WaterSMART-Applied Science Grant for Fiscal Year 2022

Notice of Funding Opportunity No. R22AS00165

Cloud Seeding Technology Validation Protocol

Santa Ana River Watershed

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April 13, 2022

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Executive Summary – Cloud Seeding Technology Validation Protocol

Date: March 1, 2022

Applicant Name: Santa Ana Watershed Project Authority (SAWPA)

City: City of Riverside

County: Riverside County

State: California

The Santa Ana Watershed Project Authority, a joint power authority, with the support of its five member agencies: Inland Empire Utilities Agencies, San Bernardino Valley Municipal Water District, Eastern Municipal Water District, Western Municipal Water District and Orange County Water District and other local public agencies, will be conducting a pilot scale program for weather modification (cloud seeding) in the Santa Ana River Watershed to increase local water supply and seeks to develop a standard protocol for cloud seeding validation process that can be utilized by water agencies and other project sponsors to document the additional water produced by seeding. Though practiced extensively throughout the world and the Western U.S., cloud seeding program quantification of precipitation increase has been difficult to determine on an annual or seasonal basis. Further, though modeling techniques of cloud seeding feasibility have improved, the uncertainties continue to be at or exceeding the cloud seeding signal in storms and seasonal runoff. SAWPA and its partner agencies seek to establish as a standard practical protocol and tool for validation and justification reflecting the results of such programs. This effort would provide standard guidelines and procedures to be undertaken by water agencies to ensure that the benefits of increased precipitation from weather modification programs can be effectively quantified based on weight of evidence approach. The validation protocol can then be used to inform water managers, support increased local precipitation for water supply and enhance stormwater capture especially important to respond to water scarcity and extreme events such as droughts.

The project is estimated to take two years to complete. Work is proposed to start November 1, 2022 and is expected to be completed by February 14, 2025.

The project is not located on a federal facility.

Technical Project Description

i. **Applicant Category**: Category A Applicant

To address water supply challenges facing the western United States, water resource managers are under increasing pressure to explore and consider all available water resource strategies particularly in the face of growing drought cycles and negative climate change impacts. One technology that was first explored in the 1940's and has now been successfully implemented nationally and internationally since the 1980's is weather modification or cloud seeding. This process involves the introduction of a cloud seeding agent, silver iodide, to cloud formations in mountainous areas to facilitate the conversion of

atmospheric subfreezing (supercooled) cloud water drops into ice and increased precipitation. This is accomplished primarily through ground-based seeding units that burn the silver iodide compound producing a light particulate ash that is delivered through upward mountain wind drafts to cold, high-altitude moisture in clouds which then condense into ice crystals forming on the particulates. As ice crystals grow at the expense of the supercooled water, they become heavy and fall back to the Earth as increased snow or melt into rain.

Though effectively implemented and scientifically shown to produce a benefit on average 5-15 percent increase in precipitation and snowpack, the validation or verification of the quantified benefit of a given weather modification operation program has been challenging since seeded precipitation during a storm event cannot be directly measured and varies based on many factors. To overcome these quantification barriers, a variety of statistical and indirect approaches have been defined as reflected in the ASCE Publication 61 Chapter suggested. These include target and control, randomization of seeding, with some newer approaches thus combine the target versus control approach with physical measurements, computer modeling, and/or trace chemistry to validate program operations and verify that the clouds intended to be seeded were suitable candidates and were actually seeded.

Despite recent advances in computer modeling of weather forecasting tools, the validation of cloud seeding program effectiveness and specific quantification of benefit have remained somewhat haphazard and inconsistent. In many cases, the level of validation is left up to the cloud seeding operator or not conducted at all due to high cost or a desire to apply available funding into more seeding vs verification. In essence, no standard practice or protocol to conduct a cost-effective validation program has been established to aid water resource managers across the western U.S. in ensuring their cloud seeding programs are worth the investment in operations funds.

SAWPA proposes to work with independent research entity, Desert Research Institute, to validate the performance of the Santa Ana River Watershed Weather Modification Pilot Program as a beta test case, conduct quantification of benefit of a cloud seeding program and then develop “Cloud Seeding Technology Validation Protocol (Cloud Seeding TVP)” in a manner that might serve as a standard and affordable protocol for use by other water resource agencies across the western United States. This protocol would help establish standard guidelines and procedures that can be undertaken to provide justification to water managers and their elected bodies based on a weight of evidence while minimizing risk.

Based on interests expressed by local decision makers to justify a future full-scale program operation, a pilot program was proposed. Feedback from NAWC and other cloud seeding industry recommended a pilot program to ensure the variability of storm system precipitation for the Santa Ana River Watershed could be accounted for.

This project focusses on the validation portion of the pilot program with emphasis on what validation tasks add the most value, affordability, and may be readily duplicated in other watersheds considering similar programs. In doing so, the project could establish a standard protocol for water managers to use to accomplish a cloud seeding validation

within a reasonable time frame using multiple and affordable verification techniques. This proposed project seeks to review the validation tasks of the Santa Ana River Watershed Weather Modification Pilot Program which would serve as a beta version of a cloud seeding verification through a set of validation tasks for the new cloud seeding project areas. The tasks use observed weather (clouds, winds, temperatures), snow chemistry, precipitation, and runoff data sets to validate the seeding operations and the impact to water resources from the cloud seeding program. These tasks are recommended for the first year of the project. In the remaining project period, the validation report will be updated using the same data set as for the 2nd year. The validation tasks will be conducted by a non-profit, well respected research firm, the Desert Research Institute. These tasks will examine the validation approach and defined tasks to ascertain the value of each, whether a multi-prong validation approach is preferred and support the establishment of a protocol using the results of the validation for use by other water agencies considering a validation approach for their cloud seeding programs.

The Santa Ana River Watershed spans approximately 5280 square miles with about 30% of this area covered by mountain forest. The watershed is highly urbanized in the lower elevations of the watershed and includes an overall watershed population of approximately six million people. As an urban watershed and the southernmost watershed considering a cloud seeding program in California, the terrain will reflect conditions non-typical to most ongoing clouds seeding programs but represents the new frontier of predominately urban watersheds who may be interested in using and implementing cloud seeding to supplement water supplies in the face of drought and climate change challenges.

The implementing agency is the Santa Ana Watershed Project Authority (SAWPA) based in Riverside, California. SAWPA is a joint powers agency and a special district with five member agencies: Inland Empire Utilities Agencies, San Bernardino Valley Municipal Water District, Eastern Municipal Water District, Western Municipal Water District and Orange County Water District.

ii. Detailed Project Description

The proposed project is divided into two main phases with the first phase being the validation tasks undertaken by a research firm as the beta process and the second phase reflects the review of the beta and development of a protocol or guidance document that may be used by other water agencies as they implement future cloud seeding programs. Both phases of this work will be conducted by the Desert Research Institute based in Reno, Nevada with oversight by SAWPA staff.

Phase 1 – Desert Research Institute (DRI)

Task 1.1 Review all of the storms crossing the area during winter 22-23 and assess the cloud seeding operations.

The cloud seeding operational meteorologists will operate the cloud seeding generators when they assess that cloud seeding weather conditions are present and the cloud seeding plume will reach the target clouds. Following the winter season, DRI will evaluate the cloud seeding operator's operation times and compare them to weather observations.

