STATE OF COLORADO
INTERAGENCY AGREEMENT
SHORT FORM

Paying State Agency Department of Natural Resources Colorado Water Conservation Board, ("CWCB")	**Contract Number** CMS Number: 188452 Encumbrance Number: CTGG1 PDAA 2024*3207
Performing State Agency The Board of Governors of the Colorado State University System acting by and through the Colorado State University	**Agreement Performance Beginning Date** The Effective Date
Contract Maximum Amount Entire Contract term for all applicable fiscal years: $269,534.19	**Agreement Effective Date** Upon approval by the State Controller or an authorized delegate
	Agreement Expiration Date January 2, 2029
	Terms Payment is due 30 days upon receipt of a valid invoice. Disputes are governed by Fiscal Rule 3-5, Section 4.2. Agencies shall report any outstanding balance on Exhibit AR_AP at Fiscal Year end.

Agreement Purpose and Obligations of the Parties

In Phase II, Colorado State University will further expand the statewide use and capabilities of the Polaris software, which can estimate future water demand based on land use patterns. Specifically, CSU will assist 25 additional communities in employing the Polaris software to develop community specific land use plans. CSU will also program Polaris to examine the effects of changes in land use codes and zoning policy, climate change, and the regulatory environment. Finally, CSU will host training workshops to enable Polaris' widespread use.

Exhibits and Attachments

The following Exhibit(s) and/or Attachment(s) are included with this Agreement:

1. Exhibit A – Statement of Work and Budget

Principal Representatives

For the Paying State Agency:

Laura Spann
Colorado Water Conservation Board
1313 Sherman St. #718
Denver, CO 80203
laura.spann@state.co.us

For the Performing State Agency:

Tiffany Roller
Colorado State University
2002 Campus Delivery
Fort Collins, CO 80523-2002
tiffany.roller@colostate.edu

Exhibit A

Statement Of Work	
Date Prepared:	December 13, 2023
Name of Grantee:	Colorado State University
Name of Water Project:	Polaris Land Use & Water Planning Tool, Phase II

Water Project Overview:

In Phase II of the Polaris Land Use & Water Planning Tool project, Colorado State University (CSU) will further develop a software called Polaris with data analysis and modeling capacities for integrated land use planning and water supply management in communities across Colorado. The tool streamlines a mechanism to quickly assess, understand, and report water use for comprehensive plans, master plans, and other planning activities within a city or utility service area.

The Polaris tool provides Colorado communities with a comprehensive, consistent, standardized, and transparent approach for prioritization of integrated strategies by assessing new land use, policy, and innovative infrastructure solutions such as indoor and outdoor conservation, water reuse, land use densification, transit-oriented design, and housing development, to name a few.

In Phase I, the existing Polaris tool was developed for integrated land use planning and water management in partnership with six utilities in the Front Range of Colorado. Phase II expands the Polaris tool and provides engagement and training opportunities for its widespread applications in all communities across Colorado. Specifically, in Phase II CSU will examine the influence of projected land development plans, land use policy, and zoning regulations on municipal water use. Through extensive stakeholder engagement, co-design scenario planning workshops, and training, CSU will facilitate collaborative and aligned planning and decision making among water and land use planners in up to 25 Colorado communities.

This project serves multiple benefit to Colorado communities:

- **Software**: An open-source and publicly available data analysis and modeling software based on the existing Polaris tool is deployed and parameterized to facilitate integrated land use planning and water supply-demand management in up to 25 Colorado communities.
- **Publicly available reports:** A public report will be delivered as a key product of this work that: 1) provides insight into processes and steps how to conduct integrated land use and water supply planning; 2) provides capacities for forecasting water demands from existing or proposed local, regional, and state-wide land use plans and zoning policy (e.g., comprehensive plans); 3) facilitates prioritization of cost-effective water conservation, end-use efficient, and demand reduction strategies to address current or future supply-demand gaps.
- **Co-produced integrated land use and water supply-demand management scenarios**: Participatory stakeholder workshops are conducted to co-design and co-produce a set of strategies and implementation actions for integrated land use planning and water supply-demand management in Colorado. Specifically, scenarios are developed in congruence with the five scenarios in the CWP.

- **Utility specific plans**: Community (i.e., city, municipality, county, or utility) specific plans are co-produced for up to 25 participating communities across Colorado, streamlining robust integrated land use and water planning. The participating communities benefit from reduced time, effort, and financial resources in implementing regular planning processes. The system helps cities, utilities, and developers understand the water use implications of their land-use plans and streamline their planning and design processes to understand tradeoffs with various management solutions. The project is likely to improve connected land use and water management decisions and other benefits to nearly 2,000,000 Coloradoans.

