Cloud Seeding in the

Management Perspective

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The Colorado River Basin is experiencing significant demands upon its available water supply and these pressures are only expected to become more intense in the future. Population over the next 20 years is expected to increase by 39 percent in the Lower Basin states (California, Arizona, and Nevada) and 26 percent in the Upper Basin states (Colorado, Utah, Wyoming, and New Mexico), representing millions of additional people who will be dependent upon the Colorado River for water.

The current level of development and use of Colorado River system water is also becoming a concern. The Lower Basin states are effectively using all of their Compact apportionment now, and the Upper Basin states will be using their full apportionment in the future due to rapidly increasing uses.

Adding to pressures on the available Colorado River water supply, the basin remains in the throes of one of the worst droughts on record. The years 2000 to 2004 were particularly severe, with Lake Powell inflows ranging between 25 and 62 percent of average and Lake Powell dropping to 33 percent of its capacity. Even with one year of near-average inflow, lakes Powell and Mead are still only about half full. Sustained droughts have become much more serious and difficult to withstand with the increased development of the Colorado River. And more uncertainty has been introduced into drought management due to new tree-ring studies of past severe drought and new theories on future effects of a warming climate on Colorado River streamflow.

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As a result of these circumstances, Colorado River water managers have been engaged in planning for shortages in the Lower Basin and evaluating coordinated operations of lakes Powell and Mead. The goals of these efforts are to improve system efficiency, to delay and reduce Lower Basin shortages, reduce risks of Upper Basin use curtailment according to the 1922 compact, and better meet the needs of system users within current law. Augmenting the supply of Colorado River water has become a high priority in the effort to meet future needs. All feasible means of doing this are being evaluated, including winter cloud seeding.

Upper Basin Seeding Efforts

Wintertime cloud seeding is not new to the Upper Basin states. Utah, Colorado, and Wyoming currently

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have significant, active, winter cloud-seeding programs. In some cases these efforts have been going on for over 30 years. Current annual expenditures for Upper Basin operational cloud-seeding programs have reached approximately $2.6 million. These operations have benefited not only specific Upper Basin states but also the entire basin.

Lower Basin states are now collectively attempting to add funding to Upper Basin cloud-seeding efforts to enhance and extend existing programs. During water year 2007, an estimated $270,000 will be added by the Lower Basin for these efforts. In general, Upper Basin states have expressed a willingness to consider additional funding to enhance and extend existing efforts, provided weather modification is adequately controlled and monitored to ensure that no Upper Basin state or local interests are harmed, such as from impacts from operations in above-average years.

The Effectiveness Debate

The scientific community is currently debating the effectiveness of winter cloud-seeding programs. Uncertainty arises primarily from the difficulty of statistically demonstrating and predicting precise amounts of increased snowpack from a certain level of effort. Some scientific organizations have decided not to support the idea that cloud seeding will increase water supplies unless there are direct, measured, and statistically verified increases over natural events. For many practical reasons, this is a difficult fact to tease out of the data. However, many scientific organizations do conclude there is increased precipitation from cloud seeding when it is properly conducted. A significant preponderance of indirect statistical information implies that snowfall and runoff will increase under proper conditions. Existing seeding operators have gained sufficient data from their efforts to allow confidence that cloud seeding is effective and justifies continued funding. Most professional cloud seeding organizations now believe that the effectiveness of these programs is in the range of a 5 to 15 percent increase in precipitation over the target areas.

Results of a winter cloud seeding preliminary feasibility study funded by the Upper Basin and conducted by Don A. Griffith of North American Weather Consultants Inc. (see page 19) agreed with this predicted increase in snowpack over selected target areas from properly designed and conducted cloud-seeding efforts. Estimates of the amount of additional water that might be generated from all cloud-seeding efforts in the basin ranged from about 600,000 acre-feet to 1.6 million acre-feet per year during average weather conditions. During drought, less additional water would be generated from seeding, so it is important to seed during wetter times and store additional water in reservoirs. A portion of these predicted increases is already contributed from existing operations, but a very significant additional amount was predicted to be gained from new efforts. The cost of developing this water was estimated to range from $4.50 to $11.50 per acre-foot. These costs are extremely low compared to any other feasible means to augment the flow of the river. Although scientific debate about the exact amount of increase generated from cloud seeding remains, the result would be the most cost-effective water that can be developed, even if estimates are off by an order of magnitude.

With proper design, controls, safeguards and monitoring, the Upper Basin states will likely consider additional cloud seeding. However, because of the difficulty in quantifying the specific effect of cloud seeding, any water generated will be considered "system water" and not specifically allocated to any state or entity. The water may be used by any state, but only within that state's Compact apportionment and consistent with state water law. Just as a high tide floats all boats, increased runoff will benefit all states, primarily through increased reservoir storage that will help the states get through periods of drought.

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cost is designated for effectiveness evaluations, including statistical studies and physical measurements such as the detection of silver in snow.

Ways to Proceed

Design studies are recommended to customize new operational winter cloud-seeding programs in the four states according to site-specific factors such as climatology, topography, the presence and frequency of seedable conditions, social considerations, and existing state regulations. Existing programs could be enhanced by new or supplemental seeding equipment or by extending the operational periods.

Federal funding should be sought to support research programs, which could be piggybacked onto operational programs, to evaluate the effectiveness of various types of seeding and impacts on streamflow. The basin states should also coordinate among themselves to share costs and administration of both new and existing programs.

Because they do not require large permanent infrastructure, cloud-seeding programs can be relatively quickly implemented, suspended, or terminated. Routine, year-after-year cloud-seeding programs could help stabilize and bolster water supplies, even though the total volume of increase will vary over wet and dry years. Establishing routine programs is recommended because predicting a wet or dry year in advance is difficult, conditions can change mid-season, additional wet-year precipitation can be stored for use during dry periods, and commitment to a long-term program helps provide stability and acceptance by funding agencies and the public.

The complete report is available at www.nawcinc.com/Colorado%20River%20Seeding.pdf. Contact Don Griffith at dgriffith@nawcinc.com.

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