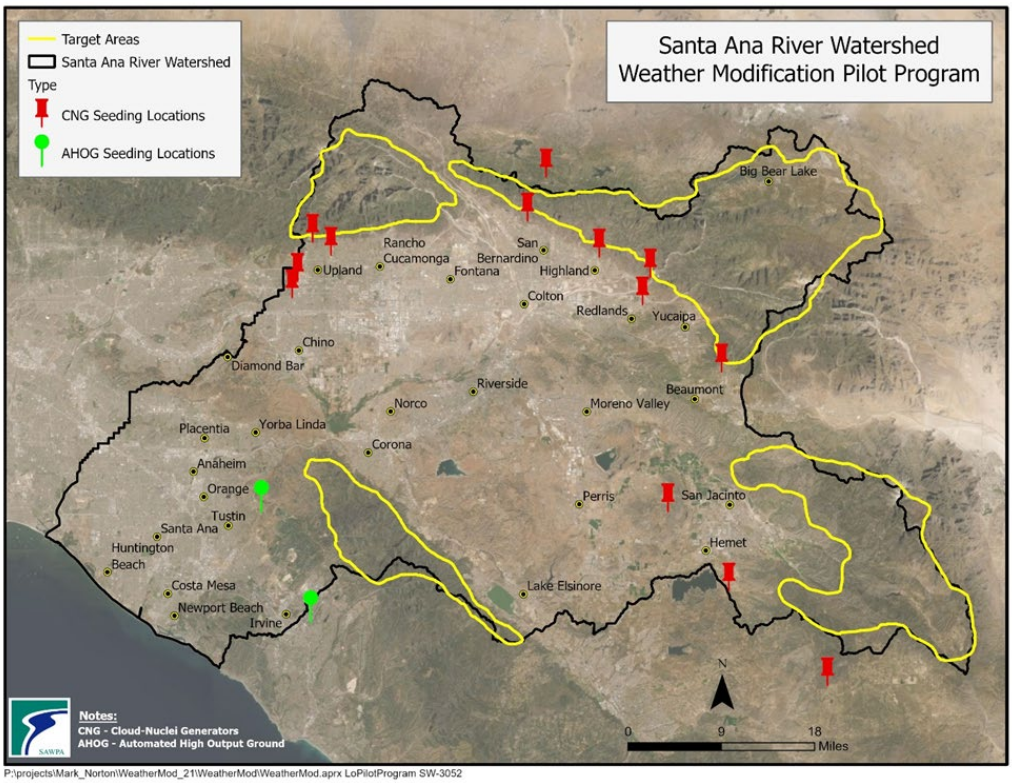

Figure 1 – Santa Ana River Watershed Map w-target areas and seeding locations

The meteorology of all of the storms crossing the area during winter 2022-2023 (WY23) will be reviewed in detail. The DRI meteorologists will independently identify all of the hourly potential seeding and non-seeding storm periods. With all of the seeding periods identified, the cloud seeding operations times will then be scored using a contingency table. The results from the analysis will allow the calculation of the percent of correct operations, cloud seeding conditions present, and the generators operated, or the correct percent of time when seeding can't be conducted due to non-seeding weather conditions and the generators were not operated. The incorrect percent of time, when either the generators are operated when seeding conditions are not present, or the generators are not operated when seeding conditions are present will also be calculated. This analysis will serve as the project efficiency metric.

Task 1.2 Targeting assessment using snow chemistry.

One of the main challenges of conducting cloud seeding from the ground is ensuring that the cloud seeding materials (silver iodide) reaches the clouds and is deposited in the target area. Successful targeting can be potentially proven by showing slightly elevated silver concentrations in fresh snow (about 40 parts per trillion for seeded snow compared to about 5 parts per trillion in unseeded snow is what has been measured in the Sierra Nevada). For two winter storms DRI personnel will visit the target areas. Up to three snow collection tubes with ultra clean bags will be placed in each of the target areas prior to the start of the storm (Fig. 2). After the storm ends the seeded snow will be collected, transported frozen to DRI and then analyzed for silver content at the DRI Ultra Trace Chemistry Lab. Snow from one seeded storm will be collected and snow from one unseeded

storm will be collected to serve as the unseeded control. If the slightly elevated silver values are found in the seeded collection compared to the unseeded collection, then the generator locations are successfully depositing the seeding material (silver iodide) in the target area. This will confirm that the generators are well placed. The collection will be done in all the target areas.

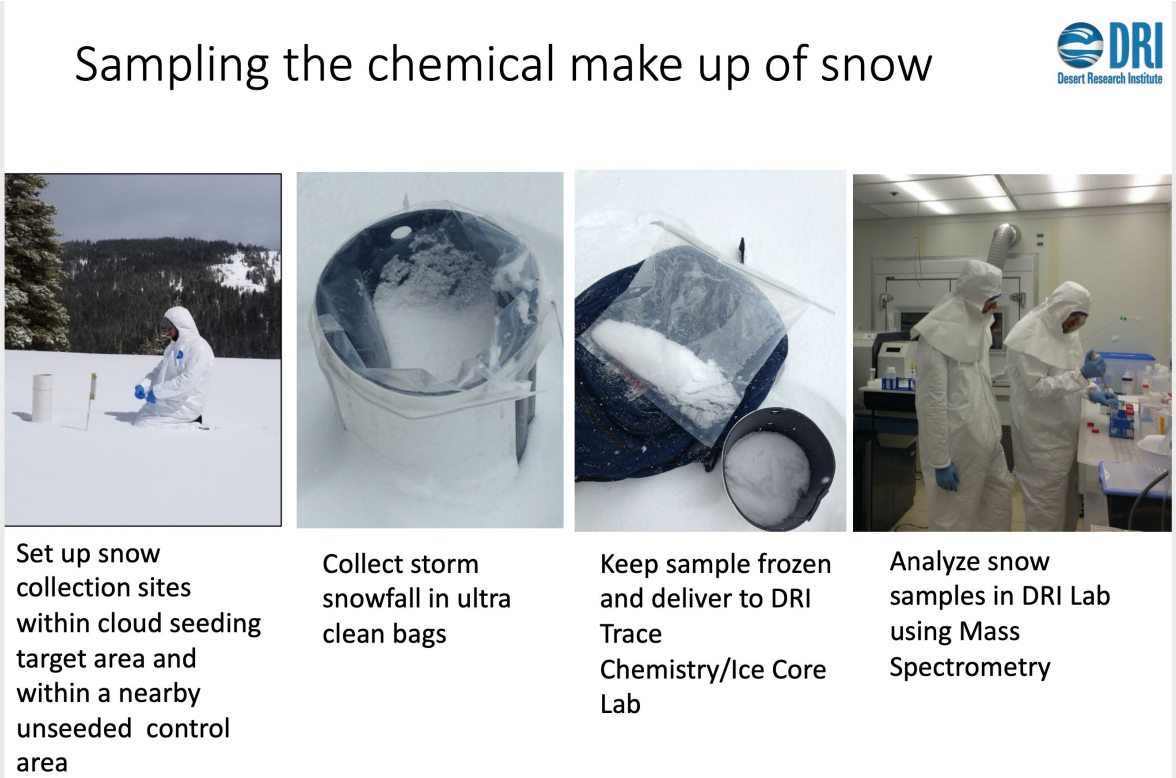

Figure 2. DRI snow chemistry collection and analysis methods.

Task 1.3 Calculating the seeding snow water equivalent (SWE) or rainfall increases for each of the seeded storms

The snowfall or rainfall observed within the target areas during the seeding periods is determined from the hourly precipitation observations. The seeding times are matched to the hourly precipitation observations at the same times. Since the seeding material takes up to 45 minutes from the release from the generator to activate snow production and impact the target area, an additional hour will be added to the seeding end times. Successful seeding would be accompanied by an increase in precipitation at the target area precipitation gauges. The maximum potential total winter season increases in water resources reaching the ground from cloud seeding can then be calculated by multiplying the additional seeded precipitation by the impacted area. This will be compared to the feasibility calculations.

(Seeded precipitation) X (impacted area) = (acre-feet of additional water resources from seeding)

Task 1.4 Precipitation, Full Seasonal Target-Control Evaluation

Next, a target and control evaluation of each of the four target areas winter season precipitation and the best control seasonal precipitation is completed. Identification of the appropriate control (unseeded) gauges for snowfall and rainfall requires similar geography, latitude, and that the site be impacted by most of the same storms impacting the target areas. A second target-control analysis will be done comparing precipitation gauges along the adjacent upstream coastal area and comparing them to gauges within the target areas (Fig. 3). This would ensure that the same storms tracks are analyzed. The 20-year relationship between the precipitation deposited in the coastal gauges and target area gauges will be calculated. For the WY23, this same analysis will be done with the hope that the target area gauges will have more precipitation compared what the historical relationship would suggest. This excess precipitation will be the cloud seeding contribution.

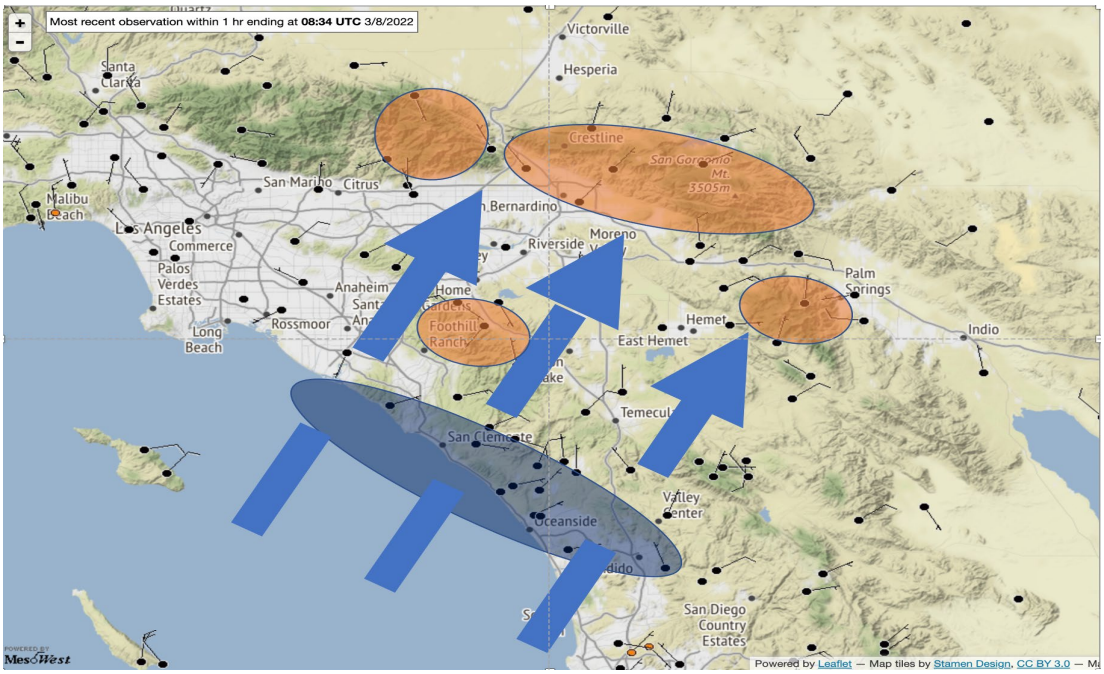

Figure 3. Target-control assessment comparing coastal precipitation to downstream mountain precipitation. Climatological storm wind directions (from the southwest; blue arrows). The long term climatological coastal sites (black shaded area) and the best available and highest elevation precipitation gauges in the four target areas (orange shaded area) will be compared.