Project Objectives:

The goal of the proposed work is to provide Colorado communities with the proper understanding and tools necessary to integrate land use and water planning. Specific objectives of the project are to:

- Engage and recruit up to 25 communities (municipalities, cities, counties, and/or water utilities) to characterize interconnected land use planning and water supply-demand planning and management processes.
- Expand the functionality of the Polaris tool to provide explicit options for examination of the effects of changes in land use codes and zoning policy, climate change, and the regulatory environment, including new land use patterns, densification, transit-oriented planning, housing development, water conservation and demand management, and drought resilience planning.
- Collect and incorporate historical and future land use, comprehensive plans, and water use from up to 25 communities across all water divisions in Colorado to parameterize and deploy Polaris.
- Quantify historical and future municipal water use and conservation trends in partnering communities to project municipal water demands for co-designed land use and water scenarios encompassing the range of conditions characterized in the 5 future scenarios in the CWP.
- Conduct community engagement and training workshops to enable widespread use of Polaris in communities across Colorado and by land use planners and water professionals in the private and public sectors.

The study objectives are examined by conducting five tasks and subtasks described below.

Task 1

Task 1 – Recruit (up to 25) cities/municipalities across Colorado to participate in the project

Description of Task:

Subtask 1-1) Stakeholder Engagement

First, the project will establish and streamline partnerships between the project team and statewide and regional planning organizations such the Department of Local Affairs (DOLA), Colorado Municipal League (CML), Colorado Water and Land Use Planning Alliance, Denver Regional Council of Governments (DRCOG), North Front Range Metropolitan Planning Organization (NFRMPO), and Northwest Colorado Council of Governments (NWCCOG). These partnerships will be leveraged to reach out to all local communities across Colorado for participation in the project. Communities that will be engaged include local city governments, planning groups, and water utilities. Up to 25 diverse communities across Colorado's eight (8) basins will be selected that represent varying population, land use, hydroclimatic, and economic growth trajectories.

Subtask 1-2) Community (Stakeholder) Onboarding Workshops
The selected communities will participate in an onboarding workshop for project orientation and initiation. The workshop will also solicit regional planning drivers and processes as well as local and regional strategies and actions for the implementation of the Colorado's Water Plan. The workshops will engage participants with diverse expertise and perspectives across water and planning agencies, organizations, departments to understand within- and cross- jurisdictional processes.

Method/Procedure:

Partnerships with the state and regional planning organizations will be streamlined through appropriate partnership agreements such as memorandum of understanding (MOU) or master research agreements to enable date and information sharing. The agreements will be developed only when necessary and requested by the partnering organizations other than CSU.

The project team will conduct five (5) regional workshops in the Gunnison/Lower Dolores, Lower Colorado, Upper Colorado/North Platte, San Juan/Dolores, and Rio Grande River basins. Communities will be invited to participate in their corresponding river basin events. The meetings will be planned and coordinated with the Basin Roundtables. Additionally, a workshop will be conducted at the CSU's Spur campus in Denver for participating communities in the Metro, South Platte, and Arkansas basins. The workshop participant will be selected to represent diverse expertise and perspectives in integrated planning and management of land and water resources. The workshops will be organized to identify data availability and gaps, barriers to integrated land use and water planning, and other local and regional insights. For example, the project team will document existing approaches and tools that are used in Colorado for water consumption analysis and forecasting.

Deliverable:

The deliverables of this task include:

- Executed partnership agreements: A short memorandum will be submitted to provide the list of communities in agreement with CSU for participation in the project will be submitted to CWCB.
- Workshop summary: A short memorandum will be created and submitted to CWCB to summarize the community (stakeholder) onboarding workshops, including dates, a list of attendees, agenda, and feedback from the participants about the desired use cases and appropriate deployment strategies for the Polaris tool.

Task 2

Task 2 – Process city demographic, economic, hydroclimatic, and water use data

Description of Task:

The existing Polaris tool, publicly available at **polaris.erams.com**, reconciles physiographic and socioeconomic characteristics of a city or community with metered historical water use data to assess water use by land use / zoning category and forecast water for planning scenarios. The following data for up to 25 participating communities will be collected, standardized, and incorporated to parameterize the Polaris tool for each community:

- Geospatial Data
    - Land use and zoning: Jurisdictional boundaries including city, incorporated area, and water utility boundaries; land use and zoning classes and definitions; comprehensive planning documents; historic, current, and future land use and zoning policy and regulations; growth boundaries
    - Population and demographics: Population, income
    - Household characteristics: Household occupancy (# of persons per household); ownership
    - Building characteristics: Year built; property value
    - Transportation zones
- Water Use Data
    - Water meter locations
    - Water use time series (monthly or smaller time scales)
    - Water use components including residential, commercial/institutional/industrial (CII), irrigation, and wholesale
    - Water supply systems: surface and groundwater systems
    - Water rates
- Other:
    - Municipal separate storm sewer system (MS4) boundaries
    - Land cover, including landscape characteristics
    - Terrain: elevation, slope, aspect
    - Soils: texture, hydrologic soil group, drainage capacity
    - Climate: temperature, precipitation, and evapotranspiration (ET)
    - Landscape (including irrigated turf) evapotranspiration

Other data, information, and resources that are identified by the participating communities as relevant to integrated land use and water planning and management will be incorporated in the Polaris Information Management System.

Method/Procedure:

Water use data and information are collected from participating communities. Polaris fetches other geospatial data from publicly available sources. For example, land use and impervious surface data are obtained from the USGS National Land Cover Datasets (NLCD) for the years 1992, 2001, 2006, 2011, 2016, and 2019. Population and demographic information are obtained from the decennial Census 1980, 1990, 2000, 2010, and 2020 datasets and are augmented with annual American Community Survey (ACS) for years 2013 through 2022. Similarly, land use and zoning data and information are obtained from published documents from the participating communities or by request from the participating agencies.

The Polaris tool is built on a robust GIS platform called eRAMS that resolves discrepancies between land use and zoning boundaries with water utility boundaries. The tool also analyzes water use by land use and zoning class, and calculates the following land use and water consumption metrics for integrated planning:

- Population density in persons per square mile
- Annual trend in population density in persons per square mile

- Household density in number of households per square mile
- Annual trend in household density in number of households per square mile
- Normalized water use in gallons per capita per day (GPCD) by zoning category
- Annual trend in normalized water use in gallons per capita per day (GPCD) by zoning category
- Normalized water use in gallons per household per day (GPHD) by zoning category
- Annual trend in normalized water use in gallons per household per day (GPHD) by zoning
- Normalized water use in million gallons per acre per year (MGAY) by zoning category
- Annual trend in normalize water use in million gallons per acre per year (MGAY) by zoning
- Correlation between water use in GPHD and number of people per household by zoning
- Median water use in GPHD to number of people per household ratio by zoning
- Ratio of annual CII to total water use by zoning category
- Annual trend in the ratio of annual CII to total water use by zoning category
- Ratio of CII to indoor residential water use
- Annual trend in ratio of annual CII to indoor residential water use
- Ratio of outdoor (irrigation) to residential water use by zoning category
- Annual trend in the ratio of outdoor (irrigation) to residential water use by zoning category

Deliverable:

The deliverables of this task include:

- Parameterized Polaris web tool for the participating communities: A short memorandum will be created and submitted to CWCB with a list of URLs for the parameterized Polaris tool for the participating communities. Access to the URLs will be available at the discretion of the communities.
- Current integrated land use/zoning and water use metrics: A memorandum will be created and submitted to CWCB with a summary of water use metrics by land use / zoning categories in each participating community.

Task 3

Task 3 – Conduct participatory land use and water scenario planning

Description of Task:

Extensive participatory scenario planning and training workshops will be conducted to develop and assess integrated land use and water management scenarios for the participating communities in a manner consistent with the five (5) scenarios in the CWP. The project will closely coordinate with the CWP staff to support the next technical update. The scenario builder module in the Polaris tool will enable seamless access to the scenario data and products from this project as well as the relevant CWP technical update for the participating communities across Colorado.

Additionally, existing city/regional comprehensive plans and other planning scenarios that are identified by the partnering stakeholders will be included. The co-design process will facilitate interactions between the project team and stakeholders in the communities to develop the following datasets for each scenario:

- Population of the analysis area is projected for the CWP scenarios as well as city/regional comprehensive plans and others that are identified by the partnering stakeholders.
- Land use, zoning, and housing scenarios will be developed based on five (5) CWP scenarios and other local or regional comprehensive planning documents.

- Land cover and impervious surface will be developed consistent with the population, land use and zoning, and housing density scenarios using the USGS NLCD classes.
- Climate data including temperature, precipitation, and ET will be developed.
- Water conservation, end-use efficiency, and demand reduction scenarios will be developed to assess the effects of social/technological innovations on integrated land use and water planning.
- Water consumption by land use/zoning categories as well the entire community will be calculated to assess the expected water use and the range of possible water consumption.
- Tradeoffs between triple bottom line social, economic, and environmental effects of the integrated land use and water management strategies will be evaluated.

