Water Supply Reserve Account – Grant and Loan Program
Water Activity Summary Sheet
March 16-17, 2016
Agenda Item 14 (ac)

Co-Applicants:	CSU Colorado Climate Center & Colorado Division of Water Resources
Fiscal Agent:	CSU Colorado Climate Center
Water Activity Name:	Continuation of lysimeter operations and consumptive use quantification in high-altitude, irrigated meadows in the Yampa/White Basin.
Water Activity Purpose:	Agricultural & Needs Assessment
County:	Basin-wide
Drainage Basin:	Yampa/White/Green
Water Source:	Basin-wide
Amount Requested/Source of Funds:	$11,304 Yampa/White/Green Basin Account $11,304 Statewide Account $22,608 Total Grant Request
Matching Funds:	Basin Account Match ($11,304) = 50% of total grant request (meets 5% min); Applicant Match ($26,854) = 118% of total grant request (meets 5% min); Basin Account & Applicant Match ($38,158) = 168% of total grant request (meets 25% min) (refer to *Funding Summary/Matching Funds* section)

Staff Recommendation:

Staff recommends approval of up to $11,304 from the Yampa/White/Green Basin Account; and $11,304 from the Statewide Account to help fund the project titled: Continuation of lysimeter operations and consumptive use quantification in high-altitude, irrigated meadows in the Yampa /White Basin.

Water Activity Summary: WSRA funds, if approved, will be expended to continue efforts to improve lysimeter operations in the Yampa Basin and to come up with better crop coefficients that can be applied to weather-based calculations of grass-reference ET. In late 2010, the Yampa-White Roundtable provided support for instrumentation, operation and maintenance for an integrated data collection system consisting of an automated weather station specifically designed for estimating evapotranspiration via the ASCE Standardized Penman-Monteith method and small bucket lysimeters designed to directly measure the amount of water lost from the soil due to evapotranspiration. The weather station was purchased and installed in 2011. Severe drought conditions in 2012 limited vegetation growth and establishment, delaying the lysimeters use, but by 2013 the vegetation was established enough to allow representative ET measurements to begin.

This project will allow 5 years of uninterrupted lysimeter data to be collected and another lysimeter load cell to be purchased for accurate weighing of the buckets. From the lysimeter data a more accurate crop coefficients can be calculated, which can then be applied to the weather station data for accurate ET estimates for the Yampa basin.

Objectives

• Review lysimeter data collection to date and identify data quality issues and the likely causes of data quality deficiencies.
• Review lysimeter operations plan and instructions.
• Obtain new load cell to assure high quality bucket weight measurements.
• Perform daily quality control assessment of Hayden CoAgMet (Colorado Agricultural Meteorological Network) weather station data.
• Conduct annual maintenance and calibration of all meteorological sensors.
• Perform emergency maintenance and calibration as needed based on weather station performance to assure high quality and continuous data collection, particularly during the growing season.
• Based on lysimeter measurements and in collaboration with the staff of the Colorado Division of Water Resources Division 6, compute crop water use for each bucket at the end of each growing season year. Intercompare data and compare to weather station ET (Evapotranspiration) estimates. Also compare with preliminary results from the ongoing North Platte Roundtable ET study.
• As opportunities appear, also use data to assist and support other ET research currently underway in the Upper Colorado River Basin (in collaboration with Dr. Perry Cabot).
• Make annual estimates of hay meadow consumptive use, sample variability and relationship to weather data-based methods. Estimate appropriate crop coefficients and compare to other available estimates. Provide updates to the Yampa-White Roundtable.

Discussion: This project aligns with well with several of the Goals and Measurable Outcomes as addressed in the Yampa/White/Green Basin Implementation Plan, such as: Protect and encourage agriculture uses of water in the YWG Basin within the context of private property rights; Improve agricultural water supplies to increase irrigated land and reduce shortages (The agricultural needs study of the YWG BRT identified an additional 14,805 acres of potential new agricultural production in the future); Develop an integrated system of water use, storage, administration and delivery to reduce water shortages and meet environmental and recreational needs (YWG BIP; Section 1.2.2: YWG Basin Goals, page 1-7). While this project has not been identified as an IPP in the YWG BIP, it is staff's opinion that this activity furthers the Goals of the YWG BIP and Colorado's Water Plan.

In addition this effort advances Agricultural Viability as presented in Colorado's Water Plan by: Develop and implement policies and strategies that support meaningful agricultural viability statewide (CWP; Chapter 6.5.2, pages 6-138 thru 6-144). Furthermore, this activity supports the goals of Colorado's Water Plan as presented in Section 6.5.4: Maintenance of Existing Projects and Methods (CWP; pages 6-153 thru 6-156). The continuation of this activity also furthers several of the Measurable Objectives, such as: D. Agriculture (CWP; Chapter 10.2: Measurable Goals and Adaptive Management; pages 10-5 thru 10-7); and Critical Goals and Actions introduced in Colorado's Water Plan, such as: A. Supply-Demand Gap: Meet Colorado's Water Gaps: Use a grassroots approach to formulate projects and methods that avoid some of the undesirable outcomes of the supply-demand gaps. The plan addresses the gap from multiple perspectives (e.g., water storage, reuse, recycling, integrated water management, restoration, and conservation); and D. Agriculture: Maintain Agricultural Viability: Maintain Colorado's agricultural productivity, support of rural economies, and food security (through meaningful incentives and grassroots efforts); and

Support Agricultural Conservation and Efficiency: Support Colorado's agricultural industry to make it more efficient, resilient, and able to reduce water consumption without impacting agricultural productivity (CWP: Chapter 10.3: Critical Goals and Actions; ages 10-8 thru 10-15).

