Water Supply Reserve Account – Grant and Loan Program
Water Activity Summary Sheet
September, 24 2013
Agenda Item 18(a)

Applicant: Conejos Water Conservancy District

Water Activity Name: Radar Monitoring & Hydrologic Modeling in the Upper Rio Grande Basin to Develop Accurate Stream Flow Forecasting

Water Activity Purpose: Technology Demonstration Project

County: Conejos

Drainage Basin: Rio Grande

Water Source: **Conejos** River

Amount Requested: $200,000 (Statewide Account), and $37,000 (Rio Grande Basin Account)

Matching Funds: $215,000 (40%) from CWCB Construction Fund Appropriation; $86,300 (16%) awarded from USBR Water Smart Program

Staff Recommendation
Staff recommends approval of up to $200,000 of Statewide WSRA funds and up to $37,000 of Rio Grande Basin WSRA funds to help complete the Radar Monitoring and Hydrologic Modeling for in the Upper Rio Grande Basin to Develop Accurate Stream Flow Forecasting.

Water Activity Summary:
Streamflow in the Rio Grande and the Conejos River comes mostly from snowfall. In the Upper Rio Grande (URG) Basin, water managers must rely on the accuracy of precipitation forecasts by the Division of Water Resources (DWR) as the basis for their decisions on the storage, release, and beneficial use of water. Ideally, these forecasts should be based on accurate estimates of snowfall, careful monitoring of the water content and behavior of snowpack, and a good understanding of snowmelt, run-off, and streamflow. Inaccurate streamflow forecasts are causing unnecessary curtailment of ditches, over- or under-delivery of Colorado's compact obligations, and a disruption of the priority system. This Project will evaluate and implement new data collection, data integration and modeling methods and seeks to reduce/eliminate errors in water supply forecasts.

This Project has four major components: 1) use radars for precipitation estimation of winter storms, 2) develop additional ground instrumentation for radar calibration and to fill modeling gaps, 3) feed precipitation estimates to gridded spatial snow and hydrologic models, 4) present the results to the science advisory team and stakeholders, 5) analyze the results of different techniques and 6) write a final report. The Project tackles the age old question of "are point data and modeling better than spatial data and modeling?" Our hypothesis is that it is superior and beneficial in wet and dry years. The Project's will site a mobile X Band polarized radar for the full winter seeing most or all of the Conejos River Basin and develop 1km gridded precipitation estimates for each winter storm to feed two operational NWS snowpack models (SNODAS and Snow-17) that are coupled three hydrologic models (NWS-SACSMA, NWS-RDHM, and WRF-Hydro). The Science Team decided that due to the burn area in the Rio Grande is was best to model the Conejos as this comparison will work best in a less disturbed basin. In essence it is difficult to forecast with any models in a burned watershed. In essence there are about seven SNOTEL sites in the Rio Grande that drive the Snow-17 model that was created in 1972. With the use of mobile radars we will create about 300-400 SNOTEL sites to feed the SNODAS model which was created in 2003. In essence the ball need to move forward and we need to start using more modern and superior physics based models but the key component is to now feed them with a lot more accurate data. Another key component

to the project is what we call the "legacy component" where ground instrumentation purchased for the project will serve two purposes which are two help validate and refine the radar precipitation estimates and then fill gaps in at different elevation bands to give more data for decisions and modeling to the currently subjective analysis of snow totals at elevation bands below the current SNOTEL network.

Threshold and Evaluation Criteria
The application meets all four Threshold Criteria.

The application articulates how the project meets the Evaluation Criteria as summarized below:

Tier 1: Promoting Collaboration/Cooperation & Meeting Water Management Goals & Identified Needs: There is broad stakeholder input and collaboration in this project including the USBR, CWCB, NOAA-National Severe Storms Lab, National Center for Atmospheric Research, Conejos WCD, San Luis Valley Irrigation District, DWR, West Gulf River Basin Forecast Center, Portland-NRCS, Colorado River Basin Forecast Center, Manassa Water Users Association, etc. The single most critical water issue confronting the Rio Grande is the management of surface and ground water. Also important to note is the ground water model and Supreme Court decrees that require the April 1 streamflow forecast numbers as input to the ground water modeling and administration work. A better April 1 streamflow forecast will also benefit ground water management.

Tier 2: Facilitating Water Activity Implementation: Without this funding, this Project would not be implemented. This is a demonstration of technology project that is providing new data and modeling techniques for consideration and comparison to existing technologies. This Project builds on the collective knowledge in the field of snowpack and hydrologic modeling and takes it that next step by forcing those models with quality radar derived precipitation estimates. This project has statewide and national implications to all River Basin Forecast Centers that forecast volumes of water and all administration agencies that apportion water based on forecasted volumes.

Tier 3: The Water Activity Addresses Issues of Statewide Value and Maximizes Benefits: This Project has values statewide and nationally and that is why it is well coordinated with federal interests. There is a large science advisory team to comment on products and reports. This Project addresses the need for better information and modeling for the number one issue in the Rio Grande which is accurate administration of surface and groundwater. It was also the highest rank proposal to the USBR Water Smart Program in its category and is matched with CWCB funds from the Construction Fund. The legacy component of additional mountain instrumentation will continue to benefit modeling and management at the project completion.

Discussion:
This Project is very unique in nature in that a local agency agreed to use their project to leverage funds in Basin fund and then the statewide account and partner with the state and federal governments to work towards the collective good which could be a 21st century data and modeling forecasting system. This is much needed all over the state and in the west for water supplies. This Project is $37,000 local funds and $200,000 Statewide funds that are matched with $215,000 CWCB funds and $86,300 USBR funds or the rations 1:1.25 WSRA funds to other funds.

Issues/Additional Needs:
CWCB staff requests that the following issues be addressed during contracting and project execution:

- It can be difficult for the State of Colorado to contract directly with the National Center for Atmospheric Research and its recommended that the Conejos WCD contract with NCAR

- The CWCB has an existing contract with NOAA-NSSL and a Scope of Work and cost estimate for the radar deployment and data processing work. The CWCB will contract with NOAA for the Radar work. The Conejos WCD will contract with NCAR for modeling and instrumentation needs.
- There are benefits to having no overhead on instrumentation purchased when funding does not go through NCAR. An equipment purchase list should be provided by NCAR but purchased locally. Some funding provided by the USBR will also purchase equipment for this project and the NCAR overhead rates are unavoidable.

Staff Recommendation:
Staff recommends approval of up to $200,000 of Statewide WSRA funds and up to $37,000 of Rio Grande Basin WSRA funds to help complete the Radar Monitoring and Hydrologic Modeling for in the Upper Rio Grande Basin to Develop Accurate Stream Flow Forecasting.

All products, data and information developed as a result of this grant must be provided to CWCB in hard copy and electronic format as part of the project documentation. This information will in turn be made widely available to Basin Roundtables and the general public and will help promote the development of a common technical platform.

In accordance with the revised WSRA Criteria and Guidelines, staff would like to highlight additional reporting and final deliverable requirements. The specific requirements are provided below.

Reporting: The applicant shall provide the CWCB a progress report and will host regular briefing calls among the advisory committee and Science Team and summarize those discussions. The applicant will also coordinate participation and incorporating comments of the science advisory team. The progress report shall describe the completion or partial completion of the tasks identified in the scope of work including a description of any major issues that have occurred and any corrective action taken to address these issues.

Final Deliverable: At completion of the project, the applicant shall provide the CWCB a final report that summarizes the project. This final report will include formal written comments in the appendix from the science advisory team and project stakeholders.

Rio Grande Inter-Basin Roundtable
c/o San Luis Valley Water Conservancy District
623 Fourth Street
Alamosa, CO 81101
Telephone: (719) 589 – 2230
Email: slvwcdco1@qwestoffice.net

July 22, 2013

Mr. Michael King, Executive Director
Colorado Department of Natural Resources

Ms. Rebecca Mitchell, Section Chief
Water Supply Planning Section
Colorado Water Conservation Board

Reference: Radar Monitoring & Hydrologic Modeling in the Upper Rio Grande Basin to Develop Accurate Stream Flow Forecasting

Dear Ms. Mitchell:

The Rio Grande Inter-Basin Roundtable (R.G.R.T) has determined that the single, most critical water issue confronting the Rio Grande Basin (Basin) is the current unsustainable management of surface and ground water. The R.G.R.T. has made the decision that water activities that address this issue be favorably considered for funding from the Water Supply Reserve Account, SB 2005 -179 (WSRA Funds), providing the proposed water activities meet the SWSI findings for the Basin and the CWCB & IBCC Criteria and Guidelines for funding.