Task 1.5 Streamflow Analysis

Similar to the precipitation target and control analysis, a runoff target-control analysis will be conducted using appropriate streamflow gauge data across the region. The 20-year relationship between the selected target areas streamflow gauges and identified control area streamflow gauges will be calculated. The four WY23 target areas runoff data will be compared to WY23 control area runoff. Any excess runoff in the target areas compared to the historical target-control relationship is potentially attributed to the cloud seeding program.

Phase 2 – Technology Validation Protocol Development

SAWPA proposes to work with and use funding from this grant proposal to fund the Desert Research Institute research staff on the protocol for validation of cloud seeding programs. This part would be called "Cloud Seeding Technology Validation Protocol (Cloud Seeding TVP)" The tasks are outlined as described below:

2.1 Establishing research study committee and roles. The committee would guide the research project, assign tasks, monitor progress, and collaborate on the final protocol. The committee members would consist of DRI and SAWPA staff and would meet quarterly to discuss progress.

2.2 Evaluating existing information on cloud seeding validation protocols and assessing water agency needs. This would include reviewing published research as well as unpublished project reports. Well-designed evaluation studies with accompanying physical evidence have consistently shown positive evidence of successful cloud seeding. In addition, many previous cloud seeding evaluation studies have been inconclusive. The projects with inconclusive results often did not include any evidence that cloud seeding occurred. The snow chemistry aspect of this potential protocol (physical study) will greatly improve the differentiation between periods with seeded precipitation from the unseeded precipitation periods. This will ensure that only seeded clouds and precipitation are included in the evaluations.

2.3 Determining the elements (framework) of a successful technology validation program, such as:

2.3.1 Define the role of Cloud Seeding TVP.
The goal of the Cloud Seeding TVP is to develop a robust, accurate, portable, affordable method for operational cloud seeding programs.

2.3.2 Develop an administration plan.
DRI and SAWPA will consult with users to the protocol to ensure proper implementation, and updates.

2.3.3 Use Expert Panels for the Validation Review.
The completed beta-test will be published and presented at the American Meteorological Society Planned and Inadvertent Weather Modification Conference and the annual Weather Modification Association conference.

2.3.4 Draft a model technology validation protocol and test plan.
Once numerical models improve to the level where they can become a tool to accurately evaluate cloud seeding results and they become affordable they should become an additional part of the protocol.

2.3.5 Draft an implementation plan.
An implementation plan will be drafted and reviewed by selected water managers. The feedback will allow tuning the protocol to make it available to all projects.

2.4 Review the list of potential beta validation techniques for cloud seeding.

2.4.1 Score the cloud seeding operations

2.4.2 Prove that the seeding material has entered clouds and reached the target area.

2.4.3 Identify the hourly precipitation periods and differentiate the seeding periods from unseeded periods. Estimate the cloud seeding contribution to the total seasonal precipitation,

2.4.4 Identify suitable control areas adjacent to the target area based on storm climatology, terrain elevation and orientation, and wind directions. Identify precipitation and snowfall data and conduct a target and control evaluation of the cloud seeding program.

2.4.5 Identify suitable gauged rivers and streams adjacent to the target area. These would be based on terrain orientation, and headwaters elevations. The target and control evaluation will be completed for the stream flow data.

2.5 Selecting three to five validation techniques as defined in the beta validation used by the Santa Ana River Watershed weather modification program as the trial, including:

2.5.1 Developing protocols

The protocols are in part based on historical validation methods, and winter storm studies, but the proof of successful seeding, physical proof that seeding agent is in the fresh snowfall will be conducted first.

2.5.2 Reviewing protocols with data from completed pilot programs.

The first beta validation will uncover the challenges and successes of implementing the initial proposed protocol.

2.5.3 Finalizing protocols.

By completing the beta test, a more robust final protocol can be produced.

2.6 Documenting the findings, recommendations, procedures, protocols, administrative plan, and implementation plan.

The results of the beta test will be documented in high detail, The protocol will then be presented to the research community, and state and local water managers, for review and discussion. Next, the reviews of the protocol will be analyzed and a final protocol will be produced. The protocol will be available to other seeding programs as a way to get accurate validation of their seeding programs, and to create a way to standardize cloud seeding results.

The project would be undertaken by:

a. The Project Manager (SAWPA) in collaboration with DRI research staff
b. A Program Development Committee will be formed among the project team and representatives of the North American Weather Modification Council to develop the framework. The North American Weather Modification Council consists of program managers of clouds seeding programs across the western US.

iii. Project Goal

The main goal of the project is to further the advancement and use of the water resource strategy of cloud seeding to improve water supply reliability in the Santa Ana River Watershed and other watersheds across the State of California and other western U.S. By creating a standard practice or protocol for conducting cloud seeding validation in a practical and economical manner, the use of cloud seeding to increase precipitation may be more broadly accepted and practiced.

One of the main drawbacks to this specific strategy is assurances that a cloud seeding can be quantified effectively to define benefit and compare it to costs to operate the program. With improvements in quantification in this technology, the benefit of such programs even with several longitudinal studies have conclusively shown benefits of 5-15% in increased precipitation, the specific percentage increase observed from implementing programs unique to specific watersheds will further enhance the trust that cloud seeding programs are a good return on investment. It is recognized that no new technology or verification tool is proposed under this project but rather the project will explore the best combination of verification tools that can be employed to provide adequate weight of evidence to justify a conclusion and support for continued annual operation.

Figure 4 Santa Ana River Watershed Location

Project Location

The location planned for the pilot program and this validation project will be Santa Ana River Watershed located in Southern California. The watershed is located in the western portion of Riverside and San Bernardino Counties, north Orange County, and a sliver of Los Angeles County to the northwest. The watershed is surrounded by San Gabriel Mountains in the northwest, the San Bernardino Mountains in northeast, the San Jacinto Mountains to the southeast and the Santa Ana Mountains and Pacific coastline to the southwest.

Data Management Practices

Shown below is a diagram reflecting the data information that will be collected for the SAWPA project and how it will be used. SAWPA will serve as the Project Sponsor working with the flood control districts in the watershed in acquiring current weather data and implementing the suspension criteria with the weather modification operators. All data collected and used by the operations director will be reviewed by the independent research firm to conduct their validation tasks. All listed data will be compiled into excel spreadsheets and incorporated into ESRI Geographic Information System (GIS) platforms that readily meet industry standard formats.

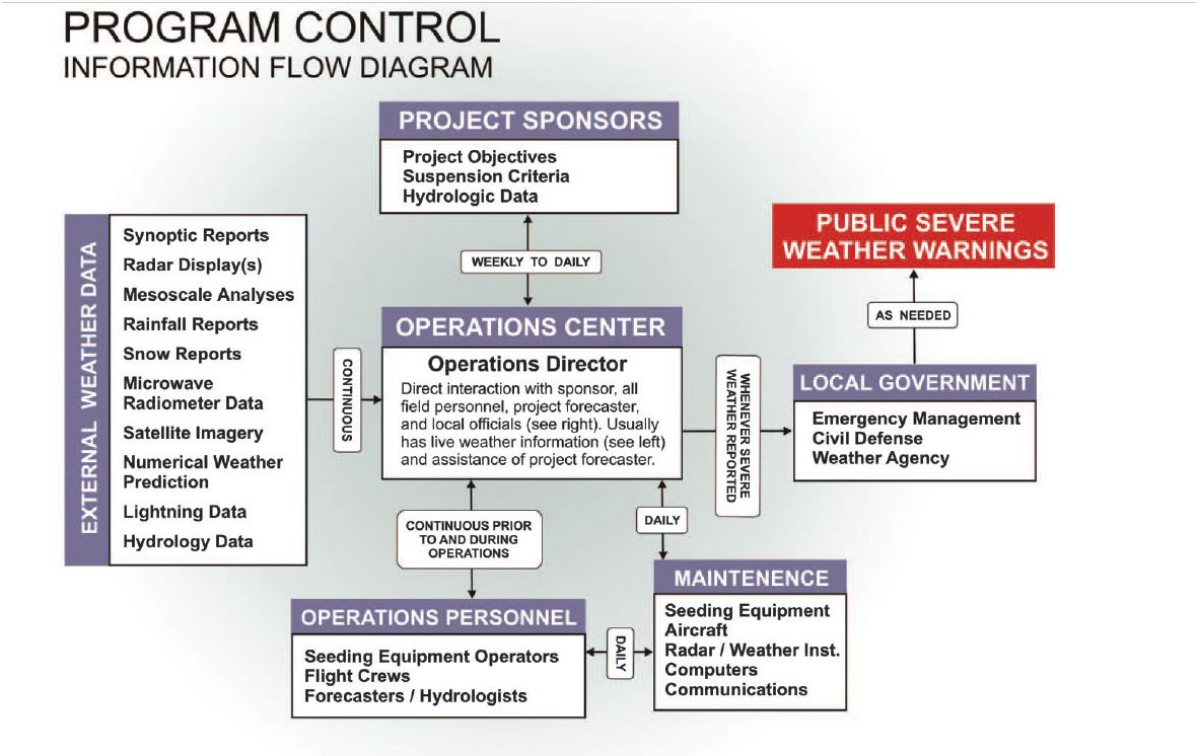

Figure 5 This diagram illustrates the communications infrastructure of a typical weather modification program; some items shown are season dependent.
Source: Figure 6-2 from ASCE Manual on Engineering Practice No. 81: Guidelines for Cloud Seeding to Augment Precipitation, 3rd Edition, Reston, VA

Evaluation Criteria

i. Evaluation Criterion A—Benefits to Water Supply Reliability

1. Describe in detail the water management issue(s) that are occurring within your project area that your project will address.