Previous WSRA funding for this activity, approved by CWCB in Sept 2010 consisted of: $10,000 Yampa/White/Green Basin Account funds, and $10,978 Statewide Account funds; for a total of $20,978. This project component was completed in June 2015.

Issues/Additional Needs: No issues or additional needs have been identified.

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

Tier 1-3 Evaluation Criteria:
This project has undergone review and evaluation and staff has determined that this request satisfies the Evaluation Criteria. Further analysis of the project, and how the project will meet Tiered Evaluation Criteria, is provided by the applicant in the WSRA Application.

Funding Summary/Matching Funds:

Funding Source	Cash	In-kind	Total
Colorado Division of Water Resources	$0	$26,854	$26,854
WSRA Yampa/White/Green Basin Account	$11,304	n/a	$11,304
WSRA Statewide Account	$11,304	n/a	$11,304
Total Project Costs	**$22,608**	**$26,854**	**$49,462**

CWCB Project Manager: Craig Godbout

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 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 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 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 and documents how the project was completed. This report may contain photographs, summaries of meetings and engineering reports/designs.

Engineering: All engineering work (as defined in the Engineers Practice Act (§12-25-102(10) C.R.S.)) performed under this grant shall be performed by or under the responsible charge of professional engineer licensed by the State of Colorado to practice Engineering.

Yampa White Green Basins Roundtable

February 2, 2016

Re: Hayden, Colorado Lysimeter Operations Project

Mr. Godbout,

At the January 13, 2016 meeting of the Yampa White Green Basin Roundtable, the membership voted unanimously to support the aforementioned project.

This project will continue efforts to improve lysimeter operations in the Yampa Basin and to determine better crop coefficients that can be applied to weather-based calculations of grass-reference ET (evapotranspiration – water evaporated directly from soil plus transpiration from the leaves of growing plants). In late 2010, the Yampa-White Roundtable provided support for instrumentation, operation and maintenance for an integrated data collection system consisting of an automated weather station specifically designed for estimating evapotranspiration and bucket lysimeters designed to directly measure the amount of water lost from the soil due to evapotranspiration. The weather station was purchased and installed in the fall of 2011 in a high grass meadow area on the Carpenter Ranch owned by the Nature Conservancy near Hayden, CO. The purpose of the weather station is to collect the meteorological data necessary for the calculation of ET via the ASCE Standardized Penman-Monteith method (ASCE, 2005).

In addition to the weather station, four bucket lysimeter plots were installed in the spring of 2012. Two of the plots were seeded with grass-reference vegetation and two were seeded with vegetation representative of the surrounding irrigated meadow. These plots were irrigated and weighed on a regular basis throughout each season of operation. Four years of data have been collected on the plots however for various reasons only two of the four years produced data of much value, which is simply not enough to properly compute the crop coefficient that is needed. As such the study would benefit highly from additional years of overlapping lysimeter operations with weather station data collection.

Please do not hesitate to contact me with any questions.

Sincerely,

Jackie Brown

Jackie Brown, Vice- Chair
(970) 819-2484
jbrown@tristategt.org

COLORADO WATER CONSERVATION BOARD

WATER SUPPLY RESERVE ACCOUNT APPLICATION FORM

Today's Date: 1 February 2016

Continuation of lysimeter operations and consumptive use quantification in high-altitude, irrigated meadows in the Yampa /White Basin.

Name of Water Activity/Project

Colorado Climate Center, Colorado Division of Water Resources

Name of Applicant

Yampa-White

Amount from Statewide Account: $11,304

Amount from Basin Account(s): $11,304

Total WSRA Funds Requested: $22,608

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

FEIN: 84-6000545

Application Content

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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. In addition, the applicant should also refer to the Supplemental Scoring Matrix applied to Evaluation Criteria Tiers 1-3 for Statewide Account requests .

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:

Craig Godbout - WSRA Application
Colorado Water Conservation Board
1313 Sherman St., Room 721
Denver, CO 80203
Craig.godbout@state.co.us

If you have questions or need additional assistance, please contact Craig Godbout at: 303-866-3441 x3210 or craig.godbout@state.co.us.

Water Supply Reserve Account – Application Form
Revised October 2013

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

1. Applicant Name(s): Colorado Climate Center, Colorado Division of Water Resources

Mailing address:
Colorado State University
1371 Campus Delivery
Fort Collins, CO 80523-1371

Division 6 Water Resources
505 Anglers Dr., Suite 101
Steamboat Spring, CO 80487

FEIN #: **84-6000545**

Primary Contact: Nolan J. Doesken Position/Title: Colorado State Climatologist

Email: Nolan@atmos.colostate.edu

Phone Numbers: Cell: Office: 970-491-3690

Alternate Contact: Erin Light Position/Title: Division 6 Engineer

Email: Erin.light@state.co.us

Phone Numbers: Cell: Office: 970-879-0272

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

[x] 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.

