

Northern Nevada Water Planning Commission ("NNWPC")

STAFF REPORT

DATE: September 28, 2017
TO: Chairman and Members,
FROM: Chris Wessel, WRWC Water Management Planner
Frank McDonough, Desert Research Institute, Associate Research Scientist
SUBJECT: Report by the Desert Research Institute ("DRI") on last winter's cloud seeding operations for the Truckee River and Lake Tahoe Basins, and alternatives for operations for the upcoming winter; discussion and possible recommendation to the Western Regional Water Commission ("WRWC") for funding in an amount not to exceed \$100,000 from the RWMF to support similar limited operations for the upcoming winter.

SUMMARY

Since 2009, DRI has conducted its cloud seeding program for the Truckee River and Lake Tahoe Basins using funds provided by either the Truckee Meadows Water Authority ("TMWA") or the Truckee River Fund ("TRF"), and the WRWC. TMWA has indicated that funding will not be available from TMWA or the TRF for cloud seeding operations for the 2017-2018 water year. DRI anticipates that some cloud seeding funding will be available from the State of Nevada for water year 2018-2019. In anticipation of reduced funding for the upcoming winter, DRI has provided a Proposal and Scope of Work, including a budget for \$100,000 (attached) from the RWMF, to support a modified cloud seeding operation for water year 2017-2018. The WRWC budget for FY 2017-2018 includes \$100,000 for the proposed cloud seeding operations.

The cloud seeding program requires permits from both the United States Forest Service and the State of California. The State permit has been 'grandfathered' in through the California Department of Water Resources since the inception of DRI's cloud seeding operations. The permits remain active as long as the project continues, without interruption, for each consecutive water year. In the event that operations were suspended for the upcoming water year, permits would likely be revoked and new permits would be required. In addition to the cost of the permits, DRI anticipates that California Environmental Quality Act and National Environmental Policy Act studies would be required, at a cost well in excess of \$50,000. This year's proposal is intended to bridge the gap to the 2018-2019 water year, at which time the program can be reevaluated based on the availability of State funding.

Mr. Frank McDonough of DRI will provide a presentation about last winter's cloud seeding operations for water year 2016-2017, and the proposed modified operations for the upcoming winter. In addition, Mr. McDonough will provide an update regarding DRI's efforts to secure funding from other cloud seeding beneficiaries and potentially interested parties.

BACKGROUND

Wintertime cloud seeding is focused on enhancing snowfall in mountainous regions to increase the snowpack, resulting in more spring runoff and water supplies in the surrounding areas. The DRI cloud seeding program has been in operation for more than 25 years. DRI estimates that, for the Truckee River Basin, cloud-seeding has boosted water in the snowpack by an average of 18,000 acre-feet a year over the last 10 years.

DRI funding cuts in 2008 threatened to eliminate its cloud seeding operations such that outside financing was necessary to continue the program. In response, DRI applied to the TRF in 2009 to support the operation of five cloud-seeding generators in the Sierra Nevada. DRI received approval for partial funding from the TRF and the WRWC for the 2009-2010 water year. DRI has applied for and received funding from the TRF, and more recently TMWA, and the WRWC to cover operations in each successive water year.

RECOMMENDATION

Staff recommends that the NNWPC accept the report and recommend that the WRWC approve the proposal from DRI for funding in an amount not to exceed \$100,000 from the RWMF, to support cloud seeding operations for the 2017-2018 water year.

CW:jp

Attachment: Proposal and Scope of Work: Cloud Seeding Project for the Tahoe and Truckee Basins for Water Year 2017-2018.



September 17, 2017

Western Regional Water Commission

1001 E. 9th St

Reno, NV 89502

To: The Western Regional Water Commission (WRWC):

Attached is our proposal and budget for the Water Year 2018 Tahoe-Truckee cloud seeding project. The project represents a smaller-scale continuation of the remote generator operations and will again focus on seeding the Tahoe - Truckee target area, and we plan to use the same seeding sites as last year.

If the revised proposal and budget are found to be satisfactory we request a purchase order be drafted in the amount of the proposed budget in order for DRI to be able to initiate and complete the work in a timely manner. A project start date of October 21, 2017 and project stop date of June 30, 2018 is requested.

