WYOMING WATER DEVELOPMENT OFFICE

6920 Yellowtail Road
Cheyenne, WY 82002

Phone: (307) 777-7626
wwdc.state.wy.us

M E M O R A N D U M

TO: Representative John Winter, Co-Chairman
Joint Agriculture, State and Public Lands & Water Resources Committee
Senator Tim French, Co-Chairman
Joint Agriculture, State and Public Lands & Water Resources Committee

SUBJECT: **Joint Agriculture, State and Public Lands & Water Resources Committee Interim Topic Priority No. 5 – Cloud Seeding**

DATE: July 31, 2025

The following background information is being provided in response to the inquiry received by the Wyoming Water Development Office from the Joint Agriculture, State and Public Lands & Water Resources Committee on July 16, 2025.

Cloud Seeding Program Start-Up

While cloud seeding research and operations date back to the early 1950's in the State of Wyoming and include the University of Wyoming's efforts working with the Eden Valley Irrigation District around Farson, the current "state-sponsored" program began with receipt of a project application in 2003 from Area V of the Wyoming Association of Conservation Districts (WACD) asking that the state investigate the technology as a potential water management tool to augment streamflow in southwestern Wyoming. The 2004 Wyoming State Legislature appropriated $100,000 for a study to assess the feasibility of conducting such a cloud seeding program in the given target areas, with particular attention being paid to the climatology of the region, including storm frequencies and characteristics, barriers, seeding potential, etc. The feasibility study laid out a blueprint for a much larger multi-year pilot program to test the efficacy of cloud seeding to include real-time modeling and a statistical evaluation as conducted by the National Center for Atmospheric Research (NCAR). This also included a NEPA investigation with a Categorical Exclusion determination by the Medicine Bow-Routt National Forest in 2006. Upon completion of the pilot program in 2014, the network of ground-based generators targeting the Medicine Bow, Sierra Madre and Wind River Ranges were scheduled for dismantling. At the same time, there was high interest both within Wyoming and downstream in maintaining the generators targeting the Wind River Range for flow augmentation in the Upper Colorado River Basin. That interest led to cooperative funding agreements with Lower Colorado River Basin entities (Central Arizona Water Conservation District, Colorado River Board of California/Six Agency Committee, and Southern Nevada Water Authority) to keep those generators operating every winter from the first operational season (Winter 2014-15) to the most recent (Winter 2024-25). Continuation of snow augmentation operations serves as a strategy for flow enhancement within Wyoming's drainages of the Colorado River Basin and is an important element of the US Bureau of Reclamation's Colorado River Basin Drought Contingency Plan. This ground-based program has been authorized by the 2025 Wyoming State Legislature for operations next winter with the special condition that "*prior to commencing project operations, the Wyoming Water Development Office shall acquire funding commitments from other Colorado River basin water users or other interested parties for a minimum of one hundred percent (100%) of actual project operations costs.*"

Airborne operations targeting the Medicine Bow and Sierra Madre Ranges in southeast Wyoming for flow augmentation in the Little Snake and North Platte River Basins began Winter 2018-19 and ran each successive winter through the most recent, Winter 2024-25. The airborne cloud seeding program has since been discontinued by the 2025 Wyoming State Legislature.

Funding Appropriations

Funding for the cloud seeding program from the Wyoming State Legislature focused on research and studies in the earlier years, transitioning to operations in the latter years. In addition to the large multi-year pilot program, several feasibility studies were funded for other target areas (mountain ranges). The complete State of Wyoming cloud seeding (research and operations) funding appropriations list follows:

Session Law	Chapter	ACCT	NAME	CATEGORY TYPE	APPROPRIATION
2004	34	I	WEATHER MODIFICATION FEASIBILITY STUDY	STUDY	$100,000.00
2005	75	I	WYOMING WEATHER MODIFICATION PILOT PROGRAM	STUDY	$8,825,000.00
2005	75	I	WEATHER MODIFICATION - SALT R & WYOMING RANGE	STUDY	$100,000.00
2010	32	I	WYOMING WEATHER MODIFICATION PILOT PROGRAM	STUDY	$2,850,000.00
2012	57	I	WYOMING WEATHER MODIFICATION PILOT PROGRAM	STUDY	$2,400,000.00
2014	74	I	WEATHER MODIFICATION - WYOMING RANGE, PHASE II	STUDY	$200,000.00
2014	100	I	WEATHER MODIFICATION - WIND RIVER RANGE (2015)	OPERATIONS	$240,000.00
2015	23	I	WEATHER MODIFICATION - BIG HORN, LARAMIE, MEDICINE BOW & SIERRA MADRE	STUDY, OPERATIONS	$1,447,500.00
2015	23	I	WEATHER MODIFICATION - WIND RIVER RANGE (2016)	OPERATIONS	$170,000.00
2016	55	I	WEATHER MODIFICATION - WIND RIVER RANGE (2017)	OPERATIONS	$160,000.00
2017	75	I	WEATHER MODIFICATION - WIND RIVER RANGE (2018)	OPERATIONS	$155,000.00
2018	121	I	WEATHER MODIFICATION - WIND RIVER RANGE (2019)	OPERATIONS	$106,000.00
2019	55	I	WEATHER MODIFICATION - MEDICINE BOW (2020)	OPERATIONS	$589,000.00
2019	55	I	WEATHER MODIFICATION - WIND RIVER RANGE (2020)	OPERATIONS	$175,000.00
2020	113	I	CLOUD SEEDING - MEDICINE BOW (2021)	OPERATIONS	$705,000.00
2020	113	I	CLOUD SEEDING - WIND RIVER RANGE (2021)	OPERATIONS	$200,000.00
2021	12	I	CLOUD SEEDING - MEDICINE BOW (2022)	OPERATIONS	$728,000.00
2021	12	I	CLOUD SEEDING - WIND RIVER RANGE (2022)	OPERATIONS	$215,000.00
2022	84	I	CLOUD SEEDING: OPS HYDROLOGICAL ASSESSMENT	STUDY	$300,000.00
2022	93	I	CLOUD SEEDING - MEDICINE BOW (2023)	OPERATIONS	$823,490.00
2022	93	I	CLOUD SEEDING - WIND RIVER & SIERRA MADRE (2023)	OPERATIONS	$316,000.00
2023	180	I	CLOUD SEEDING - MEDICINE BOW (2024)	OPERATIONS	$825,000.00
2023	180	I	CLOUD SEEDING - WIND RIVER & SIERRA MADRE (2024)	OPERATIONS	$301,000.00
2024	99	I	CLOUD SEEDING - MEDICINE BOW (2025)	OPERATIONS	$825,000.00
2024	99	I	CLOUD SEEDING - WIND RIVER & SIERRA MADRE (2025)	OPERATIONS	$298,651.00
2025	NA	NA	CLOUD SEEDING - MEDICINE BOW (2026)	OPERATIONS	$0.00
2025	111	NA	CLOUD SEEDING - WIND RIVER & SIERRA MADRE (2026)	OPERATIONS	$0.00