[ ] 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 Colorado Climate Center is a service and education arm of Colorado State University. We were founded in 1974 to monitor the climate of Colorado, archive climatic data and information, and provide information and expertise on climate matters affecting the citizens of Colorado. The majority of data that we use to monitor Colorado climatic conditions are collected by Federal agencies such as the National Weather Service and the USDA Natural Resources Conservation Service. However, we also coordinate independent monitoring efforts including the Colorado Agricultural Meteorological Network (CoAgMet) and the Community Collaborative Rain, Hail and Snow network (CoCoRaHS). We have the capacity and are currently involved in climate monitoring activities associated with determining water balances (precipitation and evaporation) including consumptive crop water use. Information about the Colorado Climate Center can be found at http://ccc.atmos.colostate.edu

The Colorado Division of Water Resources (Office of the State Engineer) is an agency within the Department of Natural Resources providing administration of Colorado's water resources to meet the demands of today, and to provide for the needs of tomorrow. We are committed to meeting the ever increasing challenges of origin issues, reserved rights, wetlands, endangered species recovery and interstate water issues on an already limited water supply. The Colorado Division of Water Resources strives to be a leader in the water community of Colorado and the western United States. This is accomplished by focusing on the following areas: people, water and stewardship. People, because we recognize that the business of water involves our employees and the public. Water, because the administration, safety and use of the State of Colorado's water resources is something we are committed to and care deeply about. Stewardship, because we understand and accept our obligation to the taxpayers and ourselves, in using and protecting the resources in the most effective manner possible. Our Mission is to provide competent and dependable distribution of water in accordance with statutes, decrees and interstate compacts; to ensure public safety through safe dams and properly permitted and constructed water wells; to maintain and provide accurate and timely information concerning water; to promote stewardship of all human, fiscal and natural resources; to serve the public through the generation of creative solutions to problems; to help the public understand complex water issues; to promote stability in the use of the state's limited water resources; and to apply modern technology to its greatest advantage.

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

The contracting entity is Colorado State University, an institution with a very long history of water resources research benefiting the citizens of the State of Colorado.

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.

☐ 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.

Water Supply Reserve Account – Application Form
Revised October 2013

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)
X	Agricultural
	Municipal/Industrial
X	Needs Assessment
	Education
	Other Explain:

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

As we embark upon projects to better understand our current demands on our rivers as well as our future demands we must have a good understanding on how much water our irrigated crops consume. To date the crop coefficients used in all of the studies have been based on the determination of crop coefficients in other parts of the State that may not replicate what exists within the Yampa and White River basins. With crop coefficients that better represent our area, we can get a better idea on the consumptive use of water associated with our irrigation.

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)
	Other Explain:

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

Latitude: 40.499 Longitude: -107.181

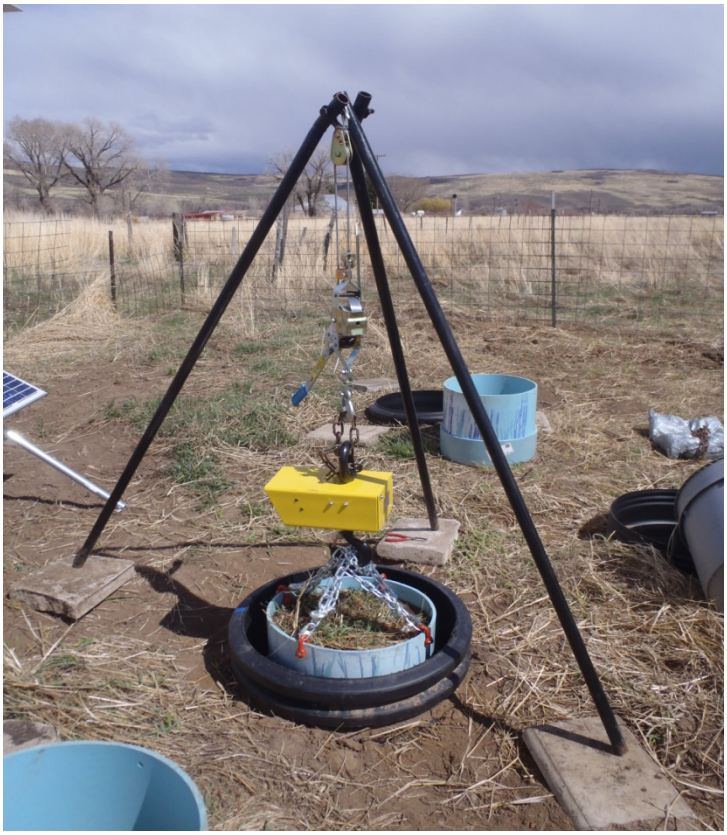
5. Please provide an overview/summary of the proposed water activity (no more than one page). Include a description of the overall water activity and specifically what the WSRA funding will be used for. A full **Statement of Work** with a detailed budget and schedule is required as **Exhibit A** of this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

This project will continue efforts to improve lysimeter operations in the Yampa Basin and to determine better crop coefficients that can be applied to weather-based calculations of grass-reference ET (evapotranspiration – water evaporated directly from soil plus transpiration from the leaves of growing plants). In late 2010, the Yampa-White Roundtable provided support for instrumentation, operation and maintenance for an integrated data collection system consisting of an automated weather station specifically designed for estimating evapotranspiration and bucket lysimeters designed to directly measure the amount of water lost from the soil due to evapotranspiration. The weather station was purchased and installed in the fall of 2011 over an irrigated grass high meadow area on the Carpenter Ranch owned by the Nature Conservancy near Hayden, CO.

