208 REGION 2 — REGIONAL NONPOINT SOURCE WATERSHED-BASED PLAN

DRAFT REPORT RSI-3527

PREPARED BY

Cindie Kirby
Seattle Briscoe
Natalie Acosta
Alan Leak

RESPEC
720 South Colorado Blvd., Suite 410 S
Denver, Colorado 80246

PREPARED FOR

North Front Range Water Quality Planning Association
257 Johnstown Center Drive, Unit 206
Johnstown, Colorado 80534

DECEMBER 2024

Project Number W0545.23001

EXECUTIVE SUMMARY

This *208 Region 2 – Regional Nonpoint Source Watershed-Based Plan* was completed for the North Front Range Water Quality Planning Association (NFRWQPA) with the purpose of preparing comprehensive U.S. Environmental Protection Agency (EPA) nine key element Nonpoint Source Watershed-Based Plans for the Section 208 Region 2 area (hereafter referred to as Watershed-Based Plans). The NFRWQPA is the designated Section 208 planning agency under the federal Clean Water Act (CWA) for the Larimer and Weld County region. Historically, the NFRWQPA has focused on water quality impacts of water treatment systems and their impact on receiving waters. The plan does not focus on Municipal Separate Storm Sewer Systems (MS4s) and their impacts on receiving waterbodies. This plan also does not focus on water treatment systems, and instead focuses on nonpoint source (NPS) impacts on receiving waterbodies.

Four Watershed-Based Plans were developed for watersheds draining to the Middle South Platte River within Larimer and Weld counties. The first plan developed was for areas draining to the Big and Little Thompson Rivers. The area in this plan transitions from the upper mountainous, forest areas in the west to more agricultural and developed areas in the lower eastern portions of the watershed. The second and third plans developed were for areas draining to the Cache la Poudre River and St. Vrain Creek. The watershed land cover characteristics in these watersheds are very similar to the Big and Little Thompson Rivers with mountainous forest areas draining easterly toward agricultural and developed areas. The final plan developed was for the other watersheds draining to the Middle South Platte River in Larimer and Weld Counties. These watersheds include the Middle South Platte-Cherry Creek (not including areas from the *Barr Lake and Milton Reservoir Watershed Plan Update* [Barr Lake & Milton Reservoir Watershed Association, 2017] or the *Big Dry Creek Watershed Management Plan* [Wright Water Engineers, 2002], Lone Tree-Owl, Crow, and Middle South Platte-Sterling. The land cover in the Middle South Platte River watershed is primarily cropland and/or herbaceous land, with very little forest cover or development.

Each plan includes an introduction, watershed characterization, summary of existing watershed plans and projects; a summary of standards and impairments; source assessments; priority areas for implementation based upon the source assessments; expected load reductions from best management practices (BMPs); existing BMPs; plans for information, education, and outreach; criteria to assess progress; effective monitoring options; and sources of technical and financial assistance. This Regional NPS Watershed Plan references the plans to suggest how to approach the watersheds regionally and recommend where to look for information for different watersheds and land cover types.

TABLE OF CONTENTS

TABLE OF CONTENTS (CONTINUED)

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

ACEP	Agricultural Conservation Easement Program
AFA	Alternative Funding Arrangement
AFP	Announcements for Funding Proposals
AML	abandoned mine land
BIP	Basin Implementation Plan
BMP	best management practices
BTWC	Big Thompson Watershed Coalition
CAWA	Colorado Ag Water Alliance
CCR	Code of Colorado Regulation
CDPHE	Colorado Department of Public Health and Environment
CIG	Conservation Innovation Grants
CPPE	Conservation Practice Physical Effects
CPRW	Coalition for the Poudre River Watershed
CSP	Conservation Stewardship Program
CSU	Colorado State University
CTA	Conservation Technical Assistance
CWA	Clean Water Act
CWCB	Colorado Water Conservation Board
CWSRF	Clean Water State Revolving Fund
DNR	Department of Natural Resources
EPA	U.S. Environmental Protection Agency
EQIP	Environmental Quality Incentives Program
FEMA	Federal Emergency Management Agency
HUC	Hydrologic Unit Code
lb/acre	pounds per acre
LID	Low Impact Development
mi^2	square miles
MIDS	Minimal Impact Design Standards
MS4	Municipal Separate Storm Sewer System
NFRWQPA	North Front Range Water Quality Planning Association
NPS	nonpoint source
NRCS	Natural Resources Conservation Service
OWTS	Onsite Wastewater Treatment System
PEPO	Public Education, Participation, and Outreach
PFAS	per- and polyfluoroalkyl substances
PLET	Pollutant Load Estimation Tool
RCPP	Regional Conservation Partnership Program
RESPEC	RESPEC Company, LLC
SPARROW	SPAtially Referenced Regression on Watershed Attributes
STEPL	Spreadsheet Tool for Estimating Pollutant Loads
SWAP	Source Water Assessment and Protection
TMDL	total maximum daily load

LIST OF ABBREVIATIONS (CONTINUED)

TSI	Trophic Status Index
USBR	U.S. Bureau of Reclamation
USDA	U.S. Department of Agriculture
USGS	U.S. Geological Survey
USFWS	U.S. Fish & Wildlife Service
USLE	Universal Soil Loss Equation
WRSF	Water Supply Reserve Fund

1.0 APPLICATION OF THIS REGIONAL PLAN

North Front Range Water Quality Planning Association (NFRWQPA) is the designated Section 208 planning agency under the federal Clean Water Act (CWA) for the Larimer and Weld County region. NFRWQPA represents its member entities in water quality legislative and regulation-setting actions. RESPEC Company, LLC (RESPEC), NFRWQPA, and other community stakeholder groups worked in partnership and coordination to prepare a comprehensive U.S. Environmental Protection Agency (EPA) nine key element Watershed Plan for the Section 208 Region 2 area (hereafter referred to as this plan or Regional NPS Watershed Plan). Historically, the primary tasks performed by the NFRWQPA have focused on point source actions, including wastewater and Municipal Separate Storm Sewer Systems (MS4) areas. Instead, this plan focuses on nonpoint sources (NPSs) and development outside of MS4 areas. Overall, the primary goal is to identify the most feasible and effective NPS management planning mechanisms for areas within the Middle South Platte River Watershed in Larimer and Weld Counties. The project area is shown in Figure 1-1. Four Nonpoint Source Watershed-Based Plans were prepared, all for areas within Larimer and Weld Counites. Watersheds addressed include the St. Vrain eight-digit Hydrologic Unit Code (HUC8) (10190005), the Big and Little Thompson HUC8 (10190006), the Cache la Poudre HUC8 (10190007), and a group of remaining HUC8s that drain to the Middle South Platte River within Larimer and Weld Counties (10190003, 10190008, 10190009, and 10190012). The four Watershed-Based Plans are included as Appendices A through D. Information is provided for the excluded areas (Barr Lake and Milton Reservoir and Big Dry Creek) in Section 3.1, but Watershed-Based Plans for these specific watersheds were not developed.

The NFRWQPA was awarded Colorado Division of Water Resources and Power Development Authority Funds from the Colorado NPS Program to develop a NPS watershed plan modeled after the EPA nine key element watershed plan guidelines. This overarching Regional NPS Watershed Plan pulls the four Watershed-Based Plans together to provide a planning framework to address waterbodies impaired by NPS pollution and/or protecting waterbodies affected or threatened by NPS pollution.

This Regional NPS Watershed Plan addresses a wide range of land and water resources, prioritizing sources of parameters of concern and determining solutions for water quality issues. This plan is intended to determine which implementation projects and programs will be best to restore degraded resources and protect high-quality resources from degradation in watersheds in Larimer and Weld Counties. The Colorado NPS Program is prioritizing collaboration with local communities to develop and implement Watershed-Based Plans that evaluate NPSs of pollution in areas experiencing growth. Therefore, RESPEC paid particular attention to the areas that are not yet permitted MS4s but are likely to become permitted MS4s. Current MS4s and areas that are growing quickly and expected to become MS4s within the next 5 to 15 years (Johnstown and Firestone/Frederick) in the Middle South Platte River project area in Larimer and Weld Counties are shown in Figure 1-1 and Table 1-1. For the purposes of this plan, MS4 areas (not represented in modeling efforts) were developed using a combination of the MS4 layer from ERAMS [Catena Analytics, 2024] (developed with the 2010 Census urban areas), the 2020 urban areas [U.S. Census Bureau, 2020], and a layer provided by the Town of Timnath [Smith, 2024]. Water quality impacts in the fast-growing but non-MS4 permitted areas have the potential to be significant; therefore, addressing the potential effects should be part of planning for growth.

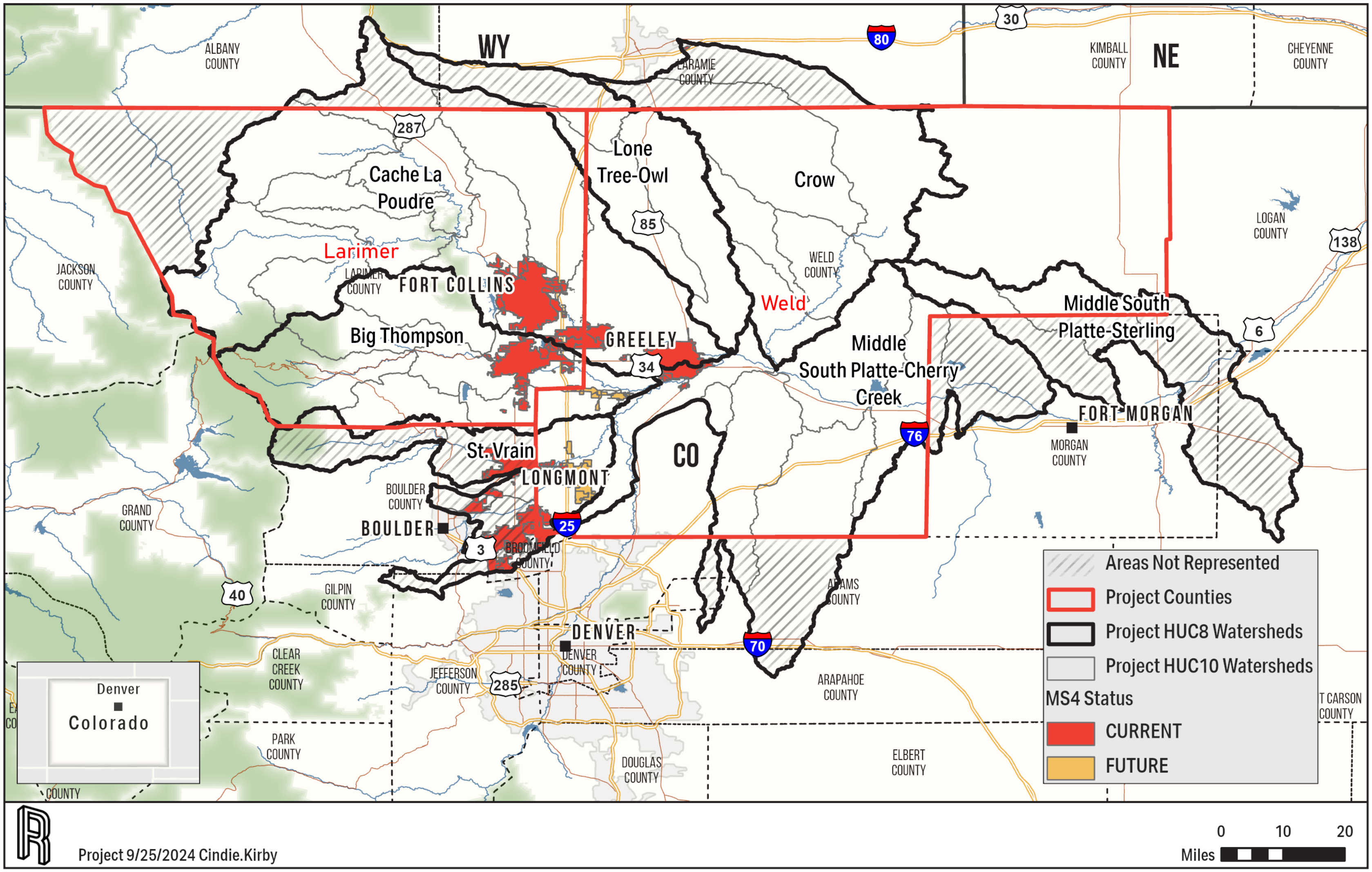


Figure 1-1. Regional Project HUC8 Watersheds and Counties.

Table 1-1. Current and Possible Future MS4s in Larimer and Weld Counties in Applicable HUC8s

MS4 Status	MS4 (Weld and Larimer Counties Only)	HUC8	County	Area (mi^2)
Current	Fort Collins	Big and Little Thompson River and Cache la Poudre River	Mostly Larimer, some Weld	137.3
Current	Greeley	Mainly Cache la Poudre River and some Middle South Platte River	Weld	43.1
Current	Lafayette—Erie--Louisville	St. Vrain Creek	Weld	6.8
Current	Longmont	St. Vrain Creek	Weld	4.0
Possible Future	Firestone/Frederick	Mainly St. Vrain Creek and some Middle South Platte River	Weld	10.1
Possible Future	Johnstown	Mainly Big and Little Thompson River and a sliver of Middle South Platte River	Mostly Weld, some Larimer	7.5

mi^2 = square miles

Developing Regional NPS Watershed Plans is an essential step in identifying priority actions that should be implemented to improve water quality. Watershed-Based Plans are required if local communities would like to compete for funding assistance administered by the NPS Program to support the implementation of best management practices (BMPs) that directly address NPS pollution. The NPS Program funding assistance is focused on voluntary, non-regulatory actions. Considering several factors is essential when evaluating where an NPS watershed plan should be developed. The nine elements of a watershed-based plan include characterization and goal-setting information to address primary NPSs of pollution in the watershed and determine management strategies needed to reduce NPS pollution to meet water quality goals. The nine elements also ensure that a specific plan of action with measurable targets and milestones is in place and identify the necessary financial and technical resources needed to restore the waterbody. For additional information about the nine elements, review the EPA's A Quick Guide to Developing Watershed Plans to Restore and Protect Our Waters online. This will aid other NPS watershed plans already created in the region. The following are EPA's nine key elements:

1. Identify the causes and sources of pollution that need to be controlled to achieve load reductions and other goals (e.g., recreational, economic, ecological) identified in the Plan.
2. Estimate load reductions expected from the Action Strategy identified.
3. Describe nonpoint source management measures, including operation/maintenance requirements, and targeted critical areas (i.e., "Action Strategy") needed to achieve identified load reductions.
4. Estimate technical and financial assistance needed, associated costs, and/ or the sources and authorities that will be relied upon to implement the watershed-based plan.
5. Develop an information and education component that will be used to enhance public understanding of the nonpoint source management measures and encourage their early and continued participation in selecting, designing, and implementing the Action Strategy.
6. Develop a project schedule.

7. Describe interim, measurable milestones.
8. Identify a set of criteria to assess progress/effectiveness in achieving water quality standards or other appropriate end targets.
9. Develop a monitoring component to evaluate the effectiveness of the implementation efforts over time and measured against the criteria established to document load reductions.

This Regional NPS Watershed Plan also provides a regional, holistic understanding of the number and types of groups working in this area of the watersheds, the types of water quality projects completed, and anticipated projects. This plan is an evolutionary step in local water planning to streamline facilitation between partners to restore impaired and degraded resources and protect high-quality resources from adverse future impacts. The following government agencies and partners participated in the development of this plan:

- Big Thompson Watershed Coalition (BTWC)
- Big Thompson Watershed Forum (dissolved); access archive information on the Big Thompson Watershed Forum Archive homepage)
- Boxelder Sanitation District
- Carestream
- City of Dacono
- City of Evans
- City of Fort Collins
- City of Greeley
- City of Longmont
- City of Loveland
- Coalition for the Poudre River Watershed (CPRW)
- Colorado Ag Water Alliance (CAWA)
- Colorado Department of Public Health and Environment (CDPHE)
- Colorado Livestock Association
- Colorado Parks & Wildlife
- Colorado Rural Water Association
- Colorado State University (CSU)
- Colorado Watershed Assembly
- Colorado Wheat Administrative Committee
- Community of Fox Acres
- Davies Mobile Home Park
- Drala Mountain Center
- Ducks Unlimited
- Estes Park Sanitation District
- Estes Valley Watershed Coalition

- FPAC-NRCS, CO
- Fox Acres Community Services
- Fresh Water Trust
- JBS Greeley Beef Plant
- Larimer County
- Left Hand Water District
- Little Thompson Watershed Coalition
- Los Rios Farm
- Northern Colorado Water Conservancy District
- Peaks to People Water Fund
- Poudre Heritage Alliance
- RNC Consulting, LLC
- St. Vrain Creek and Boulder Creek Watershed
- St. Vrain Sanitation District
- South Fort Collins Sanitation District
- South Platte Basin Roundtable
- Thompson School District
- Town of Ault
- Town of Berthoud
- Town of Eaton
- Town of Erie
- Town of Estes Park
- Town of Firestone
- Town of Frederick
- Town of Gilcrest
- Town of Johnston
- Town of Kersey
- Town of Keenesburg
- Town of La Salle
- Town of Mead
- Town of Milliken
- Town of Pierce
- Town of Severance
- Town of Timnath
- Town of Wellington

- Town of Windsor
- Trout Unlimited
- Upper Thompson Sanitation District
- Weld County
- Xcel Energy

2.0 DATA RESOURCES AND INTEGRATION

A significant amount of data was collected for this project, including spatial and temporal data. The type, description, source, and use for each dataset are shown in Table 2-1. Spatial data were primarily used to characterize potential NPSs in the watershed and generate information by 10-digit HUCs. Similarly, temporal data were used to understand water quality issues and possible sources in the HUC10s. Other data used included reductions expected from different BMPs.

Table 2-1. Data Sources and Uses (Page 1 of 2)

Type	Description	Source	Use
Spatial	Land Use	Multi-Resolution Land Characteristics Consortium [2019]	Watershed Characterization and Modeling
Spatial	Municipal Separate Storm Sewer Systems	Catena Analytics [2024]	Pollutant Load Estimation Tool (PLET) Modeling
Spatial	Hydrologic Soil Group	NRCS [2024a]	PLET Modeling
Spatial	Census Urban Areas	U.S. Census Bureau [2010, 2020]	PLET Modeling
Spatial	Onsite Wastewater Treatment System (OWTS) (Larimer County)	Larimer County [2023]	PLET Modeling and *E. coli* Production Analysis
Spatial	OWTS (Weld County)	Fischer [2023]	PLET Modeling and *E. coli* Production Analysis
Spatial	Precipitation	PRISM Climate Group [2024]	Watershed Characterization
Spatial	Geology	Horton et al. [2017]	Watershed Characterization
Spatial	Animal Units	EPA [2022]	PLET Modeling and *E. coli* Production Analysis
Spatial	303(d) Impairments	CDPHE [2024]	Impairment Summary and Maps
Spatial	Irrigation	Colorado Water Conservation Board [CWCB] and Colorado Division of Water Resources [2023]	PLET Modeling
Spatial	Wildfires	National Interagency Fire Center [2024]	Source Assessment
Spatial	Abandoned Mines	Graves [2024]	Source Assessment
Temporal	Water Quality	Bremser [2023]; Catena Analytics [2024]; Colorado Data Sharing Network [2024]; Fayram [2023], Hathaway [2023]; National Water Quality Monitoring Council [2023]; Northern Water [2024]; South Fort Collins Sanitation District [2023]	Water Quality Boxplots
Temporal	Flow	USGS [2023]	

Table 2-1. Data Sources and Uses (Page 2 of 2)

Type	Description	Source	Use
Other	Bacteria Production by Animal Type	Metcalf and Eddy, Inc. [1991]; Horsley and Witten, Inc. [1996]; Zeckoski et al. [2005]	*E. coli* Production Analysis
Other	Agricultural BMPs and Reductions	EPA [2022]; NRCS [2024b]	BMP Reduction Analysis
Other	Developed BMPs and Reductions	EPA [2022]; International Stormwater Best Management Practices Database [2023]; NRCS [2024b]	BMP Reduction Analysis
Other	Forest BMPs and Reductions	EPA [2022]; NRCS [2024b]	BMP Reduction Analysis
Other	Feedlot BMPs and Reductions	EPA [2022]; NRCS [2024b]	BMP Reduction Analysis
Other	AML BMPs	NRCS [2024c]	BMP Discussion
Other	Atmospheric Deposition	USGS [2019]	SPARROW Estimates

3.0 EXISTING WATERSHED PLANS AND OTHER RELATED PLANS

Numerous watershed plans, master plans, and other plans exist throughout the areas contributing to the South Platte River in Larimer and Weld Counties. Plans are summarized in this chapter. Areas represented in Barr Lake & Milton Reservoir Watershed Association [2017] and Wright Water Engineers [2002] were not included in this plan.

3.1 BARR LAKE AND MILTON RESERVOIR WATERSHED

Barr Lake and Milton Reservoir are two warm-water reservoirs that get their water from the upper South Platte River and its tributaries. The watershed has a variety of land and water uses that contribute to water quality issues in the reservoirs, mainly because of nutrient loading. Nutrients like nitrogen and phosphorus are carried by rivers and canals to the reservoirs, where they are stored and used by algae and other aquatic plants.

In 2002, CDPHE listed both reservoirs on the State's 303(d) list of impaired waters because their pH levels exceeded the upper limit of 9.0. This listing had a medium priority for completing a total maximum daily load (TMDL). Barr Lake & Milton Reservoir Watershed Association [2017] provides guidelines for addressing water quality problems caused by human-induced eutrophication (the aging of lakes/reservoirs because of excessive nutrient addition). The plan also outlines steps for creating an information and education program to increase stakeholder involvement and educate the public on effectively solving water quality issues.

The 2008 version of the plan is the first full iteration. Some parts of the plan are well-developed based on current understanding of watershed issues, and other parts still need to be produced.

The *Barr Lake and Milton Reservoir Watershed Plan* was first written in 2008 [Barr Lake & Milton Reservoir Watershed Association [2008] and was updated in 2017. This update covers all the accomplishments and work done from 2008 to June 2017. It is a comprehensive document that tackles the initial water quality issues, partnerships formed to address them, solutions and goals that emerged, progress made, public involvement, and future steps.

As part of the update, TMDLs and a *BMW Adaptive Implementation Plan for pH TMDL* [Barr Lake & Milton Reservoir Watershed Association, 2013] were developed. A limnocorral study was completed, and phosphorus removal was evaluated. TMDLs were created to address pH and dissolved oxygen issues in the reservoirs. Load and wasteload allocations for total phosphorus were assigned to tackle these problems, and in-lake water quality goals for total phosphorus and chlorophyll a were set. The TMDL implementation plan outlines the steps needed to meet these water quality goals. Additionally, total phosphorus removal evaluation, biomanipulation (removal of carp), and public education have been carried out in recent years [Barr Lake & Milton Reservoir Watershed Association, 2013].

The document lays out a detailed plan to enhance water quality in a specific watershed area. It pinpoints the necessary pollutant reductions and recommends BMPs to achieve these goals. The plan follows the EPA's nine element watershed-based management plan template, which serves as a guide to create a final, approvable watershed plan. Since the project began, water quality in Barr Lake and Milton

Reservoir has improved. Barr Lake shows significant decreases in chlorophyll a and total phosphorus, though clarity remains unchanged and Trophic Status Index (TSI) scores vary. Milton Reservoir shows improvements in all parameters, with decreasing total phosphorus, better clarity, and more TSI scores in the eutrophic range [Barr Lake & Milton Reservoir Watershed Association, 2017].

3.2 BIG DRY CREEK WATERSHED

The mission of the Big Dry Creek Watershed Association is to develop a solid scientific understanding of water quality, flow, aquatic life, and habitat conditions in the Big Dry Creek Watershed. This knowledge aims to support environmentally responsible decision-making regarding land and stream uses and identify measures to improve and protect stream conditions. The goals of the Watershed Association fall into three main categories: public education and involvement; monitoring and study; and protecting, preserving, and restoring water quality, aquatic life, and habitat. The watershed association is currently in the process of updating the original plan, completed in 2002 [Wright Water Engineers, 2002].

3.3 BIG THOMPSON RIVER ENVISIONING PROJECT PLAN

The *Big Thompson River Envisioning Project Plan*, completed in 2022, is a stream management planning initiative focused on the future of the watershed and the Big Thompson River system through Loveland. The project's goal was to create a shared vision for enhancing the Big Thompson River by identifying strategies and action plans that respect property and water rights, address water user needs, and improve environmental conditions and recreational opportunities. An advisory committee consisting of stakeholders, water users, and community members was involved in the project. The committee evaluated the Big Thompson River from the canyon mouth to Interstate-25, covering a 15-mile stretch [Otak, 2022].

3.4 BIG THOMPSON RIVER RESTORATION MASTER PLAN

The *Big Thompson River Restoration Master Plan* [Ayres Associates, 2015], offers high-level guidance for long-term flood recovery and watershed restoration. It evaluated the Big Thompson River from just below Olympus Dam to its confluence with the South Platte River, covering approximately 80 miles, and included main tributaries like the North Fork and Glen Haven area. This plan has been instrumental in securing more than $10 million for implementation projects.

3.5 BIG THOMPSON RIVER CORRIDOR MASTER PLAN

The City of Loveland expanded the original *Big Thompson River Restoration Master Plan* [Ayres Associates, 2015] in 2017 by adding more details on the areas of expansion within the city. This project developed a long-term vision for the Big Thompson River corridor and outlined plans for phased enhancements over time. The project aims to increase the benefits provided to the community by the river, including more open space, recreational opportunities, and natural habitats. The project also focuses on adding flood protection and improving resiliency [BTWC, 2017].

3.6 BIG THOMPSON WILDFIRE READY ACTION PLAN

The Wildfire Ready Watersheds Program offers guidance to help predict where and what post-fire impacts will affect local communities. The program provides detailed work plans, which can be customized with local priorities and values as needed. The program also offers advice on actions to reduce the impact of post-fire hazards on infrastructure and natural resources, both before and after a wildfire occurs. Currently, a Big Thompson Wildfire Ready Action Plan is being prepared and will be completed by 2025. This plan will be available on the Peaks to People Water Fund's website.

3.7 BOULDER CREEK RESTORATION MASTER PLAN

The *Boulder Creek Restoration Master Plan* aims to guide efforts to enhance resiliency along Boulder Creek, stretching from Four Mile Creek to St. Vrain Creek. The plan offers general guidance on stream restoration, addressing ecological needs and benefits, floodplain management strategies, transportation improvements at stream crossings, and planning for recreation and open space access. The plan also includes prioritization and cost estimates for these initiatives [ICON Engineering, Inc., 2015].

3.8 CACHE LA POUDRE RIVER WATERSHED-BASED PLAN

The *Cache la Poudre River Watershed-Based Plan* [CPRW, 2020] focuses on creating a framework to prioritize and implement restoration projects in two pilot sub-drainages: North Fork Lone Pine Creek (COSPCP08) in the headwaters and Sheep Draw (COSPCP13a) in the lower basin. This plan is designed to be flexible, scalable, and adaptable to other areas and concerns within the watershed as new priorities arise. The planning effort also included the development of several interactive watershed planning support tools for future planning, analysis, and implementation activities across the watershed.

Similar to the current plan, priority parameters were chosen based on impairment and stakeholder concerns, including sediment, nutrients, heavy metals, temperature, and *E. coli*. The older version of Pollutant Load Estimation Tool (PLET), Spreadsheet Tool for Estimating Pollutant Loads (STEPL), was used to quantify sources and associated loads of nutrients and sediments from cropland, pastureland, urban areas, forests, and feedlots. Additionally, GRAIP_Lite was used to evaluate sediments from roads. Because the areas represented were different, the final load and expected reductions are not comparable [CPRW, 2020].

3.9 COLORADO 10-YEAR WATER QUALITY ROADMAP

Nutrients can harm water quality and negatively impact fish and other aquatic life. The Water Quality Roadmap is a plan to keep our streams and lakes clean and healthy. It aims to reduce nutrient pollution from both direct and indirect sources. This plan will gather data and provide recommendations to support new water quality regulations. Its integrated approach ensures coordination across all aspects of the Clean Water Program, including monitoring, standards, NPS management, permits, and engineering [CDPHE, 2024a].

3.10 COLORADO WATER PLAN

The Colorado Water Plan, adopted in January 2023, aims to foster statewide collaboration in water planning, guide future decisions, and support local efforts to tackle water challenges with a balanced and solution-focused approach that builds resilience. The plan focuses on four main areas that work together to strengthen the state: Vibrant Communities, Robust Agriculture, Thriving Watersheds, and Resilient Planning. The Colorado Water Conservation Board (CWCB) developed and oversees the Colorado Water Plan framework, offering funding and technical resources to help the state's water community implement programs and projects. This initiative relies on the Colorado water community to identify and carry out basin-specific or statewide water projects that benefit the state's water users [Colorado Water Conservation Board, 2023].

3.11 HIGH PARK POST-FIRE PRIORITIZATION PLAN

After the 2012 High Park Fire in Larimer County, various agencies and groups worked on numerous projects to reduce the fire's negative impacts. However, because of differing goals and limited funding, a need for more post-fire restoration efforts might still exist. The High Park Post-Fire Prioritization Plan outlined remaining projects that were identified and prioritized them for funding and implementation [JW Associates Inc., 2017].

3.12 LEFT HAND CREEK WATERSHED MASTER PLAN

The *Left Hand Creek Watershed Master Plan* [AMEC et al., 2014] focuses on recovery efforts following the 2013 flood, aiming to restore and enhance the Left Hand Creek Watershed. The plan seeks to bolster resilience against future flooding and improve the ecological health of the area, and does the following:

- Provides detailed information on the watershed's geography, hydrology, and ecological characteristics and identifies critical areas impacted by the flood that need restoration
- Suggests various restoration methods, such as stabilizing the banks, improving habitats, and reconnecting the floodplain
- Advocates for using natural and sustainable techniques to restore the watershed
- Highlights the importance of community involvement and collaboration with local stakeholders
- Encourages public participation in restoration projects and ongoing watershed management
- Outlines a phased approach to carrying out restoration projects
- Includes detailed timelines, identifies funding sources, and specifies the responsible parties for each phase
- Outlines how to monitor the success of restoration efforts and provides guidelines for ongoing maintenance to ensure long-term effectiveness

Restoring the watershed is essential to prevent future flood damage and improve ecological health. Natural restoration methods are favored rather than engineered solutions. Community involvement is crucial for achieving sustainable watershed management. The plan concludes that a collaborative, phased approach is crucial for successful watershed restoration. Continuous monitoring and adaptive management are necessary to respond to changing conditions and ensure the longevity of restoration efforts [AMEC et al., 2014].

3.13 LOWER POUDRE WATERSHED RESILIENCE PLAN

Catastrophic flooding occurred in 2013 along Colorado's Front Range. The flooding caused extensive damage and flooding throughout Larimer and Weld Counties. In Weld County, hundreds of residents were displaced, leading the Weld County Commissioners to declare a disaster emergency. Governor Hickenlooper also declared a disaster emergency. The costly and devastating aftermath of the flood highlighted the urgent need to reduce risks along the river corridor by building a more resilient community. In the Lower Poudre River, a key part of boosting resilience involves understanding how sediment transport impacts the area. The goal of this project was to create a master plan for the river corridor and a sediment transport model following the flood. The *Lower Poudre River Flood Recovery and Resilience Plan* helps identify and prioritize future work on the lower Poudre River [Lynker Technologies, et al., 2017].

3.14 SOUTH PLATTE BASIN IMPLEMENTATION PLAN

The *South Platte Basin Implementation Plan* (BIP) [Metro Roundtable and South Platte Basin Roundtable, 2022] was created through a collaborative effort by basin stakeholders. It focuses on addressing the current and future water needs in the South Platte and Republican River Basins. The plan outlines a vision for how individuals and organizations can meet these future needs and sets goals and projects that pave the way to success. The initial South Platte BIP was completed in 2015, and this is the first update to that plan. The update includes South Platte Basin's current and future water resources. It highlights the goals, projects, and strategic vision needed to meet future water demands. The update also includes a detailed overview of the South Platte Basin's achievements, challenges, goals, and strategic vision for addressing future water needs; and legacy information, technical analyses, project data, and case studies [Metro Roundtable and South Platte Basin Roundtable, 2022].

3.15 ST. VRAIN AND LEFT HAND STREAM MANAGEMENT PLAN

The *Phase I Stream Management Plan* [St. Vrain and Left Hand Water Conservancy District, 2022] brought together stakeholders to identify projects and strategies for both St. Vrain and Left Hand Creeks. The goal was to shift the focus from flood recovery to enhancing stream health, improving environmental conditions in the river, and meeting the current and future needs of water users. The Phase I Stream Management Plan aligned with private property rights, public land and resource management plans, and the prior appropriation system. The Phase II Stream Management Plan aims to put these projects and strategies into action.

The September 2013 flood sparked a new era of collaboration and brought in hundreds of millions of dollars for stream restoration. This collaborative flood recovery effort built a stronger sense of trust and partnership among water users. Now, many are eager to shift the conversation to water management activities that can maximize the benefits of post-flood projects for environmental, recreational, agricultural, and domestic uses. The Stream Management Plan was designed to facilitate this transition. With a wide range of uses and a focused study, the Stream Management Plan balanced river health with water users' needs, identifying goals and projects to support flow management, habitat management, water quality management, and overall water management.

The St. Vrain and Left Hand Water Conservancy District is leading the Stream Management Plan effort. The District relied on various technical consultants who agreed on a two-phase approach. Phase I, completed in 2020, aimed to better understand environmental conditions and community values. The final deliverable for Phase I recommended 10 projects, including water storage, riparian revegetation, and setting environmental flow targets.

Phase II builds on the groundwork laid in Phase I by refining the potential topics and targets, selecting appropriate strategies, initiating planning actions and pilot projects, and supporting a data-driven stream management program. The objectives for Phase II include feasibility analyses of alternatives, identifying data gaps, planning logistics for implementation, and developing adaptive management plans. Six strategies are recommended to complete the Stream Management Plan and support long-term policies, financial planning, technology, and management improvements [St. Vrain and Left Hand Water Conservancy District, 2022].

3.16 ST. VRAIN BASIN WATERSHED-BASED PLAN: BOULDER CREEK, ST. VRAIN CREEK, AND TRIBUTARIES

The St. Vrain Basin Watershed-Based Plan was completed in 2015 and was funded by Colorado NPS grants. The plan focused on the western edge of the urbanized areas in the foothills eastward to Interstate 25. The primary water quality parameters addressed included nutrients, *E. coli*, and heavy metals. Aquatic life impairments were also addressed. The plan objectives were to develop a coordinated monitoring approach, improve understanding of existing water quality issues, identify steps to improve water quality, and develop a framework for implementing these measures.

3.17 ST. VRAIN WATERSHED MASTER PLAN

The St. Vrain Creek Watershed is a key natural feature in Colorado's Northern Front Range. In September 2013, a devastating flood hit the watershed, damaging infrastructure and impacting communities along the St. Vrain Creek and its tributaries. The Watershed Master Plan was developed to address the flooding and to create a science-based, community-focused stream master plan. Supported by the CWCB, the project took a holistic approach, considering the river's morphology, the importance of habitat for the ecosystem, and the needs of communities and private landowners. This included land use, flood and debris risk, and various types of in-stream recreation.

The master plan involved assessments of geomorphology, Federal Emergency Management Agency (FEMA) risk, habitat needs, and other scientific data. This information was combined with community and public input, considering land use before and after the flood. The resulting study prioritized projects that promote a resilient and healthy stream corridor, a thriving riparian zone, a vital ecosystem, and a robust economy along the riverbanks, all centered around healthy, active outdoor living [S2O, 2024].

3.18 UPPER POUDRE WATERSHED RESILIENCE PLAN

The *Upper Poudre Watershed Resilience Plan* [JW Associates Inc., 2024] examines the conditions in the Upper Poudre Watershed and suggests ways to boost its long-term resilience. By analyzing the current state of the watershed, specific areas that need attention were located and actions were prioritized to strengthen the watershed's resilience over time.

The project area for the plan covers the watersheds above the mouth of the canyon, located west of Fort Collins. This area is part of the larger Cache la Poudre Watershed (HUC 10190007), which eventually drains into the South Platte River. The Upper Poudre Watershed includes 37 smaller watersheds, spanning a total of 688,678 acres. The stakeholder group also requested including a few additional watersheds outside the Upper Poudre Watershed, whose runoff is diverted into its waters [JW Associates Inc., 2024].

4.0 REGIONAL SUMMARY OF NONPOINT SOURCE POLLUTION ISSUES AND CONCERNS

Essential to developing this Regional NPS Watershed Plan is ascertaining and collecting feedback and input from a cross section of stakeholders including cities, counties, sanitation districts, towns, watershed organizations, and others who will identify, fund, and prioritize projects to implement these practices and BMPs. As a part of this project, two surveys were sent to stakeholders. Results of the surveys are found throughout the report and in Section 4.8, Regional Stakeholder/Public Outreach and Education.

- Survey #1, in 2022, was more general and included questions related to pollutants, issues, and areas of concern.
- Survey #2, in 2024, was more specific and included questions regarding past and current planning, use of technical and financial assistance, and ideal BMPs.

Survey #1 was distributed to 96 organizations in 2022. The purpose of this survey was to better understand the stakeholders' concerns, issues, resources, and priorities. Building on the conclusions from this survey was the impetus for helping to develop a nine key elements plan.

Survey #2 was distributed to 48 organizations in March 2024 asking them to complete the following items:

- Characterize their existing watershed projects and sources of pollution
- Rank cropland, urban, pastureland, feedlot, and forest BMPs
- Identify benefits and impacts of existing BMPs
- Identify existing outreach and education efforts
- Identify technical and financial assistance needed and utilized

Table 4-1 lists the stakeholders who received each survey. Information derived from the surveys is included throughout the report, and responses are an integral part of this project.

Table 4-1. Stakeholder Survey Distribution (Page 1 of 3)

Organization	Took Survey #1 (2022)	Took Survey #2 (2024)
BTWC		
Boxelder Sanitation District	X	
Carestream		
CDPHE		
City & County of Broomfield	X	
City of Brighton		
City of Evans	X	X
City of Fort Collins		X
City of Fort Lupton	X	X
City of Greeley	X	X
City of Longmont	X	
City of Loveland	X	X
City of Northglenn		X
CPRW		
CAWA		
Colorado Livestock Association		
Colorado Parks & Wildlife		
Colorado Rural Water Association	X	
CSU	X	
Colorado Watershed Assembly		X
Colorado Wheat Administrative Committee		X
Davies Mobile Home Park		X
Drala Mountain Center	X	
Ducks Unlimited		
Estes Park Sanitation District	X	
Estes Valley Watershed Coalition	X	X
Fox Acres Community Services	X	
FPAC-NRCS, CO		
Fresh Water Trust	X	

Table 4-1. Stakeholder Survey Distribution (Page 2 of 3)

Organization	Took Survey #1 (2022)	Took Survey #2 (2024)
Galeton Water & Sanitation District	X	
JBS Greeley Beef Plant		X
Larimer County		X
Left Hand Water District	X	
Little Thompson Watershed Coalition		
Los Rios Farm		X
Metro Water Recovery	X	
Northern Colorado Water Conservancy District	X	X
Peaks to People Water Fund		X
Poudre Heritage Alliance		
Resource Colorado Water & Sanitation Metro District		
RNC Consulting LLC		X
South Fort Collins Sanitation District	X	X
South Platte Basin Roundtable		
St. Vrain Creek & Boulder Creek Watershed		
St. Vrain Sanitation District	X	
Thompson School District		X
Town of Ault	X	
Town of Berthoud	X	X
Town of Eaton		
Town of Erie	X	
Town of Estes Park		
Town of Firestone		
Town of Frederick		
Town of Hudson	X	
Town of Johnston	X	
Town of Keenesburg		
Town of LaSalle		

Table 4-1. Stakeholder Survey Distribution (Page 3 of 3)

Organization	Took Survey #1 (2022)	Took Survey #2 (2024)
Town of Lochbuie	X	
Town of Mead	X	
Town of Milliken		
Town of Pierce	X	
Town of Platteville		X
Town of Severance	X	
Town of Timnath		
Town of Wellington		X
Town of Windsor	X	
Trout Unlimited		
Upper Thompson Sanitation District	X	
Water Quality Trading in the Cache la Poudre w/ Fort Collins		
Weld County Department of Public Health and Environment	X	
Weld County	X	
Wright Water Engineers/Cherry Creek Basin Water Quality Authority		X
Xcel Energy		X

4.1 POLLUTANTS OF CONCERN

Pollutants of concern were identified using the stakeholder surveys along with the 2024 303(d) list [CDPHE, 2024b] of impairments. Pollutants of concern are listed in Table 4-2. Per- and polyfluoroalkyl substances (PFAS) and emerging contaminants are stakeholder concerns but are not included in this document. Emerging contaminants are the different types of chemicals (e.g., medication, personal care products, home cleaning products, lawn care products, and agricultural products, such as insecticides and herbicides) that end up in waterbodies but are not generally treated in wastewater facilities. Some emerging contaminants are treated by drinking water and/or wastewater facilities, but these chemicals are not well regulated or understood. A new EPA limit for PFAS of 4 parts per trillion was released in 2024 [EPA, 2024].

Table 4-2. Pollutants of Concern and Source

Parameter Type	Parameter	Stakeholder Concern	Big and Little Thompson River 303(d) List	Cache la Poudre River 303(d) List	St. Vrain Creek 303(d) List	Middle South Platte River 303(d) List
Nutrient/Sediment-Related	Ammonia (TMDL)	Y			Y	
Nutrient/Sediment-Related	Nitrate	Y	Y			Y
Nutrient/Sediment-Related	Nitrogen (T)	Y				
Nutrient/Sediment-Related	Phosphorus (T)	Y				
Nutrient/Sediment-Related	Dissolved Oxygen		Y			
Nutrient/Sediment-Related	Sediment (TMDL)	Y		Y		
Other	*E. coli*	Y	Y	Y	Y	Y
Other	Macroinvertebrates		Y	Y	Y	
Other	pH		Y		Y	Y
Other	Temperature	Y	Y	Y	Y	
Other	Sulfate					Y
Heavy Metals	Arsenic (T)	Y	Y	Y	Y	Y
Heavy Metals	Cadmium (D)	Y				Y
Heavy Metals	Copper (D)	Y	Y			
Heavy Metals	Fish Mercury	Y	Y			
Heavy Metals	Iron (T)	Y	Y	Y		
Heavy Metals	Manganese (D)	Y	Y	Y	Y	
Heavy Metals	Mercury (T)	Y	Y			
Heavy Metals	Selenium (D)	Y	Y	Y	Y	
Heavy Metals	Silver (D)	Y		Y		
Heavy Metals	Uranium (T)	Y				Y
Heavy Metals	Zinc (D)	Y	Y		Y	

D = dissolved

T = total

4.2 SOURCES ASSESSMENT

Only NPS pollutants are addressed for this project. Point sources and areas with MS4s are addressed in the *208 Areawide Water Quality Management Plan – 208 AWQMP Update (Region 2)* [NFRWQPA, 2022]. Outside of MS4 permitted areas, NPSs of nutrients are generally related to runoff from cropland, pastureland, developed land, and other lands. Sometimes sources are from natural causes. Natural causes are the physical, chemical, or biological conditions that would exist in a waterbody in the absence of measurable impacts from human activity or influence. In general, areas with higher agricultural (cropland, pastures, and feedlots) and developed land have higher loads. The land use throughout the project is shown in Figure 4-1, and primary land uses in each project area are included in Table 4-3.

Each Watershed-Based Plan summarizes sources of pollutants of concern. For nutrients and sediment, EPA's PLET was used to estimate source loads by HUC10. For *E. coli*, a GIS assessment was used to estimate source loads by HUC10. Finally, for heavy metals, literature was used to link the most likely sources to each pollutant. These include runoff from Pierre Shale from flood irrigation, abandoned mine lands (AMLs), use of herbicides, and manufacturing.

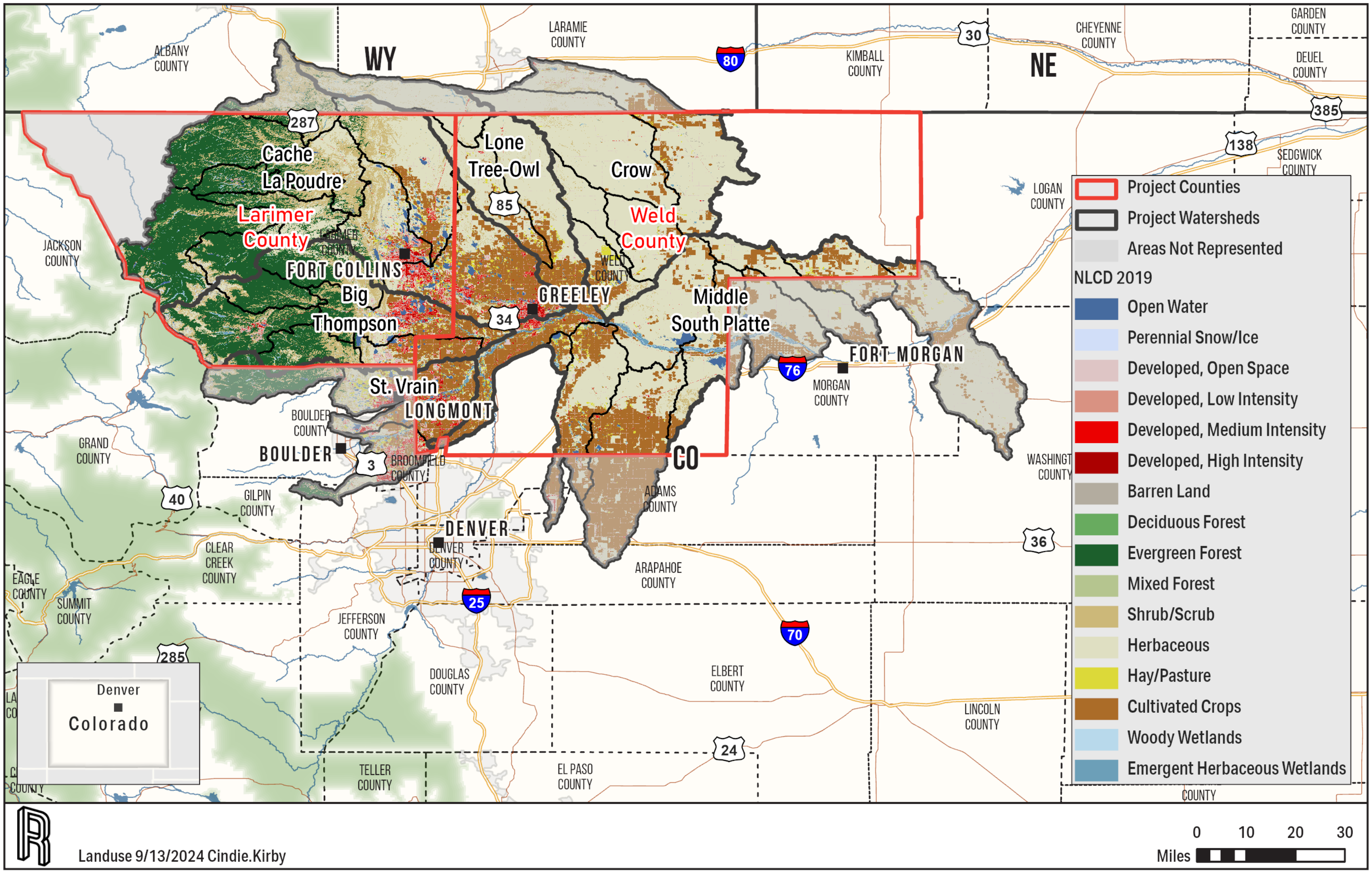


Figure 4-1. Land Use.

Table 4-3. Land Use for Each Project Area

Project	Urban Non-MS4 (mi^2)	Cropland (mi^2)	Pastureland (mi^2)	Forest (mi^2)	Feedlots (mi^2)	Other (mi^2)
Big and Little Thompson River	44	90	9	499	<1	108
Cache la Poudre River	59	195	24	886	<1	452
Middle South Platte River	64	554	45	38	<1	1,649
St. Vrain Creek	24	76	5	14	<1	18

4.2.1 NUTRIENTS AND SEDIMENT

Sources of nutrients and sediment are summarized in more detail (at the HUC10 level) in the Watershed-Based Plans included in Appendices A through D. In general, an increased presence of agricultural and developed lands leads to higher nutrient and sediment loads per acre. NPSs of sediment consist of sediment contributions through wash off, as well as bed and bank erosion during high flows. Similarly, NPSs of nutrients are generally from wash off. To show the impacts on a regional scale, loads were summarized per acre by each project area. By project area, the St. Vrain Creek Watershed had the highest per acre loads of nitrogen, phosphorus, and sediment. This is likely because as a whole, cropland is the dominant land use. Big and Little Thompson River Watershed is second for per-acre nitrogen loads but third for phosphorus and sediment loads, and Middle South Platte River Watershed is second for phosphorus and sediment loads and third for nitrogen. The Cache la Poudre River Watershed has the lowest overall per-acre loads of nitrogen, phosphorus, and sediment. Nutrient and sediment loads per acre by project area are shown in Table 4-4.

Table 4-4. Nutrient and Sediment Rank by Project Area Loads per Acre From PLET

Major Watershed	Area (mi^2)	% Agricultural	% Non-MS4 Developed	Nitrogen (lb/acre)	Phosphorus (lb/acre)	Sediment (lb/acre)	Nitrogen Source Rank	Phosphorus Source Rank	Sediment Source Rank
Big and Little Thompson River	750	13	6	0.44	0.11	0.02	2	3	3
Cache la Poudre River	1,615	14	4	0.33	0.09	0.02	4	4	4
Middle South Platte River	2,350	26	3	0.38	0.15	0.12	3	2	2
St. Vrain Creek	137	59	17	2.24	0.69	0.42	1	1	1

lb/acre = pounds per acre

A less obvious contributor of nutrients and sediment to waterbodies is wildland fires. Wildland fires significantly reduce well-established root systems in areas impacted and, as a result, soil erosion is much more likely during precipitation events, carrying nutrients with it. Wildfires in each project area are shown in Table 4-5. No significant fires occurred in the St. Vrain Creek project area during the years reported in Table 4-5.

The U.S. Geological Survey (USGS) has SPAtially Referenced Regression on Watershed Attributes (SPARROW) models that were developed by HUC8 for phosphorus, sediment, and nitrogen. Results are shown in Table 4-6 and, in general, show that phosphorus is primarily from natural sources and cropland, nitrogen is primarily from wastewater and natural sources, and sediment is generally from cropland and channels. Although SPARROW models are older, they do include wastewater so they provide a useful comparison of point versus NPS loads. More information about SPARROW models is available on the USGS SPARROW modeling webpage.

Table 4-5. Wildfires Acres by Project Area

Year	Big and Little Thompson River	Cache la Poudre River	Middle South Platte River
2000	16.9	0.1	0.0
2001	0.0	0.0	2.1
2002	7.1	1.1	0.0
2003	0.1	0.0	0.0
2004	0.2	14.2	0.0
2005	0.1	0.1	0.0
2006	0.4	0.0	0.0
2008	1.0	0.0	0.0
2009	0.1	0.1	1.1
2010	3.8	0.0	1.1
2011	4.6	0.0	1.6
2012	24.6	88.4	0.7
2013	0.0	0.0	0.1
2014	0.0	0.0	0.0
2015	0.0	0.0	1.6
2016	0.6	0.5	2.8
2017	0.0	0.0	1.6
2018	0.0	0.4	0.2
2019	0.0	0.2	1.7
2020	109.6	215.3	0.8
2021	0.2	0.1	0.1
Total	169.4	320.4	15.4

Table 4-6. SPARROW Sources of Nutrients and Sediment [USGS, 2012]

Parameter	SPARROW Sources	St. Vrain Creek	Big and Little Thompson River	Cache la Poudre River	Middle South Platte River
Phosphorus	Wastewater	9%	14%	5%	17%
Phosphorus	Urban	12%	7%	7%	12%
Phosphorus	Cropland	18%	18%	25%	40%
Phosphorus	Natural	61%	61%	63%	31%
Nitrogen	Wastewater	63%	41%	54%	76%
Nitrogen	Urban	2%	2%	1%	1%
Nitrogen	Crops	7%	14%	12%	12%
Nitrogen	Atmospheric Deposition	28%	44%	33%	11%
Sediment	Urban	12%	7%	12%	15%
Sediment	Cropland	18%	25%	24%	45%
Sediment	Natural	5%	3%	4%	17%
Sediment	Other Geology	4%	10%	11%	0%
Sediment	Channel	62%	56%	49%	23%

4.2.2 E. COLI

Production of *E. coli* is summarized in more detail (at the HUC10 level) in the Watershed-Based Plans included in Appendices A through D. Agricultural lands include crops, pastures, and feedlots. Flood irrigation on agricultural lands can increase nutrient loads. Nutrients and sediment also can increase significantly in areas where wildfires occur because of diminished root systems to hold soils in place.

In general, *E. coli* is higher when *E. coli* production is higher. Some other factors impact how much of the produced *E. coli* gets to a waterway. Some of these factors include ground cover, stream buffers, and water retention. Flood irrigation gives an additional mechanism to move *E. coli* to waterways, especially when manure is used as the primary nutrient on a field. To show contributions by a regional scale, loads were summarized per acre by each project area. By project area, the Middle South Platte River has the highest *E. coli* production per acre, followed by St. Vrain Creek, then Cache la Poudre River, then Big and Little Thompson River. *E. coli* loads/acre by project area are shown in Table 4-7.

Table 4-7. *E. coli* Rank by Project Area Loads per Acre

Major Watershed	Area (mi^2)	% Agricultural	% Non-MS4 Developed	*E. coli* (billion organisms/acre)	*E. coli* Source Rank
Big and Little Thompson River	750	13	6	1.7	4
Cache la Poudre River	1,615	14	4	2.2	3
Middle South Platte River	2,350	26	3	4.8	1
St. Vrain Creek	137	59	17	3.7	2

4.2.3 HEAVY METALS

Primary sources of heavy metals include AMLs, industrial practices, and flood irrigation on soils where metals are naturally occurring. On AMLs, precipitation exposure to rocks containing sulfide minerals becomes acidic, and acidic waters are more capable of carrying heavy metals. Table 4-8 shows the density of AMLs in each project area within Larimer and Weld Counties (outside of MS4s), and Table 4-9 shows the acres of flood and sprinkler irrigation within Larimer and Weld Counties (outside of MS4s). Both of these items contribute to NPSs of heavy metals.

Table 4-8. Abandoned Mine Land Density by Project Area

Major Watershed	AML Density (#/mi^2)	AML Density Rank
Big and Little Thompson River	0.02	3
Cache la Poudre River	0.07	2
Middle South Platte River	0.002	4
St. Vrain Creek	18.5	1

Table 4-9. Flood Irrigation Acres by HUC8

Major Watershed	Area (mi^2)	Flood Irrigation (mi^2)	% Area With Flood Irrigation	Sprinkler Irrigation (mi^2)	% Area With Sprinkler Irrigation
Big and Little Thompson River	750	41.1	5.5	26.2	3.5
Cache la Poudre River	1,615	74.0	4.6	75.1	4.7
Middle South Platte River	2,350	73.4	3.1	165.6	7.0
St. Vrain Creek	137	31.2	22.8	11.7	8.5

4.3 REGIONAL WATER QUALITY GOALS

The primary goal for water quality throughout the project area is to meet the standards set forth by the CDPHE. Standards are set based on beneficial uses of each waterbody. For more information on these standards and tiers, visit the CDPHE's Water Quality Control Commission's 5 Codes of Colorado Regulation (CCR) 1002-31 website, last updated June 14, 2023. Access the CDPHE's Water Quality Control Commission Regulation No. 38 website, last updated April 30, 2024, for information on classifications and numeric standards for South Platte River Basin, Laramie River Basin, Republican River Basin, and Smoky Hill River Basin (5 CCR 1002-38). Another water quality goal is to avoid degradation beyond the current status. Current loads and load reduction goals for nitrogen, phosphorus, *E. coli*, and sediment are provided in each Watershed-Based Plan. A figure of flow monitoring and a figure of water quality monitoring stations throughout the applicable watersheds is included in Appendix E. Water quality data, flow data, and locations of collection sites will be available for download on the NFRWQPA website. BMPs outlined in this Regional NPS Watershed Plan will help make progress toward meeting these water quality goals.

4.4 REGIONAL ACTION STRATEGIES

This section outlines the best action strategies for different land use types on a regional basis. Overall, the westerly watersheds transitioned from forested areas in the west to agricultural and developed areas in the east, and the Middle South Platte has more agricultural and other land.

4.4.1 FAST GROWTH/FUTURE MS4 AREAS

Two towns were designated as expected new MS4 areas for this project: Johnstown (7.5 mi^2) and the Firestone/Frederick Area (10.1 mi^2). Johnstown is mainly in the Big and Little Thompson River project area with a small sliver in the Middle South Platte River project area, and Firestone/Frederick is mainly in the St. Vrain Creek project area with a small area in the Middle South Platte River project area. To determine which areas were the most likely to be MS4 permitted, the current population and growth rate were examined. In 2020, Johnstown had a population of 14,329 with a growth rate of 3.9 percent per year, Firestone had a population of 16,372 with a growth rate of 4.2 percent per year, and Frederick had a population of 14,530 with a growth rate of 6.7 per year [U.S. Census Bureau, 2020]. In general, to be MS4 permitted in Colorado, a city needs to be classified as an urban area with a population of 50,000 or more (exceptions do exist) [EPA, 2023].

Existing MS4s are not discussed in the Watershed-Based Plans; however, the areas expected to become MS4s should be proactive by using development practices that will minimally impact water quality to ease the burden when they reach the MS4 requirements. If the areas expected to become MS4s plan accordingly and more implementation is completed up front, less effort will be needed to retrofit BMPs after the area becomes a designated MS4. Low Impact Development (LID) is an approach to stormwater management that mimics a site's natural hydrology while the landscape is developed and preserves and protects environmentally sensitive site features, such as riparian buffers, wetlands, steep slopes, valuable (mature) trees, floodplains, woodlands, and highly permeable soils. Minimal Impact Design Standards (MIDS) is a new concept being used in the state of Minnesota, which emphasizes keeping a raindrop where it falls to minimize stormwater runoff and pollution and preserve natural resources. Because Minnesota has been successful in implementing water quality practices using MIDS, developing communities in the North Front Range Association watersheds would likely also benefit from evaluation of the following four main elements of MIDS [Minnesota Pollution Control Agency, 2024]:

- Stormwater volume performance goals for new development, redevelopment, and linear projects
- New credit calculations that standardize the use of a range of structural stormwater techniques
- Design specifications for a variety of green infrastructure BMPs
- An ordinance guidance package to help developers and communities implement MIDS

4.4.2 DEVELOPED

Although all developed areas are not expected to become permitted MS4 areas, implementing LID and MIDS as development occurs anywhere is a good practice. This will minimize water quality impacts as these areas expand. MS4 areas are not represented in the project models. BMPs recommended for MS4 and non-MS4 developed areas are like those outlined for the fast growth/future MS4 areas. For nutrients and sediment, priority developed practices from PLET should be those with the highest rankings and reduction scores (i.e., extended wet detention, infiltration basins, and concrete gird pavement). For *E. coli*, priority developed practices should be those resulting in the largest reductions within the International BMP Database (i.e., wetland basin and retention pond). For heavy metals, priority developed practices should also be practices that resulted in the largest reductions of heavy metals in the International BMP Database (depending on pollutants of concern in downstream waterbodies). Practices do not need to be limited to these recommendations, and any practice resulting in reductions of pollutants of concern can be considered.

4.4.3 AGRICULTURAL (CROPLAND, PASTURELAND, FEEDLOTS)

For nutrients and sediment, priority agricultural practices from PLET should be those with the highest rankings and reduction scores (i.e., streambank stabilization and fencing and 35-foot grass buffers for cropland, 35-foot grass buffers and livestock exclusion fencing for pasture, and waste management systems for feedlots). For *E. coli* and heavy metals, priority agricultural practices should be the most effective agricultural BMPs from the Colorado Natural Resources Conservation Service (NRCS) Conservation Practice Physical Effects (CPPE) for reducing *E. coli*. For *E. coli*, these include vegetated treatment areas, constructed wetlands, filter strips, nutrient management, and waste treatment lagoons. For heavy metals, these include secondary containment facilities, constructed wetlands, irrigation and drainage tailwater recovery, and land reclamation. Additionally, practices that switch from flood irrigation to more efficient irrigation methods would be beneficial in reducing both *E. coli* and heavy metals such as selenium and arsenic. Although these practices are the most effective, BMPs do not need to be limited to these recommendations.

4.4.4 FORESTED AREAS

Forested areas typically have a low negative impact on water quality because of the natural cover; however, wildfires and anthropogenic activities such as mining, grazing, and recreation can increase the chance of negative impacts on water quality. Though forest land is less likely to contribute sediment, nutrients, and bacteria per acre of contributing area, BMPs are still beneficial, especially when considering historical fires, fire potential, abandoned mines, recreation, and grazing activities. For nutrients and sediment, priority forest practices from PLET should be those with the highest ranking and reduction scores (i.e., a combination of site preparation/straw/crimp seed/net/fertilizer/transplants). For *E. coli*, priority forest practices should include those listed in the NRCS CPPE that exclude forest-grazing livestock from accessing streams and septic assessments. Forest practices should also focus on pre- and post-fire activities. One watershed in the project area—the Big and Little Thompson River—is in the process of developing the Big Thompson Wildfire Ready Action Plan, which will be completed in 2025 and will be available on the Peaks to People Water Fund's website. Practices from this plan can be implemented in other watersheds in at-risk areas for wildfire.

Additionally, AMLs tend to be more heavily located in forest lands. Most AMLs in the watershed have not yet been identified because several are located on private land or in very remote locations. The primary practice completed on identified AMLs is to seal off dangerous openings, identify hazards, and implement safety measures to protect the public and the environment. To improve water quality, identifying AMLs should become a higher priority. AML BMPs are not prioritized because of the variable nature of AML lands; however, each site should be assessed and practices that target specific issues related to each site should be chosen. For heavy metals, priority practices should focus on AMLs. AML practices should include those listed in the NRCS Conservation Practice Standard [NRCS, 2024c] including erosion and sediment control practices, site preparation, storage of soil materials, highwall treatment, shafts and adits, placement of surface material, restoration of borrow material, establishment of vegetation, control of toxic aqueous discharge, and working with contaminated soil materials.

4.4.5 REMAINING AREAS

Some lands in the project area were classified as "Other." In general, the other lands include those land types that generally are natural in nature and have a smaller relative impact on water quality. These include wetlands and grasslands. This plan does not list practices for these remaining "Other" areas.

4.5 REGIONAL LOAD REDUCTION ESTIMATES BASED ON ACTION STRATEGIES

In general, land managers are more likely to implement practices that have been proven to work in the area and those that give them the highest chance of impact. In the state of Colorado, BMPs on pastureland have been the most implemented, with prescribed grazing, upland wildlife habitat management, watering facilities, livestock pipeline, fence, and access control leading the way. According to the United States Department of Agriculture (USDA), the most implemented cropland BMPs in Colorado are conservation crop rotation, pest management conservation systems, conservation cover, and nutrient management [USDA, 2024].

According to Survey #2, practices that have been implemented on cropland and pasture include filter strips, vegetation planting, vegetated buffer strips, streambank stabilization, wetland protection, wetland construction, fencing/livestock exclusion, conservation tillage, no-till practices, and crop rotation. Similarly, Survey #2 identified that in developed areas, regional stormwater detention and water quality facilities, extended detention basins, bioretention practices, hydrodynamic separators, inlet filters, sand filters, grass swales, constructed wetlands, rain gardens, manufactured treatment devices, bioswales, bank stabilization, riparian vegetation restoration, native plant installation, pollution prevention programs, spill response, and public education.

The stakeholder survey combined with expected reductions from PLET were combined to determine what the priority BMPs should be. The PLET model was used to estimate load reductions from priority BMPs for sediment and nutrients. The scenarios were run individually for each HUC10 by land use on 25 percent of each specific land use. Table 4-10 shows the overall reductions by project area to give a more regional view. Cropland BMPs had the highest overall reductions for each project area. HUC10 results are included in the Watershed-Based Plans in Appendices A through D.

Table 4-10. PLET Best Management Practice Reductions by Land Use, Practice, and Project Area for Nitrogen, Phosphorus, and Suspended Sediment (Page 1 of 2)

Land Use	Practice	Project Area	% Nitrogen Reduction	% Phosphorus Reduction	% Sediment Reduction
Cropland	Streambank Stabilization and Fencing	Big and Little Thompson River	9.5	9.1	14.6
Cropland	Streambank Stabilization and Fencing	Cache la Poudre River	8.3	7.7	14.4
Cropland	Streambank Stabilization and Fencing	St. Vrain Creek	14.9	16.2	17.9
Cropland	Streambank Stabilization and Fencing	Middle South Platte River	17.6	17.6	17.7
Cropland	35-ft Buffers	Big and Little Thompson River	4.9	5.7	10.4
Cropland	35-ft Buffers	Cache la Poudre River	4.4	4.9	10.2
Cropland	35-ft Buffers	St. Vrain Creek	9.5	11.2	12.6
Cropland	35-ft Buffers	Middle South Platte River	12.4	12.4	12.5
Pasture	Streambank Stabilization and Fencing	Big and Little Thompson River	0.6	0.2	0.3
Pasture	Streambank Stabilization and Fencing	Cache la Poudre River	0.8	0.3	0.4
Pasture	Streambank Stabilization and Fencing	St. Vrain Creek	0.5	0.4	0.4
Pasture	Streambank Stabilization and Fencing	Middle South Platte River	0.3	0.3	0.3
Pasture	35-ft Buffers	Big and Little Thompson River	3.6	2.0	2.5
Pasture	35-ft Buffers	Cache la Poudre River	0.9	0.3	0.3
Pasture	35-ft Buffers	St. Vrain Creek	0.5	0.4	0.4
Pasture	35-ft Buffers	Middle South Platte River	0.2	0.2	0.2
Pasture	Livestock Exclusion	Big and Little Thompson River	0.2	0.2	0.2
Pasture	Livestock Exclusion	Cache la Poudre River	0.2	0.2	0.3
Pasture	Livestock Exclusion	St. Vrain Creek	0.3	0.3	0.4
Pasture	Livestock Exclusion	Middle South Platte River	0.2	0.2	0.2
Feedlot	Waste Management System	Big and Little Thompson River	1.4	1.3	0.0
Feedlot	Waste Management System	Cache la Poudre River	3.1	2.6	0.0
Feedlot	Waste Management System	St. Vrain Creek	0.7	0.5	0.0
Feedlot	Waste Management System	Middle South Platte River	0.0	0.0	0.0

Table 4-10. PLET Best Management Practice Reductions by Land Use, Practice, and Project Area for Nitrogen, Phosphorus, and Suspended Sediment (Page 2 of 2)

Land Use	Practice	Project Area	% Nitrogen Reduction	% Phosphorus Reduction	% Sediment Reduction
Forest	Site Preparation/Straw/Crimp/Net	Big and Little Thompson River	0.2	0.3	1.2
Forest	Site Preparation/Straw/Crimp/Net	Cache la Poudre River	0.2	0.3	1.2
Forest	Site Preparation/Straw/Crimp/Net	St. Vrain Creek	0.1	0.1	0.1
Forest	Site Preparation/Straw/Crimp/Net	Middle South Platte River	0.0	0.0	0.0
Forest	Site Preparation/Straw/Crimp Seed/ Fertilizer/Transplant	Big and Little Thompson River	0.2	0.3	1.2
Forest	Site Preparation/Straw/Crimp Seed/ Fertilizer/Transplant	Cache la Poudre River	0.2	0.3	1.2
Forest	Site Preparation/Straw/Crimp Seed/ Fertilizer/Transplant	St. Vrain Creek	0.1	0.1	0.1
Forest	Site Preparation/Straw/Crimp Seed/ Fertilizer/Transplant	Middle South Platte River	0.0	0.0	0.0
Urban	Extended Wet Detention	Big and Little Thompson River	1.7	1.3	2.1
Urban	Extended Wet Detention	Cache la Poudre River	1.2	0.8	1.4
Urban	Extended Wet Detention	St. Vrain Creek	0.6	0.3	0.2
Urban	Extended Wet Detention	Middle South Platte	0.0	0.0	0.0
Urban	Infiltration Basin	Big and Little Thompson River	1.9	1.2	1.9
Urban	Infiltration Basin	Cache la Poudre River	1.3	0.8	1.2
Urban	Infiltration Basin	St. Vrain Creek	0.6	0.3	0.2
Urban	Infiltration Basin	Middle South Platte River	0.0	0.0	0.0
Urban	Concrete Grid Pavement	Big and Little Thompson River	2.8	1.7	2.2
Urban	Concrete Grid Pavement	Cache la Poudre River	1.3	0.8	1.2
Urban	Concrete Grid Pavement	St. Vrain Creek	0.9	0.4	0.2
Urban	Concrete Grid Pavement	Middle South Platte River	0.0	0.0	0.0

4.6 REGIONAL MANAGEMENT MEASURES

Each Watershed-Based Plan includes a final list of the most effective practices for the applicable land uses. Table 4-11 lists the priority practices for sediment and nutrients, *E. coli*, and heavy metals in each HUC8 area. These priority practices were based on the top two dominant land uses, sediment sources, nitrogen sources, and phosphorus sources by HUC10 and, therefore, most show up as priorities for all project areas because of the variation within each HUC8. More information about these priority practices is available in the Watershed-Based Plans in Appendices A through D.

Table 4-11. Priority Management Measures for Project Areas

Parameter Group	Land Use	Practice	Big and Little Thompson River	Cache la Poudre River	St. Vrain Creek	Middle South Platte River
Sediment and Nutrients	Forest	Site Preparation/ Straw/Crimp Seed/Net	Y	Y	Y	Y
Sediment and Nutrients	Forest	Site Preparation/ Straw/Crimp Seed/ Fertilizer/Transplants	Y	Y	Y	Y
Sediment and Nutrients	Urban	Extended Wet Detention	Y	Y	Y	Y
Sediment and Nutrients	Urban	Infiltration Basin	Y	Y	Y	Y
Sediment and Nutrients	Agricultural	Streambank Stabilization and Fencing	Y	Y	Y	Y
Sediment and Nutrients	Agricultural	Buffer-Grass (35 feet wide)	Y	Y	Y	Y
Sediment and Nutrients	Agricultural	Waste Management System		Y		
E. coli	Urban	Septic Upgrades	Y	Y	Y	Y
E. coli	Urban	Wastewater Treatment Facility Connections	Y	Y	Y	Y
E. coli	Urban	Wetland Basin	Y	Y	Y	Y
E. coli	Urban	Retention Pond	Y	Y	Y	Y
E. coli	Agricultural	Vegetated Treatment Area	Y	Y	Y	Y
E. coli	Agricultural	Constructed Wetlands	Y	Y	Y	Y
Heavy Metals	Urban	Discontinue Use	Y	Y		Y
Heavy Metals	Agricultural	Irrigation Water Management	Y	Y	Y	Y
Heavy Metals	Abandoned Mine Lands	Abandoned Mine Land BMPs	Y	Y	Y	Y

4.7 REGIONAL FINANCIAL/TECHNICAL PLAN IMPLEMENTATION STRATEGY

The Watershed-Based Plans list opportunities that can be used to plan and fund water quality improvement projects. Numerous private companies and organizations as well as local, state, and federal agencies provide technical assistance to address NPS pollution. Some of these organizations and agencies also provide financial assistance. Tables 4-12 through 4-14 list the local, state, federal, and private agencies and organizations with technical and financial programs that may assist with conservation and water quality implementation projects and what type of technical or financial assistance they offer (based on the land use of interest) as denoted by Xs. The following sections describe the information regarding incentive programs and funding to implement NPS projects identified in this plan. Funding includes but is not limited to the Colorado NPS Program and its annual grants, the South Platte Basin Roundtable grants, and the CAWA programs. The NPS Program funds support staffing costs and programmatic priorities including the Mini Grant Program, the NPS Watershed Planning and Tool Development Program, and the NPS Program's Success Story Initiative.

4.7.1 INCENTIVE PROGRAMS

Incentive programs are formal programs used to promote specific actions or behaviors. Participation in incentive programs is voluntary. Various mechanisms can be used to conduct incentive programs, including financial assistance or providing benefits for enrolling in programs. The following programs are relatively easy for users to take advantage of, and the money for them is generally allocated annually.

4.7.1.1 COST-SHARE PROGRAMS

In a cost-share program, the costs of systems or practices for water quality improvements are shared between the landowner, state (percentage), or federal programs (flat rate). State-funded nonstructural land management cost sharing is also typically based on a flat rate. Landowners seeking cost-share assistance should contact their county conservation district office to get information on available programs. The BMPs and conservation practices that are typically eligible are those that avoid, control, and trap nutrients, sediment, and *E. coli* from entering surface water and groundwater. Eligibility may vary depending on local priorities and needs.

4.7.1.2 FEE DISCOUNTS

Local governments or nonprofit entities may offer reduced fees for implementing projects and practices that align with program goals. For instance, stormwater fees could be reduced if a landowner voluntarily converts cropped acres to a permanent vegetative cover.

4.7.1.3 LOW-INTEREST LOANS

Low-interest loans may be available through various state agencies to landowners for agricultural BMPs, septic system updates/replacement, or other projects that meet funding eligibility criteria.

4.7.1.4 WATER QUALITY TRADING

Point source permittees should be mindful that options are available to use money available for upstream NPS implementation to improve water quality for a smaller potential cost. These options need to be further evaluated and quantified.

4.7.2 POTENTIAL FUNDING

Funding is available from private, local, county, state, and federal sources to implement projects for improving water quality. The following sections discuss these sources. Other funding sources not noted here may be available. The state of Colorado maintains a Grants Information page on its website.

4.7.2.1 CITIES

Municipalities often collect stormwater utility fees to build, repair, operate, and maintain stormwater management systems. Such fees should be set using reasonable calculations based on runoff volume or pollution quantities, property classifications, or both.

4.7.2.2 COUNTIES, WATERSHED DISTRICTS, AND AUTHORITIES

In other areas of Colorado, authorities have been developed, such as the Cherry Creek Basin Water Quality Authority and the Chatfield Watershed Authority. These authorities can levy funds for priority projects and assist with program implementation. The NFRWQPA and other 208 planning agencies cannot levy funds or taxes for projects, but they have voluntary fees and dues that contribute to planning and implementation. Recently, the Chatfield Watershed Authority also added an entrance fee to the Chatfield State Park to assist with protecting water quality.

4.7.2.3 STATE

The State of Colorado funds watershed management programs through various capacities, programs, and agencies.

The CDPHE has numerous NPS funding opportunities, which include watershed implementation projects (restoration and protection), watershed planning and tool development, and education and outreach. The primary CDPHE opportunities consist of the Source Water Assessment and Protection (SWAP) program; the Water Quality Grants and Loans Unit; CSU's Colorado Wetland Information Center; CSU's Colorado State Forest Service; the Colorado Department of Natural Resources' (DNR) CWCB; Colorado Water Plan Grants; and Colorado Watershed Restoration Grants. More information regarding each program is provided by CDPHE [2022]. Funds from the Water Supply Reserve Fund (WSRF) are issued through the South Platte Basin Roundtable. CDPHE has a state revolving fund that includes a Water Pollution Control revolving fund that completes many Onsite Wastewater Treatment System (OWTS) to sewer projects.

Under the Colorado DNR, the CWCB also administers the Federal Technical Assistance Grant Program, consisting of Local Capacity Grants and Technical Assistance Grants. Federal American Rescue Plan Act funding of $5 million is available for these two grants in Colorado. The grantee must provide a minimum of 25 percent matching funds. Grants will be awarded on a rolling basis through December 2024; grant funds must be fully expended by December 2026. Local Capacity Grants are direct awards to grantees to secure the resources needed (contractors or otherwise) to develop projects and submit competitive federal grant applications. Technical Assistance Grants are awards to grantees who want to use a contractor hired by the CWCB. This contractor can provide a wide variety of water project services, such as federal grant opportunity research, project design, partial engineering, cost estimation, and federal application development/grant writing.

Statewide education grants and outreach initiative grants are available through the Public Education, Participation, and Outreach (PEPO) Grant Program, which is administered through the CWCB. The PEPO

Grant Program also financially supports designated individual coordinators who support basin-specific outreach and education efforts alongside each of the state's basin roundtables. The Colorado DNR also maintains a Water Funding Opportunity Navigator, which lists potential federal and state grant opportunities.

Other state funding opportunities include the Colorado Healthy Rivers Fund. This program grants money to local watershed organizations to provide clean water, protect habitat, and improve recreation and accessibility throughout Colorado. Project grants and planning grants are available under the program.

4.7.2.4 FEDERAL

Federal agencies can provide funding and technical assistance for projects and monitoring. These agencies include the U.S. Fish and Wildlife Service (USFWS), USGS, NRCS, Farm Service Agency, EPA, and others. The USGS is more likely to provide support for data acquisition and monitoring programs, and the USFWS may provide land retirement program funds. The NRCS helps with applying conservation practices, and the EPA assists with studies to identify more localized sources of pollution in impaired waterbodies. The following sections provide information regarding federal NPS funding.

4.7.2.4.1 Environmental Protection Agency. The EPA provides funding opportunities for watershed restoration and protection on its funding resource webpage for NPS pollution.

Additional EPA funding opportunities are available online on the Equity Action Plan webpage and Environmental Justice Grants, Funding and Technical Assistance webpage.

The EPA also has a funding opportunity through the Office of Wetlands, Oceans, and Watersheds' Fiscal Year 2024 Building Partner Capacity and Promoting Resiliency and Equity under the CWA. The EPA is soliciting applications from eligible applicants to provide support for training and related activities to build the capacity of agricultural partners; state, territorial, and Tribal officials; and nongovernmental stakeholders in activities to be carried out to support the goals of the CWA Section 319 NPS Program.

The EPA also has funding from the Clean Water State Revolving Fund (CWSRF) accessible via the About the Clean Water State Revolving Fund (CWSRF) webpage. The funds are generally for municipal wastewater facility construction, control of NPS pollution, decentralized wastewater treatment systems, green infrastructure projects, project estuaries, and other water quality projects.

4.7.2.4.2 United States Department of Agriculture's Natural Resources Conservation Service. The NRCS's natural resources conservation programs help individuals reduce soil erosion, enhance water supplies, improve water quality, increase wildlife habitat, and reduce damage caused by floods and other natural disasters. More information is available on the USDA Programs & Initiatives webpage.

The following technical and financial assistance programs are generally awarded annually through NRCS:

- **Agricultural Conservation Easement Program (ACEP).** Applications are accepted on a continuous basis, with application cutoffs established from January through March. ACEP easement agreements are typically awarded annually by the fall.

- **Conservation Stewardship Program (CSP).** The CSP helps agricultural producers maintain and improve existing conservation systems and adopt additional conservation activities to address priority resource concerns. Participants earn CSP payments for conservation performance—the higher the performance, the higher the payment. There are different enrollment opportunities for CSP Classic, CSP Renewals and CSP Grasslands. Applications are accepted on a continuous basis, with application cutoffs established from January through March. CSP contracts are awarded by June or July.
- **Conservation Technical Assistance (CTA).** The CTA provides the nation's farmers, ranchers, and forestland owners with the knowledge and tools they need to conserve, maintain, and restore the natural resources on their lands and improve the health of their operations for the future. NRCS offers this assistance at no cost to the producers served.
- **Environmental Quality Incentives Program (EQIP).** EQIP provides financial and technical assistance to agricultural producers to address natural resource concerns and deliver environmental benefits, such as improved water and air quality; conserved ground and surface water; increased soil health; reduced soil erosion and sedimentation; improved or created wildlife habitat; and mitigation against increasing weather volatility. Applications are accepted on a continuous basis, with application cutoff for funding evaluation typically set in November of each year. EQIP contracts are typically awarded by April or May.
- **Regional Conservation Partnership Program (RCPP).** RCPP promotes coordination of NRCS conservation activities with partners that offer valuable contributions to expand the collective ability to address on-farm, watershed, and regional natural resource concerns. Announcements for Funding Proposals (AFPs) for RCPP Classic are typically advertised in October through November and awarded in June through August. RCPP Alternative Funding Arrangement (AFA) AFPs are typically announced March through May, with agreements awarded by September and, in some cases, the funds are carried over and awarded from October to December of the following fiscal year.
- **National Water Quality Initiative (NWQI).** NWQI provides a way to accelerate voluntary, on-farm conservation investments focused on water quality monitoring and assessment resources where they can deliver the greatest benefits for clean water. The NWQI is a partnership among NRCS, state water quality agencies, and the U.S. EPA to identify and address impaired water bodies through voluntary conservation.
- **Watershed Operations PL-566 Program.** The Watershed Protection and Flood Prevention Act (PL-566) authorizes the USDA–NRCS to help local organizations and units of government plan and implement watershed projects. PL-566 watershed projects are locally led to solve natural and human resource problems in watersheds up to 250,000 acres (less than 400 mi^2). At least 20 percent of any project benefits must relate directly to agriculture, including rural communities. A local sponsoring organization is needed to carry out, maintain, and operate works of improvement. The program has two main components, and each is funded separately: (1) watershed surveys and planning and (2) watershed and flood prevention operations and construction.
- **Conservation Innovation Grants (CIG).** CIG is a competitive program that supports the development of new tools, approaches, practices, and technologies to further natural resource conservation on private lands. Through creative problem-solving and innovation,

CIG partners work to address the nation's water quality, air quality, soil health, and wildlife habitat challenges while improving agricultural operations. Three program types are available: (1) national, (2) state, and (3) CIG On-Farm Conservation Innovation Trials.

- **Rural Development.** For OWTS funding, USDA Rural Development has a 504 Single Family Program, a Community Development Program, a Home repair Loan/Grant Program, a Community Pass-through Program, and Water Well Trust program. Income eligibility for these programs is often a sliding scale.

Other federal agency funding includes the U.S. Bureau of Reclamation (USBR) WaterSMART. Through WaterSMART, the USBR leverages federal and nonfederal funding to work cooperatively with states, tribes, and local entities as they plan for and implement actions to increase water supply sustainability through investments in existing infrastructure and attention to local water conflicts.

4.7.2.5 PRIVATE/OTHER SOURCES

Foundations, nonprofit organizations, and private contributions, including those from landowners and corporate entities, will be sought for plan implementation activities. Local foundations may fund education, civic engagement, and other local priority efforts. Such organizations acquire their own funding and may have project dollars and technical assistance that can be used. Major cooperators and funding sources include private landowners who typically contribute a percentage of project costs and may donate land, services, or equipment for projects or programs.