The Radar Monitoring & Hydrologic Modeling in the Upper Rio Grande Basin to Develop Accurate Stream Flow Forecasting, (Project), is sponsored by the Conejos Water Conservancy District (CWCD). The Project consists of deploying a weather radar unit in the Conejos River watershed and additional instrumentation in the watershed to measure winter precipitation events and to calibrate a series of models to the data to predict the subsequent river run-off and flows during the irrigation season.

Effective water administration, and the associated Conejos River Compact, requires accurate streamflow forecasts and decision tools that enable the Colorado Division of Water Resources (CDWR) Division 3 Engineer and water users to obtain maximum beneficial use from existing water supplies. This Project will develop those tools, resulting in improved accuracy of streamflow forecasts.

The Project aligns itself with the CWCB's mission is to conserve, develop, protect and manage Colorado's water, as the intent of the Project is development of improved methods to account for snow as part of the hydrologic cycle. This in turn, may lead to better management of water and in the case of the Conejos River watershed, to meeting Colorado's obligation to accurately deliver flows to downstream states under terms of the Conejos River Compact. In addition, the Project directly addresses the National Center for

Atmospheric Research (NCAR) priorities related to improving the understanding and prediction of precipitation, snowpack and streamflow processes in the western U.S.

This Project will also advances radar methodologies to predict floods, severe weather, rain, and rain on snow events. It thus helps CDWR and CWCB to prepare for, respond to, and mitigate the effects of these events, supporting flood plain and flood protection missions in the watershed.

This project will develop the Rio Grande Compact Decision Support Tool, thus supporting DWR in its use of Ensemble Streamflow Prediction (ESP) forecasts to evaluate curtailment scenarios and to correctly estimate the probability of Compact compliance.

In these times of severe extended drought and with rising temperatures, general drying, and the increasing occurrence of forest fires and severe floods, there is a need to increase the accuracy of streamflow forecasts. This collaborative project will improve the data and the models which will significantly increase the accuracy of precipitation observations and improve hydrologic forecasts in the Conejos Basin in the Rio Grande Basin.

A recent analysis by CWCB and CDWR illustrated that seasonal water supply forecasts, which are currently based primarily on Natural Resources Conservation Service (NRCS) 'SNOw TELemetry' (SNOTEL) data, have struggled with high rates of inaccuracy, particularly in wet and dry years in the last several years. The high error rate in the annual April 1st. forecasts translates into millions of dollars lost annually due to excessive or premature curtailments of water used by irrigators and the resulting reduced agricultural productivity of irrigated lands.

Working with the Division 3 Engineer the CWCB helped determine that the economic impact of those water supply forecast errors was $15.1M in Water Year 2005 and $19.03M in Water Year 2007. According to Division 3 Engineer Craig Cotten, "Inaccurate streamflow forecasts can cause unnecessary curtailment of ditches, over- or under-delivery of Colorado's compact obligations, and a disruption of the priority system."

Because of such tight operating margins and the unequivocal, severe costs associated with erroneous projections, it is imperative that new data collection, data integration and modeling methods be evaluated and implemented to reduce the errors in water supply forecasts.

Methods, Procedures & Deliverable – CWCB's ongoing partnership

Over the last six years the CWCB worked with federal and private partners to improve the description of spring snowpack conditions and the use of hydrologic models. One of the snowpack models being used is the NOAA/National Operational Hydrologic Remote Sensing Center's snow model called SNODAS (SNOw Data Assimilation System). Data from SNODAS has been provided to the Division 3 Engineer since 2007. SNODAS is thirty years newer than some of the currently operational forecasting models and offers promise to provide another means of "assessing" the watersheds more comprehensively during the snowmelt part of the hydrologic cycle.

One of the recommendations after the final phase of the SNODAS project was to seek more inputs and forcing data for the SNODAS model, beyond SNOTELs and numerical weather prediction model forecasts. Although the CWCB has invested in additional SNOTEL stations, there presently exist only 7 stations in the entire Upper Rio Grande River basin which encompasses over 7,000 square miles. Due to the point nature of SNOTELs and limitations of model forecasts of precipitation, it is anticipated that precipitation radars can provide high-resolution spatial observations.

The consensus is that well-calibrated radar data has the potential to simulate the precipitation observations of hundreds of SNOTEL sites that are unfeasible to deploy in Colorado. While the deployment and collection of radar data is supported through a different CWCB contract, is Project seeks to obtain support for the deployment of a network of surface instrumentation which will be used to calibrate radar precipitation estimates and to monitor local snowpack and meteorological conditions in the Conejos River watershed of the Upper Rio Grande Basin.

The Project has technical input and support of the:

- CWCD: Will act as the lead in this study, providing administrative and fiscal management of the Project. CWCB has allocated $215,000 towards this project/concept and will contract with Riverside Technologies, Inc., with administrative support from the District. The role of CWCB is detailed under Task 2 of the Scope of Work.

- NSSL – National Severe Storms Laboratory's Dr. Steve Vasiloff, will be the Basin's go-to radar site expert, running and interpreting initial radar information. Dr. Vasiloff experience includes conducting the Southwest Colorado Radar Project, completed at the end of February, 2011, with deployment of the NOAA X-Pol mobile radar unit as part of the study to collect data on snowfall in the area.

- Riverside Technology Inc., headquartered in Fort Collins, will continue & expand current contracts for development of the modeling. Riverside is an internationally recognized engineering, science, and information technology company with more than 25 years of experience providing innovative information technology solutions for environmental decision support systems using a variety of different environmental data sources, from satellite sensors and imagery to stream gages in local rivers.

- NOAA – National Oceanic and Atmospheric Administration will provide direction and expertise for the implementation of the information that comes from the radar experiments.

- NWS – The National Weather Service will provide in-kind technical support, time, and personnel, with potential further involvement, depending on the findings and outcome of this project.

As further evidence of collaboration, the following personnel from the various entities will be directly involved in running this project:

State of Colorado Sponsors:

- Joe Busto, CWCB Watershed Protection & Flood Mitigation Program
- Kevin Houck, Section Chief, CWCB Watershed Protection & Flood Mitigation Program
- Steve Shull, CWCB Contract Specialist
- Maggie Van Cleef, Department of Natural Resources Purchasing

NCAR Project Contractor & Scientific Team

- David Gochis, Scientist III, Research Applications Laboratory, National Center for Atmospheric Research
- Martyn Clark, Scientist III, Research Applications Laboratory, National Center for Atmospheric Research

NCAR Contract Specialists

- Gina Taberski, National Center for Atmospheric Research

PROJECT AND AMOUNT REQUESTED	SOURCE SB 179
Radar Monitoring & Hydrologic Modeling	BASIN $37.000
Radar Monitoring & Hydrologic Modeling	STATEWIDE $200,000

The overall cost breakdown for the Project elements include:

BUDGET				
	WSRA GRANT FUNDS			
	Labor	**Direct Costs**	**Matching Funds**	**Total Project**
Task 1 – District Administration & Direct Costs Plus Matching funds (District's fund-raising and consciousness-raising campaign)	$27,000	(not known yet)	$ 20,000	$ 47,000
Task 2 – NCAR modeling and Interpretation – CWCB funds			$ 215,000	$ 215,000
Task 3 - Procurement, deployment, operation and maintenance of in-situ measurement systems		$ 60,000		$ 60,000
Task 4 - Production and evaluation of hydrologic forecasts	$150,000			$ 150,000
Matching Funds USBR-NCAR Technical Support and expertise – Estimated			$ 89,000	$ 89,000
Total Matching Contributions				
Total Costs:	$177,000	$ 60,000	$ 324,00.00	$561,000
GRANT REQUEST	**$ 237,000**			

As can be seen from the table above, the CWCB has committed $215,000, with the District contributing $47,000.

On behalf of the R.G.R.T. members, we appreciate the Board's consideration of this request and urge your support to the fullest extent possible. Enclosed are the application and supporting materials for the Project. If you require additional information, please notify me accordingly.

The R.G.R.T. appreciates the support of the Department of Natural Resources, the Colorado Water Conservation Board and the Interbasin Compact Commission in assisting in meeting the needs of all users of Colorado's water and in fostering intrabasin and interbasin communications and discussions. We believe that the above project will assist in this effort.

Sincerely,

Mike Gibson
Chair, Rio Grande Interbasin Roundtable

Enclosures (1)

cc: Conejos Water Conservancy District

RADAR MONITORING & HYDROLOGIC MODELING
IN THE UPPER RIO GRANDE BASIN
TO DEVELOP ACCURATE STREAMFLOW FORECASTING

RIO GRANDE BASIN ROUNDTABLE

Water Supply Reserve Account

Grant Application

JULY 9, 2013

COLORADO WATER CONSERVATION BOARD

WATER SUPPLY RESERVE ACCOUNT APPLICATION EFORM

Radar Monitoring & Hydrologic Modeling in the Upper Rio Grande Basin to Develop Accurate Streamflow Forecasting

Name of Water Activity/Project

Conejos Water Conservancy District

Name of Applicant

Rio Grande Basin

Approving Basin Roundtable(s)
(If multiple basins specify amounts in parentheses.)