The purpose of the weather station is to collect the meteorological data necessary for the calculation of ET via the ASCE Standardized Penman-Monteith method (ASCE, 2005). Once these data are collected, the temperature based Hargreaves equation (Hargreaves and Samani, 1985) can be calibrated to the ASCE standard (Hargreaves and Allen, 2003). This allows for reasonably accurate estimates of crop ET throughout the basin with use of only inexpensive temperature sensors.

During the first year of the project, we worked with Danny Smith (CSU retired crop water use specialist) to help design an appropriate research plot for Carpenter Ranch. Based on his recommendations, four bucket lysimeter plots were installed in the spring of 2012. Severe drought conditions in 2012 limited vegetation growth and establishment, but by 2013 the vegetation was established enough to allow representative ET measurements to begin. Colorado Division of Water Resources Division 6 administered the lysimeter operations and data collection. Help with manual measurements was provided by summer interns working on the Carpenter Ranch. The lysimeters installed were weighing lysimeters instead of compensating lysimeters that required briefly lifting each bucket out of the ground and suspending it from a scale each time. This allows for operation of the lyismeters to closely mimic the irrigation environment of the Yampa basin. Two of the plots were seeded with grass-reference vegetation and two were seeded with vegetation representative of the surrounding irrigated meadow. The plan was that this would allow for direct determination of crop coefficients that could be applied to any future weather-based calculations of grass-reference ET. Data collected in 2013 did not appear to be useful due, in part, to a malfunctioning load cell. This sensor was then replaced and 2014 data collection efforts were more fruitful although there still appeared to be

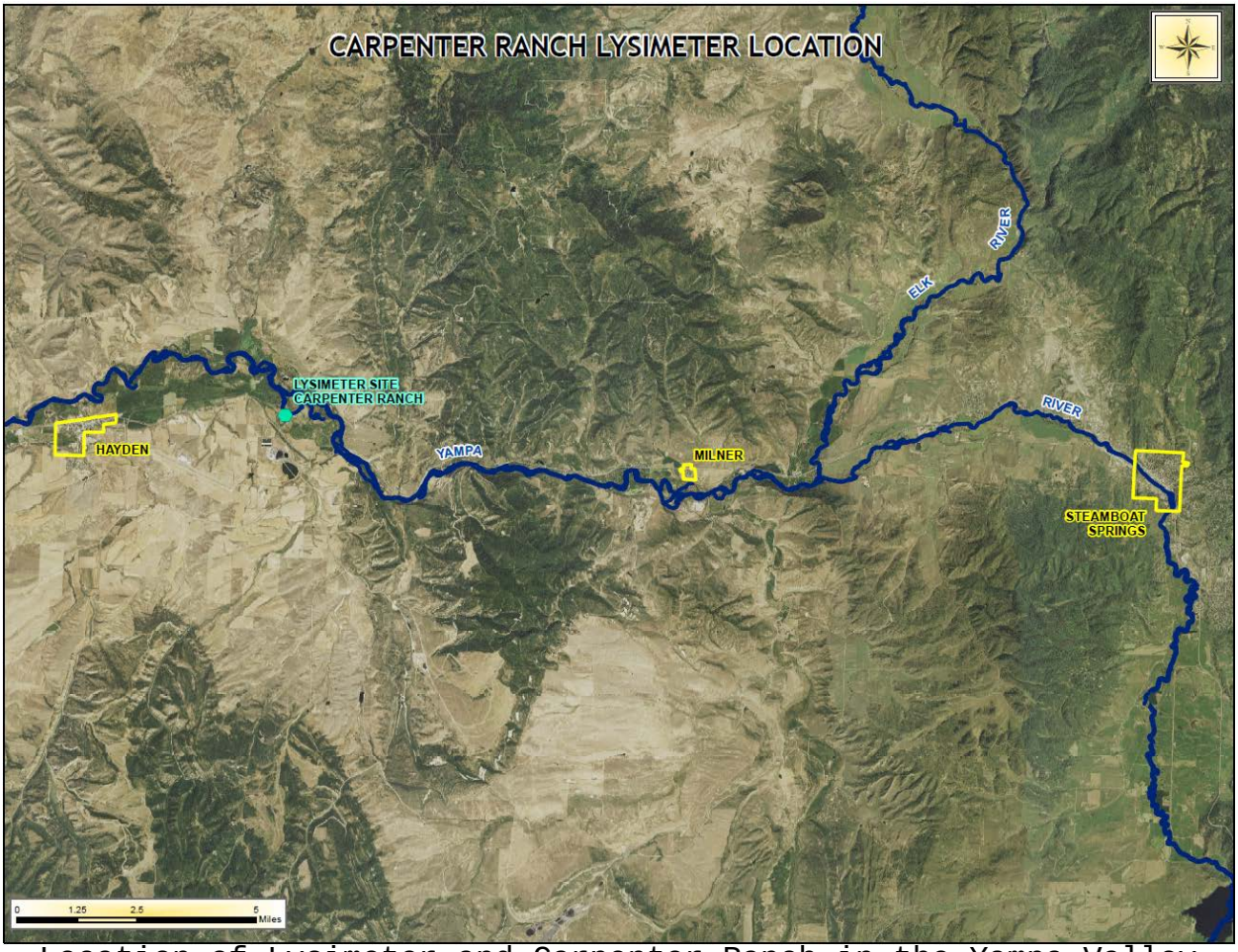
data quality issues as interns collecting the data may not have been adequately trained. For the 2015 season, better quality control checks were implemented at the point of data entry to help alert the observers to possible errors.