Some of the stakeholder questions asked in Survey #2 were related to the technical and financial assistance needed or used and how they used it. The Northern Colorado Water Conservancy District mentioned that it has an extensive, long-term water quality monitoring program in the Big and Little Thompson River HUC8. Los Rios Farm, a local farm in the watershed, stated a need for financial assistance for projects if landowners were willing and has been successful in receiving funding from FEMA, NRCS, and CWCB. Technical resources that would be helpful include education on project benefits and how resulting projects impact the adjacent communities. Los Rios Farm has received technical assistance from the CSU Watershed Group and is aware of technical assistance available from the NRCS but has not used it. The Colorado Watershed Assembly has received CWCB and NPS funds and other funds from the Cherry Creek Basin Water Quality Authority, Great Outdoors Colorado along with county and municipal funding and technical assistance. The Colorado Watershed Assembly tracks various federal grant opportunities and has used the CWCB and NPS Program for technical assistance. The Colorado Wheat Administrative Committee is aware of financial assistance from the conservation districts, NRCS, crop consultants, and NRCS Agricultural Research Service but has yet to secure funding.

The following are private foundations with available funding programs:

- The Laura Jane Musser Fund, a foundation based in Minnesota, assists public or not-for-profit entities to initiate or implement projects that enhance the ecological integrity of publicly owned open spaces, while encouraging compatible human activities. The fund's goal is to promote public use of open space that improves a community's quality of life and public health, while also ensuring the protection of healthy, viable, and sustainable ecosystems by defending or restoring habitat for the diversity of plant and animal species.
- The Moore Charitable Foundation works to preserve and protect natural resources for future generations. This foundation and its affiliates support nonprofit organizations that protect land, wildlife, habitat, and water resources in several regional planning areas, including Colorado. The foundation also supports educational and community programs in these areas.

- The Colorado River Basin Salinity Control Act, established in 1974, provides authorization for enhancing and protecting numerous salinity control projects in Colorado and other states. High levels of salinity in water can reduce crop yields, limit the choice of crops that can be grown, and, at higher concentrations over long periods, can kill trees and make the land unsuitable for agricultural purposes. Through strong partnerships between the NRCS, private landowners, USBR, CWCB, and several local conservation districts, financial and technical assistance funds have been used to install irrigation improvements, such as the installation of pipelines, more efficient irrigation systems, and lining of ditches and small laterals.
- The Colorado Watershed Assembly routinely posts funding opportunities through its bimonthly newsletter available on the Colorado Watershed Assembly homepage.
- The South Platte Basin Roundtable offers two funding cycles annually and information can be found on the South Platte Basin homepage.

Table 4-12. Local Sources of Technical and Financial Assistance (Page 1 of 2)

Agency or Organization	Website	Assistance	BMP Category						
			Developed Non-MS4	Cropland	Pasture	Feedlot	Forest	Stream	Outreach
City of Broomfield	www.broomfield.org	Financial, Technical	X					X	X
City of Boulder	bouldercolorado.gov	Financial, Technical	X					X	X
City of Fort Collins	www.fcgov.com	Financial, Technical	X					X	X
City of Lafayette	www.lafayetteco.gov	Financial, Technical	X					X	X
City of Longmont	www.longmontcolorado.gov	Financial, Technical	X					X	X
City of Louisville	www.louisvilleco.gov	Financial, Technical	X					X	X
City of Loveland	www.lovgov.org	Financial, Technical	X					X	X
Town of Erie	erieco.gov	Financial, Technical	X					X	X
Town of Estes Park	estespark.colorado.gov	Financial, Technical	X					X	X
Town of Firestone	www.firestoneco.gov	Financial, Technical	X					X	X
Town of Frederick	frederickco.gov	Financial, Technical	X					X	X
Town of Johnstown	www.johnstown.colorado.gov	Financial, Technical	X					X	X
Town of Superior	www.superiorcolorado.gov	Financial, Technical	X					X	X
Larimer County	www.larimer.gov	Financial, Technical	X	X	X	X	X	X	X
Weld County	www.weld.gov	Financial, Technical	X	X	X	X	X	X	X
BTWC	bigthompson.co	Technical	X	X	X	X	X	X	X
CPRW	www.poudrewatershed.org	Technical	X	X	X	X	X	X	X

Table 4-12. Local Sources of Technical and Financial Assistance (Page 2 of 2)

Agency or Organization	Website	Assistance	BMP Category						
			Developed Non-MS4	Cropland	Pasture	Feedlot	Forest	Stream	Outreach
Keep it Clean Partnership	www.keepitcleanpartnership.org	Technical	X	X	X	X	X	X	X
Larmer Conservation District (Previously Fort Collins and Big Thompson Conservation Districts)	https://www.larimercd.org/	Financial, Technical		X	X	X	X	X	X
Longmont and Boulder Valley Conservation District	https://bouldervalley-longmontcd.colorado.gov/	Financial, Technical		X	X	X	X	X	X
Platte Valley Conservation District	www.coloradolandcan.org/local-resources/Platte-Valley-Conservation-District/3610	Financial, Technical		X	X	X	X	X	X
Poudre Heritage Alliance	poudreheritage.org	Technical	X	X	X	X	X	X	X
South Platte Basin Roundtable	www.southplattebasin.com	Technical	X	X	X	X	X	X	X
West Greeley Conservation District	www.wgcd.org	Financial, Technical		X	X	X	X	X	X
Southeast Weld Conservation District	seweldcd-co.org	Financial, Technical		X	X	X	X	X	X

Table 4-13. State Sources of Technical and Financial Assistance

Agency or Organization	Website	Assistance	BMP Category						
			Developed Non-MS4	Cropland	Pasture	Feedlot	Forest	Stream	Outreach
CSU Extension	extension.colostate.edu	Technical	X	X	X	X	X	X	X
CSU	www.colostate.edu	Technical	X	X	X	X	X	X	X
Colorado Association of Conservation Districts	coloradoacd.org	Financial, Technical	X	X	X	X	X	X	X
CDPHE	cdphe.colorado.gov	Financial, Technical	X	X	X	X	X	X	X
Colorado Parks and Wildlife	cpw.state.co.us	Financial, Technical					X	X	X
Colorado Livestock Association	www.coloradolivestock.org	Technical				X		X	X
Colorado Department of Agriculture	ag.colorado.gov	Financial, Technical		X	X	X		X	X
Colorado Water Center	watercenter.colostate.edu	Technical						X	X
Colorado Water Conservation Board	cwcb.colorado.gov	Financial, Technical	X	X	X	X	X	X	X
Colorado Rural Water Association	www.crwa.net	Technical						X	X
Colorado DNR	dnr.colorado.gov	Financial, Technical	X	X	X	X	X	X	X
Colorado Energy and Carbon Management Commission	ecmc.state.co.us	Financial, Technical		X	X	X			
Colorado Geological Survey	coloradogeologicalsurvey.org	Financial, Technical						X	
Colorado Bureau of Land Management	www.blm.gov	Financial, Technical					X	X	X
Colorado Division of Reclamation, Mining, and Safety	drms.colorado.gov	Financial, Technical					X	X	X
Colorado State Land Board	slb.colorado.gov	Financial							X

Table 4-14. Federal and Private Sources of Technical and Financial Assistance

Agency or Organization	Website	Assistance	BMP Category						
			Developed Non-MS4	Cropland	Pasture	Feedlot	Forest	Stream	Outreach
FEDERAL									
U.S. Army Corps of Engineers	www.usace.army.mil	Financial, Technical						X	X
USDA–NRCS	www.nrcs.usda.gov	Financial, Technical		X	X	X	X	X	X
USDA–Farm Service Agency	www.fsa.usda.gov	Financial, Technical		X	X	X		X	X
USDA–Rural Development	www.rurdev.usda.gov	Financial, Technical						X	X
USDA–Bureau of Land Management	www.blm.gov	Financial, Technical					X	X	X
U.S. Department of Interior–Bureau of Reclamation	www.usbr.gov	Financial, Technical	X	X			X	X	X
EPA	www.epa.gov	Financial, Technical	X	X	X	X	X	X	X
USDA–Forest Service	www.fs.fed.us	Financial, Technical					X	X	X
USFWS	www.fws.gov	Financial, Technical						X	X
USGS	www.usgs.gov	Technical						X	X
PRIVATE									
Ducks Unlimited	www.ducks.org	Financial, Technical						X	X
Colorado Trout Unlimited	coloradotu.org	Financial, Technical						X	X
Fresh Water Trust	www.thefreshwatertrust.org	Financial, Technical	X	X	X	X	X	X	X
Mule Deer Foundation	www.muledeer.org	Financial, Technical					X	X	X
Rocky Mountain Elk Foundation	www.rmef.org	Financial, Technical					X	X	X
National Fish and Wildlife Foundation	www.nfwf.org	Financial, Technical						X	X

4.8 REGIONAL STAKEHOLDER/PUBLIC OUTREACH AND EDUCATION

Current communication, education, and outreach efforts established in regional project area should continue and be expanded to incorporate effectiveness and user feedback surveys that would complement current area outreach programs. Coordinated outreach efforts should increase the awareness of specific audiences regarding water quality problems and solutions, as well as available BMP technical and financial assistance programs for urban/residential areas, cropland, pasture lands, AMLs, and riparian areas. Stakeholders should continue to expand on their public outreach efforts and communications with the public by implementing inclusive and new engagement tactics to reach a broad audience. Education and outreach activities should target individuals and groups to evaluate effective outreach methods.

Stakeholder responses to Survey #2 were used to rank a list of information, education, and outreach options. The following survey ranking is from highest to lowest:

1. Water Quality Awareness Signage in Parks by Streams
2. Social Media Posts (Sent to Partners)
3. Website Updates
4. Educational Campaigns
5. Newsletters and Mailers
6. Pet-Waste Pickup Stations
7. Volunteer Cleanup Programs
8. School Visits
9. Project Story Map
10. Report a Concern Website
11. Radio Advertisements and Interviews
12. Tours and Field Trips

Entities within the watershed that are interested in collaborating with other stakeholder groups and hosting or participating in events include the Metro Water Recovery, Northern Colorado Water Conservancy District, City of Greeley, City of Fort Collins, City of Evans, Los Rios Farm, Colorado Watershed Assembly, Colorado Wheat Administrative Committee, and Estes Valley Watershed Coalition. Participating in existing events can also expand outreach efforts. Northern Water has an annual water quality efficiency stakeholder meeting in the spring, as well as a spring and fall water symposium and a children's water festival. Each fall, a Sustaining Colorado Watersheds conference is held in Avon, Colorado. A Lower South Platte River Water Festival is also held for children in the community.

The NFRWQPA is compiling a "Stakeholder Toolkit" for the plans. This toolkit will help stakeholders reach, inform, and partner with their networks on the NPS watershed educational resources. Some of the options included in the toolkit include digital communications, print communications, and community outreach. The stakeholders will decide which tools will be chosen during the next round of funding. Examples of these and more information about the Stakeholder Toolkit is included in Appendix F.

4.9 IMPLEMENTATION SCHEDULES, INTERIM MILESTONES, AND PROGRAM EFFECTIVENESS EVALUATION

Milestones toward progress can be shown in many different ways. In these watersheds, options for measurable milestones can include progress toward meeting water quality criteria set by the state, trends toward improvement, and progress in the installation of implementation practices that are expected to improve water quality parameters of concern. Each Watershed-Based Plan shows practices that could be implemented to make progress and count as measurable milestones. Because goals for these plans are very broad (the plan is not being written as a part of a specific TMDL with a specified goal), milestones are less specific and more general. Any practice implemented will be a part of progress toward the ultimate goal of improving water quality and ensuring water quality does not worsen. Relative implementation should be tracked, and this plan should be revisited after the first 5 years to ensure progress is being made. Reductions from NPS loadings will most likely require a significant, increased amount of technical and financial program assistance; BMP implementation through on-the-ground projects; proper watershed planning; and cooperation with willing landowners and land management agencies. Successfully achieving load reductions depends on several factors such as the amount of voluntary participation, availability of technical and financial assistance, and effectiveness of BMPs intended to reduce applicable loads. Each specific plan (included in Appendices A through D) has detailed tables of recommended practices. NFRWQPA will track any implementation that occurs as they are informed of it. Stakeholders will be informed of progress via methods chosen from the Stakeholder Toolkit.

4.10 REGIONAL MONITORING PLAN AND REQUIREMENTS

Monitoring should be completed before and after implementing BMPs to evaluate the effectiveness of priority practices. Monitoring BMP effectiveness (up- and downstream of BMPs) helps evaluate the adequacy of the implementation strategies targeted to reduce loads or transport. BMP effectiveness data will improve the understanding of implementation and management measures. Other ideal locations for monitoring include areas that have been monitored historically near the HUC10 watershed outlets and along impaired waterbodies. More information about monitoring NPSs is included on EPA's Nonpoint Source Monitoring: TechNOTES webpage. Existing water quality monitoring occurring for the NFRWQPA's 208 Areawide Water Quality Management Plan is available on its website.

Additional monitoring and evaluation efforts should occur within the communities that are the most likely to become MS4 areas. Monitoring sites up- and downstream of areas where storm drains and tributaries enter mainstem waterbodies would help evaluate contributions. Monitoring locations in storm drains throughout urbanized areas where two possible sources come together would also help isolate sources of pollution. A detailed monitoring plan that identifies the locations of additional monitoring sites should be compiled.

Continuous discharge data across a broad range of flows are helpful for calculating loads. Future monitoring should include instantaneous discharge measurements at water quality sampling areas. Continuous stage recorders should be installed at key locations in the watershed, and stage-discharge relationships should be developed to convert continuous stage data to continuous flow data. Relatively low-cost, low-maintenance technologies are available to record continuous stage data. Instantaneous and continuous flow data will increase the accuracy of future load calculations and the evaluation of BMPs and implementation practices.

Survey #2 had a question regarding in-stream monitoring activities that different entities would consider implementing. The Northern Colorado Water Conservancy District, City of Evans, and City of Longmont would be interested in quarterly sampling as well as the installation, maintenance, and operation of a monitoring station. The Town of Frederick, City of Greeley, and Colorado Wheat Administrative Committee would be interested in quarterly sampling to be analyzed by a local laboratory. The City of Fort Collins and Colorado Watershed Assembly would be interested in the installation, maintenance, and operation of a monitoring station.

5.0 REGIONAL APPLICATION OF WATER QUALITY TOOLS FROM EXISTING WATERSHED PLANS

The primary water quality tool that was used for this project is the EPA's PLET. PLET was used to estimate nutrient and sediment loads from different land uses by HUC10, and later to evaluate load reductions that would result from the implementation of various BMPs [EPA, 2022]. PLET is a newer version of the EPA's STEPL, which was used for the *Cache la Poudre Watershed-Based Plan* [CPRW, 2020].

PLET offers an easy-to-use web interface for creating customized watershed models. It calculates watershed surface runoff, nutrient loads, and sediment delivery based on different land uses and management practices. PLET can be used to evaluate loading and load reductions at various scales. The size and characteristics of each area being evaluated are defined based on the total acreage of each land use entered into PLET. For each watershed, the annual nutrient loading is calculated based on the runoff volume and the pollutant concentrations in the runoff water, influenced by factors like land use distribution and management practices.

The annual sediment load is calculated using the Universal Soil Loss Equation (USLE) and the sediment delivery ratio. The reductions in sediment and pollutant loads resulting from the implementation of BMPs are computed using known BMP efficiencies. PLET features an integrated combined BMP calculator that determines the overall BMP efficiency of multiple BMP combinations, which can then be applied in the model. This calculator can represent BMPs both in series and parallel, and it also allows users to save their BMP configurations.

6.0 CONCLUSIONS

As stated in Chapter 1.0, one focus of this plan was to identify areas that would likely become MS4 permitted within the next 5 to 15 years and provide them with methods to prepare for being permitted. Communities identified were the Town of Johnstown and the Towns of Firestone and Frederick. Decision-makers in these communities should be proactive because they grow by using development practices that will minimally impact water quality. If more implementation is completed up front, less effort will be needed to retrofit BMPs after the area becomes a designated MS4. LID is an approach to stormwater management that mimics a site's natural hydrology while the landscape is developed and preserves and protects environmentally sensitive site features, such as riparian buffers, wetlands, steep slopes, valuable (mature) trees, floodplains, woodlands, and highly permeable soils. MIDS is a new concept being used in Minnesota that emphasizes keeping a raindrop where it falls to minimize stormwater runoff and pollution as well as preserve natural resources. Because Minnesota has been successful in implementing water quality practices using MIDS, developing communities in the NFRWQPA watersheds would likely also benefit from evaluation of the following four main elements of MIDS [Minnesota Pollution Control Agency, 2024]:

- Stormwater volume performance goals for new development, redevelopment, and linear projects
- New credit calculations that standardize the use of a range of structural stormwater techniques
- Design specifications for a variety of green infrastructure BMPs
- An ordinance guidance package to help developers and communities implement MIDS

Overall, water quality issues occur throughout watersheds addressed in this planning effort. Many practices are available for reducing the pollutants of concern, and those are summarized in the Watershed-Based Plan for each specific area. Funding and technical assistance are available from many sources, and these plans will make funds easier to obtain. Further, these plans open up CWA Section 319(h) funds for implementation, which are provided only for areas with approved NPS management programs. Practices implemented should focus on the primary sources of pollutants of concern in each project area and should be the practices that provide the greatest load reductions. To avoid limiting what practices can or should be funded, a large variety of practices are listed in the Watershed-Based Plans. Similarly, the lists of practices provided in the plans should not be all inclusive, but instead should be a starting point for the determination of the most effective options and the best general locations for each.

For nutrients, the USGS SPARROW modeling [USGS, 2012] shows that phosphorus and sediment are generally from NPSs, such as runoff from agricultural and developed lands, and not from wastewater treatment plants. Nitrogen is the exception to this and comes more from wastewater treatment plants and atmospheric deposition. *E. coli* is often from runoff from agricultural lands and developed lands because wastewater facilities have regulations for *E. coli* concentrations in their effluent and generally disinfect to kill bacteria sources. Finally, heavy metals are generally coming from AMLs and flood irrigation practices on cropland where high natural concentrations exist. Therefore, implementation of NPS practices will significantly reduce pressure on wastewater facilities to decrease concentrations of phosphorus, sediment, *E. coli*, and heavy metals. Point source permittees should be mindful that water quality trading options may be available to use money available for upstream NPS implementation to improve water quality for a lower potential cost. Water quality trading options need to be further evaluated and quantified.

7.0 REFERENCES

AMEC, CDR Associates, and Walsh, 2014. *Left Hand Creek Watershed Master Plan*, prepared by AMEC, CDR Associates, and Walsh, available online at *https://watershed.center/wp-content/uploads/2017/05/final-left-hand-creek-watershed-master-plan2.pdf*

Ayres Associates, 2015. *Big Thompson River Restoration Master Plan*, prepared by Ayres Associates, Fort Collins, CO, for the Big Thompson River Coalition, Loveland, CO, available online at *https://bigthompson.co/wp-content/uploads/2019/03/BTWC_Master_Plan.pdf*

Big Dry Creek Watershed Association, 2024. "Big Dry Creek Watershed Association Reports," accessed September 18, 2024, from *https://www.bigdrycreek.org/reports*

Big Thompson Watershed Coalition, 2017. *Big Thompson River Corridor Master Plan*, prepared by Big Thompson Watershed Coalition, Loveland, CO, available online at *https://bigthompson.co/project/river-corridor-master-plan/*

Barr Lake & Milton Reservoir Watershed Association, 2008. *Barr Lake and Milton Reservoir Watershed Plan*, prepared by the Watershed Plan Writing Committee of the Barr Lake & Milton Reservoir Association, Broomfield, CO, available online at *https://barr-milton.org/wp-content/uploads/2019/07/bmw_wp_draft_text_102008.pdf*

Barr Lake & Milton Reservoir Watershed Association, 2013. *BMW Adaptive Implementation Plan for pH TMDL*, prepared by the Barr Lake & Milton Reservoir Association, Broomfield, CO, available online at *https://barr-milton.org/wp-content/uploads/2020/09/Implementation-Plan-from-State-website-9-20.pdf*

Barr Lake & Milton Reservoir Watershed Association, 2017. *Barr Lake and Milton Reservoir Watershed Plan Update*, prepared by the Barr Lake & Milton Reservoir Association, Broomfield, CO, available online at *https://barr-milton.org/wp-content/uploads/2019/07/sept_watershedplan_update_ew09202017.pdf*

Bremser, P., 2023. Personal communication between P. Bremser, St. Vrain Sanitation District, Longmont, CO, and Cindie Kirby, RESPEC, Rapid City, SD, October 2.

Catena Analytics, 2024. "eRAMS Online," accessed August 13, 2024, from *https://erams.com/catena/*

Coalition for the Poudre River Watershed, 2020. *Cache la Poudre River Watershed-Based Plan*, prepared by the Coalition for the Poudre River Watershed, Fort Collins, CO, available online at *https://static1.squarespace.com/static/5af07ab53917ee099d13c874/t/5eb1e67095ae0505f397957a/1588717186644/Final+CPRW+Watershed+Plan+-+April+2020.pdf*

Colorado Data Sharing Network, 2024. "CDSN 'AWQMS' Data Management System," accessed January 11, 2024, from *http://www.coloradowaterdata.org/awqmscdsn.html*

Colorado Department of Public Health and Environment, 2022. *Colorado's Nonpoint Source Management Plan: 2022,* prepared by Colorado Department of Public Health and Environment Water Quality Control Division, Glendale, CO, available online at *https://drive.google.com/file/d/1nrZ1D4yp2LGHUxrNsyjwGbu3w1ZCs9wz/view*

Colorado Department of Public Health and Environment, 2024a. "Water Quality Roadmap," accessed September 17, 2024, from *https://cdphe.colorado.gov/water-quality-10-year-roadmap*

Colorado Department of Public Health and Environment, 2024b. *Regulation #93 – Colorado's Section 303(d) List of Impaired Waters and Monitoring and Evaluation List*, 5 Code of Colorado Regulations 1002-93.

Colorado Water Conservation Board, 2023. *Colorado Water Plan*, prepared by the Colorado Water Conservation Board, Denver, CO, available online at *https://cwcb.colorado.gov/colorado-water-plan*

Colorado Water Conservation Board and Colorado Division of Water Resources, 2023. "Colorado's Decision Support Systems, Division 1 – South Platte," accessed July 17, 2023, from *https://cdss.colorado.gov/gis-data/division-1-south-platte*

Fayram, A., 2023. Personal communication between A. Fayram, Loveland Water and Power, Loveland, CO, and Cindie Kirby, RESPEC, Rapid City, SD, September 29.

Fischer, J., 2023. *OTWS.zip,* attachment from personal communication between J. Fischer, InVision GIS, CO, and C. Kirby, RESPEC, Rapid City, SD, December 13.

Graves, J., 2024. Personal communication between J. Graves, Colorado Division of Reclamation, Mining, and Safety, Denver, CO, and N. Acosta, RESPEC, Colorado Springs, CO, March 8.

Hathaway, B., 2023. Personal communication between B. Hathaway, City of Greeley, Greeley, CO, and Cindie Kirby, RESPEC, Rapid City, SD, September 25.

Horsley and Witten, Inc., 1996. *Identification and Evaluation of Nutrient and Bacterial Loadings to Maquoit Bay, New Brunswick, and Freeport, Maine*, prepared by Horsley & Witten, Inc., Barnstable, MA, for Casco Bay Estuary Project, Portland, ME.

Horton, J. D., C. A. San Juan, and D. B. Stoeser, 2017. "The State Geologic Map Compilation (SGMC) Geodatabase of the Conterminous United States," *US Geological Survey Data Series 1052,* Ver. 1.1, August 2017, p. 46.

ICON Engineering, Inc., 2015. *Boulder Creek Restoration Master Plan*, prepared by ICON Engineering, Centennial, CO, for the Urban Drainage and Flood Control District, Denver, CO, available online at *https://assets.bouldercounty.gov/wp-content/uploads/2018/04/Boulder-Creek-Restoration-Master-Plan-2015a.pdf*

International Stormwater Best Management Practices Database, 2023. "International Stormwater BMP Database," accessed August 14, 2024, from *https://bmpdatabase.org/*

JW Associates, Inc., 2017. *High Park Fire Identification of Post-fire Remaining Priorities*, prepared by JW Associates, Breckenridge, CO, for the Coalition for the Poudre River Watershed, Fort Collins, CO, available online at *https://static1.squarespace.com/static/5af07ab53917ee099d13c874/t/5b5752741ae6cf3b02412eeb/1532449435620/Post-fire+Targeting+Report+Final+compressed.pdf*

JW Associates Inc., 2024. *Upper Poudre Watershed Resilience Plan*, prepared by JW Associates Inc., Breckenridge, CO, for the Coalition for the Poudre River Watershed, Fort Collins, CO, available online at *https://static1.squarespace.com/static/5af07ab53917ee099d13c874/t/662bbd100a7b9519c2453695/1714142520419/UPRP+2024+Final_smaller.pdf*

Larimer County, 2023. "Larimer County GIS Digital Data," accessed month day, 2024, from *https://www.larimer.gov/it/gis/digital-data*

Lynker Technologies, Otak, AlpineEco, LVBrown Studio, LLC, 2017. *Lower Poudre River Flood Recovery and Resilience Master Plan*, prepared by Lynker Technologies, Otak, AlpineEco, LVBrown Studio, LLC, for the Coalition for the Poudre River Watershed, Fort Collins, CO, available online at *https://static1.squarespace.com/static/5af07ab53917ee099d13c874/t/5b58bebe1ae6cfc82b9e7f6d/1532542666812/Lower+Poudre+Master+Plan+FINAL+compressed.pdf*

Metcalf and Eddy, Inc., 1991. *Wastewater Engineering: Treatment, Disposal and Reuse*, 3rd Edition, McGraw-Hill, New York, NY.

Metro Roundtable and South Platte Basin Roundtable, 2022. *South Platte Basin Implementation Plan, Volume 1*, prepared by the Metro Roundtable and South Platte Basin Roundtable, Denver, CO, available online at *https://static1.squarespace.com/static/62102d32cbc97713f25c3099/t/62bdfe9537168629ce77a68d/1656618673204/99756bdcf884440d177fbeef0743f94b_SouthPlatte-Metro_BIP_Volume1_2022.pdf*

Minnesota Pollution Control Agency, 2024. "Minnesota Stormwater Manual Overview of Minimal Impact Design Standards (MIDS)," accessed May 6, 2024, from *https://stormwater.pca.state.mn.us/index.php/Overview_of_Minimal_Impact_Design_Standards_(MIDS)*

Multi-Resolution Land Characteristics Consortium, 2019. "National Land Cover Database 2019 - Landcover & Imperviousness (NLCD2019)," accessed August 14, 2024, from *https://www.mrlc.gov/data?f%5B0%5D=category%3ALand%20Cover&f%5B1%5D=year%3A2019*

National Interagency Fire Center, 2024. "InterAgencyFirePerimeterHistory All Years View," accessed August 14, 2024, from *https://data-nifc.opendata.arcgis.com/datasets/e02b85c0ea784ce7bd8add7ae3d293d0_0/explore?location=39.994103%2C-103.924962%2C8.89*

National Water Quality Monitoring Council, 2023. "Water Quality Portal," accessed October 19, 2023, from *https://www.waterqualitydata.us/*

Natural Resources Conservation Service, 2024a. "Soil Survey Geographic Database (SSURGO)," accessed August 13, 2024, from *https://www.nrcs.usda.gov/resources/data-and-reports/soil-survey-geographic-database-ssurgo*

Natural Resources Conservation Service, 2024c. "Conservation Practice Standard Land Reclamation, Abandoned Mined Land Code 543," accessed May 30, 2024, from *https://www.nrcs.usda.gov/sites/default/files/2022-09/Land_Reclamation_Abandoned_Mined_Land_543_NHCP_CPS.pdf*

North Front Range Water Quality Planning Association, 2022. *208 Areawide Water Quality Management Plan 2022 – 208 AWQMP Update (Region 2)*, prepared by the North Front Range Water Quality Planning Association, Johnstown, CO.

Northern Water, 2024. "Environmental Monitoring," accessed February 16, 2024, from *https://www.northernwater.org/what-we-do/protect-the-environment/environmental-monitoring*

Otak, 2022. *Big Thompson River Envisioning Project Plan*, prepared by Otak, Denver, CO, for the Big Thompson River Watershed Coalition, Loveland, CO, available online at *https://bigthompson.co/wp-content/uploads/2022/11/BigT_EnvisioningReport_PDF_with-Appendices_final.pdf*

PRISM Climate Group, 2024. "Average Monthly and Average Annual Precipitation 1961-1990, 1971-2000 and 1981-2010 by State," accessed May 14, 2024, from *https://gdg.sc.egov.usda.gov/Catalog/ProductDescription/PRCIP.html*

S2O, 2024. "St. Vrain River Creek Watershed Master Plan," accessed July 9, 2024, from *https://s2odesign.com/projects/saint-vrain-river-master-plan/*

Smith, E., 2024. *2023 Zoning Boundary.zip,* attachment from personal communication between E. Smith, Town of Timnath, CO, and C. Kirby, RESPEC, Rapid City, SD, January 29.

South Fort Collins Sanitation District, 2023. "Fossil Creek Water Quality Data," accessed October 6, 2023, from *https://lookerstudio.google.com/u/0/reporting/f37fd02a-76b9-4e7f-ab68-29860d999627/page/p_6jx0trsz6c/edit*

St. Vrain and Left Hand Water Conservancy District, 2022. "St. Vrain and Left Hand Stream Management Plan," accessed September 17, 2024, from *https://coloradosmp.org/wp-content/uploads/2019/02/SVLH_Summary_web.pdf*

U.S. Census Bureau, 2010. "Explore Census Data," accessed August 1, 2024, from *https://data.census.gov/*

U.S. Census Bureau, 2020. "QuickFacts," accessed July 29, 2024, from *https://www.census.gov/quickfacts/*

U.S. Department of Agriculture, 2024. "Farmers.gov," accessed May 30, 2024, from *www.farmers.gov*

U.S. Environmental Protection Agency, 2022. "User's Guide Pollutant Load Estimation Tool (PLET) Version 1.0," accessed August 1, 2024, from *https://www.epa.gov/system/files/documents/2022-04/user-guide-final-04-18-22_508.pdf*

U.S. Environmental Protection Agency, 2023. "Stormwater Phase II Rule, Factsheet 2.1," prepared by the U.S. Environmental Protection Agency Office of Water.

U.S. Environmental Protection Agency, 2024. "Per- and Polyfluoroalkyl Substances (PFAS) Final PFAS National Primary Drinking Water Regulation," accessed August 14, 2024, from *https://www.epa.gov/sdwa/and-polyfluoroalkyl-substances-pfas*

U.S. Geological Survey, 2023. "National Water Information System, USGS Surface-Water Daily Data for Colorado," accessed October 20, 2023 from *https://waterdata.usgs.gov/co/nwis/dv/?referred_module=sw*

U.S. Geological Survey, 2024. "2012 SPARROW Models for the Midwest: Total Phosphorus, Total Nitrogen, Suspended Sediment, and Streamflow," accessed September 18, 2024, from *https://sparrow.wim.usgs.gov/sparrow-midwest-2012/*

Wright Water Engineers, Inc., 2002. *Big Dry Creek Watershed Management Plan*, prepared by Wright Water Engineers, for the Big Dry Creek Watershed Association, Denver, CO.

Zeckoski, R. W., B. L. Benham, S. B. Shah, and C. D. Heatwole, 2005. "BSLC: A Tool for Bacteria Source Characterization for Watershed Management," *Applied Engineering in Agriculture*, Vol. 21, No. 5, pp. 879–889.

APPENDIX A

BIG AND LITTLE THOMPSON RIVER NONPOINT SOURCE WATERSHED-BASED PLAN

BIG AND LITTLE THOMPSON RIVERS NONPOINT SOURCE WATERSHED-BASED PLAN

DRAFT REPORT RSI-3425

PREPARED BY
Cindie Kirby
Seattle Briscoe
Natalie Acosta
Cathy McCague

RESPEC
3824 Jet Drive
Rapid City, South Dakota 57703

Communication Infrastructure Group
1660 Lincoln Street; Suite 1800
Denver, Colorado 80264

PREPARED FOR
North Front Range Water Quality Planning Association
257 Johnstown Center Drive; Unit 206
Johnstown, Colorado 80534

DECEMBER 2024

Project Number W0545.23001

TABLE OF CONTENTS

TABLE OF CONTENTS (CONTINUED)

LIST OF TABLES

LIST OF TABLES (CONTINUED)

RESPEC

LIST OF FIGURES

LIST OF ABBREVIATIONS

µg/L	micrograms per liter
ACEP	Agricultural Conservation Easement Program
AFA	Alternative Funding Arrangement
AFO	animal feeding operation
AFP	Announcement for Funding Proposals
AML	abandoned mine land
AWEP	Agricultural Water Enhancement Program
BMP	best management practices
BMPDB	International Stormwater Best Management Practices Database
BTWC	Big Thompson Watershed Coalition
CAFO	concentrated animal feed operation
CASTNET	Clean Air Status and Trends Network
CAWA	Colorado Ag Water Alliance
CCR	Code of Colorado Regulation
CDPHE	Colorado Department of Public Health and Environment
cfs	cubic feet per second
cfu/head/day	colony-forming units per head per day
CIG	Conservation Innovation Grants
CPPE	Conservation Practice Physical Effects
CPS	Conservation Practice Standard
CRP	Conservation Reserve Program
CSP	Conservation Stewardship Program
CSU	Colorado State University
CTA	Conservation Technical Assistance
CWA	Clean Water Act
CWCB	Colorado Water Conservation Board
CWSRF	Clean Water State Revolving Fund
DRUM	Defense-Related Uranium Mine
EPA	U.S. Environmental Protection Agency
EQIP	Environmental Quality Incentives Program
ESRI	Environmental Systems Research Institute, Inc.
EWP	Emergency Watershed Protection Program
FEMA	Federal Emergency Management Agency
FRPP	Farm and Ranch Lands Protection Program
GRP	Grass Reserve Program
HUC	Hydrologic Unit Code
lb/day	pounds per day
lb/year	pounds per year
LID	Low Impact Development
mg/L	milligrams per liter
mi^2	square miles
MIDS	Minimal Impact Design Standards

LIST OF ABBREVIATIONS (CONTINUED)

mL	milliliter
mpn	most probable number
MS4	Municipal Separate Storm Sewer System
NADP	National Atmospheric Deposition Program
NFRWQPA	North Front Range Water Quality Planning Association
NLCD	National Land Cover Dataset
NPS	Nonpoint Source
NRCS	Natural Resources Conservation Service
NWQI	National Water Quality Initiative
OWTS	Onsite Wastewater Treatment System
PEPO	Public Education, Participation, and Outreach
PFAS	per- and polyfluoroalkyl substances
PLET	Pollutant Load Estimation Tool
RCD	Resource Conservation and Development
RCPP	Regional Conservation Partnership Program
SSURGO	Soil Survey Geographic Database
SWAP	Source Water Assessment and Protection
SWPPP	stormwater pollution prevention plan
TMDL	total maximum daily load
TSS	total suspended solids
USBR	U.S. Bureau of Reclamation
USDA	U.S. Department of Agriculture
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
WFPO	Watershed Protection and Flood Prevention Operations
WHIP	Wildlife Habitat Incentive Program
WHRB	Watershed Rehabilitation
WRP	Wetlands Reserve Program
WRSF	Water Supply Reserve Funds
WWTP	Wastewater Treatment Plant

1.0 INTRODUCTION

The primary purpose of this watershed-based plan is to recommend best management practices (BMPs) that would reduce pollutants of concern within the Big and Little Thompson Rivers Watershed (Hydrologic Unit Code [HUC] 10190006) from nonpoint sources (NPSs). Although this watershed-based plan is a stand-alone NPS plan, water planning should be done in a holistic manner, with teamwork between point and NPSs of pollution. Pollution reductions from NPSs upstream of point sources reduce the strain on the point sources. Municipal, industrial, and agricultural entities working together toward the shared goal of protecting waterbodies before they become impaired will reduce future regulations on these entities.

The watershed-based plan is based on an adaptive approach that emphasizes making continued progress toward achieving milestones and load reduction by identifying the most impactful implementation measures for priority areas. This watershed-based plan summarizes past conservation accomplishments and recommends implementation actions that can assist residents, landowners, and stakeholders in the project area to improve water quality. Private, local, state, and federal partnership efforts should continue to support and promote the implementation of management measures while additional water quality monitoring is conducted to guide watershed plan revisions and assess adaptive implementation activities.

The watershed-based plan builds on past conservation accomplishments in the project area and complements water quality efforts by the following organizations, as well as the local communities:

- Big Thompson Watershed Coalition (BTWC)
- Big Thompson Watershed Forum (dissolved); access archive information on the Big Thompson Watershed Forum Archive homepage)
- City of Loveland
- Colorado Ag Water Alliance (CAWA)
- Colorado Department of Public Health and Environment (CDPHE)
- Colorado Livestock Association
- Colorado Parks & Wildlife
- Colorado Rural Water Association
- Colorado State University (CSU)
- Colorado Watershed Assembly
- Colorado Wheat Administrative Committee
- Ducks Unlimited
- Estes Park Sanitation District
- Estes Valley Watershed Coalition
- FPAC-NRCS, CO
- Fresh Water Trust

- Larimer County
- Little Thompson Watershed Coalition
- Los Rios Farm
- Northern Colorado Water Conservancy District
- Peaks to People Water Fund
- South Platte Basin Roundtable
- Thompson School District
- Town of Berthoud
- Town of Estes Park
- Town of Johnston
- Town of Milliken
- Trout Unlimited
- Upper Thompson Sanitation District
- Weld County
- Xcel Energy

This watershed-based plan also incorporates the strategies, goals, and objectives of CDPHE's *Colorado's Nonpoint Source Management Plan: 2022* and addresses the U.S. Environmental Protection Agency's (EPA's) nine key elements outlined in the management plan [CDPHE, 2022]. Table 1-1 describes these nine key elements and their corresponding locations within this watershed-based plan [EPA, 2008].

Table 1-1. Sections of the Watershed-Based Plan That Fulfill the U.S. Environmental Protection Agency's Nine Key Elements for Watershed Planning

EPA Element Number	EPA's Nine Key Elements Plan	Applicable Section of Watershed-Based Plan
1	Identify the causes and sources of pollution that need to be controlled to achieve load reductions and other goals (e.g., recreational, economic, ecological) identified in the plan.	5.0 Source Assessment 6.0 Priority Areas for Implementation
2	Estimate load reductions expected from the action strategy identified.	6.0 Priority Areas for Implementation 7.0 Best Management Practices Load Reductions
3	Describe NPS management measures, including operation/maintenance requirements, and targeted critical areas (i.e., action strategy) needed to achieve identified load reductions.	6.0 Priority Areas for Implementation 7.0 Best Management Practices Load Reductions 8.0 Past and Current Best Management Practices 9.0 Recommended Best Management Practices
4	Estimate technical and financial assistance needed, associated costs, and/or the sources and authorities that will be relied upon to implement the watershed-based plan.	13.0 Technical and Financial Assistance Sources
5	Develop an information and education component that will be used to enhance public understanding of the NPS management measures and encourage their early and continued participation in selecting, designing, and implementing the Action Strategy.	10.0 Information, Education, and Outreach
6	Develop a project schedule.	11.0 Criteria to Assess Progress
7	Describe interim, measurable milestones.	11.0 Criteria to Assess Progress
8	Identify a set of criteria to assess progress/effectiveness in achieving water quality standards or other appropriate end targets.	11.0 Criteria to Assess Progress
9	Develop a monitoring component to evaluate the effectiveness of the implementation efforts over time and measured against the criteria established to document load reductions.	12.0 Monitoring Best Management Practices Effectiveness

This watershed-based plan is not intended to identify which specific BMPs or remediation actions should be included in certain discharge permits, ordinances, stormwater pollution prevention plans (SWPPPs), or conservation plans. Rather, the plan provides an adaptive implementation approach with suggested structural and nonstructural BMPs necessary to address the NPSs of pollutants of concern. For the purposes of this watershed-based plan, BMPs refer to structural and nonstructural actions or measures installed or implemented to reduce the delivery of sediment and nutrients to waterbodies in the project area. Sources of available funding and technical assistance for and associated estimated costs of these BMPs are included to provide landowners, residents, stakeholders, community leaders, and public agencies perspectives on the technical and economic demands of this watershed plan.

Essential to the development of this watershed-based plan is ascertaining and collecting feedback and input from a cross section of stakeholders, including cities, counties, sanitation districts, towns, watershed organizations, and others who will identify, fund, and prioritize projects to implement these practices and BMPs. As a part of this project, two surveys were sent to stakeholders:

- Survey #1, in 2022, was more general and included questions related to pollutants, issues, and areas of concern.
- Survey #2, in 2024, was more specific and included questions regarding past and current planning, use of technical and financial assistance, and ideal BMPs.

Survey #1 was distributed to 96 organizations in 2022. The purpose of this survey was to better understand the stakeholders' concerns, issues, resources, and priorities. Building on the conclusions from this survey was the impetus for helping to develop a nine key elements plan.
Survey #2 was distributed to 48 organizations in March 2024 asking them to complete the following items:

- Characterize their existing watershed projects and sources of pollution
- Rank cropland, urban, pastureland, feedlot, and forest BMPs
- Identify benefits and impacts of existing BMPs
- Identify existing outreach and education efforts
- Identify technical and financial assistance needed and utilized

Table 1-2 lists the stakeholders who received and participated in each survey. Results of the survey are found throughout the report and in more detail in Chapter 10.0, Information, Education, and Outreach. Survey responses are an integral part of this project. Survey questions are included in Appendix A.

To help promote the novel regional watershed plan, the project team participated in the annual American Water Resources Association – Colorado Groundwater Association Conference. The team discussed the project objectives, watershed characteristics, nine key elements, and outreach efforts.

Table 1-2. Stakeholder Recipients of Two Surveys With Responses Represented by an "X" (Page 1 of 3)

Organization	Took Survey #1 (2022)	Took Survey #2 (2024)
Boxelder Sanitation District	X	
BTWC		
Carestream		
CAWA		
CDPHE		
City & County of Broomfield	X	
City of Dacono		
City of Evans	X	X
City of Fort Collins		X
City of Fort Lupton	X	X
City of Greeley	X	X
City of Longmont	X	
City of Loveland	X	X
City of Northglenn		X
Coalition for the Poudre River Watershed		

Table 1-2. Stakeholder Recipients of Two Surveys With Responses Represented by an "X" (Page 2 of 3)

Organization	Took Survey #1 (2022)	Took Survey #2 (2024)
Colorado Livestock Association		
Colorado Parks & Wildlife		
Colorado Rural Water Association	X	
Colorado Watershed Assembly		X
Colorado Wheat Administrative Committee		X
CSU	X	
Davies Mobile Home Park		X
Drala Mountain Center	X	
Ducks Unlimited		
Estes Park Sanitation District	X	
Estes Valley Watershed Coalition	X	X
Fox Acres Community Services	X	
FPAC-NRCS, CO		
Fresh Water Trust	X	
Galeton Water & Sanitation District	X	
JBS Greeley Beef Plant		X
Larimer County		X
Left Hand Water District	X	
Little Thompson Watershed Coalition		
Los Rios Farm		X
Metro Water Recovery	X	
Northern Colorado Water Conservancy District	X	X
Peaks to People Water Fund		X
Poudre Heritage Alliance		
Resource Colorado Water & Sanitation Metro District		
RNC Consulting, LLC		X
South Fort Collins Sanitation District	X	X
South Platte Basin Roundtable		
St. Vrain Creek & Boulder Creek Watershed		
St. Vrain Sanitation District	X	
Thompson School District		X
Town of Ault	X	
Town of Berthoud	X	X
Town of Brighton		
Town of Erie	X	
Town of Eaton		
Town of Estes Park		X

Table 1-2. Stakeholder Recipients of Two Surveys With Responses Represented by an "X" (Page 3 of 3)

Organization	Took Survey #1 (2022)	Took Survey #2 (2024)
Town of Firestone		
Town of Frederick		
Town of Hudson	X	
Town of Johnston	X	
Town of Keenesburg		
Town of LaSalle		
Town of Lochbuie	X	
Town of Mead	X	
Town of Milliken		
Town of Pierce	X	
Town of Platteville		X
Town of Severance	X	
Town of Timnath		
Town of Wellington		X
Town of Windsor	X	
Trout Unlimited		
Upper Thompson Sanitation District	X	
Water Quality Trading in the Cache la Poudre with Fort Collins		
Weld County	X	
Weld County Department of Public Health and Environment	X	
Wright Water Engineers/Cherry Creek Basin Water Quality Authority		X
Xcel Energy		X

2.0 WATERSHED CHARACTERIZATION

The project area for this watershed-based plan is shown in Figure 2-1, which includes the area within Larimer and Weld Counties that intersect the Big and Little Thompson Rivers Watershed (HUC 10190006) in north-central Colorado. The Big Thompson River flows east to its confluence with the South Platte River. Six HUC10 watersheds are in the Big Thompson HUC8: North Fork Big Thompson River (1019000601), Headwaters Big Thompson River (1019000602), Buckhorn Creek (1019000603), Headwaters Little Thompson River (1019000604), Dry Creek-Little Thompson River (1019000605), and Outlet Big Thompson River (1019000606). Although the figures in this document show information within the HUC10 watersheds overlapping Larimer and Weld Counties, the tables summarize only information from the HUC10 watersheds within Larimer and Weld Counties. The total area of the HUCs is 532,350 acres, but within Larimer and Weld Counties, it encompasses only 519,343 acres, according to GIS layer analysis. The watershed is a part of the Colorado-Big Thompson Project that delivers water from Grand Lake through the Adams Tunnel the East Slope distribution system [Hawley and Rodriguez-Jeangros, 2021].

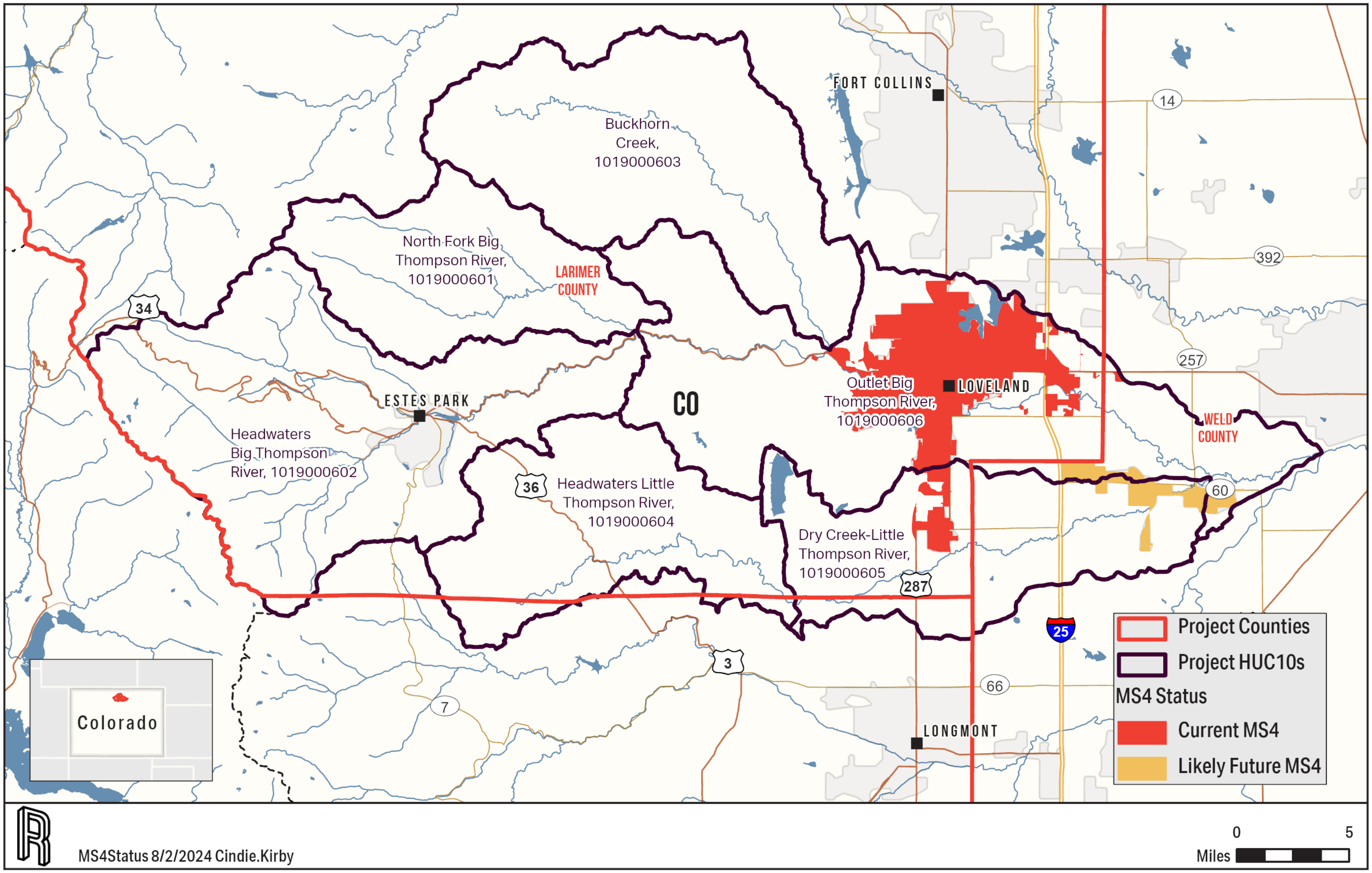


Figure 2-1. Big Thompson River HUC8 Project Area.

A summary of the project area's land cover characteristics was completed using the 2019 National Land Cover Dataset (NLCD). The NLCD is a 16-category, multilayer land cover classification dataset derived from Landsat imagery and ancillary data for consistent land cover data for all 50 states. The land cover is depicted in Figure 2-2 [Multi-Resolution Land Characteristics Consortium, 2019]. In the project area (including the Municipal Separate Storm Sewer Systems [MS4s]), approximately 45 percent of the area is forest; 20 percent is scrub/shrub; 12 percent is cultivated crops; 5 percent is developed; and barren, pasture/hay, wetlands, and open water/ice each make up 2 percent or less. The City of Loveland, Colorado, is the largest urban area in the watershed, with a 2020 Census population of 79,738 and an area of approximately 36 square miles (mi^2) [U.S. Census Bureau, 2020]. Other populated areas in the watershed include the Town of Estes Park (6,490 people, 6.9 mi^2, growing at 1.1 percent annually), the Town of Berthoud (9,482 people, 13.0 mi^2, growing at 8.6 percent annually), and the Town of Johnstown (16,020 people, 13.8 mi^2, growing at 6.2 percent annually). The watershed transitions from forest within higher elevations in the west to scrub/shrub/herbaceous within the mid-range elevations and crops within the lower elevations in the east. The City of Loveland is located at the transition between the scrub/shrub/herbaceous and cropland areas. Most of the land is privately owned (90 percent) with 9 percent being federally owned and other ownership categories making up only 1 percent. This was calculated using a combination of public parcels [Colorado Geospatial Portal, 2024] and from the Environmental Systems Research Institute, Inc.'s (ESRI's) data portal for USA Federal Lands [ESRI, 2014].

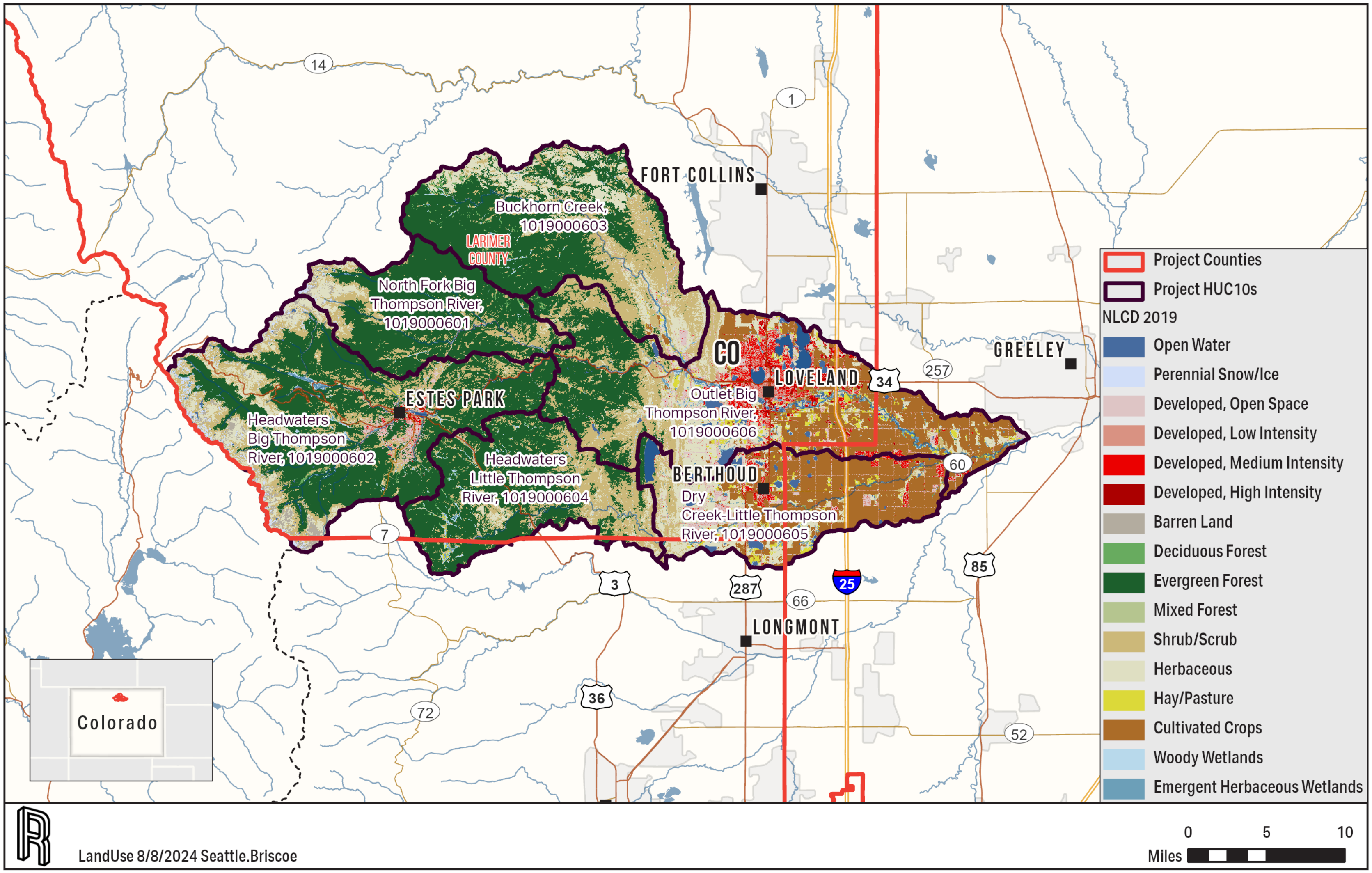


Figure 2-2. National Land Cover Dataset 2019 Land Use.

As indicated in Figure 2-3, precipitation varies throughout the project area. Typical annual precipitation is between 51 inches in the upper, western part of the watershed to 13 inches per year in the lower, eastern portion [PRISM Climate Group, 2024]. Maximum monthly average precipitation generally occurs in the summer months; however, the largest flows typically occur from winter snowmelt in the spring. According to Hawley and Rodriguez-Jeangros [2021], “flow rates in the upper watershed follow a seasonal snowmelt hydrograph pattern with peaks between May and June and the falling limb typically extending into September. The lowest flows occur in the winter months. Below the Town of Lake Estes, the snowmelt hydrograph peaks are still apparent, but are diminished in some years by Colorado-Big Thompson project diversions to the Olympus Tunnel.” Hawley and Rodriguez-Jeangros [2021] also notes a sharp drop in annual flow volumes at the top of the lower watershed, which is from irrigation and municipal water diversions, and that winter flows tend to be higher at the downstream end of the watershed because of groundwater and wastewater effluent. During a typical year, approximately 1,225,000 acre-feet are used for irrigation in the South Platte Basin [Colorado Water Plan, 2015]. In 2013, extensive flooding along the Front Range caused significant damage. The flood led to restoration work and continues to cause sediment movement.

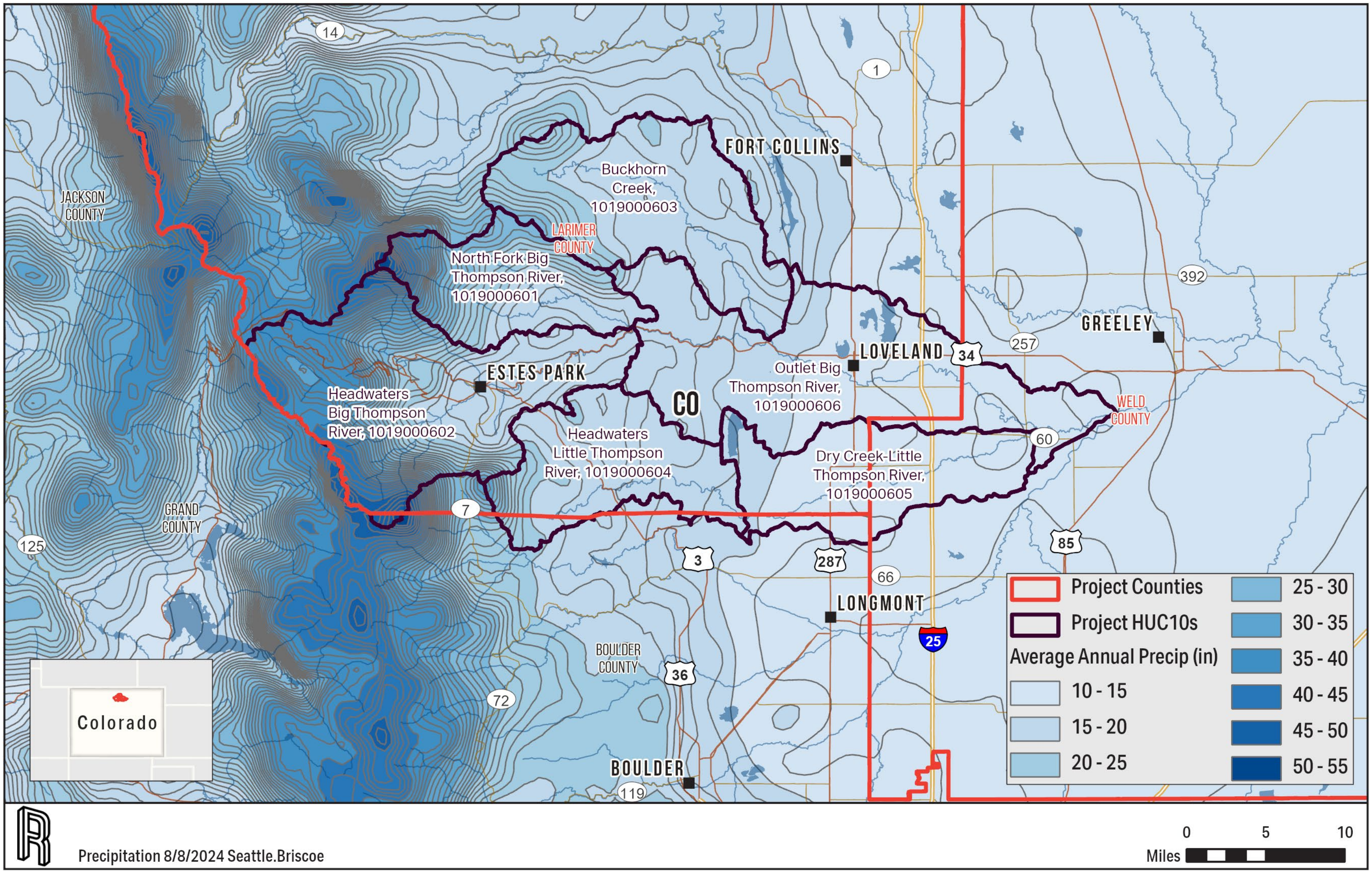


Figure 2-3. Average Annual Precipitation (1981 to 2010).

The bedrock geology of the project area is displayed in Figure 2-4 [Horton et al., 2017]. In the Big Thompson River HUC8, the mountainous portions consist mostly of intrusive igneous and undifferentiated metamorphic material, and the transitional area consists mostly of undifferentiated sedimentary and clastic sedimentary material. The lower, agricultural area consists of clastic sedimentary and undifferentiated unconsolidated material. The South Platte River originates in the mountains of central Colorado at the Continental Divide and flows approximately 450 miles northeast across the Great Plains to its confluence with the North Platte River at North Platte, Nebraska. The basin includes two physiographic provinces: the Front Range Section of the Southern Rocky Mountain Province and the Colorado Piedmont Section of the Great Plains Province [USGS Colorado Water Science Center, 2000].

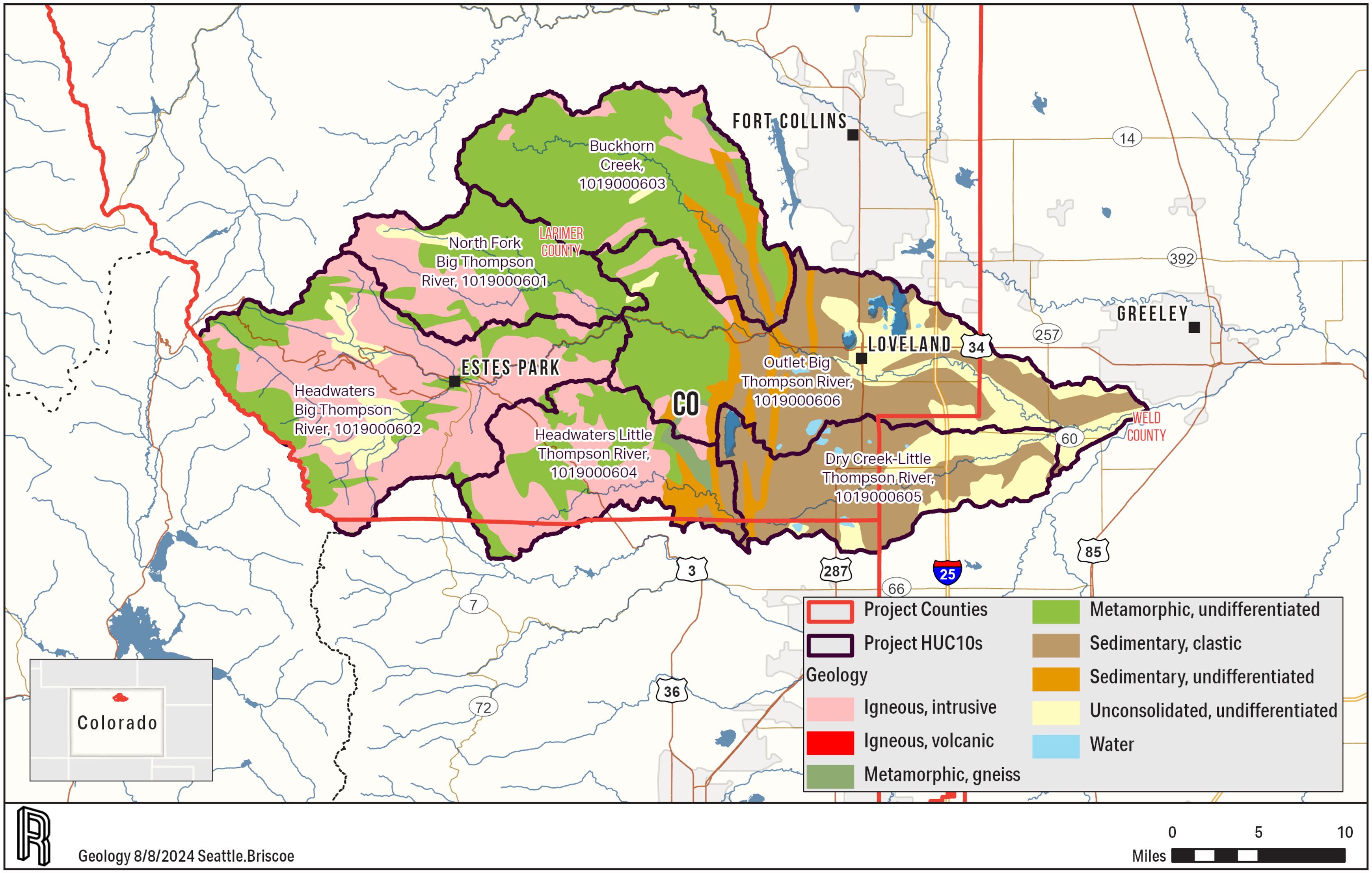


Figure 2-4. Geology.

Hydrologic soil groups can significantly impact the amount of water that infiltrates or runs off during precipitation events. Type A soils are generally sand or sandy loams with high infiltration rates; Type B soils are silt loam or loam soils with moderate rates; Type C soils are generally sandy, clay loams with low infiltration rates; and Type D soils are heavy soils; clay loams; and silty, clay soils with low infiltration rates. The project area comprises 10 percent A, 26 percent B, 20 percent C, and 44 percent D soil types. Figure 2-5 shows the distribution of hydrologic soil groups in the watershed using the Soil Survey Geographic Database (SSURGO) [NRCS, 2024a].

Survey #2 inquired about what concerns stakeholders had with the watershed, including issues related to wastewater discharges and MS4 areas. Specifically relating to the Big Thompson River HUC8, a stakeholder mentioned concerns for both point sources and NPSs. The Los Rios Farm, LLC stated its concerns are regarding the Town of Berthoud's treatment plants as well as ditches that run from municipal areas and oil locations near waterbodies.

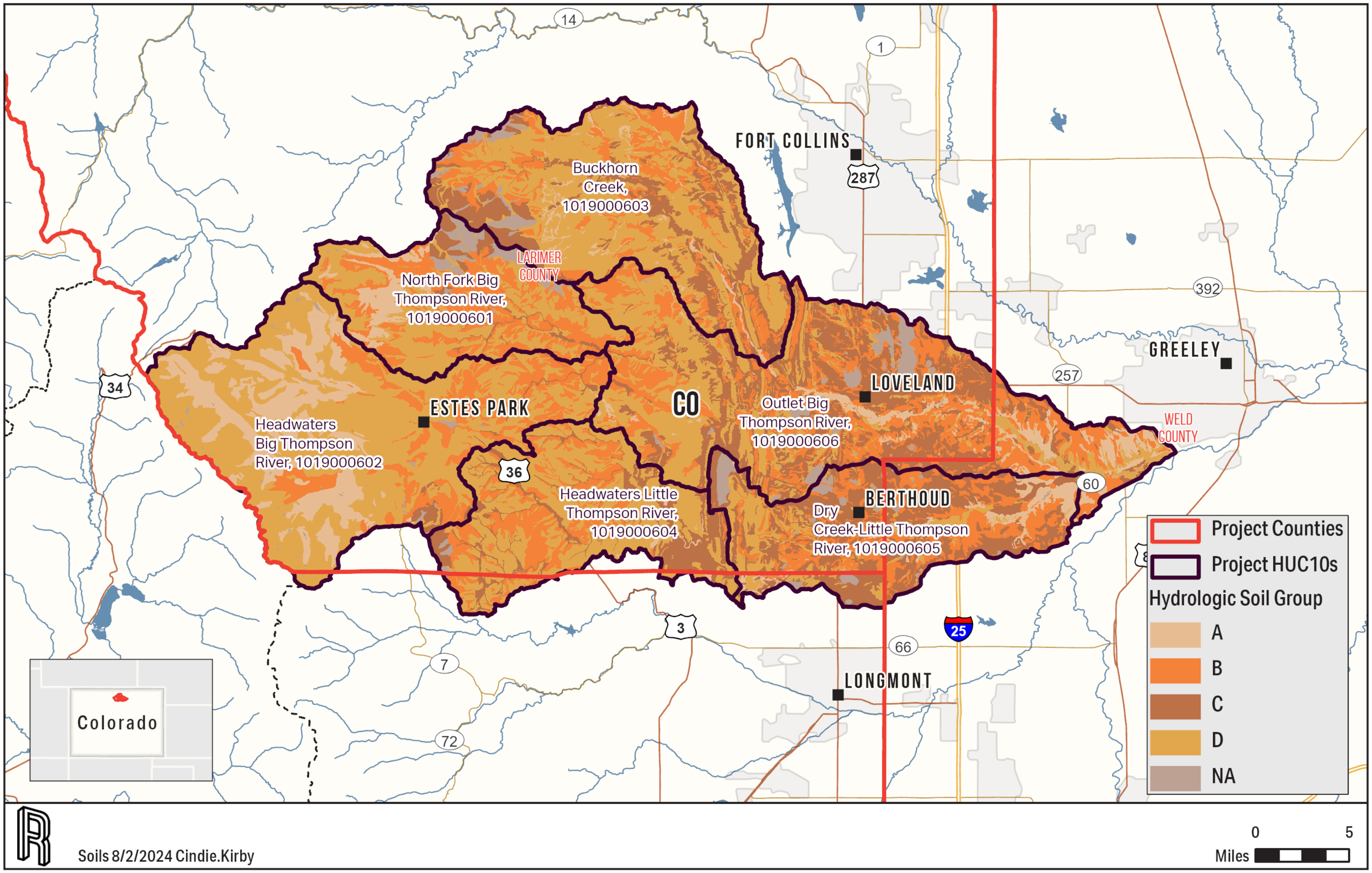


Figure 2-5. Hydrologic Soil Group.

3.0 EXISTING WATERSHED PLANS AND PROJECTS

Many conservation accomplishments have been achieved within the project area, which can be attributed to the local planning and implementation efforts of the community, state, and federal partners. Projects outlined on the BTWC website are listed in Table 3-1. More information about work completed in the Big Thompson River Watershed is available on the BTWC All BTWC Projects webpage [BTWC, 2024].

Table 3-1. Watershed Planning and Major Projects in the Big Thompson River HUC8

Project Type	Name	Year Completed
Planning	Big Thompson River Envisioning Project	2022
Planning	Big Thompson River Restoration Master Plan	2015
Planning	Big Thompson River Corridor Master Plan	2017
River	Rossum to Wilson and Ditch Improvement	2019
River	Wild Natural Area and Neighbors Flood Recovery	2019
River	Sylvan Dale Flood Recovery	2013
River	Jasper Lake Flood Recovery	2017
River	Cedar Cove Flood Recovery	2017
River	Moodie Street Flood Recovery	2018
River	Waltonia and Mountain Shadows Flood Recovery	2018
River	North Fork Flood Recovery	2017
River	Glen Haven Flood Recovery	2017
River	Big Thompson Canyon Access Pier	2019
River	Blue Mountain River Restoration	2019
River	Green Bridge/Berthoud River Restoration	2018
River	Namaqua Big Thompson River Restoration	2019
River	Storm Mountain Forestry and Community Engagement	2020
Forest	Waltonia Wildfire Mitigation	In Progress
Forest	Glen Haven Forest Restoration	In Progress
Forest	Sylvan Dale Forest Restoration	In Progress
Forest	Round Mountain Forest Health Demonstration	In Progress
Wildfire	Wildfire Ready Watershed Action Plan	In Progress
Wildfire	Cameron Peak River Reforestation	2023
Wildfire	Cameron Peak Fire Hillslope Stabilization	2023
Wildfire	Cameron Peak Fire Instream Mitigation	2023

Big Thompson River planning projects can be found on the following websites:

- Big Thompson River Envisioning Project
- Big Thompson River Restoration Master Plan
- Big Thomspon River Corridor Master Plan
- Big Thompson Wildfire Ready Action Plan

Numerous conservation measures have been completed and are currently being implemented within the project area. These projects have been made possible through CDPHE with EPA's Section 319 NPS implementation grants and CDPHE grants. Previous conservation efforts have occurred in the project area, and each project helped improve water quality and make progress toward restoring and protecting local waterbodies. Tables 3-2 and 3-3 discuss these implementations within the project area [EPA, 2024a].

Table 3-2. Nonpoint Source Grants Implemented in the Big Thompson River HUC8

Conservation Projects	Grant Number	Completion Year	Pollution Category	Section 319 Expenditures ($)	Total Expenditures ($)	Project Accomplishments
Big Thompson Watershed Management Plan	99818604	2005	All Sources; Urban Runoff/Stormwater	25,000	66,660	This project includes Phase I of a comprehensive Watershed Management Plan and will involve prioritizing water quality issues with a wide variety of stakeholders. Source Water Assessment and Protection and monitoring results will be reviewed to determine baseline conditions, contaminant sources, and data needs.
Nonpoint Source Pollution Project – Filter Strip Implementation Project and Little Thompson Watershed Plan	99818618	2023	Agriculture	300,000	542,578	The project will implement a live planted filter strip consisting of irrigated grass and legumes that can act as a means to filter out nutrients, sediment, and pathogens on return flow water into the Little Thompson and St. Vrain watersheds. The project will also determine the effectiveness of the filter strip.
Lateral Ditch Piping	99818618	2023	Agriculture	30,000	72,826	This project serves to reduce water quality issues by installing NPS BMPs by piping irrigation water from the headgate to the sprinkler system, which will allow the elimination of ditch maintenance and chemical contamination of the water as well as sediment reduction. Additional benefits will include salinity and nutrient contributions to the state waters. The project will be located in the Little Thompson River Basin.
Agricultural BMP Implementation and Evaluation Project and Little Thompson Watershed Plan	99818618	2023	Agriculture	271,514	471,114	This project involves implementing and investigating the effectiveness of NPS BMP to address water quality issues related to NPS pollution specifically associated with selenium and *E. coli*.
Water Quality, Soil Health, and Regenerative Agriculture	99818620	2024	Agriculture	308,181	633,668	This project is improving water quality through the implementation of agricultural BMPs in northern Colorado. BMPs may include strip buffer, conservation tillage, advanced nutrient management, and irrigation management.

Table 3-3. Other Nonpoint Source Projects (South Platte and/or Statewide)

Project Title	Project Sponsor	Basin	NPS Funding ($)	Match on 09/30/2022 ($)	Status on 09/30/2022 (MM/YYYY)
Little Thompson and St. Vrain Watershed Resilience Initiative	CSU	South Platte	294,940	61,367	Expected Completion 03/2023
Water Quality, Soil Health and Regenerative Agriculture: A Nexus for Sustainability	CSU	South Platte	306,518	68,010	Expected Completion 06/2024
Implementing Agricultural BMPs in a Colorado Soil Health Pilot Program	Colorado Department of Agriculture	Various	34,4894	286,427	Expected Completion 06/2025
Brush Wetland Demonstration Project	Ducks Unlimited	South Platte	80,000	18,167	Expected Completion 06/2025
Nutrient Management on Irrigated Pastures	CAWA	Various	266,355	95,912	Expected Completion 01/2026

4.0 STANDARDS AND IMPAIRMENTS

Impairment locations throughout the project area are shown in Figure 4-1. Impaired stream segments and lakes in the project area are shown in Table 4-1, with impairments including heavy metals like copper, iron, manganese, and zinc and other water quality parameters such as pH, temperature, *E. coli*, and nitrate. Mercury and selenium are measured in fish tissue, as a standard, and in water quality samples. Individual maps and box plots of each impaired parameter are included in Appendices B and C, respectively.

RESPEC

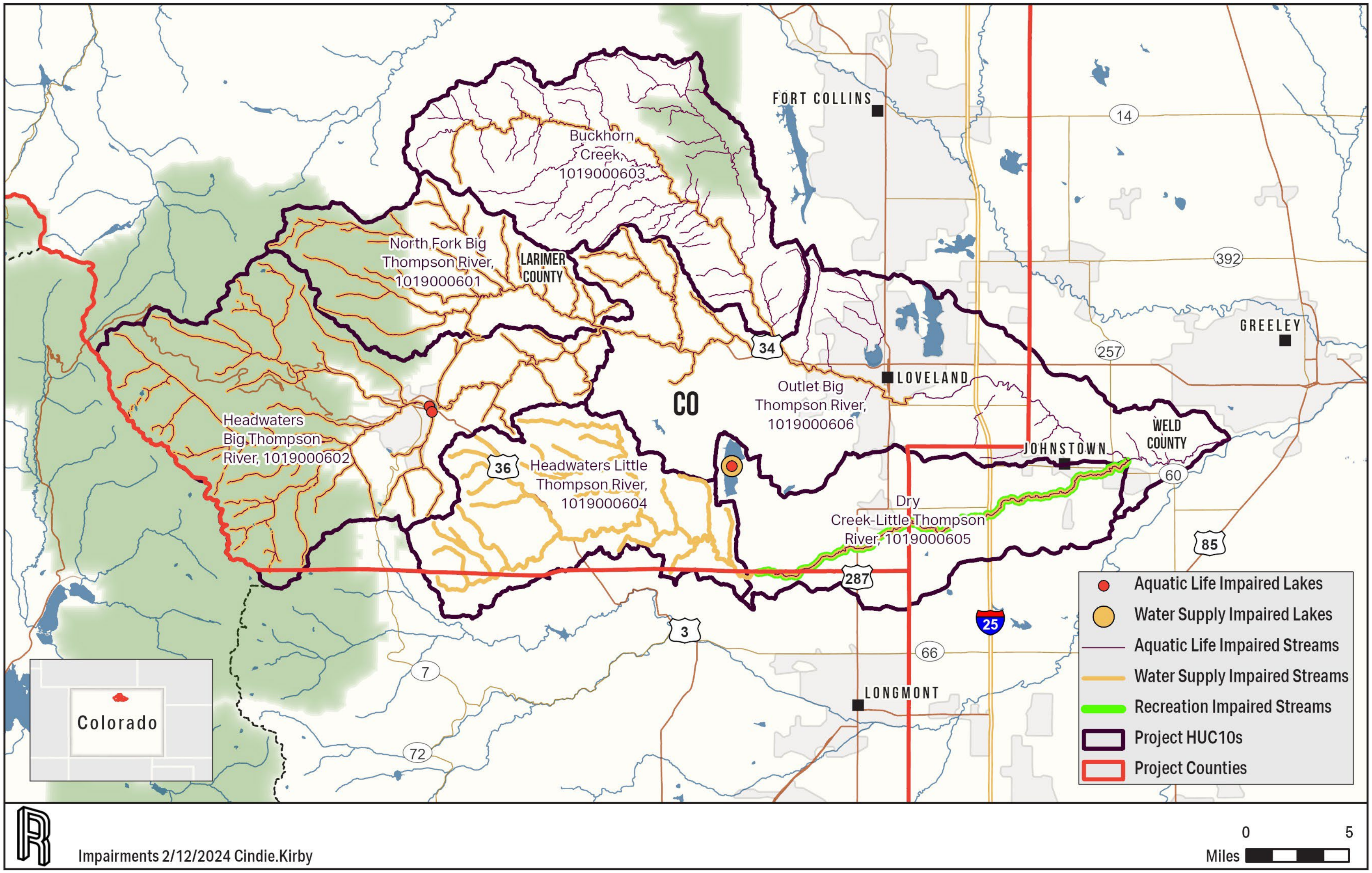


Figure 4-1. Impaired Waterbodies.

Table 4-1. Clean Water Act Section 303(d)-Impaired Waterbodies Summary (Page 1 of 2)

Impairment I.D./ HUC10s	Aquatic Life Tier/ Recreation Tier	Description	Aquatic Life Impairments	Recreation Impairment	Water Supply Impairment
COSPBT01_B/ 1019000601 and 101000602	C1/E	Mainstem of the Big Thompson River, including all tributaries and wetlands, within Rocky Mountain National Park, except for specific listings in Segment 2	Copper (D), Mercury (T), Zinc (D)	N/A	Arsenic (T)
COSPBT02_A/ 1019000601 and 1019000602 and 1019000606	C1/E	Mainstem of the Big Thompson River, including all tributaries and wetlands from Upper Thompson Sanitation District discharge to Cedar Creek, except for the specific listing in Segment 7; mainstem of Black Canyon Creek and Glacier Creek; excluding Fish Creek below Mary's Lake	Copper (D), Mercury (T)	N/A	Arsenic (T)
COSPBT02_B/ 1019000602	C1/E	Fish Creek below Mary's Lake	Macroinvertebrates, pH	N/A	Arsenic (T), Nitrate
COSPBT02_C/ 1019000602	C1/E	Mainstem of the Big Thompson River, including all tributaries and wetlands, from Rocky Mountain National Park to Upper Thompson Sanitation District discharge	Macroinvertebrates, Copper (D), Mercury (T)	N/A	Arsenic (T), Nitrate
COSPBT02_D/ 1019000606	C1/E	Mainstem of the Big Thompson River, including all tributaries and wetlands, from Cedar Creek to Home Supply Canal	Copper (D), Iron (T), Mercury (T), Temperature	N/A	Arsenic (T)
COSPBT02_E/ 1019000601	C1/E	Mainstem of the North Fork of the Big Thompson River from the boundary of Rocky Mountain National Park to the confluence with the Big Thompson River	Copper (D), Mercury (T)	N/A	Arsenic (T)
COSPBT02_F/ 1019000606	C2/E	Mainstem of the Big Thompson River from the Home Supply Canal diversion (40.397884, -105.106482) to the Greeley-Loveland Canal diversion	Copper (D)	N/A	Arsenic (T)
COSPBT02_G/ 1019000606	C2/E	Mainstem of the Big Thompson River from Big Barnes Ditch (40.406, -105.143) to the Greeley-Loveland Canal Diversion (40.397884, -105.106482)	Selenium (D)	N/A	Manganese (D)
COSPBT03_B/ 1019000606	W1/EN	Mainstem of the Big Thompson River from the Greeley-Loveland Canal diversion to County Road 11H	Mercury (T), Selenium (D),	N/A	Arsenic (T), Manganese (D)
COSPBT04_A/ 1019000606	W2/E	Mainstem of the Big Thompson River from County Road 11H to I-25	Mercury	N/A	N/A

Table 4-1. Clean Water Act Section 303(d)-Impaired Waterbodies Summary (Page 2 of 2)

Impairment I.D./ HUC10s	Aquatic Life Tier/ Recreation Tier	Description	Aquatic Life Impairments	Recreation Impairment	Water Supply Impairment
COSPBT05_A/ 1019000606	W2/NP	Mainstem of The Big Thompson River from I-25 to the confluence with the South Platte River	Mercury (T), Selenium (D)	N/A	N/A
COSPBT06_A/ 1019000603 and 1019000606	W2/E	All tributaries to the Big Thompson River, including all wetlands, from the Home Supply Canal diversion to the confluence with the South Platte River; excluding Dry Creek	Selenium (D)	N/A	N/A
COSPBT07_A/ 1019000603	C1/E	Mainstem of Buckhorn Creek from the source to the confluence with the Big Thompson River	Mercury (T)	N/A	Arsenic (T)
COSPBT08_A/ 1019000605	C1/E	Mainstem of the Little Thompson River, including all tributaries and wetlands, from the St. Vrain Supply Canal to the Culver Ditch diversion (40.253242, -105.200029)	N/A	N/A	Arsenic (T)
COSPBT08_B/ 1019000604	C1/E	Mainstem of the Little Thompson River, including all tributaries and wetlands, from the source to the St. Vrain Supply Canal	N/A	N/A	Arsenic (T)
COSPBT09_A/ 1019000605	W2/E	Mainstem of the Little Thompson River from the Culver Ditch diversion (40.259242, -105.200029) to the confluence with the Big Thompson River	Selenium (D)	*E. coli*	Manganese (D)
COSPCP14_A/ HUC10	C1/E	Horsetooth Reservoir	Fish Mercury	N/A	Arsenic (T)
COSPCP20_B/ HUC10	C2/E	Seaman Reservoir	Dissolved Oxygen	N/A	Arsenic (T)

D = dissolved
T = total

In Survey #1, local stakeholders noted their primary parameters of concern. Each parameter occurrence was counted, and the four parameters that appeared the most were nitrogen, phosphorus, total suspended solids (TSS), and *E. coli*. Others that showed up less than the most predominant parameters included temperature, emerging contaminants, metals, and per- and polyfluoroalkyl substances (PFAS). Emerging contaminants are the different types of chemicals (e.g., medication, personal care products, home cleaning products, lawn care products, and agricultural products, such as insecticides and herbicides) that end up in waterbodies but are not generally treated in wastewater facilities. PFAS and emerging contaminants of concern are not included in this report. Some emerging contaminants are treated by drinking water and/or wastewater facilities, but these chemicals are not well regulated or understood. A new EPA limit for PFAS of 4 parts per trillion was released in 2024 [EPA, 2024b].