Based on SAWPA's most recent integrated regional water management plan called the One Water One Watershed Plan 2018 Update and CA Dept of Water Resources Water Plan, the risk and uncertainty from climate change impacts and continuing drought cycles will present challenges to water agencies throughout our watershed and the Western U.S. states in ensuring water supply reliability to meet projected demands for decades to come. Water managers, on the whole, have been proactive in maximizing recycling, conservation and runoff capture of available water supplies. However, each of these strategies are still dependent heavily dependent on natural precipitation and runoff to ensure adequate water supply reliability. Climate change models project increased duration and frequency of long-term drought cycles further exacerbating the ability to have the water to capture and recharge. All long-term projections indicated that further water resource strategies must be examined and implemented especially under CA snowpack and precipitation levels reaching levels unforeseen for decades.

One technology that has now been proven to increase water supplies by increasing local precipitation is weather modification or cloud seeding. Though widely practiced in the

Western U.S., more could be done to encourage this technology to maximize low-cost water supply options. The challenge to further implementation has been assurances on the quantification of benefit.

2. Explain how your project will address the water management issues identified and provide support for your response.

The proposed project will address water management issue for **water supply reliability** by providing an effective means for water managers to conduct cloud seeding validation and incorporate results into their long-term water resource planning programs necessary to address water supply and demand imbalances. By understanding the costs and benefits of weather-based technology directly in this watershed, water managers can rank it alongside the other planned projects that they have in their future water supply portfolio. With the increasing shortages in CA State Water Project and other imported deliveries, understanding the viability of local water resource development programs is a key priority for our agency and many agencies in the southwest U.S

The proposed project will also provide a systematic approach to validation of cloud seeding programs to improve **water marketing** and use of this water strategy. The tools employed in this verification process for the Santa Ana River Watershed weather modification can then be duplicated and used in other watersheds to show the decision makers and the public that adequate evidence exist to support the program. Currently, within the California Water Plan, precipitation enhanced (or cloud seeding) has been identified as one of 19 water resource strategies to promote water supply in the State. To date, only 15 precipitation enhancement programs exist in CA where potentially 10 times this many could be implemented once more assurances are made that the benefits of the programs can be quantified on a practical and economic basis.

The project will allow for increased adaptation to increasingly longer dry periods and better **drought management**. Based on climate change models, water resource managers will need to adapt to changing conditions and explore alternatives to supplement traditional approaches to ensuring adequate water supplies to meet water demands. Many programs such as stormwater capture assume that storm runoff will continue as in the past in similar historical seasons and rainfall patterns. Climate change impacts are resulting in significant modification to planned rainfall and runoff amounts and patterns with outdated or nonadaptive capture infrastructure. Enhancing and increasing streamflow, snow melt, and precipitation even 5-15% at costs at a fraction of the cost of other water supplies such as imported water brought to Southern California is extremely economical comparatively. Further, the water quality benefit of good quality snow and rainfall which is still the case with precipitation generated by cloud seeding is tremendously important to groundwater basins recharge and effective **conjunctive use of groundwater and surface water.**

Overall, the effective implementation of cloud seeding and associated validation protocol can serve as an important tool to improve **watershed health** by creating increased local precipitation for water supply and enhance stormwater capture especially important to respond to water scarcity and extreme events such as droughts and climate change impacts.

3. Describe to what extent your project will improve water management. Describe the significance or magnitude of the benefits of your project, either quantitatively or qualitatively, in improving water management, with supported details.

SAWPA's proposed pilot project has been estimated to produce an increase of approximately 7-8% in precipitation and streamflow in the watershed. This translates into an increase of approximately 7800 AF/YR or for this full four-year pilot, producing a total new supply of 31,200 AF of new high-quality supply for the watershed. However, these benefits are transferable to other watersheds in producing an effective and affordable protocol and means to validate or verify weather modification programs and ensure quantification expectations of both the amount of increased precipitation as well as the amount that can be captured and recharged into the watershed's groundwater basins. The availability of quality assured, quality controlled hydrologic data from the operations of cloud seeding program is critical to inform water management decisions. The proposed validation project will ensure that the right data is acquired, analyzed and delivered to the water resource manager and their decision-making governing boards. This project will evaluate the full suite of validation processes such as target and control, snow sampling, statistical analyses of streamflow and precipitation data. The results of the protocol and guidance developed by evaluation of the Santa Ana River Watershed Weather Modification Pilot Program validation will serve as an important decision support tool that resource managers can use to quantify and compare to other water resource development strategies to improve water management.

4. Explain how your project complements other similar local efforts in the area:

It is understood that research projects are underway to improve numerical weather modeling of cloud seeding that will improve understanding of the physical chain of events, snowfall, and runoff, as well as help identify the seeding feasibility of different target areas. One of those projects supported by the US Bureau of Reclamation's WaterSMART Applied Science grant projects back in 2019 entitled "Precipitation Modeling Tools to Improve Water Supply Reliability" by the Idaho Power Company and their consultant, National Center for Atmospheric Research (NCAR). The intent of that project was to improve the modeling capabilities of cloud seeding programs. Such models are important for deepening understating of seeding potential and feasibility of cloud seeding programs. However, the level of uncertainties in the model microphysical fields, the plume dispersal fields, and runoff models suggest that modeling really cannot yet be used effectively and exclusively to quantify and verify the results of implemented cloud seeding programs. SAWPA examined the NCAR model to determine if it could be used for validation of programs. In the end, such models will be useful for future projections and provide improved accuracy of projections, but decision makers will still desire observational validation of operation results of implemented cloud seeding programs to compare to other water supply development options. The data set produced by these observational validation programs will provide a robust truth set to test future model development and skill. Further, the NCAR modeling can be rather expensive to operate and represents an ensemble of modeling scenarios without actual sampling or measuring of field data.

SAWPA has explored the results of several longer-term cloud seeding programs that helped to verify that a 5-15% increase in precipitation from cloud seeding programs could be

anticipated. These included the Seeded & Natural Orographic Wintertime clouds: the Idaho Experiment (SNOWIE) program in Idaho, the Wyoming Water Development Office's ten-year Wyoming Weather Modification Pilot Study, and the Snowy Precipitation Enhancement Research Project (SPERP) program in Australia. Many long-term projects in the Sierra Nevada (i.e., the SCE San Joaquin Project, the PGE Lake Almanor Project, Sacramento Municipal Utility District American River Program) all have reported similar results. Thus, the proposed SAWPA project validation project and protocol development will effectively supplement such research on projection modeling. The importance of cloud seeding technology is demonstrated by the May 20, 2019 agreement among the US Bureau of Reclamation and representatives from all seven Colorado River Basin states to include cloud seeding in their completed drought contingency plans for the Upper and Lower Colorado River basins. The agreement among the seven states and US BOR indicate that programs such as cloud seeding are designed to reduce risks from ongoing drought and protect the single most important water resource in the western United States. When approached on whether existing cloud seeding programs will be expanded or continued indefinitely, the issues of effective consistent quantification of the cloud seeding benefits has hindered decisions of further expansion of such programs in the Colorado River Basin.

ii. Evaluation Criterion B—Need for Project and Applicability of Project Results

1. Explain how your project will result in readily useful applied science tools that meet current need:

California and much of the western U.S. is experiencing record-breaking drought and local water supplies have been trending downward. Non-typical forms of water resource development are being further explored to address the need for increase water supplies. One technology that has in recent decades shown promise not necessarily as a solution to droughts but rather a supplemental water resource strategy to others is weather modification. Such programs provide an average 5-15% increase in local water supply or precipitation. However, what has hindered further advancement has been ensuring such programs are meeting the quantification goals. Various techniques and practices have been applied to estimate the benefits from implemented programs but there is a need for a uniform protocol for which of these verification techniques are most effective. Consequently, there is no national platform at present for water agencies to prove the efficacy of their cloud seeding programs. Such verification and validation processes are needed to better compare water resource development options and ensure adequate water supplies in a sustainable manner that is safe for the public and the environment.