Installation of Plots in April 2012

Meteorological data collection has proceeded rigorously, and 4 years of complete hourly weather data are now available, suitable to support ET estimates and calibrations. However, to properly compute the crop coefficient that is needed, this study would benefit from additional years of overlapping lysimeter operations with weather station data collection. Also, several new studies related to water management in the Upper Colorado River Basin have recently begun all of which will require the Carpenter Ranch CoAgMet weather station data, and benefit greatly from the lysimeter data. With the equipment and proper procedures in place, five years of uninterrupted data collection would be invaluable.

Exhibit B



Location of Lysimeter and Carpenter Ranch in the Yampa Valley

Location of Lysimeter and Weather station on the Carpenter Ranch.
Inset: Photo of lysimeter plots and weather station.

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 proposed water activity will not negatively impact or restrict the ability of any holders of water rights to use or dispose of that water right in any manner permitted by Colorado law.

   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.

The application was presented to the Yampa/White/Green Basin Roundtable in January 2016, and there was unanimous agreement by the BRT to approve the proposal.

[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 project, in addition to updating lysimeter measurements in the Yampa basin, will provide quantitative assessments of irrigated hay meadow consumptive use and its relationship to local weather conditions. This type of information is essential for this basin to help confirm and refine the consumptive needs assessment that was previously performed.

d) Matching Requirement: For requests from the **Statewide Fund**, the applicants will be required to demonstrate a **25 percent** (or greater) match of the total grant request from the other sources, including by not limited to Basin Funds. A minimum match of 5% of the total grant amount shall be from Basin funds. A minimum match of 5% of the total grant amount must come from the applicant or 3rd party sources. 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 contract or purchase order between the applicant and the State of Colorado is executed. 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)

It will be requested that no more than 50 % of this project be matched by basin funds. In addition to this, $26,854 is being contributed in the form of in-kind contribution from the Colorado Division of Water Resources.

[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.

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.**

   This activity is currently proposed specifically for the Yampa River Basin, but the question of high altitude consumptive use by native and cultivated vegetation is an issue of statewide interest and concern. The majority of Colorado consumptive use goes to service the biological needs of irrigated vegetation. Weather conditions throughout the year, the variations in weather conditions from year to year, and potentially changing weather conditions over time have and will impact consumptive use of our State's water resources. Better documentation of evapotranspiration leads to an overall improved knowledge of water supply and water demand -- an important goal for all basins and an integral part of a comprehensive needs assessment. This has the potential for promoting greater water conservation and efficiency, help sustain agriculture and provide useful data for many other water resource applications of interest to CWCB. This project also stands to serve as a model for funding and conducting evapotranspiration monitoring statewide and will support efforts to assess ET from remote sensing technologies.

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. The applicant should also refer to the Supplemental Scoring Matrix applied to Evaluation Criteria Tiers 1-3 for Statewide Account requests. 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).
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.
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.

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).
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.

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.
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.
h. The water activity assists in the recovery of threatened and endangered wildlife species or Colorado State species of concern.
i. The water activity provides a high level of benefit to Colorado in relationship to the amount of funds requested.
j. The water activity is complimentary to or assists in the implementation of other CWCB programs.

Continued: Explanation of how the water activity/project meets all applicable **Evaluation Criteria**.

Please attach additional pages as necessary.

Tier 1:

This project meets criteria by more accurately quanitfying actual crop consumptive use for the basin to be used in the basin needs assessment. The North Platte Roundtable has a similar project to quanitfy consumpive use in the North Platte River Basin. The North Platte lysimeter is a much more expensive lysimter and invloves more labor to install, which limits the number of plots that can be sutdied. There is also more uncertanty in the reliability of this lysimeter and the extent the lysimeter will cover.
These results will cover a range of elevations in the two basins and could be extended to other basins using the releationship between the weather data from the CoAgMet station and the lysimeter data.