Water quality standards for parameters of concern are based on beneficial-use tiers. For more information on these standards and tiers, visit the CDPHE's Water Quality Control Commission's 5 Codes of Colorado Regulation (CCR) 1002-31 website, last updated June 14, 2023. Access the CDPHE's Water Quality Control Commission Regulation No. 38 website, last updated April 30, 2024, for information on classifications and numeric standards for South Platte River Basin, Laramie River Basin, Republican River Basin, and Smoky Hill River Basin (5 CCR 1002-38).

The beneficial-use tiers for aquatic life, recreation, and domestic water supply are listed as follows:

- Aquatic Life
  - C1 – Class 1 Cold Water
  - C2 – Class 2 Cold Water
  - W1 – Class 1 Warm Water
  - W2 – Class 2 Warm Water
- Recreation
  - E – Existing Primary Contact Use (since November 28, 1975)
  - P – Potential Primary Contact Use
  - N – Not Primary Contact Use
  - U – Undetermined Use
- Domestic Water Supply
  - Direct Use Water Supply Lakes and Reservoirs

Current loads were determined for *E. coli*, dissolved selenium, total nitrogen, and total phosphorus using flow and water quality monitoring data collected along the mainstem of the most downstream HUC10 of the Big and Little Thompson project area (1019000606). The U.S. Geological Survey (USGS) site used for flow was USGS-06741510, which had data available from 1979 through 2024. The average annual flow was calculated using flow from 1990 through 2024 to be approximately 61.6 cubic feet per second (cfs). Numerous water quality sites were along the mainstem in the HUC10, and all available *E. coli*, selenium, total nitrogen, and total phosphorus data were used. The geometric mean from all *E. coli* data collected from 1990 through 2024 was used to represent the *E. coli* concentration; the 85th

percentile from all dissolved selenium from 1990 through 2024 was used to represent the current selenium concentration; and for both phosphorus and nitrogen, the annual median was averaged for all data from 1990 through 2024 to represent the current concentrations. Current loads were then calculated as the product of flow, concentration, and a conversion factor for each. Needed loads based on water quality standards were also calculated using the product of the same average annual flow, each water quality standard, and a conversion factor. The *E. coli* water quality standard was 126 most probable number (mpn) per 100 milliliters (mL), the selenium standard was 4.6 micrograms per liter (µg/L), the nitrogen standard was 2.01 milligrams per liter (mg/L), and the phosphorus standard was 0.17 mg/L. Current and needed flows, concentrations, and loads are shown in Table 4-2, as well as the load reduction needed at in the HUC10. At this location, reductions are needed to reach goal loads for dissolved selenium and total phosphorus. As flow and concentration data are collected at this location, they can be incorporated into the load estimations.

Table 4-2. Flows, Current Loads, Goal Loads, and Reductions to Reach Goals in Most Downstream HUC10 of the Project Area

Flow	Average Annual Flow (cfs)	61.6
Current Concentrations	*E. coli* Geomean (org/100 mL)	40.1
	Dissolved Selenium (85th Percentile)	5.4
	Average of Median Annual Nitrogen (mg/L)	1.4
	Average of Median Annual Phosphorus (mg/L)	0.2
Current Loads	*E. coli* (billion org/day)	60.4
	Selenium (lb/day)	1.8
	Nitrogen (lb/day)	472.2
	Phosphorus (lb/day)	61.4
Goal Loads	*E. coli* (billion org/day)	189.9
	Selenium (lb/day)	1.5
	Nitrogen (lb/day)	667.8
	Phosphorus (lb/day)	56.5
Reductions to Achieve Goal Loads	*E. coli*	0%
	Selenium	15%
	Nitrogen	0%
	Phosphorus	8%

cfs = cubic feet per second
lb/day = pounds per day
mg/L = milligrams per liter
mL = milliliters

5.0 SOURCE ASSESSMENT

Only NPS pollutants are addressed in this report. Point sources and areas with MS4s are addressed in the *208 Areawide Water Quality Management Plan, 2022 Update* [NFRWQPA, 2022]. Outside of MS4-permitted areas, NPSs of nutrients are generally related to runoff from cropland, pastureland, developed land, and other similar lands. NPSs of sediment consist of sediment contributions through wash off, as well as bed and bank erosion during high flows. NPSs of *E. coli* are typically from livestock, pets, wildlife, and human sources that can occur in agricultural and developed areas. NPSs of heavy metals vary by metal, but are often from abandoned mine lands (AMLs) or runoff from irrigated agricultural lands. Sometimes sources are from natural causes. Natural causes are the physical, chemical, or biological conditions that would exist in a waterbody in the absence of measurable impacts from human activity or influence. More information about the sources of each pollutant are described in this section.

5.1 NUTRIENTS AND SEDIMENT

The EPA's Pollutant Load Estimation Tool (PLET) was used to estimate nutrient and sediment loads from different land uses by HUC10 and later to evaluate load reductions that would result from the implementation of various BMPs [EPA, 2022].

For the Big Thompson River HUC8 in PLET, all six HUC10 watersheds were represented: North Fork Big Thompson River (1019000601), Headwaters Big Thompson River (1019000602), Buckhorn Creek (1019000603), Headwaters Little Thompson River (1019000604), Dry Creek-Little Thompson River (1019000605), and Outlet Big Thompson River (1019000606). The following inputs to the PLET model were included for each HUC10:

- Watershed land-use areas (acres) [Multi-Resolution Land Characteristics Consortium, 2019]
  - Urban (non-MS4)
  - Cropland
  - Pastureland
  - Forest
  - Feedlots
  - Other (all other land uses)
- Prominent hydrologic soil group (A-D) [NRCS, 2024a]
- Average annual rainfall (inches) [EPA, 2022]
- Rain days/year [EPA, 2022]
- Number of agricultural animals [EPA, 2022]
  - Beef cattle
  - Dairy cattle
  - Swine
  - Sheep

  - Horse
  - Chicken
  - Turkey
  - Duck
- Number of septic systems [Larimer County, 2024; Fischer, 2023]
- Population per septic system [Thomas, 2024]
- Septic rate failure [EPA, 2022]
- Urban land-use distribution [Multi-Resolution Land Characteristics Consortium, 2019]
- Irrigated cropland [Colorado's Decision Support Systems, 2024]
- Water depth per irrigation (inches) [EPA, 2022]
- Irrigation days/year [EPA, 2022]

Sediment erosion can be estimated in PLET; however, gullies and streambank erosion were not included because of a lack of data. Wildlife density (animals per square mile) was also not included because of a lack of data and because wildlife is considered a natural source.

Source assessment modeling results for the six HUC10 watersheds are summarized using the following categories: urban areas (excluding permitted MS4 areas), cropland, pastureland, forest (including scrub/shrub), feedlots, and a combination of all other land uses. The other land uses consist of barren, herbaceous, and wetlands, which typically are not the highest contributors per acre; therefore, BMP planning does not generally focus on these land uses even though they can make up a fairly large portion of the area. Because this is a NPS plan, permitted MS4s, which have limits to meet, are exempt from inclusion in this plan. The permitted MS4 in the project area not included is the City of Loveland, Colorado. MS4 areas were developed using a combination of the MS4 layer from ERAMS [Catena Analytics, 2024] (developed with the 2010 Census urban areas), the 2020 urban areas [U.S. Census Bureau, 2020], and a layer sent from the Town of Timnath [Smith, 2024]. The excluded area used to represent the City of Loveland was approximately 47 mi^2, primarily located in the Outlet Big Thompson River HUC10. Table 5-1 shows the percentage of each land-use source per HUC10 (in Larimer and Weld Counties only). The only source not associated with an area is septic systems. The quantified sources of nitrogen, phosphorus, and sediment are listed in Tables 5-2, 5-3, and 5-4 in order of the HUC10 watersheds. The upper five watersheds (North Fork Big Thompson River, Headwaters Thompson River, Buckhorn Creek, Headwaters Little Thompson River, and Outlet Big Thompson River) are dominated by forest, and the lowest watershed (Dry Creek-Little Thompson River) is dominated by croplands.

The primary land cover for the upper five watersheds is forest, which dominates the source loads for nutrients and sediment. The only exceptions are the Headwaters Big Thompson River and Outlet Big Thompson River Watersheds. In the former, urban non-MS4 land dominates the nitrogen and sediment sources, which is reasonable because of the substantial areas of developed land in the watershed. In the latter, cropland dominates all nutrient and sediment sources, which is reasonable because the many waterbodies primarily drain agricultural land in the watershed. In the lowest watershed, Dry Creek-Little Thompson River, the primary land cover is cropland, which dominates the source loads for nutrients and sediment.

Table 5-1. Land Cover

HUC10	Description	Area (mi^2)	Urban Non-MS4 (%)	Cropland (%)	Pastureland (%)	Forest (%)	Feedlots (%)	Other Land Uses (%)
1019000601	North Fork Big Thompson River	85	2	0	0	92	<1	7
1019000602	Headwaters Big Thompson River	184	7	0	<1	80	<1	12
1019000603	Buckhorn Creek	145	2	<1	<1	78	<1	19
1019000604	Headwaters Little Thompson River	91	1	0	<1	92	<1	7
1019000605	Dry Creek-Little Thompson River	86	14	52	3	8	<1	22
1019000606	Outlet Big Thompson River	161	9	28	3	43	<1	17

Table 5-2. Nitrogen Sources

HUC10	Description	Area (mi^2)	Urban Non-MS4 (%)	Cropland (%)	Pastureland (%)	Forest (%)	Feedlots (%)	Other Land Uses (%)	Septic (%)
1019000601	North Fork Big Thompson River	85	20	0	0	62	11	5	1
1019000602	Headwaters Big Thompson River	184	56	0	1	30	7	5	2
1019000603	Buckhorn Creek	145	15	10	3	46	9	13	4
1019000604	Headwaters Little Thompson River	91	11	0	2	66	9	6	7
1019000605	Dry Creek-Little Thompson River	86	14	73	4	<1	6	1	1
1019000606	Outlet Big Thompson River	161	18	62	5	3	8	1	3

Table 5-3. Phosphorus Sources

HUC10	Description	Area (mi²)	Urban Non-MS4 (%)	Cropland (%)	Pastureland (%)	Forest (%)	Feedlots (%)	Other Land Uses (%)	Septic (%)
1019000601	North Fork Big Thompson River	85	8	0	0	79	6	6	1
1019000602	Headwaters Big Thompson River	184	31	0	<1	53	5	9	2
1019000603	Buckhorn Creek	145	6	5	1	62	5	17	4
1019000604	Headwaters Little Thompson River	91	4	0	<1	78	4	7	6
1019000605	Dry Creek-Little Thompson River	86	10	78	2	1	5	2	3
1019000606	Outlet Big Thompson River	161	13	66	2	5	7	3	5

Table 5-4. Sediment Sources

HUC10	Description	Area (mi²)	Urban Non-MS4 (%)	Cropland (%)	Pastureland (%)	Forest (%)	Feedlots (%)	Other Land Uses (%)	Septic (%)
1019000601	North Fork Big Thompson River	85	26	0	0	60	0	14	0
1019000602	Headwaters Big Thompson River	184	66	0	<1	22	0	11	0
1019000603	Buckhorn Creek	145	20	11	2	37	0	31	0
1019000604	Headwaters Little Thompson River	91	14	0	1	68	0	17	0
1019000605	Dry Creek-Little Thompson River	86	7	90	1	<1	0	2	0
1019000606	Outlet Big Thompson River	161	8	86	2	2	0	2	0

A less obvious contributor of nutrients and sediment to waterbodies is wildland fires. Wildland fires significantly reduce well-established root systems in areas impacted and, as a result, soil erosion is much more likely during precipitation events, carrying nutrients with it. The Big Thompson River Watershed has already experienced post-wildfire flooding, debris flows, and associated economic impacts from two of the largest fires in Colorado: East Troublesome to the west and Cameron Peak to the north. Table 5-5 provides the total number of fire acres for each year past 2000 where any existed per HUC10 [National Interagency Fire Center, 2024]. The physical location of the watershed within a wildfire-prone area of Colorado and its past encounters with natural calamities make having a plan of action for any future wildfire risks imperative. A Big Thompson Wildfire Ready Action Plan is currently being prepared and will be completed by 2025 and made available on the Peaks to People Water Fund's website.

Table 5-5. Total Fire Acres per HUC10 per Year (2000-2021)

HUC10	1019000601	1019000602	1019000603	1019000604	1019000605	1019000606
2000	2,586		6,951			10,271
2002				8,705		
2003		80				10
2004		121				
2005		86				
2006		223				
2008		572	88			
2009	44					
2010	2,171	320				930
2011			5,878			
2012	14	6,832	41,171			
2014		30				
2016		196	189			0
2017		28				
2020	13,761	4,898	45,917	1		5,599
2021		127		20		4

Two locations are impaired for nitrates, a form of nitrogen, in HUC10 1019000602: COSPBT02_B and COSPBT02_C. Nitrates are a sensitive parameter for water supply because they cause cyanosis (i.e., blue baby syndrome), which causes skin to appear blue because of poorly oxygenated blood and can cause abnormalities in the heart, lungs, and blood [WebMD, 2024]. Nitrates can enter surface waters from animal manure, nitrogen fertilizers, wastewater, and decomposed plant residues and organic matter [University of Missouri Extension, 2024]. No other nutrient- or sediment-impaired waterbodies occur in the Big Thompson River HUC8, but nutrients and sediment were identified as priority parameters of concern.

Atmospheric deposition is also a source of nutrients. EPA's Clean Air Status and Trends Network (CASTNET) and the National Atmospheric Deposition Program (NADP) monitor nitrogen deposition (ammonia and nitrate) at locations throughout the United States. The SPARROW model published by the USGS estimated that in the Big Thompson River Watershed, more than 115,000 pounds of nitrogen were delivered to the stream from atmospheric deposition [USGS, 2019]. Some practices can help reduce nutrients in atmospheric deposition; however, these practices are not a focus in this plan because their impacts are less local than other BMPs.

5.2 E. COLI

Bacteria comes from the intestines of humans and warm-blooded animals. NPSs of bacteria consist primarily of waste that is transported through wash off from cropland, pastureland, and developed land, as well as septic systems and direct defecation from livestock and wildlife. For the purposes of this project, bacteria from wildlife are assumed to be a natural background source and are not included in the assessment.

E. coli from human and animal waste are dispersed throughout the landscape, spread by humans, and/or treated in facilities. Once *E. coli* are in the environment, their accumulation on land and delivery to the stream are affected by die-off and decay, surface imperviousness, detention time, ultraviolet exposure, and other mechanisms. Quantifying *E. coli* sources using PLET is not recommended [Tetra Tech, Inc., 2022], so an assessment of bacteria production within the watershed was completed per HUC10. This assessment included humans (Wastewater Treatment Plants [WWTPs] and Onsite Wastewater Treatment Systems [OWTSs]), pets (dogs and cats), and livestock (cattle, horses, poultry, sheep, and hogs); however, wildlife was not included because wildlife was assumed to be a natural source of bacteria. Publicly owned WWTPs are highly regulated and are not a significant source of *E. coli*. In some cases, WWTPs even provide dilution from other sources. OWTS contributions are largely dependent on soil and geology in an area, as well as their proximity to a waterbody. Additionally, point sources are not a focus of this study; therefore, WWTP estimates were added primarily as a comparison to the production of bacteria sent to an OWTS.

Livestock contribute *E. coli* loads directly by defecating in streams and indirectly by defecating on cropland or pastures where *E. coli* can wash off during precipitation events, snowmelt, or irrigation. Spreading livestock manure on cropland or pasture also contributes *E. coli* to waterbodies. The livestock in the project area mainly consists of cattle, poultry, hogs, horses, sheep, and goats, which are grazed and/or confined, and manure is spread on crops and pastures.

Pet waste is another potential source of *E. coli*. Pet waste is often left in yards, in parks, and along trails, and can be carried with stormwater to local storm drains and waterbodies.

Natural background sources are inputs that would be expected under natural, undisturbed conditions and include *E. coli* loading from wildlife in the area. Wildlife (e.g., waterfowl and large-game species) also contribute *E. coli* loads directly by defecating while wading or swimming in a stream and indirectly by defecating on lands that produce watershed runoff during precipitation events.

A GIS-based assessment was completed within each impaired drainage area to estimate livestock, wildlife, human, and pet populations. Animal populations were multiplied by average excretion rates from scientific literature to estimate the amount of *E. coli* produced by each source type in each HUC10 watershed. The reported literature values for fecal coliform excretion were converted to *E. coli* excretion by using a fecal coliform to *E. coli* ratio of 200:126 mpn per 100 mL. The loads produced by humans are usually treated by WWTPs and OWTSs.

Annual excretion estimates for livestock (excluding hogs) and wildlife were obtained from "BSLC: A Tool for Bacteria Source Characterization for Watershed Management" [Zeckoski et al., 2005], and bacteria estimates for humans and hogs were obtained from *Wastewater Engineering: Treatment, Disposal, and Reuse* [Metcalf and Eddy, 1991]. Annual excretion rates for dogs and cats were sourced from *Identification and Evaluation of Nutrient and Bacterial Loadings to Maquoit Bay, New Brunswick and Freeport, Maine* [Horsley and Witten, Inc., 1996]. Literature values for bacteria excretion rates are estimates and do not represent all sources and dynamics of bacteria in a natural system. Table 5-6 provides the literature rates of *E. coli* (converted from fecal coliform) produced by each animal per day, as well as the respective sources.

Table 5-6. *E. coli* Production Rates From Literature Sources

Category	Subcategory	*E. coli* Production Rate (cfu/head/day)	Source
Humans	WWTP	1,260,000,000	Metcalf and Eddy, 1991
Humans	OWTS	1,260,000,000	Metcalf and Eddy, 1991
Pets	Cats	3,150,000,000	Horsley and Witten, Inc., 1996
Pets	Dogs	3,150,000,000	Horsley and Witten, Inc., 1996
Livestock	Cattle	20,790,000,000	Zeckoski et al., 2005
Livestock	Horses	26,460,000,000	Zeckoski et al., 2005
Livestock	Poultry	58,590,000	Zeckoski et al., 2005
Livestock	Sheep	7,560,000,000	Zeckoski et al., 2005
Livestock	Goats	17,640,000,000	Zeckoski et al., 2005
Livestock	Hogs	5,607,000,000	Metcalf and Eddy, 1991
Wildlife	Deer	220,500,000	Zeckoski et al., 2005
Wildlife	Ducks	1,512,000,000	Zeckoski et al., 2005
Wildlife	Geese	504,000,000	Zeckoski et al., 2005

cfu/head/day = colony-forming units per head per day

Livestock numbers were obtained from the PLET database by HUC12 and aggregated up to the HUC10 level. Livestock counts available in PLET included cattle, horses, poultry, sheep, and hogs. PLET animal data are from the U.S. Department of Agriculture (USDA) National Agricultural Statistics Service, for which county animal data are summarized at the HUC12 level based on the pastureland area weighted ratio [EPA, 2022].

Hogs and poultry are typically kept in a total confinement facility, with their manure collected in a liquid manure storage area and later spread and/or incorporated on or into agricultural land. Grazed animals can also be kept in sheltered areas but are more likely to be pastured or have access to waterbodies than hogs and poultry. Manure that has been incorporated or spread into or on agricultural fields can contribute *E. coli* to waterways, but incorporation decreases the likelihood of transport. Livestock numbers include both animal feeding operations (AFOs) and concentrated animal feed operations (CAFOs); both are relevant because manure is applied to croplands and pasturelands and reaches surface waters even when the manure comes from a zero-runoff feedlot.

Individuals on domestic wastewater sewers within each HUC10 were estimated by summing the population for all of the 2020 U.S. Census Block Centroid Population points that fall within census urban areas, which were assumed to be connected to the WWTPs in applicable drainage areas [U.S. Census Bureau, 2020]. Bacteria within wastewater in urban areas with a WWTP were assumed to be treated according to the WWTP's permit requirement.

People using an OWTS were estimated by Larimer and Weld Counties' OWTS [Larimer County, 2024; Fischer, 2023] within each HUC10 and multiplying the total by 3.31, which is the number of individuals assumed to be on each OWTS in the applicable counties [Thomas, 2024]. This evaluation represents all OWTSs, including compliant systems.

Pet populations were estimated by calculating the number of households from the 2020 U.S. Census Block Centroid Population points within each applicable impairment drainage area and assuming 0.58 dogs (36.5 percent of households times 1.6 dogs per household) and 0.64 cats (30.4 percent of households times 2.1 cats per household) per household [American Veterinary Medical Association, 2016].

Table 5-7 summarizes the number of animals, estimated *E. coli* produced, and percent of the total *E. coli* from each animal type within each HUC10. These estimates provide watershed managers with the relative magnitudes of total production by source and do not account for treatment by WWTPs or OWTSs, wash off, delivery, instream growth, or die-off dynamics that occur with *E. coli* and substantially affect their delivery to surface waters. Because of water treatment, far less *E. coli* are generally discharged from WWTPs than what is produced and sent to them.

Several factors affect whether *E. coli* reach a stream. The analysis illustrates that across the entire project area, the amount of *E. coli* produced by livestock is substantially greater than the *E. coli* produced by humans or pets. Only one HUC10, 1019000606 (Outlet Big Thompson River), has a higher production from humans or pets than from livestock. Both Larimer and Weld Counties are Right-to-Farm counties, which protects certain types of operations from nuisance suits when their activities impact neighboring property through activities like noise or odor.

Table 5-7. Estimated Number of Animals, *E. coli* Produced, and Percent of *E. coli* Produced in Each HUC10 (Page 1 of 3)

HUC10	Description	Category	Subcategory	Count	Total *E. coli* Produced (cfu/day)	Total *E. coli* Produced (%)
1019000601	North Fork Big Thompson River	Humans	OWTS	2,880	3.6E+12	15
1019000601	North Fork Big Thompson River	Humans	WWTP	0	0.0E+00	0
1019000601	North Fork Big Thompson River	Pets	Dogs	505	1.6E+12	7
1019000601	North Fork Big Thompson River	Pets	Cats	557	1.8E+12	7
1019000601	North Fork Big Thompson River	Livestock	Cattle	678	1.4E+13	58
1019000601	North Fork Big Thompson River	Livestock	Horses	102	2.7E+12	11
1019000601	North Fork Big Thompson River	Livestock	Poultry	126	7.4E+09	0
1019000601	North Fork Big Thompson River	Livestock	Sheep	41	3.1E+11	1
1019000601	North Fork Big Thompson River	Livestock	Goats	0	0.0E+00	0
1019000601	North Fork Big Thompson River	Livestock	Hogs	6	3.4E+10	0
1019000602	Headwaters Big Thompson River	Humans	OWTS	4,737	6.0E+12	7
1019000602	Headwaters Big Thompson River	Humans	WWTP	13,644	1.7E+13	19
1019000602	Headwaters Big Thompson River	Pets	Dogs	3,221	1.0E+13	11
1019000602	Headwaters Big Thompson River	Pets	Cats	3,554	1.1E+13	13
1019000602	Headwaters Big Thompson River	Livestock	Cattle	1,734	3.6E+13	41
1019000602	Headwaters Big Thompson River	Livestock	Horses	263	7.0E+12	8
1019000602	Headwaters Big Thompson River	Livestock	Poultry	324	1.9E+10	0
1019000602	Headwaters Big Thompson River	Livestock	Sheep	103	7.8E+11	1
1019000602	Headwaters Big Thompson River	Livestock	Goats	1	1.8E+10	0
1019000602	Headwaters Big Thompson River	Livestock	Hogs	16	8.9E+10	0
1019000603	Buckhorn Creek	Humans	OWTS	6,041	7.6E+12	16

Table 5-7. Estimated Number of Animals, *E. coli* Produced, and Percent of *E. coli* Produced in Each HUC10 (Page 2 of 3)

HUC10	Description	Category	Subcategory	Count	Total *E. coli* Produced (cfu/day)	Total *E. coli* Produced (%)
1019000603	Buckhorn Creek	Humans	WWTP	0	0.0E+00	0
1019000603	Buckhorn Creek	Pets	Dogs	1,059	3.3E+12	7
1019000603	Buckhorn Creek	Pets	Cats	1,168	3.7E+12	8
1019000603	Buckhorn Creek	Livestock	Cattle	1,263	2.6E+13	56
1019000603	Buckhorn Creek	Livestock	Horses	190	5.0E+12	11
1019000603	Buckhorn Creek	Livestock	Poultry	237	1.4E+10	0
1019000603	Buckhorn Creek	Livestock	Sheep	75	5.7E+11	1
1019000603	Buckhorn Creek	Livestock	Goats	2	3.5E+10	0
1019000603	Buckhorn Creek	Livestock	Hogs	12	6.7E+10	0
1019000604	Headwaters Little Thompson River	Humans	OWTS	5,571	7.0E+12	24
1019000604	Headwaters Little Thompson River	Humans	WWTP	0	0.0E+00	0
1019000604	Headwaters Little Thompson River	Pets	Dogs	976	3.1E+12	10
1019000604	Headwaters Little Thompson River	Pets	Cats	1,077	3.4E+12	11
1019000604	Headwaters Little Thompson River	Livestock	Cattle	616	1.3E+13	43
1019000604	Headwaters Little Thompson River	Livestock	Horses	107	2.8E+12	10
1019000604	Headwaters Little Thompson River	Livestock	Poultry	109	6.4E+09	0
1019000604	Headwaters Little Thompson River	Livestock	Sheep	39	2.9E+11	1
1019000604	Headwaters Little Thompson River	Livestock	Goats	3	5.3E+10	0
1019000604	Headwaters Little Thompson River	Livestock	Hogs	8	4.6E+10	0
1019000605	Dry Creek-Little Thompson River	Humans	OWTS	10,923	1.4E+13	8
1019000605	Dry Creek-Little Thompson River	Humans	WWTP	16,719	2.1E+13	12

Table 5-7. Estimated Number of Animals, *E. coli* Produced, and Percent of *E. coli* Produced in Each HUC10 (Page 3 of 3)

HUC10	Description	Category	Subcategory	Count	Total *E. coli* Produced (cfu/day)	Total *E. coli* Produced (%)
1019000605	Dry Creek-Little Thompson River	Pets	Dogs	4,844	1.5E+13	9
1019000605	Dry Creek-Little Thompson River	Pets	Cats	5,345	1.7E+13	10
1019000605	Dry Creek-Little Thompson River	Livestock	Cattle	4,217	8.8E+13	50
1019000605	Dry Creek-Little Thompson River	Livestock	Horses	366	9.7E+12	6
1019000605	Dry Creek-Little Thompson River	Livestock	Poultry	17,543	1.0E+12	1
1019000605	Dry Creek-Little Thompson River	Livestock	Sheep	1,185	9.0E+12	5
1019000605	Dry Creek-Little Thompson River	Livestock	Goats	4	7.1E+10	0
1019000605	Dry Creek-Little Thompson River	Livestock	Hogs	54	3.1E+11	0
1019000606	Outlet Big Thompson River	Humans	OWTS	20,406	2.6E+13	6
1019000606	Outlet Big Thompson River	Humans	WWTP	10,2445	1.3E+14	30
1019000606	Outlet Big Thompson River	Pets	Dogs	21,527	6.8E+13	16
1019000606	Outlet Big Thompson River	Pets	Cats	23,754	7.5E+13	17
1019000606	Outlet Big Thompson River	Livestock	Cattle	5,453	1.1E+14	26
1019000606	Outlet Big Thompson River	Livestock	Horses	491	1.3E+13	3
1019000606	Outlet Big Thompson River	Livestock	Poultry	17,150	1.0E+12	0
1019000606	Outlet Big Thompson River	Livestock	Sheep	1,210	9.1E+12	2
1019000606	Outlet Big Thompson River	Livestock	Goats	5	8.8E+10	0
1019000606	Outlet Big Thompson River	Livestock	Hogs	54	3.0E+11	0

5.3 HEAVY METALS

Heavy metal sources are typically from abandoned mines, runoff from developed areas, and contributions from soils. Heavy metals that can be sourced from irrigation on Pierre Shale areas (selenium and arsenic) would also benefit from changing irrigation practices. Flood irrigation typically results in substantial irrigation return flows, which can be high in selenium or arsenic when soils in the irrigated fields have high selenium or arsenic content. The conversion to more modern center-pivot and side-roll sprinkler systems would help decrease the volume of selenium or arsenic-rich return flows entering waterbodies [Hawley and Rodriguez-Jeangros, 2021].

Heavy metals are also not addressed with PLET. Larimer and Weld Counties have a rich mining history dating back to the mid-1800s. Commodities consisting of beryllium, coal, copper, gold, iron, lead, manganese, molybdenum, rare earth elements, silica, silver, tungsten, uranium, vanadium, and zinc were mined [The Diggings, 2024].

Sources of some heavy metals, according to a publication within Heliyon on ScienceDirect [Briffa et al., 2020] and the *Big Thompson State of the Watershed 2021 Final Report* [Hawley and Rodriguez-Jeangros, 2021], also include:

- Zinc – mining and metal/paint/cosmetic/energy/hygiene/plastic/textile/supplement production
- Lead – metal/infrastructure/paint/glass production, manufacturing processes, and combustion of gas
- Selenium – animal feed/supplement production, manufacturing processes, fossil fuel combustion, and irrigation return flows in areas with Pierre Shale
- Arsenic – pressure-treated wood, glass/pesticide production, doping, pyrotechnics, and Pierre Shale
- Copper – copper sulfate algicide, alloy manufacturing processes, metal/fertilizer/chemical/jewelry production, and wood/fabric preservation
- Iron – mining, manufacturing processes, and metal/supplement/food production
- Manganese – alloy manufacturing processes, metal/fertilizer/firework/pesticide/cosmetic production
- Mercury – chemistry, chemical manufacturing processes, and pesticide/paint/energy production

The CDPHE Water Quality Control Commission has designated several streams within both counties as impaired (see Clean Water Act [CWA] Section 303(d) list and 5 CCR 1002-93) for these elements (Table 4-1), suggesting that mined lands or AMLs are a potential source of NPS pollution. Several federal and state agencies have mapped and cataloged abandoned mines within Colorado and quantified the AMLs in Larimer and Weld Counties. To determine areas most likely polluted by AMLs, known AML locations were summarized per HUC10. Although not all AMLs have been discovered and mapped, an assumption was made that the more points in a HUC10, the more likely that HUC10 was polluted by AMLs. Table 5-8 lists the number of AMLs for each HUC10 [Graves, 2024].

Table 5-8. Number of Identified Abandoned Mine Lands per HUC10

HUC10	Description	Count
1019000601	North Fork Big Thompson River	5
1019000602	Headwaters Big Thompson River	1
1019000603	Buckhorn Creek	4
1019000604	Headwaters Little Thompson River	0
1019000605	Dry Creek-Little Thompson River	0
1019000606	Outlet Big Thompson River	3

In *Colorado's Nonpoint Source Program: 2022 Annual Report* [Moore, 2022], the recommended BMPs associated with pollution from AMLs are hydrologic controls (diversion ditches, mine tailings removal, erosion and sediment control, and revegetation) and passive treatments (aerobic wetlands, anaerobic wetlands, and aeration and settling ponds).

In the Big and Little Thompson project area, the detailed geology layers mapping Pierre Shale did not intersect HUC10 1019000601 or 1019000602, and very little intersected 1019000603. The geology layers [Brandt and Colgan, 2023; Workman et al., 2018] include the majority of Pierre Shale in Larimer and Weld Counties. Of the watersheds where layers are available, most of the Pierre Shale is not irrigated. Every HUC10 in the project area has selenium and/or arsenic impairments. Non-irrigated Pierre Shale is also likely to be contributing to the impairments, or other unknown sources are likely present. Table 5-9 summarizes the acres of irrigation, irrigation type, and Pierre Shale (where information was available) throughout the project area.

Table 5-9. Acres of Irrigation and Pierre Shale

HUC10	Irrigated, Not Pierre Shale		Irrigated, Pierre Shale		Not Irrigated, Pierre Shale (acres)
	Flood (acres)	Sprinkler (acres)	Flood (acres)	Sprinkler (acres)	
1019000602	91	N/A	N/A	N/A	N/A
1019000603	456	138	N/A	N/A	33
1019000605	13,376	8,248	728	360	6,212
1019000606	12,729	7,700	709	182	7,373

6.0 PRIORITY AREAS FOR IMPLEMENTATION

Priority areas are locations that significantly contribute to the water quality parameters identified as pollutants of concern. The following sources were used to identify priority areas for BMP implementation:

- PLET model (for nutrients and sediment)
- production per HUC10 assessment (for *E. coli*)
- AML density assessment (for heavy metals)

Point source permittees should compare the cost options of upstream NPS BMPs to the cost of mechanical treatment. Such collaborations and coordinated efforts may improve economic feasibility for improving water quality regionally.

6.1 NUTRIENTS AND SEDIMENT

The PLET model indicates that throughout the entire Big Thompson River HUC8 within Larimer and Weld Counties, the primary source of nutrients and sediment is cropland; however, cropland only makes up approximately 12 percent of the total area. Figures 6-1, 6-2, and 6-3 show the total daily loads per HUC10 of nitrogen, phosphorus, and TSS, respectively, from PLET [EPA, 2022]. Priority areas for the reduction of nutrients and sediment are HUC10s 1019000605 (Dry Creek-Little Thompson River) and 1019000606 (Outlet Big Thompson River) on cropland. The source figures from PLET only represent areas that are not MS4s. Data trends from Hawley and Rodriguez-Jeangros [2021] show similar trends for nutrients and sediment as PLET results, with nutrients and sediment increasing in the lower watersheds. No reaches are impaired for total nitrogen, total phosphorus, or sediment in Table 4-1; however, all should be protected so that they do not become impaired over time.

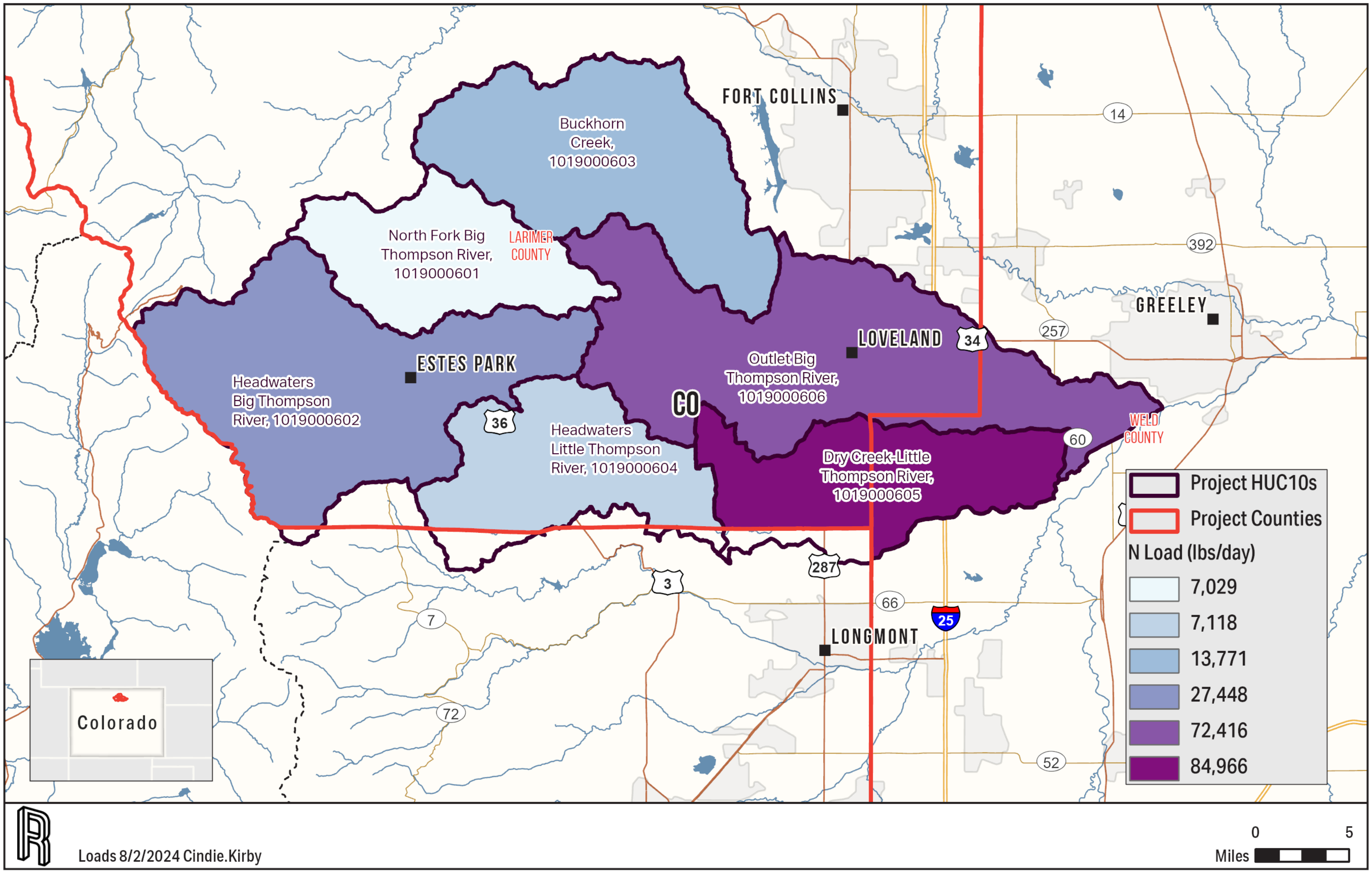


Figure 6-1. Nitrogen Contributions per HUC10.

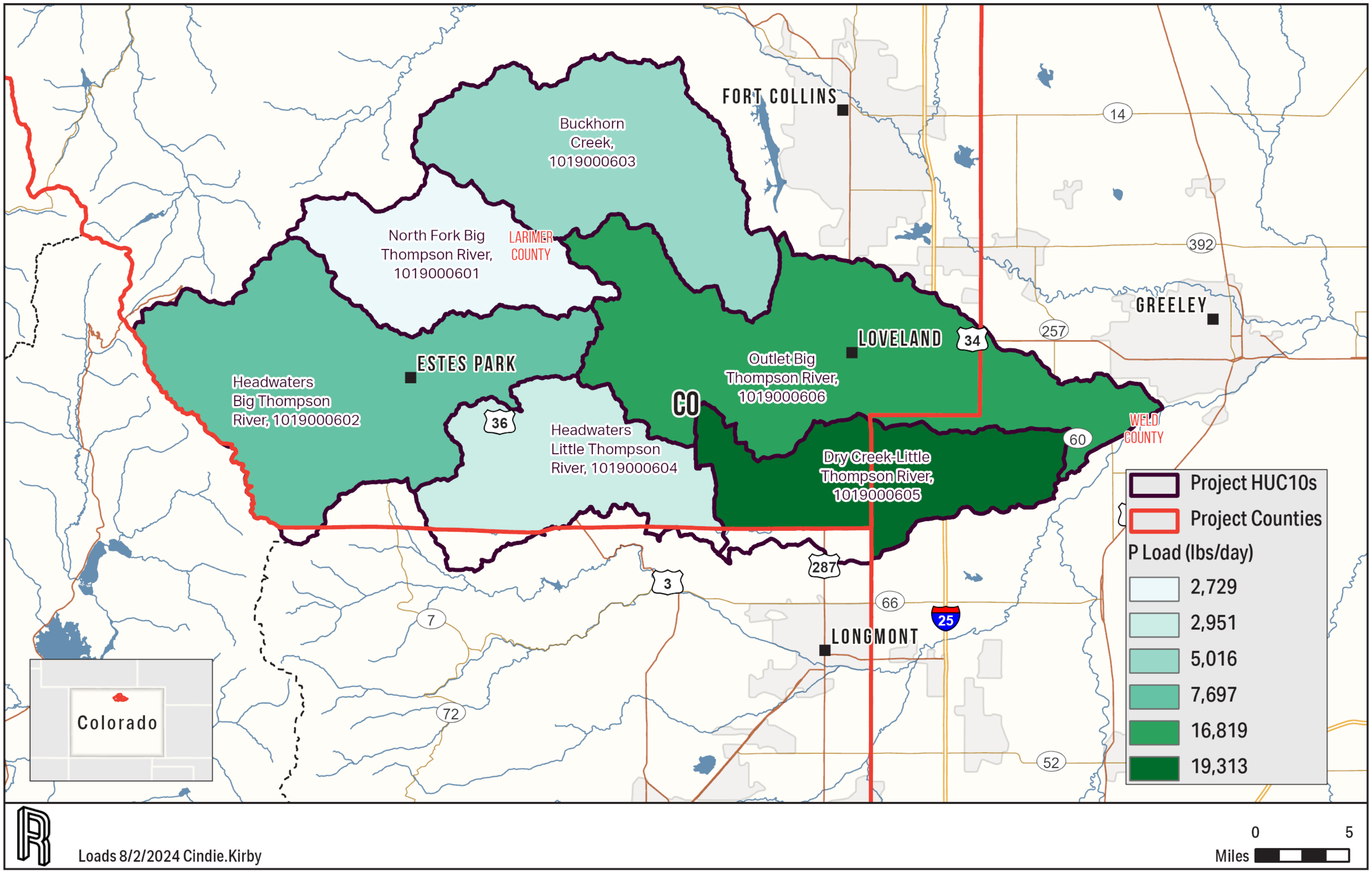


Figure 6-2. Phosphorus Contributions per HUC10.

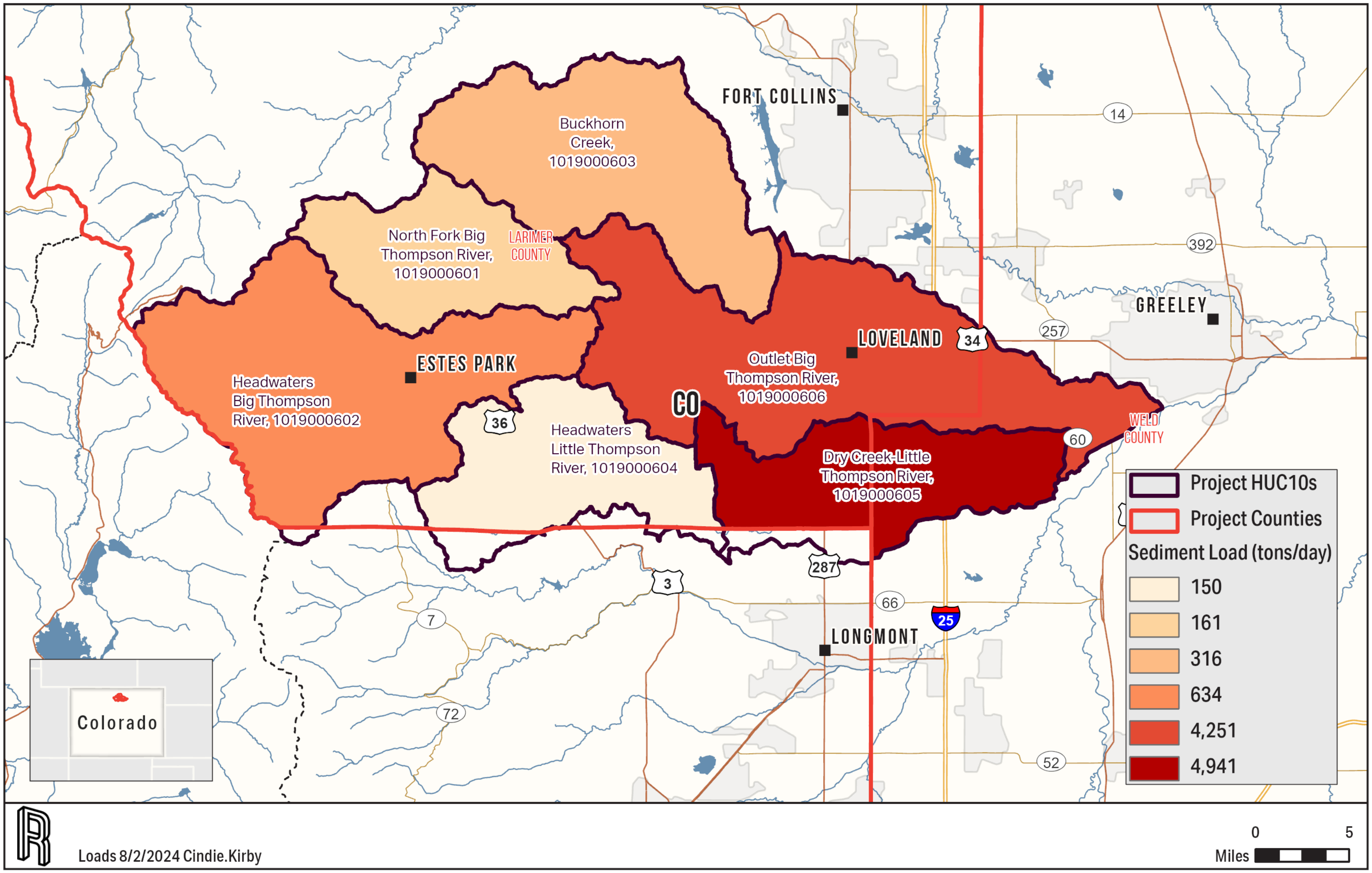


Figure 6-3. Sediment Contributions per HUC10.

6.2 E. COLI

The bacteria production assessment revealed that, overall, throughout the Big Thompson River HUC8, cattle are the primary producers of bacteria. Figure 6-4 provides the total production of bacteria per HUC10 based on the assessment within GIS. Priority areas for reduction of *E. coli* are HUC10s 1019000605 (Dry Creek-Little Thompson River) and 1019000606 (Outlet Big Thompson River) because they have the highest production rates overall. Practices related to cattle exclusion from streams, such as fencing, off-stream watering, and seasonal riparian area management, should be a priority in these watersheds. The *E. coli*-impaired waterbodies align well with the bacteria production analysis and exist in HUC10s 1019000605 (Dry Creek-Little Thompson River) and 1019000606 (Outlet Big Thompson River). The *E. coli*-impaired waterbodies in Table 4-1 are located in the priority areas.

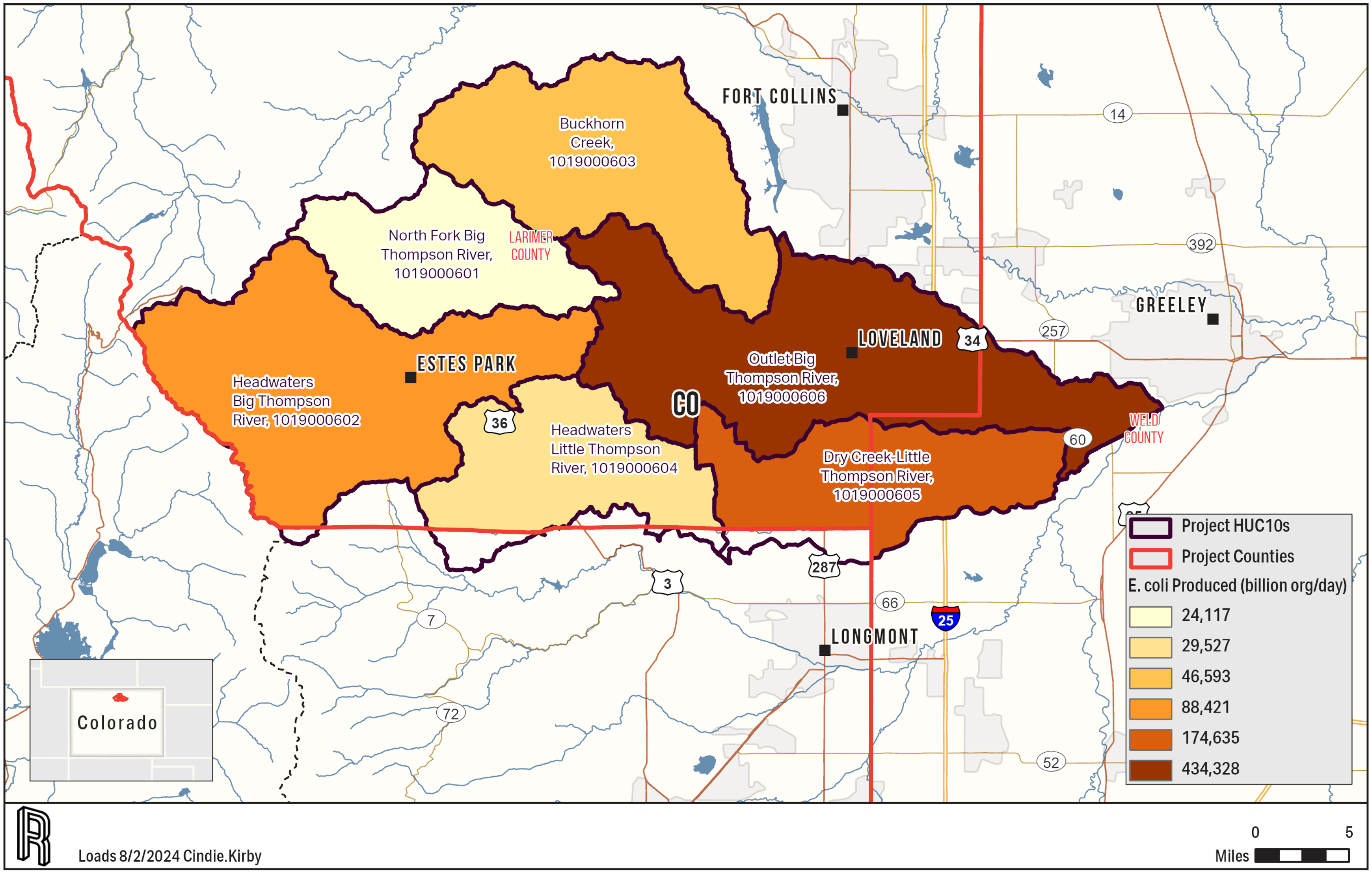


Figure 6-4. Bacteria Produced per HUC10.

6.3 HEAVY METALS

The AML density identified HUC10s 1019000601 (North Fork Big Thompson River) and 1019000603 (Buckhorn Creek) as the HUC10 watersheds with the highest densities of AMLs; therefore, they should be the primary targets (priority areas) in continuing AML identification and practice implementation to reduce heavy metals in waters. Waterbodies impaired with heavy metals for aquatic life constituents (dissolved copper, selenium, and zinc; and total mercury and iron) align well with the AML density analysis and exist in the HUC10 watersheds with identified AMLs. Similarly, waterbodies impaired with heavy metals for water supply constituents (dissolved manganese and total arsenic) occur in all HUC10 watersheds, whether or not AMLs were identified. The density of AMLs per square mile is illustrated in Figure 6-5 [Graves, 2024]. Priority watersheds for heavy metal-reducing BMPs should be the areas with the highest density of AMLs. Additionally, where selenium- and arsenic-impaired waters exist with high levels of irrigated lands on Pierre Shale, more efficient irrigation practices should be considered a priority, especially in areas draining to the arsenic/selenium impaired waters shown in Table 4-1.

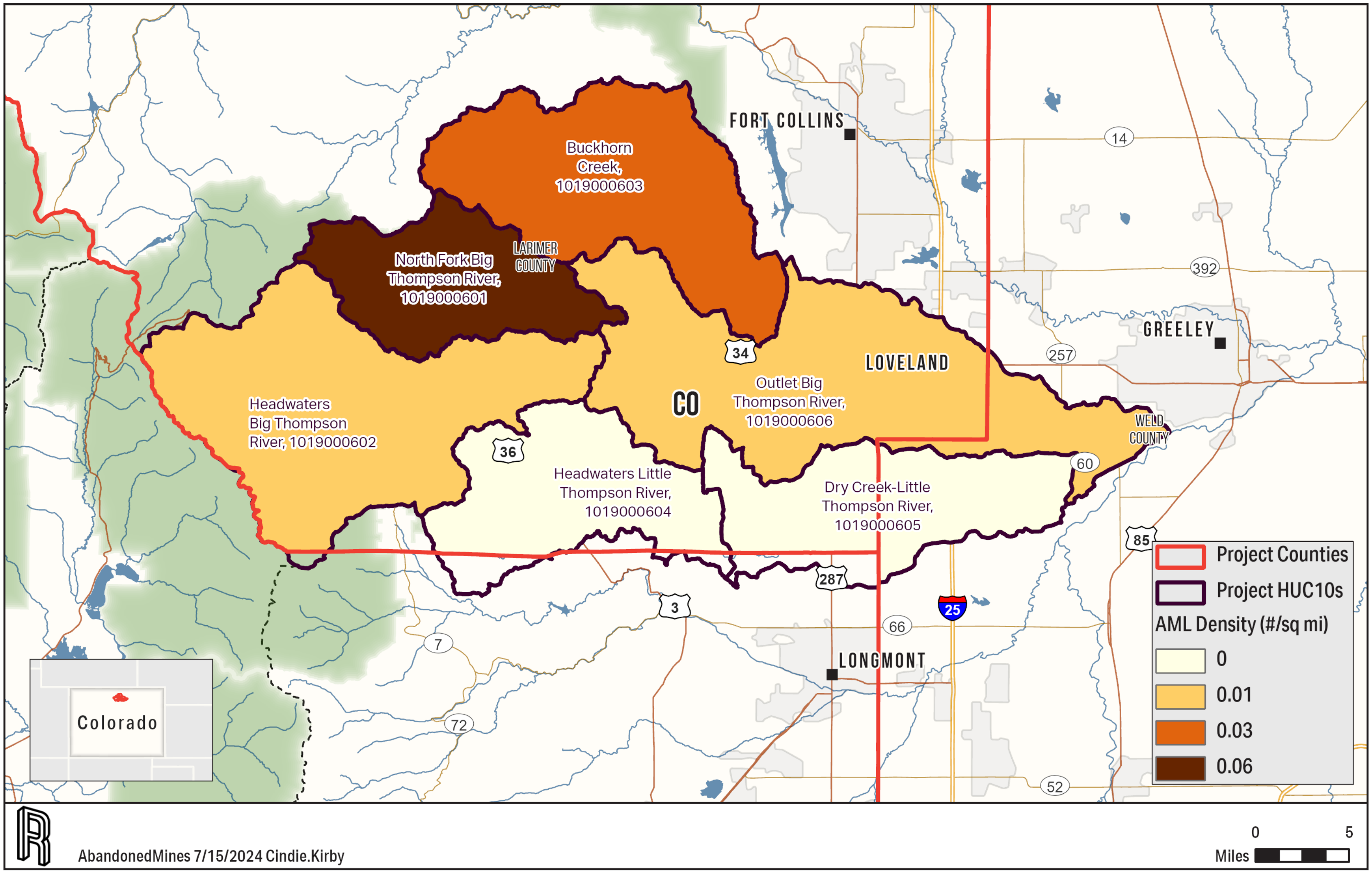


Figure 6-5. Density of Abandoned Mine Lands for Each HUC10.

7.0 BEST MANAGEMENT PRACTICES LOAD REDUCTIONS

Numerous resources exist in Colorado and nationally that provide information on BMPs. Some give data about implementation, and others inform on expected load reductions. Understanding that most BMPs require maintenance over time to remain effective is important. Some BMPs also need individuals to operate them for effectiveness. The Community-enabled Lifecycle Analysis of Stormwater Infrastructure Costs (CLASIC) tool is available on the CLASIC website and provides more information about life cycles of some stormwater BMPs. The following websites were used to summarize the overall BMP options:

- Colorado Department of Agriculture BMPs
- Colorado Water Conservation Board Floodplain Stormwater and Criteria Manual
- Colorado Water Conservation Board BMPs
- Colorado Waterwise Guidebook of Best Practices for Municipal Water Conservation in Colorado
- Colorado Ag Water Quality BMPs for Colorado
- Colorado Forestry Best Management Practices 2018 Field Monitoring Report
- Colorado Wetland Information Center Wetland BMPs
- Colorado Stormwater Center
- Colorado Department of Transportation Permanent Water Quality Program
- Upper South Platte BMPs for Protecting Source Water Quality
- International Stormwater BMP Database
- One Water Solutions Institute
- EPA Menu of Stormwater BMPs
- USDA Stream Restoration Manual
- Natural Resources Conservation Service Conservation Practice Standards
- USDA Colorado Field Office Technical Guide
- Pollution Load Estimator Tool

7.1 NUTRIENTS AND SEDIMENT

For this project, nutrient and sediment BMPs available in PLET were prioritized using multiple metrics, including stakeholder input and BMP effectiveness. The BMP reduction factors for PLET BMPs are listed in Tables 7-1 through 7-5 for cropland, pastureland, feedlots, forest, and urban lands. The average of the nitrogen, phosphorus, and sediment reduction factors was the first metric used for prioritization. The average survey score based on Survey #2 results was the second metric. The final score, the reduction survey, was the product of the two metrics. The following practices were chosen and run in PLET based on reduction survey scores: the top two cropland, top two pasture, top feedlot, top two forest, and top three urban. These priority PLET practices for each respective land use are in bold under the column headings of Tables 7-1 through 7-5. The priority PLET practices were run on

25 percent of the modeled land cover they were developed for (i.e., cropland, pasture, feedlot, forest, urban). Associated reductions for each PLET practice run are provided in Table 7-6. Reductions at the HUC10 level are included in Appendix D. Several of the practice reduction factors suggest that reducing sediment loading would simultaneously reduce nutrient loading. PLET BMP descriptions and the reduction fractions can be found in the “Best Management Practice Definition Document for Pollution Load Estimation Tool” [EPA, 2023].

Table 7-1. PLET Cropland Best Management Practices and Average Reduction Metric

Practice	Nitrogen Reduction (Fraction)	Phosphorus Reduction (Fraction)	Sediment Reduction (Fraction)	Average Reduction[a] (Fraction)	Average Survey Score[b]	Reduction Survey Score[c]
Streambank Stabilization and Fencing	**0.75**	**0.75**	**0.75**	**0.75**	**2.0**	**1.5**
Buffer - Grass (35 feet wide)	**0.34**	**0.44**	**0.53**	**0.44**	**3.0**	**1.3**
Contour Farming	0.34	0.46	0.41	0.40	2.0	0.8
Terrace	0.27	0.31	0.41	0.33	2.0	0.7
Controlled Drainage	0.39	0.35	0	0.25	2.5	0.6
Conservation Tillage 1 (30-59% residue)	0.07	0.36	0.46	0.30	2.0	0.6
Conservation Tillage 2 (equal or more than 30% residue)	0.13	0.69	0.79	0.54	1.0	0.5
Nutrient Management 2 (determined rate plus additional considerations)	0.22	0.56	0	0.26	2.0	0.5
Buffer – Forest (100 feet wide)	0.49	0.47	0.6	0.52	1.0	0.5
Nutrient Management 1 (determined rate)	0.15	0.45	0	0.20	2.0	0.4
Bioreactor	0.45	0	0	0.15	1.0	0.2
Two-Stage Ditch	0.12	0.28	0	0.13	1.0	0.1
Cover Crop 1 (group A commodity; high till only for sediment)	0.0078	0	0	0.00	0.0	0.0
Cover Crop 2 (group A traditional normal planting time; high till only for total phosphorus and sediment)	0.2	0.07	0.1	0.12	0.0	0.0
Cover Crop 3 (group A traditional early planting time) (high till only for total phosphorus and sediment)	0.2	0.15	0.2	0.18	0.0	0.0

(a) Average Reduction is the product of the nitrogen, phosphorus, and sediment reduction.

(b) Average Survey Score is the average of the survey prioritization from Survey #2.

(c) The Survey Reduction Score is the product of the average reduction and the average survey score.

Table 7-2. PLET Pasture Best Management Practices and Average Reduction Metric

Practice	Nitrogen Reduction (Fraction)	Phosphorus Reduction (Fraction)	Sediment Reduction (Fraction)	Average Reduction[a] (Fraction)	Average Survey Score[b]	Reduction Survey Score[c]
Streambank Stabilization and Fencing	**0.75**	**0.75**	**0.75**	**0.75**	**3.0**	**2.3**
Buffer – Grass (minimum 35 feet wide)	**0.87**	**0.89**	**0.65**	**0.80**	**2.8**	**2.2**
Livestock Exclusion Fencing	0.2	0.43	0.64	0.42	3.4	1.4
Buffer – Forest (minimum 35 feet wide)	0.45	0.4	0.53	0.46	2.2	1.0
Streambank Protection Without Fencing	0.15	0.22	0.58	0.32	2.8	0.9
Critical Area Planting	0.18	0.2	0.42	0.27	3.3	0.9
Grazing Land Management (rotational grazing with fenced areas)	0.43	0.26	0	0.23	3.8	0.9
Heavy Use Area Protection	0.18	0.19	0.33	0.23	3.5	0.8
Prescribed Grazing	0.41	0.23	0.33	0.32	2.5	0.8
Multiple Practices	0.25	0.2	0.22	0.22	3.6	0.8
Winter Feeding Facility	0.35	0.4	0.4	0.38	2.0	0.8
Use Exclusion	0.43	0.08	0.51	0.34	1.7	0.6
30-meter Buffer With Optimal Grazing	0.16	0.65	0	0.27	1.5	0.4
Alternative Water Supply	0.18	0.13	0.2	0.17	2.0	0.3
Pasture and Hayland Planting (also called Forage Planting)	0.18	0.15	0	0.11	3.0	0.3
Litter Storage and Management	0.14	0.14	0	0.09	3.4	0.3

(a) Average Reduction is the product of the nitrogen, phosphorus, and sediment reduction.

(b) Average Survey Score is the average of the survey prioritization from Survey #2.

(c) The Survey Reduction Score is the product of the average reduction and the average survey score.

Table 7-3. PLET Feedlot Best Management Practices and Average Reduction Metric

Practice	Nitrogen Reduction (Fraction)	Phosphorus Reduction (Fraction)	Sediment Reduction (Fraction)	Average Reduction[(a)] (Fraction)	Average Survey Score[(b)]	Reduction Survey Score[(c)]
Waste Management System	**0.8**	**0.9**	**0**	**0.57**	**3.6**	**2.0**
Waste Storage Facility	0.65	0.6	0	0.42	3.6	1.5
Diversion	0.45	0.7	0	0.38	3.5	1.3
Terrace	0.55	0.85	0	0.47	2.8	1.3
Filter Strip	0	0.85	0	0.28	4.0	1.1
Runoff Management System	0	0.83	0	0.28	3.3	0.9
Solids Separation Basin With Infiltration Bed	0	0.8	0	0.27	3.0	0.8
Solids Separation Basin	0.35	0.31	0	0.22	3.0	0.7

(a) Average Reduction is the product of the nitrogen, phosphorus, and sediment reduction.

(b) Average Survey Score is the average of the survey prioritization from Survey #2.

(c) The Survey Reduction Score is the product of the average reduction and the average survey score.

Table 7-4. PLET Forest Best Management Practices and Average Reduction Metric

Practice	Nitrogen Reduction (Fraction)	Phosphorus Reduction (Fraction)	Sediment Reduction (Fraction)	Average Reduction[a] (Fraction)	Average Survey Score[b]	Reduction Survey Score[c]
Site Preparation/Straw/ Crimp Seed/Net	0	0	0.93	0.31	3.7	1.1
Site Preparation/Straw/ Crimp Seed/Fertilizer/ Transplants	0	0	0.95	0.32	3.0	1.0
Road Grass and Legume Seeding	0	0	0.71	0.24	3.7	0.9
Site Preparation/Straw/ Polymer/Seed/Fertilizer/ Transplants	0	0	0.86	0.29	3.0	0.9
Site Preparation/Hydro Mulch/Seed/Fertilizer	0	0	0.71	0.24	3.5	0.8
Site Preparation/Steep Slope Seeder/ Transplants	0	0	0.81	0.27	3.0	0.8
Site Preparation/Straw/ Net/Seed/Fertilizer/Tran splants	0	0	0.83	0.28	2.8	0.8
Site Preparation/Hydro Mulch/Seed/Fertilizer/ Transplants	0	0	0.69	0.23	3.2	0.7
Road Hydro Mulch	0	0	0.41	0.14	4.3	0.6
Road Tree Planting	0	0	0.5	0.17	3.4	0.6
Road Straw Mulch	0	0	0.41	0.14	4.0	0.5
Road Dry Seeding	0	0	0.41	0.14	3.6	0.5

(a) Average Reduction is the product of the nitrogen, phosphorus, and sediment reduction.

(b) Average Survey Score is the average of the survey prioritization from Survey #2.

(c) The Survey Reduction Score is the product of the average reduction and the average survey score.

Table 7-5. PLET Urban Best Management Practices and Average Reduction Metric (Page 1 of 2)

Practice	Nitrogen Reduction (Fraction)	Phosphorus Reduction (Fraction)	Sediment Reduction (Fraction)	Average Reduction[(a)] (Fraction)	Average Survey Score[(b)]	Reduction Survey Score[(c)]
Extended Wet Detention	**0.55**	**0.69**	**0.86**	**0.70**	**3.8**	**2.7**
Infiltration Basin	**0.6**	**0.65**	**0.75**	**0.67**	**3.3**	**2.2**
Concrete Grid Pavement	**0.9**	**0.9**	**0.9**	**0.90**	**2.3**	**2.1**
Low Impact Development - Infiltration Swale	0.5	0.65	0.9	0.68	2.9	2.0
Porous Pavement	0.85	0.65	0.9	0.80	2.2	1.8
Bioretention Facility	0.63	0.8	0	0.48	3.6	1.7
Infiltration Trench	0.55	0.6	0.75	0.63	2.6	1.6
Infiltration Devices	0	0.83	0.94	0.59	2.7	1.6
Vegetated Filter Strips	0.4	0.45	0.73	0.53	2.9	1.5
Settling Basin	0	0.52	0.82	0.45	3.3	1.5
Low Impact Development - Infiltration Trench	0.5	0.5	0.9	0.63	2.3	1.4
Dry Detention	0.3	0.26	0.58	0.38	3.7	1.4
Wetland Detention	0.2	0.44	0.78	0.47	2.9	1.4
Sand Filter/Infiltration Basin	0.35	0.5	0.8	0.55	2.5	1.4
Low Impact Development - Filter/Buffer Strip	0.3	0.3	0.6	0.40	3.3	1.3
Low Impact Development - Bioretention	0.43	0.81	0	0.41	3.1	1.3
Low Impact Development - Dry Well	0.5	0.5	0.9	0.63	1.9	1.2
Grass Swales	0.1	0.25	0.65	0.33	3.5	1.2
Alum Treatment	0.6	0.9	0.95	0.82	1.4	1.1
Wet Pond	0.35	0.45	0.6	0.47	2.3	1.1
Sand Filters	0	0.38	0.83	0.40	2.6	1.0
Low Impact Development - Wet Swale	0.4	0.2	0.8	0.47	2.1	1.0
Water Quality Inlet With Sand Filter	0.35	0	0.8	0.38	2.5	1.0
Low Impact Development - Vegetated Swale	0.08	0.18	0.48	0.25	3.3	0.8

Table 7-5. PLET Urban Best Management Practices and Average Reduction Metric (Page 2 of 2)

Practice	Nitrogen Reduction (Fraction)	Phosphorus Reduction (Fraction)	Sediment Reduction (Fraction)	Average Reduction[a] (Fraction)	Average Survey Score[b]	Reduction Survey Score[c]
Filter Strip – Agricultural	0.53	0.61	0.65	0.60	1.3	0.8
Water Quality Inlets	0.2	0.09	0.37	0.22	3.3	0.7
Oil/Grit Separator	0.05	0.05	0.15	0.08	3.7	0.3
Weekly Street Sweeping	0	0.06	0.16	0.07	2.9	0.2

(a) Average Reduction is the product of the nitrogen, phosphorus, and sediment reduction.

(b) Average Survey Score is the average of the survey prioritization from Survey #2.

(c) The Survey Reduction Score is the product of the average reduction and the average survey score.

Table 7-6. Reductions From Priority PLET Best Management Practices Run on 25 Percent of Each Applicable Land Cover

Land Use	Percent of Total Area	Practice	Nitrogen Load (lb/year)	Nitrogen Reduction (%)	Phosphorus Load (lb/year)	Phosphorus Reduction (%)	Sediment Load (tons/year)	Sediment Reduction (%)
All	N/A	Base Load (no BMPs)	212,748	N/A	54,524	N/A	10,452	N/A
Cropland	12	Stream Stabilization and Fencing	192,456	9.5	49,586	9.1	8,922	14.6
Cropland	12	Buffer - Grass (35 feet wide)	202,308	4.9	51,401	5.7	9,370	10.4
Pasture	1	Stream Stabilization and Fencing	211,379	0.6	54,396	0.2	10,426	0.3
Pasture	1	Livestock Exclusion Fencing	212,311	0.2	54,437	0.2	10,429	0.2
Feedlot	<1	Waste Management System	209,686	1.4	53,835	1.3	10,452	0.0
Forest	66	Site Prep/Straw/ Crimp Seed/Net	212,349	0.2	54,371	0.3	10,327	1.2
Forest	66	Site Prep/Straw/ Crimp Seed/Fertilizer/ Transplants	212,341	0.2	54,367	0.3	10,324	1.2
Urban	6	Extended Wet Detention	209,149	1.7	53,811	1.3	10,230	2.1
Urban	6	Infiltration Basin	208,822	1.9	53,853	1.2	10,258	1.9
Urban	6	Concrete Grid Pavement	206,859	2.8	53,594	1.7	10,219	2.2

lb/year = pounds per year

Numerous BMPs that reduce nutrient and sediment NPS loads exist from other sources not included in PLET. Nutrient and sediment load reductions from BMPs are ranked in the Natural Resources Conservation Service (NRCS) Conservation Practice Physical Effects (CPPE) [NRCS, 2024b] as substantial, moderate to substantial, moderate, slight to moderate, and slight. Similarly, reductions expected from urban practices are provided in the International Stormwater BMP Database (BMPDB) [The Water Research Foundation, 2024]. Tables 7-7 and 7-8 list the most effective CPPE practices (i.e., substantial, moderate to substantial, and moderate reductions) and urban practices for sediment reduction. Table 7-9 shows the most effective CPPE practices (i.e., substantial, moderate to substantial, and moderate reductions) for nutrient reduction, and Tables 7-10 and 7-11 provide the urban practices for nitrogen and phosphorus reduction, respectively [NRCS, 2024b]. Irrigation practices are important in the project area for the reduction of nutrients and sediment but were not available in PLET. The NRCS Irrigation Water Management practice code Number 449 has slight to moderate improvement (less than every other practice listed in CPPE practices tables) for sediment and nutrients. However, the NRCS Irrigation Water Management practice code Number 449 has been added to these tables because of its high usage in the project area. Other practices with slight to moderate improvement should not be discouraged, even though they are not included in the tables in this section.

Table 7-7. Most Effective Sediment to Surface Water Reducing Agricultural Best Management Practices From the Colorado Natural Resources Conservation Service Conservation Practice Physical Effects (Page 1 of 2)

Practice	Practice Code	Unit	Effect	Rationale
Constructed Wetland	656	Acre	Substantial Improvement	The system traps and holds suspended materials from entering surface waters.
Filter Strip	393	Acre	Substantial Improvement	Vegetation protects the soil surface and traps sediment, nutrients, and other materials.
Grassed Waterway	412	Acre	Substantial Improvement	Erosion is controlled, vegetation traps sediment, and runoff is delivered at a safe velocity.
Lined Waterway or Outlet	468	Feet	Substantial Improvement	Erosion is controlled, vegetation traps sediment, and runoff is delivered at a safe velocity.
Riparian Forest Buffer	391	Acre	Substantial Improvement	Vegetation protects the soil surface and traps sediment, nutrients, and other materials.
Anionic Polyacrylamide Erosion Control	450	Acre	Moderate to Substantial Improvement	The action reduces erosion and sediment load.
Conservation Cover	327	Acre	Moderate to Substantial Improvement	Less erosion and runoff reduce sediment.
Critical Area Planting	342	Acre	Moderate to Substantial Improvement	Vegetation reduces erosion and sediment delivery.
Forest Farming	379	Acre	Moderate to Substantial Improvement	Varied canopy layers and surface cover and organic matter management reduce sediment-laden runoff from reaching surface water conveyances.
Grazing Land Mechanical Treatment	548	Acre	Moderate to Substantial Improvement	Improved hydrologic indicators increase infiltration and decrease runoff.
Land Reclamation, Abandoned Mined Land	543	Acre	Moderate to Substantial Improvement	Erosion control and revegetation reduces concerns about sediments.
Land Reclamation, Currently Mined Land	544	Acre	Moderate to Substantial Improvement	Erosion control and revegetation reduces concerns about sediments.
Land Reclamation, Landslide Treatment	453	N/A	Moderate to Substantial Improvement	Erosion control and increased cover reduces runoff and sediment.
Residue and Tillage Management, No Till	329	Acre	Moderate to Substantial Improvement	Less erosion and runoff reduce the transport of sediment.
Riparian Herbaceous Cover	390	Acre	Moderate to Substantial Improvement	Vegetation protects the soil surface and traps sediment, nutrients, and other materials.
Sediment Basin	350	N/A	Moderate to Substantial Improvement	The basin retains sediment, decreasing runoff turbidity.
Stormwater Runoff Control	570	N/A	Moderate to Substantial Improvement	Controlling erosion and runoff reduces off-site sediment.
Vegetative Barrier	601	Feet	Moderate to Substantial Improvement	Vegetation slows runoff and filters sediment.
Water and Sediment Control Basin	638	N/A	Moderate to Substantial Improvement	The basin retains sediment and minimizes turbidity.
Access Control	472	Acre	Moderate Improvement	Excluding animals, people, and vehicles influences the vigor and health of vegetation and soil conditions, reducing sediment supply to surface waters when applied with other management practices.
Alley Cropping	311	Acre	Moderate Improvement	Vegetation inhibits sediment-laden water to allow it to drop sediment load.
Conservation Crop Rotation	328	Acre	Moderate Improvement	Depending on crop rotation and biomass produced, crop rotation reduces erosion and runoff, which reduces transport of sediment.
Contour Buffer Strips	332	Acre	Moderate Improvement	Contour buffer strips reduce sheet and rill erosion and slow the velocity of runoff, thereby reducing the transport of sediment to surface water.

Table 7-7. Most Effective Sediment to Surface Water Reducing Agricultural Best Management Practices From the Colorado Natural Resources Conservation Service Conservation Practice Physical Effects (Page 2 of 2)

Practice	Practice Code	Unit	Effect	Rationale
Contour Orchard and Other Perennial Crops	331	Acre	Moderate Improvement	Contouring reduces sheet and rill erosion and slows the velocity of runoff, thereby reducing the transport of sediment to surface water.
Field Border	386	Feet	Moderate Improvement	Vegetation protects the soil surface and traps sediment.
Residue and Tillage Management, Reduced Till	345	Acre	Moderate Improvement	Less erosion and runoff reduce the transport of sediment.
Road/Trail/Landing Closure and Treatment	654	Feet	Moderate Improvement	Vegetation and other treatments reduce erosion and sediment delivery.
Silvopasture	381	Acre	Moderate Improvement	On sites that previously lacked permanent vegetation, establishing a combination of trees or shrubs and compatible forages reduces the erosive force of water and reduces sedimentation.
Stripcropping	585	Acre	Moderate Improvement	Stripcropping reduces erosion and slows water and wind velocities, increasing infiltration.
Surface Roughening	609	Acre	Moderate Improvement	The formation of clods reduces wind-borne sediment.
Tree/Shrub Establishment	612	Acre	Moderate Improvement	Vegetation provides cover, reduces wind velocities, and increases infiltration.
Wetland Wildlife Habitat Management	644	Acre	Moderate Improvement	Improved vegetative cover reduces runoff and sedimentation.
Irrigation Water Management	449	Acre	Slight to Moderate Improvement	Water is applied at rates that minimize soil erosion.

Table 7-8. Most Effective Sediment (Greater Than 10 Percent) Reducing Urban Best Management Practices From the International Best Management Practice Database

BMP Category	Concentration In (mg/L)	Concentration Out (mg/L)	Reduction (%)
High-Rate Biofiltration	30.8	3.8	88
Media Filter	44	7.2	84
Bioretention	44	10	77
Retention Pond	49	12	76
Porous Pavement	77	22	71
Detention Basin	65.1	22	66
Wetland Basin	35.5	14	61
High-Rate Media Filtration	44	18	59
Oil-Grit Separator	36	15.5	57
Grass Strip	48	23	52
Grass Swale	26	13.7	47
Hydrodynamic Separator	63.9	39	39

mg/L = milligrams per liter

Table 7-9. Most Effective Nutrient to Surface Water Reducing Agricultural Best Management Practices From the Colorado Natural Resources Conservation Service Conservation Practice Physical Effects (Page 1 of 2)

Practice	Practice Code	Unit	Effect	Rationale
Filter Strip	393	Acre	Substantial Improvement	Solid organics and sediment-attached nutrients are filtered out; soluble nutrients infiltrate the soil and may be taken up by plants or used by soil organisms.
Nutrient Management	590	Acre	Substantial Improvement	The right amount, source, placement, and timing (4Rs) provide nutrients when plants need them most.
Riparian Forest Buffer	391	Acre	Substantial Improvement	Plants and soil organisms in the buffer will use nutrients; the buffer will filter out suspended particles to which nutrients are attached.
Riparian Herbaceous Cover	390	Acre	Substantial Improvement	Permanent vegetation will uptake excess nutrients.
Saturated Buffer	604	Feet	Substantial Improvement	The buffer removes 60-100% of nitrogen from drain pipe discharge.
Sediment Basin	350	N/A	Substantial Improvement	The action will tend to accumulate contaminants attached to sediments, and infiltrating waters will remove soluble contaminants.
Conservation Cover	327	Acre	Moderate to Substantial Improvement	Less erosion and runoff reduce the transport of nutrients; permanent cover can take up excess nutrients and convert them to stable organic forms.
Constructed Wetland	656	Acre	Moderate to Substantial Improvement	The action traps nutrients and organics, which are broken down and used by wetland plants.
Short-Term Storage of Animal Waste and Byproducts	318	Cu. Yard	Moderate to Substantial Improvement	Short-term storage provides flexibility in rate, timing, and location of waste application, with the potential for reductions of contaminants available for transport.
Vegetated Treatment Area	635	Acre	Moderate to Substantial Improvement	Infiltration and plant uptake in the treatment area will remove contaminants from polluted runoff and wastewater.
Waste Storage Facility	313	#	Moderate to Substantial Improvement	Storage provides flexibility in rate, timing, and location of waste application, with the potential for reductions of contaminants available for transport.
Waste Treatment Lagoon	359	#	Moderate to Substantial Improvement	Storage provides flexibility in rate, timing, and location of waste application, with the potential for reductions of contaminants available for transport.
Watering Facility	614	#	Moderate to Substantial Improvement	When used in place of an instream water source, this action decreases manure deposition in the stream.
Alley Cropping	311	Acre	Moderate Improvement	Plants and soil organisms uptake nutrients.
Conservation Crop Rotation	328	Acre	Moderate Improvement	Nitrogen-demanding or deep-rooted crops can remove excess nitrogen; legumes in rotation will provide slow-release nitrogen and reduce the need for additional nitrogen.
Denitrifying Bioreactor	605	#	Moderate Improvement	Reactors remove 30 to 60% of the nitrogen load coming from a drain pipe.
Diversion	362	Feet	Moderate Improvement	The action diverts surface water away from feedlots and reduces 5-day Biological Oxygen Demand (BOD5); total phosphorous and total nitrogen load to receiving surface waters.

Table 7-9. Most Effective Nutrient to Surface Water Reducing Agricultural Best Management Practices From the Colorado Natural Resources Conservation Service Conservation Practice Physical Effects (Page 2 of 2)

Practice	Practice Code	Unit	Effect	Rationale
Grazing Land Mechanical Treatment	548	Acre	Moderate Improvement	Modifications to soil conditions will increase infiltration and reduce runoff; improved plant growth will better use nutrients, decreasing the potential for losses in runoff.
Livestock Shelter Structure	576	#	Moderate Improvement	Moving livestock away from streams and riparian areas will decrease the probability of excess manure nutrients in the water.
Silvopasture	381	Acre	Moderate Improvement	Depending on previous vegetative conditions, whether forestland or pasture, the permanent silvopasture vegetation may take up comparatively greater amounts of nutrients.
Wetland Creation	658	Acre	Moderate Improvement	Wetland systems will use dissolved nutrients and trap sediment-attached nutrients and organics.
Wetland Enhancement	659	Acre	Moderate Improvement	Wetland systems will use dissolved nutrients and trap sediment-attached nutrients and organics.
Wetland Restoration	657	Acre	Moderate Improvement	Wetland systems will use dissolved nutrients and trap sediment-attached nutrients and organics.
Irrigation Water Management	449	Acre	Slight to Moderate Improvement	Water is applied at rates that reduce the potential for erosion and detachment, and minimize nutrient transport to surface water.