Chemicals Used

The high-performance silver iodide-based seeding solution used on the program was tested at the Colorado State University Cloud Simulation and Aerosol Laboratory by DeMott (1997). These tests determined that colder cloud temperatures produce a higher yield of active ice nucleating particles per gram of AgI burned. The yield increases markedly from -6° C (+21.2° F) to -10° C (+14° F). At a cloud temperature of -6° C, 3 x 10^{11} ice nucleating particles are active per gram of AgI burned. In more conventional notation, this is 300,000,000,000, or 300 billion. At -10° C (+14° F), 10^{14}, or 100 trillion ice nucleating particles are active.

Weather Modification International (WMI) Solution Formulation			
Ingredient (per 5 U.S. Gallons)	*WMI Solution formula*		Grams Per Gallon
Silver Iodide	304.2	g	60.84
Ammonium Iodide	93.9	g	18.78
Sodium Perchlorate	181.8	g	36.36
Paradichlorobenzene (Moth Crystals)	28.35	g	5.67

The AgI seeding solution is composed of the chemicals in the table dissolved in acetone. The units listed comprise a five-gallon batch. Combustion of the seeding solution generates silver iodide particles with hygroscopic (water attracting) properties, which serve as exceptionally effective ice nuclei. Because AgI creates so many nucleating particles per gram, it is used in small quantities.

Cloud Seeding Process

Up to 10 (ten) remote-controlled ice nucleus generators are used to seed clouds upwind of the Wind River Mountain Range. Three additional ice nucleus generators target the western slopes of the Sierra Madre Mountain Range. Operations in both ranges target higher elevations to increase snowpack. In any seeding event, the quantity of and specific generators used is determined by the prevailing wind speed and direction and the extent of the seedable conditions across the range. The ground-based generator seeding rate is approximately 25 grams of silver iodide (AgI) per generator, per hour. Seeding is guided by a dedicated project meteorologist, aided by weather observations and prognostic numerical models. Seeding occurs only when the following conditions are met over the ranges: (1) the temperature at the 700 mb pressure (approximately 10,000 ft msl) is less than or equal to -6 degrees C, (2) the wind direction is such that the proper transport of the ice nuclei will occur, from the ground-based generators to the target, and (3) liquid water is observed and/or predicted to exist over the range.

The timetables for operations and related activities follows:

- Annual maintenance of generator sites is conducted prior to the cloud seeding season.
- An initial report is submitted to the National Oceanic and Atmospheric Administration (NOAA) as the federal agency to which weather modification activities in the United States must be reported. Prior to the beginning of each project season, these reports describe the intended target, the seeding agent(s), the firm or person(s) conducting the operations, the project start and end dates, and the sponsor. A final report is submitted at the completion of each season which details the amount of seeding and number of days of operations.
- Annual permits are obtained from the Wyoming State Engineer's Office prior to the cloud seeding season. Monthly reports are also provided for the duration of the seeding season which detail the date and length of each seeding event as well as the amount of seeding agent burned.
- Seeding operations are then conducted from the 13 ground-based generators (10 – Wind River Range; 3 – Sierra Madre Range) as conditions allow (see above) beginning in November and running through April.
- The ground-based ice nuclei generators are maintained as needed throughout the seeding season. Generator sites are also visited as needed to replenish seeding solution. Dates for generator maintenance and resupply are dependent upon the frequency of any equipment issues and consumption of seeding agent (frequency and duration of seeding events), and thus are unpredictable.
- Seasonal snowpack (snow water equivalents, or SWE) is closely monitored against 30-year averages during the season as part of the program's strict suspension criteria.

Other States' Programs

Operational cloud seeding programs exist in the following 10 States: Arizona, California, Colorado, Idaho, Nevada, New Mexico, North Dakota, Texas, Utah and Wyoming. The States of North Dakota and Texas have seen some counties withdraw from their programs, while the Santa Ana Watershed Project Authority program in California has been discontinued. Cloud seeding feasibility studies are currently underway or wrapping up in the additional States of Montana, Oregon and Washington.