Respectively yours,

Frank McDonough

Frank McDonough Research Meteorologist: Project Manager

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Attachments: Proposal and Budget

Cc: Maria Garretson (DRI)

Proposal and Scope of Work

Cloud Seeding Project for the Tahoe and Truckee Basins for WY2018

Submitted to the

Western Regional Water Commission

By

**Desert Research Institute
Division of Atmospheric Sciences
Desert Research Institute
2215 Raggio Parkway
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September 2017

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Introduction

Cloud seeding is a long-term water management tool designed to increase snowpack, streamflow, and subsequent water supplies. Since the State of Nevada halted funding the statewide cloud seeding program in 2009, the Tahoe-Truckee portion of the former State project has been funded locally by the Truckee Meadows Water Authority (TMWA) and the Western Regional Water Commission (WRWC). Through their support of the program, these entities have built the project infrastructure to include; 7 high-altitude remote controlled cloud seeding generators, 2 weather stations, a mountain top web camera, 8 precipitation gauges, and cellular and satellite communications systems to operate the equipment, obtain realtime weather and generator performance data.

The Tahoe-Truckee program has added over 14,000 acre-feet of snow water equivalent (SWE), on average, to the watershed for more than 30 years. The project has been operated along and west of the Sierra Crest, delivering snowfall to the east slopes of the Sierra and the Carson Range. Over the past few years funding through the WRWC has allowed DRI to add 8 winter precipitation gauges to Tahoe-Truckee watershed.

Most of the project equipment is located on US Forest Service land. Significant time and resources have been spent to acquire all necessary permits to site and operate this equipment. In addition, the Tahoe-Truckee Cloud Seeding project has been operated under a 'grandfather' permit from the California Department of Water Resources. These permits require operations to be conducted on a continuous yearly basis. If the Tahoe-Truckee program is halted, starting a new project over the region may require new permits to be issued and new environmental impact studies (California Environmental Quality Act and National Environmental Policy Act) to be funded and conducted. While studies in other California watersheds have shown that there are no negative effects from cloud seeding, the studies have cost the projects well over \$50,000.

Although there was well-above normal snowpack this past winter, the past 10-years shows that snowfall and the resulting Sierra snowpack can vary widely. Four of the past six years had well below average snowpack and Lake Tahoe was below its natural rim for 18 straight months between Fall 2014 and Spring 2016 (Fig. 1). The heavy snowfall this past winter caused the suspension the cloud seeding program in early January. As a result the cloud seeding generators remain 75% full of silver iodide solution. This is nearly \$40,000 worth of consumables that are available to the project for the 2018 water year.

A continuation of a smaller scale cloud seeding effort for water year 2018 will help keep the project infrastructure operational, keep all permits current, and potentially add 6,000 to 10,000 acre-feet of SWE snowpack to the watershed at a cost of \$10 to \$16 per acre-foot. It is expected that the State of Nevada will begin to fund a significant portion of the Tahoe-Truckee program beginning in water year 2019.

Project location

The limited WY2018 project proposal focuses on a cloud seeding effort for the Tahoe Basin and the Truckee River Basin. Figure 2 shows the location of the project. The red-shaded region closely approximates the cloud seeding target area for the two basins. The DRI ground-based cloud seeding generator (CSG) sites used in WY2017 are shown as yellow squares.

Project description

The project design and method of operation will be the same as those used for the project conducted in WY2017 and previous years, except the duration will be for 2-months instead of the entire winter. Seeding will be conducted from a line of five ground-based CSG locations (7 CSGs) positioned on, or a few miles upwind of, the main Sierra Nevada crest to the west of Lake Tahoe (Fig. 2). The generators have been positioned to take advantage of the generally southwest wind directions in winter storms in the Tahoe area, and are remotely activated by DRI staff when the proper weather and cloud conditions for seeding have been verified.

Ground-based cloud seeding is based on the following sequence of events. The seeding material is silver iodide (AgI). The seeding “generators” burn a solution containing AgI dissolved in acetone. The burning process produces a “smoke” of microscopic AgI particles (about 0.0001 mm is size) that are transported downwind and dispersed into clouds over the mountains. Vertical dispersion up to at least 3000 feet above the surface is produced by the turbulence created by wind moving over the uneven terrain. In the presence of cloud droplets existing at temperatures below -5° C the silver iodide particles act as ice-forming nuclei and enhance the ice particle concentration in the natural clouds. Once initiated by silver iodide the ice particles grow in size and mass as they move downwind and begin falling to the surface when they have sufficient mass to overcome the upward motion in the clouds. In the time frame of 20 to 30 minutes snowfall within a seeding plume can reach the surface in and around the Tahoe Basin. This “chain-of-events” in the cloud seeding process has been verified by numerous detailed experiments conducted in the Sierra Nevada and other mountainous regions of the western U.S. (Huggins, 2009).