Amount from Statewide Account: $200,000

Amount from Basin Account(s): $ 37,000

Total WSRA Funds Requested: $237,000

Application Content

Required Exhibits

A. Statement of Work, Budget, and Schedule
B. Project Map
C. As Needed (i.e. letters of support, photos, maps, etc.)

Appendices – Reference Material

1. Program Information
2. Insurance Requirements
3. WSRA Standard Contract Information (Required for Projects Over $100,000)
4. W-9 Form (Required for All Projects Prior to Contracting)

Instructions

To receive funding from the Water Supply Reserve Account (WSRA), a proposed water activity must be approved by the local Basin Roundtable **AND** the Colorado Water Conservation Board (CWCB). The process for Basin Roundtable consideration and approval is outlined in materials in Appendix 1.

Once approved by the local Basin Roundtable, the applicant should submit this application **with a detailed statement of work including budget and schedule as Exhibit A** to CWCB staff by the application deadline.

WSRA applications are due with the roundtable letter of support 60 calendar days prior to the bi-monthly Board meeting at which it will be considered. Board meetings are held in January, March, May, July, September, and November. Meeting details, including scheduled dates, agendas, etc. are posted on the CWCB website at: http://cwcb.state.co.us Applications to the WSRA Basin Account are considered at every board meeting, while applications to the WSRA Statewide Account are only considered at the March and September board meetings.

When completing this application, the applicant should refer to the WSRA Criteria and Guidelines available at: http://cwcb.state.co.us/LoansGrants/water-supply-reserve-account-grants/Documents/WSRACriteriaGuidelines.pdf

The application, statement of work, budget, and schedule **must be submitted in electronic format** (Microsoft Word or text-enabled PDF are preferred) and can be emailed or mailed on a disk to:

Greg Johnson – WSRA Application
Colorado Water Conservation Board
1580 Logan Street, Suite 200
Denver, CO 80203
gregory.johnson@state.co.us

If you have questions or need additional assistance, please contact Greg Johnson at: 303-866-3441 x3249 or gregory.johnson@state.co.us.

Water Supply Reserve Account – Application Form
Revised December 2011

Part I. - Description of the Applicant (Project Sponsor or Owner);

1.	Applicant Name(s):	Conejos Water Conservancy District		
	Mailing address:	Nathan Coombs, Manager P. O. Box 550 Manassa, CO 81141		
	Taxpayer ID#:	XH-84-0776076		
	Primary Contact:	Nathan Coombs	Position/Title:	Manager
	Email:	cwc548@centurytel.net		
	Phone Numbers:	Cell:	Office:	719-843-5261
	Alternate Contact:	Joe Busto	Position/Title:	Project Director
	Email:			
	Phone Numbers:	Cell:	Office:	303 587-5585

2. Eligible entities for WSRA funds include the following. What type of entity is the Applicant?

[ ] Public (Government) – municipalities, enterprises, counties, and State of Colorado agencies. Federal agencies are encouraged to work with local entities and the local entity should be the grant recipient. Federal agencies are eligible, but only if they can make a compelling case for why a local partner cannot be the grant recipient.

[x] Public (Districts) – authorities, Title 32/special districts, (conservancy, conservation, and irrigation districts), and water activity enterprises.

[ ] Private Incorporated – mutual ditch companies, homeowners associations, corporations.

[ ] Private individuals, partnerships, and sole proprietors are eligible for funding from the Basin Accounts but not for funding from the Statewide Account.

[ ] Non-governmental organizations – broadly defined as any organization that is not part of the government.

3. Provide a brief description of your organization

The Conejos Water Conservancy District (CWCD or the District) is a public, quasi-governmental entity, eligible under SB 06-179 to apply for funds for this structural water project to improve the water management capabilities of District on the area of the Conejos River (the Conejos) commonly known as "The Confluence." The District's boundaries include about 100,000 acres, of which 86,000 acres are capable of being irrigated. An additional 8,000 acres that are not within the boundaries of the District are also irrigated by the Conejos and its tributaries. CWCD is that portion of the *San Luis Valley Project Colorado* designated by the Bureau of Reclamation in 1928 and formed in September 1940 under the *Water Conservancy Act of 1938* codified at 37-45-101. The CWCD formed an Enterprise when Platoro Reservoir, a U.S. Bureau of Reclamation project, became available for the CWCD's operation and control, after Colorado's Rio Grande Compact debt was satisfied in 1985. Total operating budget for the Conejos Water Conservancy District is about $200,000, which includes one full time salary.

The District plays a critical role in the management of flows on the Conejos River and its tributaries, ensuring that sufficient quantities of water are available to meet agricultural needs within the District and to satisfy Colorado's obligation to the Rio Grande Compact. The Compact requires deliveries of water from the Rio Grande to the New Mexico State line based on an annual volumetric delivery, with the volume of water obligated downstream in a given year depending on the volume of flow measured at four index stream gages within the Rio Grande basin. In any given year Colorado is required to deliver between 25 and 70 percent of the water generated in the two river systems -- the Rio Grande and the Conejos.

Erroneous seasonal water supply forecasts in the Upper Rio Grande (URG) basin have a profound impact on water management, agricultural production and economic vitality. A recent analysis by the Colorado Water Conservation Board (CWCB) and Colorado Division of Water Resources (CDWR) illustrated that seasonal water supply forecasts based primarily on Natural Resources Conservation Service (NRCS) 'SNOw TELemetry' (SNOTEL) data have struggled with inaccuracy, particularly in wet and dry years. The high error rate in the annual April 1 forecasts translates into millions of dollars lost annually due to reduced agricultural productivity on irrigated lands. Working with the DWR Division Engineer, the CWCB helped determine that the economic impact of those water supply forecast errors was $15.1M in Water Year 2005 and $19.03M in Water Year 2007. This project aims to develop systems for the accurate measurement and prediction of snowfall and snowpack, and, through advanced radar systems and 21st Century hydrologic modeling, for error-free forecasts of streamflow.

4. If the Contracting Entity is different than the Applicant (Project Sponsor or Owner) please describe the Contracting Entity here.

NA

5. Successful applicants will have to execute a contract with the CWCB prior to beginning work on the portion of the project funded by the WSRA grant. In order to expedite the contracting process the CWCB has established a standard contract with provisions the applicant must adhere to. A link to this standard contract is included in Appendix 3. Please review this contract and check the appropriate box.

   [x] The Applicant will be able to contract with the CWCB using the Standard Contract

   [ ] The Applicant has reviewed the standard contract and has some questions/issues/concerns. Please be aware that any deviation from the standard contract could result in a significant delay between grant approval and the funds being available.

6. The Tax Payer Bill of Rights (TABOR) may limit the amount of grant money an entity can receive. Please describe any relevant TABOR issues that may affect the applicant.

The Conejos Water Conservancy District is exempt from Tabor regulations per the passing of Referendum B in a Conejos County election held November 6, 2007 in which voters granted the District its exemption.

Part II. - Description of the Water Activity/Project

1. What is the primary purpose of this grant application? (Please check only one)

   [ ] Nonconsumptive (Environmental or Recreational)

   [ ] Agricultural

   [ ] Municipal/Industrial

   [ ] Needs Assessment

   [ ] Education

   [X] Other Explain: Use RADAR for accurate Streamflow Forecasts

2. If you feel this project addresses multiple purposes please explain.

   a. **Improved water management efficiency:** Gather enhanced precipitation and snowpack data to improve weather forecasting, thereby reducing uncertainty in current estimates of water resources.
   b. **Support CWCB Flood Decision Support System:** Use radar, satellite, and ground-based observations to upgrade forecasting capabilities and previous CWCB Flood Decision Support System studies, providing accurate streamflow forecasts, even after headwaters have experienced extensive beetlekill and wildfires.
   c. **Safety and flood plain function:** Deploy radar sites and gather data to more accurately anticipate annual water supplies, including run-off prediction, monitoring of monsoon precipitation, and flash flood events.
   d. **Improve administration of Rio Grande Compact deliveries:** Reducing streamflow forecast errors will reduce or eliminate premature and unnecessary curtailments, delivering the correct amount of water to downstream Compact partners.