What is needed is a consistent, transparent, and cost-effective mechanism to assess and validate the performance of cloud seeding technologies. In response, SAWPA working collaboratively with an independent research firm, the Desert Research Institute, proposes to develop a framework for Cloud Seeding Technology Validation Protocol (Cloud Seeding TVP) to advance and streamline the adoption of validation techniques for cloud seeding technologies through a credible, independent third-party validation program. This TVP would standardize the validation methods across projects and allow a pathway for new proven validation methods to be added to the TVP.

The Cloud Seeding TVP would be established by building upon: (1) information generated from past U.S. Bureau of Reclamation research programs on cloud seeding (2) information generated under the Desert Research Institute for the SAWPA weather modification pilot program; (3) technology validations performed by other pilots, both nationally and internationally; and (4) the expertise of a Program Development Committee made up of individuals with experience in testing and evaluating water treatment technologies. The results of this research study will inform the development of the framework for the Water TVP. Specifically, once implemented, Cloud Seeding TVP will be used by sponsors (i.e., a vendor, utility, or consulting firm) to provide administration of the validation process; develop the validation program; develop the protocols (test plans); coordinate the validation with pilot facilities; develop an Expert Panel to review the results, including the final validation report.

The proposed project will be a set of standard practices or protocol representing a useful applied science tool that can be readily used to validate and verify the quantification of increased precipitation in a cloud seeding program. It is recognized that such verification cannot be completed over one cloud seeding season or year and that part of the protocol involves applying the validation process over the course of a cloud seeding program a minimum of 3-5 years, four years in the case of SAWPA's project. However, during the term of the proposed project, the first two years, will be instrumental in establishing the validation and subsequent years will be focused on using the same techniques with updated data.

iii. Evaluation Criterion C—Project Implementation

Describe your project implementation plan:

1. Briefly describe and provide support for the approach and methodology

Phase I consists of five tasks and will be conducted for each of the four target areas. The goal of this verification component is to first (Task 1) ensure that the seeding operations are matched to the seedable storm periods. Task 2 will ensure that the cloud seeding generator placement is able to deliver seeding material to the target areas. Task 3 determines the estimated amount of additional seeded snowfall/precipitation for each storm, and the winter total in each area. Task 4 compares the long-term unseeded seasonal precipitation amounts within the target areas to one or two adjacent unseeded areas with similar topography, then compares the seeded year to the long-term relationship. Task 5 compares the long-term seasonal unseeded stream flow amounts within the target areas to one or two adjacent unseeded areas, then compares the seeded year to the long-term relationships. A detailed final report will be prepared and delivered to SAWPA and Reclamation with results to be presented in person at the SAWPA Commission meetings.

Phase II consists of developing a protocol that will create an affordable framework for operational cloud seeding programs to validate the success of the project. The protocol identifies techniques which use observational weather and hydrological data sets to create a multifaceted validation of cloud seeding. The first task is to develop a technique to independently verify and score the cloud seeding operations, Next, a standard methodology to collect snow within the target area and have it analyzed for trace chemistry is developed. This analysis will show that cloud seeding materials have been delivered to the target area.

A method of identify the seeded hourly snowfall is then developed and applied to the program. Next, a set of techniques to create target-control snowfall and streamflow statistics is developed. This work includes new approaches to identify the best control areas.

2. Describe the work plan for implementing the proposed scope of work.

			2022		2023												2024						
	Phase/Milestones	Task Cost	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
Task	Phase 1																						
1	Review storms (winters 2022-2024) and assess cloud seeding	$24,000																					
2	Assess target area snow chemistry - Winter 2022-2023 only	$15,000																					
3	Calculate seeding snow water equivalent (SWE) / rainfall increases for each seeded storm	$16,000																					
4	Evaluate Precipitation, Full Seasonal Target-Control	$10,000																					
5	Conduct Streamflow Analysis	$10,000																					
6	Prepare Annual Validation Report	$9,500																					
7	SAWPA Project Management	$15,500																					
	Phase 1 Subtotal	$100,000																					
	Phase 2																						
1	Develop methods and weather data sets necessary to identify cloud seeding times	$15,000																					
2	Develop standard methods for collecting uncontaminated snow samples	$5,000																					
3	Develop methods to estimate hourly contributions to precipitation from cloud seeding	$15,000																					
4	Develop methods to identify appropriate control areas, precipitation gauge observations, and statistical relation techniques	$15,000																					
5	Develop methods identify appropriate runoff control areas, stream flow gauge observations, and statistical relations techniques	$15,000																					
6	Prepare Protocol Document	$10,500																					
7	SAWPA Project/Grant Management	$24,500																					
	Phase II Subtotal	$100,000																					

3. Provide a summary description of the products that are anticipated to result from the project.

The project will create several new comparative climatological relationships (data sets) and storm analysis for storms that impact the SAWPA. These new data sets are listed below:

	Products
1	Analysis of storms impacting project area
2	Contingency table evaluating the success of the cloud seeding operations
3	An inventory of several elements found in fresh snowfall
4	A storm-scale analysis of snowfall associated with cloud seeding
5	A set of climatological precipitation relationships between mountain weather stations and mountain and coastal weather stations
6	A set of climatological precipitation relationships between streamflow gauges
7	A detailed evaluation of the Santa River Watershed Pilot cloud seeding program
8	An inventory of metals found in local snowfall
9	A cloud seeding validation protocol using observational data sets.

4. Identify staff with appropriate credentials and experience and describe their qualifications.

The validation project will be led by DRI research meteorologist Mr. Frank McDonough, with the snow chemistry work being done by Mr. Jesse Juchtzer, Mr. Patrick Melarkey, and Dr. Nathan Chellman (see personal section below).

Mr. Frank McDonough. MS Atmospheric Science- Colorado State University. 25 years' experience studying subfreezing clouds. https://www.dri.edu/wp-content/uploads/resume-1517.pdf

Mr. Jesse Juchtzer. BS Enviro Science – Sierra Nevada University. 10 years' experience as a cloud seeding scientist, 5-year experience as a hydrologist USGS. https://www.dri.edu/directory/jesse-juchtzer/

Mr. Mikhail Korotkin MS Atmospheric Science, University of Nevada Reno

Mr. Patrick Melarkey BS - University of Nevada Reno. Field and Instrument Technician

Mr. Nathan Chellman PhD Hydrology – University of Nevada Reno. Ice Core specialist https://www.dri.edu/directory/nathan-chellman/

Project Management will be conducted by Mark Norton P.E., SAWPA Water Resources & Planning Manager, MPA & BS University of Colorado, 40 years of water resource management experience.

a. Describe the process and criteria that will be used to select appropriate staff members for any positions that have not yet been filled.

All DRI staff members have been assigned by DRI's lead, Frank McDonough.

b. Describe any plans to request additional technical assistance from Reclamation or via a contract.

None at this time, though review feedback from Reclamation Denver staff is encouraged.

c. Have the project team members accomplished projects similar in scope to the proposed project in the past either as a lead or team member?

Yes, DRI and its project team members has completed many similar types of cloud seeding validation work as lead. SAWPA, as the project administrator, has executed many past Reclamation grant programs and has experience with executing such grant programs.

d. Is the project team capable of proceeding with tasks within the proposed project immediately upon entering into a financial assistance agreement? If not, please explain the reason for any anticipated delay.

Yes, the validation of the Santa Ana River Watershed Weather Modification Pilot Program Protocol by DRI can proceed with their work immediately regardless of whether a Reclamation financial assistance agreement is executed. However, if the Reclamation financial assistance is not obtained, the DRI protocol or guidance document development will not occur.

iv. Evaluation Criterion D—Dissemination of Results

Explain how the results will be disseminated, including:

Formalizing the process of validation would allow information to be shared in a guidance manual or protocol and can be disseminated to weather modification associations and research bodies. These results of this project (e.g., protocol, validation reports, etc.) would also be available in the public domain to support similar weather modification projects across the U.S. The validation report will provide important information accessible to water utilities and water resource agencies to conduct their respective quantification of precipitation benefit at less cost and time than individual pilot validation process for their respective pilot programs or even ongoing programs. This protocol development project would define and produce effective a validation approach, guidance, standards, templates, and materials.

The results of the validation of the pilot program and the processes used can be immediately applied to other proposed cloud seeding programs across the U.S. As a member of the North American Weather Modification Council (NAWMC), SAWPA will share results with others so that their validation processes may be improved in other watersheds. Further DRI and SAWPA will disseminate the protocol and lessons learned via written reports and scientific publications that will be made publicly available.

v. Evaluation Criterion E—Presidential and Department of the Interior Priorities

Sub-criterion No. E1. Climate Change

The proposed cloud seeding validation protocol will support expansion of cloud seeding programs for increased snowpack, precipitation and streamflow runoff. The water produced is high quality, low salt water and snow that will replenish groundwater supplies, restore dry riparian habitat, improve public health and conserve our water supplies. The additional water supply will increase watershed resilience in the face of continuing negative climate change impacts facing southwest CA and the western U.S.