Table 7-10. Most Effective Nitrogen (Greater Than 10 Percent) Reducing Urban Best Management Practices From the International Best Management Practice Database

BMP Category	Concentration In (mg/L)	Concentration Out (mg/L)	Reduction (%)
High-Rate Media Filtration	1.88	1	47
Retention Pond	1.63	1.2	26
Bioretention	1.26	0.96	24
Wetland Channel	1.76	1.45	18
Media Filter	1.06	0.89	16
Grass Strip	1.47	1.27	14
Grass Swale	0.71	0.63	11

Table 7-11. Most Effective Phosphorus (Greater Than 10 Percent) Reducing Urban Best Management Practices From the International Best Management Practice Database

BMP Category	Concentration In (mg/L)	Concentration Out (mg/L)	Reduction (%)
Oil-Grit Separator	0.316	0.115	64
Retention Pond	0.246	0.12	51
High-Rate Biofiltration	0.099	0.05	49
Media Filter	0.165	0.09	45
Porous Pavement	0.17	0.1	41
High-Rate Media Filtration	0.12	0.08	33
Wetland Basin	0.17	0.122	28
Detention Basin	0.25	0.186	26
Hydrodynamic Separator	0.23	0.176	23

Practices associated with reducing wildfire impacts include susceptibility and post-fire hazard analyses and pre-disaster planning and mitigation. The susceptibility analysis includes determining the assets at risk from fire and the risk severity of post-fire impacts, such as flooding, loss of life, loss of property, damage to infrastructure, utility interruptions, and water quality and quantity issues. Post-fire hazards consist of flooding, sediment/hillslope erosion, debris flow, fluvial hazard zones, water quality issues, and risk to water infrastructure. Post-fire BMPs should involve slope stabilization and reforestation.

7.2 E. COLI

E. coli load reductions from BMPs are ranked in the NRCS CPPE as substantial, moderate to substantial, moderate, slight to moderate, and slight. Table 7-12 lists the most effective practices (i.e., substantial, moderate to substantial, and moderate reductions) [NRCS, 2024b]. *E. coli* reductions expected from the International BMPDB's urban practices are summarized in Table 7-13 [The Water Research Foundation, 2024]. Unlike the sediment and nutrient reductions, *E. coli* reductions are not quantified using the PLET model; therefore, priority BMPs should be those with the highest amount of reduction in the priority areas on the relative land cover. The NRCS Irrigation Water Management practice code Number 449 has slight to moderate improvement for bacteria, and it was included in Table 7-12 because of its high probability of installation. Practices with slight to moderate improvement should not be discouraged, even though they are not included in the tables in this section.

Table 7-12. Most Effective Bacteria (Pathogen) to Surface Water Reducing Agricultural Best Management Practices From the Colorado Natural Resources Conservation Service Conservation Practice Physical Effects

Practice	Practice Code	Unit	Effect	Rationale
Vegetated Treatment Area	635	Acre	Substantial Improvement	Infiltration and plant uptake in the treatment area will remove contaminants from polluted runoff and wastewater.
Constructed Wetland	656	Acre	Moderate to Substantial Improvement	Pathogens are trapped in the wetland.
Filter Strip	393	Acre	Moderate to Substantial Improvement	Filter strips capture and delay pathogen movement, but mortality may also be delayed because vegetative cover may protect pathogens from desiccation.
Nutrient Management	590	Acre	Moderate to Substantial Improvement	Proper application of manure, compost, and bio-solids should reduce or eliminate pathogens and/or chemicals (if present in source material) from moving into surface water.
Waste Treatment Lagoon	359	N/A	Moderate to Substantial Improvement	Storage provides flexibility in rate, timing, and location of waste application, with the potential for reductions of contaminants available for transport.
Alley Cropping	311	Acre	Moderate Improvement	Ground vegetation captures and delays pathogen movement and thereby increases their mortality.
Forest Farming	379	Acre	Moderate Improvement	Management of multi-layered canopy cover and organic matter impedes the movement of harmful pathogens.
Land Reclamation, Abandoned Mined Land	543	Acre	Moderate Improvement	Reconstructed mine land provides reduced runoff and erosion, and the filtering effects of vegetation reduce the risk of harmful levels of pathogens entering surface water.
Land Reclamation, Currently Mined Land	544	Acre	Moderate Improvement	Reconstructed mine land provides reduced runoff and erosion, and the filtering effects of vegetation reduce the risk of harmful levels of pathogens entering surface water.
Riparian Forest Buffer	391	Acre	Moderate Improvement	Riparian areas capture and delay pathogen movement and thereby increase their mortality.
Riparian Herbaceous Cover	390	Acre	Moderate Improvement	Vegetation traps pathogens providing increased opportunity for solar and microbial action to destroy some.
Irrigation Water Management	449	Acre	Slight to Moderate Improvement	Water is applied at rates that minimize pathogens transport to surface water.

Table 7-13. Most Effective *E. coli* (Greater Than 10 Percent) Reducing Urban Best Management Practices From the International Best Management Practice Database

BMP Category	Concentration In (mpn/100 mL)	Concentration Out (mpn/100 mL)	Reduction (%)
Wetland Basin	6,210	884	86
Retention Pond	4,110	708	83
Media Filter	570	215	62
Detention Basin	900	500	44
Bioretention	275	158	43
Hydrodynamic Separator	2,400	1,700	29

7.3 HEAVY METALS

Several risks are associated with abandoned mines. To prioritize public safety, specific locations of abandoned mines are not disclosed; however, taking action to mitigate potential dangers is important. The efforts of groups like Defense-Related Uranium Mines (DRUMs) are crucial in sealing off dangerous openings, identifying hazards, and implementing safety measures to protect the public and environment. This approach balances transparency with the need to safeguard communities from potential harm and is more focused on water quality and heavy-metal-impaired waterbodies. When waters are exposed to rocks containing sulfide minerals, they tend to become acid-rich. This occurrence is called acid rock drainage and is prevalent in mined areas where spent materials were left unclaimed. When the waters become acidic, they are more capable of gathering up and carrying heavy metals, including those that impair the waterbodies on the 303(d) list within the project area.

The AML implementation should be guided by the NRCS Code 543 practices. The NRCS Conservation Practice Standard (CPS) states the following options for land reclamation of AML [NRCS, 2024c]:

Public health and safety: Prior to beginning onsite investigations, identify possible hazards and implement appropriate safety precautions.

Erosion and sediment control practices: Control or treat runoff and sedimentation from treatment areas, soil material stockpiles, access roads, and permanent impoundments. Use sediment-trapping practices, such as filter strips, riparian forest buffers, contour buffer strips, silt fences, sediment basins, or similar practices. Include temporary practices necessary during earth moving activities and permanent practices necessary to stabilize the site and control runoff from the site after reclamation.

Control the generation of particulate matter and fugitive dust during removal and replacement of soil and other materials.

Site preparation: Identify areas for preservation during construction. Include areas containing desirable trees, shrubs, grasses, stream corridors, natural springs, historic structures, or other important features that will be protected during construction activities.

Remove trees, logs, brush, rubbish, and other debris that interfere with reclamation operations.

Dispose of debris material in a way that does not create a resource problem or interfere with reclamation activities and the planned land use.

Storage of soil materials: Stockpile soil or fill materials until needed for reclamation. Protect stockpiles from wind and water erosion, dust generation, unnecessary compaction, and contamination by noxious weeds, invasive species, or other undesirable materials.

Highwall treatment: Prior to backfilling, rock walls should have horizontal:vertical slopes of 0.5:1 or less. before placing backfill against the wall. Determine the thickness and density of lifts for fill material to limit the deep infiltration of precipitation and to limit settlement of the completed fill to acceptable levels, based on the available fill material and planned land use.

Shafts and adits: Use NRCS Conservation Practice Standard (CPS) Mine Shaft and Adit Closing (Code 457) to close/seal a shaft or adit. Divert runoff away from the shaft or adit.

Placement of surface material: Develop a grading plan that returns the site, including any off-site borrow areas, to contours that are suitable for the planned land use and control soil loss. Include the spreading of stockpiled topsoil material as the final layer. Treat graded areas to eliminate slippage surfaces and promote root penetration before spreading surface material. Spread surface soil without causing over-compaction.

Shape the land surface to provide adequate surface drainage and to blend into the surrounding topography. Use erosion control practices to reduce slope lengths where sheet and rill erosion exceeds acceptable levels. If settlement is likely to interfere with the planned land use, develop surface drainage or water disposal plans that compensate for the expected settlement.

If the subsurface material is not a source of contamination, improve soil permeability after placing backfill material by using deep ripping tools to decrease compaction, promote infiltration, and encourage root development. Do not plan practices that promote infiltration if seepage through cover materials has the potential to develop or exacerbate acid mine drainage loading or treatment.

Restoration of borrow material: If cover or fill material is taken from areas outside the reclamation site, stockpile the topsoil from the borrow area separately, and replace it on the borrow area after the area is restored for its intended purpose. Grade and shape the borrow area for proper drainage, and revegetate the site to control erosion.

Establishment of vegetation: Prepare a revegetation plan for the treated areas. Select plant materials suitable for the specified end land use according to local climate potential, site conditions, and local NRCS criteria. Use native species where possible. Avoid use of invasive species.

Use the criteria in NRCS CPS Critical Area Planting (Code 342) to establish grasses and forbs. Use NRCS CPS Tree-Shrub Establishment (Code 612) for the establishment of trees and shrubs. If vegetation cannot be established, use NRCS CPS Mulching (Code 484).

Control of toxic aqueous discharge: Identify and document water quality and quantity and releases from seeps, overland, and mine shafts. Quantify water impacts such as low pH, arsenic, etc. Identify measures that may affect treatment such as dissolved oxygen, iron, aluminum, magnesium, manganese, etc.

Methods for treatment of toxic aqueous discharge depend upon the type and extent of the contamination. When control of toxic mine drainage is needed, use BMPs that comply with state regulatory requirements. Evaluate the consequences of each potential treatment method to avoid creating a secondary problem. Select a method that can adequately treat the water based on the quantity and chemistry of the mine water and that is suitable for the planned level of operation and maintenance. Size the treatment area and settling basin(s) to allow for the volume of flow and treatment rate. Include a plan for disposal of the precipitated metals and spent treatment material.

Reduce the volume of contaminated water by diverting clean water away from the contaminated area or by limiting the opportunity for water to contact contaminated soil materials. Install practices, such as diversions, underground outlets, lined waterways, or grade stabilization structures, to control surface runoff. To the extent possible, divert clean upslope runoff away from the treated area.

- **Contaminated soil materials:** Remove, bury, or treat soil materials that adversely affect or have the potential to adversely affect water quality or plant growth. Bury materials containing heavy metals below the root zone, add suitable soil amendments, or both, to minimize the negative effect of this material. Separate soils with high electrical conductivity, calcium carbonate, sodium, or other restrictive properties, and treat, if practicable.
- Add a layer of compacted clay or a landfill cover over the contaminated material to deter infiltration. Place an earthfill blanket over the compacted clay to support plant growth. For each layer, identify the lift thickness and density needed to limit deep infiltration of precipitation and excessive settlement of the completed fill.
- **Mine sealing:** If clean water is entering a mine opening, divert the water away. If contaminated water is exiting the mine, it may be necessary to seal the mine to prevent water movement. Use NRCS CPS Mine Shaft and Adit Closing (Code 457) to design the mine seal. Divert surface water away from the mine seal.
- **Neutralization and precipitation:** Precipitate toxic metals and neutralize acidity in mine drainage using chemical or biological treatment. Select a method that can adequately treat the water based on the quantity and chemistry of the mine water and that is suitable for the planned level of operation and maintenance. Size the treatment area and settling basin(s) to allow for the volume of flow and treatment rate. Include a plan for disposal of the precipitated metals and spent treatment material.

Aside from AMLs, heavy metals also come from agricultural lands and urbanized areas. Heavy metal load reductions from BMPs are ranked in the NRCS CPPE as substantial, moderate to substantial, moderate, slight to moderate, and slight. Table 7-14 lists the most effective practices (i.e., substantial, moderate to substantial, and moderate reductions) [NRCS, 2024b]. Heavy metal reductions expected from the BMPDB's urban practices are summarized in Table 7-15 [The Water Research Foundation, 2024]. Heavy metal reductions are not quantified using the PLET model; therefore, priority BMPs should be those with the highest amount of reduction in the priority areas on the relative land cover. The NRCS Irrigation Water Management practice code Number 449 has slight to moderate improvement for heavy metals. Irrigation management is the only NRCS practice included with less than moderate improvement. It was included because of its high probability of installation in the project area. Practices with slight to moderate improvement should not be discouraged, even though they are not included in the tables in this section.

Table 7-14. Most Effective Heavy Metals to Surface Water Reducing Agricultural Best Management Practices From the Colorado Natural Resources Conservation Service Conservation Practice Physical Effects

Practice	Practice Code	Unit	Effect	Rationale
On-Farm Secondary Containment Facility	319	N/A	Substantial Improvement	Provides for spill containment of petroleum products.
Constructed Wetland	656	Acre	Moderate to Substantial Improvement	Vegetation and anaerobic conditions trap heavy metals.
Irrigation and Drainage Tailwater Recovery	447	N/A	Moderate to Substantial Improvement	The action captures irrigation and/or drainage runoff and associated metal-laden sediment.
Land Reclamation, Landslide Treatment	453	N/A	Moderate to Substantial Improvement	Increased vegetation increases infiltration and reduces runoff and erosion.
Land Reclamation, Toxic Discharge Control	455	N/A	Moderate to Substantial Improvement	Control of discharge and reduction in infiltration reduce off-site movement of contaminated water.
Riparian Forest Buffer	391	Acre	Moderate Improvement	The action filters sediment, and some plants may uptake heavy metals.
Road/Trail/Landing Closure and Treatment	654	Feet	Moderate Improvement	Decreased erosion and runoff reduce heavy metal delivery to surface water; increased soil organic matter increases the capacity of soils to retain heavy metals; permanent vegetation can uptake heavy metals.
Irrigation Water Management	449	Acre	Slight to Moderate Improvement	Water is applied at rates that minimize heavy metals transport to surface water.

Table 7-15. Most Effective Heavy Metal (Greater Than 10 Percent) Reducing Urban Best Management Practices From the International Best Management Practice Database

Category	BMP Category	Concentration In (µg/L)	Concentration Out (µg/L)	Reduction (%)
Arsenic (T)	Media Filter	0.9	0.765	15
Arsenic (T)	Retention Pond	1	0.87	13
Arsenic (T)	Grass Swale	1.11	1	10
Cadmium (D)	Grass Swale	0.2	0.116	42
Cadmium (D)	Grass Strip	0.114	0.07	39
Cadmium (D)	Media Filter	0.2	0.128	36
Cadmium (D)	Oil-Grit Separator	0.155	0.101	35
Cadmium (D)	Hydrodynamic Separator	0.137	0.0933	32
Cadmium (D)	Retention Pond	0.163	0.125	23
Cadmium (D)	Detention Basin	0.117	0.0942	19
Copper (D)	Wetland Basin	3.95	2.29	42
Copper (D)	Grass Strip	12	7.4	38
Copper (D)	Retention Pond	5.08	3.5	31
Copper (D)	Detention Basin	3.96	2.99	24
Copper (D)	High-Rate Biofiltration	4.5	3.4	24
Copper (D)	Media Filter	3.86	3	22
Copper (D)	Grass Swale	6.5	5.63	13
Iron (T)	Retention Pond	1050	285	73
Iron (T)	Media Filter	685	195	72
Iron (T)	Grass Strip	746	320	57
Iron (T)	Grass Swale	216	136	37
Zinc (D)	Media Filter	32	7.15	78
Zinc (D)	Porous Pavement	17.8	4.09	77
Zinc (D)	Wetland Basin	22.6	8.35	63
Zinc (D)	High-Rate Biofiltration	189	79	58
Zinc (D)	Grass Strip	33.6	17	49
Zinc (D)	Grass Swale	34.2	19.8	42
Zinc (D)	Bioretention	20.8	12.5	40
Zinc (D)	Retention Pond	23.4	16	32
Zinc (D)	Detention Basin	12.1	9.38	22

µg/L = micrograms per liter

D = dissolved

T = total

8.0 PAST AND CURRENT BEST MANAGEMENT PRACTICES

A significant amount of BMPs have been, and are currently being, implemented in the Big Thompson River HUC8 Watershed. Based on Survey #2 provided to the stakeholders, the following BMPs have been or are being implemented in the Big Thompson River Watershed project area:

- Conservation tillage
- Crop rotation
- No-till practices
- Rain gardens
- Splitter drop structures
- Streambank stabilization
- Wetland construction
- Wetland protection
- Construction BMPs
- Streamside fencing to exclude livestock
- Vegetated buffer strips

The surveys also provided planned, near-future projects (including continuation of existing programs) and a pilot program to use water treatment residuals as filter media in bioretention basins to sequester phosphorus from stormwater runoff.

Although this list includes some of the implementation accomplishments within the project area, it does not include all the BMPs that have been or are currently being implemented.

Practices implemented by watershed and/or county were not available from the NRCS; however, they were available for the State of Colorado. An assumption was made that the more likely a practice is to be implemented in Colorado, the more likely it would be implemented in the project area. Funding sources and programs involved in implementing practices in Colorado include the Agricultural Conservation Easement Program (ACEP), Agricultural Water Enhancement Program (AWEP) Conservation Reserve Program (CRP), Conservation Stewardship Program (CSP), Conservation Technical Assistance (CTA), Emergency Watershed Protection Program (EWP), Environmental Quality Incentives Program (EQIP), Farm and Ranch Lands Protection Program (FRPP), Grass Reserve Program (GRP), Regional Conservation Partnership Program (RCPP), Resource Conservation and Development (RCD) Program, Watershed Protection and Flood Prevention Operations (WFPO) Program, Watershed Rehabilitation (WHRB), Wetlands Reserve Program (WRP), and Wildlife Habitat Incentive Program (WHIP). Table 8-1 lists the practices implemented on more than 50 mi^2 in Colorado since 2005 that should continue to be implemented for water quality improvement [USDA, 2024].

Table 8-1. Best Management Practices Implemented Annually on More Than 50 Square Miles in Colorado Since 2005 (Page 1 of 2)

Practice Name	Practice Code	Colorado (mi^2)	Associated Land Use	Percent of Associated Area	Project Area Land Use (mi^2)	Project Area Practice (Available Remaining) (mi^2)
Prescribed Grazing	528	1,169	Pasture	100	8.7	-
Upland Wildlife Habitat Management	645	433	Pasture	38	8.7	3.3
Conservation Crop Rotation	328	287	Cropland	2	90.2	2.1
Watering Facility	614	286	Pasture	25	8.7	2.2
Livestock Pipeline	516	210	Pasture	18	8.7	1.6
Fence	382	194	Pasture	17	8.7	1.5
Pest Management Conservation System	595	180	Cropland	1	90.2	1.3
Conservation Cover	327	154	Cropland	1	90.2	1.1
Access Control	472	154	Pasture	13	8.7	1.2
Nutrient Management	590	134	Cropland	1	90.2	1.0
Pumping Plant	533	121	Cropland	1	90.2	0.9
Brush Management	314	118	Forest	<1	342.6	0.8
Residue and Tillage Management, Reduced Till	345	104	Cropland	<1	90.2	0.7
Residue and Tillage Management, No Till	329	99	Cropland	<1	90.2	0.7
Irrigation Water Management	449	98	Cropland	<1	90.2	0.7
Residue Management, Seasonal	344	85	Cropland	<1	90.2	0.6
Prescribed Grazing - Enhancements	E528	81	Pasture	7	8.7	0.6
Early Successional Habitat Development - Management	647	72	Other	<1	270.4	0.6
Pest Management Conservation System - Enhancements	E595	68	Cropland	<1	90.2	0.5
Herbaceous Weed Treatment	315	66	Cropland	<1	90.2	0.5
Nutrient Management - Enhancements	E590	57	Cropland	<1	90.2	0.4
Water Well	642	55	Cropland	<1	90.2	0.4

Table 8-1. Best Management Practices Implemented Annually on More Than 50 Square Miles in Colorado Since 2005 (Page 2 of 2)

Practice Name	Practice Code	Colorado (mi^2)	Associated Land Use	Percent of Associated Area	Project Area Land Use (mi^2)	Project Area Practice (Available Remaining) (mi^2)
Range Planting	550	51	Pasture	4	8.7	0.4
Cover Crop	340	49	Cropland	<1	90.2	0.4
Forage Harvest Management	511	47	Forest	<1	342.6	0.3
Structure for Water Control	587	33	Cropland	<1	90.2	0.2
Irrigation Pipeline	430	30	Cropland	<1	90.2	0.2
Forest Stand Improvement	666	27	Forest	<1	342.6	0.2

9.0 RECOMMENDED BEST MANAGEMENT PRACTICES

This watershed-based plan provides recommendations for NPS implementation practices to reduce loads of pollutants of concern. The recommended implementation practices are based on practices that are the most likely to be implemented and most impactful in reducing pollutants of concern.

9.1 FUTURE MUNICIPAL SEPARATE STORM SEWER SYSTEM AREAS

Stormwater resulting from rainfall, snowmelt, or other surface water runoff and drainage originates from impervious areas in towns; cities; residential developments; and industrial, manufacturing, or agricultural facilities. Stormwater flows accumulate from streets, parking lots, rooftops, catch basins, curbs, gutters, ditches, drainage channels, storm drains, and other impervious surfaces that may play a role in the contribution of pollutant loading because of the proximity of these impervious areas to the impaired waterbodies. Stormwater discharges are permitted under numerous MS4 permits in Colorado, which include the statewide standard MS4 general permit (COR090000) and statewide nonstandard MS4 general permit (COR070000). Areas covered by MS4 permits are not considered NPSs.

The Town of Johnstown (approximately 7.5 mi^2 acres) is within the Big Thompson River HUC8 and has not yet been designated as an MS4; however, this town is one of the areas identified to become one within the near future (5 to 15 years). Johnston was identified using the same sources as in Section 5.1 [Catena Analytics, 2024; U.S. Census Bureau, 2020; Smith, 2024]. Therefore, the town's decision-makers should be proactive by using development practices that will minimally impact water quality. Less effort will be needed to retrofit BMPs after the area becomes a designated MS4 if more implementation is completed upfront. Low Impact Development (LID) is an approach to stormwater management that mimics a site's natural hydrology while the landscape is developed and preserves and protects environmentally sensitive site features, such as riparian buffers, wetlands, steep slopes, valuable (mature) trees, floodplains, woodlands, and highly permeable soils. Minimal Impact Design Standards (MIDS) is a new concept being used in the state of Minnesota, which emphasizes keeping a raindrop where it falls to minimize stormwater runoff and pollution as well as preserve natural resources. Because Minnesota has been successful in implementing water quality practices using MIDS, developing communities in the North Front Range Water Quality Planning Association (NFRWQPA) watersheds would likely also benefit from evaluation of the following four main elements of MIDS [Minnesota Pollution Control Agency, 2024]:

- Stormwater volume performance goals for new development, redevelopment, and linear projects
- New credit calculations that standardize the use of a range of structural stormwater techniques
- Design specifications for a variety of green infrastructure BMPs
- An ordinance guidance package to help developers and communities implement MIDS

9.2 DEVELOPED

Throughout the Big Thompson River project area, approximately 44 mi^2 of non-MS4 developed land exist. MS4 areas are not represented in the project models. BMPs recommended for MS4 and non-MS4 developed areas are like those outlined in Section 9.1. For nutrients and sediment, priority developed practices from PLET (Table 7-5) should be those with the highest rankings and reduction scores (i.e., extended wet detention, infiltration basins, and concrete gird pavement). For *E. coli*, priority developed practices should be those resulting in the largest reductions within the BMPDB (i.e., wetland basin and retention pond), as shown in Table 7-13. For heavy metals, priority developed practices should also be practices that resulted in the largest reductions of heavy metals in the BMPDB (depending on pollutants of concern in downstream waterbodies), as shown in Table 7-15. Practices do not need to be limited to these recommendations, and any practice that reduces pollutants of concern can be considered.

9.3 AGRICULTURAL (CROPLAND, PASTURELAND, AND FEEDLOT BEST MANAGEMENT PRACTICES)

Throughout the Big Thompson River project area, approximately 90 mi^2 of cropland exist and are all within the easternmost watersheds. Similarly, approximately 9 mi^2 of pastureland exist, primarily in the easternmost HUC8 watersheds. Less than 1 mi^2 consists of feedlots. For sediment and nutrients, priority agricultural practices from PLET (Tables 7-1 through 7-3) should be those with the highest rankings and reduction scores (i.e., streambank stabilization and fencing and 35-foot grass buffers for cropland, 35-foot grass buffers and livestock exclusion fencing for pasture, and waste management systems for feedlots). For *E. coli*, priority agricultural practices should be the most effective agricultural BMPs from the Colorado NRCS CPPE for reducing *E. coli* (i.e., vegetated treatment area, constructed wetland, filter strip, nutrient management, and waste treatment lagoon) as shown in Table 7-12. For heavy metals, priority agricultural practices should be the most effective agricultural BMPs from the Colorado NRCS CPPE for reducing heavy metals (i.e., on-farm secondary containment facility, constructed wetland, irrigation and drainage tailwater recovery, land reclamation (landslide treatment or toxic discharge control) as shown in Table 7-14. Additionally, practices that switch from flood irrigation to more efficient irrigation methods would be beneficial in reducing both *E. coli* and heavy metals such as selenium and arsenic. Although these practices are the most effective, BMPs do not need to be limited to these recommendations.

9.4 FOREST

Throughout the Big Thompson River project area, approximately 499 mi^2 of forest land exist. Although forest land is less likely to contribute sediment, nutrients, and bacteria per acre of contributing area, BMPs are still beneficial, especially when considering historical fires, fire potential, abandoned mines, recreation, and grazing activities. For nutrients and sediment, priority forest practices from PLET (Table 7-4) should be those with the highest ranking and reduction scores (i.e., a combination of site preparation/straw/crimp seed/net/fertilizer/transplants). For *E. coli*, priority forest practices are not prioritized but should include those that exclude forest-grazing livestock from accessing streams and septic assessments. Forest practices should also focus on pre- and post-fire activities outlined in the Big Thompson Wildfire Ready Action Plan, which will be completed in 2025 and will be available on the Peaks to People Water Fund's website.

9.5 ABANDONED MINE LANDS

Most AMLs in the watershed have not yet been identified because several are located on private land or in very remote locations. The primary practice completed on identified AMLs is to seal off dangerous openings, identify hazards, and implement safety measures to protect the public and environment. To improve water quality, identifying AMLs should become a higher priority. Although AML BMPs are not prioritized because of the variable nature of AML lands, each site should be assessed, and practices should be chosen that target specific issues related to each site. For heavy metals, priority practices should focus on AMLs, as outlined in Section 7.3.

10.0 INFORMATION, EDUCATION, AND OUTREACH

Current communication, education, and outreach efforts established in the Big Thompson River HUC8 should continue and be expanded to incorporate effectiveness and user feedback surveys that would complement current area outreach programs. Coordinated outreach efforts should increase the awareness of specific audiences regarding water quality problems and solutions, as well as available BMP technical and financial assistance programs for urban/residential areas, cropland, pasture lands, AMLs, and riparian areas. Stakeholders should continue to expand on their public outreach efforts and communications with the public by implementing inclusive and new engagement tactics to reach a broad audience. Education and outreach activities should target individuals and groups to evaluate effective outreach methods.

Stakeholder responses to Survey #2 were used to rank a list of information, education, and outreach options. The following survey ranking is from highest to lowest:

1. Water Quality Awareness Signage in Parks by Streams
2. Social Media Posts (Sent to Partners)
3. Website Updates
4. Educational Campaigns
5. Newsletters and Mailers
6. Pet-Waste Pickup Stations
7. Volunteer Cleanup Programs
8. School Visits
9. Project Story Map
10. Report a Concern Website
11. Radio Advertisements and Interviews
12. Tours and Field Trips

Entities within the watershed that are interested in collaborating with other stakeholder groups and hosting or participating in events include the Northern Colorado Water Conservancy District, Los Rios Farm, Colorado Watershed Assembly, Colorado Wheat Administrative Committee, and Estes Valley Watershed Coalition. Participating in existing events can also expand outreach efforts. Northern Water has an annual water quality efficiency stakeholder meeting in the spring, as well as a spring and fall water symposium and a children's water festival. Each fall, a Sustaining Colorado Watersheds conference is held in Avon, Colorado. A Lower South Platte River Water Festival is also held for children in the community.

The NFRWQPA is compiling a "Stakeholder Toolkit" for the plans. This toolkit will help stakeholders reach, inform, and partner with their networks on the NPS watershed educational resources. Some of the options included in the toolkit include digital communications, print communications, and community outreach. The stakeholders will decide which tools will be chosen during the next round of funding. Examples of these and more information about the Stakeholder Toolkit are included in Appendix E.

11.0 CRITERIA TO ASSESS PROGRESS

Milestones toward progress can be demonstrated in many different ways. In these watersheds, options for measurable milestones can include progress toward meeting water quality criteria set by the state, trends toward improvement, and progress in the installation of implementation practices that are expected to improve water quality parameters of concern. Table 11-1 shows practices that could be implemented to make progress and count as measurable milestones. Because goals in this watershed for this plan are very broad (the plan is not being written as a part of a specific Total Maximum Daily Load [TMDL] with a specified goal), milestones are more general than specific. Any practice implemented will be a part of progress toward the ultimate goal of improving water quality and ensuring water quality does not worsen. Relative implementation should be tracked, and this plan should be revisited after the first 5 years to ensure progress is being made. NFRWQPA will track any implementation that occurs as they are informed of it. Stakeholders will be informed of progress via methods chosen from the Stakeholder Toolkit. Reductions from NPS loadings will most likely require a significant, increased amount of technical and financial program assistance; BMP implementation through on-the-ground projects; proper watershed planning; and cooperation with willing landowners and land management agencies. Successfully achieving load reductions depends on several factors, such as the amount of voluntary participation, availability of technical and financial assistance, and effectiveness of BMPs intended to reduce applicable loads.

In Survey #2, organizations were asked about interim measurable criteria/goals and what progress would look like after 5 and 10 years. Los Rios Farm stated that preserving open space, reducing development near waterways, and increasing flows during irrigation season would demonstrate progress. The Colorado Wheat Administrative Committee advised that monitoring water quality, reducing pollutants of concern loads, and meeting water quality criteria would display progress.

An implementation schedule is recommended to reduce pollutants of concern by implementing NPS BMPs. Table 11-1 provides a list of BMPs that would be most likely to benefit the area over the next 10 years by land-use category. Tables 11-2, 11-3, and 11-4 provide the top two sources for each parameter group and the top practices for implementation.

Table 11-1. Best Management Practices (Page 1 of 2)

Land-Use Category	Source	Recommended Implementation Activity
Future Stormwater/ Developed/Urban/Residential	PLET and Survey	Extended Wet Detention Ponds
Future Stormwater/ Developed/Urban/Residential	PLET and Survey	Infiltration Basins
Future Stormwater/ Developed/Urban/Residential	PLET and Survey	Concrete Grid Pavement
Future Stormwater/ Developed/Urban/Residential	BMPDB	High-Rate Biofiltration
Future Stormwater/ Developed/Urban/Residential	BMPDB	Media Filter
Future Stormwater/ Developed/Urban/Residential	BMPDB	Oil-Grit Separator
Future Stormwater/ Developed/Urban/Residential	BMPDB	Retention Pond
Future Stormwater/ Developed/Urban/Residential	BMPDB	High-Rate Media Filtration
Future Stormwater/ Developed/Urban/Residential	BMPDB	Wetland Basin
Future Stormwater/ Developed/Urban/Residential	BMPDB	Grass Swale
Future Stormwater/ Developed/Urban/Residential	Other	LID Practices
Future Stormwater/ Developed/Urban/Residential	Other	Septic Upgrades
Ag - Cropland	PLET and Survey	Streambank Stabilization and Fencing
Ag - Cropland	PLET and Survey	Buffer - Grass (35 feet wide)
Ag - Cropland	NRCS	Constructed Wetland (656)
Ag - Cropland	NRCS	Filter Strip (393)
Ag - Cropland	NRCS	Vegetated Treatment Area (635)
Ag - Cropland	NRCS	On-Farm Secondary Containment Area (319)
Ag - Cropland	NRCS	Irrigation Water Management (449)
Ag - Pasture	PLET	Buffer - Grass (35 feet wide)
Ag - Pasture	PLET	Livestock Exclusion Fencing
Ag - Pasture	PLET and Survey	Streambank Stabilization and Fencing
Ag - Feedlot	PLET and Survey	Waste Management System
Forest	PLET and Survey	Site Preparation/ Straw/Crimp Seed/Net
Forest	PLET and Survey	Site Preparation/Straw/Crimp Seed/ Fertilizer/Transplants

Table 11-1. Best Management Practices (Page 2 of 2)

Land-Use Category	Source	Recommended Implementation Activity
AML	NRCS	Storage of Soil Materials
AML	NRCS	Placement of Surface Material
AML	NRCS	Restoration of Borrow Material
AML	NRCS	Establishment of Vegetation
AML	NRCS	Control of Toxic Aqueous Discharge
Monitoring	Other	Water Quality Sampling (base and storm events)
Monitoring	Other	Discharge Measurement (base and storm events)
Monitoring	Other	Monitor Implemented Agricultural BMP Effectiveness
Monitoring	Other	Monitor Implemented Urban BMP Effectiveness
Monitoring	Other	Monitor Implemented AML BMP Effectiveness
Outreach	Survey	Social Media Posts
Outreach	Survey	Website Updates
Outreach	Survey	Educational Campaigns
Outreach	Survey	Newsletters and Mailers
Outreach	Survey	Pet-Waste Pickup Stations
Outreach	Survey	Volunteer Cleanup Programs
Outreach	Survey	School Visits
Outreach	Survey	Project Story Map
Outreach	Survey	Report a Concern Website

Table 11-2. Dominant Land Uses, Sources, and Priority Practices by HUC10 for Nutrients and Sediment

Watershed	Dominant Land Uses	Top Sediment Sources	Top Phosphorus Sources	Top Nitrogen Sources	Priority Practices
1019000601 North Fork Big Thompson River	Forest and Urban non-MS4	Forest and Urban non-MS4	Forest and Urban non-MS4	Forest and Urban non-MS4	/ Site Preparation/Straw/Crimp Seed/Net / Site Preparation/Straw/Crimp Seed/Fertilizer/Transplants / Extended Wet Detention / Infiltration Basins
1019000602 Headwaters Big Thompson River	Forest and Urban non-MS4	Urban non-MS4 and Forest	Forest and Urban non-MS4	Urban non-MS4 and Forest	/ Extended Wet Detention / Infiltration Basin / Site Preparation/Straw/Crimp Seed/Net / Site Preparation/Straw/Crimp Seed/Fertilizer/Transplants
1019000603 Buckhorn Creek	Forest and Urban non-MS4	Forest and Urban non-MS4	Forest and Urban non-MS4	Forest and Urban non-MS4	/ Site Preparation/Straw/Crimp Seed/Net / Site Preparation/Straw/Crimp Seed/Fertilizer/Transplants / Extended Wet Detention / Infiltration Basin
1019000604 Headwaters Little Thompson River	Forest and Urban non-MS4	Forest and Urban non-MS4	Forest and Urban non-MS4	Forest and Urban non-MS4	/ Site Preparation/Straw/Crimp Seed/Net / Site Preparation/Straw/Crimp Seed/Fertilizer/Transplants / Extended Wet Detention / Infiltration Basin
1019000605 Dry Creek-Little Thompson River	Cropland and Urban non-MS4	Cropland and Urban non-MS4	Cropland and Urban non-MS4	Cropland and Urban non-MS4	/ Streambank Stabilization and Fencing / Buffer-Grass (35 feet wide) / Extended Wet Detention / Infiltration Basin
1019000606 Outlet Big Thompson River	Forest and Cropland	Cropland and Urban non-MS4	Cropland and Urban non-MS4	Cropland and Urban non-MS4	/ Streambank Stabilization and Fencing / Buffer-Grass (35 feet wide) / Extended Wet Detention / Infiltration Basin

Table 11-3. *E. coli* Impairment Status, Primary Sources, Associated Land Use, and Priority Practices by HUC10

Watershed	*E. coli* Impaired	Primary *E. coli* Sources	Associated Land Use (*E. coli*)	Priority Practices
1019000601 North Fork Big Thompson River	N	/ Livestock (more Cattle) / Humans (more OWTS)	/ Agricultural Land / Urban non-MS4	/ Vegetated Treatment Area / Constructed Wetlands / Septic Upgrades / Wastewater Treatment Facility Connections
1019000602 Headwaters Big Thompson River	N	/ Livestock (more Cattle) / Humans (more WWTP)	/ Agricultural Land / Urban non-MS4	/ Vegetated Treatment Area / Constructed Wetlands / Wetland Basin / Retention Pond
1019000603 Buckhorn Creek	N	/ Livestock (more Cattle) / Humans (more OWTS)	/ Agricultural Land / Urban non-MS4	/ Vegetated Treatment Area / Constructed Wetlands / Septic Upgrades / Wastewater Treatment Facility Connections
1019000604 Headwaters Little Thompson River	N	/ Livestock (more Cattle) / Humans (more OWTS)	/ Agricultural Land / Urban non-MS4	/ Vegetated Treatment Area / Constructed Wetlands / Septic Upgrades / Wastewater Treatment Facility Connections
1019000605 Dry Creek-Little Thompson River	Y	/ Livestock (more Cattle) / Humans (more WWTP)	/ Agricultural Land / Urban non-MS4	/ Vegetated Treatment Area / Constructed Wetlands / Wetland Basin / Retention Pond
1019000606 Outlet Big Thompson River	Y	/ Humans (more WWTP) / Livestock (more Cattle)	/ Urban non-MS4 / Agricultural Land	/ Wetland Basin / Retention Pond / Vegetated Treatment Area / Constructed Wetlands

Table 11-4. Dominant Land Uses, Metal Impairments, Associated Causes, and Priority Practices by HUC10 (Page 1 of 2)

Watershed	Dominant Land Uses	Metal Impairments	Associated Cause	Priority Practices
1019000601 North Fork Big Thompson River	Forest and Urban non-MS4	Arsenic	Pressure-Treated Wood, Material Production, Pierre Shale, etc.	Irrigation Water Management
1019000601 North Fork Big Thompson River	Forest and Urban non-MS4	Copper	Algicide, Manufacturing Processes, Material Production/Preservation	Discontinue Use
1019000601 North Fork Big Thompson River	Forest and Urban non-MS4	Mercury	Chemistry, Manufacturing Processes, and Material Production	AML BMPs
1019000601 North Fork Big Thompson River	Forest and Urban non-MS4	Zinc	Mining, Material Production	AML BMPs
1019000602 Headwaters Big Thompson River	Forest and Urban non-MS4	Arsenic	Pressure-Treated Wood, Material Production, Pierre Shale, etc.	Irrigation Water Management
1019000602 Headwaters Big Thompson River	Forest and Urban non-MS4	Copper	Algicide, Manufacturing Processes, Material Production/Preservation	Discontinue Use
1019000602 Headwaters Big Thompson River	Forest and Urban non-MS4	Lead	Material Production, Manufacturing Processes, Gas Combustion	Discontinue Use
1019000602 Headwaters Big Thompson River	Forest and Urban non-MS4	Mercury	Chemistry, Manufacturing Processes, and Material Production	AML BMPs
1019000602 Headwaters Big Thompson River	Forest and Urban non-MS4	Zinc	Mining, Material Production	AML BMPs
1019000603 Buckhorn Creek	Forest and Urban non-MS4	Arsenic	Pressure-Treated Wood, Material Production, Pierre Shale, etc.	Irrigation Water Management
1019000603 Buckhorn Creek	Forest and Urban non-MS4	Mercury	Chemistry, Manufacturing Processes, and Material Production	AML BMPs
1019000603 Buckhorn Creek	Forest and Urban non-MS4	Selenium	Material Production, Manufacturing Processes, Gas Combustion, Pierre Shale	Irrigation Water Management
1019000604 Headwaters Little Thompson River	Forest and Urban non-MS4	Arsenic	Pressure-Treated Wood, Material Production, Pierre Shale, etc.	Irrigation Water Management

Table 11-4. Dominant Land Uses, Metal Impairments, Associated Causes, and Priority Practices by HUC10 (Page 2 of 2)

Watershed	Dominant Land Uses	Metal Impairments	Associated Cause	Priority Practices
1019000605 Dry Creek-Little Thompson River	Cropland and Urban non-MS4	Arsenic	Pressure-Treated Wood, Pesticides, Piere Shale	Irrigation Water Management
1019000605 Dry Creek-Little Thompson River	Cropland and Urban non-MS4	Manganese	Manufacturing Processes, Material Production	AML BMPs
1019000605 Dry Creek-Little Thompson River	Cropland and Urban non-MS4	Selenium	Material Production, Manufacturing Processes, Gas Combustion, Pierre Shale	Irrigation Water Management
1019000606 Outlet Big Thompson River	Forest and Cropland	Arsenic	Pressure-Treated Wood, Material Production, Pierre Shale, etc.	Irrigation Water Management
1019000606 Outlet Big Thompson River	Forest and Cropland	Copper	Algicide, Manufacturing Processes, Material Production/Preservation	Discontinue Use
1019000606 Outlet Big Thompson River	Forest and Cropland	Iron	Mining, Manufacturing Processes, Material Production	AML BMPs
1019000606 Outlet Big Thompson River	Forest and Cropland	Manganese	Manufacturing Processes, Material Production	AML BMPs
1019000606 Outlet Big Thompson River	Forest and Cropland	Mercury	Chemistry, Manufacturing Processes, and Material Production	AML BMPs
1019000606 Outlet Big Thompson River	Forest and Cropland	Selenium	Material Production, Manufacturing Processes, Gas Combustion, Pierre Shale	Irrigation Water Management

Implementation practices were run in the PLET model on 25 percent of each applicable land cover. This number represents the acres affected by the practice, not the acres of the practice implemented. Cropland practices typically resulted in the highest reductions of nitrogen and phosphorus; therefore, these are the practices incorporated in the schedule. As shown in Table 11-5, incorporating stream stabilization and fencing on 25 percent of the cropland and 35-foot buffers on an additional 25 percent of the cropland in the project area resulted in the needed nitrogen and phosphorus reductions. Reductions required were calculated for the entire area draining to the outlet HUC10. The reduction required for the specific project area was not calculated because project areas were drawn using county lines; therefore, the following cost estimates were made made assuming that all reductions had to come from within the project area. Table 11-6 shows the proposed schedule for implementation in the Big and Little Thompson River project area. These practices will also help with *E. coli* and heavy metals. Load reductions for heavy metals came from the PLET model and, therefore, were not run for *E. coli* and heavy metals. Because the current load reductions from PLET were not calibrated and did not include areas outside of Larimer and Weld Counties or MS4 areas, they should be considered relative and should not be compared to actual loads calculated with observed data.

Table 11-5. Reductions Achieved by Implementation of Priority Cropland Practices

Practice	Nitrogen Load (lb/yr)	Nitrogen Reduction (%)	Nitrogen Reduction Needed (lb/yr)	Phosphorus Load (lb/yr)	Phosphorus Reduction (%)	Phosphorus Reduction Needed (lb/yr)
Base Load	212,748	N/A	0	54,524	N/A	8
Stream Stabilization and Fencing on 25% of Cropland (14,434 acres)	20,292	9.5		4,938	9.1	
Buffer - Grass (35 feet wide) on 25% of Cropland (14,434 acres)	10,440	4.9		3,123	5.7	
Total Reduction	30,372	14.4		8,061	14.8	

Table 11-6. Schedule for Primary Cropland Practices to Achieve Nutrient Goals

Practices	5-Year Goal	10-Year Goal	Ultimate Goal
Stream Stabilization and Fencing on Cropland	5,000 acres	10,000 acres	15,000 acres
Buffer - Grass (35 feet wide) on Cropland	5,000 acres	10,000 acres	15,000 acres

In general, 35-foot buffers cost about $10.37 per acre impacted per year, fencing costs about $22.66 per acre impacted per year, and streambank stabilization costs $13,472 per mile. If a mile of streambank stabilization impacted a square mile of the watershed area, it would cost approximately $21.05 per acre impacted per year; therefore, every 5,000 acres impacted by buffers would cost approximately $51,838 and with the rough streambank stabilization estimate, every 5,000 acres impacted by stream stabilization would cost approximately $218,549.

12.0 MONITORING BEST MANAGEMENT PRACTICES EFFECTIVENESS

Monitoring should be completed before and after implementing BMPs to evaluate the effectiveness of priority practices. Monitoring BMP effectiveness (up- and downstream of BMPs) helps evaluate the adequacy of the implementation strategies targeted to reduce loads or transport. BMP effectiveness data will improve the understanding of implementation and management measures. Other ideal locations for monitoring include areas that have been monitored historically near the HUC10 watershed outlets and along impaired waterbodies. More information about monitoring NPSs is included on EPA's Nonpoint Source Monitoring: TechNOTES webpage. Existing water quality monitoring occurring for the NFRWQPA's 208 Areawide Water Quality Management Plan is available on its website.

Additional monitoring and evaluation efforts should occur within the communities that are the most likely to become MS4 areas. Monitoring sites up- and downstream of areas where storm drains and tributaries enter the mainstem Big and Little Thompson Rivers would help evaluate contributions. Monitoring locations in storm drains throughout urbanized areas where two possible sources come together would also help isolate sources of pollution. A detailed monitoring plan that identifies the locations of additional monitoring sites should be compiled.

Continuous discharge data across a broad range of flows are helpful for calculating loads. Future monitoring should include instantaneous discharge measurements at water quality sampling areas. Continuous stage recorders should be installed at key locations in the watershed and stage-discharge relationships should be developed to convert continuous stage data to continuous flow data. Relatively low-cost, low-maintenance technologies are available to record continuous stage data. Instantaneous and continuous flow data will increase the accuracy of future load calculations and the evaluation of BMPs and implementation practices.

Survey #2 had a question regarding in-stream monitoring activities that different entities would consider implementing. The Northern Colorado Water Conservancy District would be interested in quarterly sampling as well as the installation, maintenance, and operation of a monitoring station. The Colorado Wheat Administrative Committee would be interested in quarterly sampling to be analyzed by a local laboratory. The Colorado Watershed Assembly would be interested in the installation, maintenance, and operation of a monitoring station.

13.0 TECHNICAL AND FINANCIAL ASSISTANCE SOURCES

Technical and financial assistance sources are available to implement BMPs. Numerous private companies and organizations as well as local, state, and federal agencies provide technical assistance to address NPS pollution. A few of these organizations and agencies also provide financial assistance. Table 13-1 lists the agencies and organizations with technical and financial programs that may assist with conservation and water quality implementation projects and what type of technical or financial assistance they offer (based on the land use of interest) as denoted by Xs. The following sections describe the information regarding incentive programs and funding to implement NPS projects identified in this plan. Funding includes but is not limited to the CDPHE's NPS Program and its annual grants, the South Platte Basin Roundtable grants, and the CAWA programs. The NPS Program funds support staffing costs and programmatic priorities including the Mini Grant Program, the NPS Watershed Planning and Tool Development Program, and the NPS Program's Success Story Initiative.

Table 13-1. Sources of Technical and Financial Assistance (Page 1 of 3)

Agency or Organization	Website	Assistance	BMP Category						
			Developed Non-MS4	Cropland	Pasture	Feedlot	Forest	Stream	Outreach
LOCAL									
City of Loveland	www.lovgov.org	Financial, Technical	X					X	X
Town of Johnstown	www.johnstown.colorado.gov	Financial, Technical	X					X	X
Town of Estes Park	estespark.colorado.gov	Financial, Technical	X					X	X
Larimer County	www.larimer.gov	Financial, Technical	X	X	X	X	X	X	X
Weld County	www.weld.gov	Financial, Technical	X	X	X	X	X	X	X
BTWC	bigthompson.co	Technical	X	X	X	X	X	X	X
South Platte Basin Roundtable	www.southplattebasin.com	Technical	X	X	X	X	X	X	X
Larimer Conservation District (Previously Fort Collins and Big Thompson Conservation Districts)	https://www.larimercd.org/	Financial, Technical		X	X	X	X	X	X
Platte Valley Conservation District	www.coloradolandcan.org/local-resources/Platte-Valley-Conservation-District/3610	Financial, Technical		X	X	X	X	X	X
Southeast Weld Conservation District	seweldcd-co.org	Financial, Technical		X	X	X	X	X	X

Table 13-1. Sources of Technical and Financial Assistance (Page 2 of 3)

Agency or Organization	Website	Assistance	BMP Category						
			Developed Non-MS4	Cropland	Pasture	Feedlot	Forest	Stream	Outreach
STATE									
CSU Extension	extension.colostate.edu	Technical	X	X	X	X	X	X	X
CSU	www.colostate.edu	Technical	X	X	X	X	X	X	X
Colorado Association of Conservation Districts	coloradoacd.org	Financial, Technical	X	X	X	X	X	X	X
Colorado Department of Public Health and Environment	cdphe.colorado.gov	Financial, Technical	X	X	X	X	X	X	X
Colorado Parks and Wildlife	cpw.state.co.us	Financial, Technical					X	X	X
Colorado Livestock Association	www.coloradolivestock.org	Technical				X		X	X
Colorado Department of Agriculture	ag.colorado.gov	Financial, Technical		X	X	X		X	X
Colorado Water Center	watercenter.colostate.edu	Technical						X	X
Colorado Water Conservation Board	cwcb.colorado.gov	Financial, Technical	X	X	X	X	X	X	X
Colorado Rural Water Association	www.crwa.net	Technical						X	X
Colorado Department of Natural Resources	dnr.colorado.gov	Financial, Technical	X	X	X	X	X	X	X
Colorado Energy and Carbon Management Commission	ecmc.state.co.us	Financial, Technical		X	X	X			
Colorado Geological Survey	coloradogeologicalsurvey.org	Financial, Technical						X	
Colorado Bureau of Land Management	www.blm.gov	Financial, Technical					X	X	X
Colorado Division of Reclamation, Mining, and Safety	drms.colorado.gov	Financial, Technical					X	X	X
Colorado State Land Board	slb.colorado.gov	Financial							X

Table 13-1. Sources of Technical and Financial Assistance (Page 3 of 3)

Agency or Organization	Website	Assistance	BMP Category						
			Developed Non-MS4	Cropland	Pasture	Feedlot	Forest	Stream	Outreach
FEDERAL									
U.S. Army Corps of Engineers	www.usace.army.mil	Financial, Technical						X	X
USDA–NRCS	www.nrcs.usda.gov	Financial, Technical		X	X	X	X	X	X
USDA–Farm Service Agency	www.fsa.usda.gov	Financial, Technical		X	X	X		X	X
USDA–Rural Development	www.rurdev.usda.gov	Financial, Technical						X	X
USDA–Bureau of Land Management	www.blm.gov	Financial, Technical					X	X	X
U.S. Department of Interior–Bureau of Reclamation	www.usbr.gov	Financial, Technical	X	X			X	X	X
EPA	www.epa.gov	Financial, Technical	X	X	X	X	X	X	X
USDA–Forest Service	www.fs.fed.us	Financial, Technical					X	X	X
USFWS	www.fws.gov	Financial, Technical						X	X
USGS	www.usgs.gov	Technical						X	X
PRIVATE									
Ducks Unlimited	www.ducks.org	Financial, Technical						X	X
Colorado Trout Unlimited	coloradotu.org	Financial, Technical						X	X
Fresh Water Trust	www.thefreshwatertrust.org	Financial, Technical	X	X	X	X	X	X	X
Mule Deer Foundation	www.muledeer.org	Financial, Technical					X	X	X
Rocky Mountain Elk Foundation	www.rmef.org	Financial, Technical					X	X	X
National Fish and Wildlife Foundation	www.nfwf.org	Financial, Technical						X	X

13.1 INCENTIVE PROGRAMS

Incentive programs are formal programs used to promote specific actions or behaviors. Participation in incentive programs is voluntary. Various mechanisms can be used to conduct incentive programs, including financial assistance or providing benefits for enrolling in programs. The following programs are relatively easy for users to take advantage of, and the money for them is generally allocated annually.

13.1.1 COST-SHARE PROGRAMS

In a cost-share program, the costs of systems or practices for water quality improvements are shared between the landowner, state (percentage), or federal programs (flat rate). State-funded nonstructural land management cost sharing is also typically based on a flat rate. Landowners seeking cost-share assistance should contact their county conservation district office for information on available programs. The BMPs and conservation practices that are typically eligible are those that avoid, control, and trap nutrients, sediment, and *E. coli* from entering surface water and groundwater. Eligibility may vary depending on local priorities and needs.

13.1.2 FEE DISCOUNTS

Local governments or nonprofit entities may offer reduced fees for implementing projects and practices that align with program goals. For instance, stormwater fees could be reduced if a landowner voluntarily converts cropped acres to a permanent vegetative cover.

13.1.3 LOW-INTEREST LOANS

Low-interest loans may be available through various state agencies to landowners for agricultural BMPs, septic system updates/replacement, or other projects that meet funding eligibility criteria.

13.1.4 WATER QUALITY TRADING

Point source permittees should be mindful that options are available to use money available for upstream NPS implementation to improve water quality for a smaller potential cost. These options need to be further evaluated and quantified.

13.2 POTENTIAL FUNDING

Funding is available from private, local, county, state, and federal sources to implement projects for improving water quality. The following sections discuss these sources. Other funding sources not noted here may be available. The state of Colorado maintains a Grants Information page on its website.

13.2.1 CITIES

Municipalities often collect stormwater utility fees to build, repair, operate, and maintain stormwater management systems. Such fees should be set using reasonable calculations based on runoff volume or pollution quantities, property classifications, or both.

13.2.2 COUNTIES, WATERSHED DISTRICTS, AND AUTHORITIES

In other areas of Colorado, authorities have been developed, such as the Cherry Creek Basin Water Quality Authority and the Chatfield Watershed Authority. These authorities can levy funds for priority projects and assist with program implementation. The NFRWQPA and other 208 planning agencies cannot levy funds or taxes for projects, but they have voluntary fees and dues that contribute to planning and implementation. Recently, the Chatfield Watershed Authority also added an entrance fee to the Chatfield State Park to assist with protecting water quality.

13.2.3 STATE

The State of Colorado funds watershed management programs through various capacities, programs, and agencies.

The CDPHE has numerous NPS funding opportunities, which include watershed implementation projects (restoration and protection), watershed planning and tool development, and education and outreach. The primary CDPHE opportunities consist of the Source Water Assessment and Protection (SWAP) Program; the Water Quality Grants and Loans Unit; CSU's Colorado Wetland Information Center; CSU's Colorado State Forest Service; the Department of Natural Resources' Colorado Water Conservation Board (CWCB); Colorado Water Plan Grants; and Colorado Watershed Restoration Grants. More information regarding each program is provided in CDPHE [2022]. Funds from the Water Supply Reserve Fund (WSRF) are issued through the South Platte Basin Roundtable. CDPHE has a state revolving fund that includes a Water Pollution Control revolving fund that completes many OWTS to sewer projects.

Under the Colorado Natural Resources Department, the CWCB also administers the Federal Technical Assistance Grant Program, consisting of Local Capacity Grants and Technical Assistance Grants. Federal American Rescue Plan Act funding of $5 million is available for these two grants in Colorado. The grantee must provide a minimum of 25 percent matching funds. Grants will be awarded on a rolling basis through December 2024; grant funds must be fully expended by December 2026. Local Capacity Grants are direct awards to grantees to secure the resources needed (contractors or otherwise) to develop projects and submit competitive federal grant applications. Technical Assistance Grants are awards to grantees who want to use a contractor hired by the CWCB. This contractor can provide a wide variety of water project services, such as federal grant opportunity research, project design, partial engineering, cost estimation, and federal application development/grant writing.
Statewide education grants and outreach initiative grants are available through the Public Education, Participation, and Outreach (PEPO) Grant Program, which is administered through the CWCB. The PEPO Grant Program also financially supports designated individual coordinators who support basin-specific outreach and education efforts alongside each of the state's basin roundtables. The Colorado Department of Natural Resources also maintains a Water Funding Opportunity Navigator, which lists potential federal and state grant opportunities.

Other state funding opportunities include the Colorado Healthy Rivers Fund. This program grants money to local watershed organizations to provide clean water, protect habitat, and improve recreation and accessibility throughout Colorado. Project grants and planning grants are available under the program.

RESPEC

13.2.4 FEDERAL

Federal agencies can provide funding and technical assistance for projects and monitoring. These agencies include the U.S. Fish and Wildlife Service (USFWS), USGS, NRCS, Farm Service Agency, EPA, and others. The USGS is more likely to support data acquisition and monitoring programs and the USFWS may provide land retirement program funds. The NRCS helps with applying conservation practices, and the EPA assists with studies to identify more localized sources of pollution in impaired waterbodies. The following sections provide information regarding federal NPS funding.

13.2.4.1 U.S. ENVIRONMENTAL PROTECTION AGENCY

The EPA provides funding opportunities for watershed restoration and protection on its funding resource webpage for NPS pollution. Additional EPA funding opportunities are available online on the Equity Action Plan webpage and Environmental Justice Grants, Funding and Technical Assistance webpage.

The EPA also has a funding opportunity through the Office of Wetlands, Oceans, and Watersheds' Fiscal Year 2024 Building Partner Capacity and Promoting Resiliency and Equity under the CWA. The EPA is soliciting applications from eligible applicants to provide support for training and related activities to build the capacity of agricultural partners; state, territorial, and Tribal officials; and nongovernmental stakeholders in support of the goals of the CWA Section 319 Nonpoint Source Management Program.

The EPA also has funding from the Clean Water State Revolving Fund (CWSRF) accessible via the About the Clean Water State Revolving Fund (CWSRF) webpage. The funds are generally for municipal wastewater facility construction, control of NPS pollution, decentralized wastewater treatment systems, green infrastructure projects, project estuaries, and other water quality projects.

13.2.4.2 U.S. DEPARTMENT OF AGRICULTURE'S NATURAL RESOURCES CONSERVATION SERVICE

The NRCS's natural resources conservation programs help individuals reduce soil erosion, enhance water supplies, improve water quality, increase wildlife habitat, and reduce damage caused by floods and other natural disasters. More information is available on the USDA Programs & Initiatives webpage.

The following technical and financial assistance programs are generally awarded annually through NRCS:

- **Agricultural Conservation Easement Program (ACEP).** Applications are accepted from April through December. ACEP easement agreements are typically awarded annually by the fall.
- **Conservation Stewardship Program (CSP).** The CSP helps agricultural producers maintain and improve existing conservation systems and adopt additional conservation activities to address priority resource concerns. Participants earn CSP payments for conservation performance—the higher the performance, the higher the payment. Different enrollment opportunities are available for CSP Classic, CSP Renewals and CSP Grasslands. Applications are accepted from April through December. CSP contracts are awarded by June or July.
- **Conservation Technical Assistance (CTA).** The CTA provides the nation's farmers, ranchers, and forestland owners with the knowledge and tools they need to conserve, maintain, and restore the natural resources on their lands and improve the health of their operations for the future. NRCS offers this assistance at no cost to the producers served.

- **Environmental Quality Incentives Program (EQIP).** EQIP provides financial and technical assistance to agricultural producers to address natural resource concerns and deliver environmental benefits, such as improved water and air quality; conserved ground and surface water; increased soil health; reduced soil erosion and sedimentation; improved or created wildlife habitat; and mitigation against increasing weather volatility. Applications are accepted on a continuous basis, with application cutoff for funding evaluation typically set in November of each year. EQIP contracts are typically awarded by April or May.
- **Regional Conservation Partnership Program (RCPP).** RCPP promotes coordination of NRCS conservation activities with partners that offer valuable contributions to expand the collective ability to address on-farm, watershed, and regional natural resource concerns. Announcements for Funding Proposals (AFPs) for RCPP Classic are typically advertised in October through November and awarded in June through August. RCPP Alternative Funding Arrangement (AFA) AFPs are typically announced March through May, with agreements awarded by September and, in some cases, the funds are carried over and awarded from October to December of the following fiscal year.
- **National Water Quality Initiative (NWQI).** NWQI provides a way to accelerate voluntary, on-farm conservation investments focused on water quality monitoring and assessment resources, where they can deliver the greatest benefits for clean water. The NWQI is a partnership among NRCS, state water quality agencies, and EPA to identify and address impaired waterbodies through voluntary conservation.
- **Watershed Operations PL-566 Program.** The Watershed Protection and Flood Prevention Act (PL-566) authorizes the USDA-NRCS to help local organizations and units of government plan and implement watershed projects. PL-566 watershed projects are locally led to solve natural and human resource problems in watersheds up to 250,000 acres (less than 400 mi^2). At least 20 percent of any project benefits must relate directly to agriculture, including rural communities. A local sponsoring organization is needed to carry out, maintain, and operate works of improvement. The program has two main components, and each is funded separately: (1) watershed surveys and planning and (2) watershed and flood prevention operations and construction.
- **Conservation Innovation Grants (CIG).** CIG is a competitive program that supports the development of new tools, approaches, practices, and technologies to further natural resource conservation on private lands. Through creative problem-solving and innovation, CIG partners work to address the nation's water quality, air quality, soil health, and wildlife habitat challenges while improving agricultural operations. Three program types are available: (1) national, (2) state, and (3) CIG On-Farm Conservation Innovation Trials.
- **Rural Development.** For OWTS funding, USDA Rural Development has a 504 Single Family Program, a Community Development Program, a Home Repair Loan/Grant Program, a Community Pass-through Program, and Water Well Trust Program. Income eligibility for these programs is often a sliding scale.

Other federal agency funding includes the U.S. Bureau of Reclamation (USBR) WaterSMART. Through WaterSMART, the USBR leverages federal and nonfederal funding to work cooperatively with states, tribes, and local entities as they plan for and implement actions to increase water supply sustainability through investments in existing infrastructure and attention to local water conflicts.

13.2.5 PRIVATE/OTHER SOURCES

Foundations, nonprofit organizations, and private contributions, including those from landowners and corporate entities, will be sought for plan implementation activities. Local foundations may fund education, civic engagement, and other local priority efforts. Such organizations acquire their own funding and may have project dollars and technical assistance that can be used. Major cooperators and funding sources include private landowners who typically contribute a percentage of project costs and may donate land, services, or equipment for projects or programs.

Some of the stakeholder questions asked in Survey #2 were related to the technical and financial assistance needed or used and how they used it. The Northern Colorado Water Conservancy District mentioned that it has an extensive, long-term water quality monitoring program in the Big Thompson River HUC8. Los Rios Farm, a local farm in the watershed, stated a need for financial assistance for projects if landowners were willing and has been successful in receiving funding from the Federal Emergency Management Agency (FEMA), NRCS, and CWCB. Technical resources that would be helpful include education on project benefits and how resulting projects impact the adjacent communities. Los Rios Farm has received technical assistance from the CSU Watershed Group and is aware of technical assistance available from the NRCS but has not used it. The Colorado Watershed Assembly has received CWCB and NPS funds and other funds from the Cherry Creek Basin Water Quality Authority and Great Outdoors Colorado, as well as county and municipal funding and technical assistance. The Colorado Watershed Assembly tracks various federal grant opportunities and has used the CWCB and NPS Program for technical assistance. The Colorado Wheat Administrative Committee is aware of financial assistance from the conservation districts, NRCS, crop consultants, and NRCS Agricultural Research Service but has yet to secure funding.

The following are private foundations with available funding programs:

- The Laura Jane Musser Fund, a foundation based in Minnesota, assists public or not-for-profit entities to initiate or implement projects that enhance the ecological integrity of publicly owned open spaces while encouraging compatible human activities. The fund's goal is to promote public use of open space that improves a community's quality of life and public health, while also ensuring the protection of healthy, viable, and sustainable ecosystems by defending or restoring habitat for the diversity of plant and animal species.
- The Moore Charitable Foundation works to preserve and protect natural resources for future generations. This foundation and its affiliates support nonprofit organizations that protect land, wildlife, habitat, and water resources in several regional planning areas, including Colorado. The foundation also supports educational and community programs in these areas.
- The Colorado River Basin Salinity Control Act, established in 1974, provides authorization for enhancing and protecting numerous salinity control projects in Colorado and other states. High levels of salinity in water can reduce crop yields, limit the choice of crops that can be grown, and, at higher concentrations over long periods, can kill trees and make the land unsuitable for agricultural purposes. Through strong partnerships between the NRCS, private landowners, USBR, CWCB, and several local conservation districts, financial and technical assistance funds have been used to install irrigation improvements, such as the installation of pipelines, more efficient irrigation systems, and lining of ditches and small laterals.

- The Colorado Watershed Assembly routinely posts funding opportunities through its bimonthly newsletter available on the Colorado Watershed Assembly homepage.
- The South Platte Basin Roundtable offers two funding cycles annually, and information is available on the South Platte Basin homepage.

14.0 REFERENCES

American Veterinary Medical Association, 2016. "U.S. Pet Ownership Statistics," *avma.org*, accessed June 30, 2016, from *https://www.avma.org/KB/Resources/Statistics/Pages/Market-research-statistics-US-pet-ownership.aspx*

Big Thompson Watershed Coalition, 2024. "All BTWC Projects," accessed May 30, 2024, from *https://bigthompson.co/big-thompson-projects/*

Brandt, T. R. and J. P. Colgan, 2023. Digital database of the previously published geologic map of the Boulder-Fort Collins-Greeley area, Colorado: U.S. Geological Survey data release, available online at *https://doi.org/10.5066/P95MSFVF*.

Briffa, J., E. Sinagra, and R. Blundell, 2020. "Heavy Metal Pollution in the Environment and Their Toxicological Effects on Humans", *Heliyon*, Volume 6, Issue 9, e04691, ISSN 2405-8440, available online at *https://doi.org/10.1016/j.heliyon.2020.e04691*

Catena Analytics, 2024. "eRAMS Online," accessed August 13, 2024, from *https://erams.com/catena/*

Colorado's Decision Support Systems, 2024. "GIS Data by Category," accessed August 13, 2024, from *https://cdss.colorado.gov/gis-data/gis-data-by-category*

Colorado Department of Public Health and Environment, 2022. *Colorado's Nonpoint Source Management Plan: 2022,* prepared by Colorado Department of Public Health and Environment Water Quality Control Division, Glendale, CO, available online at *https://drive.google.com/file/d/1nrZ1D4yp2LGHUxrNsyjwGbu3w1ZCs9wz/view*

Colorado Geospatial Portal, 2024. *2024 State of Colorado Public Parcels*, CO Office of Information Technology, Enterprise GIS, accessed August 14, 2024, from *https://geodata.colorado.gov*

Colorado Water Plan, 2015. "South Platte/Metro Analysis and Technical Update," accessed May 30, 2024, from *https://dnrftp.state.co.us/CWCB/Technical%20Update%20to%20Water%20Plan/1.%20Technical%20Update%20Documentation/Volume%201-Section%204.8-S%20Platte%20Metro%20Republican%20Results.pdf*

The Diggings, 2024. "Mining In Weld County, Colorado," accessed August 15, 2024, from *https://thediggings.com/usa/colorado/weld-co123*

Environmental Systems Research Institute, Inc., 2014. "USA Federal Lands," accessed August 14, 2024, from *https://www.arcgis.com/home/item.html?id=c959f521c02f4f64abf4d39019c5ccd5*

Fischer, J., 2023. Personal communication between J. Fischer, Invision GIS, CO, and C. Kirby, RESPEC, Rapid City, SD, December 14.

Graves, J., 2024. Personal communication between J. Graves, Colorado Division of Reclamation, Mining, and Safety, Denver, CO, and N. Acosta, RESPEC, Colorado Springs, CO, March 8.

Hawley, C. and N. Rodriquez-Jeangros, 2021. *Big Thompson State of the Watershed 2021 Final Report*, prepared by Hydros Consulting, Boulder, CO, for Big Thompson Watershed Forum, Fort Collins, CO.

Horsley and Witten, Inc., 1996. *Identification and Evaluation of Nutrient and Bacterial Loadings to Maquoit Bay, New Brunswick, and Freeport, Maine*, prepared by Horsley & Witten, Inc., Barnstable, MA, for Casco Bay Estuary Project, Portland, ME.

Horton, J.D., C. A. San Juan, and D. B. Stoeser, 2017. "The State Geologic Map Compilation (SGMC) Geodatabase of the Conterminous United States," *US Geological Survey Data Series 1052,* Ver. 1.1, August 2017, p. 46.

Larimer County, 2024. "Larimer County GIS Digital Data," accessed August 14, 2024, from *https://www.larimer.gov/it/gis/digital-data*

Metcalf and Eddy, Inc., 1991. *Wastewater Engineering: Treatment, Disposal and Reuse*, 3rd Edition, McGraw-Hill, New York, NY.

Minnesota Pollution Control Agency, 2024. "Minnesota Stormwater Manual Overview of Minimal Impact Design Standards (MIDS)," accessed May 6, 2024, from *https://stormwater.pca.state.mn.us/index.php/Overview_of_Minimal_Impact_Design_Standards_(MIDS)*

Moore, E., 2022. *Colorado's Nonpoint Source Program: 2022 Annual Report*, prepared by Colorado Department of Public Health and Environment Water Quality Control Division, Denver, CO, available online at *https://storymaps.arcgis.com/stories/e7212fd7f8224b839b669fd8bbd058a4*

Multi-Resolution Land Characteristics Consortium, 2019. "National Land Cover Database 2019 - Landcover & Imperviousness (NLCD2019)," accessed August 14, 2024, from *https://www.mrlc.gov/data?f%5B0%5D=category%3ALand%20Cover&f%5B1%5D=year%3A2019*

National Interagency Fire Center, 2024. "InterAgencyFirePerimeterHistory All Years View," accessed August 14, 2024, from *https://data-nifc.opendata.arcgis.com/datasets/e02b85c0ea784ce7bd8add7ae3d293d0_0/explore?location=39.994103%2C-103.924962%2C8.89*

Natural Resources Conservation Service, 2024a. "Soil Survey Geographic Database (SSURGO)," accessed August 13, 2024, from *https://www.nrcs.usda.gov/resources/data-and-reports/soil-survey-geographic-database-ssurgo*

Natural Resources Conservation Service, 2024b. "Conservation Practices Physical Effects (CPPE) – FY24 National Template-Version 2," accessed May 14, 2024, from *https://www.nrcs.usda.gov/resources/guides-and-instructions/conservation-practice-physical-effects*

Natural Resources Conservation Service, 2024c. "Conservation Practice Standard Land Reclamation, Abandoned Mined Land Code 543," accessed May 30, 2024, from *https://www.nrcs.usda.gov/sites/default/files/2022-09/Land_Reclamation_Abandoned_Mined_Land_543_NHCP_CPS.pdf*

North Front Range Water Quality Planning Association, 2022. *208 Areawide Water Quality Management Plan 2022 – 208 AWQMP Update (Region 2)*, prepared by the North Front Range Water Quality Planning Association, Johnstown, CO.

PRISM Climate Group, 2024. "Average Monthly and Average Annual Precipitation 1961-1990, 1971-2000 and 1981-2010 by State," accessed May 14, 2024, from *https://gdg.sc.egov.usda.gov/Catalog/ProductDescription/PRCIP.html*

Smith, E., 2024. *2023 Zoning Boundary.zip,* attachment from personal communication between E. Smith, Town of Timnath, CO, and C. Kirby, RESPEC, Rapid City, SD, January 29.

Tetra Tech, Inc., 2022. *User's Guide Pollution Load Estimation Tool Version 1.0*, developed for the U.S. Environmental Protection Agency by Tetra Tech, Inc. Fairfax, VA.

The Water Research Foundation, 2024. "International Stormwater BMP Database," accessed August 14, 2024, from *https://bmpdatabase.org/*

Thomas, M., 2024. Personal communication between M. Thomas, North Front Range Water Quality Planning Association, Johnstown, CO, and C. Kirby, RESPEC, Rapid City, SD, May 2.

University of Missouri Extension, 2024. "Nitrogen in the Environment: Nitrogen's Most Common Forms," accessed June 5, 2024, from *https://extension.missouri.edu/publications/wq253*

U.S. Census Bureau, 2020. "QuickFacts: Loveland City, Colorado; United States" accessed July 29, 2024, from *https://www.census.gov/quickfacts/fact/table/lovelandcitycolorado,US/PST045222*

U.S. Department of Agriculture, 2024. "Farmers.gov," accessed May 30, 2024, from *www.farmers.gov*

U.S. Environmental Protection Agency, 2008. "Handbook for Developing Watershed Plans to Restore and Protect Our Waters," accessed August 13, 2024, from *https://www.epa.gov/nps/handbook-developing-watershed-plans-restore-and-protect-our-waters*

U.S. Environmental Protection Agency, 2022. "User's Guide Pollutant Load Estimation Tool (PLET) Version 1.0," accessed August 1, 2024, from *https://www.epa.gov/system/files/documents/2022-04/user-guide-final-04-18-22_508.pdf*

U.S. Environmental Protection Agency, 2023. "Best Management Practice Definitions Document for Pollutant Load Estimation Tool," accessed May 1, 2024, from *https://www.epa.gov/system/files/documents/2023-04/BMP_Description_revised%203-9-23_final%20with%20alt%20text_508.pdf*

U.S. Environmental Protection Agency, 2024a. "Nonpoint Source (NPS) Watershed Projects Data Explorer," accessed August 14, 2024, from *https://ordspub.epa.gov/ords/grts/f?p=109:940::::940::*

U.S. Environmental Protection Agency, 2024b. "Per- and Polyfluoroalkyl Substances (PFAS) Final PFAS National Primary Drinking Water Regulation," accessed August 14, 2024, from *https://www.epa.gov/sdwa/and-polyfluoroalkyl-substances-pfas*

U.S. Geological Survey, 2019. "SPARROW Modeling Program," accessed August 14, 2024, from *https://www.usgs.gov/software/sparrow-modeling-program*

U.S. Geological Survey Colorado Water Science Center, 2000. "NAWQA South Platte River Basin Study," accessed May 30, 2024, from *https://www.usgs.gov/centers/colorado-water-science-center/science/nawqa-south-platte-river-basin-study*

WebMD, 2024. "Blue Baby Syndrome: What Is It?," accessed May 30, 2024, from *https://www.webmd.com/baby/what-is-blue-baby-syndrome*

Workman, J. B., J. C. Cole, R. R. Shroba, K. S. Kellogg, and W. R. Premo, 2018. Geologic Map of the Fort Collins 30'×60' quadrangle, Larimer and Jackson Counties, Colorado, and Albany and Laramie Counties, Wyoming, available online at *https://ngmdb.usgs.gov/Prodesc/proddesc_108070.htm*

Zeckoski, R. W., B. L. Benham, S. B. Shah, and C. D. Heatwole, 2005. "BSLC: A Tool for Bacteria Source Characterization for Watershed Management," *Applied Engineering in Agriculture*, Vol. 21, No. 5, pp. 879–889.

APPENDIX A
SURVEY QUESTIONS

2022 SURVEY

1. Agency/organization's name
2. Website URL
3. Contact person(s), name(s)
4. Email address(s)
5. Phone number(s)
6. Which of the following watersheds is/are the focus of your organization
    a. Big and Little Thompson
    b. Middle South Platte
    c. Cache la Poudre
    d. St. Vrain Creek
    e. Other
7. If known, please list the waterbody name and segment identification (AUID) (i.e., COSPUS15) if it was selected from question #6, please provide the watershed name.
8. Does your agency have an existing watershed plan, source water plan, NPS plan, or other?
9. Please provide the link to the watershed plan(s) if available below or send a copy to Mark Thomas at: mthomas@nfrwqpa.org
10. Is the plan under development if you agency does not have an existing watershed plan identified in question #8?
11. What level of impact do the following nonpoint sources have on water quality in your watershed? (check one for each row)
    a. Abandoned mine lands
    b. Agriculture (including agricultural return flows and agricultural stormwater runoff)
    c. Hydromodification (diversions including transbasin diversions)
    d. Habitat alteration
    e. Urbanization
    f. Onsite wastewater systems (aka septic systems)
    g. Runoff from roadways
    h. Post wildfire impacts (includes post-wildfire flooding)
    i. Climate change
    j. Hazardous household or industrial wastes (pharmaceuticals, oil, paint, acids, pesticides, etc.)
12. What are the major pollutants of concern? (check all that apply)
    a. Sediment (includes ash from wildfire)
    b. Total suspended solids (TSS)
    c. Nitrogen
    d. Phosphorus
    e. Temperature
    f. Metals
    g. *E. coli*
    h. Emerging contaminants
    i. Other
13. Please check all water quality parameters/analytes that your group measures:
    a. Sediment (includes ash from wildfire)
    b. Total suspended solids (TSS)

c. Nitrogen
d. Phosphorus
e. Temperature
f. Metals
g. *E. coli*
h. Emerging contaminants
i. Other

14. If known, what is the period of record for each of the analytes listed above?
15. Is the data publicly available on the Colorado Data Sharing Network (CDSN)?
16. If the data is not publicly available, would you be willing to share your data with NFRWQPA?
17. What types of watershed projects have been completed?
    a. Habitat improvements
    b. Bank stabilization - grading
    c. Bank stabilization – vegetation
    d. Installation of drop or other in rivers
    e. Vegetation buffers
    f. Agricultural tailwater BMPs
    g. Unknown
18. What projects are high priority for your organization/watershed group?
19. What barriers from question (#18) may be preventing the project?
    a. Funding
    b. Technical resources
    c. Instrumentation
    d. Staffing/volunteer time
    e. No barriers are preventing the project
    f. Other
20. Does your organization/agency provide any of the following services:
    a. BMP recommendations
    b. Technical advice
    c. Water quality sampling
    d. Public education
    e. Other
21. Do you have policies, guidelines, or governing codes related to nonpoint source water quality adoption? Please, provide sources or weblinks.
22. Does your jurisdiction's county/municipal code reference the NFRWQPA 208 Areawide Water Quality Management Plan?
23. What can a regional NPS watershed plan help your watershed organization accomplish?
24. If known, provide or identify areas of special interest that need to be protected from NPS pollutants.
25. Why does your watershed organization value water quality?
26. What is the public perception of your watershed's water quality?
27. What other issues or concerns would you like NFRWQPA to be aware of?
28. If you want to be added to the email/ notification/distribution list regarding meetings and updates concerning the Regional NPS Watershed Plan, please provide your email below.

2024 SURVEY

1. Email address
2. First name
3. Last name
4. Please provide your contact information
5. Are you interested in participating with the NFRWQPA Technical Advisory Committee in guiding the Nonpoint Source plan best management practices (BMPs) for the Larimer and Weld County region and participating in the final report review for this project? If yes, please provide your name and email address.
6. What watershed are you most concerned with? Select all that apply.
    a. Middle South Platte - Cherry (Area of Concern: 10190003)
    b. St. Vrain (Area of Concern: 10190005)
    c. Big Thompson (Area of Concern: 10190006)
    d. Cache la Poudre (Area of Concern: 10190007)
    e. Lone Tree-Owl (Area of Concern: 10190008)
    f. Crow (Area of Concern: 10190009)
    g. Middle South Platte Sterling (Area of Concern: 10190012)
    h. Other (please specify)
7. Aside from watershed plans, what other major projects have you done or are you aware of that has or may improve water quality in the watershed?
8. When were they completed?
9. What is the approximate area impacted by the project?
10. What is the approximate area impacted by the project? Please describe.
11. Are there current plans for a watershed plan or update of an existing plan in your area?
12. How many months a year do agriculture producers typically apply manure on crops?
13. Rank the likelihood of each following cropland BMPs to be implemented in your area from 1 to 5, with 1 being unlikely and 5 being very likely
    a. List of BMPs from PLET
14. Does your watershed have BMPs for non-point source pollution? The following would be important to attain if available (including list/count estimate).
15. What BMPs have been implemented in your watershed? Please describe.
16. Approximately how many of each BMP type/technology (many are included in Section 5 questions) have been implemented in your HUC8?
17. What area of concern and/or water bodies are benefiting from the implemented BMPs? Please describe.
18. What land use(s) are the BMPs developed for? Select all that apply.
    a. Cropland
    b. Pasture
    c. Forest
    d. Urban
    e. Feedlot
    f. Other (please specify)
19. Please estimate the approximate area impacted by the implemented BMPs.

20. Is there any monitoring associated with determining pollutant load reductions and/or do the BMPs have estimated pollutant load reductions?
21. If you answered no, do you need technical and financial assistance to conduct monitoring?
22. What were the costs associated with the BMPs?
23. Are there noticeable improvements associated with implementing the BMPs? If yes, please describe.
24. Are there other BMPs you would like to see in addition to those currently constructed or implemented?
25. Please list any funded projects, activities, or next steps for non-point source pollution in your watershed in the next five years.
26. What types of information/education/outreach do you see being the most effective? Please check all that apply.
    a. Water Quality Awareness Signage in Parks by Streams
    b. Educational Campaign
    c. Social Media
    d. Story Map
    e. Newsletters, Mailers, Blurbs
    f. Website Update
    g. Park Signage
    h. "Report a Concern" Website
    i. Volunteer Cleanup Programs
    j. School Visits
    k. Pet-waste Pickup Stations
    l. Other (please specify)
27. Are you interested in collaboration with other stakeholder groups and hosting/participation in events?
28. Do you have any annual events/activities we could attend? If yes, please provide date/time/location/contact information.
29. Please describe what interim measurable criteria/milestones are used to determine goal achievement.
30. In 5 years, what does progress look like to you regarding pollution loading reduction in your area of concern?
31. In 10 years, what does progress look like to you regarding pollution loading reduction in your area of concern?
32. Which of the following in-stream monitoring activities would you likely consider implementing in your area of concern? Please select one or both options.
33. Do you need technical and financial assistance to conduct in-stream monitoring? If yes, please describe.
34. To develop/implement BMPs, do you need any financial assistance? If yes, please describe.
35. What financial assistance have you received for watershed improvement projects?
36. What are sources of financial assistance you know of but have not used?
37. What technical resources are needed to develop/implement BMPs?
38. What sources of technical assistance have you received in the past?
39. What are sources of technical assistance you know of but have not used?