3. Is this project primarily a study or implementation of a water activity/project? (Please check only one)

X	Study		Implementation

4. To catalog measurable results achieved with WSRA funds can you provide any of the following numbers?

	New Storage Created (acre-feet)
	New Annual Water Supplies Developed, Consumptive or Nonconsumptive (acre-feet)
	Existing Storage Preserved or Enhanced (acre-feet)
	Length of Stream Restored or Protected (linear feet)
	Length of Pipe/Canal Built or Improved (linear feet)
	Efficiency Savings (acre-feet/year OR dollars/year – **circle one**)
	Area of Restored or Preserved Habitat (acres)
X	Other -- Explain: Use radar to improve stream flow forecasts

4. To help us map WSRA projects please include a map (Exhibit B) and provide the general coordinates below:

   Latitude: TBD Longitude: TBD

5. Please provide an overview/summary of the proposed water activity (no more than one page). Include a description of the overall water activity and specifically what the WSRA funding will be used for. A full **Statement of Work** with a detailed budget and schedule is required as **Exhibit A** of this application.

(next page please)

Knowing where the Basin's water comes from: Streamflow in the Rio Grande and the Conejos River comes mostly from snowfall in the San Juan and the Sangre de Cristo ranges of the Rocky Mountains. In the Upper Rio Grande (URG) Basin, water managers must rely on the accuracy of precipitation forecasts by the Division of Water Resources (DWR) as the basis for their decisions on the storage, release, and beneficial use of water. Ideally, these forecasts should be based on accurate estimates of snowfall, careful monitoring of the water content and behavior of snowpack, and a good understanding of snowmelt, run-off, and streamflow. But that is not the case. Inaccurate streamflow forecasts are causing unnecessary curtailment of ditches, over- or under-delivery of Colorado's compact obligations, and a disruption of the priority system. This Project will evaluate and implement new data collection, data integration and modeling methods in order to reduce/eliminate errors in water supply forecasts.

This project has three major components: (1) Develop a Rio Grande Compact Decision Support Tool for DWR; (2) generate historical forecasts using the Weather Service hydrologic models to better understand forecast errors; and (3) use snow-covered area data to improve snow modeling and water supply forecasts. The District requests $237,000 in WSRA funds: $60,000 for the NCAR instrumentation required to ground-truth the radar readings; $150,000 for contracting the hydrologic modeling and the interpretation of the radar data; and $27,000 to cover the District's direct costs and administration.

Need for more data: These funds will complement, leverage, and expand upon CWCB's ongoing studies in the Rio Grande Basin, for which matching funds of $215,000 were recently allocated under SB 13-181. Since 2007 the CWCB has worked with federal and private partners to improve the description of spring snowpack conditions, using hydrologic models, and providing SNODAS data to the Rio Grande Division Engineer. SNODAS is thirty years newer than some of the currently operational forecasting models, so it will provide another means of "assessing" our watersheds more comprehensively during the snowmelt part of the hydrologic cycle. One of the recommendations after the final phase of the SNODAS project was to seek more inputs and forcing data for the SNODAS model, beyond SNOTELs and numerical weather prediction model forecasts.

Need for better data: Although the CWCB has invested in additional SNOTEL stations, the URG Basin has only 7 stations in its entire 7,000 square mile region. The team of scientists in this study anticipates that well-calibrated radars have the potential to simulate the precipitation observations of hundreds of SNOTEL sites – far more than could possibly be deployed in a lifetime. The goal of this pilot project is to develop an accurate April 1 annual streamflow forecast and to improve forecast updates during the melt season. Instead of basing forecasts on data from only seven SNOTEL sites, this project will deploy modern radars, creating thousands of data points to feed into prediction models. Dr. Nolan Doesken, Colorado State Climatologist, will advise the project, representing the interests of Rio Grande Basin water users, and CWCB's Joe Busto is Project Director.

Need to verify or "ground-truth" the data: The work proposed here is the deployment of a network of surface instrumentation which will be used to calibrate radar precipitation estimates and to monitor local snowpack and meteorological conditions in the URG Basin. These instruments will be left in the Basin as a legacy of this Project, providing water managers nearly twice the in-situ observing capacity in monitoring snowpack, snowmelt, and streamflow conditions as they presently have.

Need for 21st Century modeling: The Basin is seeing radical changes in watershed conditions due to widespread forest fires and insect-induced forest mortality, causing ash and mud flows, flash floods, and streambank instability like we've never seen before. This Project will advance streamflow forecasting into the 21st Century, developing dynamic and evolving streamflow prediction models and state-of-the-art modeling approaches.

Part III. – Threshold and Evaluation Criteria

1. Describe how the water activity meets these **Threshold Criteria.** (Detailed in Part 3 of the Water Supply Reserve Account Criteria and Guidelines.)

   a) The water activity is consistent with Section 37-75-102 Colorado Revised Statutes.[1]

   This is a pilot project to more accurately estimate Rio Grande Basin snowfall and snowpack, providing new models and predictive systems to improve forecasts of streamflow. Nothing in this project has any effect with the issues raised in Section 37-75-102 Colorado Revised Statutes.

   b) The water activity underwent an evaluation and approval process and was approved by the Basin Roundtable (BRT) and the application includes a description of the results of the BRTs evaluation and approval of the activity. At a minimum, the description must include the level of agreement reached by the roundtable, including any minority opinion(s) if there was not general agreement for the activity. The description must also include reasons why general agreement was not reached (if it was not), including who opposed the activity and why they opposed it. Note- If this information is included in the letter from the roundtable chair simply reference that letter.

   This information is provided in the cover letter by the Chairman of the Rio Grande Basin Roundtable.

[1] 37-75-102. Water rights - protections. (1) It is the policy of the General Assembly that the current system of allocating water within Colorado shall not be superseded, abrogated, or otherwise impaired by this article. Nothing in this article shall be interpreted to repeal or in any manner amend the existing water rights adjudication system. The General Assembly affirms the state constitution's recognition of water rights as a private usufructuary property right, and this article is not intended to restrict the ability of the holder of a water right to use or to dispose of that water right in any manner permitted under Colorado law. (2) The General Assembly affirms the protections for contractual and property rights recognized by the contract and takings protections under the state constitution and related statutes. This article shall not be implemented in any way that would diminish, impair, or cause injury to any property or contractual right created by intergovernmental agreements, contracts, stipulations among parties to water cases, terms and conditions in water decrees, or any other similar document related to the allocation or use of water. This article shall not be construed to supersede, abrogate, or cause injury to vested water rights or decreed conditional water rights. The General Assembly affirms that this article does not impair, limit, or otherwise affect the rights of persons or entities to enter into agreements, contracts, or memoranda of understanding with other persons or entities relating to the appropriation, movement, or use of water under other provisions of law.

c) The water activity meets the provisions of Section 37-75-104(2), Colorado Revised Statutes.[2] The Basin Roundtable Chairs shall include in their approval letters for particular WSRA grant applications a description of how the water activity will assist in meeting the water supply needs identified in the basin roundtable's consumptive and/or non-consumptive needs assessments.

This information is provided in the cover letter by the Chairman of the Rio Grande Basin Roundtable.

d) Matching Requirement: For requests from the **Statewide Fund**, the applicants is required to demonstrate a **20 percent** (or greater) match of the request from the Statewide Account. Statewide requests must also include a minimum match of **5 percent** of the total grant amount from Basin Funds. Sources of matching funds include but are not limited to Basin Funds, in-kind services, funding from other sources, and/or direct cash match. Past expenditures directly related to the project may be considered as matching funds if the expenditures occurred within 9 months of the date the application was submitted to the CWCB. Please describe the source(s) of matching funds. (NOTE: These matching funds should also be reflected in your Detailed Budget in **Exhibit A** of this application)

Total Project Cost	$561,000
CWCB	$215,000 as matching funds for this project
Local stakeholders	$ 20,000 toward administrative costs
USBR & NCAR	$ 89,000 in-kind and estimated matching funds*
TOTAL MATCH	$324,000 = more than the total WSRA request
Statewide Fund Request	$200,000
Basin Fund Request	$ 37,000
Total Grant Request	$237,000

* Even if the $89,000 from USBR is not approved, the match is 99% of the grant request!

2. For Applications that include a request for funds from the **Statewide Account**, describe how the water activity/project meets all applicable **Evaluation Criteria.** (Detailed in Part 3 of the Water Supply Reserve Account Criteria and Guidelines and repeated below.) Projects will be assessed on how well they meet the Evaluation Criteria. **Please attach additional pages as necessary.**

[2] 37-75-104 (2)(c). Using data and information from the Statewide Water Supply Initiative and other appropriate sources and in cooperation with the on-going Statewide Water Supply Initiative, develop a basin-wide consumptive and nonconsumptive water supply needs assessment, conduct an analysis of available unappropriated waters within the basin, and propose projects or methods, both structural and nonstructural, for meeting those needs and utilizing those unappropriated waters where appropriate. Basin Roundtables shall actively seek the input and advice of affected local governments, water providers, and other interested stakeholders and persons in establishing its needs assessment, and shall propose projects or methods for meeting those needs. Recommendations from this assessment shall be forwarded to the Interbasin Compact Committee and other basin roundtables for analysis and consideration after the General Assembly has approved the Interbasin Compact Charter.