Method/Procedure:

The co-design process will leverage and incorporate the five (5) CWP planning scenarios (CWCB, 2019). The CWP planning scenarios have been defined by considering nine high-impact drivers that could significantly shape the course of Colorado's water future. These drivers include population/economic growth, social/environmental values, climate change/water supply availability, urban land use/urban growth patterns, energy economics/water demand, level of regulatory oversight/constraint, agricultural economics/water demand, municipal and industrial water demands, availability of water-efficient technologies. Some of these drivers exhibit interdependencies, meaning that their effects are interconnected rather than independent from one another. Hence, for the purpose of this study, the five CWP scenarios are defined based on independent drivers that can potentially influence integrated land use and water planning in Colorado. These drivers include population, land use, climate, regulations, and adaptation to new technology.

The participatory co-design process will engage stakeholders to define and characterize each of these drivers in scenario planning. For example, the "Regulation" driver may include, but is not limited to:

- Local and regional comprehensive plans
- Growth management boundaries
- Land use densification policy
- New zoning ordinance
- Transit-oriented land use policy
- Housing policy and development policy

Once these drivers are developed, detailed geospatial and time-series data will be developed for the participating communities.

Through careful data collection and generation aligned with the five CWP planning scenarios, this study will provide local communities across Colorado with valuable data, information, and insight to integrate land use and water planning processes and decision.

The co-produced community level water conservation, end-use efficiency and demand reduction strategies will be evaluated using the Integrated Urban Water Model (IUWM) (https://erams.com/iuwm), developed by the project team at the CSU One Water Solutions Institute (Sharvelle et al., 2017). The performance validity and application of the tool for the assessment of demand reduction strategies and water recycling has been extensively evaluated in communities across Colorado, including the city of Fort Collins (Sharvelle et al., 2017), Denver (Neale et al, 2020), and the South Platte River Basin (Gharib et al., 2023). Similarly, the tool has

been used for integrated assessment of land use development and water use in Colorado (Heidari et al., 2021). Multi-objective assessments will be conducted to assess triple bottom line social, economic, and environmental tradeoffs associated with water conservation, end-use efficiency, and demand management strategies compared with water supply development and alternative water rights transfer methods (Neale et al, 2020, Dozier et al., 2017).

Deliverable:

The deliverables of this task include:

- Community scenario planning data and information: A memorandum will be created and submitted to CWCB, which will include specific land use, zoning/rezoning, housing, and water demand management (e.g., conservation) policy scenarios for the participating communities. The document will also provide a catalog of integrated land use and water management planning scenarios for Colorado.
- Future integrated land use/zoning and water use metrics: A memorandum will be created and submitted to CWCB to summarize how the stakeholder-driven integrated land use and water management policy would influence water use intensity metrics such as gallons per year, gallons per capita per day (GPCD) by land use/zoning categories, million gallons per acre (MG/AC) by land use/zoning category, gallons per year per use type (e.g., residential, commercial, industrial).

Task 4

Task 4 – Develop the Polaris integrated land use and water supply planning module

Description of Task:

The scenario planning processes from Task 3 will be incorporated in Polaris for applications across Colorado communities. Specifically, two (2) new modules will be developed and deployed in Polaris:

1. Scenario planning module for integrated land use and water assessments and decision making
2. Integrated land use and water planning report generation module

The new modules will be developed in the Polaris software as web services with user interfaces consistent with the existing tool.

Method/Procedure:

The modules will be developed in close collaboration with the partnering state and regional entities and participating community stakeholders. In-person and virtual hands-on training sessions will be conducted to collect feedback and enhance the design and deployment of the new planning and reporting modules in Polaris. The tool will be published in a high impact peer-reviewed journal to establish the scientific validity and rigor of the methods that are used for integrated land use and water assessments.

The project team will develop written and video tutorials for the Polaris integrated land use and water planning tool to facilitate its widespread application in all communities across Colorado.

Deliverable:

The deliverables of this task include:

- Enhanced Polaris web tool with integrated land-water scenario planning and reporting modules: A memorandum will be created and submitted to CWCB to describe the methodology used in the enhanced Polaris tool for the assessment of stakeholder-driven integrated land use and water management policy and strategies. Short YouTube videos will be produced to demonstrate the application of the tool for relevant case studies. A user's guide will be created and submitted to CWCB to facilitate application of the Polaris tool. The videos and user's guide will be made available from the Polaris landing page.
- Parameterized Polaris web-tool for the participating communities: A short memorandum will be created and submitted to CWCB with a list of updated URLs for the parameterized Polaris tool with options for the assessment of integrated land use and water management strategies for the participating communities. Access to the URLs will be available at the discretion of the communities.
- Hands-on publicly available Polaris training sessions
- Polaris user's guide documentation and video tutorials
- Peer-reviewed journal publication