1. Please provide specific details and examples on how the project will address the impacts of climate change and help combat the climate crisis.

One of the negative impacts of climate change is anticipated to be decreased precipitation and more extreme heat exacerbating forest health and local water supply resources. More local water supply is paramount to ensure resiliency. Tools that promote and support increase local precipitation such as cloud seeding need to be implemented. In order for local water resource agencies to take on such program, validation of cloud seeding programs that are fact and science based is imperative. The proposed project will expand the use of cloud seeding as a supplemental water resource strategy.

2. Does this proposed project strengthen water supply sustainability to increase resilience to climate change?

The proposed validation protocol and guidance document will provide an important tool that will help enhance local water supplies allowing many areas that are dependent on more expensive external water supplies to make greater strides to local sustainability and resiliently respond to drought conditions.

3. Does the proposed project contribute to climate change resiliency in other ways not described above?

The cloud seeding validation protocol advances the science and use of this technology from a non-defensible fringe strategy of unknown benefit and value to a respected and legitimate means to address decreasing local water supplies resulting from climate change.

Sub-criterion No. E2. Disadvantaged or Underserved Communities

The proposed project creates an important standard for validation of cloud seeding that will promulgate the use of this water resources strategy as a supplemental water resource strategy to others. The Santa Ana River Watershed is highly urbanized with approximately 30% of its households considered to be disadvantaged communities. The impacts of the climate change crisis often hit the low-income households first and foremost. Creating a tool to further expand the use of a water resource development strategy that could increase local water supplies by 5-15% benefiting small mutual water agencies and small city water departments who often serve disadvantaged communities with additional good quality snowpack in the mountains and increased streamflow serving downstream lakes, rivers, streams and tributaries.

The additional snowpack and precipitation resulting from the new watershed agencies that begin to implement cloud seeding as a result of the validation protocol will aid underserved communities and advance racial equity by ensuring all water agencies across the watersheds benefit. Supplemental precipitation from cloud seeding targets mountain ranges but all areas downstream will benefit from the investment in this project.

Since the increased precipitation benefit from cloud seeding is designed as watershed-based system, the benefits expand to underserved communities such as underrepresented communities such as Native American Tribes, many of which reside in the Santa Ana River Watershed and watershed across the western U.S. The proposed project will help to

address the challenges that have systematically denied opportunities to participate in aspects of economic, social, and civic life.

Project Budget

i. Funding Plan

Please identify the sources of the non-Federal cost-share contribution for the project, including:

- Any monetary contributions by the applicant towards the cost-share requirement and source of funds (e.g., reserve account, tax revenue, and/or assessments)?

SAWPA will contribute $100,000 in monetary contributions towards the cost share requirement. The source of funding will be from the operating expenses of the organizations as a joint power authority with funding support provided and budgeted for by the five SAWPA member agencies.

- Any costs that will be contributed by the applicant?

SAWPA staff time to manage Phase I activities including the Desert Research Institute contract and SAWPA grant management will be fully provided by SAWPA contributions.

- Any third-party in-kind costs (i.e., goods and services provided by a third party)?

There are no third-party in-kind costs for this project.

- Any cash requested or received from other non-Federal entities?

None at this time.

- Any pending funding requests (i.e., grants or loans) that have not yet been approved and explain how the project will be affected if such funding is denied?

SAWPA will be seeking a State of California grant to support 50% of the local share but will be proceeding with the local share and the project funding regardless of whether the State grant is awarded.

ii. Budget Proposal

Budget and Personnel

Table 3. shows the budget to conduct the two-year validation of the Santa Ana cloud seeding program by the Desert Research Institute, the Cloud Seeding Technology Protocol Development by the Desert Research Institute and SAWPA project and grant administration. The validation project will be led research meteorologist Mr. Frank McDonough, meteorologist Mikhail Korotkin will assist, and the snow chemistry lab work will be done by Dr. Nathan Chellman. This budget also includes reporting and a presentation to the Santa Ana Watershed Project Authority if requested. The report would be completed by July 31, 2023.

Table 1. Summary of Non-Federal and Federal Funding Sources

FUNDING SOURCES	AMOUNT
Non-Federal Entities	
1. Santa Ana Watershed Project Authority	$100,000
Non-Federal Subtotal	$100,000
REQESTED RECLAMATION FUNDING	$100,000

Table 2. —Total Project Cost Table

SOURCE	AMOUNT
Costs to be reimbursed with the requested Federal funding	$100,000
Costs to be paid by the applicant	$100,000
Value of third-party contributions	$0
TOTAL PROJECT COST	**$200,000**

Table 3a SAWPA Project and Grant Management Budget Table

BUDGET ITEM DESCRIPTION	COMPUTATION		Quantity Type	TOTAL COST
	$/Unit	Quantity		
Salaries and Wages				
Mark Norton	$ 99.13/hour	60	Hours	$5,948
Karen Williams	$123.80/hour	10	Hours	$1238
Marie Jauregui	$ 60.15/hour	60	Hours	$3609
Bonnie Gallagher	$ 29.63/hour	50	Hours	$1482
Alison Lewis	$ 49.22/hour	20	Hours	$984
Fringe Benefits (39% of S&W)				
Mark Norton	$39.26/hour	60	Hours	$2356
Karen Williams	$49.02/hour	10	Hours	$490
Marie Jauregui	$23.82/hour	60	Hours	$1429
Bonnie Gallagher	$11.73/hour	50	Hours	$587
Alison Lewis	$19.49/hour	20	Hours	$390
Equipment				
Item A				$
Supplies and Materials				
Copying				$100
Contractual/Construction				
Contractor A				$
Third-Party In-Kind Contributions				
				$
Other				
TOTAL DIRECT COSTS				$18,613
Indirect Costs (161.3% of S&W)				
Mark Norton	$159.90/hour	60	Hours	$9594
Karen Williams	$199.69/hour	10	Hours	$1997
Marie Jauregui	$ 97.02/hour	60	Hours	$5821
Bonnie Gallagher	$ 47.79/hour	50	Hours	$2390
Alison Lewis	$ 79.39/hour	20	Hours	$1588
			Subtotal	$21,390
TOTAL ESTIMATED PROJECT COSTS				**$40,000**

Table 3b Desert Research Institute Budget Table

BUDGET ITEM DESCRIPTION	COMPUTATION		Quantity Type	TOTAL COST
	$/Unit	Quantity		
Salaries and Wages				
McDonough	$12,140	3.51	Monthly	$42,612
Juchtzer	$ 6,866	1.21	Monthly	$8,308
Korotkin	$ 3,702	1.5	Monthly	$5,553
Melarkey	$ 4,354	1.20	Monthly	$5,225
Fringe Benefits				
Professional (McDonough)	(% of S&W)	47.5%	--	$20,241
Technologist (others)	(% of S&W)	50.3%	--	$9,600
Equipment				
Trace Chemistry Lab Time				$5000
Item B				$
Item C				$
Supplies and Materials				
Item A				$
Item B				$
Contractual/Construction				
Contractor A				$
Contractor B				
Third-Party In-Kind Contributions				
Contributor A				$
Contributor B				$
Other				
Travel				$4000
TOTAL DIRECT COSTS				**$100,539**
Indirect Costs				
	65%	$59,500		**$59,500**
TOTAL ESTIMATED PROJECT COSTS				**$160,039**

iii. Budget Narrative

1. Salaries and Wages:

DRI - $61,698 ($30,849 Federal funding; $30,849 local cost share)

All labor rates proposed represent actual labor rates of the identified personnel with anticipated 3% annual increase for faculty.

• PI/Program Manager Mr. McDonough requests 1.755-month salary/year (14.6% effort/year) for a total of $42,612 request funding with $21,306 cost share. Mr. McDonough will direct the project to accomplish associated tasks and dissemination of project outputs.

*Meteorologist Mr. Mikhail Korotkin with a total salary of $5,553,

*Field Technician Mr. Jesse Juchtzer with a total salary for $8,308,

*Field Technician Mr. Patrick Melarkey with a total salary of $5,225

SAWPA Staff – Grant Management

SAWPA - $13,261 ($8122 Federal funding; $5139 local cost share)
Project Grant Manager. Mark Norton will serve as SAWPA project lead and will expend approximately 1/3 of the $5948, or $1963 for compliance with reporting requirements, including the final financial and performance reports. All staff listed below provide financial and administrative oversight for the grant reporting and financial management.

Employee Name	Classification	Hourly Rate	Total Salary
Mark Norton	Water Resource and Planning Manager	99.13	$5,948
Karen Williams	Deputy GM / Chief Financial Officer	123.80	$1238
Marie Jauregui	Project Manager	60.15	$3609
Bonnie Gallagher	Accounting Technician I	29.63	$1482
Alison Lewis	Accountant	49.22	$984
		Total	$13,261

2. Fringe Benefits:

DRI: $29,841 ($14,920.50 Federal Funding; $14,920.50 cost share)
• Fringe benefits are charged at (47.0% for FY2023) for professional faculty, 50,3% for technicians. These are DRI's benefit rates and for faculty and staff they cover Social Security, retirement, insurance, unemployment, disability, and Worker's Compensation costs.
The total fringe benefits are $29,841 with $14,920.50 cost share.