Evaluation Criteria – the following criteria will be utilized to further evaluate the merits of the water activity proposed for funding from the Statewide Account. In evaluation of proposed water activities, preference will be given to projects that meet one or more criteria from each of the three "tiers" or categories. Each "tier" is grouped in level of importance. For instance, projects that meet Tier 1 criteria will outweigh projects that only meet Tier 3 criteria. WSRA grant requests for projects that may qualify for loans through the CWCB loan program will receive preference in the Statewide Evaluation Criteria if the grant request is part of a CWCB loan/WSRA grant package. For these CWCB loan/WSRA grant packages, the applicant must have a CWCB loan/WSRA grant ratio of 1:1 or higher. Preference will be given to those with a higher loan/grant ratio.

Tier 1: Promoting Collaboration/Cooperation and Meeting Water Management Goals and Identified Water Needs

a. The water activity addresses multiple needs or issues, including consumptive and/or non-consumptive needs, or the needs and issues of multiple interests or multiple basins. This can be demonstrated by obtaining letters of support from other basin roundtables (in addition to an approval letter from the sponsoring basin).

Multiple needs and issues:

Effective water administration requires accurate streamflow forecasts and decision tools that enable water users to obtain maximum beneficial use from existing water supplies. This project will develop those tools, resulting in accurate streamflow forecasts.

This project directly addresses National Center for Atmospheric Research (NCAR) priorities related to improving the understanding and prediction of precipitation, snowpack and streamflow processes in the western U.S.

The CWCB's mission is to conserve, develop, protect and manage Colorado's water. Better methods to account for snow as part of the hydrologic cycle may lead to better management of water within its boundaries and to meeting Colorado's obligation to accurately deliver flows to downstream states under terms of the RIo Grande Compact.

This project advances radar methodologies to predict floods, severe weather, rain, and rain on snow events. It thus helps DWR and CWCB to prepare for, respond to, and mitigate the effects of these events, supporting flood plain and flood protection missions in the watershed.

This project will develop the Rio Grande Compact Decision Support Tool, thus supporting DWR in its use of Ensemble Streamflow Prediction (ESP) forecasts to evaluate curtailment scenarios and to correctly estimate the probability of Compact compliance.

This project addresses the Colorado Water Conservation Board (CWCB) mandate to utilize the maximum amount of water in the state. In these times of severe extended drought and with rising temperatures, general drying, and the increasing occurrence of forest fires and severe floods, we need to increase the accuracy of streamflow forecasts. This collaborative project provides the data and the models which will significantly increase the accuracy of precipitation observations and improve hydrologic forecasts in the Rio Grande Basin.

This project, spearheaded by the District, complements the CWCB Flood Decision Support System. Its accurate streamflow and radar-derived quantitative precipitation estimates will assist the Basin's water managers and decision makers to identify areas of concern, and will help to more adequately prepare Colorado to meet its future water needs.

b. The number and types of entities represented in the application and the degree to which the activity will promote cooperation and collaboration among traditional consumptive water interests and/or non-consumptive interests, and if applicable, the degree to which the water activity is effective in addressing intrabasin or interbasin needs or issues.

THE PARTNERSHIPS to be developed in this project bring together a diverse group of stakeholders and decision makers who have vested interests in improving water supply prediction capabilities. At its core, this project is a user-motivated project that is driven by the imperative to create improved methods for measuring and predicting snowpack, snowmelt and streamflow in a critically-stressed river basin, the Upper Rio Grande. Providing improved tools to meet those objectives are critically important to the Basin, CWCB, DWR, and NCAR.

THE DISTRICT was selected by the team to take the lead in this study, providing administrative and fiscal management of the Project. The District therefore seeks funding to deploy specific data-gathering devices and to expand on previous studies and modeling done by Riverside Technologies, Inc. and continuing currently thanks to the investment of CWCB.

CWCB has allocated $215,000 towards this project/concept and will contract Riverside Technologies, Inc., with administrative support from the District. The role of CWCB is detailed under Task 2 of the Scope of Work.

NSSL – National Severe Storms Laboratory's Steve Vasiloff, will be the Basin's go-to radar site expert, running and interpreting initial radar information. Dr. Vasiloff conducted the Southwest Colorado Radar Project, completed at the end of February, 2011, with deployment of the NOAA X-Pol mobile radar unit as part of the study to collect data on snowfall in the area. Dr. Vasiloff was awarded the 2001 NOAA Distinguished Career Award for Scientific Achievement for the design and implementation of a seamless gridded system for multi-sensor-derived precipitation estimation over the continental U.S..

Riverside Technology Inc., headquartered in Fort Collins, will continue & expand previous contracts for development of the modeling. Riverside is an internationally recognized engineering, science, and information technology company with more than 25 years of experience providing innovative information technology solutions for environmental decision support systems using a variety of different environmental data sources, from satellite sensors and imagery to stream gages in local rivers. Riverside has projects in more than 30 countries and maintains a strong worldwide customer base, including U.S. government agencies such as USAID and USTDA, and international donor organizations such as the World Bank, Asian Development Bank, and FAO.

NOAA – National Oceanic and Atmospheric Administration will provide direction and expertise for the implementation of the information that comes from the radar experiments.

NWS – The National Weather Service will provide in-kind technical support, time, and personnel, with potential further involvement, depending on the findings and outcome of this project.

As further evidence of collaboration, the following personnel from the various entities will be directly involved in running this project:

State of Colorado Sponsors

Joe Busto, CWCB Watershed Protection & Flood Mitigation Program
Joe.busto@state.co.us;(Ph) (Ph) 303 866 3441, ext. 3209, Fax (303) 861-4272

Kevin Houck, Section Chief, CWCB Watershed Protection & Flood Mitigation Program
kevin.houck@state.co.us;(Ph) 303-866- 3441 ext. 3219, (Fax) 303-861-4272

Steve Shull, CWCB Contract Specialist
steve.shull@state.co.us, (Ph) 303-866-3441 ext. 3235, (Fax) 303-866-4474

Maggie Van Cleef, Department of Natural Resources Purchasing
maggie.vancleef@state.co.us, (Ph) 303-866-3292 ext.8641, (Fax) 303-866-5575

NCAR Project Contractor & Scientific Team

David Gochis, Scientist III, Research Applications Laboratory, National Center for Atmospheric Research. gochis@ucar.edu, (Ph) 303-497-2809

Martyn Clark, Scientist III, Research Applications Laboratory, National Center for Atmospheric Research. mclark@ucar.edu, (Ph) 303-497-2732

NCAR Contract Specialists

Gina Taberski, National Center for Atmospheric Research
taberski@ucar.edu, (Ph) 303-497-2132

c. The water activity helps implement projects and processes identified as helping meet Colorado's future water needs, and/or addresses the gap areas between available water supply and future need as identified in SWSI or a roundtable's basin-wide water needs assessment.

In 1981, the Natural Resources Conservation Service (then known as the Soil Conservation Service) Colorado Snow Survey Supervisor teamed up with a water engineer from the Colorado Division of Water Resources, also called the Office of the State Engineer, to devise a relatively simple Surface Water Supply Index (SWSI) that would take Colorado's precipitation, mountain snowpack, stream

flow, and stored water in reservoirs into account in a way that was specific to each major Colorado watershed.

The Surface Water Supply Index has been produced every month for 30 years by either the NRCS Snow Survey during winter and spring, or the Colorado State Engineer's Office in summer and fall. While imperfect and often criticized, the index prevailed because it incorporated complex data into a simple number so that anyone could quickly judge conditions.

In the past few years SWSI has been undergoing modernization to take advantage of considerable advances in streamflow forecasting that have occurred during the past several decades. A new SWSI is now being generated for each river forecast point in the Colorado River Basin in western Colorado, with other basins to follow. (From *Monitoring Drought: Using Indices to Simplify Complex Climate Data* by Nolan Doesken and Wendy Ryan, Colorado Climate Center, Colorado Water Magazine, August/September 2011.)

The results of this project will enable critical advances in the evolution and expansion of SWSI, contributing to the improvement of streamflow forecasts throughout Colorado. With CWCB's strong commitment to this ongoing study in the Rio Grande Basin, the District appreciates the opportunity to administer this important project.

Tier 2: Facilitating Water Activity Implementation

d. Funding from this Account will reduce the uncertainty that the water activity will be implemented. For this criterion the applicant should discuss how receiving funding from the Account will make a significant difference in the implementation of the water activity (i.e., how will receiving funding enable the water activity to move forward or the inability obtaining funding elsewhere).

