State Land Department, the United States Forest Service, Geological Survey, and the Bureau of Indian Affairs.

The program consists of block and strip cutting of spruce and fir, thinning of ponderosa pine, and eradication of juniper, pinyon, phreatophytes, and non-beneficial chaparral. The removal of vegetation is being accomplished by prescribed burning, and mechanical and chemical means.

Studies indicating increases in water yield of 5 to 10 per cent of precipitation and increased plant efficiency in use of water have been reported by researchers from the University of California; however, the program is still in the calibration stage in Arizona.

Treatment of Watershed Areas

On an 18 square mile watershed near Tucson, the average runoff for the past three years has been barely three per cent of the precipitation - the rest of the water is almost all lost by evaporation and transpiration by non-beneficial plants. To increase water yields,
to provide water for domestic livestock and game animals, small areas are being paved with asphalt, cement, concrete, tar paper, rubber, or plastics. Chemical sprays, which can be applied from airplanes, are being considered for large areas; sufficient chemical to cover an acre would cost only about 30 dollars.

The research program currently in progress at the Arizona Agricultural Experiment Station is investigating the effectiveness, durability, and economics of the various materials used to seal the surface areas.

**Increasing Irrigation Efficiencies**

The largest single use of water by far in the Southwest is for irrigation; yet, Dr. O.W. Israelson, one of the most eminent authorities on the subject, estimates that just 25 to 35 per cent of the water diverted for irrigation is ever used by the growing crop. A 10 per cent increase in irrigation efficiencies in Arizona alone would result in a saving of 500,000 acre-feet of water - this is nearly five times the yearly amount used by both Tucson and Phoenix.

To increase irrigation efficiencies, the following operations are required: Better land preparation; better irrigation systems, including lined ditches, etc.; determine when to irrigate and how much water to apply; measure water being applied; breed varieties of plants which are more efficient water users; and attempt to get maximum yields per unit of water rather than per unit of land. The cost-benefit ratio of these operations would most probably be very favorable.
CONCLUSIONS

Water is the limiting factor in human well-being throughout the Southwest. Better utilization of the rainfall, although it is inadequate and uncertain, holds the best present promise technically and economically of meeting to an appreciable extent the tremendous need for water in this area, and, in fact, all the arid areas of the world.

There are a number of agencies, private, State, and Federal, concerned with the problem. A recent count shows that no less than 26 Federal agencies are involved - every time a drop of water falls, they examine it, name it, claim it, dam it, or fight over it. With this interest, plus the interest of the others, more efficient use, with resulting improved cost-benefit ratios for the operations, of the available water resources in the future certainly is assured.