SAWPA - $5,252 ($3,217 Federal Funding; $2035 cost share)

• Fringe benefits are charged at (39.0% for FY2023) for SAWPA staff. These are SAWPA's benefit rates for all staff and they cover Social Security, retirement, insurance, unemployment, disability, and Worker's Compensation costs.
The total fringe benefits are $5252 with $2035 reflecting cost share.

Employee Name	Classification	Hourly Rate	Fringe Benefits
Mark Norton	Water Resource and Planning Manager	99.13	$2356
Karen Williams	Deputy GM / Chief Financial Officer	123.80	$490
Marie Jauregui	Project Manager	60.15	$1429
Bonnie Gallagher	Accounting Technician I	29.63	$587
Alison Lewis	Accountant	49.22	$390
		Subtotal	$5252

3. **Travel Costs**: DRI $4,000.00 ($0 Federal Funding; $4,000 cost share)

   • Domestic travel costs are included for one trip per year for Mr. McDonough and another project member to conduct the snow sampling and present the first year's results as part of the local cost share and Phase I.

4. **Equipment:** DRI $5,000.00 ($0 Federal Funding; $5,000 cost share) The DRI Ultra Trace Chemistry Lab will be used to analyze the snow samples which reflect a total cost of $5,000 and are 100% local share.

5. **Materials and Supplies**

   SAWPA Copying - $100 ($62 Federal Funding; $38 for local share)

6. **Contractual:** None

7. **3rd Party In-Kind Contributions:** None.

8. **Environmental Regulatory Compliance Costs**: None required.

9. **Other Expenses** None

10. **Indirect Costs**

    DRI - $59,500 ($29,750 Federal funding; $29,750 local cost share)

    Indirect Costs reflect 65% of the Salary and Wages. The pool indirect costs for DRI is $59,500. These costs are reflective of overhead costs of DRI office facilities including utilities, training, office supplies, computer equipment hardware and software, safety, security services, custodial services, audit, and education.

SAWPA – $21,390 ($13,101 Federal funding; $8289 cost share)

Indirect Costs reflect 161.3% of the Salary and Wages. The pool indirect costs for SAWPA is $21,390. These costs are reflective of overhead costs of DRI office facilities including utilities, training, office supplies, computer equipment hardware and software, safety, security services, custodial services, audit and education.

Employee Name	Classification	Hourly Rate	Indirect Costs
Mark Norton	Water Resource and Planning Manager	99.13	$9594
Karen Williams	Deputy GM / Chief Financial Officer	123.80	$1997
Marie Jauregui	Project Manager	60.15	$5821
Bonnie Gallagher	Accounting Technician I	29.63	$2390
Alison Lewis	Accountant	49.22	$1588
		Subtotal	$21,390

11. Total Costs

DRI - $160,000 ($75,500 Federal funding; $84,500 local share)
SAWPA - $40,000 ($24,500 Federal funding; $15,500 local share)

Total Approximate Costs ($100,000 Federal funding; $100,000 local share)

Environmental and Cultural Resources Compliance

- Will the proposed project impact the surrounding environment (e.g., soil [dust], air, water [quality and quantity], animal habitat)? Please briefly describe all earth-disturbing work and any work that will affect the air, water, or animal habitat in the project area. Please also explain the impacts of such work on the surrounding environment and any steps that could be taken to minimize the impacts.

  No, the project is the development of a cloud seeding technology validation protocol document and will not impact the environment.

- Are you aware of any species listed or proposed to be listed as a Federal threatened or endangered species, or designated critical habitat in the project area? If so, would they be affected by any activities associated with the proposed project?

  No, the project is the development of a cloud seeding technology validation protocol document and will not impact the environment

- Are there wetlands or other surface waters inside the project boundaries that potentially fall under CWA jurisdiction as "Waters of the United States?" If so, please describe and estimate any impacts the proposed project may have.

No

- When was the water delivery system constructed?

  Not applicable.

- Will the proposed project result in any modification of or effects to, individual features of an irrigation system (e.g., headgates, canals, or flumes)? If so, state when those features were constructed and describe the nature and timing of any extensive alterations or modifications to those features completed previously.

  No

- Are any buildings, structures, or features in the irrigation district listed or eligible for listing on the National Register of Historic Places? A cultural resources specialist at your local Reclamation office or the State Historic Preservation Office can assist in answering this question.

  No

- Are there any known archeological sites in the proposed project area?

  Not applicable.

- Will the proposed project have a disproportionately high and adverse effect on low income or minority populations?

  No

- Will the proposed project limit access to and ceremonial use of Indian sacred sites or result in other impacts on tribal lands?

  No

- Will the proposed project contribute to the introduction, continued existence, or spread of noxious weeds or non-native invasive species known to occur in the area?

  No

Required Permits or Approvals

Applicants must state in the application whether any permits or approvals are required and explain the plan for obtaining such permits or approvals.

No, permits or approvals are required since the validation protocol will be completed as a document and will not impact the environment.

Letters of Support and Letters of Participation

Please find the letters of support included on the following pages.

EASTERN MUNICIPAL WATER DISTRICT

March 22, 2022

Jeffery J. Mosher
General Manager
Santa Ana Watershed Project Authority
11615 Sterling Avenue
Riverside, CA 92503

Subject: Letter of Support for the SAWPA WaterSMART Applied Science Fiscal Year 2022 Grant Application

Dear Mr. Mosher:

Eastern Municipal Water District (EMWD) is writing to support SAWPA's Santa Ana River Watershed Weather Modification Validation Protocol Project (Project) and your submission for funding from the Bureau of Reclamation's WaterSMART Applied Science Grants for Fiscal Year 2022 program. The Project is centered on developing a standard protocol for validating the water supply-related benefits of weather modification (also known as "cloud seeding").

There is a strong need for the Project to inform water managers in Southern California of the increased local precipitation from weather modification, which is important to respond to water scarcity and long-term droughts. Weather modification programs have proven successful in many locations throughout California and neighboring states; however, implementing water agencies continue to struggle with validation and quantification of cloud seeding results. This Project will fill that void and inform agencies like ours of the Project's supply benefits through an "evidence based" multi-prong approach that relies on cloud seeding operation assessment, field monitoring of snow chemistry, rainfall and streamflow analysis, and a target and control evaluation. Validation will also include hydrologic modeling of the increased runoff caused by the additional precipitation and what is expected to be captured and recharged in the watershed.

Our agency will benefit from the Project as we can take the results of the validation and incorporate them into our long-term water resource planning program that we utilize to prepare for supply and

2270 Trumble Road • P.O. Box 8300 • Perris, CA 92572-8300
T 951.928.3777 • F 951.928.6177 www.emwd.org

demand imbalances. By understanding the costs and benefits of weather-based technology directly in this watershed, we can rank it alongside the other planned projects we have in our future water supply portfolio. With the increase in shortages along the State Water Project and other imported sources, understanding the viability of local programs is a key priority for our agency.

For these reasons, EMWD is proud to support SAWPA's Bureau of Reclamation's WaterSMART Applied Science Grants for Fiscal Year 2022 grant application.

If you have any questions, please contact Mr. Vincent Lopez, Grants and Project Control Manager at lopezvi@emwd.org or (951) 928-3777 extension 4323.

Sincerely,

Joe Mouawad, P.E.
General Manager

VL:vr

Inland Empire Utilities Agency
A MUNICIPAL WATER DISTRICT

6075 Kimball Avenue • Chino, CA 91708
P.O. Box 9020 • Chino Hills, CA 91709
TEL (909) 993-1600 • FAX (909) 993-1985
www.ieua.org

March 22, 2022

Jeffery J. Mosher
General Manager
Santa Ana Watershed Project Authority
11615 Sterling Avenue
Riverside, CA 92503

RE: Letter of Support for the SAWPA WaterSMART Applied Science Fiscal Year 2022 Grant Application

Dear Mr. Mosher,

The Inland Empire Utilities Agency (IEUA) is writing to support SAWPA's Santa Ana River Watershed Weather Modification Validation Protocol Project (Project) and your submission for funding from the Bureau of Reclamation's WaterSMART Applied Science Grants for Fiscal Year 2022 program. The Project is centered on developing a standard protocol for validating the water supply-related benefits of weather modification (also known as "cloud seeding").

There is a strong need for the Project to inform water managers in Southern California of the potential increased local precipitation from weather modification, which is important to respond to water scarcity and long-term droughts. Weather modification programs have proven successful in many locations throughout California and neighboring states; however, implementing water agencies continue to struggle with validation and quantification of cloud seeding results. This Project will help fill that void and inform agencies like ours of the Project's potential supply benefits through an "evidence based" multi-prong approach that relies on cloud seeding operation assessment, field monitoring of snow chemistry, rainfall and streamflow analysis, and a target and control evaluation. Validation will also include hydrologic modeling of the increased runoff caused by the additional precipitation and what is expected to be captured and recharged in the watershed.