   Without the funds requested in this proposal, the scientists and agencies involved in this project could not proceed, as they do not have the cash or the budgets to conduct such a large field experiment and modeling program. The project has requested $89,000 from the US Bureau of Reclamation in order to increase the number of data points, but if this does not materialize, the District will still be able to carry the project forward with the WSRA funds requested here. If the USBR funds are forthcoming, it will improve, but not materially change the project. The entire team is counting on the District obtaining these funds.

e. The amount of matching funds provided by the applicant via direct contributions, demonstrable in-kind contributions, and/or other sources demonstrates a significant & appropriate commitment to the project.

   The applicant and participating partners are providing more than 100% match of funds.

Tier 3: The Water Activity Addresses Other Issues of Statewide Value and Maximizes Benefits

f. The water activity helps sustain agriculture & open space, or meets environmental or recreational needs.

This project provides the means to improve forecasts of snowfall and streamflow, thereby helping water managers to more accurately manage irrigation.

g. The water activity assists in the administration of compact-entitled waters or addresses problems related to compact entitled waters and compact compliance and the degree to which the activity promotes maximum utilization of state waters.

This project will develop a Rio Grande Compact Decision Support Tool for DWR, materially assisting in the administration of compact-entitled waters, reducing errors in the forecasting of streamflow, and reducing the occurrence of premature or unnecessary curtailments.

h. The water activity assists in the recovery of threatened and endangered wildlife species or Colorado State species of concern.

NA

i. The water activity provides a high level of benefit to Colorado in relationship to the amount of funds requested.

This is a top priority initiative of multiple state and federal agencies, and is being closely watched by other basins, which also have problems related to uncertainties in today's streamflow forecasting methods.

j. The water activity is complimentary to or assists in the implementation of other CWCB programs.

The District is participating as a partner with CWCB in this project.

Continued: Explanation of how the water activity/project meets all applicable **Evaluation Criteria**.
Please attach additional pages as necessary.

Part IV. – Required Supporting Material

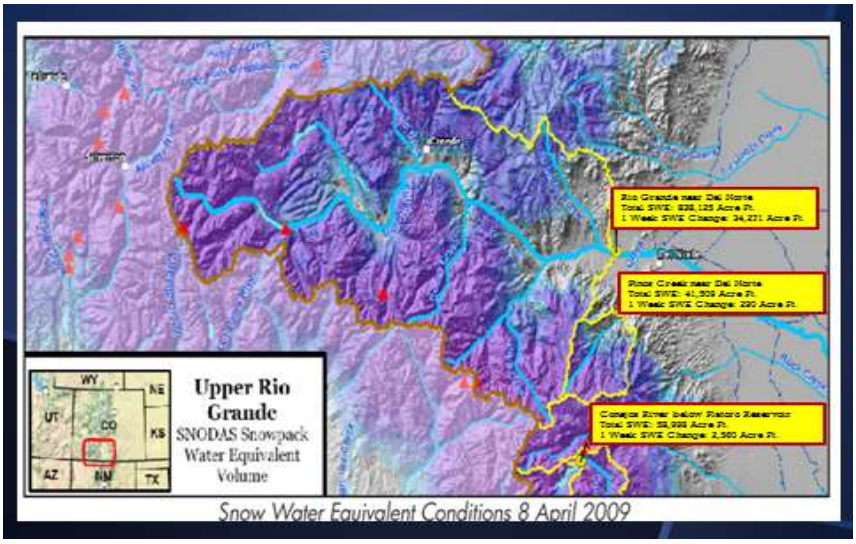
1. **Water Rights, Availability, and Sustainability** – This information is needed to assess the viability of the water project or activity. Please provide a description of the water supply source to be utilized, or the water body to be affected by, the water activity. This should include a description of applicable water rights, and water rights issues, and the name/location of water bodies affected by the water activity.

   No water bodies will be affected by this water activity. No water rights will be involved; no issues of availability and sustainability will be raised; and no water supplies will be utilized.

2. **Please provide a brief narrative of any related studies or permitting issues.**

   In his article, *Advancing Snow Science in Changing Climate and Complex Terrain*, Joe Busto, Scientist and researcher with CWCB, reviews prior science and studies directly related to this project. Most of the following is quoted from that article:

   Since 2004, the CWCB has partnered with the NRCS and water users to establish 20 new SNOTEL sites for an 18 percent increase and a total of 110 SNOTEL sites in Colorado. However, SNOTEL sites represent a fraction of a basin's area and are limited in developing spatial assessments of snow water equivalent (SWE). Many sub-basins do not have SNOTEL sites. This lack of representation directly translates to water supply forecast difficulties. In search of spatially-continuous data, the CWCB contracted with Riverside Technologies, Inc. (RTi) to utilize data from the NWS/NOHRSC—Snow Data Assimilation System…. The Division Engineer uses SNODAS SWE maps to track melt-out in three key basins in the Rio Grande, delineated in yellow in Figure 1.



SNOTEL sites are shown as red triangles. This represents use of spatial modeled snowpack data to complement the point measurement snowpack data. For more information about the CWCB SNODAS Project, visit: http://www.riverside.com/projects/uscanada/tabid/121/ItemId/45/Default.aspx .

3. Statement of Work, Detailed Budget, and Project Schedule

The statement of work will form the basis for the contract between the Applicant and the State of Colorado. In short, the Applicant is agreeing to undertake the work for the compensation outlined in the statement of work and budget, and in return, the State of Colorado is receiving the deliverables/products specified. **Please note that costs incurred prior to execution of a contract or purchase order are not subject to reimbursement**. All WSRA funds are disbursed on a reimbursement basis after review invoices and appropriate backup material.

Please provide a detailed statement of work using the template in Exhibit A. Additional sections or modifications may be included as necessary. Please define all acronyms and include page numbers.

REPORTING AND FINAL DELIVERABLE

Reporting: The applicant shall provide the CWCB a progress report every 6 months, beginning from the date of the executed contract. The progress report shall describe the completion or partial completion of the tasks identified in the statement of work including a description of any major issues that have occurred and any corrective action taken to address these issues.

Final Deliverable: At completion of the project, the applicant shall provide the CWCB a final report that summarizes the project and documents how the project was completed. This report may contain photographs, summaries of meetings and engineering reports/designs.

PAYMENT

Payment will be made based on actual expenditures and invoicing by the applicant. Invoices from any other entity (i.e. subcontractors) cannot be processed by the State. The request for payment must include a description of the work accomplished by major task, and estimate of the percent completion for individual tasks and the entire water activity in relation to the percentage of budget spent, identification of any major issues and proposed or implemented corrective actions. The last 5 percent of the entire water activity budget will be withheld until final project/water activity documentation is completed. All products, data and information developed as a result of this grant must be provided to the CWCB in hard copy and electronic format as part of the project documentation. This information will in turn be made widely available to Basin Roundtables and the general public and help promote the development of a common technical platform.

The above statements are true to the best of my knowledge:

Signature of Applicant:

Print Applicant's Name:

Project Title:

Return an electronic version (hardcopy may also be submitted) of this application to:

Greg Johnson – WSRA Application
Colorado Water Conservation Board
1580 Logan Street, Suite 200
Denver, CO 80203
gregory.johnson@state.co.us

Exhibit A

Statement of Work

WATER ACTIVITY NAME – Radar Monitoring & Hydrologic Modeling in the Upper Rio Grande Basin to Develop Accurate Streamflow Forecasting

GRANT RECIPIENT – Conejos Water Conservancy District

FUNDING SOURCE – Water Supply Reserve Account - $237,000
($200,000 Statewide; $37,000 Basin)

INTRODUCTION AND BACKGROUND

Provide a brief description of the project. (Please limit to **no more than 200 words**; this will be used to inform reviewers and the public about your proposal)

Lack of reliable data and antiquated methodologies in the measurement and prediction of snowfall, snowpack, and snowmelt, cause water managers in the Upper Rio Grande (URG) Basin to contend with inevitable errors in streamflow forecasts. In the Conejos Water Conservancy District this causes premature and unnecessary curtailments, imposing hardship and severe economic consequences for the farmers and ranchers who depend on the waters of the Conejos River. This Project will deploy additional in-place measurement stations in the URG Basin and evaluate currently operational snowfall and snowpack estimation products. Experimental hydrologic forecast models will be deployed to assess the performance of existing operational forecast models, comparing currently operational data against data collected by this project. Three hydrological prediction models will be compared: (1) the NRCS seasonal water supply forecast model; (2) the spatially-distributed and lumped versions of the National Weather Service River Forecast System model; and (3) an experimental, physics-based version of the operational community NOAA land surface model. At the end of the Project, radar, data, and some other elements of the observing system will be left in place as a legacy to the URG Basin.

OBJECTIVES

List the objectives of the project

1. To more accurately measure and predict snowfall and snowpack in the Upper Rio Grande Basin by assessing new experimental precipitation and snowpack estimation products and comparing them against currently operational products;

2. To significantly improve the accuracy of streamflow forecasts, assisting the Division of Water Resources in its efforts to eliminate the high error rate in its Apr. 1 annual forecasts;

3. To develop and evaluate experimental streamflow forecasts, comparing them with currently operational forecasts, providing real-time assessment of the demonstration radar and existing operational products during the project.