40. Are there point discharges you are concerned about in your watershed (even in areas that are MS4 permitted)? If yes, please explain.
41. Are there non-point sources that you are concerned about in your watershed (even in areas that are MS4 permitted)? If yes, please explain.
42. Are you aware of abandoned mined land in your area?
43. If yes, are you aware of abandoned mined land BMP strategies implemented in your area?
44. What are the results of implementing such abandoned mined land BMP strategies?
45. Are you aware of agricultural practices (Cropland, Pasture, and/or Feedlot) in your area?
46. From the highest concern to the lowest, please rank the following agricultural concerns with 1 being the largest and 3 being the smallest: Cropland, Pasture, Feedlot.
47. Are you aware of agricultural BMP strategies implemented in your area?
48. If yes, what are the results of implementing such agricultural BMP strategies?
49. Are you aware of atmospheric deposition in your area?
50. If yes, are you aware of atmospheric deposition BMP strategies implemented in your area?
51. What are the results of implementing such atmospheric deposition BMP strategies?
52. Are you aware of forestry non-point source in your area?
53. If yes, are you aware of forestry non-point source BMP strategies implemented in your area?
54. Are you aware of hydromodification and habitat alteration in your area?
55. If yes, are you aware of hydromodification and habitat alteration BMP strategies implemented in your area?
56. If yes, what are the results of implementing such hydromodification and habitat alteration BMP strategies?
57. Are you aware of urbanization in your area?
58. If yes, are you aware of urbanization BMP strategies implemented in your area?
59. If yes, what are the results of implementing such urbanization BMP strategies?

APPENDIX B

MAPS OF IMPAIRED PARAMETERS

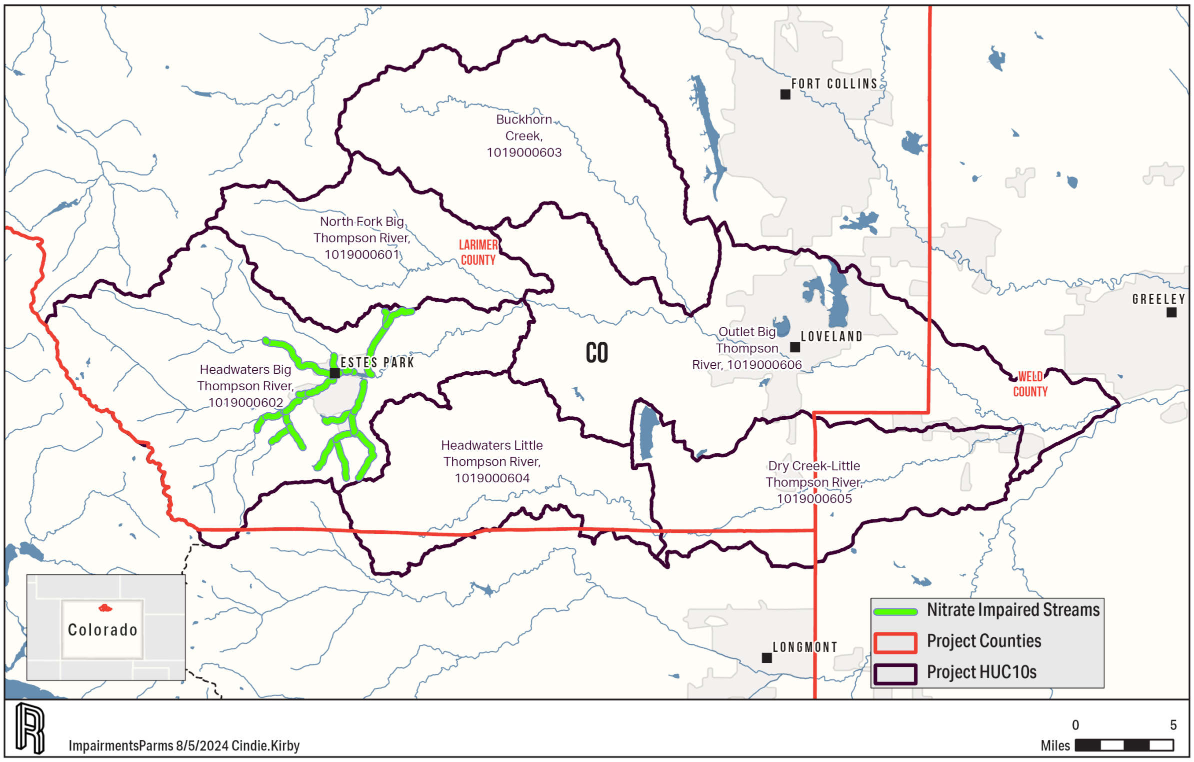


Figure B-1. Nitrate Impairments.

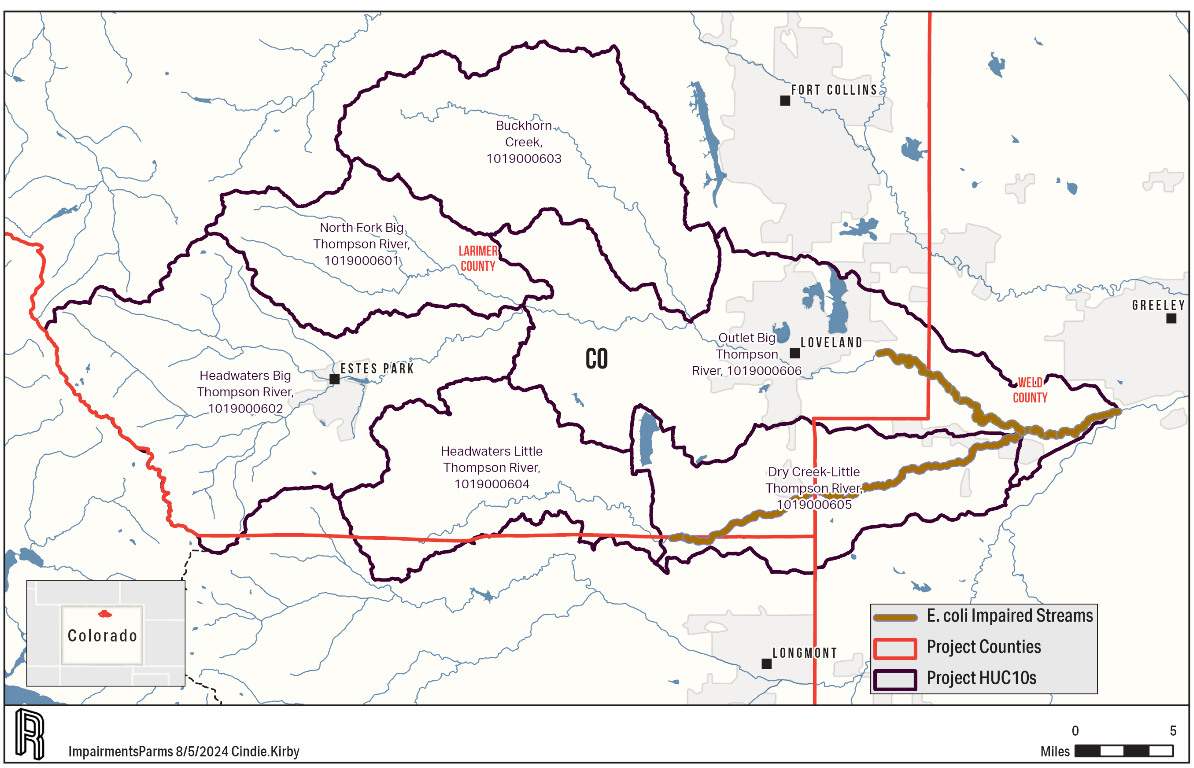


Figure B-2. *E. coli* Impairments.

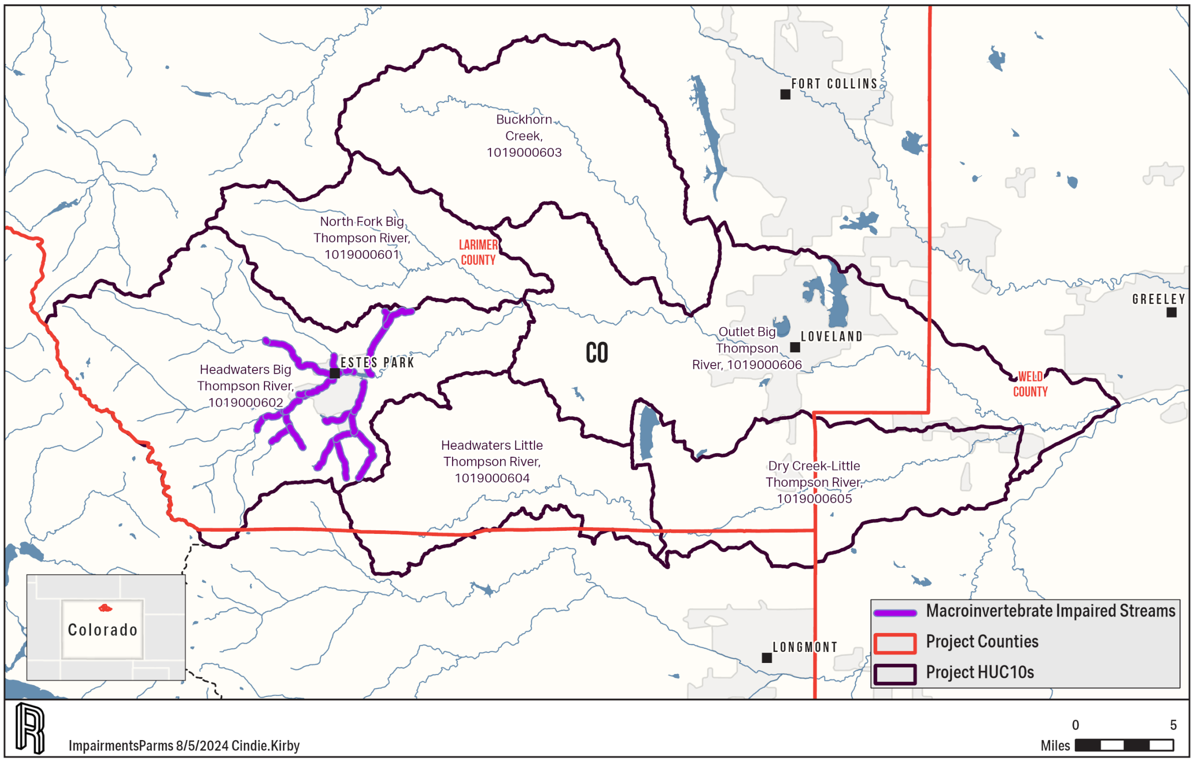


Figure B-3. Macroinvertebrate Impairments.

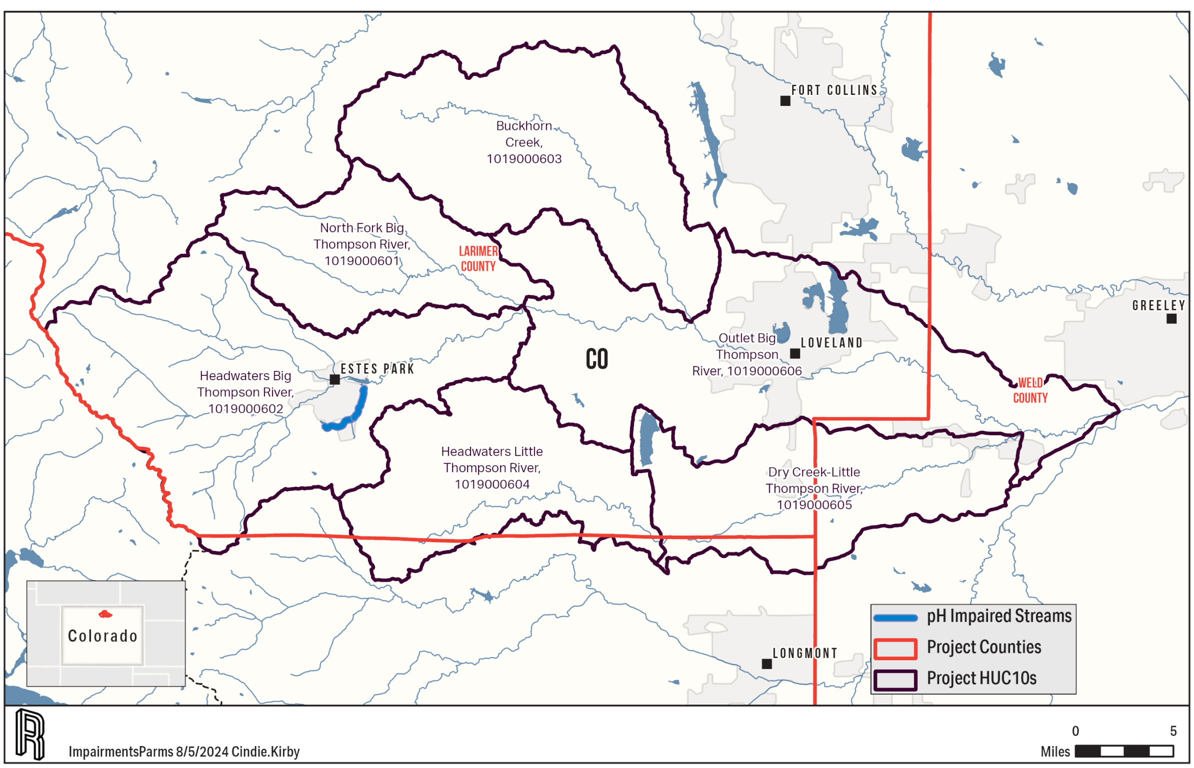


Figure B-4. pH Impairments.

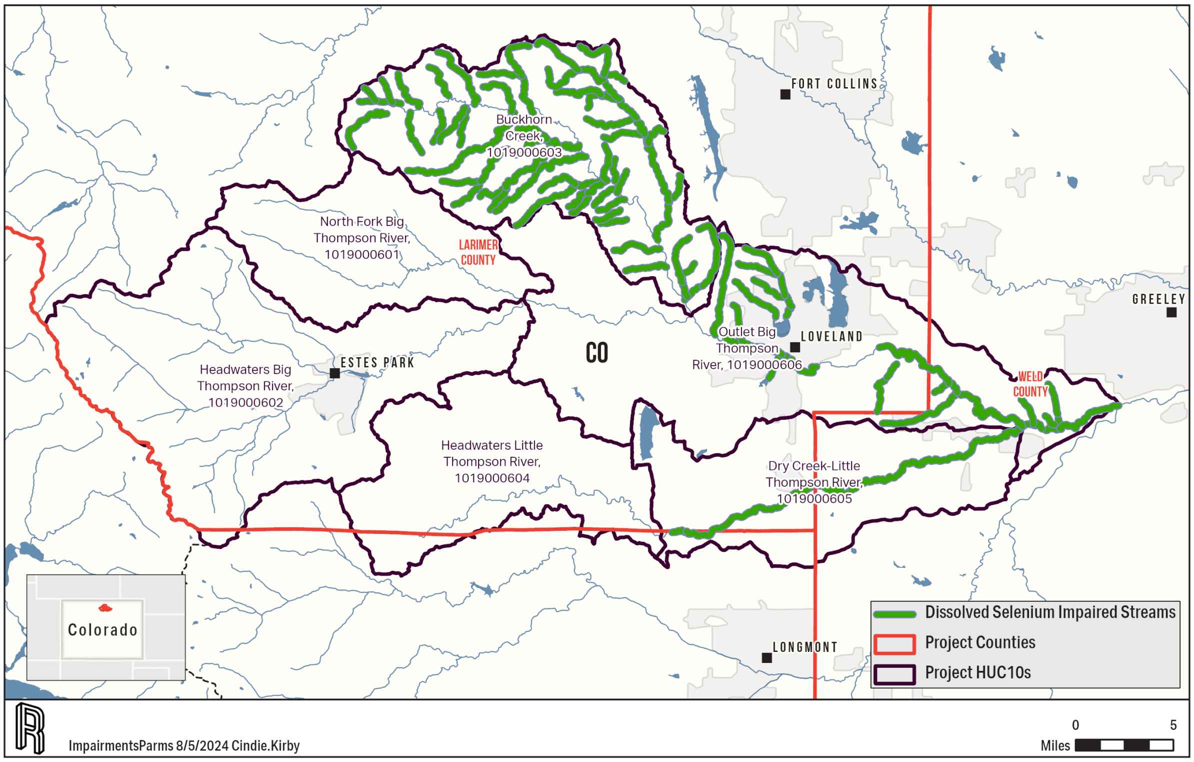


Figure B-5. Selenium Impairments.

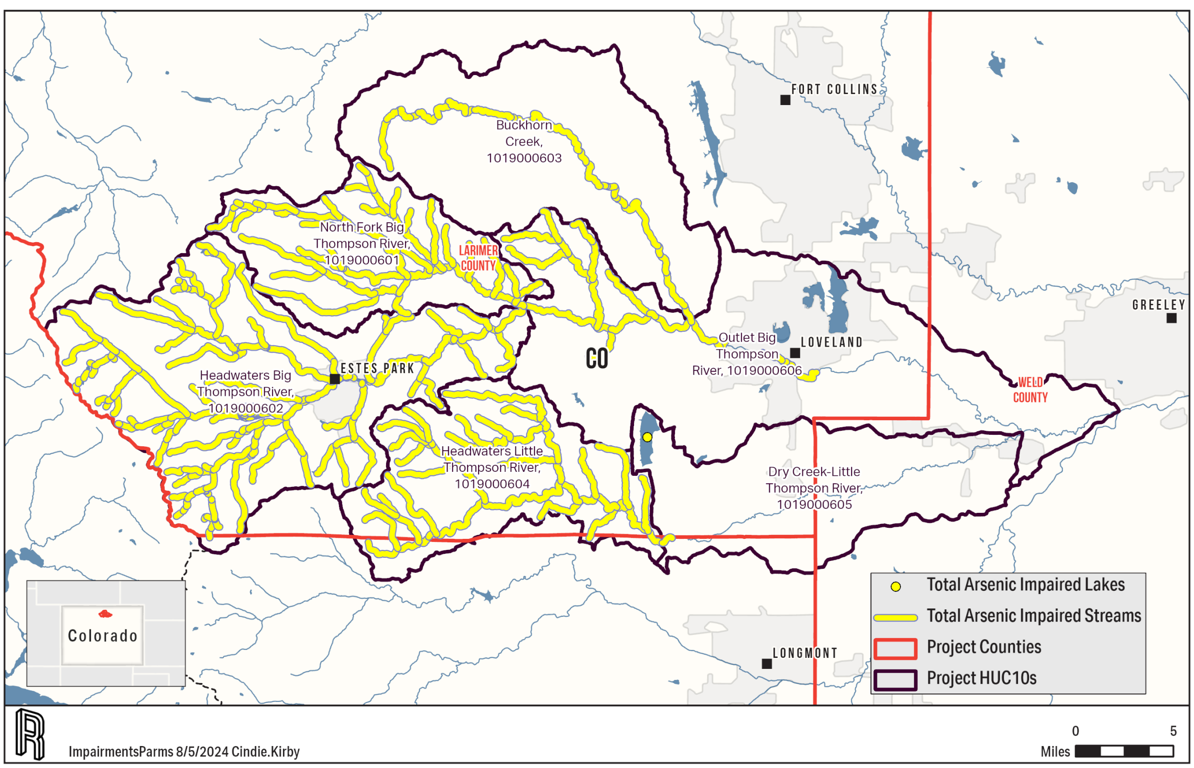


Figure B-6. Arsenic Impairments.

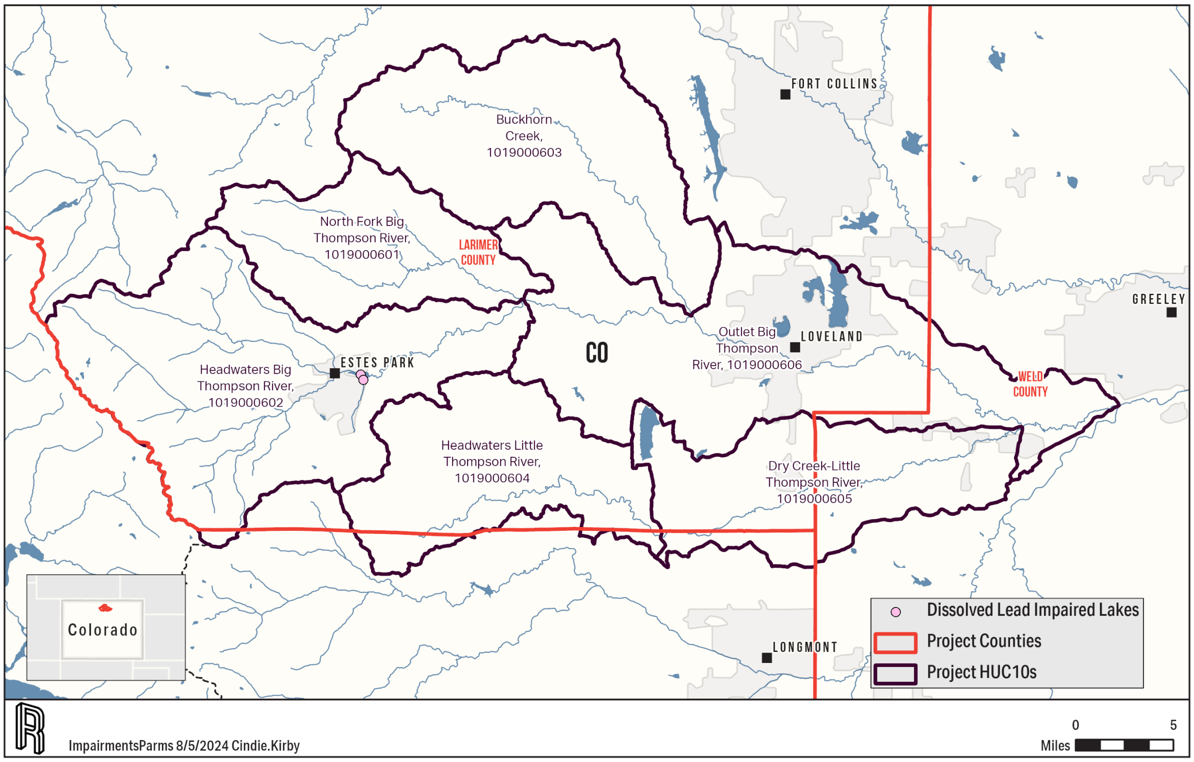


Figure B-7. Lead Impairments.

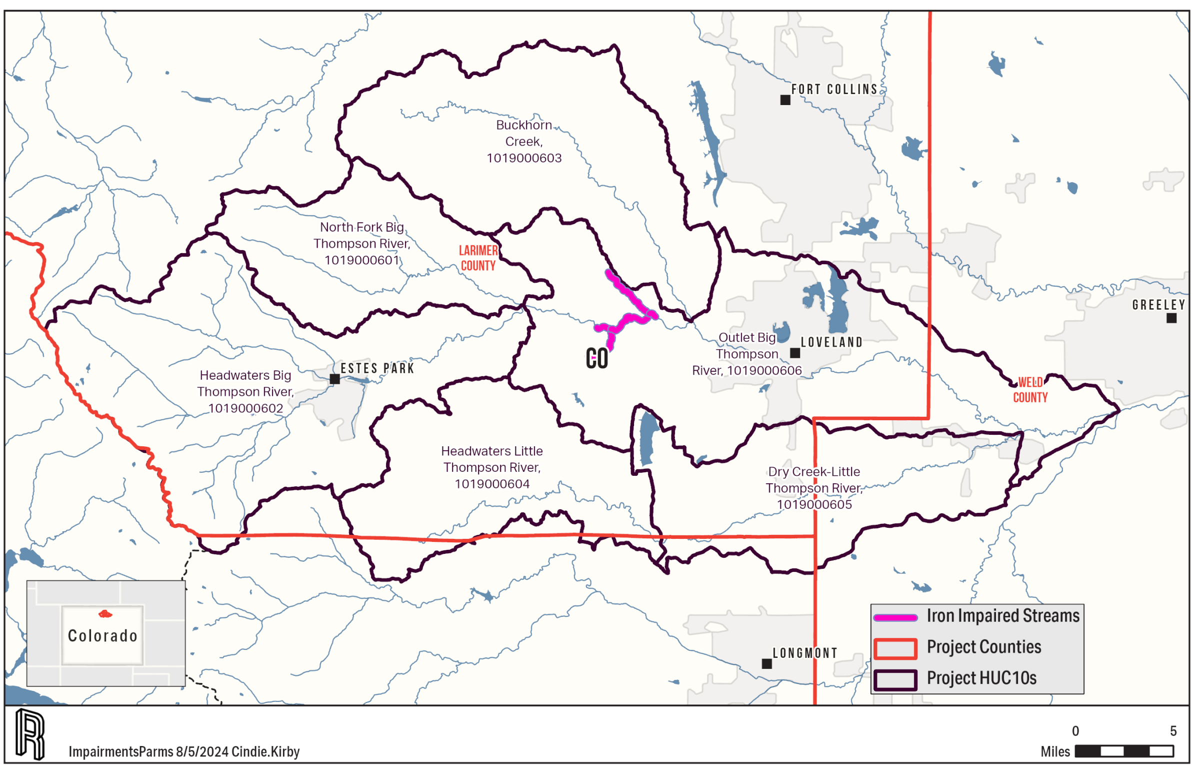


Figure B-8. Iron Impairments.

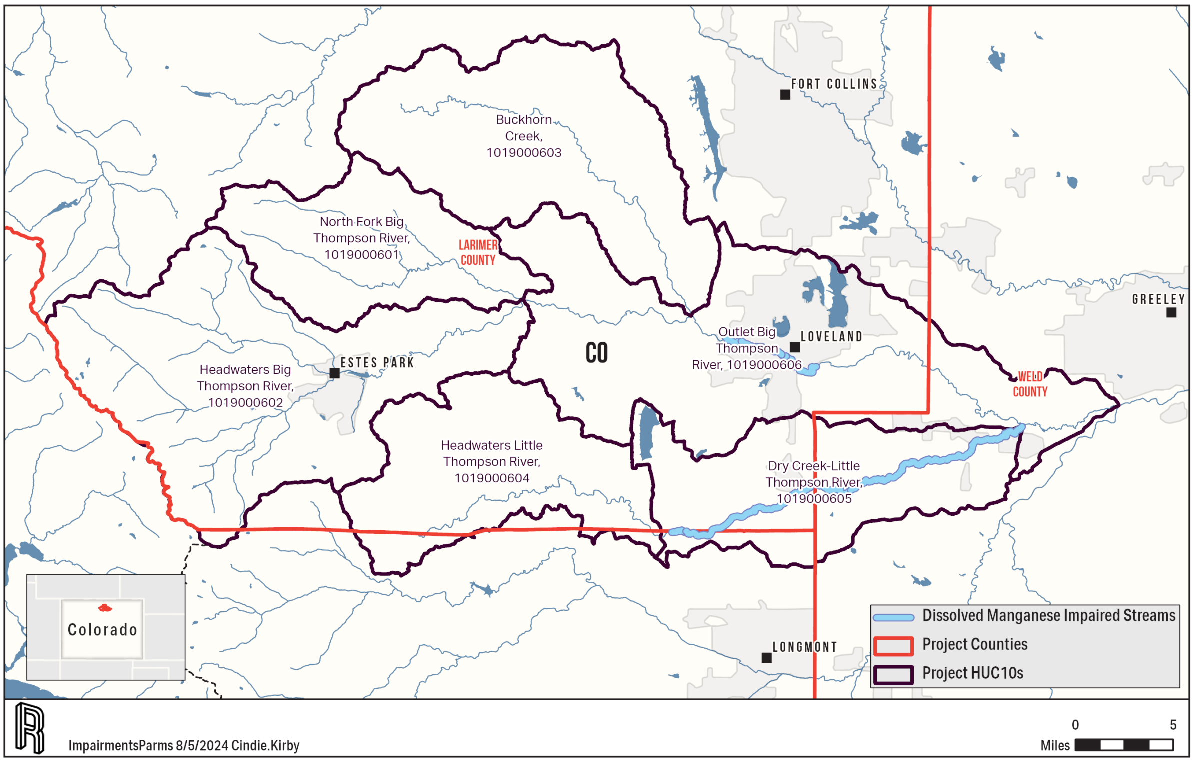


Figure B-9. Manganese Impairments.

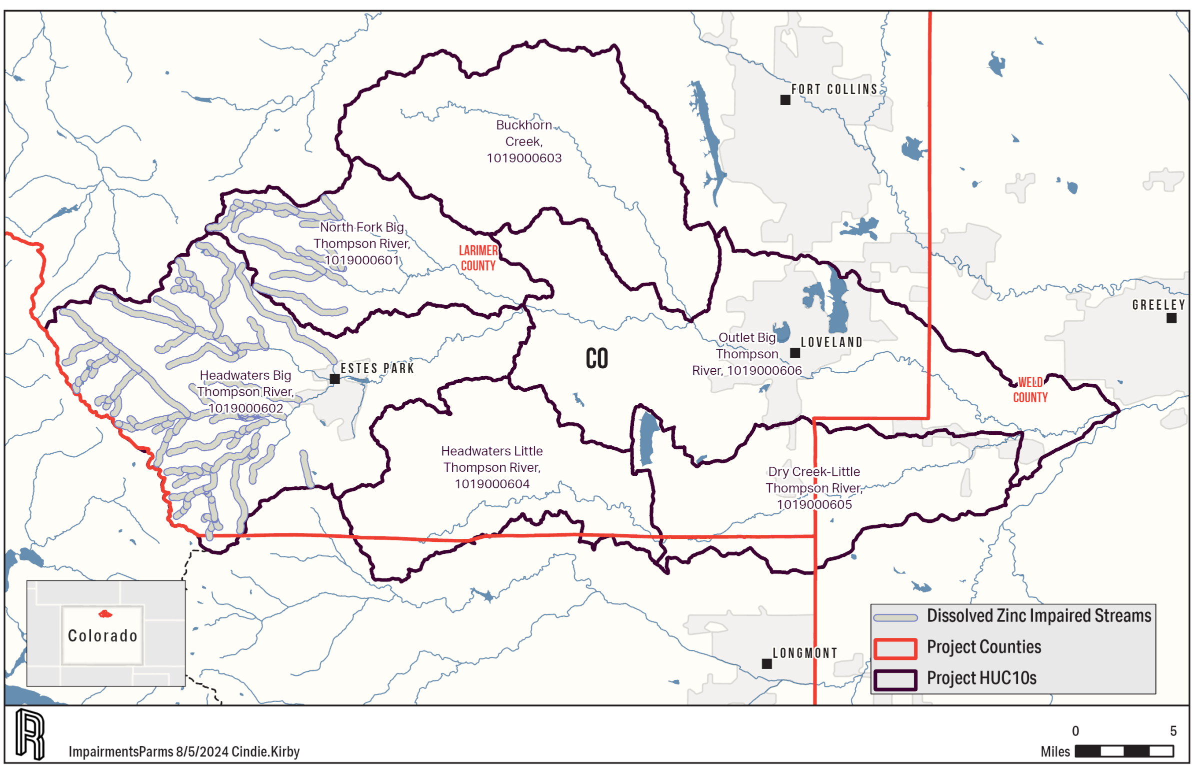


Figure B-10. Zinc Impairments.

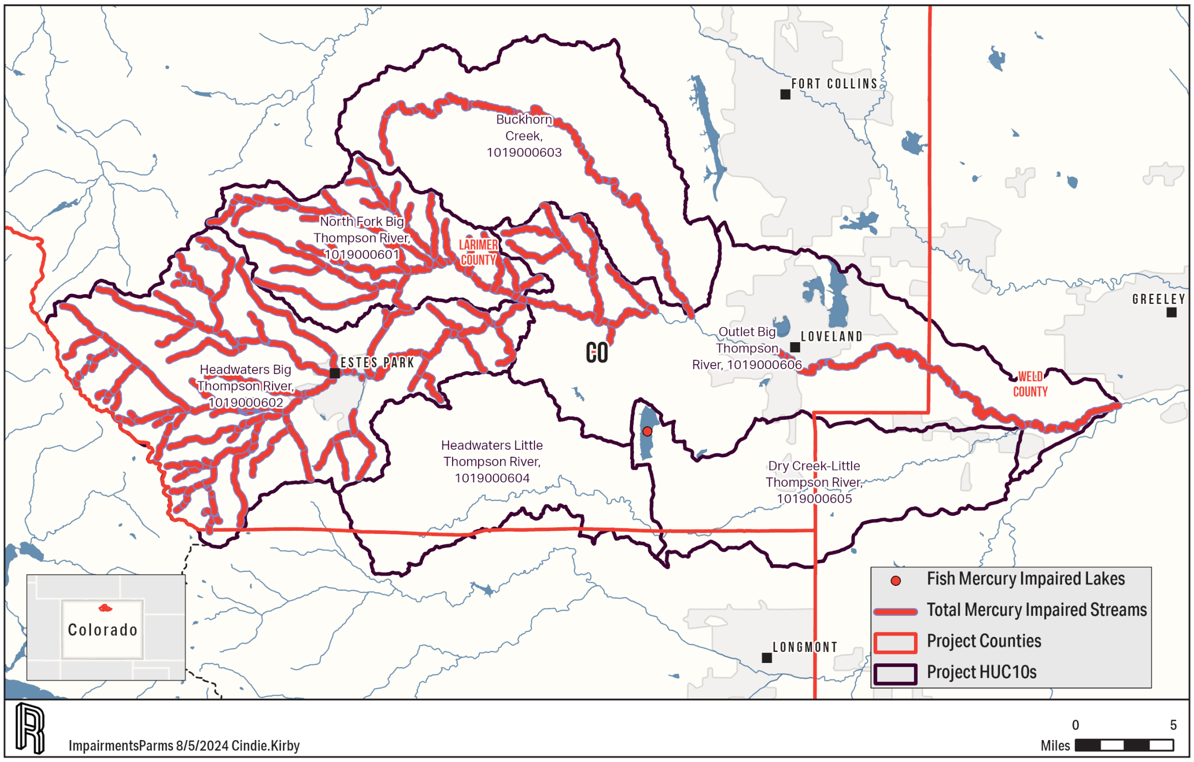


Figure B-11. Mercury Impairments.

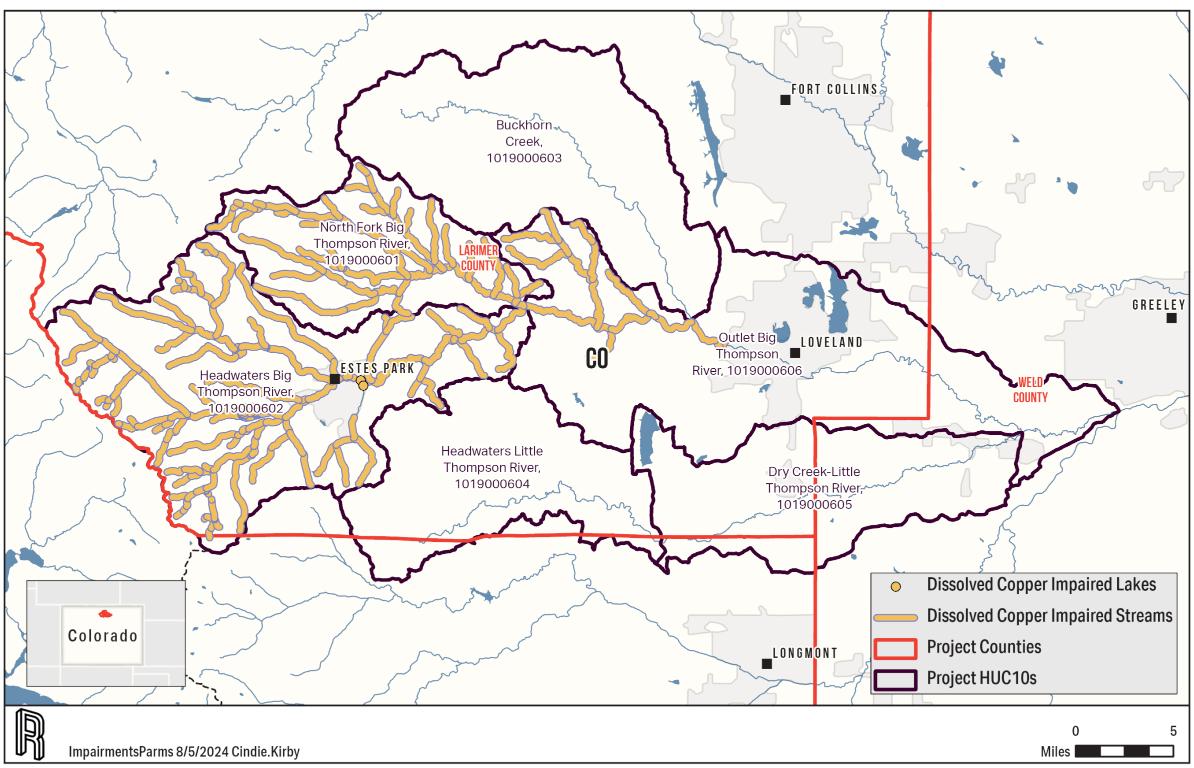


Figure B-12. Copper Impairments.

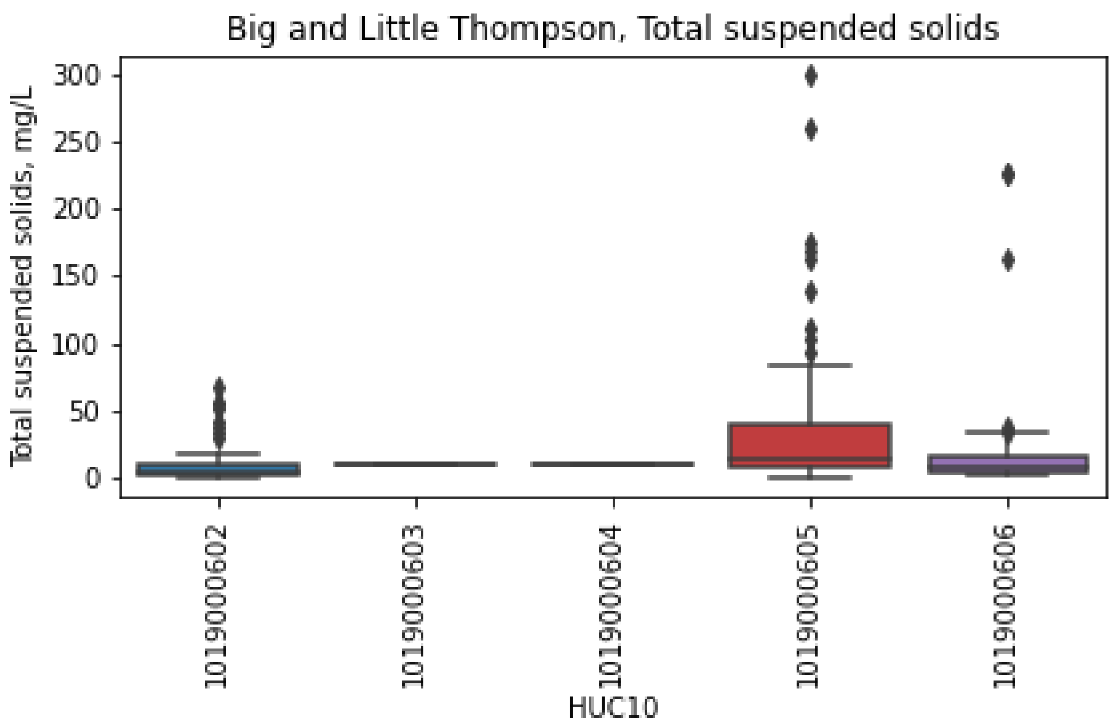
APPENDIX C

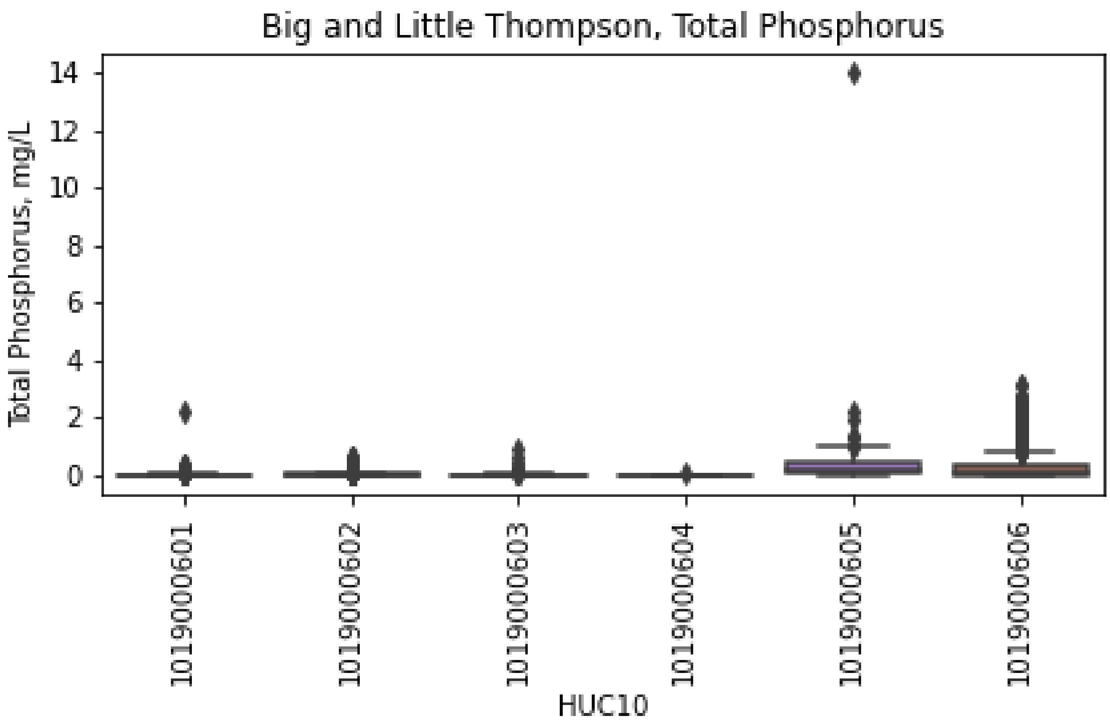
APPLICABLE WATER QUALITY BOX PLOTS BY HUC10

DATASET

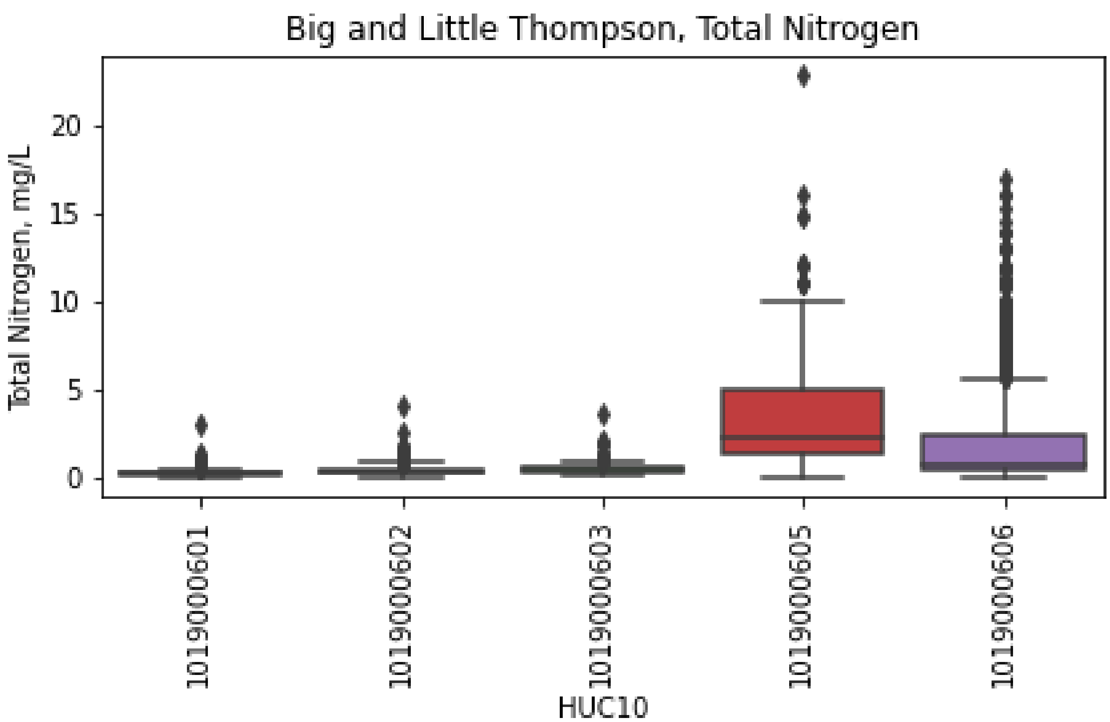
Data for boxplots were collected for the years 1990 through 2023 from various sources. Sources included the Water Quality Portal, the Colorado Data Sharing Network, Northern Water, ERAMS, and numerous individuals including Paul Bremser (St. Vrain), Andy Fayram (City of Loveland), Brian Hathaway (City of Greeley), and Jason Meier (Fossil Creek). Data were organized and grouped into a single file with consistent naming and units for applicable parameters and were assigned a "Y" or a "N" for an attribute representing if the monitoring point was located on a mainstem HUC10 reach. The boxplots only include data along the mainstem HUC10 reaches because water quality can vary greatly for headwater streams.

PLET PARAMETERS

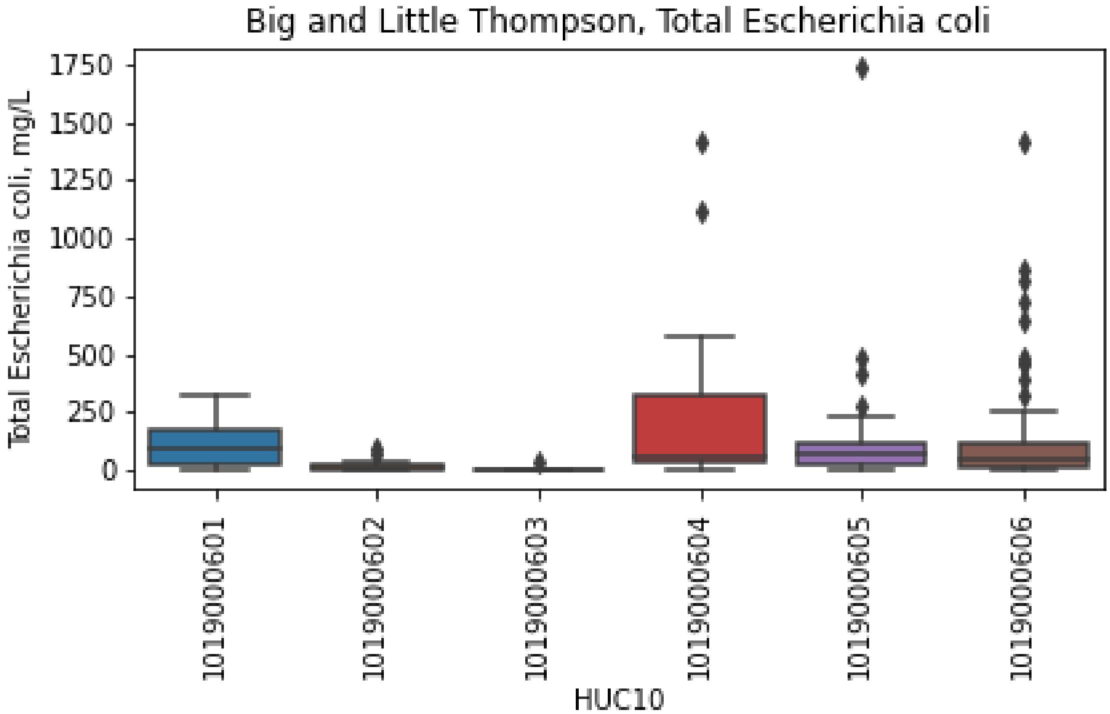




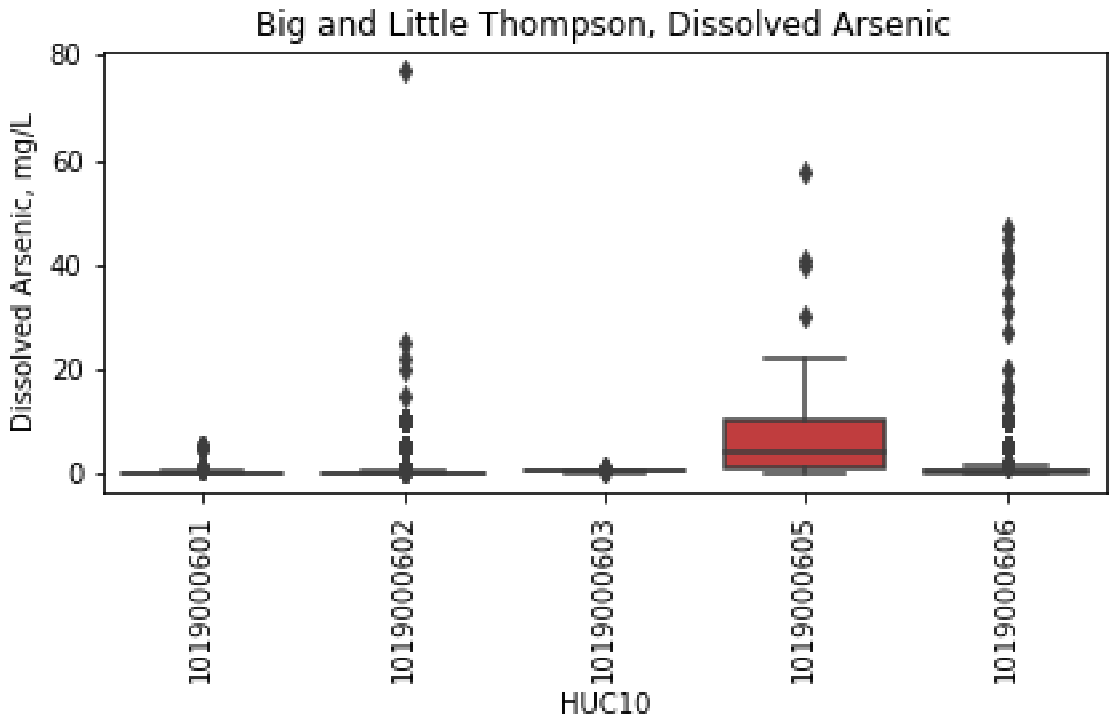
Big and Little Thompson, Total Phosphorus
Total Phosphorus, mg/L
0
2
4
6
8
10
12
14
1019000601
1019000602
1019000603
1019000604
1019000605
1019000606
HUC10

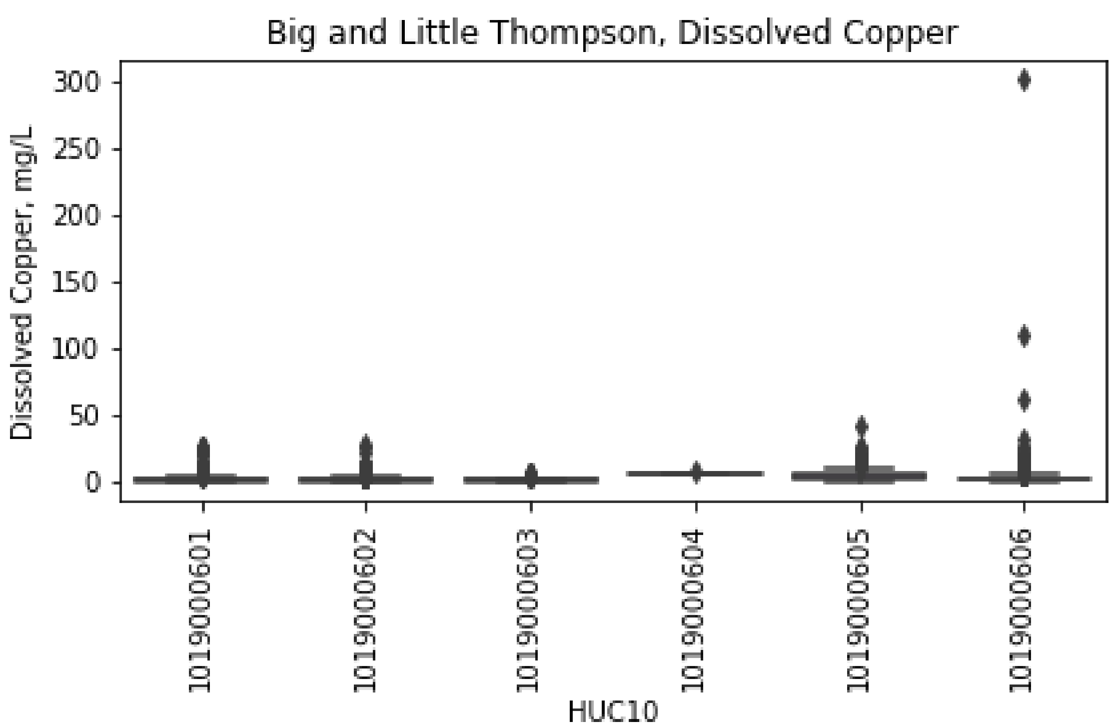


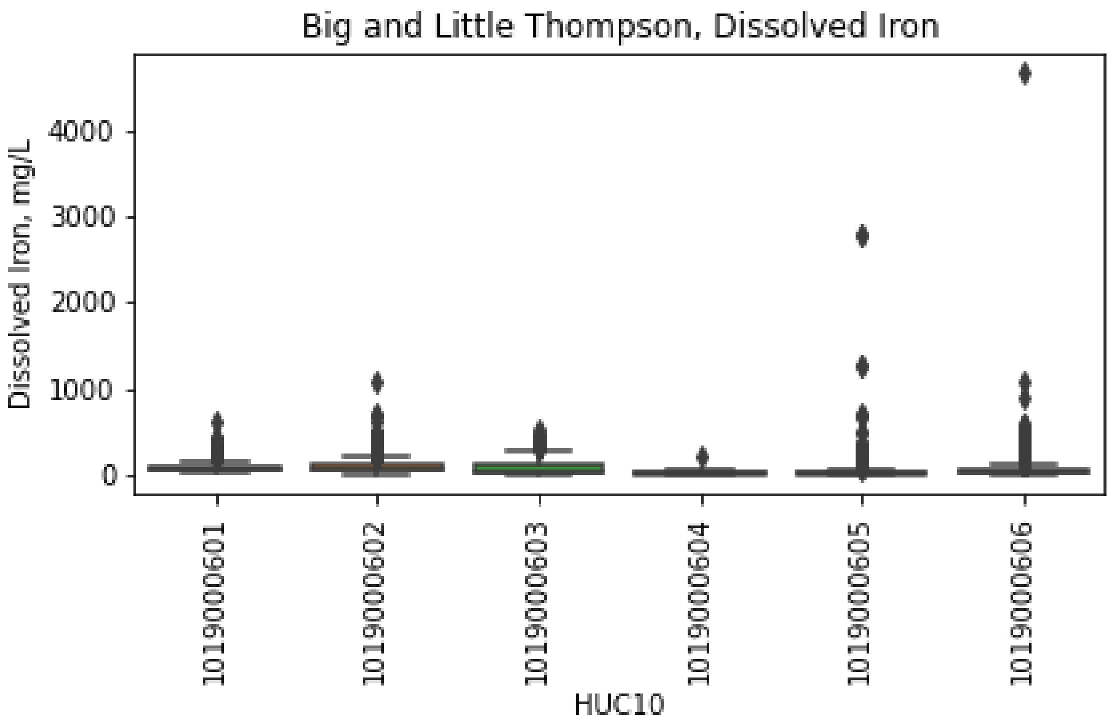
Big and Little Thompson, Total Nitrogen
Total Nitrogen, mg/L
0
5
10
15
20
1019000601
1019000602
1019000603
1019000605
1019000606
HUC10

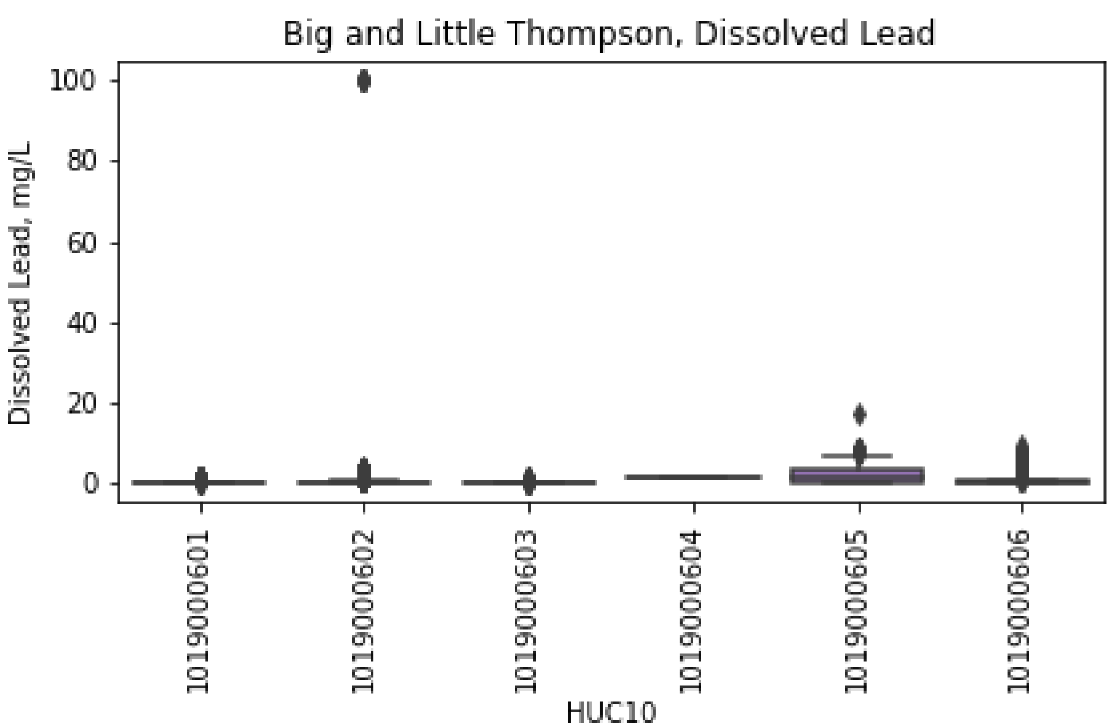

Big and Little Thompson, Total Escherichia coli
Total Escherichia coli, mg/L
1750
1500
1250
1000
750
500
250
0
1019000601
1019000602
1019000603
1019000604
1019000605
1019000606
HUC10

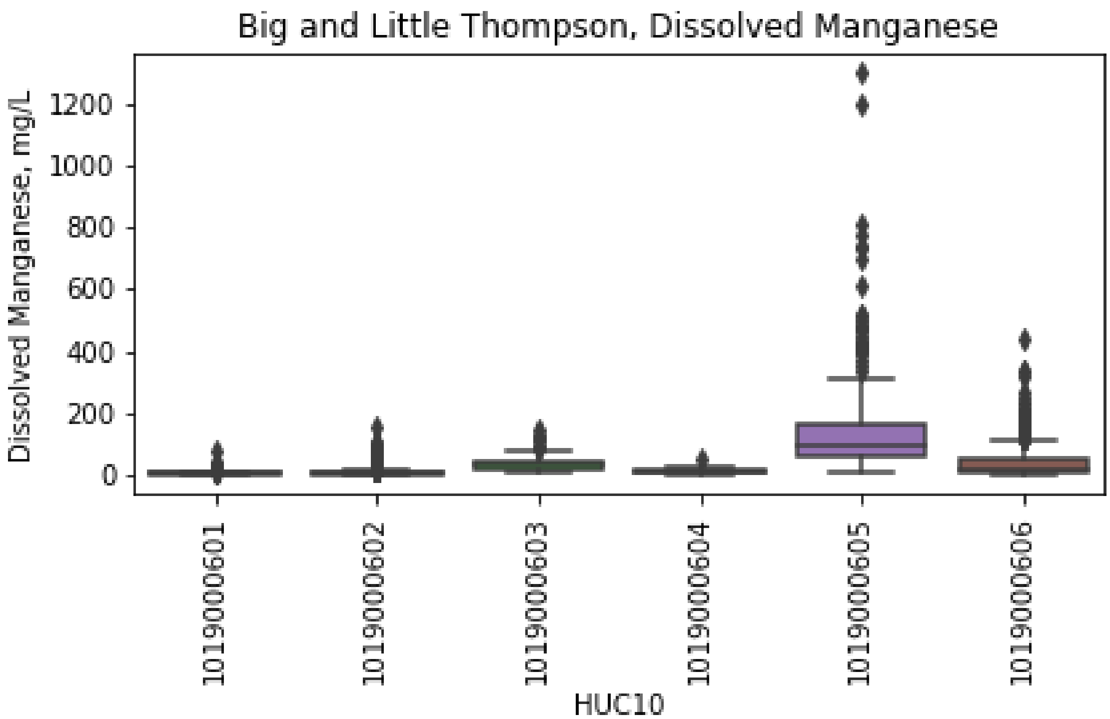
HEAVY METALS



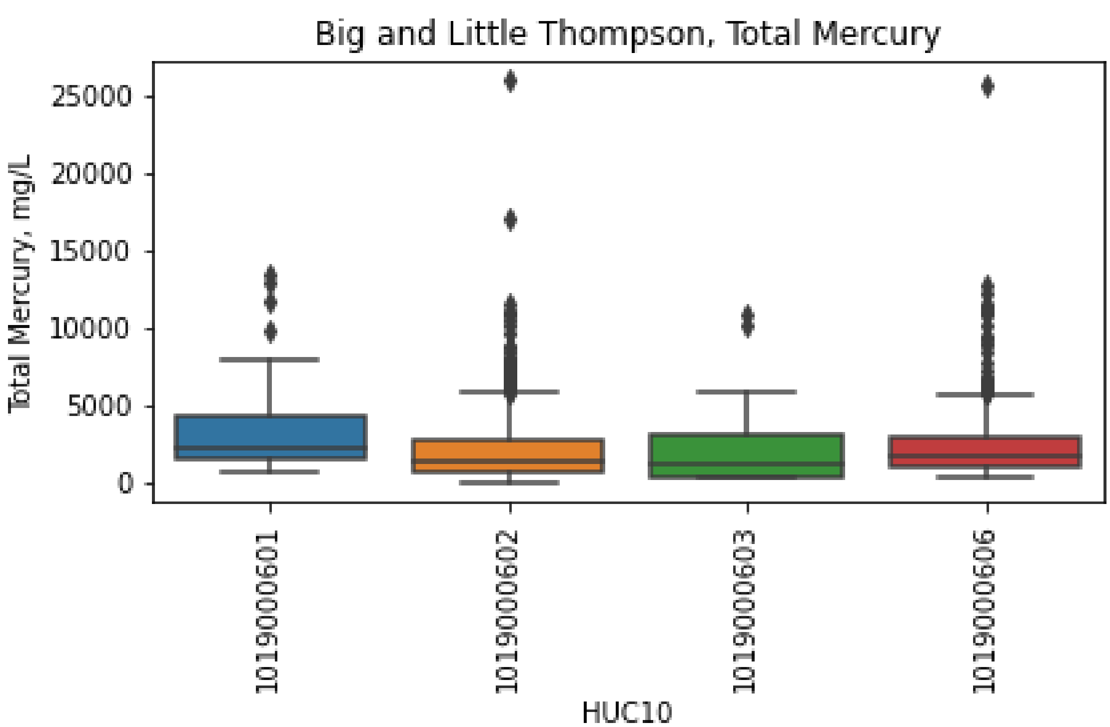



Big and Little Thompson, Dissolved Iron
Dissolved Iron, mg/L
4000
3000
2000
1000
0
1019000601
1019000602
1019000603
1019000604
1019000605
1019000606
HUC10

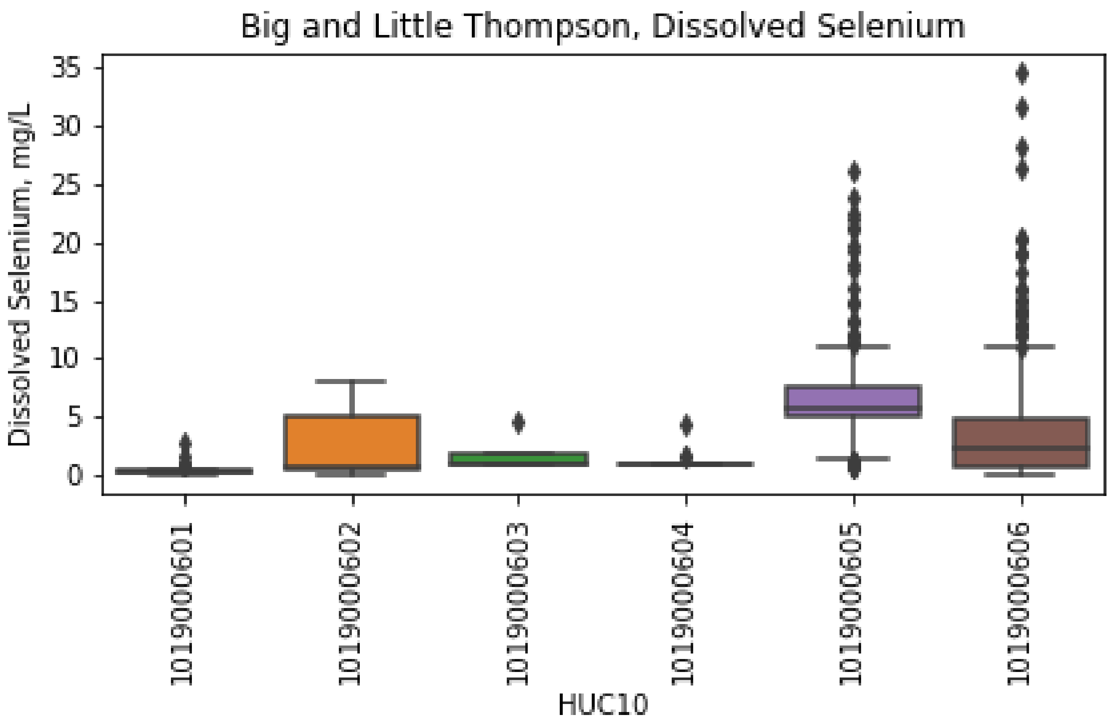

Big and Little Thompson, Dissolved Lead
Dissolved Lead, mg/L
100
80
60
40
20
0
1019000601
1019000602
1019000603
1019000604
1019000605
1019000606
HUC10

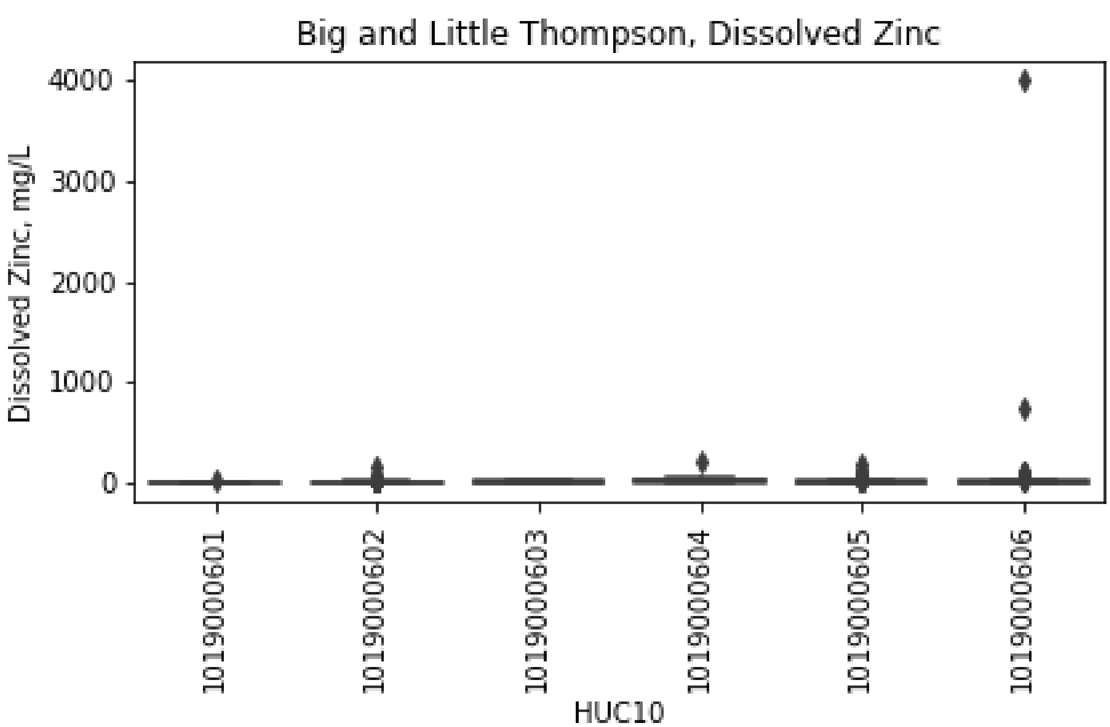


Big and Little Thompson, Dissolved Manganese
Dissolved Manganese, mg/L
0
200
400
600
800
1000
1200
1019000601
1019000602
1019000603
1019000604
1019000605
1019000606
HUC10



Big and Little Thompson, Total Mercury
Total Mercury, mg/L
0
5000
10000
15000
20000
25000
1019000601
1019000602
1019000603
1019000606
HUC10


Big and Little Thompson, Dissolved Selenium
Dissolved Selenium, mg/L
35
30
25
20
15
10
5
0
1019000601
1019000602
1019000603
1019000604
1019000605
1019000606
HUC10


Big and Little Thompson, Dissolved Zinc
Dissolved Zinc, mg/L
4000
3000
2000
1000
0
1019000601
1019000602
1019000603
1019000604
1019000605
1019000606
HUC10

APPENDIX D

PLET SCENARIO REDUCTIONS

Table D-1. PLET Scenario Reductions (Page 1 of 3)

Land Use	Practice	HUC10	Nitrogen Reduction (%)	Phosphorus Reduction (%)	Sediment Reduction (%)
Cropland	Streambank Stabilization and Fencing	1019000601	0	0	0
Cropland	Streambank Stabilization and Fencing	1019000602	0	0	0
Cropland	Streambank Stabilization and Fencing	1019000603	1.88	0.92	2.01
Cropland	Streambank Stabilization and Fencing	1019000604	0	0	0
Cropland	Streambank Stabilization and Fencing	1019000605	13.75	14.61	16.96
Cropland	Streambank Stabilization and Fencing	1019000606	11.54	12.31	16.13
Cropland	35 ft Buffers	1019000601	0	0	0
Cropland	35 ft Buffers	1019000602	0	0	0
Cropland	35 ft Buffers	1019000603	0.89	0.56	1.42
Cropland	35 ft Buffers	1019000604	0	0	0
Cropland	35 ft Buffers	1019000605	7.03	9.21	11.99
Cropland	35 ft Buffers	1019000606	6	7.82	11.4
Pasture	Streambank Stabilization and Fencing	1019000601	0	0	0
Pasture	Streambank Stabilization and Fencing	1019000602	0.15	0.05	0.07
Pasture	Streambank Stabilization and Fencing	1019000603	0	0	0
Pasture	Streambank Stabilization and Fencing	1019000604	0.36	0.08	0.22
Pasture	Streambank Stabilization and Fencing	1019000605	0.7	0.28	0.2
Pasture	Streambank Stabilization and Fencing	1019000606	0.98	0.41	0.36
Pasture	35 ft Buffers	1019000601	0	0	0
Pasture	35 ft Buffers	1019000602	0.04	0.03	0.06
Pasture	35 ft Buffers	1019000603	0.17	0.09	0.25
Pasture	35 ft Buffers	1019000604	0.1	0.05	0.19
Pasture	35 ft Buffers	1019000605	0.21	0.18	0.17
Pasture	35 ft Buffers	1019000606	0.3	0.27	0.31
Pasture	Livestock Exclusion	1019000601	1.52	0.62	2.62
Pasture	Livestock Exclusion	1019000602	6.52	3.63	10.91
Pasture	Livestock Exclusion	1019000603	4.29	1.72	6.47
Pasture	Livestock Exclusion	1019000604	2.74	0.97	4.57
Pasture	Livestock Exclusion	1019000605	3.03	1.86	1.69
Pasture	Livestock Exclusion	1019000606	3.17	1.84	1.69
Feedlot	Waste Management System	1019000601	2.21	1.28	0
Feedlot	Waste Management System	1019000602	1.32	1.06	0
Feedlot	Waste Management System	1019000603	1.88	1.16	0

Table D-1. PLET Scenario Reductions (Page 2 of 3)

Land Use	Practice	HUC10	Nitrogen Reduction (%)	Phosphorus Reduction (%)	Sediment Reduction (%)
Feedlot	Waste Management System	1019000604	1.82	0.99	0
Feedlot	Waste Management System	1019000605	1.13	1.12	0
Feedlot	Waste Management System	1019000606	1.65	1.6	0
Forest	Site Preparation/Straw/ Crimp/Net	1019000601	1.01	1.01	13.88
Forest	Site Preparation/Straw/ Crimp/Net	1019000602	0.39	0.53	5.22
Forest	Site Preparation/Straw/ Crimp/Net	1019000603	0.64	0.68	8.72
Forest	Site Preparation/Straw/ Crimp/Net	1019000604	1.06	0.98	15.72
Forest	Site Preparation/Straw/ Crimp/Net	1019000605	0.01	0.01	0.04
Forest	Site Preparation/Straw/ Crimp/Net	1019000606	0.07	0.12	0.38
Forest	Site Preparation/Straw/Crimp Seed/Fertilizer/Transplant	1019000601	1.04	1.03	14.17
Forest	Site Preparation/Straw/Crimp Seed/Fertilizer/Transplant	1019000602	0.39	0.54	5.33
Forest	Site Preparation/Straw/Crimp Seed/Fertilizer/Transplant	1019000603	0.65	0.69	8.9
Forest	Site Preparation/Straw/Crimp Seed/Fertilizer/Transplant	1019000604	1.08	1	16.06
Forest	Site Preparation/Straw/Crimp Seed/Fertilizer/Transplant	1019000605	0.01	0.01	0.04
Forest	Site Preparation/Straw/Crimp Seed/Fertilizer/Transplant	1019000606	0.07	0.12	0.39
Urban	Extended Wet Detention	1019000601	0.93	0.47	2.51
Urban	Extended Wet Detention	1019000602	3.88	2.74	10.37
Urban	Extended Wet Detention	1019000603	2.21	1.2	5.94
Urban	Extended Wet Detention	1019000604	1.42	0.68	4.18
Urban	Extended Wet Detention	1019000605	1.36	1.19	1.45
Urban	Extended Wet Detention	1019000606	1.25	1.07	1.32
Urban	Infiltration Basin	1019000601	1.01	0.45	2.19
Urban	Infiltration Basin	1019000602	4.23	2.58	9.05
Urban	Infiltration Basin	1019000603	2.41	1.13	5.18
Urban	Infiltration Basin	1019000604	1.55	0.64	3.65
Urban	Infiltration Basin	1019000605	1.49	1.12	1.26
Urban	Infiltration Basin	1019000606	1.37	1.01	1.15
Urban	Concrete Grid Pavement	1019000601	1.52	0.62	2.62
Urban	Concrete Grid Pavement	1019000602	6.35	3.57	10.85

Table D-1. PLET Scenario Reductions (Page 3 of 3)

Land Use	Practice	HUC10	Nitrogen Reduction (%)	Phosphorus Reduction (%)	Sediment Reduction (%)
Urban	Concrete Grid Pavement	1019000603	3.61	1.57	6.22
Urban	Concrete Grid Pavement	1019000604	2.33	0.89	4.38
Urban	Concrete Grid Pavement	1019000605	2.23	1.55	1.51
Urban	Concrete Grid Pavement	1019000606	2.05	1.39	1.38

APPENDIX E
RESPEC STAKEHOLDER TOOLKIT

Stakeholder Toolkit
June 13, 2024

Introduction
The North Front Range Water Quality Planning Association (NFRWQPA) seeks to compile a stakeholder toolkit for the five regional Nonpoint Source (NPS) Watershed Plan areas in Larimer and Weld Counties.

This toolkit will help stakeholders reach, inform and partner with their networks on the NPS watershed educational resources. Here is a link to a final stakeholder toolkit formatting example.

Digital Communications
Digital communications can reach a large audience on a broad scale, with tactics including:

- **Press releases:** This document will serve as NFRWQPA's official statement on the NPS watersheds and respective plans. The press release can be distributed to industry-relevant publications as well as local news outlets.
    - Example
- **Social media:** Targeted social posts to reach industry-specific and locally relevant audiences. Content can vary based on NFRWQPA's needs, seasonality and other updates.
    - Example
- **Newsletters:** Regular updates to an email list of subscribers about the plans, NPS findings and other news.
    - Example
- **Website:** Content updates such as banner announcements, blog posts and home page edits upon project completion.
    - Example
- **Story Map:** Multimedia application to share plan findings, next steps and other dynamic information.
    - Example
- **"Report a Concern" button or website:** Dedicated resource for stakeholders to use when submitting an NPS issue to NFRWQPA (similar to a "contact us" button).
    - Example – Contact Info at bottom of webpage
- **Radio ads and interviews:** Reach stakeholders on a local and national level through a radio ad or securing a news station interview.
    - Example

Print Communications
Print communications can reach targeted, local audiences using the following tactics:

- **Signage:** Capture pedestrian, biking and other rolling traffic's attention with signage strategically placed in a given area. Informational signage can include water quality awareness signage in parks near streams, pet waste pickup stations, and general project information signage.
    - Example
- **Mailers:** Reach residents and businesses via postcard to communicate project benefits and updates, as well as solicit feedback.
    - Example

Community Outreach
Community outreach is a boots-on-the-ground approach to connecting with stakeholders and disseminating information. Community outreach also helps put a face to a project through the following tactics:

- **Educational campaign:** Increase awareness about the plan and NPS concerns in ways that are simplified and relatable for stakeholders.
    - Example
- **Volunteer cleanup program:** Foster community pride and engagement through organizing a park cleanup day.
    - Example
- **School visits, tours and field trips:** Create memories, connect with younger stakeholders and ignite a lifelong interest in the environment by inviting project team members to visit schools for presentations, organize park tours and host field trips.
    - Example – project engineers visited a local library to show students that popular game Fortnite had real-life applications and similarities to simulating virtual environments in the construction industry

APPENDIX B

CACHE LA POUDRE RIVER NONPOINT SOURCE WATERSHED-BASED PLAN

CACHE LA POUDRE RIVER NONPOINT SOURCE WATERSHED-BASED PLAN

DRAFT REPORT RSI-3521

PREPARED BY
Cindie Kirby
Seattle Briscoe
Natalie Acosta
Cathy McCague

RESPEC
3824 Jet Drive
Rapid City, South Dakota 57703

Communication Infrastructure Group
1660 Lincoln Street; Suite 1800
Denver, Colorado 80264

PREPARED FOR
North Front Range Water Quality Planning Association
257 Johnstown Center Drive; Unit 206
Johnstown, Colorado 80534

DECEMBER 2024

Project Number W0545.23001

TABLE OF CONTENTS

TABLE OF CONTENTS (CONTINUED)

LIST OF TABLES

LIST OF TABLES

RESPEC

LIST OF FIGURES

LIST OF ABBREVIATIONS

µg/L	micrograms per liter
ACEP	Agricultural Conservation Easement Program
AFA	Alternative Funding Arrangement
AFO	animal feeding operation
AFP	Announcement for Funding Proposals
AML	abandoned mine land
AWEP	Agricultural Water Enhancement Program
BMP	best management practice
BMPDB	International Stormwater Best Management Practices Database
CAFO	concentrated animal feed operation
CASTNET	Clean Air Status and Trends Network
CAWA	Colorado Ag Water Alliance
CCR	Code of Colorado Regulation
CDPHE	Colorado Department of Public Health and Environment
cfs	cubic feet per second
cfu/head/day	colony-forming units per head per day
CIG	Conservation Innovation Grants
CPPE	Conservation Practice Physical Effects
CPRW	Coalition for the Poudre River Watershed
CPS	Conservation Practice Standard
CRP	Conservation Reserve Program
CSP	Conservation Stewardship Program
CSU	Colorado State University
CTA	Conservation Technical Assistance
CWA	Clean Water Act
CWCB	Colorado Water Conservation Board
CWSRF	Clean Water State Revolving Fund
DRUM	Defense-Related Uranium Mine
EPA	U.S. Environmental Protection Agency
EQIP	Environmental Quality Incentives Program
ESRI	Environmental Systems Research Institute, Inc.
EWP	Emergency Watershed Protection Program
FRPP	Farm and Ranch Lands Protection Program
GRP	Grass Reserve Program
HUC	Hydrologic Unit Code
lb/day	pounds per day
lb/year	pounds per year
LID	Low Impact Development
mg/L	milligrams per liter
mi^2	square miles
MIDS	Minimal Impact Design Standards
mL	milliliter

LIST OF ABBREVIATIONS (CONTINUED)

mpn	most probable number
MS4	Municipal Separate Storm Sewer System
NADP	National Atmospheric Deposition Program
NFRWQPA	North Front Range Water Quality Planning Association
NLCD	National Land Cover Dataset
NPS	nonpoint source
NRCS	Natural Resources Conservation Service
NWQI	National Water Quality Initiative
OWTS	Onsite Wastewater Treatment System
PEPO	Public Education, Participation, and Outreach
PFAS	per- and polyfluoroalkyl substances
PLET	Pollutant Load Estimation Tool
RCD	Resource Conservation and Development
RCPP	Regional Conservation Partnership Program
SSURGO	Soil Survey Geographic Database
STEPL	Spreadsheet Tool for Estimating Pollutant Loads
SWAP	Source Water Assessment and Protection
SWPPP	stormwater pollution prevention plan
TMDL	total maximum daily load
TSS	total suspended solids
USBR	U.S. Bureau of Reclamation
USDA	U.S. Department of Agriculture
USGS	U.S. Geological Survey
WFPO	Watershed Protection and Flood Prevention Operations
WHIP	Wildlife Habitat Incentive Program
WHRB	Watershed Rehabilitation
WRP	Wetlands Reserve Program
WSRF	Water Supply Reserve Fund
WWTP	Wastewater Treatment Plant

1.0 INTRODUCTION

The primary purpose of this watershed-based plan is to recommend best management practices (BMPs) that would reduce pollutants of concern within the Cache la Poudre River Watershed (Hydrologic Unit Code [HUC] 10190007) from nonpoint sources (NPSs). Although this watershed-based plan is a stand-alone NPS plan, water planning should be done in a holistic manner, with teamwork between point and NPSs of pollution. Pollution reductions from NPSs upstream of point sources reduce the strain on the point sources. Municipal, industrial, and agricultural entities working together toward the shared goal of protecting waterbodies before they become impaired will reduce future regulations on these entities.

The watershed-based plan is based on an adaptive approach that emphasizes making continued progress toward achieving milestones and load reduction by identifying the most impactful implementation measures for priority areas. This watershed-based plan summarizes past conservation accomplishments and recommends implementation actions that can assist residents, landowners, and stakeholders in the project area to improve water quality. Private, local, state, and federal partnership efforts should continue to support and promote the implementation of management measures while additional water quality monitoring is conducted to guide watershed plan revisions and assess adaptive implementation activities.