Task 5
Task 5 – Develop and disseminate reports
Description of Task:
Progress reports will be written and submitted every six months. The final report will be developed and submitted by the end of the project execution. A hands-on stakeholder training workshop for the community participants and software documentation will foster the use of the Polaris tool by the project partners and participants as well as other cities and water utilities across Colorado.
Method/Procedure:
Documents will be typed using word processors and provided to CWCB electronically. The hands-on community workshop for the participating communities will be conducted at the CSU Spur campus in Denver.
Deliverable:
The deliverables of this task include: ● Semi-annual reports ● Final report ● Documentation of hands-on Polaris community stakeholder training workshop: A memorandum will be created and submitted to CWCB with information about the date, list of attendees, agenda, narrative of hands on exercises, and a summary of functionality of the Polaris tool for integrated assessment of land use and water management policy and strategies as reported by the workshop participants.

Budget and Schedule
This Statement of Work is accompanied by a combined Budget and Schedule that reflects the tasks identified in the Statement of Work.

Task No.	Task Description	Estimated Task Start Date	Estimated Task End Date	Grant Funding	Match Funding	Total
1	Recruit up to 25 cities/municipalities across Colorado to participate in the project and conduct stakeholder onboarding workhops	1/15/2023	10/31/2025	$20,421.83	$19,820.00	$40,241.83
2	Process city demographic, economic, hydroclimatic, and water use data	1/15/2023	12/31/2024	$45,504.02	$0.00	$45,504.02
3	Conduct participatory land use and water scenario planning	1/15/2023	12/31/2024	$44,751.76	$19,254.00	$64,005.76
4	Develop the Polaris integrated land use and water supply planning module	1/15/2023	10/31/2025	$98,041.87	$31,878.00	$129,919.87
5	Develop and disseminate reports	1/15/2023	10/31/2025	$25,657.72	$18,899.40	$44,557.12
	CSU Indirect Rate	1/15/2023	10/31/2025	$35,157.00	$0.00	$35,157.00
			Total	$269,534.19	$89,851.40	$359,385.59

Reporting Requirements

Progress Reports: The grantee shall provide the CWCB a progress report every six months, beginning from the date of issuance of the grant agreement. The progress report shall describe the status 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 Report: At completion of the project, the applicant shall provide the CWCB a final report on the applicant's letterhead that:

- Summarizes the project and how the project was completed.
- Describes any obstacles encountered, and how these obstacles were overcome.
- Confirms that all matching commitments have been fulfilled.
- Includes photographs, summaries of meetings and engineering reports/designs.

The CWCB will pay out the last 10% of the budget when the final report is completed to the satisfaction of CWCB staff. Once the final report has been accepted, and final payment has been issued, the grant agreement will be closed without any further payment.

Payment

Payment will be made based on actual expenditures and must include invoices for all work completed. The request for payment must include a description of the work accomplished by task, an estimate of the percent completion for individual tasks and the entire project in relation to the percentage of budget spent, identification of any major issues, and proposed or implemented corrective actions.

Costs incurred prior to the effective date of this grant agreement are not reimbursable. The last 10% of the entire grant will be paid out when the final deliverable has been received. All products, data and information developed as a result of the grant agreement must be provided to the CWCB as part of the project documentation.

Performance Measures

Performance measures for the grant agreement shall include the following:

(a) Performance standards and evaluation: Grantee will produce detailed deliverables for each task as specified. Grantee shall maintain receipts for all project expenses and documentation of the minimum in-kind contributions (if applicable) per the budget. Per grant guidelines, the CWCB will pay out the last 10% of the budget when the final report is completed to the satisfaction of CWCB staff. Once the final report has been accepted, and final payment has been issued, the grant agreement will be closed without any further payment.

(b) Accountability: Per grant guidelines full documentation of project progress must be submitted with each invoice for reimbursement. Grantee must confirm that all grant conditions have been complied with on each invoice. In addition, per Grant Guidelines, progress reports must be submitted at least once every 6 months. A final report must be submitted and approved before final project payment.

(c) Monitoring Requirements: Grantee is responsible for ongoing monitoring of project progress per Exhibit A. Progress shall be detailed in each invoice and in each progress report, as detailed above. Additional inspections or field consultations will be arranged as may be necessary.

(d) Noncompliance Resolution: Payment will be withheld if grantee is not current on all grant conditions. Flagrant disregard for grant conditions will result in a stop work order and cancellation of the grant agreement.