Tier 2:

The funds requested by the Statewide Account will be matched by 100% by the Basin Roundtable Funds. In-kind contributions totalling $26,854 is being provided by the Colorado Division of Water Resources and The Nature Concervancy's Carpenter Ranch.
This project has already been started with a previous grant. This project cannot continue without this funding which is needed in order to continue maintaing the weather station with calibrated data so accurate weather data can be collected and the continued costs of data transmission so the data can be sent to the Colorado Climate Center where is can be processed, quality controlled, analyzed and archived. Since this station was created with outside funds, it cannot be sustained without support. This project will most likely not be funded by another entity but the Basin Roundtable and Statewide funds. When the Crop Coefficients are calculated and impltemented, more efficient water use will be possible in the Yampa Basin and other high altitude irrigated basin.

Tier 3:
This activity is currently proposed specifically for the Yampa River Basin, but the question of high altitude consumptive use by native and cultivated vegetation is an issue of statewide interest and concern. The majority of Colorado consumptive use goes to service the biological needs of irrigated vegetation. Weather conditions throughout the year, the variations in weather conditions from year to year, and potentially changing weather conditions over time have and will impact consumptive use of our State's water resources. Better documentation of evapotranspiration leads to an overall improved knowledge of water supply and water demand -- an important goal for all basins and an integral part of a comprehensive needs assessment. This has the potential for promoting greater water conservation and efficiency, help sustain agriculture and provide useful data for many other water resource applications of interest to CWCB. This project also stands to serve as a model for funding and conducting evapotranspiration monitoring statewide and will support efforts to assess ET from remote sensing technologies.
This project also has a high cost/benefit for the Yampa Basin and Colorado. Lysimeter studies have been and are being performed in Colorado. Some lysimeters are very expensive and require staff to operate and maintain a system. The lysimeter that has been installed in the North Platte Basin is still high in cost to purchase and install, but with technology that does not require the continual staff to be maintained. However, since this technology is newer, and the lysimeter is smaller, there is uncertainty if it will be worth the cost.
Now that this project at the Carpenter Ranch in Hayden has been set up and we have accurate data coming from both the lysimeter and the CoAgMet station, we know results will be there after we have more years with variable weather to analyze. Once a crop coefficient is calculated, we can start calculating accurate crop evapotranspiration for the Yampa basin. With the weather station data a simple temperature based ET equation can be calibrated so crop reference ET can be calculated using less expensive temperature sensors throughout the basin.
Additionally, results from this project can be used to compare the North Platte study to assess the results. If results from both studies prove to be reliable, relationships between the two basins can be made and perhaps used to aid in creating better reference ET for similar high elevation basins in the state.

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.

This study will only utilize water at the Carpenter Ranch to fill lysimeters. No water supply source or body of water will be affected by the proposed activity.

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

The Colorado Climate Center is currently working on a similar project in the North Platte Basin to quantify consumptive use throughout North Park for their consumptive use needs assessment. Three automated weather stations were placed around North Park to not only characterize weather conditions across North Park but to also understand differences in consumptive use across the basin. Two automated 60 cm weighing lysimeters were installed at the weather station in Cowdrey for crop coefficient calculation. The two lysimeters are for replication of the data, in case one fails. Each lysimeter is installed into the ground, with the undisturbed soil monolith in order to keep the soil as close to surrounding conditions as possible. Advantages to using this type of lysimeter are, because it is automated, no manual measurements need to be taken, reducing the possibility for errors and the need for extra staff. A major disadvantage of this type of lysimeter is the cost of the lysimeter, about $39,000, plus the cost of labor to install the devices. This greatly limits the number of replications and the ability to sample different types of crops. Since the devices were installed fall 2015, we do not have enough time yet to know if the data will be useful.

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

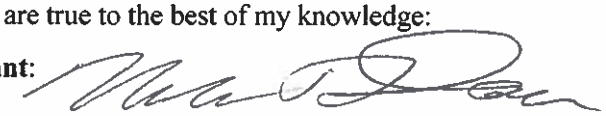
Reporting: The applicant shall provide the CWCB a progress report every 6 months, beginning from the date of the executed contract. The progress report shall describe the completion or partial completion of the tasks identified in the statement of work including a description of any major issues that 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 10 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: Nolan Doesken

Project Title: Continuation of lysimeter operations and consumptive use quantification in high-altitude, irrigated meadows in the Yampa /White Basin.

Date: 1 February 2016

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

Craig Godbout – WSRA Application
Colorado Water Conservation Board
1313 Sherman St., Room 721
Denver, CO 80203
303-866-3441, ext. 3210 (office)
303-547-8061 (cell)
craig.godbout@state.co.us

Exhibit A

Statement of Work
Date: 1 February 2016

WATER ACTIVITY NAME - Continuation of lysimeter operations and consumptive use quantification in high-altitude, irrigated meadows in the Yampa /White Basin.

GRANT RECIPIENT – Colorado Climate Center and Colorado Division of Water Resources

FUNDING SOURCE - – Water Supply Reserve Account
Statewide Account: $11,304
Basin Account: $11,304
Total Funds: $22,608

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)

This project will continue efforts to improve lysimeter operations in the Yampa Basin and to come up with better crop coefficients that can be applied to weather-based calculations of grass-reference ET. In late 2010, the Yampa-White Roundtable provided support for instrumentation, operation and maintenance for an integrated data collection system consisting of an automated weather station specifically designed for estimating evapotranspiration via the ASCE Standardized Penman-Monteith method and small bucket lysimeters designed to directly measure the amount of water lost from the soil due to evapotranspiration. The weather station was purchased and installed in 2011. Severe drought conditions in 2012 limited vegetation growth and establishment, delaying the lysimeters use, but by 2013 the vegetation was established enough to allow representative ET measurements to begin.
This project will allow 5 years of uninterrupted lysimeter data to be collected and another lysimeter load cell to be purchased for accurate weighing of the buckets. From the lysimeter data a more accurate crop coefficients can be calculated, which can then be applied to the weather station data for accurate ET estimates for the Yampa basin.