Project Phases

Phase 1 of the project will include preparation of the seeding generators at the locations shown in Figure 2. This will require two weeks of work. The Barker Pass generator, which is always removed in the spring, will be reinstalled per the annual use USFS permit. Phase 1 typically includes refilling the seeding solution tanks, refilling propane tanks, testing all generator components and communications links. The precipitation gauge network will also be prepared for the winter. With the cloud seeding generator tanks about 75% full there will be no additional cloud seeding solution added to the generators. Three generators have ~90 gallons of solution, which allows for about 200 hours of seeding per unit, the two dual-generators are

filled with 110 gallons of solution, which allows for 240 hours of seeding per unit for a grand total of 880 hours of possible seeding this season. This translates to a potential to add 6,000 to 10,000 acre-feet of water stored as snow the mountains in the Tahoe-Truckee basin.

The meteorological forecasts and observations needed to conduct the project are available either through the DRI Western Regional Climate Center or through public web-based weather data links. These data links are combined in a special cloud seeding weather web page (<http://www.dri.edu/weather-information>) that will be revised as needed for the water year 2018 season. Water year snow conditions and the progress of seeding operations for the Tahoe area can also be monitored throughout the winter at the following site: <http://www.dri.edu/current-operations>.

All operational guidelines, safety restrictions and suspension criteria for the project have previously been developed and can also be found on the DRI cloud seeding web site at: <http://cloudseeding.dri.edu/>. These guidelines specify the cloud conditions, wind and temperature conditions in which a seeding operation can be initiated, and also specify certain hazardous weather conditions (such as avalanche, heavy holiday traffic and potential flooding situations) during which no seeding can be done.

Phase 2 of the project will involve the actual cloud seeding operations. In this reduced season's program DRI will conduct 24/7 cloud seeding operations for two months (January and February 2018). In Phase 2 the project manager will begin monitoring the weather and making forecasts for seeding events to be expected within three to five days. The project manager (meteorologist), and an experienced cloud seeding meteorologist/graduate student will ensure that 24/7 operations will be conducted. As a storm begins to affect the Tahoe-Truckee River region cloud and weather conditions will be monitored more frequently to determine when seeding criteria are satisfied. When the shift meteorologist determines that conditions for conducting a seeding operation are satisfied, seeding will commence using the remotely controlled CSG communication network. The Tahoe communication links are internet-based and a generator can be started from any computer with Internet access. Seeding commences when all pre-established seeding criteria are met, and continues until conditions in the storm fail to meet the criteria.

Phase 3 of the project will begin in May 2018 and includes the documentation of weather events to verify that seeding occurred during optimal time periods. Each period will be evaluated and a seedability factor (SF) will be applied to quantify the fraction of time when seeding was potentially effective. The estimates of snow water enhancement will be made and adjusted by the SF. A report on project operations, including the measureable outcome, will be completed during Phase 3. Phase 3 also includes the removal of seeding units as dictated by some of the Forest Service special use permits. Phase 3 will end on June 30, 2018.

Principals involved

The project will be managed by Frank McDonough, he will be assisted by an experienced cloud seeding meteorologist/graduate student. Two experienced technicians that

are jointly supported by this and other DRI cloud seeding projects will provide field operations and maintenance support.

Schedule

Start Phase 1: 21 October 2017. Generator preparations begin.

End Phase 1: 1 November 2017. All seeding generators are installed, upgraded, tested and ready for use. All web-based computer products are prepared for use in Phase 2.

Start Phase 2: 1 January 2018. Cloud seeding occurs as storm conditions dictate. Cloud seeding equipment is monitored and maintained as needed. A log of seeding operations is maintained and the weather data needed to assess operations are archived. The cloud seeding update page is frequently revised throughout the season.

End Phase 2: 28 February 2018 is the approximate end of the operational cloud seeding period.

Start Phase 3: 1 May 2018. Weather data are analyzed to assess the seeding operations. Estimates of water augmentation from seeding operations are made. A report on operations is completed by 30 June 2018.