4. To share these assessments with the full project team, with water managers in the Upper Rio Grande Basin, and with water users throughout the San Luis Valley, with a final report delivered by 12/31/14

TASKS
Provide a detailed description of each task

Task 1 – **District Administration and Direct Costs**

Description of Task - The District will provide administrative oversight of the project; assist with written reports and otherwise facilitate/support internal and external communication; coordinate and assist with the logistics of the scientific team's bi-weekly telecasts and teleconferences; coordinate stakeholder and other meetings; pursue additional grant funds as the team's needs evolve and as situations may require; assist scientific team in preparing and submitting reports, including periodic and final CWCB reports; provide grant administration and manage invoicing and reimbursement; assist with Rio Grande Basin Roundtable presentations and coordination of public/academic meetings/events; help maintain whatever level of press/media exposure the team wants and help prepare press and media releases as appropriate; provide other administrative/logistical support and assist in troubleshooting, smoothing the way for the entire project, as best we can.

Method/Procedure – District Manager staff time plus one part time technical writer / administrative support staff person. In order to raise consciousness and appreciation for this project and to enlist broad participation, the District will initially conduct an outreach campaign with the goal of raising $20,000 from ditch companies, conservancy and conservation districts, restoration and conservation initiatives, and contacts made through the Rio Grande Basin Roundtable.

Deliverable – The efforts of the various team members and scientists will be supported, saving time, greasing the wheels of communication, and ensuring that the goals of this project are achieved efficiently, promoting optimum human synergy.

Task 2a – **NCAR Modeling and Interpretation Phase I**
(Funded separately with matching CWCB funds, this Task is already underway and will continue)

Description of Task and Background - A recent analysis by the Colorado Water Conservation Board (CWCB) and Colorado Division of Water Resources (CDWR) illustrated that seasonal water supply forecasts, which are based primarily on Natural Resources Conservation Service (NRCS) 'SNOw TELemetry' (SNOTEL) data, have struggled with high rates of inaccuracy, particularly in wet and dry years in the last several years. The high error rate in the annual Apr. 1 forecasts translates into millions of dollars lost annually due to excessive or premature curtailments and the resulting reduced agricultural productivity of irrigated lands.

Working with the DWR Division Engineer the CWCB helped determine that the economic impact of those water supply forecast errors was $15.1M in Water Year 2005 and $19.03M in Water Year 2007. According to CDWR Engineer Craig Cotten, "Inaccurate streamflow forecasts can cause unnecessary curtailment of ditches, over- or under-delivery of Colorado's compact obligations, and a disruption of the priority system."

Because of such tight operating margins and the unequivocal, severe costs associated with erroneous projections, it is imperative that new data collection, data integration and modeling methods be evaluated and implemented to reduce the errors in water supply forecasts.

Methods, Procedures & Deliverable – CWCB's ongoing partnership

Over the last six years the CWCB worked with federal and private partners to improve the description of spring snowpack conditions and the use of hydrologic models. One of the snowpack models being used is the NOAA/National Operational Hydrologic Remote Sensing Center's snow model called SNODAS (SNOw Data Assimilation System). Data from SNODAS has been provided to the Rio Grande Division Engineer since 2007. SNODAS is thirty years newer than some of the currently operational forecasting models and offers promise to provide another means of "assessing" our watersheds more comprehensively during the snowmelt part of the hydrologic cycle.

One of the recommendations after the final phase of the SNODAS project was to seek more inputs and forcing data for the SNODAS model, beyond SNOTELs and numerical weather prediction model forecasts. Although the CWCB has invested in additional SNOTEL stations, there presently exist only 7 stations in the entire Upper Rio Grande River basin which encompasses over 7,000 square miles. Due to the point nature of SNOTELs and limitations of model forecasts of precipitation, it is anticipated that precipitation radars can provide high-resolution spatial observations.

The consensus is that well-calibrated radar data has the potential to simulate the precipitation observations of hundreds of SNOTEL sites that are unfeasible to deploy in Colorado in our lifetime. While the deployment and collection of radar data is supported through a different CWCB contract the work proposed here seeks to obtain support for the deployment of a network of surface instrumentation which will be used to calibrate radar precipitation estimates and to monitor local snowpack and meteorological conditions in the URG.

Task 3: Procure, deploy and operate in-situ measurement systems per Project Specifications.

Description of Task - Deploy in-situ measurement stations in the URG and evaluate currently operational snowfall and snowpack estimation products**.**

Method/Procedure –

1. Procure and deploy new instruments in the URG, per project team specifications;

2. Request and deploy optional additional instruments, as determined by the project team, with funds from the U.S. Bureau of Reclamation (USBR) to increase data collection capacity and to otherwise complement those instruments deployed and funded by this grant.

3. Mobilize instruments into topographically-distributed network, per project team specifications.

4. Conduct limited field surveys of SWE conditions across the Project's sites. Take measurements from topographically-distributed network. Gather measurements from radar estimated precipitation and existing NRCS basin-scale snowpack and water supply products, the National Weather Service (NWS)/NOHRSC SNODAS product and the NWS weather model analyses of precipitation and snowpack. The data feed from most of the sites will be in real-time, once per

day, via cell phone modem or RF-link where feasible. Sites not within real-time communication will be visited periodically during the project, and data will be downloaded.

5. Compare measurements of radar estimated precipitation against existing NRCS basin-scale snowpack and water supply products in near peak SWE conditions in late March/early April.

6. Use in-situ automated measurements of snowdepth and precipitation to evaluate snowfall estimates from the radar and from operational snowpack and precipitation estimates from other sources.

Deliverables –

1. Updated station, basin and gridded comparisons of snowpack conditions from SNODAS and in situ measurements

2. Weather model validation of predicted precipitation

3. Comparison of energy forcing data from models and in-situ observation and observed versus forecasted streamflow conditions from operational products.

4. Real-time assessment of the demonstration radar and existing operational products during the project

TASK 4 – Production and evaluation of hydrologic forecasts

Description of Task - Deploy experimental hydrologic forecast models and assess the performance of experimental and existing operational forecast models against currently operational data and data collected by this project.

Method/Procedure –

1. Compare the three different hydrological prediction models. Include the NRCS seasonal water supply forecast model, the spatially-distributed and lumped versions of the NWS River Forecast System model and an experimental, physics-based distributed routing version of the operational community NOAA land surface model.

2. Once every week, run each of these models at NCAR in an identical manner to which they are run at the operational center, **except** use the experimental radar data and available in-situ field measurements to initialize and run the models.

3. Disseminate the results of these forecast assessments to the project team via the NCAR web portal and the CWCB URG-DSS.

4. Integrate data, execute and evaluate models and synthesize findings.

5. Coordinate delivery and assessment of these products with the project team through bi-weekly web-casts and teleconference so members from the entire project will have access to the project web pages where they can view observation and forecast data as they please.

6. Conduct webcasts to go over the most significant results from the project, evaluate differences between currently operational and experimental monitoring products, analyze past forecast performance and discuss future forecasts.

Deliverables –

1. Obtain accurate evaluation of operational streamflow prediction models with spatially-distributed and ground validated precipitation and snowpack information collected as part of this project.

2. Quantify the impact of the experimental observations and assess the performance of newer, physics-based modeling system against currently operational streamflow prediction models.

3. Contribute these forecasts to the 10-day update reports developed by the CDWR State Engineer during the springtime melt and runoff seasons.

4. All project participants will gain a clear understanding of the value of the experimental products in direct contrast to currently operational products.

5. At project completion leave equipment and instruments, per Project Specifications, in place, constituting a legacy observing system in the URG Basin.

REPORTING AND FINAL DELIVERABLE

Reporting: The applicant shall provide the CWCB a progress report every 6 months, beginning from the date of the executed contract. The progress report shall describe the completion or partial completion of the tasks identified in the statement of work including a description of any major issues that have occurred and any corrective action taken to address these issues.

Final Deliverable: At completion of the project, the applicant shall provide the CWCB a final report that summarizes the project and documents how the project was completed. This report may contain photographs, summaries of meetings and engineering reports/designs.

The District will provide administrative support for all reporting, invoicing, and final deliverable.

BUDGET

Provide a detailed budget by task including number of hours and rates for labor and unit costs for other direct costs (i.e. mileage, $/unit of material for construction, etc.). A detailed and perfectly balanced budget that shows all costs is required for the State's contracting and purchase order processes. Sample budget tables are provided below. Please note that these budget tables are examples and will need to be adapted to fit each individual application. Tasks should correspond to the tasks described above.

