Desert Research Institute

August 24, 2016

**Mr. Robert (Bert) Bryan**
**General Manager**
**Walker River Irrigation District**
**410 N. Main St.**
**Yerington, NV 89447**

Dear Mr. Bryan:

Attached is our proposal and budget for a WY2017 Walker Basin cloud seeding project. The project represents a continuation of the remote generator operations conducted during WY2016 and will again focus on cloud seeding the Walker River target area.

A project start date of October 1, 2016 and project stop date of July 31, 2017 is requested. With operational cloud seeding operations conducted from November 1, 2016 though April 30, 2017.

Respectively yours,

*Frank McDonough*

Frank McDonough Research Meteorologist: Project Manager
Frank.McDonough@dri.edu
775.674.7140
720.839.5309 (cell)
Attachments: Proposal and Budget
Cc: Maria Garretson (DRI)

**Proposal and Scope of Work**

**Cloud Seeding Project for the Walker Basin for WY2017**

**Submitted to**

**Mr. Robert (Bert) Bryan**
**General Manager**
**Walker River Irrigation District**
**410 N. Main St.**
**Yerington, NV 89447**

**By**

**Division of Atmospheric Sciences**
**Desert Research Institute**
**2215 Raggio Parkway**
**Reno, NV 89512**

**August 2016**

**Project Contact: Frank McDonough**
**Project Manager 775-674-7140**
**Frank.McDonough@dri.edu**

## Introduction

The goal of this project is to enhance snowfall from winter storms and to increase the snowpack of the Walker Basin through the application of wintertime cloud seeding technology. Cloud seeding will be conducted from 4-ground based cloud seeding generators for the winter 2016-2017 period at a cost of $30,000. The enhanced snowfall from cloud seeding is expected to enhance the water supply of the Walker River Irrigation System.

A continuation of the cloud seeding effort conducted in WY2016 will help improve water storage supplies for the Walker River system. Results from carefully conducted experiments in the Sierra Nevada and other mountainous regions in the western U. S. have shown that snowfall can be increased by 5-15% annually in the specific basins targeted by cloud seeding operations, and DRI's past reports have indicated estimates of approximate 10% overall water augmentation for the Sierra Nevada projects. Past runoff studies in the central Sierra Nevada Mountains suggest increases of 5% in river flow from cloud seeded basins as compared to adjacent unseeded basins. Past and current environmental assessments have all indicated that no negative impacts to watersheds are produced by cloud seeding operations.

The primary measureable outcome of the project will be an estimate of the enhancement in snow water computed for each seeded storm period, and for the entire winter season, based on the hours of seeding, the amount of seeding material released, the expected increase in precipitation rate, and the average areal coverage of the fallout from each seeding site. Historical research results from ground-based cloud seeding projects have documented the hourly increases in precipitation rate due to seeding to be in the range of a few hundredths to greater than 2 mm of snow water equivalent per hour. As a conservative estimate of the effect for the WY 2017 Walker Basin project a value of 0.25 mm (0.01") per hour will be used in the enhancement estimates.

## Project location

The WY2017 proposal focuses on a cloud seeding effort for the Walker Basin where DRI has conducted seeding for at least the past 18 years years. Figure 1 shows the location of the project. The DRI ground-based cloud seeding generator (CSG) sites used in WY2016 and proposed for WY2017 are shown as red X's.

## Project description

The project design and method of operation will be the same as those used for the project conducted in WY2016. Seeding will be conducted from a line of three ground-based CSGs positioned just east of the main Sierra Nevada crest near Conway Summit and a generator sited at Sweetwater Summit (Fig. 1). The generators have been positioned to take advantage of the generally southeasterly through southwesterly wind directions in winter storms in the Walker area, as well as northeasterly winds for "Inside Slider" storms that move

south east of the Sierra. The generators 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 2000 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 Walker 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 four cloud seeding generators at the locations shown in Figure 1. This will take one week. The Conway Summit generators, which were removed in the spring, will be reinstalled. Phase 1 usually includes refilling the seeding solution tanks, refilling propane tanks. Drought conditions over the past few years has led to silver iodide cloud seeding solution and propane supplies left over from the previously funded Bureau of Reclamation and WRID projects. These supplies (over 100 hours of operational generators time for each generator) will be provided to the WY2017 project at no cost to WRID. This translates to a potential to add approximately 5,000 acre-feet of water stored as snow the mountains in the Walker basin. The generator components and communications links will be tested during the installation.

Several upgrades were implemented to improve the performance of the generators and the weather observations from the generator sites. As part of the maintenance trips the DRI technicians will be installing a flow control system to more accurately control the solution flow to the desired release rate. A webcam has been installed at the Conway site to improve the weather forecasting and validation of the seeding forecasts. We have also a data retrieval system will be implemented to produce reports and graphs in realtime.

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 2016-17 season.

