ATMOSPHERIC WATER RESOURCES DEVELOPMENT IN THE COLORADO RIVER BASIN

From the onset of the Bureau of Reclamation's research program to increase water supplied by weather modification, the Colorado River Basin has been a major area of research efforts. The very first contract in the program was made with the University of Wyoming to study increasing the water supply by cloud seeding for Reclamation projects in Wyoming. To date, we have invested over one-third of the program funds on research projects for developing precipitation enhancement techniques in the Colorado River Basin.

This year, three major "Project Skywater" field activities are being conducted for the Colorado River Basin. The University of Wyoming is studying methods for obtaining more snowfall from mountain cap clouds. Present experiments are being conducted at Elk Mountain, an isolated peak just outside the Basin drainage. Experimental cloud seeding is being continued in the Park Range by E. Bollay Associates with ground-based generators using silver iodide. Field support for the Park Range experiment is being provided by the Soil Conservation Service, the Geological Survey, and the Forest Service through formal agreements with the Bureau of Reclamation. At Flagstaff, Arizona, Meteorology Research, Inc., is developing modification techniques to increase precipitation from summer cumulus clouds. Techniques perfected at Flagstaff will be particularly significant in enhancing precipitation over the Lower Basin and in the lower elevations of the Upper Basin.

In total, the Bureau of Reclamation has 11 organizations involved in Colorado River precipitation modification research—4 university groups, 2 private research firms, and 5 Federal agencies.

Detailed planning is now beginning for a large-scale pilot operation in the Upper Colorado River Basin. Knowledge gained through our comprehensive efforts and those financed through the National Science Foundation gives a firm basis for planning an undertaking of this magnitude. This first pilot project could be logically initiated as early as 1969 or 1970.

We believe it reasonable to anticipate that within 10 years a firm capability to augment Upper Basin streamflow by about 1,900,000 acre-feet annually could be developed. A justifiable large-scale operation could then be started involving:

Seeding with in well-defined and localized target areas by remote controlled ground-based generators using silver iodide.

Seeding susceptible winter storms at high elevations to increase winter snowpack.

Modification of winter precipitation in lower or middle elevations of the Upper and Lower Basin and summer precipitation throughout the region are further potentials that could be realized by 1985.

Primary target areas for initial large-scale operations can be identified where precipitation and runoff are sufficient to warrant modification and where temperatures are suitably cold during reasonably long periods. With these fundmental considerations, 14,200 square miles of major primary target areas have been tentatively identified. These areas are generally above 9,500 feet where settlement is sparse and, except for the skiing enthusiasts, activity is reduced in the wintertime. The best seeding season will normally be November through April when an average of 19.4 inches of precipitation occurs.

We believe it safe to assume that a 15-percent increase in the average winter precipitation is likely within 10 years. Recognizing that indicated precipitation increases by current cloud seeding operations and experiments are generally in the 10-to-20-percent range and that considerably expanded knowledge and improved systems should be available by the mid-1970's, a 15-percent increase seems conservative.

Although the average annual streamflow augmentation of about 1,900,000 acre-feet will occur during the spring runoff, regulation provided by the large storage capacity built in the Colorado River Basin will make virtually all the increase usable water supply.

The total annual cost of a full-scale cloud seeding operation in the prime target areas is estimated at $2,650,000. This estimate includes amortized initial installation and replacement costs, supplies, maintenance, and a continuing analysis of results and any effects on ecological regimes.

The unit cost of producing 1,900,000 acre-feet of new water by cloud seeding is thus estimated as about $1.50 per acre-foot. The estimated cost is probably on the high side, representing an upper boundary for costs. Once more is known, careful planning may reduce unit costs to as low as $1.00 per acre-foot.