B U D G E T				
	WSRA GRANT FUNDS			
	Labor	**Direct Costs**	**Matching Funds**	**Total Project**
Task 1 – District Administration & Direct Costs Plus Matching funds (District's fund-raising and consciousness-raising campaign)	$27,000	(not known yet)	$ 20,000	$ 47,000
Task 2 – NCAR modeling and Interpretation – CWCB funds			$ 215,000	$ 215,000
Task 3 - Procurement, deployment, operation and maintenance of in-situ measurement systems		$ 60,000		$ 60,000
Task 4 - Production and evaluation of hydrologic forecasts	$150,000			$ 150,000
Matching Funds USBR-NCAR Technical Support and expertise – Estimated			$ 89,000	$ 89,000
Total Matching Contributions				
Total Costs:	$177,000	$ 60,000	$ 324,00.00	$561,000
GRANT REQUEST	**$ 237,000**			

SCHEDULE

Provide a project schedule including key milestones for each task and the completion dates or time period from the Notice to Proceed (NTP). This dating method allows flexibility in the event of potential delays from the procurement process. Sample schedules are provided below. Please note that these schedules are examples and will need to be adapted to fit each individual application.

The field deployment of instrumentation will occur between 1 October 2013 and 31 December 2014. A final report will be completed by 31 September 2014.

Task	**Start Date**	**Finish Date**
1 Administration	Upon NTP	09/31/14 Final Report
2 NCAR – CWCB modeling/interpretation	7/1/13	12/31/14
3 Field deployment of instrumentation	10/1/13	12/31/14
4 Produce, evaluate hydrologic forecasts	10/1/13	12/31/11

PAYMENT

Payment will be made based on actual expenditures and invoicing by the applicant. Invoices from any other entity (i.e. subcontractors) cannot be processed by the State. The request for payment must include a description of the work accomplished by major task, and estimate of the percent completion for individual tasks and the entire water activity in relation to the percentage of budget spent, identification of any major issues and proposed or implemented corrective actions. The last 5 percent of the entire water activity budget will be withheld until final project/water activity documentation is completed. All products, data and information developed as a result of this grant must be provided to the CWCB in hard copy and electronic format as part of the project documentation. This information will in turn be made widely available to Basin Roundtables and the general public and help promote the development of a common technical platform.

Appendix 1
Reference Information

The following information is available via the internet. The reference information provides additional detail and background information.

- Water Supply Reserve Account main webpage:
  - http://cwcb.state.co.us/LoansGrants/water-supply-reserve-account-grants/Pages/main.aspx
- Water Supply Reserve Account – Basin Fund Application Details:
  - http://cwcb.state.co.us/LoansGrants/water-supply-reserve-account-grants/Pages/BasinWaterSupplyReserveAccountGrants.aspx
- Water Supply Reserve Account – Statewide Fund Application Details:
  - http://cwcb.state.co.us/LoansGrants/water-supply-reserve-account-grants/Pages/StatewideWaterSupplyReserveAccountGrants.aspx
- Colorado Water Conservation Board main website:
  - http://cwcb.state.co.us/
- Interbasin Compact Committee and Basin Roundtables:
  - http://cwcb.state.co.us/about-us/about-the-ibcc-brts/Pages/main.aspx/Templates/BasinHome.aspx
- House Bill 05-1177 – (Also known as the Water for the 21st Century Act):
  - http://cwcbweblink.state.co.us/DocView.aspx?id=105662&searchhandle=28318
- House Bill 06-1400 – (Adopted the Interbasin Compact Committee Charter):
  - http://cwcbweblink.state.co.us/DocView.aspx?id=21291&searchhandle=12911
- Senate Bill 06-179 – (Created the Water Supply Reserve Account):
  - http://cwcbweblink.state.co.us/DocView.aspx?id=21379&searchhandle=12911
- Statewide Water Supply Initiative 2010:
  - http://cwcb.state.co.us/water-management/water-supply-planning/Pages/SWSI2010.aspx

Appendix 2
Insurance Requirements

NOTE: The following insurance requirements taken from the standard contract apply to WSRA projects that exceed $25,000 in accordance with the policies of the State Controller's Office. Proof of insurance as stated below is necessary prior to the execution of a contract.

13. INSURANCE

Grantee and its Sub-grantees shall obtain and maintain insurance as specified in this section at all times during the term of this Grant: All policies evidencing the insurance coverage required hereunder shall be issued by insurance companies satisfactory to Grantee and the State.

A. Grantee

i. Public Entities

If Grantee is a "public entity" within the meaning of the Colorado Governmental Immunity Act, CRS §24-10-101, et seq., as amended (the "GIA"), then Grantee shall maintain at all times during the term of this Grant such liability insurance, by commercial policy or self-insurance, as is necessary to meet its liabilities under the GIA. Grantee shall show proof of such insurance satisfactory to the State, if requested by the State. Grantee shall require each Grant with Sub-grantees that are public entities, providing Goods or Services hereunder, to include the insurance requirements necessary to meet Sub-grantee's liabilities under the GIA.

ii. Non-Public Entities

If Grantee is not a "public entity" within the meaning of the GIA, Grantee shall obtain and maintain during the term of this Grant insurance coverage and policies meeting the same requirements set forth in **§13(B)** with respect to sub-Grantees that are not "public entities".

B. Sub-Grantees

Grantee shall require each Grant with Sub-grantees, other than those that are public entities, providing Goods or Services in connection with this Grant, to include insurance requirements substantially similar to the following:

i. Worker's Compensation

Worker's Compensation Insurance as required by State statute, and Employer's Liability Insurance covering all of Grantee and Sub-grantee employees acting within the course and scope of their employment.

ii. General Liability

Commercial General Liability Insurance written on ISO occurrence form CG 00 01 10/93 or equivalent, covering premises operations, fire damage, independent Grantees, products and completed operations, blanket Grantual liability, personal injury, and advertising liability with minimum limits as follows: **(a)**$1,000,000 each occurrence; **(b)** $1,000,000 general aggregate; **(c)** $1,000,000 products and completed operations aggregate; and **(d)** $50,000 any one fire. If any aggregate limit is reduced below $1,000,000 because of claims made or paid, Sub-grantee shall immediately obtain additional insurance to restore the full aggregate limit and furnish to Grantee a certificate or other document satisfactory to Grantee showing compliance with this provision.

iii. Automobile Liability

Automobile Liability Insurance covering any auto (including owned, hired and non-owned autos) with a minimum limit of $1,000,000 each accident combined single limit.

iv. Additional Insured

Grantee and the State shall be named as additional insured on the Commercial General Liability and Automobile Liability Insurance policies (leases and construction Grants require additional insured coverage for completed operations on endorsements CG 2010 11/85, CG 2037, or equivalent).

v. Primacy of Coverage

Coverage required of Grantee and Sub-grantees shall be primary over any insurance or self-insurance program carried by Grantee or the State.

vi. Cancellation

The above insurance policies shall include provisions preventing cancellation or non-renewal without at least 45 days prior notice to the Grantee and the State by certified mail.

vii. Subrogation Waiver

All insurance policies in any way related to this Grant and secured and maintained by Grantee or its Sub-grantees as required herein shall include clauses stating that each carrier shall waive all rights of recovery, under subrogation or otherwise, against Grantee or the State, its agencies, institutions, organizations, officers, agents, employees, and volunteers.

C. Certificates

Grantee and all Sub-grantees shall provide certificates showing insurance coverage required hereunder to the State within seven business days of the Effective Date of this Grant. No later than 15 days prior to the expiration date of any such coverage, Grantee and each Sub-grantee shall deliver to the State or Grantee certificates of insurance evidencing renewals thereof. In addition, upon request by the State at any other time during the term of this Grant or any sub-grant, Grantee and each Sub-grantee shall, within 10 days of such request, supply to the State evidence satisfactory to the State of compliance with the provisions of this **§13**.

Appendix 3
Water Supply Reserve Account Standard Contract Information

NOTE: The standard contract is required for WSRA projects that exceed $100,000. (Projects under this amount will normally be funded through a purchase order process.) Applicants are encouraged to review the standard contract to understand the terms and conditions required by the State in the event a WSRA grant is awarded. Significant changes to the standard contract require approval of the State Controller's Office and often prolong the contracting process.

It should also be noted that grant funds to be used for the purchase of real property (e.g. water rights, land, conservation easements, etc.) will require additional review and approval. In such cases applicants should expect the grant contracting process to take approximately 3 to 6 months from the date of CWCB approval.

The standard contract is available here under the header "Additional Resources" on the right side: http://cwcb.state.co.us/LoansGrants/water-supply-reserve-account-grants/Pages/BasinWaterSupplyReserveAccountGrants.aspx

Appendix 4
W-9 Form

NOTE: A completed W-9 form is required for all WSRA projects prior execution of a contract or purchase order. Please submit this form with the completed application.