Water year snow conditions and the progress of seeding operations for the Walker 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 and potential flooding situations) during which no seeding can be done.

**Phase 2** of the project will involve the actual cloud seeding operations, beginning on 1 November 2016. 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 Walker 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 Walker 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. The end date for Phase 2 is scheduled for late April but could occur sooner than April 30 if a big winter materializes and generators run out of solution or other expendable supplies. The DRI technical staff will monitor and maintain seeding generators throughout the operational period.

**Phase 3** of the project will begin between 1-15 May (depending on when operations end) 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. In addition some case studies will be included to document the forecast and assessment methodologies. Phase 3 also includes the removal of seeding units as dictated by some of the BLM special use permits. Removal of generators is only possible after snow has melted and the roads to the sites become useable. In some years this can be mid- to late July (as occurred in 2011).

**Principals involved**

The project will be managed by Frank McDonough, he will primarily be assisted by an experienced cloud seeding meteorologist/graduate student. Field operations and maintenance support will be provided by two technicians (Jeff Dean and Jesse Juchtzer) that are jointly supported by this and other DRI cloud seeding projects.

**Schedule**

**Start Phase 1**: 1 October 2016. Generator preparations begin.

**End Phase 1**: 1 Nov 2016. All seeding generators are installed, upgraded, tested and ready for use. Bad weather could produce delays, but testing and other work can be done if units have been installed. All web-based computer products are prepared for use in Phase 2.

**Start Phase 2**: 1 Nov 2016. 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**: 30 April 2017. This is the approximate end of the operational cloud seeding period.

**Start Phase 3**: 1 May 2017. 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 31 July 2017.

**End Phase 3**: 30 Sept 2017. All generators have been removed and the final report has been presented to the WRID.

**Budget discussion:**

The budget for WY2017 is $30,000. The details of the budget are presented in the spreadsheet in Table 1. As indicated in the discussion there will be no charge to WRID for the consumables (cloud seeding solution and propane).

**Desert Research Institute**

**Sponsor: Walker River Irrigation District**

| **Labor** | Hourly Rate | Hours | Amount |
|---|---|---|---|
| McDonough | $153.84 | 95 | $14,615 |
| Dean | $94.36 | 64 | $6,039 |
| Juchtzer | $68.71 | 64 | $4,397 |
| Grad Student Forecaster | $51.31 | 45 | $2,309 |
| | | | |
| Subtotal Labor | | | $27,360 |
| | | | |
| | | | |
| **Generator Components and Communications** | | | $1,800 |
| | | | |
| **Travel to deliver Generator to field site:** | | | |
| DRI Truck (daily rate $140) | 6 | $140 | $840 |
| Per Diem (meals/lodging for 2 people) | 0 | | $0 |
| | | | |
| | | | |
| **TOTAL** | | | $30,000 |

Table 1. Proposed budget for WY2016 for both the TMWA and WRWC match components.

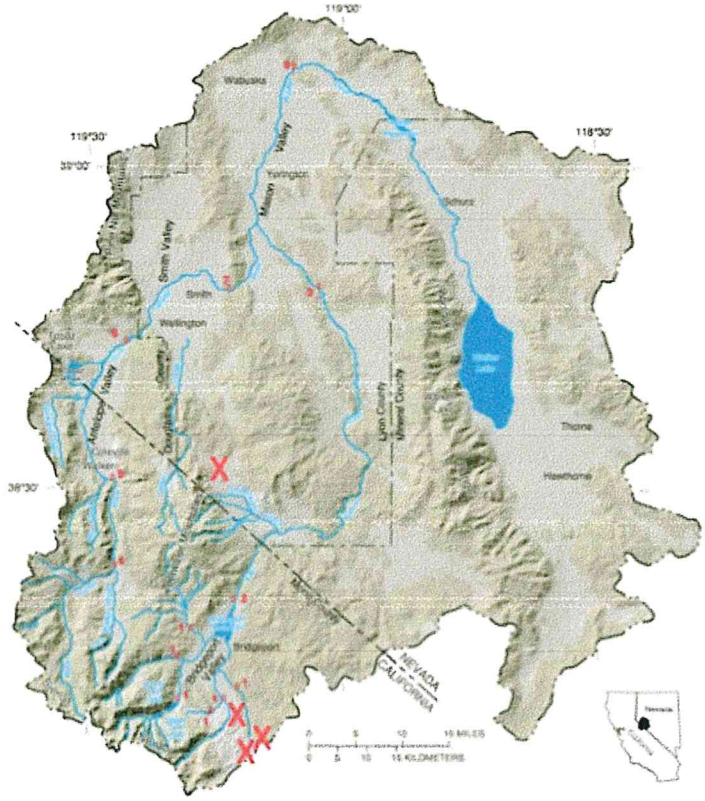


Figure 1. Walker River watershed with cloud seeding generator sites identified as red X's.