The watershed-based plan builds on past conservation accomplishments in the project area and complements water quality efforts by the following organizations, as well as the local communities:

- Boxelder Sanitation District
- Carestream
- City of Fort Collins
- City of Greeley
- Coalition for the Poudre River Watershed (CPRW)
- Colorado Ag Water Alliance (CAWA)
- Colorado Department of Public Health and Environment (CDPHE)
- Colorado Livestock Association
- Colorado Parks & Wildlife
- Colorado Rural Water Association
- Colorado State University (CSU)
- Colorado Watershed Assembly
- Colorado Wheat Administrative Committee
- Davies Mobile Home Park
- Drala Mountain Center
- Ducks Unlimited
- Fox Acres Community Services

- FPAC-NRCS, CO
- Fresh Water Trust
- JBS Greeley Beef Plant
- Larimer County
- Peaks to People Water Fund
- Poudre Heritage Alliance
- South Fort Collins Sanitation District
- South Platte Basin Roundtable
- Town of Ault
- Town of Eaton
- Town of Severance
- Town of Timnath
- Town of Wellington
- Town of Windsor
- Trout Unlimited
- Water Quality Trading in the Cache la Poudre with Fort Collins
- Weld County
- Xcel Energy

This watershed-based plan also incorporates the strategies, goals, and objectives of CDPHE's *Colorado's Nonpoint Source Management Plan: 2022* and addresses the U.S. Environmental Protection Agency's (EPA's) nine key elements outlined in the management plan [CDPHE, 2022]. Table 1-1 describes these nine key elements and their corresponding locations within this implementation plan [EPA, 2008].

Table 1-1. Sections of the Watershed-Based Plan That Fulfill the U.S. Environmental Protection Agency's Nine Key Elements for Watershed Planning

EPA Element Number	EPA's Nine Key Elements Plan	Applicable Section of Watershed-Based Plan
1	Identify the causes and sources of pollution that need to be controlled to achieve load reductions and other goals (e.g., recreational, economic, ecological) identified in the plan.	5.0 Source Assessment 6.0 Priority Areas for Implementation
2	Estimate load reductions expected from the action strategy identified.	6.0 Priority Areas for Implementation 7.0 Best Management Practices Load Reductions
3	Describe NPS management measures, including operation/maintenance requirements, and targeted critical areas (i.e., action strategy) needed to achieve identified load reductions.	6.0 Priority Areas for Implementation 7.0 Best Management Practices Load Reductions 8.0 Past and Current Best Management Practices 9.0 Recommended Best Management Practices
4	Estimate technical and financial assistance needed, associated costs, and/or the sources and authorities that will be relied upon to implement the watershed-based plan.	13.0 Technical and Financial Assistance Sources
5	Develop an information and education component that will be used to enhance public understanding of the NPS management measures and encourage their early and continued participation in selecting, designing, and implementing the Action Strategy.	10.0 Information, Education, and Outreach
6	Develop a project schedule.	11.0 Criteria to Assess Progress
7	Describe interim, measurable milestones.	11.0 Criteria to Assess Progress
8	Identify a set of criteria to assess progress/effectiveness in achieving water quality standards or other appropriate end targets.	11.0 Criteria to Assess Progress
9	Develop a monitoring component to evaluate the effectiveness of the implementation efforts over time and measured against the criteria established to document load reductions.	12.0 Monitoring Best Management Practices Effectiveness

This watershed-based plan is not intended to identify which specific BMPs or remediation actions should be included in certain discharge permits, ordinances, stormwater pollution prevention plans (SWPPPs), or conservation plans. Rather, the plan provides an adaptive implementation approach with suggested structural and nonstructural BMPs necessary to address the NPSs of pollutants of concern. For the purposes of this watershed-based plan, BMPs refer to structural and nonstructural actions or measures installed or implemented to reduce the delivery of sediment and nutrients to waterbodies in the project area. Sources of available funding and technical assistance for and associated estimated costs of these BMPs are included to provide landowners, residents, stakeholders, community leaders, and public agencies perspectives on the technical and economic demands of this watershed plan.

Essential to the development of this watershed-based plan is ascertaining and collecting feedback and input from a cross section of stakeholders, including cities, counties, sanitation districts, towns, watershed organizations, and others who will identify, fund, and prioritize projects to implement these practices and BMPs. As a part of this project, two surveys were sent to stakeholders:

- Survey #1, in 2022, was more general and included questions related to pollutants, issues, and areas of concern.
- Survey #2, in 2024, was more specific and included questions regarding past and current planning, use of technical and financial assistance, and ideal BMPs.

Survey #1 was distributed to 96 organizations in 2022. The purpose of this survey was to better understand the stakeholders' concerns, issues, resources, and priorities. Building on the conclusions from this survey was the impetus for helping to develop a nine key elements plan.

Survey #2 was distributed to 48 organizations in March 2024 asking them to complete the following items:

- Characterize their existing watershed projects and sources of pollution
- Rank cropland, urban, pastureland, feedlot, and forest BMPs
- Identify benefits and impacts of existing BMPs
- Identify existing outreach and education efforts
- Identify technical and financial assistance needed and utilized

Table 1-2 lists the stakeholders who received each survey. Results of the surveys are found throughout the report and in more detail in Chapter 10.0, Information, Education, and Outreach. Survey responses are an integral part of this project. Survey questions are included in Appendix A.

To help promote the novel regional watershed plan, the project team participated in the annual American Water Resources Association – Colorado Groundwater Association Conference. The team discussed the project objectives, watershed characteristics, nine key elements, and outreach efforts.

Table 1-2. Stakeholder Recipients of Two Surveys With Responses Represented by an "X" (Page 1 of 3)

Organization	Took Survey #1 (2022)	Took Survey #2 (2024)
Big Thompson Watershed Coalition		
Boxelder Sanitation District	X	
Brink Corp		
Carestream		
CAWA		
CDPHE		
City & County of Broomfield	X	
City of Dacono		
City of Evans	X	X
City of Fort Collins		X
City of Fort Lupton	X	X
City of Greeley	X	X
City of Longmont	X	
City of Loveland	X	X

Table 1-2. Stakeholder Recipients of Two Surveys With Responses Represented by an "X" (Page 2 of 3)

Organization	Took Survey #1 (2022)	Took Survey #2 (2024)
City of Northglenn		X
Colorado Livestock Association		
Colorado Parks & Wildlife		
Colorado Rural Water Association	X	
Colorado Watershed Assembly		X
Colorado Wheat Administrative Committee		X
CPRW		
CSU	X	
Davies Mobile Home Park		X
Drala Mountain Center	X	
Ducks Unlimited		
Estes Park Sanitation District	X	
Estes Valley Watershed Coalition	X	X
Fox Acres Community Services	X	
FPAC-NRCS, CO		
Fresh Water Trust	X	
Galeton Water & Sanitation District	X	
JBS Greeley Beef Plant		X
Larimer County		X
Left Hand Water District	X	
Little Thompson Watershed Coalition		
Los Rios Farm		X
Metro Water Recovery	X	
Northern Colorado Water Conservancy District	X	X
Peaks to People Water Fund		X
Poudre Heritage Alliance		
Resource Colorado Water & Sanitation Metro District		
RNC Consulting, LLC		X
South Fort Collins Sanitation District	X	X
South Platte Basin Roundtable		
St. Vrain Creek & Boulder Creek Watershed		
St. Vrain Sanitation District	X	
Thompson School District		X
Town of Ault	X	
Town of Berthoud	X	X
Town of Brighton		

Table 1-2. Stakeholder Recipients of Two Surveys With Responses Represented by an "X" (Page 3 of 3)

Organization	Took Survey #1 (2022)	Took Survey #2 (2024)
Town of Eaton		
Town of Erie	X	
Town of Estes Park		X
Town of Firestone		
Town of Frederick		
Town of Hudson	X	
Town of Johnston	X	
Town of LaSalle		
Town of Lochbuie	X	
Town of Keenesburg		
Town of Mead	X	
Town of Milliken		
Town of Pierce	X	
Town of Platteville		X
Town of Severance	X	
Town of Timnath		
Town of Wellington		X
Town of Windsor	X	
Trout Unlimited		
Upper Thompson Sanitation District	X	
Water Quality Trading in the Cache la Poudre with Fort Collins		
Weld County	X	
Weld County Department of Public Health and Environment	X	
Wright Water Engineers/Cherry Creek Basin Water Quality Authority		X
Xcel Energy		X

2.0 WATERSHED CHARACTERIZATION

The project area for this watershed-based plan is shown in Figure 2-1, which includes the area within Larimer and Weld Counties that intersect the Cache la Poudre River Watershed (HUC 10190007) in north-central Colorado. The Cache la Poudre River flows east to its confluence with the South Platte River. Ten HUC10 watersheds are in the Cache la Poudre HUC8: South Fork Cache la Poudre River (1019000701), Headwaters Cache la Poudre River (1019000702), Gordon Creek-Cache la Poudre River (1019000703), Dale Creek (1019000704), Upper North Fork Cache la Poudre River (1019000705), Lone Pine Creek (1019000706), Rabbit Creek-North Fork Cache la Poudre River (1019000707), Horsetooth Reservoir-Cache la Poudre River (1019000708), Boxelder Creek (1019000709), and City of Greeley-Cache la Poudre River (1019000710). Although the figures in this document show information within the HUC10 watersheds overlapping Larimer and Weld Counties, the tables summarize only information from the HUC10 watersheds within Larimer and Weld Counties. The total area of the HUCs is 1,209,008 acres, but within Larimer and Weld Counties, it encompasses only 1,128,817 acres, according to GIS layer analysis.

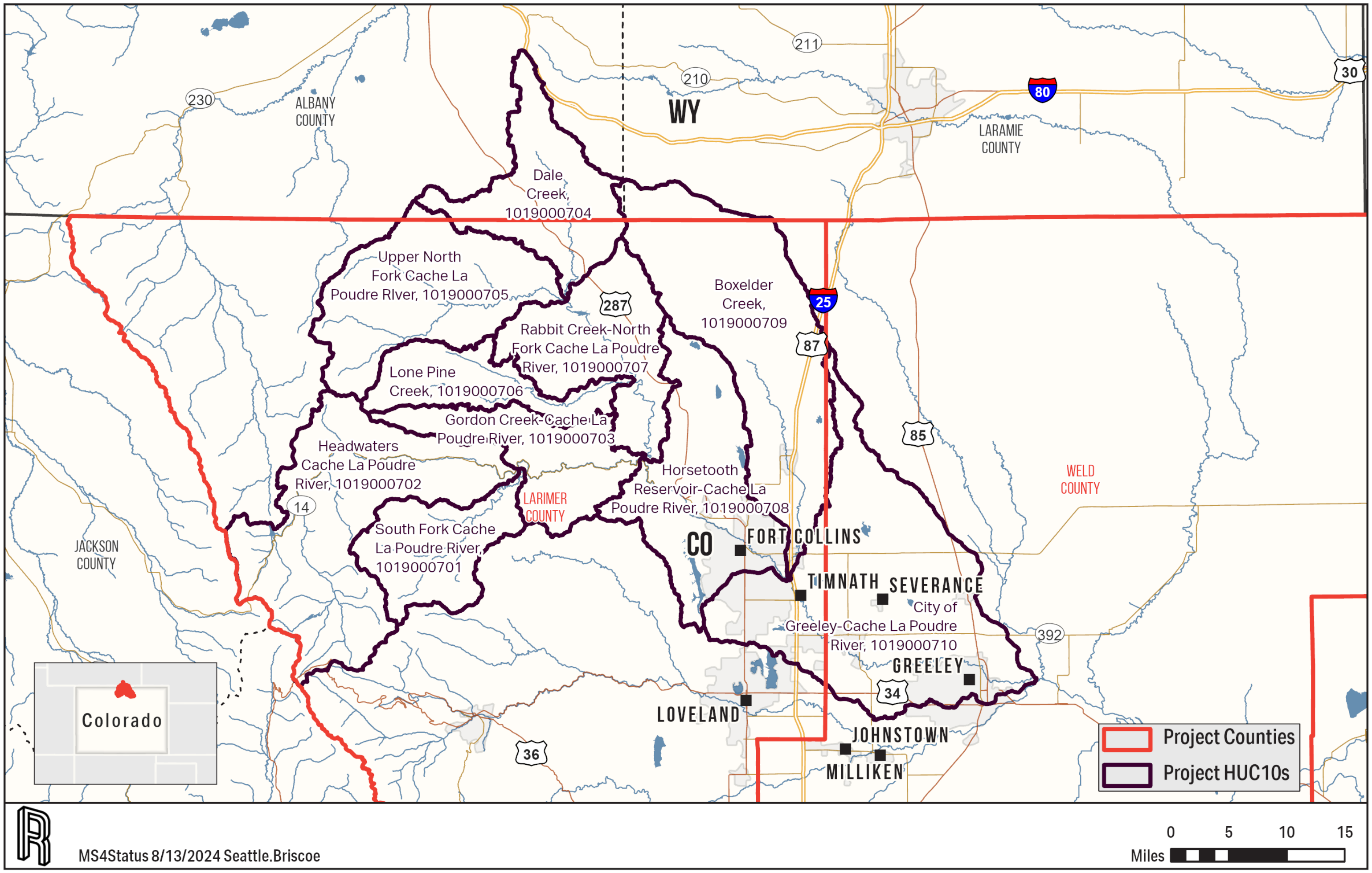


Figure 2-1. Cache la Poudre River HUC8 Project Area.

A summary of the project area's land cover characteristics was completed using the 2019 National Land Cover Dataset (NLCD). The NLCD is a 16-category, multilayer land cover classification dataset derived from Landsat imagery and ancillary data for consistent land cover data for all 50 states. The land cover is depicted in Figure 2-2 [Multi-Resolution Land Characteristics Consortium, 2019]. In the project area (including the Municipal Separate Storm Sewer Systems [MS4s]), approximately 34 percent of the area is forest; 25 percent is herbaceous; 20 percent is scrub/shrub; 12 percent is cultivated crops; 3 percent is developed; and barren, pasture/hay, wetlands, and open water/ice each make up 2 percent or less. The City of Fort Collins, Colorado, is the largest urban area in the watershed, with a 2020 Census population of 169,810 and an area of approximately 57 square miles (mi^2) [U.S. Census Bureau, 2020]. Other populated areas in the watershed include the City of Greeley (113,712 people, 49.0 mi^2, growing at 2.2 percent annually), the Town of Severance (6,674 people, 8.7 mi^2, growing at 11.1 percent annually), and the Town of Timnath (4,549 people, 6.3 mi^2, growing at 62.3 percent annually). The watershed transitions from forest within higher elevations in the west to scrub/shrub/herbaceous within the mid-range elevations and crops within the lower elevations in the east. The City of Fort Collins is located near the transition between the scrub/shrub/herbaceous and cropland areas. Most of the land is privately owned (90 percent) with 7 percent being federally owned and other ownership categories making up only 3 percent. This was calculated using a combination of public parcels [Colorado Geospatial Portal, 2024] and from the Environmental Systems Research Institute, Inc.'s (ESRI's) data portal for USA Federal Lands [ESRI, 2014].

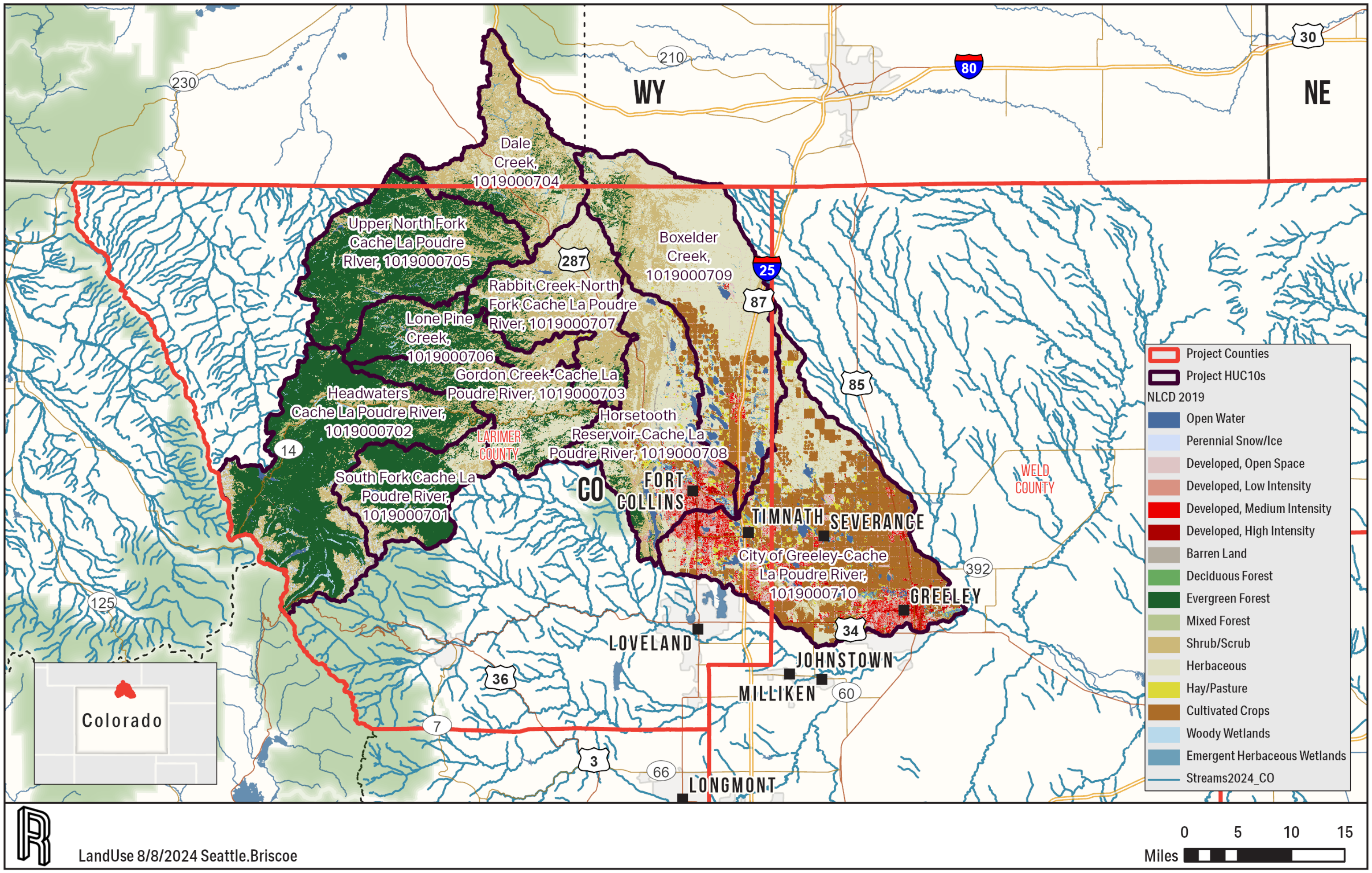


Figure 2-2. National Land Cover Dataset 2019 Land Use.

As indicated in Figure 2-3, precipitation varies throughout the project area. Typical annual precipitation is between 52 inches in the lower, western part of the watershed to 12 inches per year in the lower, eastern portion [PRISM Climate Group, 2024]. Maximum monthly average precipitation generally occurs in the summer months; however, the largest flows typically occur from winter snowmelt in the spring. According to the *Cache la Poudre Watershed-Based Plan* , 50 to 90 percent of stream water in the Poudre River comes from snowmelt [CPRW, 2020]; however, drought is still common. Three different types of snow zones contribute to precipitation: persistent, transitional, and intermittent. The persistent zone has consistent snow cover during winter months and at high elevations, even for warmer months. The snow from this zone is the primary source of water to downstream cities and farms. The transitional zone has a higher temperature and less precipitation, where snow at these lower elevations does not stay on the ground long. The intermittent snow zone occurs at even lower elevations mainly in foothill areas, so snow accumulation and persistence are highly variable. According to CPRW, approximately 75 percent of annual precipitation occurs from mid-April through late September [CPRW, 2020]. During a typical year, approximately 1,225,000 acre-feet are used for irrigation in the South Platte Basin [Colorado Water Plan, 2015]. In 2013, extensive flooding along the Front Range caused significant damage. The flood led to restoration work and continues to cause sediment movement.

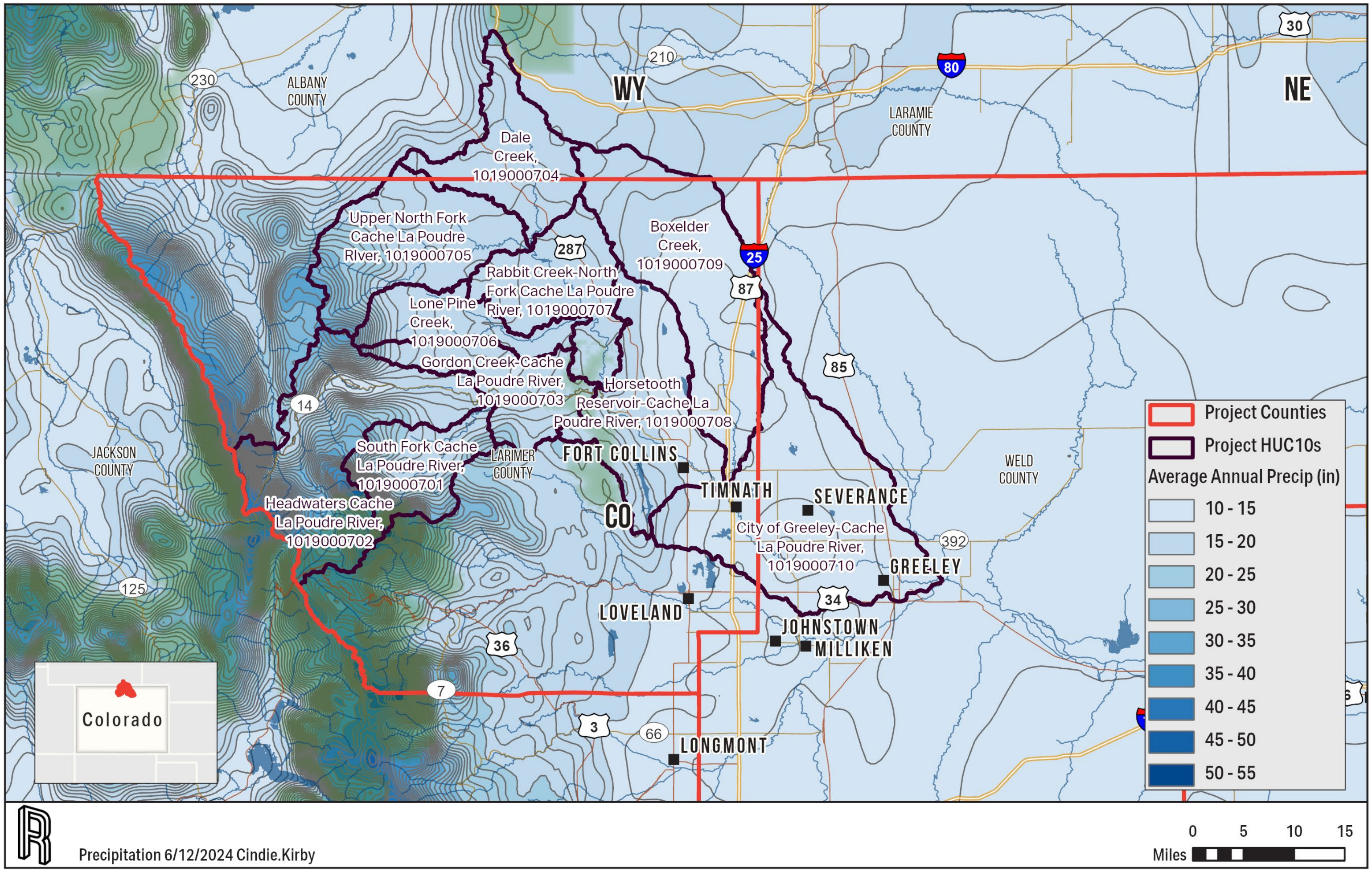


Figure 2-3. Average Annual Precipitation (1981 to 2010).

The bedrock geology of the project area is displayed in Figure 2-4 [Horton et al., 2017]. In the Cache la Poudre River HUC8, the mountainous portions consist mostly of intrusive igneous and undifferentiated metamorphic material, and the transitional area consists mostly of undifferentiated sedimentary and clastic sedimentary material. The lower, agricultural area consists of clastic sedimentary and undifferentiated unconsolidated material. The South Platte River originates in the mountains of central Colorado at the Continental Divide and flows approximately 450 miles northeast across the Great Plains to its confluence with the North Platte River at North Platte, Nebraska. The basin includes two physiographic provinces: the Front Range Section of the Southern Rocky Mountain Province and the Colorado Piedmont Section of the Great Plains Province [USGS Colorado Water Science Center, 2000].

Hydrologic soil groups can significantly impact the amount of water that infiltrates or runs off during precipitation events. Type A soils are generally sand or sandy loams with high infiltration rates; Type B soils are silt loam or loam soils with moderate rates; Type C soils are generally sandy, clay loams with low infiltration rates; and Type D soils are heavy soils; clay loams; and silty, clay soils with low infiltration rates. The project area comprises 14 percent A, 21 percent B, 28 percent C, and 37 percent D soil types. Figure 2-5 shows the distribution of hydrologic soil groups in the watershed using the Natural Resources Conservation Service (NRCS) Soil Survey Geographic Database (SSURGO) [NRCS, 2024a].

Survey #2 inquired about what concerns stakeholders had with the watershed, including issues related to wastewater discharges and MS4 areas. Specifically relating to the Cache la Poudre River HUC8, stakeholders mentioned various concerns for both point sources and NPSs. The City of Fort Collins mentioned it is concerned with unpermitted industries and construction projects, urban corrals (i.e., private property with animals and manure) through which a creek flows, community-supported agriculture that discharges stormwater runoff, dog daycare discharge runoff with pet waste, horse manure along river trails, and raccoon populations. The City of Greeley specified concerns with permits of industrial users who discharge into their MS4 as well as *E. coli* and nutrients within waterbodies that cause eutrophication and other algae problems.

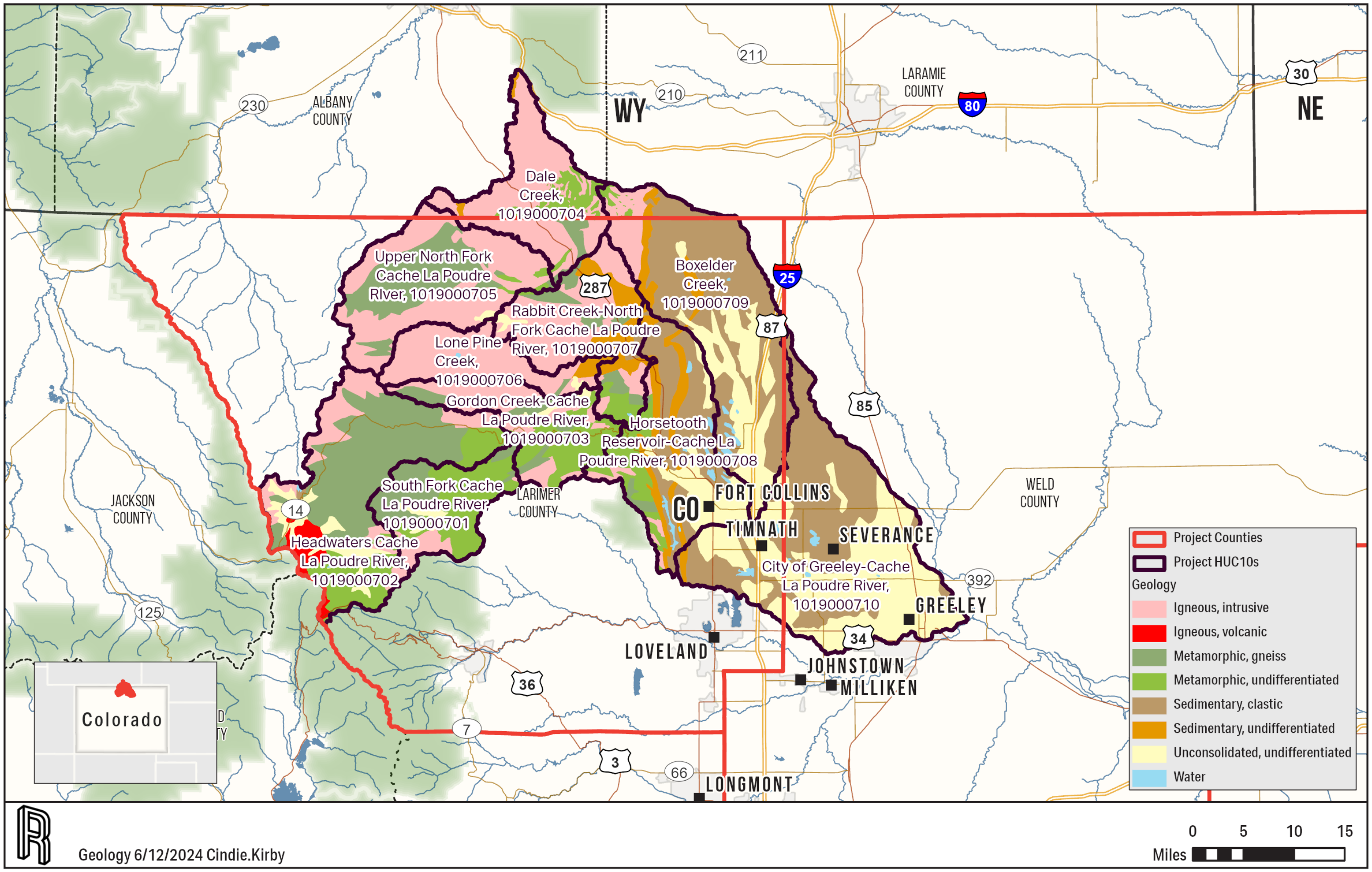


Figure 2-4. Geology.

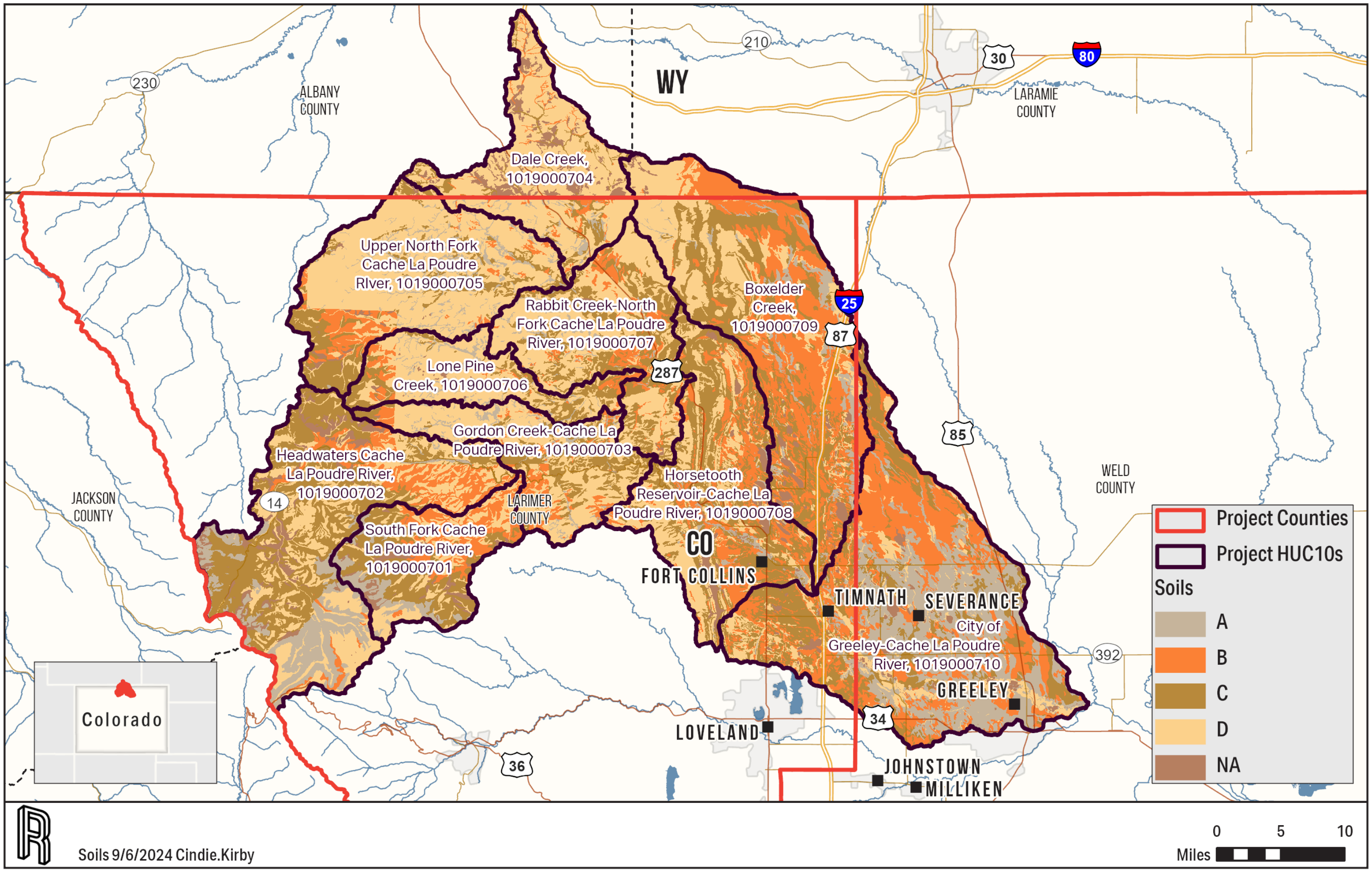


Figure 2-5. Hydrologic Soil Group.

3.0 EXISTING WATERSHED PLANS AND PROJECTS

Many conservation accomplishments have been achieved within the project area, which can be attributed to the local planning and implementation efforts of the community, state, and federal partners. Projects outlined on the CPRW website are listed in Table 3-1. More information about work done in the Cache la Poudre Watershed is available on the CPRW All CPRW Projects webpage. Table 3-2 provides website links to planning projects [CPRW, 2024].

Table 3-1. Watershed Planning and Major Projects in the Cache la Poudre River HUC8

Project Type	Name	Year Completed
Planning	Upper Poudre Watershed Resilience Plan	2024
Planning	Lower Poudre Watershed Resilience Plan	2017
River	Godfrey Ditch Restoration Project	2021
River	Whitney and B.H. Eaton Ditch Restoration Project	Ongoing
River	"Reach 13" Phase 2 Design Project	Ongoing
River	Poudre River Downtown Project – Reach 3	2020
Forest	Swanson Ranch Forest Restoration	2023
Forest	W.O.L.F. Sanctuary Wildfire Mitigation Project	2023
Forest	Lazy D Ranch Forest Restoration	2024
Forest	Horsetooth Mountain Park	2018
Forest	Elkhorn Creek Forest Health Initiative	Ongoing
Forest	Lory State Park Forest Management	2019
Wildfire	Cameron Peak Post-Fire Restoration	2022
Wildfire	Skin Gulch Post-Fire Restoration	2016
Wildfire	Seaman Reservoir Delta Stabilization Project	2018
Wildfire	Unnamed Tributary 3	2019
Wildfire	2020 Post-Fire Restoration Lessons Learned	2020
Other	Green Ditch Rehabilitation and Fish Passage Project	2018
Other	Josh Ames Diversion Removal on Poudre River and North Sterling Pond Restoration	2013
Community Outreach	Poudre River Mural	2023

Table 3-2. Links to Cache la Poudre Planning Projects

Plan	Web Link
CPRW Strategic Plan 2023-2028	https://www.poudrewatershed.org/strategic-plan
Upper Poudre Watershed Resilience Plan	https://www.poudrewatershed.org/upper-watershed-resilience-plan
Lower Poudre Watershed Resilience Plan	https://www.poudrewatershed.org/lower-watershed-resilience-plan
High Park Post-Fire Prioritization Plan	https://www.poudrewatershed.org/high-park-post-fire-plan
Cache la Poudre River Non-Point Source 319 Watershed-Based Plan	https://static1.squarespace.com/static/5af07ab53917ee099d13c874/t/5eb1e67095ae0505f397957a/1588717186644/Final+CPRW+Watershed+Plan+-+April+2020.pdf
North Fork of the Cache la Poudre River Conservation Plan	https://drive.google.com/file/d/120udbAjb1wKxqxdYmgiRhhpAX_UOsdom/view

Numerous conservation measures have been completed and are currently being implemented within the project area. These projects have been made possible through CDPHE with EPA's Section 319 NPS implementation grants and CDPHE grants. Previous conservation efforts have occurred in the project area, and each project helped improve water quality and make progress toward restoring and protecting local waterbodies. Tables 3-3 and 3-4 discuss these implementations within the project area [EPA, 2024a].

Table 3-3. Nonpoint Source Grants Implemented in the Cache la Poudre River HUC8

Conservation Projects	Grant Number	Completion Year	Pollution Category	Section 319 Expenditures ($)	Total Expenditures ($)	Project Accomplishments
Characterizing Bioaccumulation of Mercury In Sport Fish - Informing TMDL Development	99818610	2015	Other NPS Pollution	286,353	286,353	The project created a predictive model to manage mercury bioaccumulation in Colorado sport fish, incorporating biotic and abiotic data. The project assessed strategies to lower mercury levels and communicated results with stakeholder reports and presentations.
Tools to Address Agricultural Nutrient Nonpoint Source Contamination	99818612	2017	Agriculture	80,138	263,261	The project created a decision support tool and nutrient BMP clearinghouse to manage agricultural nutrient NPS pollution in Colorado, facilitating site-specific BMP assessments via GIS. Stakeholder acceptance was garnered through an advisory task force, and project outcomes were effectively communicated through reports and outreach efforts.
2012 Colorado Wildfires - Reclamation at the High Park Burn Area	99818613	2018	Other NPS Pollution	200,000	371,445	The project effectively addressed the impacts of the 2012 wildfires in the Poudre River subwatersheds through revegetation, erosion control, and sediment reduction activities. It collaborated with partners to implement BMPs, improved soil stability, promoted native vegetation, and conducted comprehensive monitoring of water quality and vegetation growth, with results accessible online.
Upper Cache la Poudre River Watershed Plan	99818615	2020	Other NPS Pollution; Resource Extraction	65,419	115,927	The project developed a comprehensive watershed plan for the Poudre River, incorporating stakeholder input and EPA's nine key elements of a watershed plan. It engaged key stakeholders and assessed existing conditions to create a strong foundation for future watershed health restoration activities.
Cameron Peak Fire Post-Wildfire Implementation in the Poudre River Watershed	99818621	2025	Other NPS Pollution	274,063	521,434	This project addresses post-wildfire water quality impacts in the South Platte Basin following the Cameron Peak Fire, using NPS BMPs to mitigate debris flows, runoff, sedimentation, and nutrient loading. Stakeholder input, Burned Area Emergency Response Reports, and predictive models guide the prioritization of subwatersheds for BMP implementation, supported by interagency coordination through the Larimer Recovery Collaborative.

Table 3-4. Other Nonpoint Source Projects (South Platte and/or Statewide)

Project Title	Project Sponsor	Basin	NPS Funding ($)	Match on 09/30/2022 ($)	Status on 09/30/2022 (MM/YYYY)
Little Thompson and St. Vrain Watershed Resilience Initiative	CSU	South Platte	294,940	61,367	Expected Completion 03/2023
Water Quality, Soil Health and Regenerative Agriculture: A Nexus for Sustainability	CSU	South Platte	306,518	68,010	Expected Completion 06/2024
Implementing Agricultural BMPs in a Colorado Soil Health Pilot Program	Colorado Department of Agriculture	Various	34,4894	286,427	Expected Completion 06/2025
Brush Wetland Demonstration Project	Ducks Unlimited	South Platte	80,000	18,167	Expected Completion 06/2025
Nutrient Management on Irrigated Pastures	CAWA	Various	266,355	95,912	Expected Completion 01/2026

The *Cache la Poudre River Watershed-Based Plan* was completed in 2020 [CPRW, 2020]. The plan focuses on creating a framework to prioritize and implement restoration projects in two pilot sub-drainages: North Fork Lone Pine Creek (COSPCP08) in the headwaters and Sheep Draw (COSPCP13a) in the lower basin. This plan is designed to be flexible, scalable, and adaptable to other areas and concerns within the watershed as new priorities arise. The planning effort also included the development of several interactive watershed planning support tools for future planning, analysis, and implementation activities across the watershed.

Similar to the current plan, priority parameters were chosen based on impairment and stakeholder concerns, including sediment, nutrients, heavy metals, temperature, and *E. coli*. The older version of Pollutant Load Estimation Tool (PLET), Spreadsheet Tool for Estimating Pollutant Loads (STEPL), was used to quantify sources and associated loads of nutrients and sediments from cropland, pastureland, urban areas, forests, and feedlots. Additionally, GRAIP_Lite was used to evaluate sediments from roads. Because the areas represented were different, the final load and expected reductions are not comparable [CPRW, 2020].

4.0 STANDARDS AND IMPAIRMENTS

Impairment locations throughout the project area are shown in Figure 4-1. Impaired stream segments and lakes in the project area are shown in Table 4-1, with impairments including heavy metals like arsenic, silver, iron, manganese, and selenium, and other water quality parameters such as macroinvertebrates, sediment, temperature, and *E. coli*. Selenium is measured in fish tissue, as a standard, and in water quality samples. Individual maps and box plots of each impaired parameter are included in Appendices B and C, respectively. A sediment TMDL exists in the project area; however, the reductions needed for that TMDL are not specifically addressed in this document because a single, large upstream sediment release from a reservoir was determined to be the cause of this impairment [CDPHE, 2002].

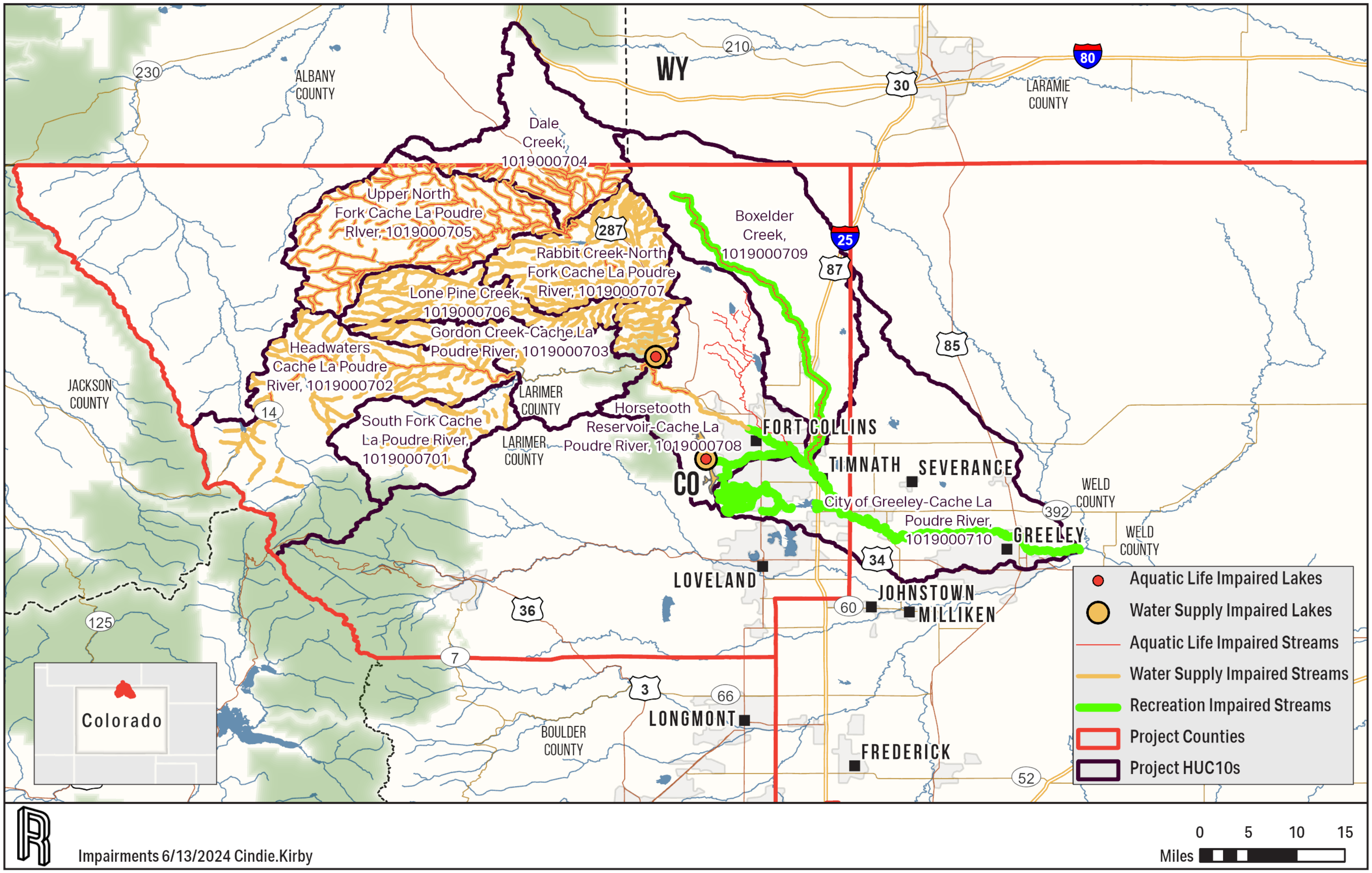


Figure 4-1. Impaired Waterbodies.

Table 4-1. Clean Water Act Section 303(d)-Impaired Waterbodies Summary (Page 1 of 3)

Impairment I.D./ HUC10s	Aquatic Life Tier/ Recreation Tier	Description	Aquatic Life Impairments	Recreation Impairment	Water Supply Impairment
COSPCP02a_B/ 1019000701 and 1019000702	C1/E	Mainstem of the Cache la Poudre River from the boundaries of Rocky Mountain National Park, and the Rawah, Neota, Comanche Peak, and Cache la Poudre Wilderness Areas to a point immediately below the confluence with the South Fork Cache la Poudre River	Macroinvertebrates	N/A	Arsenic (T)
COSPCP02a_C/ 1019000701 and 1019000702	C1/E	All tributaries and wetlands of the Cache la Poudre River from the boundaries of Rocky Mountain National Park, and the Rawah, Neota, Comanche Peak, and Cache la Poudre Wilderness Areas to a point immediately below the confluence with the South Fork Cache la Poudre River	Arsenic(T)	N/A	N/A
COSPCP03_B/ 1019000703	C1/E	Elkhorn Creek, including all tributaries and wetlands, from the source to a point immediately above the confluence with Manhattan Creek	N/A	N/A	Arsenic (T)
COSPCP06_A/ 1019000704 and 1019000705 and 1019000707	C1/E	North Fork of the Cache la Poudre River, including all tributaries and wetlands, from the source to the inlet of Halligan Reservoir	Silver (D)	N/A	Arsenic (T)
COSPCP07_C/ 1019000707	C1/E	Mainstem of the North Fork of the Cache la Poudre River, including wetlands, from immediately below the outlet of Halligan Reservoir to a point five miles downstream	Sediment (TMDL), Silver (D)	N/A	Arsenic (T), Iron (D), Manganese (D)
COSPCP07_D/ 1019000706 and 1019000707	C2/E	Tributaries to the North Fork of the Cache la Poudre River, including wetlands, from the inlet of Halligan Reservoir to the confluence with the Cache la Poudre River, except Lone Pine Creek, Rabbit Creek, and listings in segments 8 and 20	N/A	N/A	Arsenic (T)
COSPCP07_E/ 1019000706 and 1019000707	C1/E	Mainstem of the North Fork of the Cache la Poudre River from a point 5 miles downstream of Halligan Reservoir to Seaman Reservoir	N/A	N/A	Arsenic (T)
COSPCP07_F/ 1019000707	C1/E	Mainstem of the North Fork of the Cache la Poudre River from below Seaman Reservoir to the confluence with the Cache la Poudre River	Temperature	N/A	Arsenic (T), Manganese (D)

Table 4-1. Clean Water Act Section 303(d)-Impaired Waterbodies Summary (Page 2 of 3)

Impairment I.D./ HUC10s	Aquatic Life Tier/ Rec Tier	Description	Aquatic Life Impairments	Recreation Impairment	Water Supply Impairment
COSPCP07_G/ 1019000706	C1/E	Mainstem of Lone Pine Creek, including wetlands, from the confluence of North Fork Lone Pine Creek and South Fork Lone Pine Creek to the confluence with the North Fork of the Cache la Poudre River	N/A	N/A	Arsenic (T), Iron (D)
COSPCP07_H/ 1019000707	C1/E	Mainstem of Rabbit Creek, including wetlands, from the source to the confluence with the North Fork of the Cache la Poudre River	N/A	N/A	Arsenic (T)
COSPCP08_B/ 1019000703 and 1019000706 and 1019000707	C2/E	Middle Fork of Rabbit Creek, including all tributaries and wetlands, from the source to the confluence with Rabbit Creek. Stonewall Creek, including all tributaries and wetlands, from the source to the confluence with the North Fork of the Cache la Poudre River; North Fork Lone Pine Creek and South Fork Lone Pine Creek, including all tributaries and wetlands, from the source to the confluence with Lone Pine Creek	N/A	N/A	Arsenic (T)
COSPCP10a_A/ 1019000703 and 1019000707 and 1019000708	C1/E	Mainstem of the Cache la Poudre River from the Munroe Gravity Canal Headgate (also known as the North Poudre Supply Canal diversion; 40.691700, -105.255292) to a point immediately above the Larimer County Ditch diversion (40.656612, -105.185244)	Temperature	N/A	Arsenic (T)
COSPCP10b_A/ 1019000708	C2/E	Mainstem of the Cache la Poudre River from a point immediately above the Larimer County Ditch diversion (40.656612, -105.185244) to Shields Street in Fort Collins, Colorado	N/A	N/A	Arsenic (T)
COSPCP11_B/ 1019000708	C1/E	Mainstem of the Cache la Poudre River from Shields Street in Fort Collins to Prospect Road	N/A	*E. coli*	N/A
COSPCP12a_A/ 1019000709 and 1019000710	W1/E	Mainstem of the Cache la Poudre River from Project Road to U.S. Hwy 85 in Greely	N/A	*E. coli* (May - October)	N/A
COSPCP12a_B/ 1019000708 and 1019000709	W1/E	Mainstem of the Cache la Poudre River from Prospect Road to Boxelder Creek	N/A	*E. coli*	N/A
COSPCP12b_A/ 1019000710	W1/E	Mainstem of the Cache la Poudre River from U.S. Hwy 85 in Greeley to the confluence with the South Platte River	N/A	*E. coli* (May - October)	N/A

Table 4-1. Clean Water Act Section 303(d)-Impaired Waterbodies Summary (Page 2 of 3)

Impairment I.D./ HUC10s	Aquatic Life Tier/ Rec Tier	Description	Aquatic Life Impairments	Recreation Impairment	Water Supply Impairment
COSPCP13a_B/ 1019000708	W1/E	Dry Creek and all tributaries	Selenium (D)	NA	N/A
COSPCP13a_D/ 1019000708	W1/E	Spring Creek and all its tributaries	N/A	*E. coli* (May - October)	N/A
COSPCP13a_E/ 1019000710	W1/E	Fossil Creek and its tributaries	N/A	*E. coli* (May - October)	N/A
COSPCP13b_C/ 1019000709	C1/E	Mainstem of Boxelder Creek from its source to a point immediately above Slab Canyon Wash	Selenium (D), Macroinvertebrates	*E. coli*	N/A
COSPCP13c_B/ 1019000709	W1/P	Mainstem of Boxelder Creek from a point immediately above Slab Canyon Wash to the confluence with the Cache la Poudre River	Selenium (D), Macroinvertebrates	*E. coli*	N/A

D = dissolved
T = total
TMDL = total maximum daily load

In Survey #1, local stakeholders noted their primary parameters of concern. Each parameter occurrence was counted, and the four parameters that appeared the most were nitrogen, phosphorus, total suspended solids (TSS), and *E. coli*. Others that showed up less than the most predominant parameters included temperature, emerging contaminants, metals, and per- and polyfluoroalkyl substances (PFAS). Emerging contaminants are the different types of chemicals (e.g., medication, personal care products, home cleaning products, lawn care products, and agricultural products, such as insecticides and herbicides) that end up in waterbodies but are not generally treated in wastewater facilities. PFAS and emerging contaminants of concern are not included in this report. Some emerging contaminants are treated by drinking water and/or wastewater facilities, but these chemicals are not well regulated or understood. A new EPA limit for PFAS of 4 parts per trillion was released in 2024 [EPA, 2024b].

Water quality standards for parameters of concern are based on beneficial-use tiers. For more information on these standards and tiers, visit the CDPHE's Water Quality Control Commission's 5 Codes of Colorado Regulation (CCR) 1002-31 website, last updated June 14, 2023. Access the CDPHE's Water Quality Control Commission Regulation No. 38 website, last updated April 30, 2024, for information on classifications and numeric standards for South Platte River Basin, Laramie River Basin, Republican River Basin, and Smoky Hill River Basin (5 CCR 1002-38).

The beneficial-use tiers for aquatic life, recreation, and domestic water supply are listed as follows:

- Aquatic Life
  - C1 – Class 1 Cold Water
  - C2 – Class 2 Cold Water
  - W1 – Class 1 Warm Water
  - W2 – Class 2 Warm Water
- Recreation
  - E – Existing Primary Contact Use (since November 28, 1975)
  - P – Potential Primary Contact Use
  - N – Not Primary Contact Use
  - U – Undetermined Use
- Domestic Water Supply
  - Direct Use Water Supply Lakes and Reservoirs

Current loads were determined for *E. coli*, dissolved selenium, total nitrogen, and total phosphorus using flow and water quality monitoring data collected along the mainstem of the most downstream HUC10 of the Cache la Poudre project area (1019000710). The U.S. Geological Survey (USGS) site used for flow was USGS-06752500, which had data available from 1903 through 1998. The average annual flow was calculated using flow from 1990 through 1998 (the last year with data available) to be approximately 176 cubic feet per second (cfs). Numerous water quality sites were along the mainstem in the HUC10, and all available *E. coli*, selenium, total nitrogen, and total phosphorus data were used. The geometric mean from all *E. coli* data collected from 1990 through 2024 was used to represent the *E. coli* concentration; the 85th percentile from all dissolved selenium from 1990 through 2024 was used to represent the current selenium concentration; and for both phosphorus and nitrogen, the annual median was averaged for all data from 1990 through 2024 to represent the current concentrations. Current loads were then calculated as the product of flow, concentration, and a conversion factor for each. Needed loads based on water quality standards were also calculated using the product of the same average annual flow, each water quality standard, and a conversion factor. The *E. coli* water quality standard was 126 most probable number (mpn) per 100 milliliters (mL), the selenium standard was 4.6 micrograms per liter (µg/L), the nitrogen standard was 2.01 milligrams per liter (mg/L), and the phosphorus standard was 0.17 mg/L. Current and needed flows, concentrations, and loads are shown in Table 4-2, as well as the load reduction needed at in the HUC10. At this location, reductions are needed to reach goal loads for E. coli, total nitrogen, and total phosphorus. As flow and concentration data are collected at this location, they can be incorporated into the load estimations.

Table 4-2. Flows, Current Loads, Goal Loads, and Reductions to Reach Goals in Most Downstream HUC10 of the Project Area

Flow	Average Annual Flow (cfs)	176.0
Current Concentrations	*E. coli* Geomean (org/100 mL)	189.8
	Dissolved Selenium (85th Percentile)	3.2
	Average of Median Annual Nitrogen (mg/L)	4.7
	Average of Median Annual Phosphorus (mg/L)	0.5
Current Loads	*E. coli* (billion org/day)	816.9
	Selenium (lb/day)	3.0
	Nitrogen (lb/day)	4,469.2
	Phosphorus (lb/day)	443.0
Goal Loads	*E. coli* (billion org/day)	542.4
	Selenium (lb/day)	4.4
	Nitrogen (lb/day)	1,907.6
	Phosphorus (lb/day)	161.3
Reductions to Achieve Goal Loads	*E. coli*	34%
	Selenium	0%
	Nitrogen	57%
	Phosphorus	64%

cfs = cubic feet per second
lb/day = pounds per day
mg/L = milligrams per liter
mL = milliliters

5.0 SOURCE ASSESSMENT

Only NPS pollutants are addressed in this report. Point sources and areas with MS4s are addressed in the *208 Areawide Water Quality Management Plan, 2022 Update* [NFRWQPA, 2022]. Outside of MS4-permitted areas, NPSs of nutrients are generally related to runoff from cropland, pastureland, developed land, and other similar lands. NPSs of sediment consist of sediment contributions through wash off, as well as bed and bank erosion during high flows. NPSs of *E. coli* are typically from livestock, pets, wildlife, and human sources that can occur in agricultural and developed areas. NPSs of heavy metals vary by metal, but are often from abandoned mine lands (AMLs) or runoff from irrigated agricultural lands. Sometimes sources are from natural causes. Natural causes are the physical, chemical, or biological conditions that would exist in a waterbody in the absence of measurable impacts from human activity or influence. More information about the sources of each pollutant are described in this section.

5.1 NUTRIENTS AND SEDIMENT

The EPA's Pollutant Load Estimation Tool (PLET) was used to estimate nutrient and sediment loads from different land uses by HUC10 and later to evaluate load reductions that would result from the implementation of various BMPs [EPA, 2022].

For the Cache la Poudre River HUC8 in PLET, all 10 HUC10 watersheds were represented: South Fork Cache la Poudre River (1019000701), Headwaters Cache la Poudre River (1019000702), Gordon Creek-Cache la Poudre River (1019000703), Dale Creek (1019000704), Upper North Fork Cache la Poudre River (1019000705), Lone Pine Creek (1019000706), Rabbit Creek-North Fork Cache la Poudre River (1019000707), Horsetooth Reservoir-Cache la Poudre River (1019000708), Boxelder Creek (1019000709), and City of Greeley-Cache la Poudre River (1019000710). The following inputs to the PLET model were included for each HUC10:

- Watershed land-use areas (acres) [Multi-Resolution Land Characteristics Consortium, 2019]
  - Urban (non-MS4)
  - Cropland
  - Pastureland
  - Forest
  - Feedlots
  - Other (all other land uses)
- Prominent hydrologic soil group (A-D) [NRCS, 2024a]
- Average annual rainfall (inches) [EPA, 2022]
- Rain days/year [EPA, 2022]
- Number of agricultural animals [EPA, 2022]
  - Beef cattle
  - Dairy cattle
  - Swine

    - Sheep
    - Horse
    - Chicken
    - Turkey
    - Duck
- Number of septic systems [Larimer County, 2024; Fischer, 2023]
- Population per septic system [Thomas, 2024]
- Septic rate failure [EPA, 2022]
- Urban land-use distribution [Multi-Resolution Land Characteristics Consortium, 2019]
- Irrigated cropland [Colorado's Decision Support Systems, 2024]
- Water depth per irrigation (inches) [EPA, 2022]
- Irrigation days/year [EPA, 2022]

Sediment erosion can be estimated in PLET; however, gullies and streambank erosion were not included because of a lack of data. Wildlife density (animals per square mile) was also not included because of a lack of data and because wildlife is considered a natural source.

Source assessment modeling results for the 10 HUC10 watersheds are summarized using the following categories: urban areas (excluding permitted MS4 areas), cropland, pastureland, forest (including scrub/shrub), feedlots, and a combination of all other land uses. The other land uses consist of barren, herbaceous, and wetlands, which typically are not the highest contributors per acre; therefore, BMP planning does not generally focus on these land uses even though they can make up a fairly large portion of the area. Because this is a NPS plan, permitted MS4s, which have limits to meet, are exempt from inclusion in this plan. The permitted MS4s in the project area not included are the City of Fort Collins and the City of Greeley, Colorado. MS4 areas were developed using a combination of the MS4 layer from ERAMS [Catena Analytics, 2024] (developed with the 2010 Census urban areas), the 2020 urban areas [U.S. Census Bureau, 2020], and a layer sent from the Town of Timnath [Smith, 2024]. The excluded area used to represent these MS4s was approximately 118 mi^2, primarily located in the City of Greeley in the Cache la Poudre River HUC10. Table 5-1 shows the percentage of each land-use source per HUC10 (in Larimer and Weld Counties only). The only source not associated with an area is septic systems. The quantified sources of nitrogen, phosphorus, and sediment are listed in Tables 5-2, 5-3, and 5-4 in order of the HUC10 watersheds. The western watersheds (South Fork Cache la Poudre River, Headwaters Cache la Poudre River, Gordon Creek-Cache la Poudre River, Dale Creek, Upper North Fork Cache la Poudre River, Lone Pine Creek, and Rabbit Creek-North Fork Cache la Poudre River) are dominated by forest, while the eastern watersheds (Horsetooth Reservoir-Cache la Poudre River, Boxelder Creek, and City of Greeley-Cache la Poudre River) are dominated by other land or croplands.

In the western seven watersheds (South Fork Cache la Poudre River, Headwaters Cache la Poudre River, Gordon Creek-Cache la Poudre River, Dale Creek, Upper North Fork Cache la Poudre River, Lone Pine Creek, and Rabbit Creek-North Fork Cache la Poudre River), the forest lands dominate the source loads for nutrients and sediment. The only exceptions are in the Gordon Creek-Cache la Poudre River, Dale Creek, and Rabbit Creek-North Fork Cache la Poudre River watersheds where other land dominates sediment sources. In the two mid-east watersheds (Horsetooth Reservoir-Cache la Poudre

River and Boxelder Creek), the primary land cover is other land but cropland dominates the source loads for nutrients and sediment. In the easternmost watershed, City of Greeley-Cache la Poudre River, the primary land cover is cropland, which dominates the source loads for nutrients and sediment.

Table 5-1. Land Cover

HUC101	Description	Area (mi^2)	Urban Non-MS4 (%)	Cropland (%)	Pastureland (%)	Forest (%)	Feedlots (%)	Other Land Uses (%)
1019000701	South Fork Cache la Poudre River	102	<1	0	0	83	<1	17
1019000702	Headwaters Cache la Poudre River	262	1	0	0	91	<1	8
1019000703	Gordon Creek-Cache la Poudre River	113	2	0	<1	64	<1	34
1019000704	Dale Creek	42	<1	0	<1	69	<1	30
1019000705	Upper North Fork Cache la Poudre River	188	<1	0	<1	94	<1	5
1019000706	Lone Pine Creek	86	2	<1	<1	88	<1	10
1019000707	Rabbit Creek-North Fork Cache la Poudre River	148	<1	<1	<1	65	<1	33
1019000708	Horsetooth Reservoir-Cache la Poudre River	151	6	6	3	38	<1	47
1019000709	Boxelder Creek	251	5	14	2	19	<1	61
1019000710	City of Greeley-Cache la Poudre River	273	10	55	5	3	<1	27

Table 5-2. Nitrogen Sources

HUC10	Description	Area (mi^2)	Urban Non-MS4 (%)	Cropland (%)	Pastureland (%)	Forest (%)	Feedlots (%)	Other Land Uses (%)	Septic (%)
1019000701	South Fork Cache la Poudre River	102	9	0	0	62	13	15	<1
1019000702	Headwaters Cache la Poudre River	262	23	0	<1	61	9	6	<1
1019000703	Gordon Creek-Cache la Poudre River	113	17	0	1	39	14	24	6
1019000704	Dale Creek	42	11	0	3	47	15	24	1
1019000705	Upper North Fork Cache la Poudre River	188	9	0	1	70	15	4	2
1019000706	Lone Pine Creek	86	14	5	8	46	14	6	6
1019000707	Rabbit Creek-North Fork Cache la Poudre River	148	7	16	3	29	27	17	<1
1019000708	Horsetooth Reservoir-Cache la Poudre River	151	20	32	12	6	14	9	6
1019000709	Boxelder Creek	251	17	49	5	2	18	8	2
1019000710	City of Greeley-Cache la Poudre River	273	15	65	3	<1	14	<1	2

Table 5-3. Phosphorus Sources

HUC10	Description	Area (mi²)	Urban Non-MS4 (%)	Cropland (%)	Pastureland (%)	Forest (%)	Feedlots (%)	Other Land Uses (%)	Septic (%)
1019000701	South Fork Cache la Poudre River	102	3	0	0	73	6	17	<1
1019000702	Headwaters Cache la Poudre River	262	10	0	<1	78	5	7	<1
1019000703	Gordon Creek-Cache la Poudre River	113	7	0	<1	50	7	30	6
1019000704	Dale Creek	42	4	0	1	58	7	29	1
1019000705	Upper North Fork Cache la Poudre River	188	3	0	<1	83	7	5	2
1019000706	Lone Pine Creek	86	6	2	2	66	8	8	7
1019000707	Rabbit Creek-North Fork Cache la Poudre River	148	3	9	<1	44	17	25	<1
1019000708	Horsetooth Reservoir-Cache la Poudre River	151	13	31	4	13	12	18	9
1019000709	Boxelder Creek	251	11	50	2	4	15	15	3
1019000710	City of Greeley-Cache la Poudre River	273	10	71	1	<1	12	2	4

Table 5-4. Sediment Sources

HUC10	Description	Area (mi^2)	Urban Non-MS4 (%)	Cropland (%)	Pastureland (%)	Forest (%)	Feedlots (%)	Other Land Uses (%)	Septic (%)
1019000701	South Fork Cache la Poudre River	102	9	0	0	54	0	36	0
1019000702	Headwaters Cache la Poudre River	262	28	0	<1	57	0	16	0
1019000703	Gordon Creek-Cache la Poudre River	113	18	0	<1	29	0	52	0
1019000704	Dale Creek	42	9	0	1	37	0	53	0
1019000705	Upper North Fork Cache la Poudre River	188	16	0	<1	71	0	13	0
1019000706	Lone Pine Creek	86	21	7	5	49	0	18	0
1019000707	Rabbit Creek-North Fork Cache la Poudre River	148	10	18	1	26	0	44	0
1019000708	Horsetooth Reservoir-Cache la Poudre River	151	16	57	5	4	0	18	0
1019000709	Boxelder Creek	251	9	74	2	1	0	14	0
1019000710	City of Greeley-Cache la Poudre River	273	5	91	2	<1	0	2	0

A less obvious contributor of nutrients and sediment to waterbodies is wildland fires. Wildland fires significantly reduce well-established root systems in areas impacted and, as a result, soil erosion is much more likely during precipitation events, carrying nutrients with it. The Cache la Poudre River watershed has already experienced post-wildfire flooding, debris flows, and associated economic impacts from the largest fire in Colorado: Cameron Peak to the southwest. Table 5-5 provides the total number of fire acres for each year past 2000 where any existed per HUC10 [National Interagency Fire Center, 2024]. The physical location of the watershed within a wildfire-prone area of Colorado and its past encounters with natural calamities make having a plan of action for any future wildfire risks imperative. The CPRW has made many post-fire recovery, mitigation, and restoration efforts since the Cameron Peak fire, including facilitation of the "Water Recovery Group"; completion of a "Cameron Peak Watershed Hazards, Treatments and Targeting Prioritization" analysis; and active fundraising, outreach, and education [CPRW, 2021]. Projects are still ongoing and are available on the All CPRW Projects webpage.

Table 5-5. Total Fire Acres per HUC10 per Year (2000-2021)

HUC10	1019000701	1019000702	1019000703	1019000704	1019000705	1019000706	1019000707	1019000708
2000			64				24	
2002	50		673					
2004			14				11,038	6,894
2005					41	48		
2009			34					
2011			17					
2012	22,280	5,568	76,230				10,728	34,188
2016					301			
2018			187				44	
2019	100					1		
2020	32,406	94,248	9,005		18	2,202		
2021				32	1			

Although nitrate impairments do not exist within the Cache la Poudre River HUC8, addressing why these should continue to be avoided for future water quality considerations is important. Nitrates can enter surface waters from animal manure, nitrogen fertilizers, wastewater, and decomposed plant residues and organic matter [University of Missouri Extension, 2024]. Only one location is impaired with sediment in HUC10 1019000707: COSPCP07_C. No other nutrient- or sediment-impaired waterbodies occur in the Cache la Poudre River HUC8, but nutrients and sediment were identified as priority parameters of concern.

Atmospheric deposition is also a source of nutrients. EPA's Clean Air Status and Trends Network (CASTNET) and the National Atmospheric Deposition Program (NADP) monitor nitrogen deposition (ammonia and nitrate) at locations throughout the United States. The SPARROW model published by the USGS estimated that in the Cache la Poudre River Watershed, more than 190,000 pounds of nitrogen were delivered to the stream from atmospheric deposition [USGS, 2019]. Some practices can help reduce nutrients in atmospheric deposition; however, these practices are not a focus in this plan because their impacts are less local than other BMPs.

5.2 E. COLI

Bacteria comes from the intestines of humans and warm-blooded animals. NPSs of bacteria consist primarily of waste that is transported through wash-off from cropland, pastureland, and developed land, as well as septic systems and direct defecation from livestock and wildlife. For the purposes of this project, bacteria from wildlife are assumed to be a natural background source and are not included in the assessment.

E. coli from human and animal waste are dispersed throughout the landscape, spread by humans, and/or treated in facilities. Once *E. coli* are in the environment, their accumulation on land and delivery to the stream are affected by die-off and decay, surface imperviousness, detention time, ultraviolet exposure, and other mechanisms. Quantifying *E. coli* sources using PLET is not recommended [Tetra Tech, Inc., 2022], so an assessment of bacteria production within the watershed was completed per HUC10. This assessment included humans (Wastewater Treatment Plants [WWTPs] and Onsite Wastewater Treatment Systems [OWTSs]), pets (dogs and cats), and livestock (cattle, horses, poultry, sheep, and hogs); however, wildlife was not included because wildlife was assumed to be a natural source of bacteria. Publicly owned WWTPs are highly regulated and are not a significant source of *E. coli*. In some cases, WWTPs even provide dilution from other sources. OWTS contributions are largely dependent on soil and geology in an area, as well as their proximity to a waterbody. Additionally, point sources are not a focus of this study; therefore, WWTP estimates were added primarily as a comparison to the production of bacteria sent to an OWTS.

Livestock contribute *E. coli* loads directly by defecating in streams and indirectly by defecating on cropland or pastures where *E. coli* can wash off during precipitation events, snowmelt, or irrigation. Spreading livestock manure on cropland or pasture also contributes *E. coli* to waterbodies. The livestock in the project area mainly consists of cattle, poultry, hogs, horses, sheep, and goats, which are grazed and/or confined, and manure is spread on crops and pastures.

Pet waste is another potential source of *E. coli*. Pet waste is often left in yards, in parks, and along trails, and can be carried with stormwater to local storm drains and waterbodies.

Natural background sources are inputs that would be expected under natural, undisturbed conditions and include *E. coli* loading from wildlife in the area. Wildlife (e.g., waterfowl and large-game species) also contribute *E. coli* loads directly by defecating while wading or swimming in a stream and indirectly by defecating on lands that produce watershed runoff during precipitation events.

A GIS-based assessment was completed within each impaired drainage area to estimate livestock, wildlife, human, and pet populations. Animal populations were multiplied by average excretion rates from scientific literature to estimate the amount of *E. coli* produced by each source type in each HUC10 watershed. The reported literature values for fecal coliform excretion were converted to *E. coli* excretion by using a fecal coliform to *E. coli* ratio of 200:126 mpn per 100 mL. The loads produced by humans are usually treated by WWTPs and OWTSs.

Annual excretion estimates for livestock (excluding hogs) and wildlife were obtained from "BSLC: A Tool for Bacteria Source Characterization for Watershed Management" [Zeckoski et al., 2005], and bacteria estimates for humans and hogs were obtained from *Wastewater Engineering: Treatment, Disposal, and Reuse* [Metcalf and Eddy, 1991]. Annual excretion rates for dogs and cats were sourced from *Identification and Evaluation of Nutrient and Bacterial Loadings to Maquoit Bay, New Brunswick and Freeport, Maine* [Horsley and Witten, Inc., 1996]. Literature values for bacteria excretion rates are estimates and do not represent all sources and dynamics of bacteria in a natural system. Table 5-6 provides the literature rates of *E. coli* (converted from fecal coliform) produced by each animal per day, as well as the respective sources.

Table 5-6. *E. coli* Production Rates From Literature Sources

Category	Subcategory	*E. coli* Production Rate (cfu/head/day)	Source
Humans	WWTP	1,260,000,000	Metcalf and Eddy 1991
Humans	OWTS	1,260,000,000	Metcalf and Eddy, 1991
Pets	Cats	3,150,000,000	Horsley and Witten, Inc., 1996
Pets	Dogs	3,150,000,000	Horsley and Witten, Inc., 1996
Livestock	Cattle	20,790,000,000	Zeckoski et al., 2005
Livestock	Horses	26,460,000,000	Zeckoski et al., 2005
Livestock	Poultry	58,590,000	Zeckoski et al., 2005
Livestock	Sheep	7,560,000,000	Zeckoski et al., 2005
Livestock	Goats	17,640,000,000	Zeckoski et al., 2005
Livestock	Hogs	5,607,000,000	Metcalf and Eddy, 1991
Wildlife	Deer	220,500,000	Zeckoski et al., 2005
Wildlife	Ducks	1,512,000,000	Zeckoski et al., 2005
Wildlife	Geese	504,000,000	Zeckoski et al., 2005

cfu/head/day = colony-forming units per head per day

Livestock numbers were obtained from the PLET database by HUC12 and aggregated up to the HUC10 level. Livestock counts available in PLET included cattle, horses, poultry, sheep, and hogs. PLET animal data are from the U.S. Department of Agriculture (USDA) National Agricultural Statistics Service, for which county animal data are summarized at the HUC12 level based on the pastureland area weighted ratio [EPA, 2022].

Hogs and poultry are typically kept in a total confinement facility, with their manure collected in a liquid manure storage area and later spread and/or incorporated on or into agricultural land. Grazed animals can also be kept in sheltered areas but are more likely to be pastured or have access to waterbodies than hogs and poultry. Manure that has been incorporated or spread into or on agricultural fields can contribute *E. coli* to waterways, but incorporation decreases the likelihood of transport. Livestock numbers include both animal feeding operations (AFOs) and concentrated animal feed operations (CAFOs); both are relevant because manure is applied to croplands and pasturelands and reaches surface waters even when the manure comes from a zero-runoff feedlot.

Individuals on domestic wastewater sewers within each HUC10 were estimated by summing the population for all of the 2020 U.S. Census Block Centroid Population points that fall within census urban areas, which were assumed to be connected to the WWTPs in applicable drainage areas [U.S. Census Bureau, 2020]. Bacteria within wastewater in urban areas with a WWTP were assumed to be treated according to the WWTP's permit requirement.

People using an OWTS were estimated by Larimer and Weld Counties' OWTS [Larimer County, 2024; Fischer, 2023] within each HUC10 and multiplying the total by 3.31, which is the number of individuals assumed to be on each OWTS in the applicable counties [Thomas, 2024]. This evaluation represents all OWTSs, including compliant systems.

Pet populations were estimated by calculating the number of households from the 2020 U.S. Census Block Centroid Population points within each applicable impairment drainage area and assuming 0.58 dogs (36.5 percent of households times 1.6 dogs per household) and 0.64 cats (30.4 percent of households times 2.1 cats per household) per household [American Veterinary Medical Association, 2016].

Table 5-7 summarizes the number of animals, estimated *E. coli* produced, and percent of the total *E. coli* from each animal type within each HUC10. These estimates provide watershed managers with the relative magnitudes of total production by source and do not account for treatment by WWTPs or OWTSs, wash off, delivery, instream growth, or die-off dynamics that occur with *E. coli* and substantially affect their delivery to surface waters. Because of water treatment, far less *E. coli* are generally discharged from WWTPs than what is produced and sent to them.

Several factors affect whether *E. coli* reach a stream. The analysis illustrates that across the entire project area, the amount of *E. coli* produced by livestock is substantially greater than the *E. coli* produced by humans or pets. Only two HUC10s—1019000708 (Horsetooth Reservoir-Cache la Poudre River) and 1019000710 (City of Greeley-Cache la Poudre River)—have higher production from humans or pets than from livestock. Both Larimer and Weld Counties are Right-to-Farm counties, which protects certain types of operations from nuisance suits when their activities impact neighboring property through activities like noise or odor.

Table 5-7. Estimated Number of Animals, *E. coli* Produced, and Percent of *E. coli* Produced in Each HUC10 (Page 1 of 4)

HUC10	Description	Category	Subcategory	Count	Total *E. coli* Produced (cfu/day)	Total *E. coli* Produced (%)
1019000701	South Fork Cache la Poudre River	Humans	OWTS	530	6.7E+11	4
1019000701	South Fork Cache la Poudre River	Humans	WWTP	0	0.0E+00	0
1019000701	South Fork Cache la Poudre River	Pets	Dogs	93	2.9E+11	2
1019000701	South Fork Cache la Poudre River	Pets	Cats	102	3.2E+11	2
1019000701	South Fork Cache la Poudre River	Livestock	Cattle	681	1.4E+13	77
1019000701	South Fork Cache la Poudre River	Livestock	Horses	102	2.7E+12	15
1019000701	South Fork Cache la Poudre River	Livestock	Poultry	126	7.4E+09	0
1019000701	South Fork Cache la Poudre River	Livestock	Sheep	40	3.0E+11	2
1019000701	South Fork Cache la Poudre River	Livestock	Goats	0	0.0E+00	0
1019000701	South Fork Cache la Poudre River	Livestock	Hogs	6	3.4E+10	0
1019000702	Headwaters Cache la Poudre River	Humans	OWTS	1165	1.5E+12	4
1019000702	Headwaters Cache la Poudre River	Humans	WWTP	0	0.0E+00	0
1019000702	Headwaters Cache la Poudre River	Pets	Dogs	204	6.4E+11	2
1019000702	Headwaters Cache la Poudre River	Pets	Cats	225	7.1E+11	2
1019000702	Headwaters Cache la Poudre River	Livestock	Cattle	1508	3.1E+13	76
1019000702	Headwaters Cache la Poudre River	Livestock	Horses	228	6.0E+12	15
1019000702	Headwaters Cache la Poudre River	Livestock	Poultry	282	1.7E+10	0
1019000702	Headwaters Cache la Poudre River	Livestock	Sheep	90	6.8E+11	2
1019000702	Headwaters Cache la Poudre River	Livestock	Goats	1	1.8E+10	0
1019000702	Headwaters Cache la Poudre River	Livestock	Hogs	15	8.4E+10	0
1019000703	Gordon Creek-Cache la Poudre River	Humans	OWTS	5131	6.5E+12	14
1019000703	Gordon Creek-Cache la Poudre River	Humans	WWTP	0	0.0E+00	0
1019000703	Gordon Creek-Cache la Poudre River	Pets	Dogs	899	2.8E+12	6
1019000703	Gordon Creek-Cache la Poudre River	Pets	Cats	992	3.1E+12	7
1019000703	Gordon Creek-Cache la Poudre River	Livestock	Cattle	1294	2.7E+13	60
1019000703	Gordon Creek-Cache la Poudre River	Livestock	Horses	195	5.2E+12	11

Table 5-7. Estimated Number of Animals, *E. coli* Produced, and Percent of *E. coli* Produced in Each HUC10 (Page 2 of 4)

HUC10	Description	Category	Subcategory	Count	Total *E. coli* Produced (cfu/day)	Total *E. coli* Produced (%)
1019000703	Gordon Creek-Cache la Poudre River	Livestock	Poultry	244	1.4E+10	0
1019000703	Gordon Creek-Cache la Poudre River	Livestock	Sheep	77	5.8E+11	1
1019000703	Gordon Creek-Cache la Poudre River	Livestock	Goats	2	3.5E+10	0
1019000703	Gordon Creek-Cache la Poudre River	Livestock	Hogs	12	6.7E+10	0
1019000704	Dale Creek	Humans	OWTS	305	3.8E+11	3
1019000704	Dale Creek	Humans	WWTP	0	0.0E+00	0
1019000704	Dale Creek	Pets	Dogs	53	1.7E+11	1
1019000704	Dale Creek	Pets	Cats	59	1.9E+11	2
1019000704	Dale Creek	Livestock	Cattle	430	8.9E+12	77
1019000704	Dale Creek	Livestock	Horses	65	1.7E+12	15
1019000704	Dale Creek	Livestock	Poultry	80	4.7E+09	0
1019000704	Dale Creek	Livestock	Sheep	25	1.9E+11	2
1019000704	Dale Creek	Livestock	Goats	3	5.3E+10	0
1019000704	Dale Creek	Livestock	Hogs	4	2.2E+10	0
1019000705	Upper North Fork Cache la Poudre River	Humans	OWTS	3641	4.6E+12	7
1019000705	Upper North Fork Cache la Poudre River	Humans	WWTP	0	0.0E+00	0
1019000705	Upper North Fork Cache la Poudre River	Pets	Dogs	638	2.0E+12	3
1019000705	Upper North Fork Cache la Poudre River	Pets	Cats	704	2.2E+12	4
1019000705	Upper North Fork Cache la Poudre River	Livestock	Cattle	2263	4.7E+13	75
1019000705	Upper North Fork Cache la Poudre River	Livestock	Horses	228	6.0E+12	10
1019000705	Upper North Fork Cache la Poudre River	Livestock	Poultry	246	1.4E+10	0
1019000705	Upper North Fork Cache la Poudre River	Livestock	Sheep	146	1.1E+12	2
1019000705	Upper North Fork Cache la Poudre River	Livestock	Goats	4	7.1E+10	0
1019000705	Upper North Fork Cache la Poudre River	Livestock	Hogs	9	5.0E+10	0
1019000706	Lone Pine Creek	Humans	OWTS	5081	6.4E+12	13
1019000706	Lone Pine Creek	Humans	WWTP	3509	4.4E+12	9

Table 5-7. Estimated Number of Animals, *E. coli* Produced, and Percent of *E. coli* Produced in Each HUC10 (Page 3 of 4)

HUC10	Description	Category	Subcategory	Count	Total *E. coli* Produced (cfu/day)	Total *E. coli* Produced (%)
1019000706	Lone Pine Creek	Pets	Dogs	1505	4.7E+12	9
1019000706	Lone Pine Creek	Pets	Cats	1661	5.2E+12	10
1019000706	Lone Pine Creek	Livestock	Cattle	1161	2.4E+13	48
1019000706	Lone Pine Creek	Livestock	Horses	176	4.7E+12	9
1019000706	Lone Pine Creek	Livestock	Poultry	220	1.3E+10	0
1019000706	Lone Pine Creek	Livestock	Sheep	70	5.3E+11	1
1019000706	Lone Pine Creek	Livestock	Goats	5	8.8E+10	0
1019000706	Lone Pine Creek	Livestock	Hogs	11	6.2E+10	0
1019000707	Rabbit Creek-North Fork Cache la Poudre River	Humans	OWTS	1509	1.9E+12	2
1019000707	Rabbit Creek-North Fork Cache la Poudre River	Humans	WWTP	0	0.0E+00	0
1019000707	Rabbit Creek-North Fork Cache la Poudre River	Pets	Dogs	264	8.3E+11	1
1019000707	Rabbit Creek-North Fork Cache la Poudre River	Pets	Cats	292	9.2E+11	1
1019000707	Rabbit Creek-North Fork Cache la Poudre River	Livestock	Cattle	4772	9.9E+13	80
1019000707	Rabbit Creek-North Fork Cache la Poudre River	Livestock	Horses	722	1.9E+13	15
1019000707	Rabbit Creek-North Fork Cache la Poudre River	Livestock	Poultry	897	5.3E+10	0
1019000707	Rabbit Creek-North Fork Cache la Poudre River	Livestock	Sheep	284	2.1E+12	2
1019000707	Rabbit Creek-North Fork Cache la Poudre River	Livestock	Goats	6	1.1E+11	0
1019000707	Rabbit Creek-North Fork Cache la Poudre River	Livestock	Hogs	44	2.5E+11	0
1019000708	Horsetooth Reservoir-Cache la Poudre River	Humans	OWTS	19231	2.4E+13	6
1019000708	Horsetooth Reservoir-Cache la Poudre River	Humans	WWTP	100349	1.3E+14	30
1019000708	Horsetooth Reservoir-Cache la Poudre River	Pets	Dogs	20954	6.6E+13	16
1019000708	Horsetooth Reservoir-Cache la Poudre River	Pets	Cats	23121	7.3E+13	17
1019000708	Horsetooth Reservoir-Cache la Poudre River	Livestock	Cattle	5290	1.1E+14	26
1019000708	Horsetooth Reservoir-Cache la Poudre River	Livestock	Horses	800	2.1E+13	5
1019000708	Horsetooth Reservoir-Cache la Poudre River	Livestock	Poultry	995	5.8E+10	0
1019000708	Horsetooth Reservoir-Cache la Poudre River	Livestock	Sheep	315	2.4E+12	1

Table 5-7. Estimated Number of Animals, *E. coli* Produced, and Percent of *E. coli* Produced in Each HUC10 (Page 4 of 4)

HUC10	Description	Category	Subcategory	Count	Total *E. coli* Produced (cfu/day)	Total *E. coli* Produced (%)
1019000708	Horsetooth Reservoir-Cache la Poudre River	Livestock	Goats	7	1.2E+11	0
1019000708	Horsetooth Reservoir-Cache la Poudre River	Livestock	Hogs	49	2.7E+11	0
1019000709	Boxelder Creek	Humans	OWTS	9870	1.2E+13	4
1019000709	Boxelder Creek	Humans	WWTP	9099	1.1E+13	3
1019000709	Boxelder Creek	Pets	Dogs	3324	1.0E+13	3
1019000709	Boxelder Creek	Pets	Cats	3668	1.2E+13	4
1019000709	Boxelder Creek	Livestock	Cattle	11152	2.3E+14	71
1019000709	Boxelder Creek	Livestock	Horses	1521	4.0E+13	12
1019000709	Boxelder Creek	Livestock	Poultry	8566	5.0E+11	0
1019000709	Boxelder Creek	Livestock	Sheep	1189	9.0E+12	3
1019000709	Boxelder Creek	Livestock	Goats	8	1.4E+11	0
1019000709	Boxelder Creek	Livestock	Hogs	101	5.7E+11	0
1019000710	City of Greeley-Cache la Poudre River	Humans	OWTS	29664	3.7E+13	3
1019000710	City of Greeley-Cache la Poudre River	Humans	WWTP	239214	3.0E+14	27
1019000710	City of Greeley-Cache la Poudre River	Pets	Dogs	47115	1.5E+14	13
1019000710	City of Greeley-Cache la Poudre River	Pets	Cats	51988	1.6E+14	14
1019000710	City of Greeley-Cache la Poudre River	Livestock	Cattle	19287	4.0E+14	35
1019000710	City of Greeley-Cache la Poudre River	Livestock	Horses	615	1.6E+13	1
1019000710	City of Greeley-Cache la Poudre River	Livestock	Poultry	114513	6.7E+12	1
1019000710	City of Greeley-Cache la Poudre River	Livestock	Sheep	7236	5.5E+13	5
1019000710	City of Greeley-Cache la Poudre River	Livestock	Goats	9	1.6E+11	0
1019000710	City of Greeley-Cache la Poudre River	Livestock	Hogs	186	1.0E+12	0

5.3 HEAVY METALS

Heavy metal sources are typically from abandoned mines, runoff from developed areas, and contributions from soils. Heavy metals that can be sourced from irrigation on Pierre Shale areas (selenium and arsenic) would also benefit from changing irrigation practices. Flood irrigation typically results in substantial irrigation return flows, which can be high in selenium or arsenic when soils in the irrigated fields have high selenium or arsenic content. The conversion to more modern center-pivot and side-roll sprinkler systems would help decrease the volume of selenium or arsenic-rich return flows entering waterbodies [Hawley and Rodriguez-Jeangros, 2021].