Our agency will benefit from the Project as we can take the results of the validation and incorporate them into our long-term water resource planning program that we utilize to prepare for supply and demand imbalances. By understanding the potential costs and benefits of weather-based technology directly in this watershed, we can rank it alongside the other planned projects we have in our future water supply portfolio. With the increase in shortages along the State Water Project and other imported sources, understanding the viability of local programs is a key priority for our agency.

For these reasons, IEUA is proud to support SAWPA's Bureau of Reclamation's WaterSMART Applied Science Grants for Fiscal Year 2022 grant application.

Sincerely,

Shivaji Deshmukh

Shivaji Deshmukh, P.E.
General Manager

SINCE 1933

ORANGE COUNTY WATER DISTRICT

ORANGE COUNTY'S GROUNDWATER AUTHORITY

March 28, 2022

Jeffery J. Mosher
General Manager
Santa Ana Watershed Project Authority
11615 Sterling Avenue
Riverside, CA 92503

RE: Letter of Support for the SAWPA WaterSMART Applied Science Fiscal Year 2022 Grant Application

Dear Mr. Mosher,

The Orange County Water District (OCWD) is writing to support SAWPA's Santa Ana River Watershed Weather Modification Validation Protocol Project (Project) and your submission for funding from the Bureau of Reclamation's WaterSMART Applied Science Grants for Fiscal Year 2022 program. The Project is centered on developing a standard protocol for validating the water supply-related benefits of weather modification (also known as "cloud seeding").

There is a strong need for the Project to inform water managers in Southern California of the increased local precipitation from weather modification, which is important to respond to water scarcity and long-term droughts. Data has been collected to demonstrate weather modification programs have increased precipitation in locations in California and neighboring states; however, implementing water agencies continue to struggle with assessing the benefits of cloud seeding results. This Project will fill that void and inform agencies like ours of the Project's supply benefits through an "evidence based" multi-prong approach that relies on cloud seeding operation assessment, field monitoring of snow chemistry, rainfall and streamflow analysis, and a target and control evaluation. Assessment and validation will also include hydrologic modeling of the increased runoff caused by the additional precipitation and what is expected to be captured and recharged in the watershed.

Our agency will benefit from the Project as we can take the results of the assessment and validation and incorporate them into our long-term water resource planning program. With the increase in shortages along the State Water Project and other imported sources, understanding the viability of local programs is a key priority for our agency.

For these reasons, OCWD supports SAWPA's Bureau of Reclamation's WaterSMART Applied Science Grants for Fiscal Year 2022 grant application.

If you have any questions, please contact Greg Woodside at 714-378-3275 or gwoodside@ocwd.com.

Sincerely,

Michael R. Markus, P.E., D.WRE, BCEE, F.ASCE
General Manager

SAN BERNARDINO Valley MUNICIPAL WATER DISTRICT

380 East Vanderbilt Way
San Bernardino, CA 92408
phone: 909.387.9200
fax: 909.387.9247
www.sbvmwd.com

April 13, 2022

Jeffery J. Mosher
General Manager
Santa Ana Watershed Project Authority
11615 Sterling Avenue
Riverside, CA 92503

RE: Letter of Support for the SAWPA WaterSMART Applied Science Fiscal Year 2022 Grant Application

Dear Mr. Mosher,

The San Bernardino Valley Municipal Water District (Valley District) is writing to support SAWPA's Santa Ana River Watershed Weather Modification Validation Protocol Project (Project) and your submission for funding from the Bureau of Reclamation's WaterSMART Applied Science Grants for Fiscal Year 2022 program. The Project is centered on developing a standard protocol for validating the water supply-related benefits of weather modification (also known as "cloud seeding").

There is a strong need for the Project to inform water managers in Southern California of the increased local precipitation from weather modification, which is important to respond to water scarcity and long-term droughts. Weather modification programs have proven successful in many locations throughout California and neighboring states; however, implementing water agencies continue to struggle with validation and quantification of cloud seeding results. This Project will fill that void and inform agencies like ours of the Project's supply benefits through an "evidence based" multi-prong approach that relies on cloud seeding operation assessment, field monitoring of snow chemistry, rainfall and streamflow analysis, and a target and control evaluation. Validation will also include hydrologic modeling of the increased runoff caused by the additional precipitation and what is expected to be captured and recharged in the watershed.

Our agency will benefit from the Project as we can take the results of the validation and incorporate them into our long-term water resource planning program that we utilize to prepare for supply and demand imbalances. By understanding the costs and benefits of weather-based technology directly in this watershed, we can rank it alongside the other planned projects we have in our future water supply portfolio. With the increase in shortages along the State Water Project and other imported sources, understanding the viability of local programs is a key priority for our agency.

For these reasons, Valley District is proud to support SAWPA's Bureau of Reclamation's WaterSMART Applied Science Grants for Fiscal Year 2022 grant application.

If you have any questions, please contact me at heatherd@sbvmwd.com or 909-387-9256.

Sincerely,

Heather Dyer, MS, MBA
Chief Executive Officer/General Manager

cc:

March 28, 2022

Jeffery J. Mosher, General Manager
Santa Ana Watershed Project Authority
11615 Sterling Avenue
Riverside, CA 92503

RE: Letter of Support for the SAWPA WaterSMART Applied Science Fiscal Year 2022 Grant Application

Dear Mr. Mosher:

Western Municipal Water District (Western) is writing to support SAWPA's Santa Ana River Watershed Weather Modification Validation Protocol Project (the Project) and your submission for funding from the Bureau of Reclamation's WaterSMART Applied Science Grants for Fiscal Year 2022 program. The Project is centered on developing a standard protocol for validating the water supply-related benefits of weather modification (also known as "cloud seeding").

There is a strong need for the Project to inform water managers in Southern California of the increased local precipitation from weather modification, which is important to respond to water scarcity and long-term droughts. Weather modification programs have proven successful in many locations throughout California and neighboring states; however, implementing water agencies continue to struggle with validation and quantification of cloud seeding results. This Project will fill that void and inform agencies like ours of the Project's supply benefits through an "evidence based" multi-prong approach that relies on cloud seeding operation assessment, field monitoring of snow chemistry, rainfall and streamflow analysis, and a target and control evaluation. Validation will also include hydrologic modeling of the increased runoff caused by the additional precipitation and what is expected to be captured and recharged in the watershed.

Western will benefit from the Project as we can take the results of the validation and incorporate them into our long-term water resource planning program that we utilize to prepare for supply and demand imbalances. By understanding the costs and benefits of weather-based technology directly in this watershed, we can rank it alongside the other planned projects we have in our future water supply portfolio. With the increase in shortages along the State Water Project and other imported sources, understanding the viability of local programs is a key priority for our agency. For these reasons, Western supports SAWPA's Bureau of Reclamation's WaterSMART Applied Science Grants for Fiscal Year 2022 grant application.

If you have any questions, please contact Ryan Shaw at rshaw@wmwd.com or 951.571.7256.

Sincerely,

Craig D. Miller
General Manager

Draft Official Resolution

Please find the draft resolution included on the following page. It will be presented to the SAWPA Board of Commissioners on May 3rd, 2022.

RESOLUTION NO. _____

A RESOLUTION OF THE COMMISSIONERS OF THE SANTA ANA WATERSHED PROJECT AUTHORITY AUTHORIZING PREPARATION AND SUBMITTAL OF AN APPLICATION TO THE BUREAU OF RECLAMATION TO OBTAIN A 2022 WATERSMART APPLIED SCIENCE GRANT

WHEREAS, the Santa Ana Watershed Project Authority wishes to facilitate the implementation of the Cloud Seeding Technology Validation Protocol ("Project") for the benefit of the watershed.

WHEREAS, the Santa Ana Watershed Project Authority will work with the Bureau of Reclamation to meet established deadlines for entering into a financial assistance agreement;

WHEREAS, the Santa Ana Watershed Project Authority and its project partners have the capability to commit the required $100,000 cost share match;

NOW, THEFEFORE, BE IT RESOLVED that the Board of Commissioners of the Santa Ana Watershed Project Authority (SAWPA) *hereby authorizes that* an application be prepared and submitted to the Bureau of Reclamation to obtain a 2022 WaterSMART Applied Science Grant Program Grant, and to enter into an agreement to receive grant funds for the Project.

BE IT FURTHER RESOLVED, that the General Manager of the Santa Ana Watershed Project Authority, or designee, is hereby authorized and directed to prepare the necessary data, conduct investigations, file such application, meet established deadlines, and execute an agreement and any amendments thereto, with the Bureau of Reclamation for the Project.

ADOPTED this 3rd day of May, 2022

SANTA ANA WATERSHED PROJECT AUTHORITY

By: _____
Marco Tule, Chair

Conflict of Interest Disclosure

Per the Financial Assistance Interior Regulation (FAIR), 2 CFR §1402.112, the Santa Ana Watershed Project Authority (SAWPA) has no actual or potential conflict of interest exists at the time of submission of this application.

Uniform Audit Reporting Statement

Not applicable.

Certification Regarding Lobbying

Not applicable, although the webform was completed and submitted through Grants.gov with pertinent information.