OBJECTIVES

- Review lysimeter data collection to date and identify data quality issues and the likely causes of data quality deficiencies.
- Review lysimeter operations plan and instructions.
- Obtain new load cell to assure high quality bucket weight measurements.
- Perform daily quality control assessment of Hayden CoAgMet (Colorado Agricultural Meteorological Network) weather station data.
- Conduct annual maintenance and calibration of all meteorological sensors.
- Perform emergency maintenance and calibration as needed based on weather station performance to assure high quality and continuous data collection, particularly during the growing season.

- Based on lysimeter measurements and in collaboration with the staff of the Colorado Division of Water Resources Division 6, compute crop water use for each bucket at the end of each growing season year. Intercompare data and compare to weather station ET (Evapotranspiration) estimates. Also compare with preliminary results from the ongoing North Platte Roundtable ET study.
- As opportunities appear, also use data to assist and support other ET research currently underway in the Upper Colorado River Basin (in collaboration with Dr. Perry Cabot).
- Make annual estimates of hay meadow consumptive use, sample variability and relationship to weather data-based methods. Estimate appropriate crop coefficients and compare to other available estimates. Provide updates to the Yampa-White Roundtable.

TASKS

Provide a detailed description of each task using the following format

TASK 1 – Continue data collection from lysimeters and CoAgMet weather station

Description of Task – Continue collecting data during the growing season from bucket lysimeter plots at the Carpenter Ranch. Continue data collection, quality control and maintenance of the co-located Hayden CoAgMet weather station.

Method/Procedure – Carpenter Ranch and Division 6 Water Resources staff will maintain the lysimeters and take observations. The Colorado Climate Center staff will continue to collect data and perform daily quality control of the data. Normal CoAgMet annual maintenance will be on the weather station by CoAgMet staff. Every year, wind bearings will be changed and all equipment checked. Every other year, the temperature/relative humidity sensor and pyranometer will be replaced and recalibrated to ensure data quality. Along with annual visits, emergency maintenance and calibration will be conducted when needed.

Deliverable –Data lysimeter for use in crop coefficient calculation and publicly available data access to weather station in daily and hourly increments.

TASK 2 – Development of Crop Coefficients

Description of Task - Use data from the bucket lysimeters to calculate crop coefficients. These coefficients can then be applied to any future weather-based calculations of ET.

Method/Procedure- The use of two different species on the plots will provide both a grass ET reference and a crop ET reference. From these two measurements, crop coefficients can be determined directly.

Deliverable – Yampa Basin specific crop coefficients.

TASK 3 –Calculate Crop ET

Description of Task - Calibration of ASCE ET weather based calculations to temperature-based Hargreaves method.

Method/Procedure - Use weather station data to calculate ASCE standardized equation grass reference ET. These estimates will then be calibrated to the Hargreaves temperature based method. Once this relationship is established and crop coefficients are determined, crop ET can be determined anywhere in the basin temperature is monitored.

Deliverable- Summary of findings.

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.

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.

Total Costs				
	Labor	Other Direct Costs	Matching Funds (If Applicable)	Total Project Costs
Task 1 - Continue data collection from lysimeters and CoAgMet weather station	$7,952.00	$8,388.00		$16,340.00
Task 2 - Development of Crop Coefficients	$5,336.00	$32.00		$5,368.00
Task 3 - Calculate Crop ET	$475.00	$425.00		$900.00
In-Kind Contributions				
Total Costs:	$13,763.00	$8,845.00		$22,608.00

Total Costs			
	Matching Funds In-kind Contributions	WSRA Funds	Total Project Costs
Task 1 - Continue data collection from lysimeters and CoAgMet weather station	$19,004	$16,340.00	$35,344.00
Task 2 - Development of Crop Coefficients	$7,850	$5,368.00	$13,218.00
Task 3 - Calculate Crop ET		$900.00	$900.00
Total Costs:	$26,854	$22,608.00	$49,462.00

Project Personnel: Hourly Rate:	Project Manager $65.30	Project Supervisor $30.74		Total Costs
Task 1 - Continue data collection from lysimeters and CoAgMet weather station	$2,249.00	$5,703.00		$7,952.00
Task 2 - Development of Crop Coefficients	$1,313.00	$4,023.00		$5,336.00
Task 3 – Calculate Crop ET	$100.00	$375.00		$475.00
Total Hours:	48.8	285.7		
Cost:	$3,663.00	$10,100.00		$13,763.00*

*Hourly rate does not include 15% IDC, dollar amounts include 15% IDC rate.