Heavy metals are also not addressed with PLET. Larimer and Weld Counties have a rich mining history dating back to the mid-1800s. Commodities consisting of beryllium, coal, copper, gold, iron, lead, manganese, molybdenum, rare earth elements, silica, silver, tungsten, uranium, vanadium, and zinc were mined [The Diggings, 2024].

Sources of some heavy metals, according to a publication within Heliyon on ScienceDirect [Briffa et al., 2020] and the *Big Thompson State of the Watershed 2021 Final Report* [Hawley and Rodriguez-Jeangros, 2021], also include:

- Silver – mining, metal/jewelry production, and manufacturing processes
- Selenium – animal feed/supplement production, manufacturing processes, fossil fuel combustion, and irrigation return flows in areas with Pierre Shale
- Arsenic – pressure-treated wood, glass/pesticide production, doping, pyrotechnics, and Pierre Shale
- Iron – mining, manufacturing processes, and metal/supplement/food production
- Manganese – alloy manufacturing processes, metal/fertilizer/firework/pesticide/cosmetic production

The CDPHE Water Quality Control Commission has designated several streams within both counties as impaired (see Clean Water Act (CWA) Section 303(d) list and 5 CCR 1002-93) for these elements (Table 4-1), suggesting that mined lands or AMLs are a potential source of NPS pollution. Several federal and state agencies have mapped and cataloged abandoned mines within Colorado and quantified the AMLs in Larimer and Weld Counties. To determine areas most likely polluted by AMLs, known AML locations were summarized per HUC10. Although not all AMLs have been discovered and mapped, an assumption was made that the more points in a HUC10, the more likely that HUC10 was polluted by AMLs. Table 5-8 lists the number of AMLs for each HUC10 [Graves, 2024].

Table 5-8. Number of Identified Abandoned Mine Lands per HUC10

HUC10	Description	Count
1019000701	South Fork Cache la Poudre River	0
1019000702	Headwaters Cache la Poudre River	35
1019000703	Gordon Creek-Cache la Poudre River	23
1019000704	Dale Creek	0
1019000705	Upper North Fork Cache la Poudre River	1
1019000706	Lone Pine Creek	5
1019000707	Rabbit Creek-North Fork Cache la Poudre River	6
1019000708	Horsetooth Reservoir-Cache la Poudre River	4
1019000709	Boxelder Creek	6
1019000710	City of Greeley-Cache la Poudre River	26

In *Colorado's Nonpoint Source Program: 2022 Annual Report* [Moore, 2022], the recommended BMPs associated with pollution from AMLs are hydrologic controls (diversion ditches, mine tailings removal, erosion and sediment control, and revegetation) and passive treatments (aerobic wetlands, anaerobic wetlands, and aeration and settling ponds).

In the Cache la Poudre project area, the detailed geology layers mapping Pierre Shale did not intersect HUC10s 1019000701, 1019000702, 1019000703, 1019000704, 1019000705, 1019000706, or 1019000707. The geology layers [Brandt and Colgan, 2023; Workman et al., 2018] include the majority of Pierre Shale in Larimer and Weld Counties. Of the watersheds where layers are available, most of the Pierre Shale is not irrigated. The upstream HUC10s in the project area are arsenic impaired, but the one with Pierre Shale (irrigated and not, 1019000708) is only a mainstem impairment. Two of the watersheds are selenium impaired (1019000708 and 1019000709) with Pierre Shale present. Non-irrigated Pierre Shale is likely to also be contributing to the impairments, and other unknown sources are likely present in the upper arsenic impaired reaches. Table 5-9 summarizes the acres of irrigation, irrigation type, and Pierre Shale (where information was available) throughout the project area.

Table 5-9. Acres of Irrigation and Pierre Shale

HUC10	Irrigated, Not Pierre Shale		Irrigated, Pierre Shale		Not Irrigated, Pierre Shale (acres)
	Flood (acres)	Sprinkler (acres)	Flood (acres)	Sprinkler (acres)	
1019000704	205	0	N/A	N/A	N/A
1019000705	89	0	N/A	N/A	N/A
1019000706	641	0	N/A	N/A	N/A
1019000707	438	816	N/A	N/A	N/A
1019000708	5,055	3,399	632	488	14,359
1019000709	8,192	10,772	416	643	13,696
1019000710	34,140	30,825	1,385	560	14,418

6.0 PRIORITY AREAS FOR IMPLEMENTATION

Priority areas are locations that significantly contribute to the water quality parameters identified as pollutants of concern. The following sources were used to identify priority areas for BMP implementation:

- PLET model (for nutrients and sediment)
- production per HUC10 assessment (for *E. coli*)
- AML density assessment (for heavy metals)

Point source permittees should compare the cost options of upstream NPS BMPs to the cost of mechanical treatment. Such collaborations and coordinated efforts may improve economic feasibility for improving water quality regionally.

6.1 NUTRIENTS AND SEDIMENT

The PLET model indicates that throughout the entire Cache la Poudre River HUC8 within Larimer and Weld Counties, the primary source of nutrients and sediment is cropland; however, cropland only makes up approximately 12 percent of the total area. Figures 6-1, 6-2, and 6-3 show the total daily loads per HUC10 of nitrogen, phosphorus, and TSS, respectively, from PLET [EPA, 2022]. Priority areas for the reduction of nutrients and sediment are HUC10s 1019000709 (Boxelder Creek) and 1019000710 (City of Greeley-Cache la Poudre River) on cropland. The source figures from PLET only represent areas that are not MS4s. Data trends from CPRW [2020] show similar trends for nutrients and sediment as PLET results, with nutrients and sediment increasing in the eastern watersheds. No reaches shown in Table 4-1 are impaired for total nitrogen or total phosphorus, and the one sediment impairment is not related to nonpoint sources; therefore, all should be protected so that they do not become impaired over time.

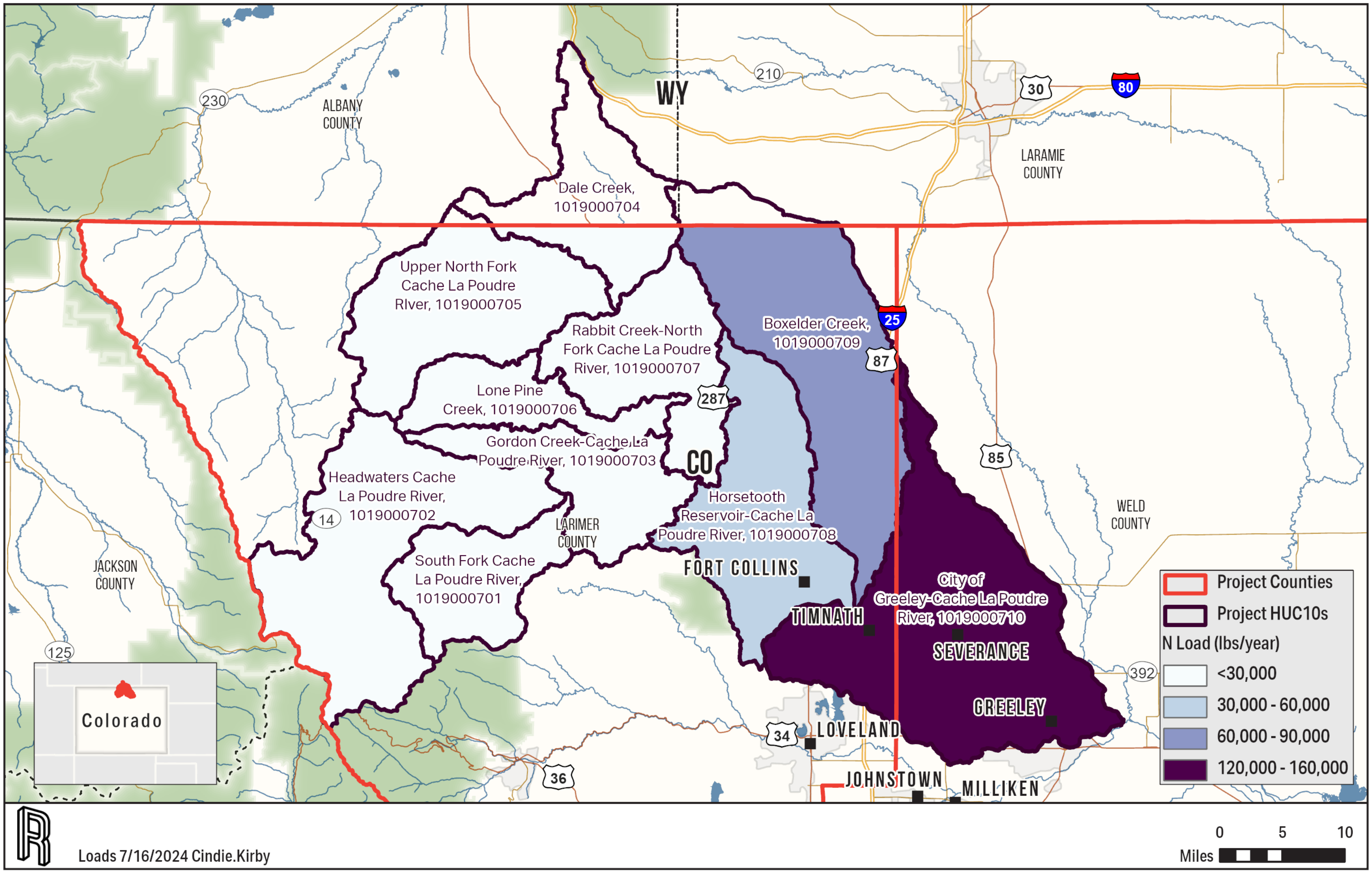


Figure 6-1. Nitrogen Contributions per HUC10.

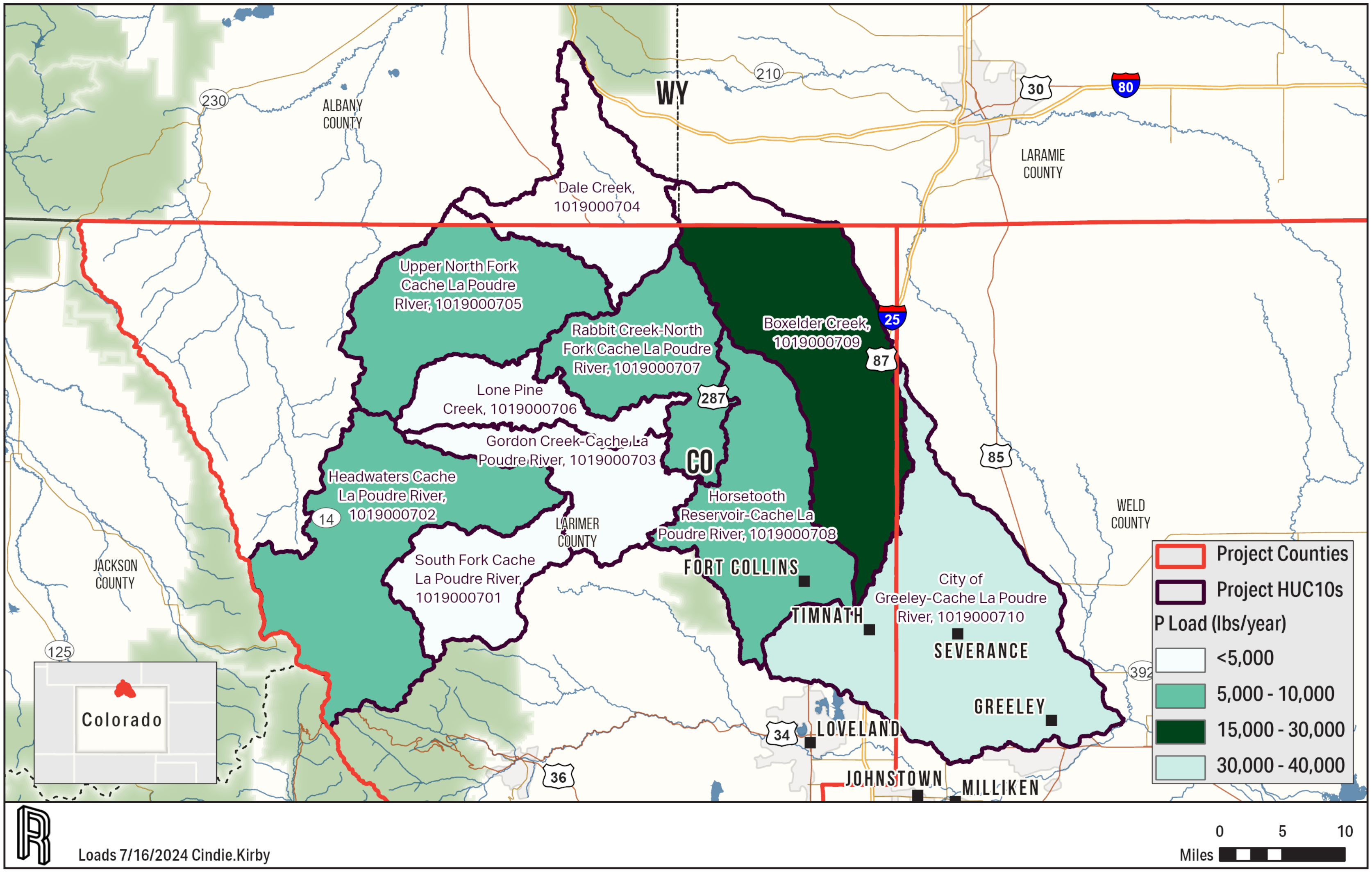


Figure 6-2. Phosphorus Contributions per HUC10.

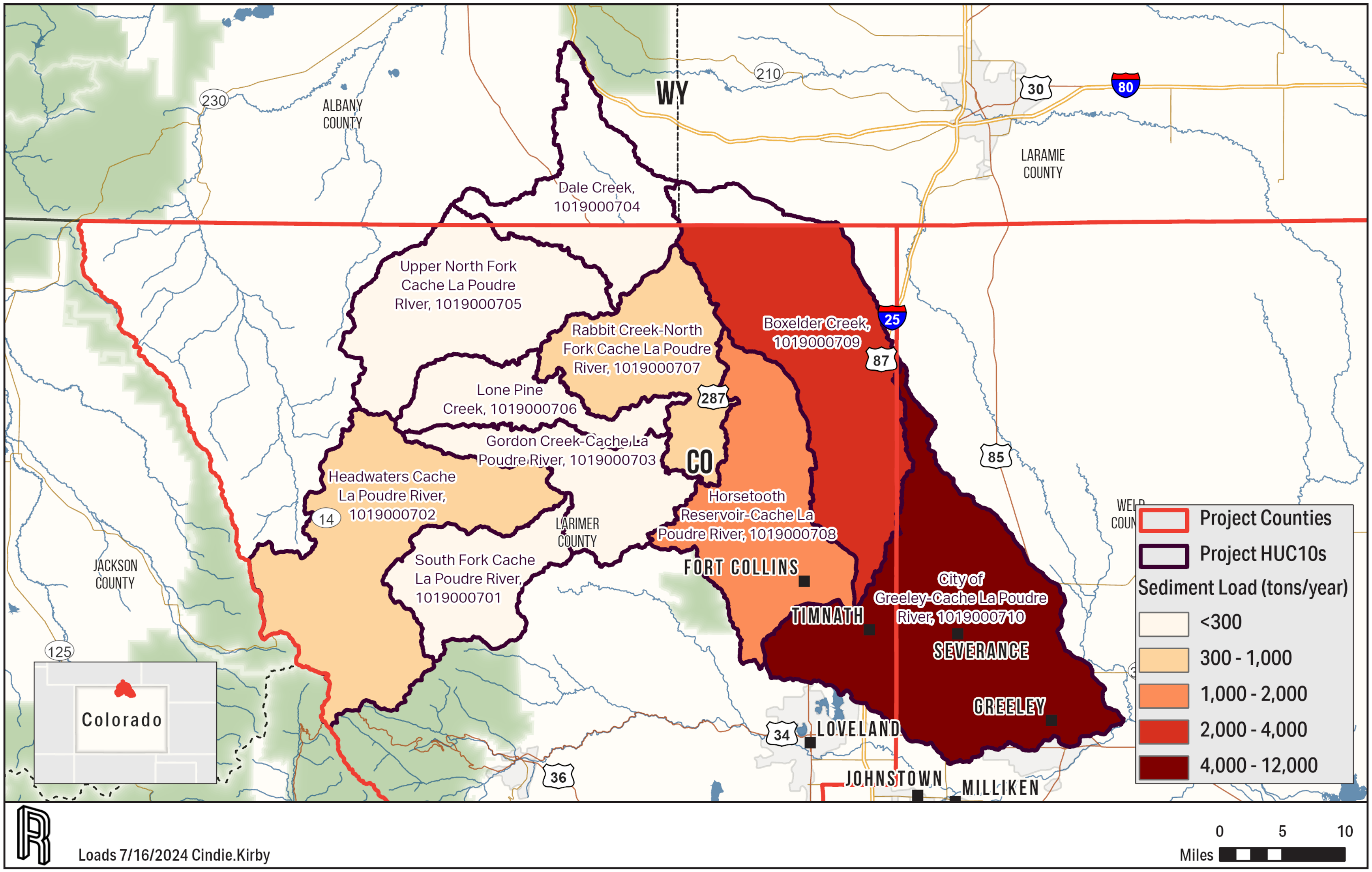


Figure 6-3. Sediment Contributions per HUC10.

6.2 E. COLI

The bacteria production assessment revealed that, overall, throughout the Cache la Poudre River HUC8, cattle are the primary producers of bacteria. Figure 6-4 provides the total production of bacteria per HUC10 based on the assessment within GIS. Priority areas for reduction of *E. coli* are HUC10s 1019000708 (Horsetooth Reservoir-Cache la Poudre River), 1019000709 (Boxelder Creek), and 1019000710 (City of Greeley-Cache la Poudre River) because have the highest production rates overall and primarily from cattle; therefore, practices related to cattle exclusion from streams, such as fencing, off-stream watering, and seasonal riparian area management, should be a priority in these watersheds. The *E. coli*-impaired waterbodies align well with the bacteria production analysis and exist in HUC10s 1019000708 (Horsetooth Reservoir-Cache la Poudre River), 1019000709 (Boxelder Creek), and 1019000710 (City of Greeley-Cache la Poudre River). The *E. coli*-impaired waterbodies shown in Table 4-1 are located in the priority areas.

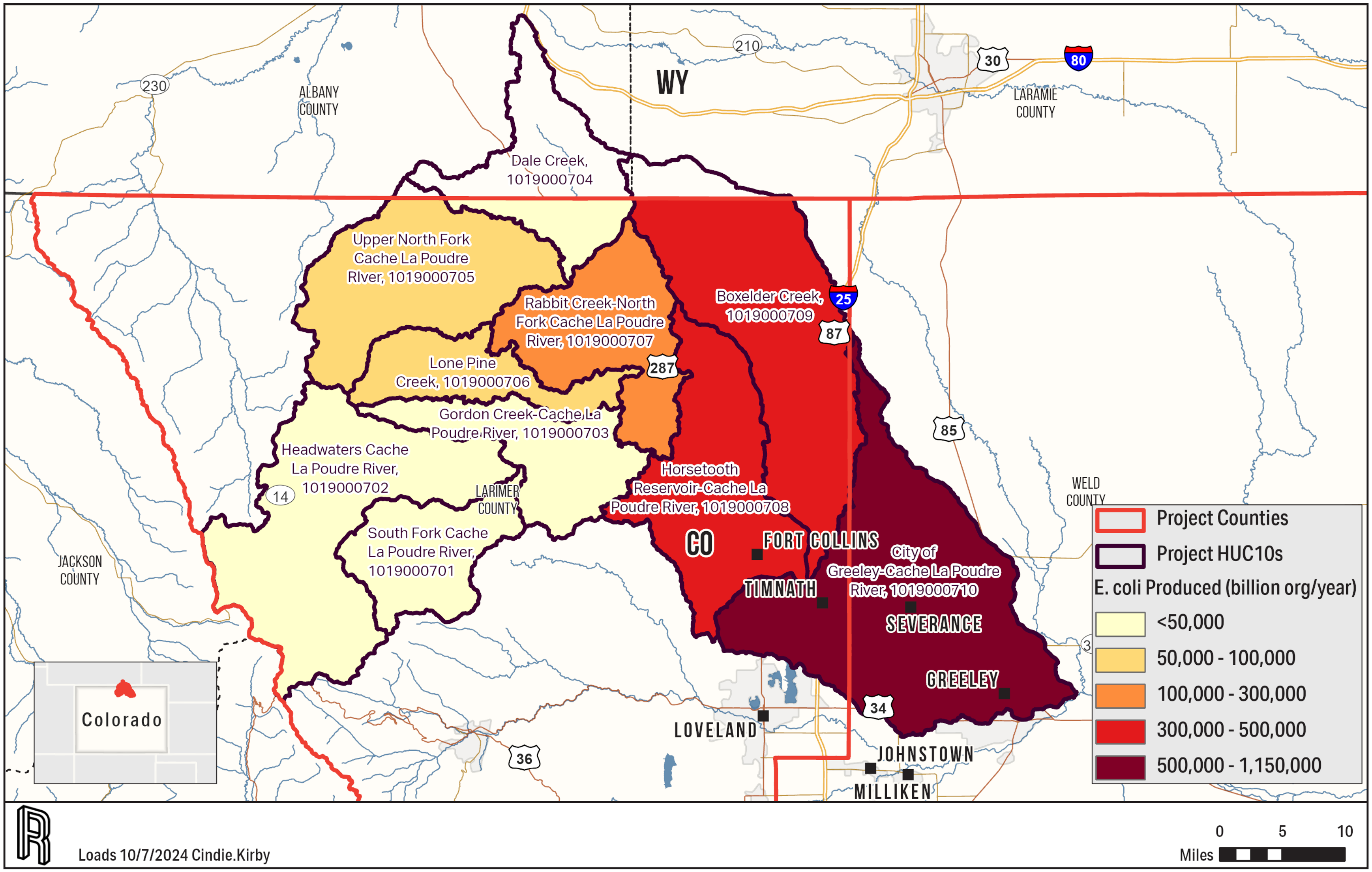


Figure 6-4. Bacteria Produced per HUC10.

6.3 HEAVY METALS

The AML density identified HUC10s 1019000702 (Headwaters Cache la Poudre River) and 1019000703 (Gordon Creek-Cache la Poudre River) as the HUC10 watersheds with the highest densities of AMLs; therefore, they should be the primary targets (priority areas) in continuing AML identification and practice implementation to reduce heavy metals in waters. Waterbodies impaired with heavy metals for aquatic life constituents (dissolved silver and selenium, and total arsenic) align well with the AML density analysis and primarily exist in HUC10 watersheds with identified AMLs. Similarly, waterbodies impaired with heavy metals for water supply constituents (dissolved iron and manganese, and total arsenic) occur in almost all HUC10 watersheds, whether or not AMLs were identified. The density of AMLs per square mile is illustrated in Figure 6-5 [Graves, 2024]. Priority watersheds for heavy metal-reducing BMPs should be the areas with the highest density of AMLs. Additionally, where selenium- and arsenic-impaired waters exist with high levels of irrigated lands on Pierre Shale, more efficient irrigation practices should be a priority, especially in the areas draining to the arsenic/selenium-impaired waters shown in Table 4-1.

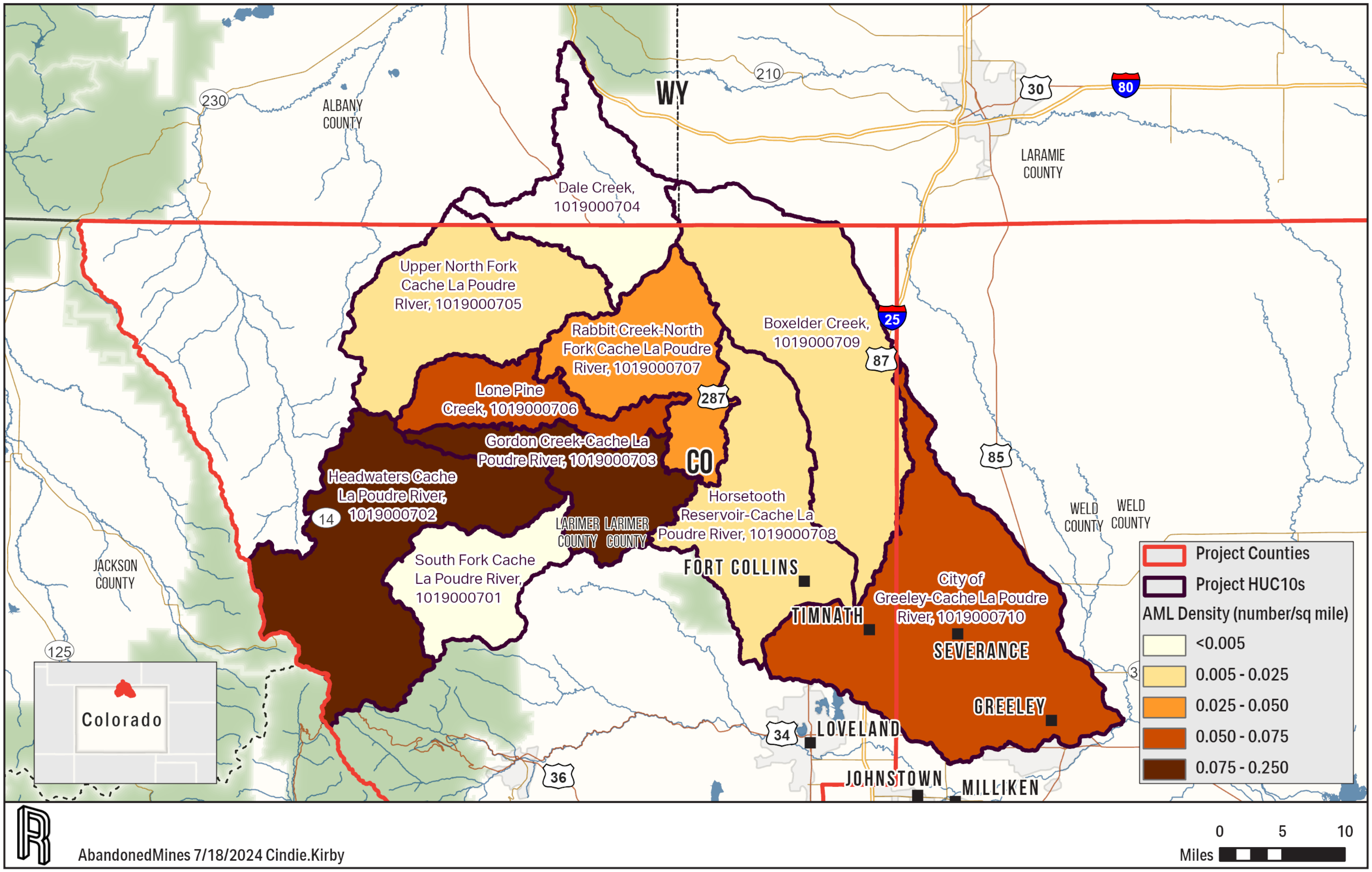


Figure 6-5. Density of Abandoned Mine Lands for Each HUC10.

7.0 BEST MANAGEMENT PRACTICES LOAD REDUCTIONS

Numerous resources exist in Colorado and nationally that provide information on BMPs. Some give data about implementation, and others inform on expected load reductions. Understanding that most BMPs require maintenance over time to remain effective is important. Some BMPs also need individuals to operate them for effectiveness. The Community-enabled Lifecycle Analysis of Stormwater Infrastructure Costs (CLASIC) tool is available on the CLASIC website and provides more information about life cycles of some stormwater BMPs. The following websites were used to summarize the overall BMP options:

- Colorado Department of Agriculture BMPs
- Colorado Water Conservation Board Floodplain Stormwater and Criteria Manual
- Colorado Water Conservation Board BMPs
- Colorado Waterwise Guidebook of Best Practices for Municipal Water Conservation in Colorado
- Colorado Ag Water Quality BMPs for Colorado
- Colorado Forestry Best Management Practices 2018 Field Monitoring Report
- Colorado Wetland Information Center Wetland BMPs
- Colorado Stormwater Center
- Colorado Department of Transportation Erosion Control and Stormwater Quality Guide
- Upper South Platte BMPs for Protecting Source Water Quality
- International Stormwater BMP Database
- One Water Solutions Institute
- EPA Menu of Stormwater BMPs
- USDA Stream Restoration Manual
- Natural Resources Conservation Service Conservation Practice Standards
- USDA Colorado Field Office Technical Guide
- Pollution Load Estimator Tool

7.1 NUTRIENTS AND SEDIMENT

For this project, nutrient and sediment BMPs available in PLET were prioritized using multiple metrics, including stakeholder input and BMP effectiveness. The BMP reduction factors for PLET BMPs are listed in Tables 7-1 through 7-5 for cropland, pastureland, feedlots, forest, and urban lands. The average of the nitrogen, phosphorus, and sediment reduction factors was the first metric used for prioritization. The average survey score based on Survey #2 results was the second metric. The final score, the reduction survey, was the product of the two metrics. The following practices were chosen and run in PLET based on reduction survey scores: the top two cropland, top two pasture, top feedlot, top two forest, and top three urban. These priority PLET practices for each respective land use are in bold under the column headings of Tables 7-1 through 7-5. The priority PLET practices were run on 25 percent of the modeled land cover they were developed for (i.e. cropland, pasture, feedlot, forest, urban). Associated reductions for each PLET practice run are provided in Table 7-6. Several of the practice reduction factors suggest that reducing sediment loading would simultaneously reduce nutrient loading. PLET BMP descriptions and the reduction fractions can be found in the "Best Management Practice Definition Document for Pollution Load Estimation Tool" [EPA, 2023].

Table 7-1. PLET Cropland Best Management Practices and Average Reduction Metric

Practice	Nitrogen Reduction (Fraction)	Phosphorus Reduction (Fraction)	Sediment Reduction (Fraction)	Average Reduction (Fraction)[(a)]	Average Survey Score[(b)]	Reduction Survey Score[(c)]
Streambank Stabilization and Fencing	**0.75**	**0.75**	**0.75**	**0.75**	**2.0**	**1.5**
Buffer - Grass (35 feet wide)	**0.34**	**0.44**	**0.53**	**0.44**	**3.0**	**1.3**
Contour Farming	0.34	0.46	0.41	0.40	2.0	0.8
Terrace	0.27	0.31	0.41	0.33	2.0	0.7
Controlled Drainage	0.39	0.35	0	0.25	2.5	0.6
Conservation tillage 1 (30-59% residue)	0.07	0.36	0.46	0.30	2.0	0.6
Conservation Tillage 2 (equal or more than 30% residue)	0.13	0.69	0.79	0.54	1.0	0.5
Nutrient Management 2 (determined rate plus additional considerations)	0.22	0.56	0	0.26	2.0	0.5
Buffer – Forest (100 feet wide)	0.49	0.47	0.6	0.52	1.0	0.5
Nutrient Management 1 (determined rate)	0.15	0.45	0	0.20	2.0	0.4
Bioreactor	0.45	0	0	0.15	1.0	0.2
Two-Stage Ditch	0.12	0.28	0	0.13	1.0	0.1
Cover Crop 1 (group A commodity; high till only for sediment)	0.0078	0	0	0.00	0.0	0.0
Cover Crop 2 (group A traditional normal planting time; high till only for total phosphorus and sediment)	0.2	0.07	0.1	0.12	0.0	0.0
Cover Crop 3 (group A traditional early planting time) (high till only for total phosphorus and sediment)	0.2	0.15	0.2	0.18	0.0	0.0

(a) Average Reduction is the product of the nitrogen, phosphorus, and sediment reduction

(b) Average Survey Score is the average of the survey prioritization from Survey #2

(c) The Survey Reduction Score is the product of the average reduction and the average survey score

Table 7-2. PLET Pasture Best Management Practices and Average Reduction Metric

Practice	Nitrogen Reduction (Fraction)	Phosphorus Reduction (Fraction)	Sediment Reduction (Fraction)	Average Reduction[(a)] (Fraction)	Average Survey Score[(b)]	Reduction Survey Score[(c)]
Streambank Stabilization and Fencing	**0.75**	**0.75**	**0.75**	**0.75**	**3.0**	**2.3**
Buffer – Grass (minimum 35 feet wide)	**0.87**	**0.89**	**0.65**	**0.80**	**2.8**	**2.2**
Livestock Exclusion Fencing	0.2	0.43	0.64	0.42	3.4	1.4
Buffer – Forest (minimum 35 feet wide)	0.45	0.4	0.53	0.46	2.2	1.0
Streambank Protection Without Fencing	0.15	0.22	0.58	0.32	2.8	0.9
Critical Area Planting	0.18	0.2	0.42	0.27	3.3	0.9
Grazing Land Management (rotational grazing with fenced areas)	0.43	0.26	0	0.23	3.8	0.9
Heavy Use Area Protection	0.18	0.19	0.33	0.23	3.5	0.8
Prescribed Grazing	0.41	0.23	0.33	0.32	2.5	0.8
Multiple Practices	0.25	0.2	0.22	0.22	3.6	0.8
Winter Feeding Facility	0.35	0.4	0.4	0.38	2.0	0.8
Use Exclusion	0.43	0.08	0.51	0.34	1.7	0.6
30-meter Buffer With Optimal Grazing	0.16	0.65	0	0.27	1.5	0.4
Alternative Water Supply	0.18	0.13	0.2	0.17	2.0	0.3
Pasture and Hayland Planting (also called Forage Planting)	0.18	0.15	0	0.11	3.0	0.3
Litter Storage and Management	0.14	0.14	0	0.09	3.4	0.3

(a) Average Reduction is the product of the nitrogen, phosphorus, and sediment reduction
(b) Average Survey Score is the average of the survey prioritization from Survey #2
(c) The Survey Reduction Score is the product of the average reduction and the average survey score

Table 7-3. PLET Feedlot Best Management Practices and Average Reduction Metric

Practice	Nitrogen Reduction (Fraction)	Phosphorus Reduction (Fraction)	Sediment Reduction (Fraction)	Average Reduction[(a)] (Fraction)	Average Survey Score[(b)]	Reduction Survey Score[(c)]
Waste Management System	**0.8**	**0.9**	**0**	**0.57**	**3.6**	**2.0**
Waste Storage Facility	0.65	0.6	0	0.42	3.6	1.5
Diversion	0.45	0.7	0	0.38	3.5	1.3
Terrace	0.55	0.85	0	0.47	2.8	1.3
Filter Strip	0	0.85	0	0.28	4.0	1.1
Runoff Management System	0	0.83	0	0.28	3.3	0.9
Solids Separation Basin With Infiltration Bed	0	0.8	0	0.27	3.0	0.8
Solids Separation Basin	0.35	0.31	0	0.22	3.0	0.7

(a) Average Reduction is the product of the nitrogen, phosphorus, and sediment reduction
(b) Average Survey Score is the average of the survey prioritization from Survey #2
(c) The Survey Reduction Score is the product of the average reduction and the average survey score

Table 7-4. PLET Forest Best Management Practices and Average Reduction Metric

Practice	Nitrogen Reduction (Fraction)	Phosphorus Reduction (Fraction)	Sediment Reduction (Fraction)	Average Reduction[a] (Fraction)	Average Survey Score[b]	Reduction Survey Score[c]
Site Preparation/Straw/Crimp Seed/Net	0	0	0.93	0.31	3.7	1.1
Site Preparation/Straw/Crimp Seed/Fertilizer/Transplants	0	0	0.95	0.32	3.0	1.0
Road Grass and Legume Seeding	0	0	0.71	0.24	3.7	0.9
Site Preparation/Straw/ Polymer/Seed/Fertilizer/ Transplants	0	0	0.86	0.29	3.0	0.9
Site Preparation/Hydro Mulch/ Seed/Fertilizer	0	0	0.71	0.24	3.5	0.8
Site Preparation/Steep Slope Seeder/ Transplants	0	0	0.81	0.27	3.0	0.8
Site Preparation/Straw/ Net/Seed/Fertilizer/Transplants	0	0	0.83	0.28	2.8	0.8
Site Preparation/Hydro Mulch/ Seed/Fertilizer/Transplants	0	0	0.69	0.23	3.2	0.7
Road Hydro Mulch	0	0	0.41	0.14	4.3	0.6
Road Tree Planting	0	0	0.5	0.17	3.4	0.6
Road Straw Mulch	0	0	0.41	0.14	4.0	0.5
Road Dry Seeding	0	0	0.41	0.14	3.6	0.5

(a) Average Reduction is the product of the nitrogen, phosphorus, and sediment reduction

(b) Average Survey Score is the average of the survey prioritization from Survey #2

(c) The Survey Reduction Score is the product of the average reduction and the average survey score

Table 7-5. PLET Urban Best Management Practices and Average Reduction Metric (Page 1 of 2)

Practice	Nitrogen Reduction (Fraction)	Phosphorus Reduction (Fraction)	Sediment Reduction (Fraction)	Average Reduction[a] (Fraction)	Average Survey Score[b]	Reduction Survey Score[c]
Extended Wet Detention	0.55	0.69	0.86	0.70	3.8	2.7
Infiltration Basin	0.6	0.65	0.75	0.67	3.3	2.2
Concrete Grid Pavement	0.9	0.9	0.9	0.90	2.3	2.1
Low Impact Development - Infiltration Swale	0.5	0.65	0.9	0.68	2.9	2.0
Porous Pavement	0.85	0.65	0.9	0.80	2.2	1.8
Bioretention Facility	0.63	0.8	0	0.48	3.6	1.7
Infiltration Trench	0.55	0.6	0.75	0.63	2.6	1.6
Infiltration Devices	0	0.83	0.94	0.59	2.7	1.6
Vegetated Filter Strips	0.4	0.45	0.73	0.53	2.9	1.5
Settling Basin	0	0.52	0.82	0.45	3.3	1.5
Low Impact Development - Infiltration Trench	0.5	0.5	0.9	0.63	2.3	1.4
Dry Detention	0.3	0.26	0.58	0.38	3.7	1.4
Wetland Detention	0.2	0.44	0.78	0.47	2.9	1.4
Sand Filter/Infiltration Basin	0.35	0.5	0.8	0.55	2.5	1.4
Low Impact Development - Filter/Buffer Strip	0.3	0.3	0.6	0.40	3.3	1.3
Low Impact Development - Bioretention	0.43	0.81	0	0.41	3.1	1.3
Low Impact Development - Dry Well	0.5	0.5	0.9	0.63	1.9	1.2
Grass Swales	0.1	0.25	0.65	0.33	3.5	1.2
Alum Treatment	0.6	0.9	0.95	0.82	1.4	1.1
Wet Pond	0.35	0.45	0.6	0.47	2.3	1.1
Sand Filters	0	0.38	0.83	0.40	2.6	1.0
Low Impact Development - Wet Swale	0.4	0.2	0.8	0.47	2.1	1.0
Water Quality Inlet With Sand Filter	0.35	0	0.8	0.38	2.5	1.0
Low Impact Development - Vegetated Swale	0.08	0.18	0.48	0.25	3.3	0.8

Table 7-5. PLET Urban Best Management Practices and Average Reduction Metric (Page 2 of 2)

Practice	Nitrogen Reduction (Fraction)	Phosphorus Reduction (Fraction)	Sediment Reduction (Fraction)	Average Reduction[a] (Fraction)	Average Survey Score[b]	Reduction Survey Score[c]
Filter Strip – Agricultural	0.53	0.61	0.65	0.60	1.3	0.8
Water Quality Inlets	0.2	0.09	0.37	0.22	3.3	0.7
Oil/Grit Separator	0.05	0.05	0.15	0.08	3.7	0.3
Weekly Street Sweeping	0	0.06	0.16	0.07	2.9	0.2

(a) Average Reduction is the product of the nitrogen, phosphorus, and sediment reduction

(b) Average Survey Score is the average of the survey prioritization from Survey #2

(c) The Survey Reduction Score is the product of the average reduction and the average survey score

Table 7-6. Reductions From Priority PLET Best Management Practices Run on 25 Percent of Each Applicable Land Cover

Land Use	Percent of Total Area	Practice	Nitrogen Load (lb/year)	Percent Nitrogen Reduction	Phosphorus Load (lb/year)	Percent Phosphorus Reduction	Sediment Load (tons/year)	Percent Sediment Reduction
All	N/A	Base Load (no BMPs)	334,904	NA	90,435	NA	17,404	NA
Cropland	12	Stream Stabilization and Fencing	307,157	8.3	83,443	7.7	14,893	14.4
Cropland	12	Buffer - Grass (35 feet wide)	320,290	4.4	85,962	5.0	15,629	10.2
Pasture	1	Stream Stabilization and Fencing	332,197	0.8	90,171	0.3	17,343	0.4
Pasture	1	Livestock Exclusion Fencing	334,067	0.3	90,263	0.2	17,351	0.3
Feedlot	<1	Waste Management System	324,550	3.1	88,105	2.6	17,404	0.0
Forest	55	Site Prep/Straw/ Crimp Seed/Net	334,239	0.2	90,179	0.3	17,196	1.2
Forest	66	Site Prep/Straw/ Crimp Seed/Fertilizer/ Transplants	334,225	0.2	90,173	0.3	17,191	1.2
Urban	4	Extended Wet Detention	331,065	1.2	89,677	0.8	17,167	1.4
Urban	4	Infiltration Basin	330,708	1.3	89,719	0.8	17,197	1.2
Urban	4	Concrete Grid Pavement	328,623	1.9	89,446	1.1	17,156	1.4

lb/year = pounds per year

Numerous BMPs that reduce nutrient and sediment NPS loads exist from other sources not included in PLET. Nutrient and sediment load reductions from BMPs are ranked in the NRCS Conservation Practice Physical Effects (CPPE) [NRCS, 2024b] as substantial, moderate to substantial, moderate, slight to moderate, and slight. Similarly, reductions expected from urban practices are provided in the International Stormwater BMP Database (BMPDB) [The Water Research Foundation, 2024]. Tables 7-7 and 7-8 list the most effective CPPE practices (i.e., substantial, moderate to substantial, and moderate reductions) and urban practices for sediment reduction. Table 7-9 shows the most effective CPPE practices (i.e., substantial, moderate to substantial, and moderate reductions) for nutrient reduction, and Tables 7-10 and 7-11 provide the urban practices for nitrogen and phosphorus reduction, respectively [NRCS, 2024b]. Irrigation practices are important in the project area for the reduction of nutrients and sediment but were not available in PLET. The NRCS Irrigation Water Management practice code Number 449 has slight to moderate improvement (less than every other practice listed in CPPE practices tables) for sediment and nutrients. However, the NRCS Irrigation Water Management practice code Number 449 has been added to these tables because of its high usage in the project area. Other practices with slight to moderate improvement should not be discouraged, even though they are not included in the tables in this section.

Table 7-7. Most Effective Sediment to Surface Water Reducing Agricultural Best Management Practices From the Colorado Natural Resources Conservation Service Conservation Practice Physical Effects (Page 1 of 2)

Practice	Practice Code	Unit	Effect	Rationale
Constructed Wetland	656	Acre	Substantial Improvement	The system traps and holds suspended materials from entering surface waters.
Filter Strip	393	Acre	Substantial Improvement	Vegetation protects the soil surface and traps sediment, nutrients, and other materials.
Grassed Waterway	412	Acre	Substantial Improvement	Erosion is controlled, vegetation traps sediment, and runoff is delivered at a safe velocity.
Lined Waterway or Outlet	468	Feet	Substantial Improvement	Erosion is controlled, vegetation traps sediment, and runoff is delivered at a safe velocity.
Riparian Forest Buffer	391	Acre	Substantial Improvement	Vegetation protects the soil surface and traps sediment, nutrients, and other materials.
Anionic Polyacrylamide Erosion Control	450	Acre	Moderate to Substantial Improvement	The action reduces erosion and sediment load.
Conservation Cover	327	Acre	Moderate to Substantial Improvement	Less erosion and runoff reduce sediment.
Critical Area Planting	342	Acre	Moderate to Substantial Improvement	Vegetation reduces erosion and sediment delivery.
Forest Farming	379	Acre	Moderate to Substantial Improvement	Varied canopy layers and surface cover and organic matter management reduce sediment-laden runoff from reaching surface water conveyances.
Grazing Land Mechanical Treatment	548	Acre	Moderate to Substantial Improvement	Improved hydrologic indicators increase infiltration and decrease runoff.
Land Reclamation, Abandoned Mined Land	543	Acre	Moderate to Substantial Improvement	Erosion control and revegetation reduces concerns about sediments.
Land Reclamation, Currently Mined Land	544	Acre	Moderate to Substantial Improvement	Erosion control and revegetation reduces concerns about sediments.
Land Reclamation, Landslide Treatment	453	N/A	Moderate to Substantial Improvement	Erosion control and increased cover reduces runoff and sediment.
Residue and Tillage Management, No Till	329	Acre	Moderate to Substantial Improvement	Less erosion and runoff reduce the transport of sediment.
Riparian Herbaceous Cover	390	Acre	Moderate to Substantial Improvement	Vegetation protects the soil surface and traps sediment, nutrients, and other materials.
Sediment Basin	350	N/A	Moderate to Substantial Improvement	The basin retains sediment, decreasing runoff turbidity.
Stormwater Runoff Control	570	N/A	Moderate to Substantial Improvement	Controlling erosion and runoff reduces off-site sediment.
Vegetative Barrier	601	Feet	Moderate to Substantial Improvement	Vegetation slows runoff and filters sediment.
Water and Sediment Control Basin	638	N/A	Moderate to Substantial Improvement	The basin retains sediment and minimizes turbidity.
Access Control	472	Acre	Moderate Improvement	Excluding animals, people, and vehicles influences the vigor and health of vegetation and soil conditions, reducing sediment supply to surface waters when applied with other management practices.
Alley Cropping	311	Acre	Moderate Improvement	Vegetation inhibits sediment-laden water to allow it to drop sediment load.
Conservation Crop Rotation	328	Acre	Moderate Improvement	Depending on crop rotation and biomass produced, crop rotation reduces erosion and runoff, which reduces transport of sediment.
Contour Buffer Strips	332	Acre	Moderate Improvement	Contour buffer strips reduce sheet and rill erosion and slow the velocity of runoff, thereby reducing the transport of sediment to surface water.

Table 7-7. Most Effective Sediment to Surface Water Reducing Agricultural Best Management Practices From the Colorado Natural Resources Conservation Service Conservation Practice Physical Effects (Page 2 of 2)

Practice	Practice Code	Unit	Effect	Rationale
Contour Orchard and Other Perennial Crops	331	Acre	Moderate Improvement	Contouring reduces sheet and rill erosion and slows the velocity of runoff, thereby reducing the transport of sediment to surface water.
Field Border	386	Feet	Moderate Improvement	Vegetation protects the soil surface and traps sediment.
Residue and Tillage Management, Reduced Till	345	Acre	Moderate Improvement	Less erosion and runoff reduce the transport of sediment.
Road/Trail/Landing Closure and Treatment	654	Feet	Moderate Improvement	Vegetation and other treatments reduce erosion and sediment delivery.
Silvopasture	381	Acre	Moderate Improvement	On sites that previously lacked permanent vegetation, establishing a combination of trees or shrubs and compatible forages reduces the erosive force of water and reduces sedimentation.
Stripcropping	585	Acre	Moderate Improvement	Stripcropping reduces erosion and slows water and wind velocities, increasing infiltration.
Surface Roughening	609	Acre	Moderate Improvement	The formation of clods reduces wind-borne sediment.
Tree/Shrub Establishment	612	Acre	Moderate Improvement	Vegetation provides cover, reduces wind velocities, and increases infiltration.
Wetland Wildlife Habitat Management	644	Acre	Moderate Improvement	Improved vegetative cover will reduce of runoff and sedimentation.
Irrigation Water Management	449	Acre	Slight to Moderate Improvement	Water is applied at rates that minimize soil erosion.

Table 7-8. Most Effective Sediment (Greater Than 10 Percent) Reducing Urban Best Management Practices From the International Best Management Practice Database

BMP Category	Concentration In (mg/L)	Concentration Out (mg/L)	Reduction (%)
High-Rate Biofiltration	30.8	3.8	88
Media Filter	44	7.2	84
Bioretention	44	10	77
Retention Pond	49	12	76
Porous Pavement	77	22	71
Detention Basin	65.1	22	66
Wetland Basin	35.5	14	61
High-Rate Media Filtration	44	18	59
Oil-Grit Separator	36	15.5	57
Grass Strip	48	23	52
Grass Swale	26	13.7	47
Hydrodynamic Separator	63.9	39	39

mg/L = milligrams per liter

Table 7-9. Most Effective Nutrient to Surface Water Reducing Agricultural Best Management Practices From the Colorado Natural Resources Conservation Service Conservation Practice Physical Effects (Page 1 of 2)

Practice	Practice Code	Unit	Effect	Rationale
Filter Strip	393	Acre	Substantial Improvement	Solid organics and sediment-attached nutrients are filtered out; soluble nutrients infiltrate the soil and may be taken up by plants or used by soil organisms.
Nutrient Management	590	Acre	Substantial Improvement	The right amount, source, placement, and timing (4Rs) provide nutrients when plants need them most.
Riparian Forest Buffer	391	Acre	Substantial Improvement	Plants and soil organisms in the buffer will use nutrients; the buffer will filter out suspended particles to which nutrients are attached.
Riparian Herbaceous Cover	390	Acre	Substantial Improvement	Permanent vegetation will uptake excess nutrients.
Saturated Buffer	604	Feet	Substantial Improvement	The buffer removes 60-100% of nitrogen from drain pipe discharge.
Sediment Basin	350	N/A	Substantial Improvement	The action will tend to accumulate contaminants attached to sediments, and infiltrating waters will remove soluble contaminants.
Conservation Cover	327	Acre	Moderate to Substantial Improvement	Less erosion and runoff reduce the transport of nutrients; permanent cover can take up excess nutrients and convert them to stable organic forms.
Constructed Wetland	656	Acre	Moderate to Substantial Improvement	The action traps nutrients and organics, which are broken down and used by wetland plants.
Short-Term Storage of Animal Waste and Byproducts	318	Cu. Yard	Moderate to Substantial Improvement	Short-term storage provides flexibility in rate, timing, and location of waste application, with the potential for reductions of contaminants available for transport.
Vegetated Treatment Area	635	Acre	Moderate to Substantial Improvement	Infiltration and plant uptake in the treatment area will remove contaminants from polluted runoff and wastewater.
Waste Storage Facility	313	#	Moderate to Substantial Improvement	Storage provides flexibility in rate, timing, and location of waste application, with the potential for reductions of contaminants available for transport.
Waste Treatment Lagoon	359	#	Moderate to Substantial Improvement	Storage provides flexibility in rate, timing, and location of waste application, with the potential for reductions of contaminants available for transport.
Watering Facility	614	#	Moderate to Substantial Improvement	When used in place of an instream water source, this action decreases manure deposition in the stream.
Alley Cropping	311	Acre	Moderate Improvement	Plants and soil organisms uptake nutrients.
Conservation Crop Rotation	328	Acre	Moderate Improvement	Nitrogen-demanding or deep-rooted crops can remove excess nitrogen; legumes in rotation will provide slow-release nitrogen and reduce the need for additional nitrogen.
Denitrifying Bioreactor	605	#	Moderate Improvement	Reactors remove 30 to 60% of the nitrogen load coming from a drain pipe.
Diversion	362	Feet	Moderate Improvement	The action diverts surface water away from feedlots and reduces 5-day Biological Oxygen Demand (BOD5); total phosphorous and total nitrogen load to receiving surface waters.

Table 7-9. Most Effective Nutrient to Surface Water Reducing Agricultural Best Management Practices From the Colorado Natural Resources Conservation Service Conservation Practice Physical Effects (Page 2 of 2)

Practice	Practice Code	Unit	Effect	Rationale
Grazing Land Mechanical Treatment	548	Acre	Moderate Improvement	Modifications to soil conditions will increase infiltration and reduce runoff; improved plant growth will better use nutrients, decreasing the potential for losses in runoff.
Livestock Shelter Structure	576	#	Moderate Improvement	Moving livestock away from streams and riparian areas will decrease the probability of excess manure nutrients in the water.
Silvopasture	381	Acre	Moderate Improvement	Depending on previous vegetative conditions, whether forestland or pasture, the permanent silvopasture vegetation may take up comparatively greater amounts of nutrients.
Wetland Creation	658	Acre	Moderate Improvement	Wetland systems will use dissolved nutrients and trap sediment-attached nutrients and organics.
Wetland Enhancement	659	Acre	Moderate Improvement	Wetland systems will use dissolved nutrients and trap sediment-attached nutrients and organics.
Wetland Restoration	657	Acre	Moderate Improvement	Wetland systems will use dissolved nutrients and trap sediment-attached nutrients and organics.
Irrigation Water Management	449	Acre	Slight to Moderate Improvement	Water is applied at rates that reduce the potential for erosion and detachment, and minimize nutrient transport to surface water.

Table 7-10. Most Effective Nitrogen (Greater Than 10 Percent) Reducing Urban Best Management Practices From the International Best Management Practice Database

BMP Category	Concentration In (mg/L)	Concentration Out (mg/L)	Reduction (%)
High-Rate Media Filtration	1.88	1	47
Retention Pond	1.63	1.2	26
Bioretention	1.26	0.96	24
Wetland Channel	1.76	1.45	18
Media Filter	1.06	0.89	16
Grass Strip	1.47	1.27	14
Grass Swale	0.71	0.63	11

Table 7-11. Most Effective Phosphorus (Greater Than 10 Percent) Reducing Urban Best Management Practices From the International Best Management Practice Database

BMP Category	Concentration In (mg/L)	Concentration Out (mg/L)	Reduction (%)
Oil-Grit Separator	0.316	0.115	64
Retention Pond	0.246	0.12	51
High-Rate Biofiltration	0.099	0.05	49
Media Filter	0.165	0.09	45
Porous Pavement	0.17	0.1	41
High-Rate Media Filtration	0.12	0.08	33
Wetland Basin	0.17	0.122	28
Detention Basin	0.25	0.186	26
Hydrodynamic Separator	0.23	0.176	23

Practices associated with reducing wildfire impacts include susceptibility and post-fire hazard analyses and pre-disaster planning and mitigation. The susceptibility analysis includes determining the assets at risk from fire and the risk severity of post-fire impacts, such as flooding, loss of life, loss of property, damage to infrastructure, utility interruptions, and water quality and quantity issues. Post-fire hazards consist of flooding, sediment/hillslope erosion, debris flow, fluvial hazard zones, water quality issues, and risk to water infrastructure. Post-fire BMPs should involve slope stabilization and reforestation.

7.2 E. COLI

E. coli load reductions from BMPs are ranked in the NRCS CPPE as substantial, moderate to substantial, moderate, slight to moderate, and slight. Table 7-12 lists the most effective practices (i.e., substantial, moderate to substantial, and moderate reductions) [NRCS, 2024b]. *E. coli* reductions expected from the BMPDB's urban practices are summarized in Table 7-13 [The Water Research Foundation, 2024]. Unlike the sediment and nutrient reductions, *E. coli* reductions are not quantified using the PLET model; therefore, priority BMPs should be those with the highest amount of reduction in the priority areas on the relative land cover. The NRCS Irrigation Water Management practice code Number 449 has slight to moderate improvement for bacteria, and it was included in Table 7-12 because of its high probability of installation. Practices with slight to moderate improvement should not be discouraged, even though they are not included in the tables in this section.

Table 7-12. Most Effective Bacteria (Pathogen) to Surface Water Reducing Agricultural Best Management Practices From the Colorado Natural Resources Conservation Service Conservation Practice Physical Effects

Practice	Practice Code	Unit	Effect	Rationale
Vegetated Treatment Area	635	Acre	Substantial Improvement	Infiltration and plant uptake in the treatment area will remove contaminants from polluted runoff and wastewater.
Constructed Wetland	656	Acre	Moderate to Substantial Improvement	Pathogens are trapped in the wetland.
Filter Strip	393	Acre	Moderate to Substantial Improvement	Filter strips capture and delay pathogen movement, but mortality may also be delayed because vegetative cover may protect pathogens from desiccation.
Nutrient Management	590	Acre	Moderate to Substantial Improvement	Proper application of manure, compost, and bio-solids should reduce or eliminate pathogens and/or chemicals (if present in source material) from moving into surface water.
Waste Treatment Lagoon	359	N/A	Moderate to Substantial Improvement	Storage provides flexibility in rate, timing, and location of waste application, with the potential for reductions of contaminants available for transport.
Alley Cropping	311	Acre	Moderate Improvement	Ground vegetation captures and delays pathogen movement and thereby increases their mortality.
Forest Farming	379	Acre	Moderate Improvement	Management of multi-layered canopy cover and organic matter impedes the movement of harmful pathogens.
Land Reclamation, Abandoned Mined Land	543	Acre	Moderate Improvement	Reconstructed mine land provides reduced runoff and erosion, and the filtering effects of vegetation reduce the risk of harmful levels of pathogens entering surface water.
Land Reclamation, Currently Mined Land	544	Acre	Moderate Improvement	Reconstructed mine land provides reduced runoff and erosion, and the filtering effects of vegetation reduce the risk of harmful levels of pathogens entering surface water.
Riparian Forest Buffer	391	Acre	Moderate Improvement	Riparian areas capture and delay pathogen movement and thereby increase their mortality.
Riparian Herbaceous Cover	390	Acre	Moderate Improvement	Vegetation traps pathogens providing increased opportunity for solar and microbial action to destroy some.
Irrigation Water Management	449	Acre	Slight to Moderate Improvement	Water is applied at rates that minimize pathogens transport to surface water.

Table 7-13. Most Effective *E. coli* (Greater Than 10 Percent) Reducing Urban Best Management Practices From the International Best Management Practice Database

BMP Category	Concentration In (mpn/100 mL)	Concentration Out (mpn/100 mL)	Reduction (%)
Wetland Basin	6,210	884	86
Retention Pond	4,110	708	83
Media Filter	570	215	62
Detention Basin	900	500	44
Bioretention	275	158	43
Hydrodynamic Separator	2,400	1,700	29

7.3 HEAVY METALS

Several risks are associated with abandoned mines. To prioritize public safety, specific locations of abandoned mines are not disclosed; however, taking action to mitigate potential dangers is important. The efforts of groups like Defense-Related Uranium Mines (DRUMs) are crucial in sealing off dangerous openings, identifying hazards, and implementing safety measures to protect the public and environment. This approach balances transparency with the need to safeguard communities from potential harm and is more focused on water quality and heavy-metal-impaired waterbodies. When waters are exposed to rocks containing sulfide minerals, they tend to become acid-rich. This occurrence is called acid rock drainage and is prevalent in mined areas where spent materials were left unclaimed. When the waters become acidic, they are more capable of gathering up and carrying heavy metals, including those that impair the waterbodies on the 303(d) list within the project area.

The AML implementation should be guided by the NRCS Code 543 practices. The NRCS Conservation Practice Standard (CPS) states the following options for land reclamation of AML [NRCS, 2024c]:

Public health and safety: Prior to beginning onsite investigations, identify possible hazards and implement appropriate safety precautions.

Erosion and sediment control practices: Control or treat runoff and sedimentation from treatment areas, soil material stockpiles, access roads, and permanent impoundments. Use sediment-trapping practices, such as filter strips, riparian forest buffers, contour buffer strips, silt fences, sediment basins, or similar practices. Include temporary practices necessary during earth moving activities and permanent practices necessary to stabilize the site and control runoff from the site after reclamation.

Control the generation of particulate matter and fugitive dust during removal and replacement of soil and other materials.

Site preparation: Identify areas for preservation during construction. Include areas containing desirable trees, shrubs, grasses, stream corridors, natural springs, historic structures, or other important features that will be protected during construction activities.

Remove trees, logs, brush, rubbish, and other debris that interfere with reclamation operations.

Dispose of debris material in a way that does not create a resource problem or interfere with reclamation activities and the planned land use.

Storage of soil materials: Stockpile soil or fill materials until needed for reclamation. Protect stockpiles from wind and water erosion, dust generation, unnecessary compaction, and contamination by noxious weeds, invasive species, or other undesirable materials.

Highwall treatment: Prior to backfilling, rock walls should have horizontal:vertical slopes of 0.5:1 or less. before placing backfill against the wall. Determine the thickness and density of lifts for fill material to limit the deep infiltration of precipitation and to limit settlement of the completed fill to acceptable levels, based on the available fill material and planned land use.

Shafts and adits: Use NRCS Conservation Practice Standard (CPS) Mine Shaft and Adit Closing (Code 457) to close/seal a shaft or adit. Divert runoff away from the shaft or adit.

Placement of surface material: Develop a grading plan that returns the site, including any off-site borrow areas, to contours that are suitable for the planned land use and control soil loss. Include the spreading of stockpiled topsoil material as the final layer. Treat graded areas to eliminate slippage surfaces and promote root penetration before spreading surface material. Spread surface soil without causing over-compaction.

Shape the land surface to provide adequate surface drainage and to blend into the surrounding topography. Use erosion control practices to reduce slope lengths where sheet and rill erosion exceeds acceptable levels. If settlement is likely to interfere with the planned land use, develop surface drainage or water disposal plans that compensate for the expected settlement.

If the subsurface material is not a source of contamination, improve soil permeability after placing backfill material by using deep ripping tools to decrease compaction, promote infiltration, and encourage root development. Do not plan practices that promote infiltration if seepage through cover materials has the potential to develop or exacerbate acid mine drainage loading or treatment.

Restoration of borrow material: If cover or fill material is taken from areas outside the reclamation site, stockpile the topsoil from the borrow area separately, and replace it on the borrow area after the area is restored for its intended purpose. Grade and shape the borrow area for proper drainage, and revegetate the site to control erosion.

Establishment of vegetation: Prepare a revegetation plan for the treated areas. Select plant materials suitable for the specified end land use according to local climate potential, site conditions, and local NRCS criteria. Use native species where possible. Avoid use of invasive species.

Use the criteria in NRCS CPS Critical Area Planting (Code 342) to establish grasses and forbs. Use NRCS CPS Tree-Shrub Establishment (Code 612) for the establishment of trees and shrubs. If vegetation cannot be established, use NRCS CPS Mulching (Code 484).

Control of toxic aqueous discharge: Identify and document water quality and quantity and releases from seeps, overland, and mine shafts. Quantify water impacts such as low pH, arsenic, etc. Identify measures that may affect treatment such as dissolved oxygen, iron, aluminum, magnesium, manganese, etc.

Methods for treatment of toxic aqueous discharge depend upon the type and extent of the contamination. When control of toxic mine drainage is needed, use BMPs that comply with state regulatory requirements. Evaluate the consequences of each potential treatment method to avoid creating a secondary problem. Select a method that can adequately treat the water based on the quantity and chemistry of the mine water and that is suitable for the planned level of operation and maintenance. Size the treatment area and settling basin(s) to allow for the volume of flow and treatment rate. Include a plan for disposal of the precipitated metals and spent treatment material.

Reduce the volume of contaminated water by diverting clean water away from the contaminated area or by limiting the opportunity for water to contact contaminated soil materials. Install practices, such as diversions, underground outlets, lined waterways, or grade stabilization structures, to control surface runoff. To the extent possible, divert clean upslope runoff away from the treated area.

- **Contaminated soil materials:** Remove, bury, or treat soil materials that adversely affect or have the potential to adversely affect water quality or plant growth. Bury materials containing heavy metals below the root zone, add suitable soil amendments, or both, to minimize the negative effect of this material. Separate soils with high electrical conductivity, calcium carbonate, sodium, or other restrictive properties, and treat, if practicable.
- Add a layer of compacted clay or a landfill cover over the contaminated material to deter infiltration. Place an earthfill blanket over the compacted clay to support plant growth. For each layer, identify the lift thickness and density needed to limit deep infiltration of precipitation and excessive settlement of the completed fill.
- **Mine sealing:** If clean water is entering a mine opening, divert the water away. If contaminated water is exiting the mine, it may be necessary to seal the mine to prevent water movement. Use NRCS CPS Mine Shaft and Adit Closing (Code 457) to design the mine seal. Divert surface water away from the mine seal.
- **Neutralization and precipitation:** Precipitate toxic metals and neutralize acidity in mine drainage using chemical or biological treatment. Select a method that can adequately treat the water based on the quantity and chemistry of the mine water and that is suitable for the planned level of operation and maintenance. Size the treatment area and settling basin(s) to allow for the volume of flow and treatment rate. Include a plan for disposal of the precipitated metals and spent treatment material.

Aside from AMLs, heavy metals also come from agricultural lands and urbanized areas. Heavy metal load reductions from BMPs are ranked in the NRCS CPPE as substantial, moderate to substantial, moderate, slight to moderate, and slight. Table 7-14 lists the most effective practices (i.e., substantial, moderate to substantial, and moderate reductions) [NRCS, 2024b]. Heavy metal reductions expected from the BMPDB's urban practices are summarized in Table 7-15 [The Water Research Foundation, 2024]. Heavy metal reductions are not quantified using the PLET model; therefore, priority BMPs should be those with the highest amount of reduction in the priority areas on the relative land cover. The NRCS Irrigation Water Management practice code Number 449 has slight to moderate improvement for heavy metals. Irrigation management is the only NRCS practice included with less than moderate improvement. It was included because of its high probability of installation in the project area. Practices with slight to moderate improvement should not be discouraged, even though they are not included in the tables in this section.

Table 7-14. Most Effective Heavy Metals to Surface Water Reducing Agricultural Best Management Practices From the Colorado Natural Resources Conservation Service Conservation Practice Physical Effects

Practice	Practice Code	Unit	Effect	Rationale
On-Farm Secondary Containment Facility	319	N/A	Substantial Improvement	Provides for spill containment of petroleum products.
Constructed Wetland	656	Acre	Moderate to Substantial Improvement	Vegetation and anaerobic conditions trap heavy metals.
Irrigation and Drainage Tailwater Recovery	447	N/A	Moderate to Substantial Improvement	The action captures irrigation and/or drainage runoff and associated metal-laden sediment.
Land Reclamation, Landslide Treatment	453	N/A	Moderate to Substantial Improvement	Increased vegetation increases infiltration and reduces runoff and erosion.
Land Reclamation, Toxic Discharge Control	455	N/A	Moderate to Substantial Improvement	Control of discharge and reduction in infiltration reduce off-site movement of contaminated water.
Riparian Forest Buffer	391	Acre	Moderate Improvement	The action filters sediment, and some plants may uptake heavy metals.
Road/Trail/Landing Closure and Treatment	654	Feet	Moderate Improvement	Decreased erosion and runoff reduce heavy metal delivery to surface water; increased soil organic matter increases the capacity of soils to retain heavy metals; permanent vegetation can uptake heavy metals.
Irrigation Water Management	449	Acre	Slight to Moderate Improvement	Water is applied at rates that minimize heavy metals transport to surface water.

Table 7-15. Most Effective Heavy Metal (Greater Than 10 Percent) Reducing Urban Best Management Practices From the International Best Management Practice Database

Category	BMP Category	Concentration In (µg/L)	Concentration Out (µg/L)	Reduction (%)
Arsenic (T)	Media Filter	0.9	0.765	15
Arsenic (T)	Retention Pond	1	0.87	13
Arsenic (T)	Grass Swale	1.11	1	10
Cadmium (D)	Grass Swale	0.2	0.116	42
Cadmium (D)	Grass Strip	0.114	0.07	39
Cadmium (D)	Media Filter	0.2	0.128	36
Cadmium (D)	Oil-Grit Separator	0.155	0.101	35
Cadmium (D)	Hydrodynamic Separator	0.137	0.0933	32
Cadmium (D)	Retention Pond	0.163	0.125	23
Cadmium (D)	Detention Basin	0.117	0.0942	19
Copper (D)	Wetland Basin	3.95	2.29	42
Copper (D)	Grass Strip	12	7.4	38
Copper (D)	Retention Pond	5.08	3.5	31
Copper (D)	Detention Basin	3.96	2.99	24
Copper (D)	High-Rate Biofiltration	4.5	3.4	24
Copper (D)	Media Filter	3.86	3	22
Copper (D)	Grass Swale	6.5	5.63	13
Iron (T)	Retention Pond	1050	285	73
Iron (T)	Media Filter	685	195	72
Iron (T)	Grass Strip	746	320	57
Iron (T)	Grass Swale	216	136	37
Zinc (D)	Media Filter	32	7.15	78
Zinc (D)	Porous Pavement	17.8	4.09	77
Zinc (D)	Wetland Basin	22.6	8.35	63
Zinc (D)	High-Rate Biofiltration	189	79	58
Zinc (D)	Grass Strip	33.6	17	49
Zinc (D)	Grass Swale	34.2	19.8	42
Zinc (D)	Bioretention	20.8	12.5	40
Zinc (D)	Retention Pond	23.4	16	32
Zinc (D)	Detention Basin	12.1	9.38	22

µg/L = micrograms per liter

D = dissolved

T = total

8.0 PAST AND CURRENT BEST MANAGEMENT PRACTICES

A significant amount of BMPs have been, and are currently being, implemented in the Cache la Poudre HUC8 Watershed. Based on Survey #2 provided to the stakeholders, the following BMPs have been or are being implemented in the Cache la Poudre River Watershed project area:

- Regional Stormwater Detention
- Extended Detention Basins
- Retention Ponds
- Bioretention
- Hydrodynamic Separators
- Inlet Filters
- Sand Filters
- Bioswales
- Other Structural Stormwater BMPs
- Pollution Prevention Programs
- Spill Response
- Public Education

The surveys also provided planned, near-future projects (including continuation of existing programs) and a pilot program to use water treatment residuals as filter media in bioretention basins to sequester phosphorus from stormwater runoff. Although this list includes some of the implementation accomplishments within the project area, it does not include all of the BMPs that have been or are currently being implemented.

Practices implemented by watershed and/or county were not available from the NRCS; however, they were available for the State of Colorado. An assumption was made that the more likely a practice is to be implemented in Colorado, the more likely it would be implemented in the project area. Funding sources and programs involved in implementing practices in Colorado include the Agricultural Conservation Easement Program (ACEP), Agricultural Water Enhancement Program (AWEP) Conservation Reserve Program (CRP), Conservation Stewardship Program (CSP), Conservation Technical Assistance (CTA), Emergency Watershed Protection Program (EWP), Environmental Quality Incentives Program (EQIP), Farm and Ranch Lands Protection Program (FRPP), Grass Reserve Program (GRP), Regional Conservation Partnership Program (RCPP), Resource Conservation and Development (RCD) Program, Watershed Protection and Flood Prevention Operations (WFPO) Program, Watershed Rehabilitation (WHRB), Wetlands Reserve Program (WRP), and Wildlife Habitat Incentive Program (WHIP). Table 8-1 lists the practices implemented on more than 50 mi^2 in Colorado since 2005 that should continue to be implemented for water quality improvement [USDA, 2024].

Table 8-1. Best Management Practices Implemented Annually on More Than 50 Square Miles in Colorado Since 2005 (Page 1 of 2)

Practice Name	Practice Code	Colorado (mi^2)	Associated Land Use	Percent of Associated Area	Project Area Land Use (mi^2)	Project Area Practice (Available Remaining) (mi^2)
Prescribed Grazing	528	1,169	Pasture	100	23.9	-
Upland Wildlife Habitat Management	645	433	Pasture	38	23.9	9.0
Conservation Crop Rotation	328	287	Cropland	2	194.0	4.4
Watering Facility	614	286	Pasture	25	23.9	5.9
Livestock Pipeline	516	210	Pasture	18	23.9	4.4
Fence	382	194	Pasture	17	23.9	4.0
Pest Management Conservation System	595	180	Cropland	1	194.0	2.8
Conservation Cover	327	154	Cropland	1	194.0	2.4
Access Control	472	154	Pasture	13	23.9	3.2
Nutrient Management	590	134	Cropland	1	194.0	2.1
Pumping Plant	533	121	Cropland	1	194.0	1.9
Brush Management	314	118	Forest	<1	552.8	1.2
Residue and Tillage Management, Reduced Till	345	104	Cropland	<1	194.0	1.6
Residue and Tillage Management, No Till	329	99	Cropland	<1	194.0	1.5
Irrigation Water Management	449	98	Cropland	<1	194.0	1.5
Residue Management, Seasonal	344	85	Cropland	<1	194.0	1.3
Prescribed Grazing - Enhancements	E528	81	Pasture	7	23.9	1.7
Early Successional Habitat Development - Management	647	72	Other	<1	788.6	1.7
Pest Management Conservation System - Enhancements	E595	68	Cropland	<1	194.0	1.0
Herbaceous Weed Treatment	315	66	Cropland	<1	194.0	1.0
Nutrient Management - Enhancements	E590	57	Cropland	<1	194.0	0.9
Water Well	642	55	Cropland	<1	194.0	0.8

RESPEC

Table 8-1. Best Management Practices Implemented Annually on More Than 50 Square Miles in Colorado Since 2005 (Page 2 of 2)

Practice Name	Practice Code	Colorado (mi^2)	Associated Land Use	Percent of Associated Area	Project Area Land Use (mi^2)	Project Area Practice (Available Remaining) (mi^2)
Range Planting	550	51	Pasture	4	23.9	1.1
Cover Crop	340	49	Cropland	<1	194.0	0.8
Forage Harvest Management	511	47	Forest	<1	552.8	0.5
Structure for Water Control	587	33	Cropland	<1	194.0	0.5
Irrigation Pipeline	430	30	Cropland	<1	194.0	0.5
Forest Stand Improvement	666	27	Forest	<1	552.8	0.3

9.0 RECOMMENDED BEST MANAGEMENT PRACTICES

This watershed-based plan provides recommendations for NPS implementation practices to reduce loads of pollutants of concern. The recommended implementation practices are based on practices that are the most likely to be implemented and most impactful in reducing pollutants of concern.

9.1 FUTURE MUNICIPAL SEPARATE STORM SEWER SYSTEM AREAS

Stormwater resulting from rainfall, snowmelt, or other surface water runoff and drainage originates from impervious areas in towns; cities; residential developments; and industrial, manufacturing, or agricultural facilities. Stormwater flows accumulate from streets, parking lots, rooftops, catch basins, curbs, gutters, ditches, drainage channels, storm drains, and other impervious surfaces that may play a role in the contribution of pollutant loading because of the proximity of these impervious areas to the impaired waterbodies. Stormwater discharges are permitted under numerous MS4 permits in Colorado, which include the statewide standard MS4 general permit (COR090000) and statewide nonstandard MS4 general permit (COR070000). Areas covered by MS4 permits are not considered NPSs.

No areas within the Cache la Poudre HUC8 have been identified to become MS4s in the near future (5 to 15 years); however, town decision-makers should be proactive by using development practices that will minimally impact water quality in areas where an MS4 is possible. Less effort would be needed to retrofit BMPs after an area becomes a designated MS4 if more implementation is completed upfront. Low Impact Development (LID) is an approach to stormwater management that mimics a site's natural hydrology while the landscape is developed and preserves and protects environmentally sensitive site features, such as riparian buffers, wetlands, steep slopes, valuable (mature) trees, floodplains, woodlands, and highly permeable soils. Minimal Impact Design Standards (MIDS) is a new concept being used in the state of Minnesota, which emphasizes keeping a raindrop where it falls to minimize stormwater runoff and pollution as well as preserve natural resources. Because Minnesota has been successful in implementing water quality practices using MIDS, developing communities in the North Front Range Water Quality Planning Association (NFRWQPA) watersheds would likely also benefit from evaluation of the following four main elements of MIDS [Minnesota Pollution Control Agency, 2024]:

- Stormwater volume performance goals for new development, redevelopment, and linear projects
- New credit calculations that standardize the use of a range of structural stormwater techniques
- Design specifications for a variety of green infrastructure BMPs
- An ordinance guidance package to help developers and communities implement MIDS

9.2 DEVELOPED

Throughout the Cache la Poudre River project area, approximately 59 mi^2 of non-MS4 developed land exist. MS4 areas are not represented in the project models. BMPs recommended for MS4 and non-MS4 developed areas are similar to those outlined in Section 9.1. For nutrients and sediment, priority developed practices from PLET (Table 7-5) should be those with the highest rankings and reduction scores (i.e., extended wet detention, infiltration basins, and concrete gird pavement). For *E. coli*, priority developed practices should be those resulting in the largest reductions within the BMPDB (i.e., wetland basin and retention pond), as shown in Table 7-13. For heavy metals, priority developed practices should also be practices that resulted in the largest reductions of heavy metals in the BMPDB (depending on pollutants of concern in downstream waterbodies), as shown in Table 7-15. Practices do not need to be limited to these recommendations, and any practice resulting in reductions of pollutants of concern can be considered.

9.3 AGRICULTURAL (CROPLAND, PASTURELAND, AND FEEDLOT BEST MANAGEMENT PRACTICES)

Throughout the Cache la Poudre River project area, approximately 195 mi^2 of cropland exist and are all within the easternmost watersheds. Similarly, approximately 24 mi^2 of pastureland exist, primarily in the easternmost watersheds. Only approximately 40 acres are feedlots. For sediment and nutrients, priority agricultural practices from PLET (Tables 7-1 through 7-3) should be those with the highest rankings and reduction scores (i.e., streambank stabilization and fencing and 35-foot grass buffers for cropland, 35-foot grass buffers and livestock exclusion fencing for pasture, and waste management systems for feedlots). For *E. coli*, priority agricultural practices should be the most effective agricultural BMPs from the Colorado NRCS CPPE for reducing *E. coli* (i.e., vegetated treatment area, constructed wetland, filter strip, nutrient management, and waste treatment lagoon), as shown in Table 7-12 . For heavy metals, priority agricultural practices should be the most effective agricultural BMPs from the Colorado NRCS CPPE for reducing heavy metals (i.e., on-farm secondary containment facility, constructed wetland, irrigation and drainage tailwater recovery, land reclamation (landslide treatment or toxic discharge control), as shown in Table 7-14. Additionally, practices that switch from flood irrigation to more efficient irrigation methods would be beneficial in reducing both *E. coli* and heavy metals such as selenium and arsenic. Although these practices are the most effective, BMPs do not need to be limited to these recommendations.