End Phase 3: 30 June 2018 end of season summer shutdown for the generators, per USFS permits.

Budget discussion:

Budget for the smaller scale WY2018 project is \$100,000. Approximately \$40,000 worth of cloud seeding solution from last year's operation is currently in the generators. The details of the budget are presented in the spreadsheet in Table 1. As indicated the total cost for the WY2018 project is \$100,000. In the event that additional program funding is made available for WY2018, cloud seeding operations may be extended accordingly.

Table 1. Proposed budget for WY2018 DRI Tahoe-Truckee Cloud Seeding Program Budget	Costs (\$)
Field Technician Labor	\$34,000
Meteorological Forecasting/Program Management/Reporting	\$50,000
Truck/Snowmobile/Fuel	\$6,000
Parts and Equipment for generators, weather stations, and precipitation gauges	\$10,000
TOTAL	\$100,000

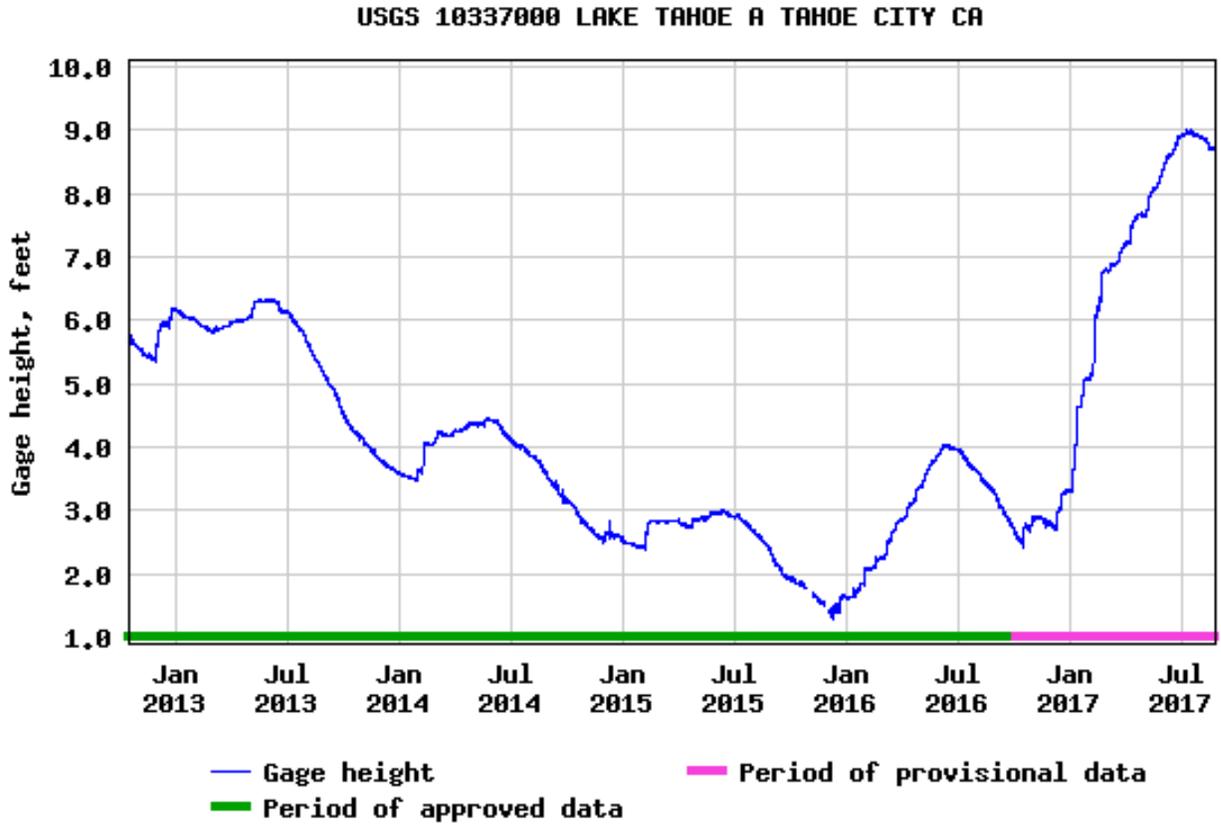


Figure 1. Hydrograph of Lake Tahoe lake level from mid-2013 through mid-2017 from the Tahoe City, CA gage. Gage heights are the lake level minus 6220 feet, thus a value of 5' implies a lake level of 6225'. The natural rim is 6223'.