Other Direct Costs						
Item: Units: Unit Cost:	Travel $340.00	Materials Parts N/A	Equipment/ Supplies N/A	Computer Network Fee Person Months $42		Total
Task 1 - Continue data collection from lysimeters and CoAgMet weather station	$2,310.00	$6,026.00	$0.00	$52.00		$8,388.00
Task 2 – Development of Crop Coefficients	$0.00	$0.00	$0.00	$32.00		$32.00
Task 3 – Calculate Crop ET	$421.00	$0.00	$0.00	$4.00		$425.00
Total Units:	7					
Total Cost:	$2,731.00	$6,026.00	$0.00	$86.00		$8,845.00*

*Amounts include 15% IDC rate

In-Kind Contributions (If Applicable)				
Project Personnel: Hourly Rate:	Lead WC $39.25	Deputy WC $28.62		 Total
Task 1 -	$10,990	$8,014		$19,004
Task 2 -	$7,850			$7,850
Total Hours:	480	280		760
Total Cost:	$18,840	$8,014		$26,854

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.

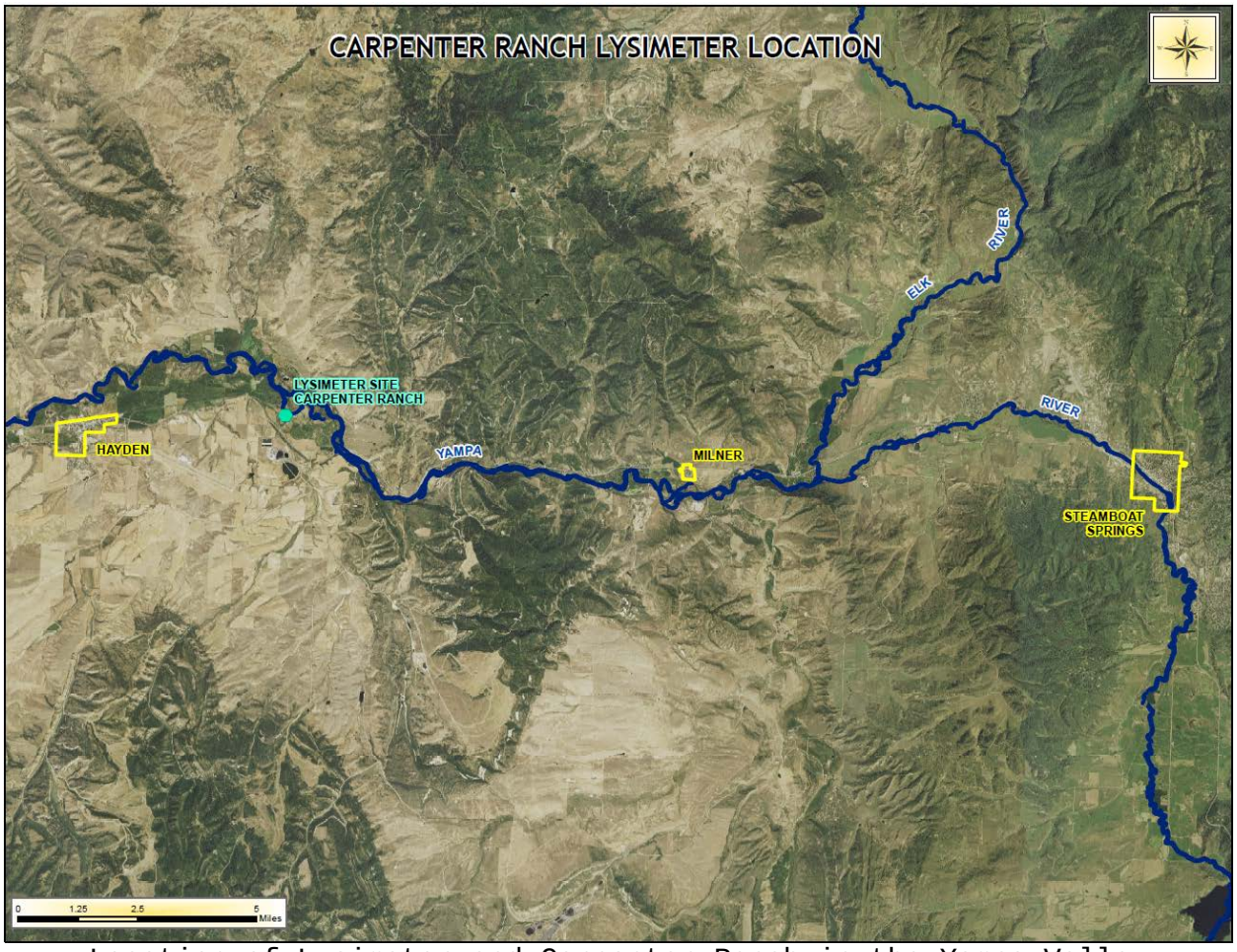
Task	Start Date	Finish Date
1	Upon NTP	Through end of project
2	Upon NTP	April – October 2016, 2017, 2018, 2019 and 2020
3	Upon NTP	Final report deliverable 2020

NTP = Notice to Proceed

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.

Exhibit B



Location of Lysimeter and Carpenter Ranch in the Yampa Valley

Location of Lysimeter and Weather station on the Carpenter Ranch.
Inset: Photo of lysimeter plots and weather station.