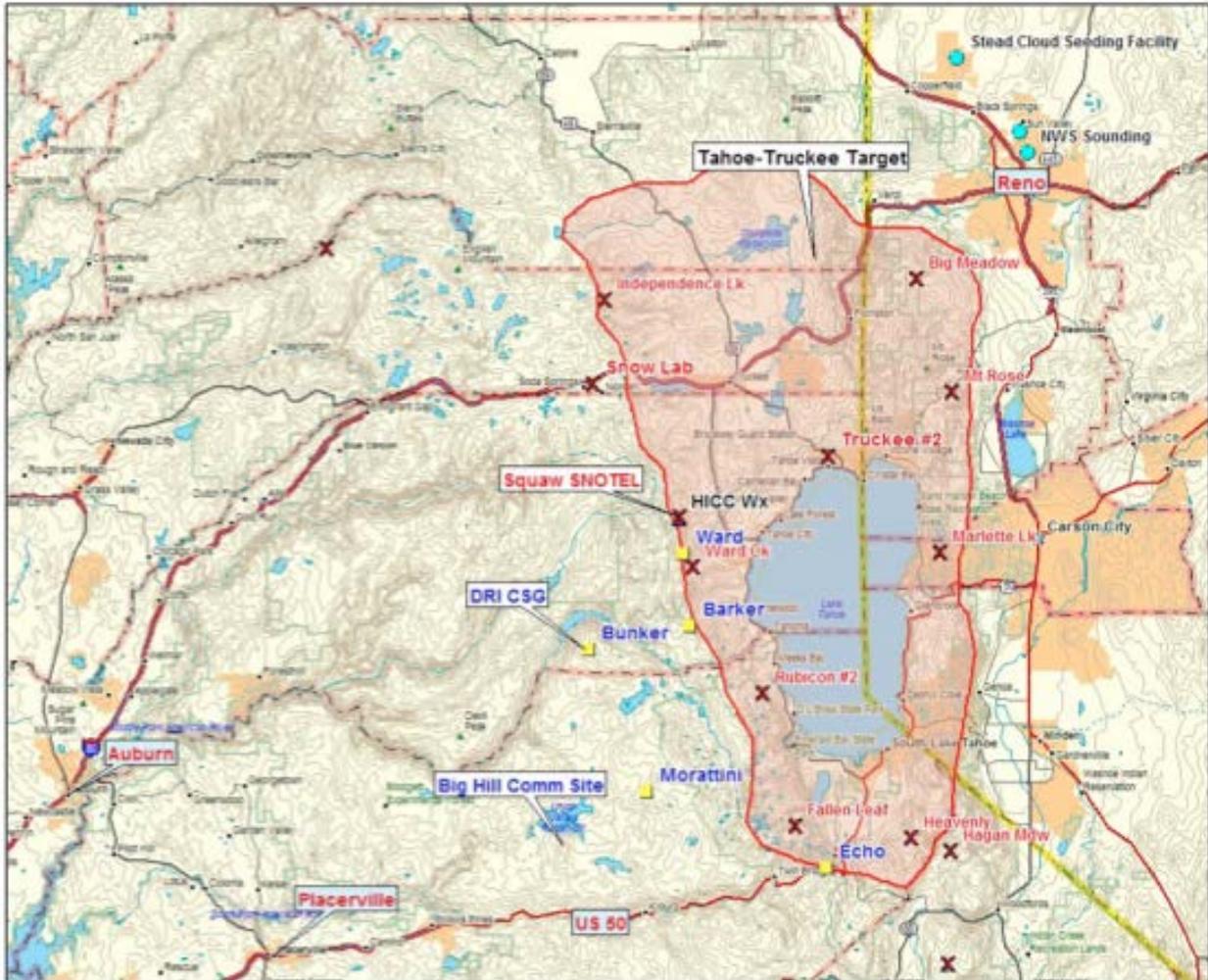


Figure 2. Operations area for WY2017 Tahoe-Truckee cloud seeding project. Red shaded area denotes the target region; Yellow pins with blue labels represent DRI cloud seeding generators; Red X's denote SNOTEL stations and other geographic features are as labeled.