9.4 FOREST

Throughout the Cache la Poudre River project area, approximately 886 mi^2 of forest land exist. Although forest land is less likely to contribute sediment, nutrients, and bacteria per acre of contributing area, BMPs are still beneficial, especially when considering historical fires, fire potential, abandoned mines, recreation, and grazing activities. For nutrients and sediment, priority forest practices from PLET (Table 7-4) should be those with the highest ranking and reduction scores (i.e., a combination of site preparation/straw/
crimp seed/net/fertilizer/transplants). For *E. coli*, priority forest practices are not prioritized but should include those that exclude forest-grazing livestock from accessing streams and septic assessments. Forest practices should also focus on pre- and post-fire activities outlined on the Cameron Peak Fire Update: CPRW's Role in Post-Fire Recovery & Restoration webpage [CPRW, 2021].

9.5 ABANDONED MINE LANDS

Most AMLs in the watershed have not yet been identified because several are located on private land or in very remote locations. The primary practice completed on identified AMLs is to seal off dangerous openings, identify hazards, and implement safety measures to protect the public and environment. To improve water quality, identifying AMLs should become a higher priority. Although AML BMPs are not prioritized because of the variable nature of AML lands, each site should be assessed, and practices should be chosen that target specific issues related to each site. For heavy metals, priority practices should focus on AMLs, as outlined in Section 7.3.

10.0 INFORMATION, EDUCATION, AND OUTREACH

Current communication, education, and outreach efforts established in the Cache la Poudre River HUC8 should continue and be expanded to incorporate effectiveness and user feedback surveys that would complement current area outreach programs. Coordinated outreach efforts should increase the awareness of specific audiences regarding water quality problems and solutions, as well as available BMP technical and financial assistance programs for urban/residential areas, cropland, pasture lands, AMLs, and riparian areas. Stakeholders should continue to expand on their public outreach efforts and communications with the public by implementing inclusive and new engagement tactics to reach a broad audience. Education and outreach activities should target individuals and groups to evaluate effective outreach methods.

Stakeholder responses to Survey #2 were used to rank a list of information, education, and outreach options. The following survey ranking is from highest to lowest:

1. Water Quality Awareness Signage in Parks by Streams
2. Social Media Posts (Sent to Partners)
3. Website Updates
4. Educational Campaigns
5. Newsletters and Mailers
6. Pet-Waste Pickup Stations
7. Volunteer Cleanup Programs
8. School Visits
9. Project Story Map
10. Report a Concern Website
11. Radio Advertisements and Interviews
12. Tours and Field Trips

Entities within the watershed that are interested in collaborating with other stakeholder groups and hosting or participating in events include the City of Greeley, City of Fort Collins, Colorado Watershed Assembly, and Colorado Wheat Administrative Committee. Participating in existing events can also expand outreach efforts. Northern Water has an annual water quality efficiency stakeholder meeting in the spring, as well as a spring and fall water symposium and a children's water festival. Each fall, a Sustaining Colorado Watersheds conference is held in Avon, Colorado. A Lower South Platte River Water Festival is also held for children in the community.

The NFRWQPA is compiling a "Stakeholder Toolkit" for the plans. This toolkit will help stakeholders reach, inform, and partner with their networks on the NPS watershed educational resources. Some of the options included in the toolkit include digital communications, print communications, and community outreach. The stakeholders will decide which tools will be chosen during the next round of funding. Examples of these and more information about the Stakeholder Toolkit is included in Appendix E.

11.0 CRITERIA TO ASSESS PROGRESS

Milestones toward progress can be shown in many different ways. In these watersheds, options for measurable milestones can include progress toward meeting water quality criteria set by the state, trends toward improvement, and progress in the installation of implementation practices that are expected to improve water quality parameters of concern. Table 11-1 in the previous chapter shows practices that could be implemented to make progress and count as measurable milestones. Because goals in this watershed for this plan are very broad (the plan is not being written as a part of a specific Total Maximum Daily Load [TMDL] with a specified goal), milestones are more general than specific. Any practice implemented will be a part of progress toward the ultimate goal of improving water quality and ensuring water quality does not worsen. Relative implementation should be tracked, and this plan should be revisited after the first 5 years to ensure progress is being made. Reductions from NPS loadings will most likely require a significant, increased amount of technical and financial program assistance; BMP implementation through on-the-ground projects; proper watershed planning; and cooperation with willing landowners and land management agencies. Successfully achieving load reductions depends on several factors such as the amount of voluntary participation, availability of technical and financial assistance, and effectiveness of BMPs intended to reduce applicable loads.

In Survey #2, organizations were asked about interim measurable criteria/goals and what progress would look like after 5 and 10 years. The City of Greeley stated that continuing localized improvements will help reduce *E. coli* and nutrient loads to ponds and lakes with respect to NPSs. The City also supported continued outreach with NPS dischargers and successful watershed-based plans across the watersheds to align with CDPHE goals and help share the load between point and NPS dischargers. The City of Fort Collins mentioned that monitoring pollutant hotspots, implementing BMPs, and conducting follow-up monitoring would be helpful in accessing goal achievement and that progress would be the identification of potential sources and implementation of practices/programs to minimize those pollutants at the source. The City of Fort Collins also stated that a proactive program with an engaged community that works together to prevent water pollution at the source would exemplify progress. The Colorado Wheat Administrative Committee advised that monitoring water quality, reducing pollutants of concern loads, and meeting water quality criteria would display progress.

An implementation schedule is recommended to reduce pollutants of concern by implementing NPS BMPs. Table 11-1 provides a list of BMPs that would be most likely to benefit the area over the next 10 years options by land-use category. Tables 11-2, 11-3, and 11-4 provide the top two sources for each parameter group and the top practices to implement.

RESPEC

Table 11-1. Best Management Practices (Page 1 of 2)

Land-Use Category	Source	Recommended Implementation Activity
Future Stormwater/ Developed/Urban/Residential	PLET and Survey	Extended Wet Detention Ponds
Future Stormwater/ Developed/Urban/Residential	PLET and Survey	Infiltration Basins
Future Stormwater/ Developed/Urban/Residential	PLET and Survey	Concrete Grid Pavement
Future Stormwater/ Developed/Urban/Residential	BMPDB	High-Rate Biofiltration
Future Stormwater/ Developed/Urban/Residential	BMPDB	Media Filter
Future Stormwater/ Developed/Urban/Residential	BMPDB	Oil-Grit Separator
Future Stormwater/ Developed/Urban/Residential	BMPDB	Retention Pond
Future Stormwater/ Developed/Urban/Residential	BMPDB	High-Rate Media Filtration
Future Stormwater/ Developed/Urban/Residential	BMPDB	Wetland Basin
Future Stormwater/ Developed/Urban/Residential	BMPDB	Grass Swale
Future Stormwater/ Developed/Urban/Residential	Other	LID Practices
Future Stormwater/ Developed/Urban/Residential	Other	Septic Upgrades
Ag - Cropland	PLET and Survey	Streambank Stabilization and Fencing
Ag - Cropland	PLET and Survey	Buffer - Grass (35 feet wide)
Ag - Cropland	NRCS	Constructed Wetland (656)
Ag - Cropland	NRCS	Filter Strip (393)
Ag - Cropland	NRCS	Vegetated Treatment Area (635)
Ag - Cropland	NRCS	On-Farm Secondary Containment Area (319)
Ag - Cropland	NRCS	Irrigation Water Management (449)
Ag - Pasture	PLET	Buffer - Grass (35 feet wide)
Ag - Pasture	PLET	Livestock Exclusion Fencing
Ag - Pasture	PLET and Survey	Streambank Stabilization and Fencing
Ag - Feedlot	PLET and Survey	Waste Management System

Table 11-1. Best Management Practices (Page 2 of 2)

Land-Use Category	Source	Recommended Implementation Activity
Forest	PLET and Survey	Site Preparation/Straw/Crimp Seed/Net
Forest	PLET and Survey	Site Preparation/Straw/Crimp Seed/Fertilizer/Transplants
AML	NRCS	Storage of Soil Materials
AML	NRCS	Placement of Surface Material
AML	NRCS	Restoration of Borrow Material
AML	NRCS	Establishment of Vegetation
AML	NRCS	Control of Toxic Aqueous Discharge
Monitoring	Other	Water Quality Sampling (base and storm events)
Monitoring	Other	Discharge Measurement (base and storm events)
Monitoring	Other	Monitor Implemented Agricultural BMP Effectiveness
Monitoring	Other	Monitor Implemented Urban BMP Effectiveness
Monitoring	Other	Monitor Implemented AML BMP Effectiveness
Outreach	Survey	Social Media Posts
Outreach	Survey	Website Updates
Outreach	Survey	Educational Campaigns
Outreach	Survey	Newsletters and Mailers
Outreach	Survey	Pet-Waste Pickup Stations
Outreach	Survey	Volunteer Cleanup Programs
Outreach	Survey	School Visits
Outreach	Survey	Project Story Map
Outreach	Survey	Report a Concern Website

Table 11-2. Dominant Land Uses, Sources, and Priority Practices by HUC10 for Nutrients and Sediment (Page 1 of 2)

Watershed	Dominant Land Uses	Top Sediment Sources	Top Phosphorus Sources	Top Nitrogen Sources	Priority Practices
1019000701 South Fork Cache la Poudre River	Forest and Urban non-MS4	Forest and Urban non-MS4	Forest and Feedlots	Forest and Feedlots	/ Site Preparation/Straw/Crimp Seed/Net / Site Preparation/Straw/Crimp Seed/Fertilizer/Transplants / Extended Wet Detention / Infiltration Basins / Waste Management System
1019000702 Headwaters Cache la Poudre River	Forest and Urban non-MS4	Forest and Urban non-MS4	Forest and Urban non-MS4	Forest and Urban non-MS4	/ Site Preparation/Straw/Crimp Seed/Net / Site Preparation/Straw/Crimp Seed/Fertilizer/Transplants / Extended Wet Detention / Infiltration Basins
1019000703 Gordon Creek-Cache la Poudre River	Forest and Urban non-MS4	Forest and Urban non-MS4	Forest and Feedlots	Forest and Urban non-MS4	/ Site Preparation/Straw/Crimp Seed/Net / Site Preparation/Straw/Crimp Seed/Fertilizer/Transplants / Extended Wet Detention / Infiltration Basins
1019000704 Dale Creek	Forest and Urban non-MS4	Forest and Urban non-MS4	Forest and Feedlots	Forest and Feedlots	/ Site Preparation/Straw/Crimp Seed/Net / Site Preparation/Straw/Crimp Seed/Fertilizer/Transplants / Extended Wet Detention / Infiltration Basins / Waste Management System
1019000705 Upper North Fork Cache la Poudre River	Forest and Urban non-MS4	Forest and Urban non-MS4	Forest and Feedlots	Forest and Feedlots	/ Site Preparation/Straw/Crimp Seed/Net / Site Preparation/Straw/Crimp Seed/Fertilizer/Transplants / Extended Wet Detention / Infiltration Basins / Waste Management System
1019000706 Lone Pine Creek	Forest and Urban non-MS4	Forest and Urban non-MS4	Forest and Feedlots	Forest and Urban non-MS4	/ Site Preparation/Straw/Crimp Seed/Net / Site Preparation/Straw/Crimp Seed/Fertilizer/Transplants / Extended Wet Detention / Infiltration Basins / Waste Management System

Table 11-2. Dominant Land Uses, Sources, and Priority Practices by HUC10 for Nutrients and Sediment (Page 2 of 2)

Watershed	Dominant Land Uses	Top Sediment Sources	Top Phosphorus Sources	Top Nitrogen Sources	Priority Practices
1019000707 Rabbit Creek-North Fork Cache la Poudre River	Forest and Urban non-MS4	Forest and Cropland	Forest and Feedlots	Forest and Feedlots	/ Site Preparation/Straw/Crimp Seed/Net / Site Preparation/Straw/Crimp Seed/Fertilizer/Transplants / Streambank Stabilization and Fencing / Buffer-Grass (35 feet wide) / Waste Management System
1019000708 Horsetooth Reservoir-Cache la Poudre River	Forest and Cropland	Cropland and Urban non-MS4	Cropland and Feedlots	Cropland and Urban non-MS	/ Streambank Stabilization and Fencing / Buffer-Grass (35 feet wide) / Extended Wet Detention / Infiltration Basins / Waste Management System
1019000709 Boxelder Creek	Forest and Cropland	Cropland and Urban non-MS4	Cropland and Feedlots	Cropland and Feedlots	/ Streambank Stabilization and Fencing / Buffer-Grass (35 feet wide) / Extended Wet Detention / Infiltration Basins / Waste Management System
1019000710 City of Greeley-Cache la Poudre River	Cropland and Urban non-MS	Cropland and Urban non-MS4	Cropland and Feedlots	Cropland and Urban non-MS4	/ Streambank Stabilization and Fencing / Buffer-Grass (35 feet wide) / Extended Wet Detention / Infiltration Basins / Waste Management System

Table 11-3. *E. coli* Impairment Status, Primary Sources, Associated Land Use, and Priority Practices by HUC10

Watershed	*E. coli* Impaired	Primary *E. coli* Sources	Associated Land Use (*E. coli*)	Priority Practices
1019000701 South Fork Cache la Poudre River	N	/ Livestock (more Cattle) / Humans (more OWTS)	/ Agricultural Land / Urban non-MS4	/ Vegetated Treatment Area / Constructed Wetlands / Septic Upgrades / WWTF Connections
1019000702 Headwaters Cache la Poudre River	N	/ Livestock (more Cattle) / Humans (more OWTS)	/ Agricultural Land / Urban non-MS4	/ Vegetated Treatment Area / Constructed Wetlands / Septic Upgrades / WWTF Connections
1019000703 Gordon Creek-Cache la Poudre River	N	/ Livestock (more Cattle) / Humans (more OWTS)	/ Agricultural Land / Urban non-MS4	/ Vegetated Treatment Area / Constructed Wetlands / Septic Upgrades / WWTF Connections
1019000704 Dale Creek	N	/ Livestock (more Cattle) / Humans (more OWTS)	/ Agricultural Land / Urban non-MS4	/ Vegetated Treatment Area / Constructed Wetlands / Septic Upgrades / WWTF Connections
1019000705 Upper North Fork Cache la Poudre River	N	/ Livestock (more Cattle) / Humans (more OWTS)	/ Agricultural Land / Urban non-MS4	/ Vegetated Treatment Area / Constructed Wetlands / Septic Upgrades / WWTF Connections
1019000706 Lone Pine Creek	N	/ Livestock (more Cattle) / Humans (more OWTS)	/ Agricultural Land / Urban non-MS4	/ Vegetated Treatment Area / Constructed Wetlands / Septic Upgrades / WWTF Connections
1019000707 Rabbit Creek-North Fork Cache la Poudre River	N	/ Livestock (more Cattle) / Humans (more OWTS)	/ Agricultural Land / Urban non-MS4	/ Vegetated Treatment Area / Constructed Wetlands / Septic Upgrades / WWTF Connections
1019000708 Horsetooth Reservoir-Cache la Poudre River	Y	/ Humans (more WWTP) / Pets (more Cats	/ Urban non-MS4 / Urban non-MS4	/ Wetland Basin / Retention Pond
1019000709 Boxelder Creek	Y	/ Livestock (more Cattle) / Humans (more OWTS)	/ Agricultural Land / Urban non-MS4	/ Vegetated Treatment Area / Constructed Wetlands / Septic Upgrades / WWTF Connections
1019000710 City of Greeley-Cache la Poudre River	Y	/ Livestock (more Cattle) / Humans (more WWTP)	/ Agricultural Land / Urban non-MS4	/ Vegetated Treatment Area / Constructed Wetlands / Wetland Basin / Retention Pond

Table 11-4. Dominant Land Uses, Metal Impairments, Associated Causes, and Priority Practices by HUC10 (Page 1 of 2)

Watershed	Dominant Land Uses	Metal Impairments	Associated Cause	Priority Practices
1019000701 South Fork Cache la Poudre River	Forest and Urban non-MS4	Arsenic	Pressure-Treated Wood, Material Production, Pierre Shale, etc.	Irrigation Water Management
1019000702 Headwaters Cache la Poudre River	Forest and Urban non-MS4	Arsenic	Pressure-Treated Wood, Material Production, Pierre Shale, etc.	Irrigation Water Management
1019000703 Gordon Creek-Cache la Poudre River	Forest and Urban non-MS4	Arsenic	Pressure-Treated Wood, Material Production, Pierre Shale, etc.	Irrigation Water Management
1019000704 Dale Creek	Forest and Urban non-MS4	Arsenic	Pressure-Treated Wood, Material Production, Pierre Shale, etc.	Irrigation Water Management
1019000704 Dale Creek	Forest and Urban non-MS4	Silver	Mining, Manufacturing Processes, Material Production	AML BMPs
1019000705 Upper North Fork Cache la Poudre River	Forest and Urban non-MS4	Arsenic	Pressure-Treated Wood, Material Production, Pierre Shale, etc.	Irrigation Water Management
1019000705 Upper North Fork Cache la Poudre River	Forest and Urban non-MS4	Silver	Mining, Manufacturing Processes, Material Production	AML BMPs
1019000706 Lone Pine Creek	Forest and Urban non-MS4	Arsenic	Pressure-Treated Wood, Material Production, Pierre Shale, etc.	Irrigation Water Management
1019000706 Lone Pine Creek	Forest and Urban non-MS4	Iron	Mining, Manufacturing Processes, Material Production	AML BMPs
1019000707 Rabbit Creek-North Fork Cache la Poudre River	Forest and Urban non-MS4	Arsenic	Pressure-Treated Wood, Material Production, Pierre Shale, etc.	Irrigation Water Management
1019000707 Rabbit Creek-North Fork Cache la Poudre River	Forest and Urban non-MS4	Silver	Mining, Manufacturing Processes, Material Production	AML BMPs
1019000707 Rabbit Creek-North Fork Cache la Poudre River	Forest and Urban non-MS4	Iron	Mining, Manufacturing Processes, Material Production	AML BMPs
1019000707 Rabbit Creek-North Fork Cache la Poudre River	Forest and Urban non-MS4	Manganese	Manufacturing Processes, Material Production	Discontinue Use

Table 11-4. Dominant Land Uses, Metal Impairments, Associated Causes, and Priority Practices by HUC10 (Page 2 of 2)

Watershed	Dominant LUs	Metal Impairments	Associated Cause	Priority Practices
1019000708 Horsetooth Reservoir-Cache la Poudre River	Forest and Cropland	Arsenic	Pressure-Treated Wood, Material Production, Pierre Shale, etc.	Irrigation Water Management
1019000708 Horsetooth Reservoir-Cache la Poudre River	Forest and Cropland	Selenium	Material Production, Manufacturing Processes, Gas Combustion, Pierre Shale	Irrigation Water Management
1019000709 Boxelder Creek	Forest and Cropland	Selenium	Material Production, Manufacturing Processes, Gas Combustion, Pierre Shale	Irrigation Water Management
1019000710 City of Greeley-Cache la Poudre River	Cropland and Urban non-MS	None	None	None

Implementation practices were run in the PLET model on 25 percent of each applicable land cover. This number represents the acres affected by the practice, not the acres of the practice implemented. Cropland practices typically resulted in the highest reductions of nitrogen and phosphorus; therefore, these are the practices incorporated in the schedule. As shown in Table 11-5, incorporating stream stabilization and fencing on 25 percent of the cropland and 35-foot buffers on an additional 25 percent of the cropland in the project area did not result in the needed nitrogen and phosphorus reductions. Reductions required were calculated for the entire area draining to the outlet HUC10. The reduction required for the specific project area was not calculated because project areas were drawn using county lines; therefore, the following cost estimates were made assuming that all reductions had to come from within the project area. These practices need to be implemented in all cropland to meet the load reductions needed. Some of the loads are assumed to come from areas outside of Larimer and Weld counties and from other land uses. Table 11-6 shows the proposed schedule for implementation in the Cache la Poudre River project area. These practices will also help with *E. coli* and heavy metals. Load reductions for heavy metals came from the PLET model and, therefore, were not run for *E. coli* and heavy metals. Because the current load reductions from PLET were not calibrated and did not include areas outside of Larimer and Weld Counties or MS4 areas, they should be considered relative and should not be compared to actual loads calculated with observed data.

Table 11-5. Reductions Achieved by Implementation of Priority Cropland Practices

Practice	Nitrogen Load (lb/yr)	Nitrogen Reduction (%)	Nitrogen Reduction Needed (lb/yr)	Phosphorus Load (lb/yr)	Phosphorus Reduction (%)	Phosphorus Reduction Needed (lb/yr)
Base Load	334,904	N/A	57	90,435	N/A	64
Stream Stabilization and Fencing on 25% of Cropland (31,178 acres)	27,747	8.3		6,992	7.7	
Buffer - Grass (35 feet wide) on 25% of Cropland (31,178 acres)	14,614	4.4		4,473	5	
Total Reduction	42,361	12.7		11,465	12.7	

Table 11-6. Schedule for Primary Cropland Practices to Achieve Nutrient Goals

Practices	5-Year Goal	10-Year Goal	Ultimate Goal
Stream Stabilization and Fencing on Cropland	40,000 acres	80,000 acres	125,000 acres
Buffer - Grass (35 feet wide) on Cropland	40,000 acres	80,000 acres	125,000 acres

In general, 35-foot buffers cost about $10.37 per acre impacted per year, fencing costs about $22.66 per acre impacted per year, and streambank stabilization costs $13,472 per mile. If a mile of streambank stabilization impacted a square mile of the watershed area, it would cost approximately $21.05 per acre impacted per year; therefore, every 5,000 acres impacted by buffers would cost approximately $51,838 and with the rough streambank stabilization estimate every 5,000 acres impacted by stream stabilization would cost approximately $218,549.

12.0 MONITORING BEST MANAGEMENT PRACTICES EFFECTIVENESS

Monitoring should be completed before and after implementing BMPs to evaluate the effectiveness of priority practices. Monitoring BMP effectiveness (up- and downstream of BMPs) helps evaluate the adequacy of the implementation strategies targeted to reduce loads or transport. BMP effectiveness data will improve the understanding of implementation and management measures. Other ideal locations for monitoring include areas that have been monitored historically near the HUC10 watershed outlets and along impaired waterbodies. More information about monitoring NPSs is included in on EPA's Nonpoint Source Monitoring: TechNOTES webpage. Existing water quality monitoring occurring for the NFRWQPA's 208 Areawide Water Quality Management Plan is available on its website.

Additional monitoring and evaluation efforts should occur within the communities that are the most likely to become MS4 areas. Monitoring sites up- and downstream of areas where storm drains and tributaries enter the Cache la Poudre River would help evaluate contributions. Monitoring locations in storm drains throughout urbanized areas where two possible sources come together would also help isolate sources of pollution. A detailed monitoring plan that identifies the locations of additional monitoring sites should be compiled.

Continuous discharge data across a broad range of flows are helpful for calculating loads. Future monitoring should include instantaneous discharge measurements at water quality sampling areas. Continuous stage recorders should be installed at key locations in the watershed and stage-discharge relationships should be developed to convert continuous stage data to continuous flow data. Relatively low-cost, low-maintenance technologies are available to record continuous stage data. Instantaneous and continuous flow data will increase the accuracy of future load calculations and the evaluation of BMPs and implementation practices.

Survey #2 had a question regarding in-stream monitoring activities that different entities would consider implementing. The City of Greeley would be interested in quarterly sampling to be analyzed by a local laboratory. The City of Fort Collins would be interested in the installation, maintenance, and operation of a monitoring station.

13.0 TECHNICAL AND FINANCIAL ASSISTANCE SOURCES

Technical and financial assistance sources are available to implement BMPs. Numerous private companies and organizations as well as local, state, and federal agencies provide technical assistance to address NPS pollution. A few of these organizations and agencies also provide financial assistance. Table 13-1 lists the agencies and organizations with technical and financial programs that may assist with conservation and water quality implementation projects and what type of technical or financial assistance they offer (based on the land use of interest) as denoted by Xs. The following sections describe the information regarding incentive programs and funding to implement NPS projects identified in this plan. Funding includes but is not limited to the CDPHE's NPS Program and its annual grants, the South Platte Basin Roundtable grants, and the CAWA programs. The NPS Program funds support staffing costs and programmatic priorities including the Mini Grant Program, the NPS Watershed Planning and Tool Development Program, and the NPS Program's Success Story Initiative.

Table 13-1. Sources of Technical and Financial Assistance (Page 1 of 3)

Agency or Organization	Website	Assistance	BMP Category						
			Developed Non-MS4	Cropland	Pasture	Feedlot	Forest	Stream	Outreach
LOCAL									
City of Fort Collins	www.fcgov.com	Financial, Technical	X					X	X
Larimer County	www.larimer.gov	Financial, Technical	X	X	X	X	X	X	X
Weld County	www.weld.gov	Financial, Technical	X	X	X	X	X	X	X
CPRW	www.poudrewatershed.org	Technical	X	X	X	X	X	X	X
Poudre Heritage Alliance	poudreheritage.org	Technical	X	X	X	X	X	X	X
South Platte Basin Roundtable	www.southplattebasin.com	Technical	X	X	X	X	X	X	X
Larimer Conservation District (Previously Fort Collins and Big Thompson Conservation Districts)	https://www.larimercd.org/	Financial, Technical		X	X	X	X	X	X
West Greeley Conservation District	www.wgcd.org	Financial, Technical		X	X	X	X	X	X
Platte Valley Conservation District	www.coloradolandcan.org/local-resources/Platte-Valley-Conservation-District/3610	Financial, Technical		X	X	X	X	X	X
Southeast Weld Conservation District	seweldcd-co.org	Financial, Technical		X	X	X	X	X	X

Table 13-1. Sources of Technical and Financial Assistance (Page 2 of 3)

Agency or Organization	Website	Assistance	BMP Category						
			Developed Non-MS4	Cropland	Pasture	Feedlot	Forest	Stream	Outreach
STATE									
CSU Extension	extension.colostate.edu	Technical	X	X	X	X	X	X	X
CSU	www.colostate.edu	Technical	X	X	X	X	X	X	X
Colorado Association of Conservation Districts	coloradoacd.org	Financial, Technical	X	X	X	X	X	X	X
CDPHE	cdphe.colorado.gov	Financial, Technical	X	X	X	X	X	X	X
Colorado Parks and Wildlife	cpw.state.co.us	Financial, Technical					X	X	X
Colorado Livestock Association	www.coloradolivestock.org	Technical				X		X	X
Colorado Department of Agriculture	ag.colorado.gov	Financial, Technical		X	X	X		X	X
Colorado Water Center	watercenter.colostate.edu	Technical						X	X
Colorado Water Conservation Board	cwcb.colorado.gov	Financial, Technical	X	X	X	X	X	X	X
Colorado Rural Water Association	www.crwa.net	Technical						X	X
Colorado Department of Natural Resources	dnr.colorado.gov	Financial, Technical	X	X	X	X	X	X	X
Colorado Energy and Carbon Management Commission	ecmc.state.co.us	Financial, Technical		X	X	X			
Colorado Geological Survey	coloradogeologicalsurvey.org	Financial, Technical						X	
Colorado Bureau of Land Management	www.blm.gov	Financial, Technical					X	X	X
Colorado Division of Reclamation, Mining, and Safety	drms.colorado.gov	Financial, Technical					X	X	X
Colorado State Land Board	slb.colorado.gov	Financial							X

Table 13-1. Sources of Technical and Financial Assistance (Page 3 of 3)

Agency or Organization	Website	Assistance	BMP Category						
			Developed Non-MS4	Cropland	Pasture	Feedlot	Forest	Stream	Outreach
FEDERAL									
U.S. Army Corps of Engineers	www.usace.army.mil	Financial, Technical						X	X
USDA–NRCS	www.nrcs.usda.gov	Financial, Technical		X	X	X	X	X	X
USDA–Farm Service Agency	www.fsa.usda.gov	Financial, Technical		X	X	X		X	X
USDA–Rural Development	www.rurdev.usda.gov	Financial, Technical						X	X
USDA–Bureau of Land Management	www.blm.gov	Financial, Technical					X	X	X
U.S. Department of Interior–Bureau of Reclamation	www.usbr.gov	Financial, Technical	X	X			X	X	X
EPA	www.epa.gov	Financial, Technical	X	X	X	X	X	X	X
USDA–Forest Service	www.fs.fed.us	Financial, Technical					X	X	X
U.S. Fish & Wildlife Service	www.fws.gov	Financial, Technical						X	X
USGS	www.usgs.gov	Technical						X	X
PRIVATE									
Ducks Unlimited	www.ducks.org	Financial, Technical						X	X
Colorado Trout Unlimited	coloradotu.org	Financial, Technical						X	X
Fresh Water Trust	www.thefreshwatertrust.org	Financial, Technical	X	X	X	X	X	X	X
Mule Deer Foundation	www.muledeer.org	Financial, Technical					X	X	X
Rocky Mountain Elk Foundation	www.rmef.org	Financial, Technical					X	X	X
National Fish and Wildlife Foundation	www.nfwf.org	Financial, Technical						X	X

13.1 INCENTIVE PROGRAMS

Incentive programs are formal programs used to promote specific actions or behaviors. Participation in incentive programs is voluntary. Various mechanisms can be used to conduct incentive programs, including financial assistance or providing benefits for enrolling in programs. The following programs are relatively easy for users to take advantage of, and the money for them is generally allocated annually.

13.1.1 COST-SHARE PROGRAMS

In a cost-share program, the costs of systems or practices for water quality improvements are shared between the landowner, state (percentage), or federal programs (flat rate). State-funded nonstructural land management cost sharing is also typically based on a flat rate. Landowners seeking cost-share assistance should contact their county conservation district office for information on available programs. The BMPs and conservation practices that are typically eligible are those that avoid, control, and trap nutrients, sediment, and *E. coli* from entering surface water and groundwater. Eligibility may vary depending on local priorities and needs.

13.1.2 FEE DISCOUNTS

Local governments or nonprofit entities may offer reduced fees for implementing projects and practices that align with program goals. For instance, stormwater fees could be reduced if a landowner voluntarily converts cropped acres to a permanent vegetative cover.

13.1.3 LOW-INTEREST LOANS

Low-interest loans may be available through various state agencies to landowners for agricultural BMPs, septic system updates/replacement, or other projects that meet funding eligibility criteria.

13.1.4 WATER QUALITY TRADING

Point source permittees should be mindful that options are available to use money available for upstream NPS implementation to improve water quality for a smaller potential cost. These options need to be further evaluated and quantified.

13.2 POTENTIAL FUNDING

Funding is available from private, local, county, state, and federal sources to implement projects for improving water quality. The following sections discuss these sources. Other funding sources not noted here may be available. The state of Colorado maintains a Grants Information page on its website.

13.2.1 CITIES

Municipalities often collect stormwater utility fees to build, repair, operate, and maintain stormwater management systems. Such fees should be set using reasonable calculations based on runoff volume or pollution quantities, property classifications, or both.

13.2.2 COUNTIES, WATERSHED DISTRICTS, AND AUTHORITIES

In other areas of Colorado, authorities have been developed, such as the Cherry Creek Basin Water Quality Authority and the Chatfield Watershed Authority. These authorities can levy funds for priority projects and assist with program implementation. The NFRWQPA and other 208 planning agencies cannot levy funds or taxes for projects, but they have voluntary fees and dues that contribute to planning and implementation. Recently, the Chatfield Watershed Authority also added an entrance fee to the Chatfield State Park to assist with protecting water quality.

13.2.3 STATE

The State of Colorado funds watershed management programs through various capacities, programs, and agencies.

The CDPHE has numerous NPS funding opportunities, which include watershed implementation projects (restoration and protection), watershed planning and tool development, and education and outreach. The primary CDPHE opportunities consist of the Source Water Assessment and Protection (SWAP) Program; the Water Quality Grants and Loans Unit; CSU's Colorado Wetland Information Center; CSU's Colorado State Forest Service; the Department of Natural Resources' Colorado Water Conservation Board (CWCB); Colorado Water Plan Grants; and Colorado Watershed Restoration Grants. More information regarding each program is provided in CDPHE [2022]. Funds from the Water Supply Reserve Fund (WSRF) are issued through the South Platte Basin Roundtable. CDPHE has a state revolving fund that includes a Water Pollution Control revolving fund that completes many OWTS to sewer projects.

Under the Colorado Natural Resources Department, the CWCB also administers the Federal Technical Assistance Grant Program, consisting of Local Capacity Grants and Technical Assistance Grants. Federal American Rescue Plan Act funding of $5 million is available for these two grants in Colorado. The grantee must provide a minimum of 25 percent matching funds. Grants will be awarded on a rolling basis through December 2024; grant funds must be fully expended by December 2026. Local Capacity Grants are direct awards to grantees to secure the resources needed (contractors or otherwise) to develop projects and submit competitive federal grant applications. Technical Assistance Grants are awards to grantees who want to use a contractor hired by the CWCB. This contractor can provide a wide variety of water project services, such as federal grant opportunity research, project design, partial engineering, cost estimation, and federal application development/grant writing.

Statewide education grants and outreach initiative grants are available through the Public Education, Participation, and Outreach (PEPO) Grant Program, which is administered through the CWCB. The PEPO Grant Program also financially supports designated individual coordinators who support basin-specific outreach and education efforts alongside each of the state's basin roundtables. The Colorado Department of Natural Resources also maintains a Water Funding Opportunity Navigator, which lists potential federal and state grant opportunities.

Other state funding opportunities include the Colorado Healthy Rivers Fund. This program grants money to local watershed organizations to provide clean water, protect habitat, and improve recreation and accessibility throughout Colorado. Project grants and planning grants are available under the program.

13.2.4 FEDERAL

Federal agencies can provide funding and technical assistance for projects and monitoring. These agencies include U.S. Fish and Wildlife Service (USFWS), USGS, NRCS, Farm Service Agency, EPA, and others. The USGS is more likely to support data acquisition and monitoring programs and the USFWS may provide land retirement program funds. The NRCS helps with applying conservation practices, and the EPA assists with studies to identify more localized sources of pollution in impaired waterbodies. The following sections provide information regarding federal NPS funding.

13.2.4.1 U.S. ENVIRONMENTAL PROTECTION AGENCY

The EPA provides funding opportunities for watershed restoration and protection on its funding resource webpage for NPS pollution. Additional EPA funding opportunities are available online on the Equity Action Plan webpage and Environmental Justice Grants, Funding and Technical Assistance webpage.

The EPA also has a funding opportunity through the Office of Wetlands, Oceans, and Watersheds' Fiscal Year 2024 Building Partner Capacity and Promoting Resiliency and Equity under the CWA. The EPA is soliciting applications from eligible applicants to provide support for training and related activities to build the capacity of agricultural partners; state, territorial, and Tribal officials; and nongovernmental stakeholders in support of the goals of the CWA Section 319 Nonpoint Source Management Program.

The EPA also has funding from the Clean Water State Revolving Fund (CWSRF) accessible via the About the Clean Water State Revolving Fund (CWSRF) webpage. These generally include funds for municipal wastewater facility construction, control of NPS pollution, decentralized wastewater treatment systems, green infrastructure projects, project estuaries, and other water quality projects.

13.2.4.2 U. S. DEPARTMENT OF AGRICULTURE'S NATURAL RESOURCES CONSERVATION SERVICE

The NRCS's natural resources conservation programs help individuals reduce soil erosion, enhance water supplies, improve water quality, increase wildlife habitat, and reduce damage caused by floods and other natural disasters. More information is available on the USDA Programs & Initiatives webpage.

The following technical and financial assistance programs are generally awarded annually through NRCS:

- **Agricultural Conservation Easement Program (ACEP).** Applications are accepted from April through December. ACEP easement agreements are typically awarded annually by the fall.
- **Conservation Stewardship Program (CSP).** The CSP helps agricultural producers maintain and improve existing conservation systems and adopt additional conservation activities to address priority resource concerns. Participants earn CSP payments for conservation performance—the higher the performance, the higher the payment. Different enrollment opportunities are available for CSP Classic, CSP Renewals and CSP Grasslands. Applications are accepted from April through December. CSP contracts are awarded by June or July.
- **Conservation Technical Assistance (CTA).** The CTA provides the nation's farmers, ranchers, and forestland owners with the knowledge and tools they need to conserve, maintain, and restore the natural resources on their lands and improve the health of their operations for the future. NRCS offers this assistance at no cost to the producers served.

- **Environmental Quality Incentives Program (EQIP).** EQIP provides financial and technical assistance to agricultural producers to address natural resource concerns and deliver environmental benefits, such as improved water and air quality; conserved ground and surface water; increased soil health; reduced soil erosion and sedimentation; improved or created wildlife habitat; and mitigation against increasing weather volatility. Applications are accepted on a continuous basis, with application cutoff for funding evaluation typically set in November of each year. EQIP contracts are typically awarded by April or May.
- **Regional Conservation Partnership Program (RCPP).** RCPP promotes coordination of NRCS conservation activities with partners that offer valuable contributions to expand the collective ability to address on-farm, watershed, and regional natural resource concerns. Announcements for Funding Proposals (AFPs) for RCPP Classic are typically advertised in October through November and awarded in June through August. RCPP Alternative Funding Arrangement (AFA) AFPs are typically announced March through May, with agreements awarded by September and, in some cases, the funds are carried over and awarded from October to December of the following fiscal year.
- **National Water Quality Initiative (NWQI).** NWQI provides a way to accelerate voluntary, on-farm conservation investments focused on water quality monitoring and assessment resources where they can deliver the greatest benefits for clean water. The NWQI is a partnership among NRCS, state water quality agencies, and EPA to identify and address impaired waterbodies through voluntary conservation.
- **Watershed Operations PL-566 Program.** The Watershed Protection and Flood Prevention Act (PL-566) authorizes the USDA-NRCS to help local organizations and units of government plan and implement watershed projects. PL-566 watershed projects are locally led to solve natural and human resource problems in watersheds up to 250,000 acres (less than 400 mi^2). At least 20 percent of any project benefits must relate directly to agriculture, including rural communities. A local sponsoring organization is needed to carry out, maintain, and operate works of improvement. The program has two main components, and each is funded separately: (1) watershed surveys and planning and (2) watershed and flood prevention operations and construction.
- **Conservation Innovation Grants (CIG)**. CIG is a competitive program that supports the development of new tools, approaches, practices, and technologies to further natural resource conservation on private lands. Through creative problem-solving and innovation, CIG partners work to address the nation's water quality, air quality, soil health, and wildlife habitat challenges while improving agricultural operations. Three program types are available: (1) national, (2) state, and (3) CIG On-Farm Conservation Innovation Trials.
- **Rural Development.** For OWTS funding, USDA Rural Development has a 504 Single Family Program, a Community Development Program, a Home Repair Loan/Grant Program, a Community Pass-through Program, and Water Well Trust Program. Income eligibility for these programs is often a sliding scale.

Other federal agency funding includes the U.S. Bureau of Reclamation (USBR) WaterSMART. Through WaterSMART, the USBR leverages federal and nonfederal funding to work cooperatively with states, tribes, and local entities as they plan for and implement actions to increase water supply sustainability through investments in existing infrastructure and attention to local water conflicts.

13.2.5 PRIVATE/OTHER SOURCES

Foundations, nonprofit organizations, and private contributions, including those from landowners and corporate entities, will be sought for plan implementation activities. Local foundations may fund education, civic engagement, and other local priority efforts. Such organizations acquire their own funding and may have project dollars and technical assistance that can be used. Major cooperators and funding sources include private landowners who typically contribute a percentage of project costs and may donate land, services, or equipment for projects or programs.

Some of the stakeholder questions asked in Survey #2 were related to the technical and financial assistance needed or used and how they used it. The City of Greeley is unsure of any financial assistance needs but has received federal relief or grants for fire recovery actions in the High Mountain Reservoir area. The City of Fort Collins does not need financial assistance for in-stream monitoring of BMP implementation but is aware of 319 NPS grants through the EPA for eligibility concerns and MS4 requirements. The City of Fort Collins has received grants from the LID program for pilot projects that test the effectiveness of LID technologies, as well as assistance from consultants, internal experts, CSU, field experts, and the BMPDB; however, the City would like more resources for agriculture and forest practices in urban environments. Colorado Watershed Assembly has received CWCB and NPS funds and other funds from the Cherry Creek Basin Water Quality Authority and Great Outdoors Colorado, as well as county and municipal funding and technical assistance. The Colorado Watershed Assembly tracks various federal grant opportunities and has used the CWCB and NPS Program for technical assistance. The Colorado Wheat Administrative Committee is aware of financial assistance from the conservation districts, NRCS, crop consultants, and NRCS Agricultural Research Service but has yet to secure funding.

The following are private foundations with available funding programs:

- The Laura Jane Musser Fund, a foundation based in Minnesota, assists public or not-for-profit entities to initiate or implement projects that enhance the ecological integrity of publicly owned open spaces while encouraging compatible human activities. The fund's goal is to promote public use of open space that improves a community's quality of life and public health, while also ensuring the protection of healthy, viable, and sustainable ecosystems by defending or restoring habitat for the diversity of plant and animal species.
- The Moore Charitable Foundation works to preserve and protect natural resources for future generations. This foundation and its affiliates support nonprofit organizations that protect land, wildlife, habitat, and water resources in several regional planning areas, including Colorado. The foundation also supports educational and community programs in these areas.
- The Colorado River Basin Salinity Control Act, established in 1974, provides authorization for enhancing and protecting numerous salinity control projects in Colorado and other states. High levels of salinity in water can reduce crop yields, limit the choice of crops that can be grown, and, at higher concentrations over long periods, can kill trees and make the land unsuitable for agricultural purposes. Through strong partnerships between the NRCS, private landowners, USBR, CWCB, and several local conservation districts, financial and technical assistance funds have been used to install irrigation improvements, such as the installation of pipelines, more efficient irrigation systems, and lining of ditches and small laterals.

- The Colorado Watershed Assembly routinely posts funding opportunities through its bimonthly newsletter available on the Colorado Watershed Assembly homepage.
- The South Platte Basin Roundtable offers two funding cycles annually, and information is available on the South Platte Basin homepage.

14.0 REFERENCES

American Veterinary Medical Association, 2016. "U.S. Pet Ownership Statistics," *avma.org*, accessed June 30, 2016, from *https://www.avma.org/KB/Resources/Statistics/Pages/Market-research-statistics-US-pet-ownership.aspx*

Brandt, T. R. and J. P. Colgan, 2023. Digital database of the previously published geologic map of the Boulder-Fort Collins-Greeley area, Colorado: U.S. Geological Survey data release, available online at *https://doi.org/10.5066/P95MSFVF*.

Briffa, J., E. Sinagra, and R. Blundell, 2020. "Heavy metal pollution in the environment and their toxicological effects on humans", Heliyon, Volume 6, Issue 9, e04691, ISSN 2405-8440, available online at *https://doi.org/10.1016/j.heliyon.2020.e04691*

Catena Analytics, 2024. "eRAMS Online," accessed August 13, 2024, from *https://erams.com/catena/*

Colorado's Decision Support Systems, 2024. "GIS Data by Category," accessed August 13, 2024 at *https://cdss.colorado.gov/gis-data/gis-data-by-category*

Coalition for the Poudre River Watershed, 2020. *Cache la Poudre River Watershed-Based Plan*, prepared by the Coalition for the Poudre River Watershed, Fort Collins, CO, available online at *https://static1.squarespace.com/static/5af07ab53917ee099d13c874/t/5eb1e67095ae0505f397957a/1588717186644/Final+CPRW+Watershed+Plan+-+April+2020.pdf*

Coalition for the Poudre River Watershed, 2021. "Cameron Peak Fire Update: CPRW's Role in Post-Fire Recovery & Restoration," accessed July 30, 2024, from *https://www.poudrewatershed.org/blog/cprw-post-fire-recovery-update-june2021*

Coalition for the Poudre River Watershed, 2024. "All CPRW Projects," accessed May 30, 2024, from *https://www.poudrewatershed.org/cprw-projects/*

Colorado Department of Public Health and Environment, 2002. North Fork Cache La Pode River, Sep r 7 Larimer Counrp, Colorado, prepared by CDPHE Water Quality Control Division, Denver, CO, for U.S. Environmental Protection Agency, Denver, CO.

Colorado Department of Public Health and Environment, 2022. *Colorado's Nonpoint Source Management Plan: 2022,* prepared by Colorado Department of Public Health and Environment Water Quality Control Division, Glendale, CO, available online at *https://drive.google.com/file/d/1nrZ1D4yp2LGHUxrNsyjwGbu3w1ZCs9wz/view*

Colorado Geospatial Portal, 2024. *2024 State of Colorado Public Parcels*, CO Office of Information Technology, Enterprise GIS, accessed August 14, 2024, from *https://geodata.colorado.gov*

Colorado Water Plan, 2015. "South Platte/Metro Analysis and Technical Update," accessed May 30, 2024, from *https://dnrftp.state.co.us/CWCB/Technical%20Update%20to%20Water%20Plan/1.%20Technical%20Update%20Documentation/Volume%201-Section%204.8-S%20Platte%20Metro%20Republican%20Results.pdf*

The Diggings, 2024. "Mining In Weld County, Colorado," accessed August 15, 2024, from *https://thediggings.com/usa/colorado/weld-co123*

Environmental Systems Research Institute, Inc., 2014. "USA Federal Lands," accessed August 14, 2024, from *https://www.arcgis.com/home/item.html?id=c959f521c02f4f64abf4d39019c5ccd5*

Fischer, J., 2023. Personal communication between J. Fischer, Invision GIS, CO, and C. Kirby, RESPEC, Rapid City, SD, December 14.

Graves, J., 2024. Personal communication between J. Graves, Colorado Division of Reclamation, Mining, and Safety, Denver, CO, and N. Acosta, RESPEC, Colorado Springs, CO, March 8.

Hawley, C. and N. Rodriquez-Jeangros, 2021. *Big Thompson State of the Watershed 2021 Final Report*, prepared by Hydros Consulting, Boulder, CO, for Big Thompson Watershed Forum, Fort Collins, CO.

Horsley and Witten, Inc., 1996. *Identification and Evaluation of Nutrient and Bacterial Loadings to Maquoit Bay, New Brunswick, and Freeport, Maine*, prepared by Horsley & Witten, Inc., Barnstable, MA, for Casco Bay Estuary Project, Portland, ME.

Horton, J.D., C. A. San Juan, and D. B. Stoeser, 2017. *The State Geologic Map Compilation (SGMC) geodatabase of the conterminous United States (ver. 1.1, August 2017): US Geological Survey Data Series 1052*, 46 p.

Larimer County, 2024. "Larimer County GIS Digital Data," accessed August 14, 2024, from *https://www.larimer.gov/it/gis/digital-data*

Metcalf and Eddy, 1991. *Wastewater Engineering: Treatment, Disposal and Reuse*, 3rd Edition, McGraw-Hill, New York.

Minnesota Pollution Control Agency, 2024. "Minnesota Stormwater Manual Overview of Minimal Impact Design Standards (MIDS)," accessed May 6, 2024, from *https://stormwater.pca.state.mn.us/index.php/Overview_of_Minimal_Impact_Design_Standards_(MIDS)*

Moore, E., 2022. *Colorado's Nonpoint Source Program: 2022 Annual Report*, prepared by Colorado Department of Public Health and Environment Water Quality Control Division, Denver, CO, available online at *https://storymaps.arcgis.com/stories/e7212fd7f8224b839b669fd8bbd058a4*

Multi-Resolution Land Characteristics Consortium, 2019. "National Land Cover Database 2019 - Landcover & Imperviousness (NLCD2019)," accessed August 14, 2024, from *https://www.mrlc.gov/data?f%5B0%5D=category%3ALand%20Cover&f%5B1%5D=year%3A2019*

National Interagency Fire Center, 2024. "InterAgencyFirePerimeterHistory All Years View," accessed August 14, 2024, from *https://data-nifc.opendata.arcgis.com/datasets/e02b85c0ea784ce7bd8add7ae3d293d0_0/explore?location=39.994103%2C-103.924962%2C8.89*

Natural Resources Conservation Service, 2024a. "Soil Survey Geographic Database (SSURGO)," accessed August 13, 2024, from *https://www.nrcs.usda.gov/resources/data-and-reports/soil-survey-geographic-database-ssurgo*

Natural Resources Conservation Service, 2024b. "Conservation Practices Physical Effects (CPPE) – FY24 National Template-Version 2," accessed May 14, 2024, from *https://www.nrcs.usda.gov/resources/guides-and-instructions/conservation-practice-physical-effects*

Natural Resources Conservation Service, 2024c. "Conservation Practice Standard Land Reclamation, Abandoned Mined Land Code 543," accessed May 30, 2024, from *https://www.nrcs.usda.gov/sites/default/files/2022-09/Land_Reclamation_Abandoned_Mined_Land_543_NHCP_CPS.pdf*

North Front Range Water Quality Planning Association, 2022. *208 Areawide Water Quality Management Plan 2022 – 208 AWQMP Update (Region 2)*, prepared by the North Front Range Water Quality Planning Association, Johnstown, CO.

PRISM Climate Group, 2024. "Average Monthly and Average Annual Precipitation 1961-1990, 1971-2000 and 1981-2010 by State," accessed May 14, 2024, from *https://gdg.sc.egov.usda.gov/Catalog/ProductDescription/PRCIP.html*

Smith, E., 2024. *2023 Zoning Boundary.zip,* attachment from personal communication between E. Smith, Town of Timnath, CO, and C. Kirby, RESPEC, Rapid City, SD, January 29.

Tetra Tech, Inc., 2022. *User's Guide Pollution Load Estimation Tool Version 1.0*, developed for the U.S. Environmental Protection Agency by Tetra Tech, Inc. Fairfax, VA.

The Water Research Foundation, 2024. "International Stormwater BMP Database," accessed August 14, 2024, from *https://bmpdatabase.org/*

Thomas, M., 2024. Personal communication between M. Thomas, North Front Range Water Quality Planning Association, Johnstown, CO, and C. Kirby, RESPEC, Rapid City, SD, May 2.

University of Missouri Extension, 2024. "Nitrogen in the Environment: Nitrogen's Most Common Forms," accessed June 5, 2024, from *https://extension.missouri.edu/publications/wq253*

U.S. Census Bureau, 2020. "QuickFacts: Loveland City, Colorado; United States" accessed July 29, 2024, from *https://www.census.gov/quickfacts/fact/table/lovelandcitycolorado,US/PST045222*

U.S. Department of Agriculture, 2024. "Farmers.gov," accessed May 30, 2024, from *www.farmers.gov*

U.S. Environmental Protection Agency, 2008. "Handbook for Developing Watershed Plans to Restore and Protect Our Waters," accessed August 13, 2024, from *https://www.epa.gov/nps/handbook-developing-watershed-plans-restore-and-protect-our-waters*

U.S. Environmental Protection Agency, 2022. "User's Guide Pollutant Load Estimation Tool (PLET) Version 1.0," accessed August 1, 2024, from *https://www.epa.gov/system/files/documents/2022-04/user-guide-final-04-18-22_508.pdf*

U.S. Environmental Protection Agency, 2023. "Best Management Practice Definitions Document for Pollutant Load Estimation Tool," accessed May 1, 2024, from *https://www.epa.gov/system/files/documents/2023-04/BMP_Description_revised%203-9-23_final%20with%20alt%20text_508.pdf*

U.S. Environmental Protection Agency, 2024a, "Nonpoint Source (NPS) Watershed Projects Data Explorer," accessed August 14, 2024, from *https://ordspub.epa.gov/ords/grts/f?p=109:940::::940::*

U.S. Environmental Protection Agency, 2024b. "Per- and Polyfluoroalkyl Substances (PFAS) Final PFAS National Primary Drinking Water Regulation," accessed August 14, 2024, from *https://www.epa.gov/sdwa/and-polyfluoroalkyl-substances-pfas*

U.S. Geological Survey, 2019. "SPARROW Modeling Program," accessed August 14, 2024, from *https://www.usgs.gov/software/sparrow-modeling-program*

U.S. Geological Survey Colorado Water Science Center, 2000. "NAWQA South Platte River Basin Study," accessed May 30, 2024, from *https://www.usgs.gov/centers/colorado-water-science-center/science/nawqa-south-platte-river-basin-study*

Workman, J. B., J. C. Cole, R. R. Shroba, K. S. Kellogg, and W. R. Premo, 2018. Geologic Map of the Fort Collins 30'×60' quadrangle, Larimer and Jackson Counties, Colorado, and Albany and Laramie Counties, Wyoming, available online at *https://ngmdb.usgs.gov/Prodesc/proddesc_108070.htm*

Zeckoski, R. W., B. L. Benham, S. B. Shah, and C. D. Heatwole, 2005. "BSLC: A Tool for Bacteria Source Characterization for Watershed Management," *Applied Engineering in Agriculture*, Vol. 21, No. 5, pp. 879–889.

APPENDIX A
SURVEY QUESTIONS

RESPEC

2022 SURVEY

1. Agency/organization's name
2. Website URL
3. Contact person(s), name(s)
4. Email address(s)
5. Phone number(s)
6. Which of the following watersheds is/are the focus of your organization
    a. Big and Little Thompson
    b. Middle South Platte
    c. Cache la Poudre
    d. St. Vrain Creek
    e. Other
7. If known, please list the waterbody name and segment identification (AUID) (i.e., COSPUS15) if it was selected from question #6, please provide the watershed name.
8. Does your agency have an existing watershed plan, source water plan, NPS plan, or other?
9. Please provide the link to the watershed plan(s) if available below or send a copy to Mark Thomas at: mthomas@nfrwqpa.org
10. Is the plan under development if you agency does not have an existing watershed plan identified in question #8?
11. What level of impact do the following nonpoint sources have on water quality in your watershed? (check one for each row)
    a. Abandoned mine lands
    b. Agriculture (including agricultural return flows and agricultural stormwater runoff)
    c. Hydromodification (diversions including transbasin diversions)
    d. Habitat alteration
    e. Urbanization
    f. Onsite wastewater systems (aka septic systems)
    g. Runoff from roadways
    h. Post wildfire impacts (includes post-wildfire flooding)
    i. Climate change
    j. Hazardous household or industrial wastes (pharmaceuticals, oil, paint, acids, pesticides, etc.)
12. What are the major pollutants of concern? (check all that apply)
    a. Sediment (includes ash from wildfire)
    b. Total suspended solids (TSS)
    c. Nitrogen
    d. Phosphorus
    e. Temperature
    f. Metals
    g. *E. coli*
    h. Emerging contaminants
    i. Other
13. Please check all water quality parameters/analytes that your group measures:
    a. Sediment (includes ash from wildfire)
    b. Total suspended solids (TSS)

c. Nitrogen
d. Phosphorus
e. Temperature
f. Metals
g. E. coli
h. Emerging contaminants
i. Other

14. If known, what is the period of record for each of the analytes listed above?
15. Is the data publicly available on the Colorado Data Sharing Network (CDSN)?
16. If the data is not publicly available, would you be willing to share your data with NFRWQPA?
17. What types of watershed projects have been completed?
    a. Habitat improvements
    b. Bank stabilization - grading
    c. Bank stabilization – vegetation
    d. Installation of drop or other in rivers
    e. Vegetation buffers
    f. Agricultural tailwater BMPs
    g. Unknown
18. What projects are high priority for your organization/watershed group?
19. What barriers from question (#18) may be preventing the project?
    a. Funding
    b. Technical resources
    c. Instrumentation
    d. Staffing/volunteer time
    e. No barriers are preventing the project
    f. Other
20. Does your organization/agency provide any of the following services:
    a. BMP recommendations
    b. Technical advice
    c. Water quality sampling
    d. Public education
    e. Other
21. Do you have policies, guidelines, or governing codes related to nonpoint source water quality adoption? Please, provide sources or weblinks.
22. Does your jurisdiction's county/municipal code reference the NFRWQPA 208 Areawide Water Quality Management Plan?
23. What can a regional NPS watershed plan help your watershed organization accomplish?
24. If known, provide or identify areas of special interest that need to be protected from NPS pollutants.
25. Why does your watershed organization value water quality?
26. What is the public perception of your watershed's water quality?
27. What other issues or concerns would you like NFRWQPA to be aware of?
28. If you want to be added to the email/ notification/distribution list regarding meetings and updates concerning the Regional NPS Watershed Plan, please provide your email below.

2024 SURVEY

1. Email address
2. First name
3. Last name
4. Please provide your contact information
5. Are you interested in participating with the NFRWQPA Technical Advisory Committee in guiding the Nonpoint Source plan best management practices (BMPs) for the Larimer and Weld County region and participating in the final report review for this project? If yes, please provide your name and email address.
6. What watershed are you most concerned with? Select all that apply.
    a. Middle South Platte - Cherry (Area of Concern: 10190003)
    b. St. Vrain (Area of Concern: 10190005)
    c. Big Thompson (Area of Concern: 10190006)
    d. Cache la Poudre (Area of Concern: 10190007)
    e. Lone Tree-Owl (Area of Concern: 10190008)
    f. Crow (Area of Concern: 10190009)
    g. Middle South Platte Sterling (Area of Concern: 10190012)
    h. Other (please specify)
7. Aside from watershed plans, what other major projects have you done or are you aware of that has or may improve water quality in the watershed?
8. When were they completed?
9. What is the approximate area impacted by the project?
10. What is the approximate area impacted by the project? Please describe.
11. Are there current plans for a watershed plan or update of an existing plan in your area?
12. How many months a year do agriculture producers typically apply manure on crops?
13. Rank the likelihood of each following cropland BMPs to be implemented in your area from 1 to 5, with 1 being unlikely and 5 being very likely
    a. List of BMPs from PLET
14. Does your watershed have BMPs for non-point source pollution? The following would be important to attain if available (including list/count estimate).
15. What BMPs have been implemented in your watershed? Please describe.
16. Approximately how many of each BMP type/technology (many are included in Section 5 questions) have been implemented in your HUC8?
17. What area of concern and/or water bodies are benefiting from the implemented BMPs? Please describe.
18. What land use(s) are the BMPs developed for? Select all that apply.
    a. Cropland
    b. Pasture
    c. Forest
    d. Urban
    e. Feedlot
    f. Other (please specify)
19. Please estimate the approximate area impacted by the implemented BMPs.
20. Is there any monitoring associated with determining pollutant load reductions and/or do the BMPs have estimated pollutant load reductions?

21. If you answered no, do you need technical and financial assistance to conduct monitoring?
22. What were the costs associated with the BMPs?
23. Are there noticeable improvements associated with implementing the BMPs? If yes, please describe.
24. Are there other BMPs you would like to see in addition to those currently constructed or implemented?
25. Please list any funded projects, activities, or next steps for non-point source pollution in your watershed in the next five years.
26. What types of information/education/outreach do you see being the most effective? Please check all that apply.
    a. Water Quality Awareness Signage in Parks by Streams
    b. Educational Campaign
    c. Social Media
    d. Story Map
    e. Newsletters, Mailers, Blurbs
    f. Website Update
    g. Park Signage
    h. "Report a Concern" Website
    i. Volunteer Cleanup Programs
    j. School Visits
    k. Pet-waste Pickup Stations
    l. Other (please specify)
27. Are you interested in collaboration with other stakeholder groups and hosting/participation in events?
28. Do you have any annual events/activities we could attend? If yes, please provide date/time/location/contact information.
29. Please describe what interim measurable criteria/milestones are used to determine goal achievement.
30. In 5 years, what does progress look like to you regarding pollution loading reduction in your area of concern?
31. In 10 years, what does progress look like to you regarding pollution loading reduction in your area of concern?
32. Which of the following in-stream monitoring activities would you likely consider implementing in your area of concern? Please select one or both options.
33. Do you need technical and financial assistance to conduct in-stream monitoring? If yes, please describe.
34. To develop/implement BMPs, do you need any financial assistance? If yes, please describe.
35. What financial assistance have you received for watershed improvement projects?
36. What are sources of financial assistance you know of but have not used?
37. What technical resources are needed to develop/implement BMPs?
38. What sources of technical assistance have you received in the past?
39. What are sources of technical assistance you know of but have not used?
40. Are there point discharges you are concerned about in your watershed (even in areas that are MS4 permitted)? If yes, please explain.

41. Are there non-point sources that you are concerned about in your watershed (even in areas that are MS4 permitted)? If yes, please explain.
42. Are you aware of abandoned mined land in your area?
43. If yes, are you aware of abandoned mined land BMP strategies implemented in your area?
44. What are the results of implementing such abandoned mined land BMP strategies?
45. Are you aware of agricultural practices (Cropland, Pasture, and/or Feedlot) in your area?
46. From the highest concern to the lowest, please rank the following agricultural concerns with 1 being the largest and 3 being the smallest: Cropland, Pasture, Feedlot.
47. Are you aware of agricultural BMP strategies implemented in your area?
48. If yes, what are the results of implementing such agricultural BMP strategies?
49. Are you aware of atmospheric deposition in your area?
50. If yes, are you aware of atmospheric deposition BMP strategies implemented in your area?
51. What are the results of implementing such atmospheric deposition BMP strategies?
52. Are you aware of forestry non-point source in your area?
53. If yes, are you aware of forestry non-point source BMP strategies implemented in your area?
54. Are you aware of hydromodification and habitat alteration in your area?
55. If yes, are you aware of hydromodification and habitat alteration BMP strategies implemented in your area?
56. If yes, what are the results of implementing such hydromodification and habitat alteration BMP strategies?
57. Are you aware of urbanization in your area?
58. If yes, are you aware of urbanization BMP strategies implemented in your area?
59. If yes, what are the results of implementing such urbanization BMP strategies?

APPENDIX B
MAPS OF IMPAIRED PARAMETERS

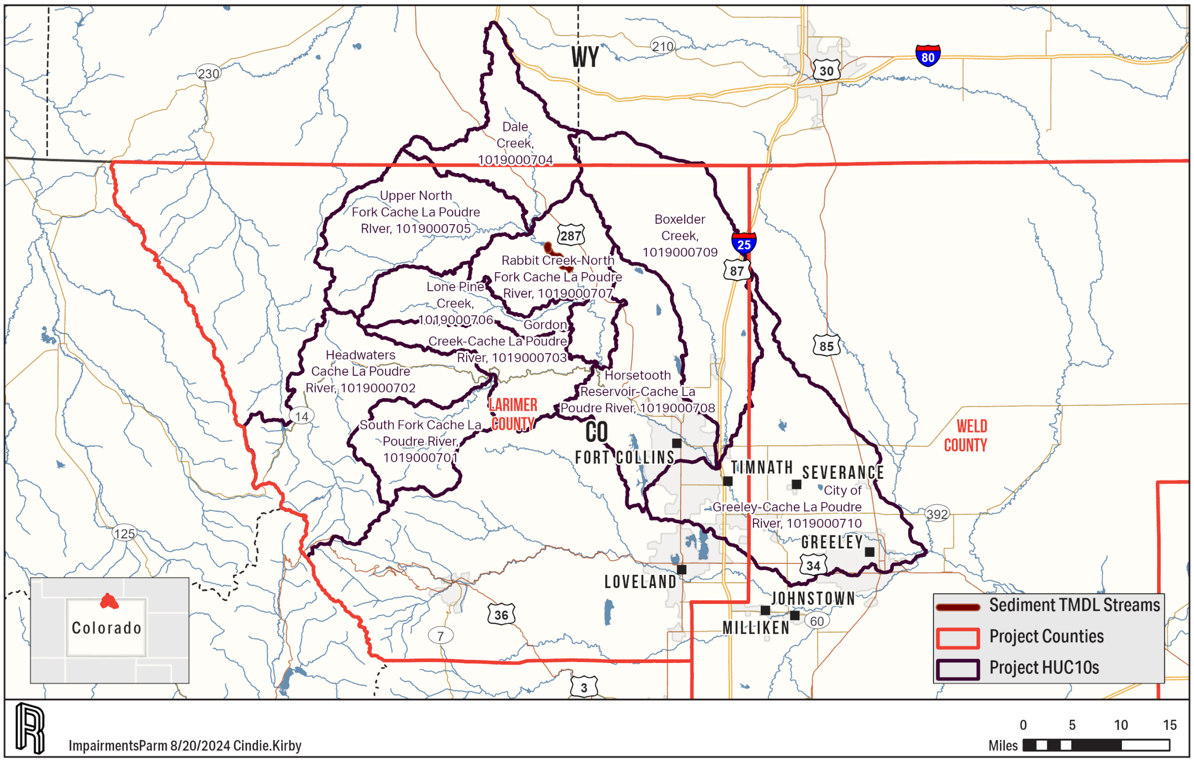


Figure B-1. Sediment Impairments.

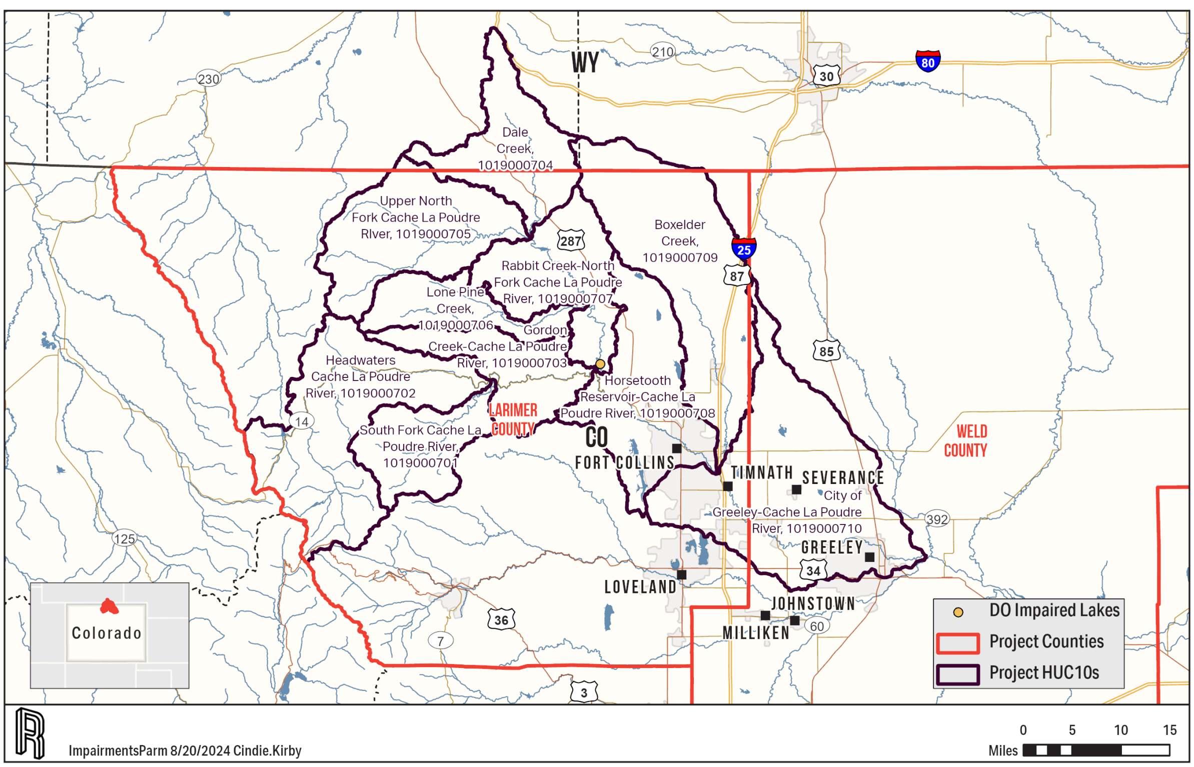


Figure B-2. Dissolved Oxygen Impairments.

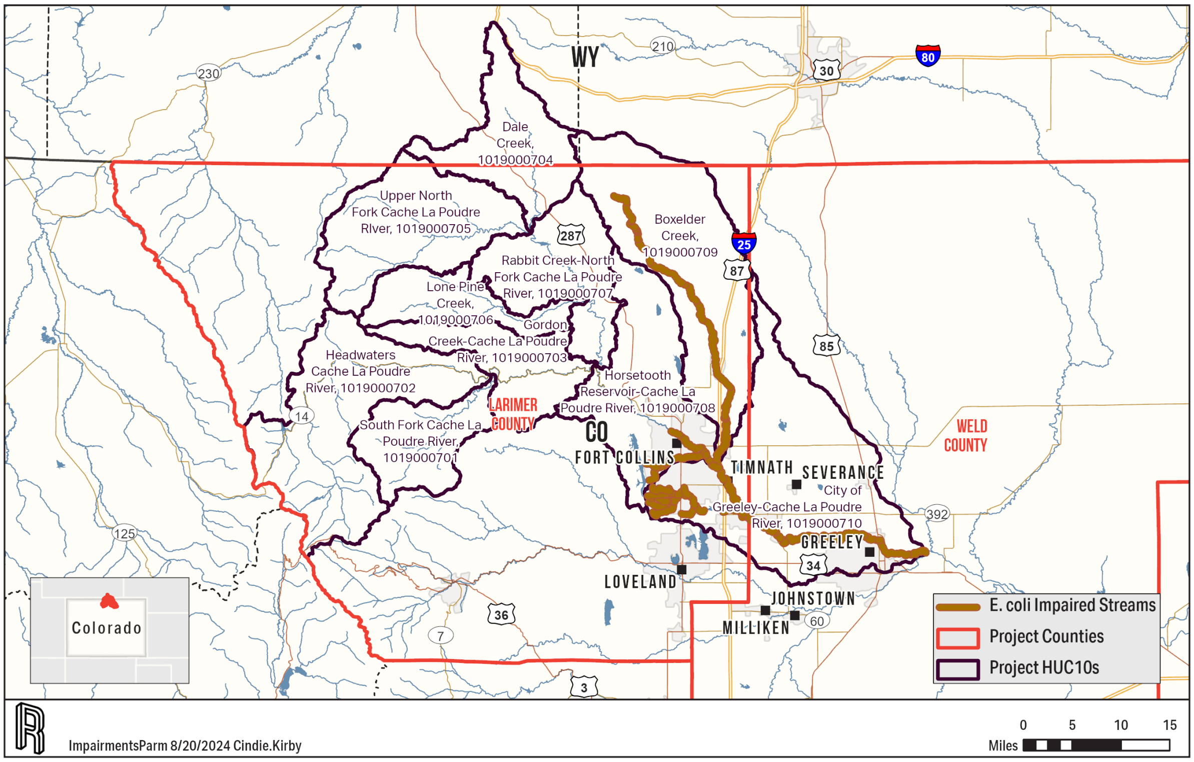


Figure B-3. *E. coli* Impairments.

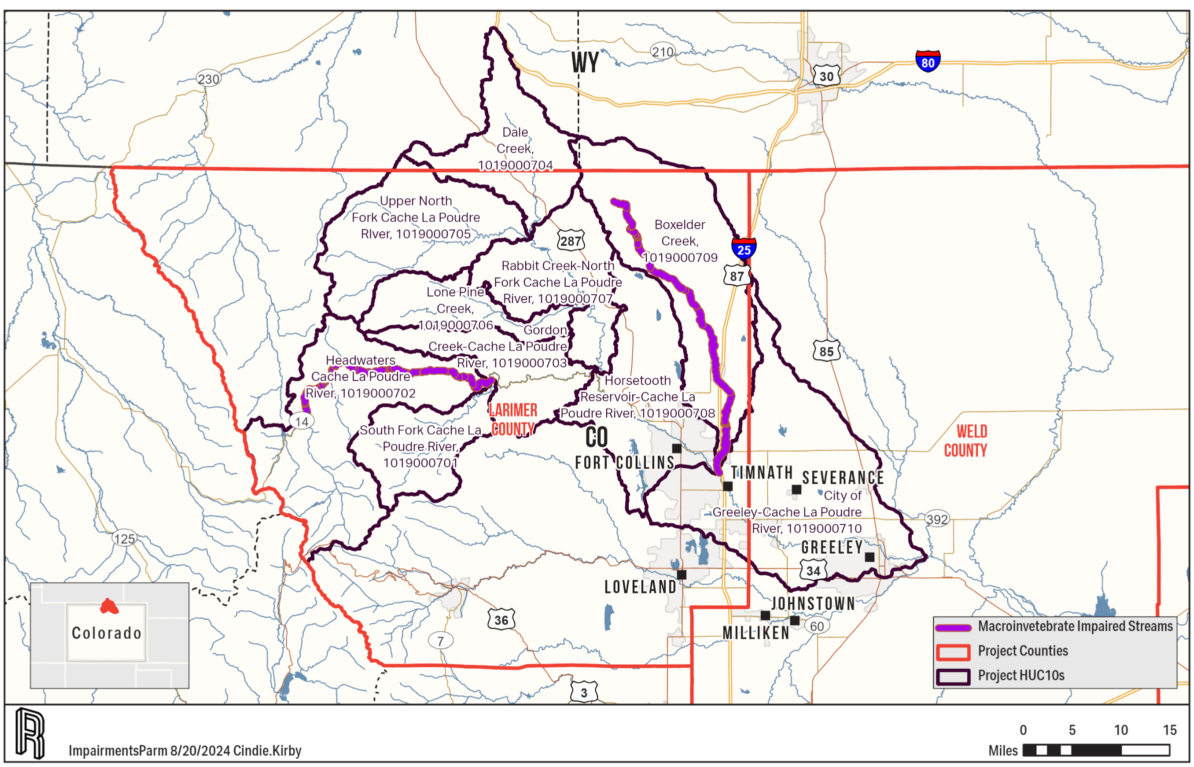


Figure B-4. Macroinvertebrate Impairments.

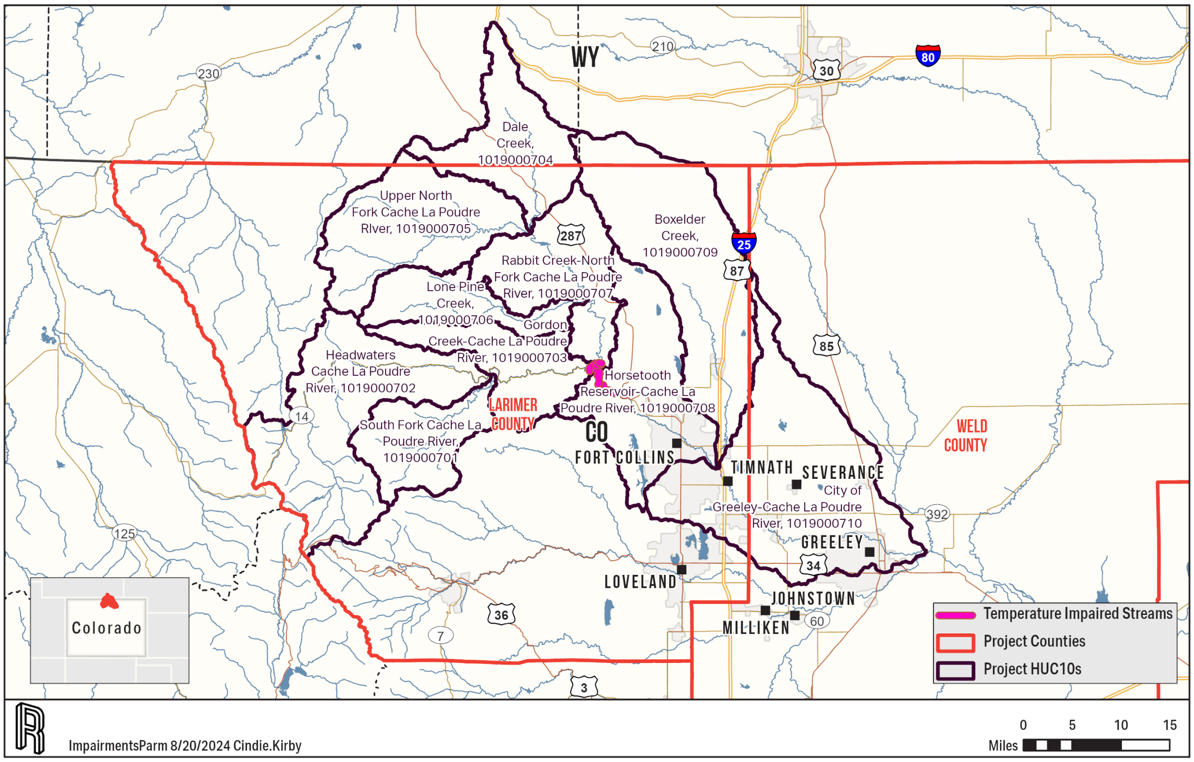


Figure B-5. Temperature Impairments.

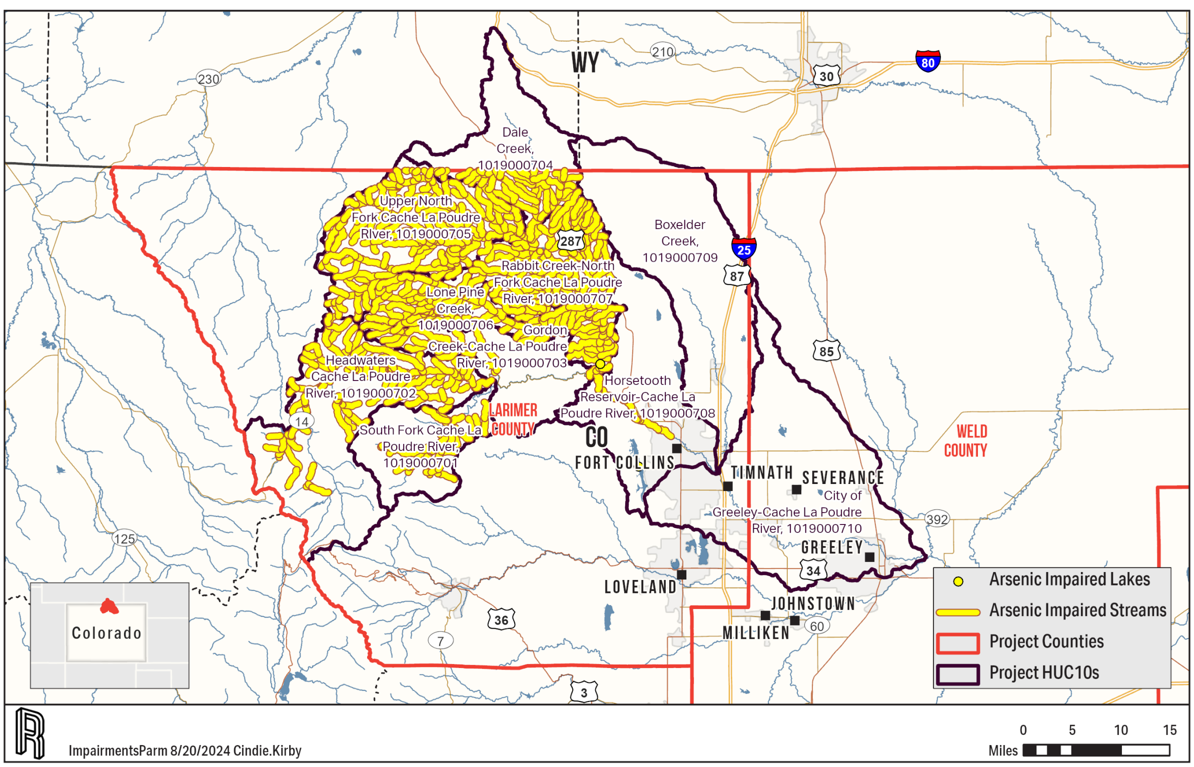


Figure B-6. Arsenic Impairments.

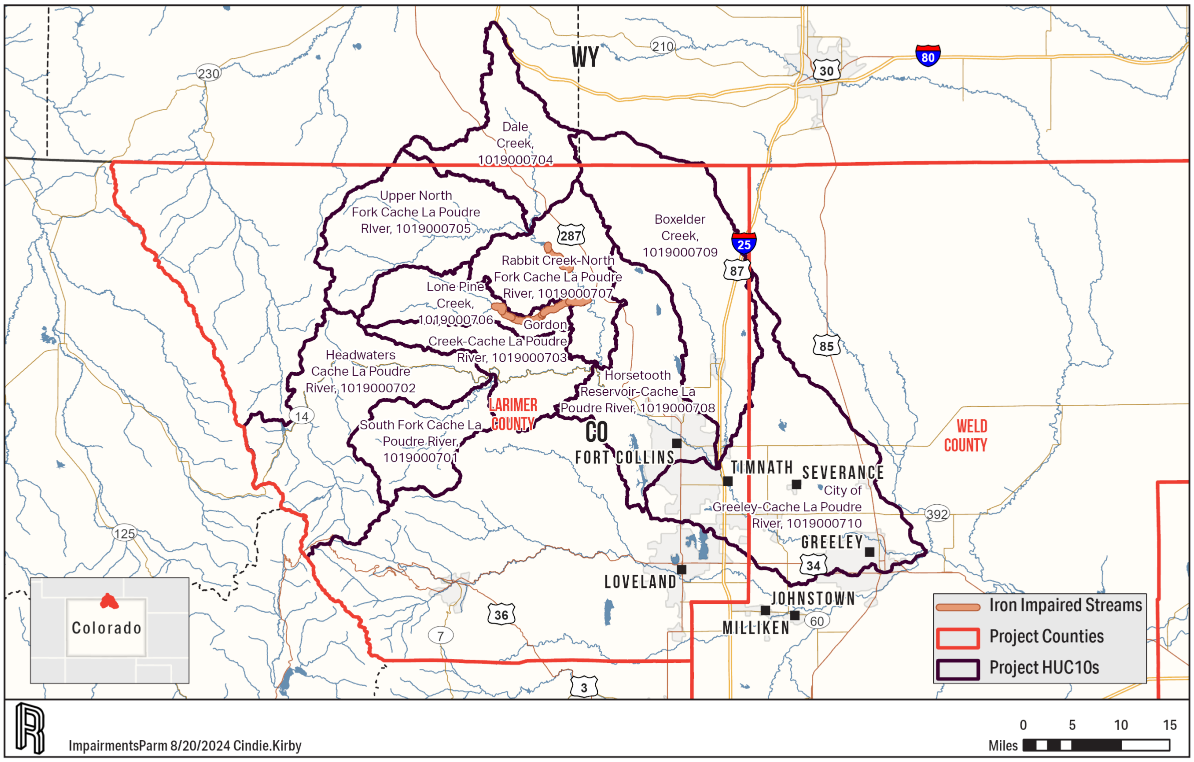


Figure B-7. Iron Impairments.

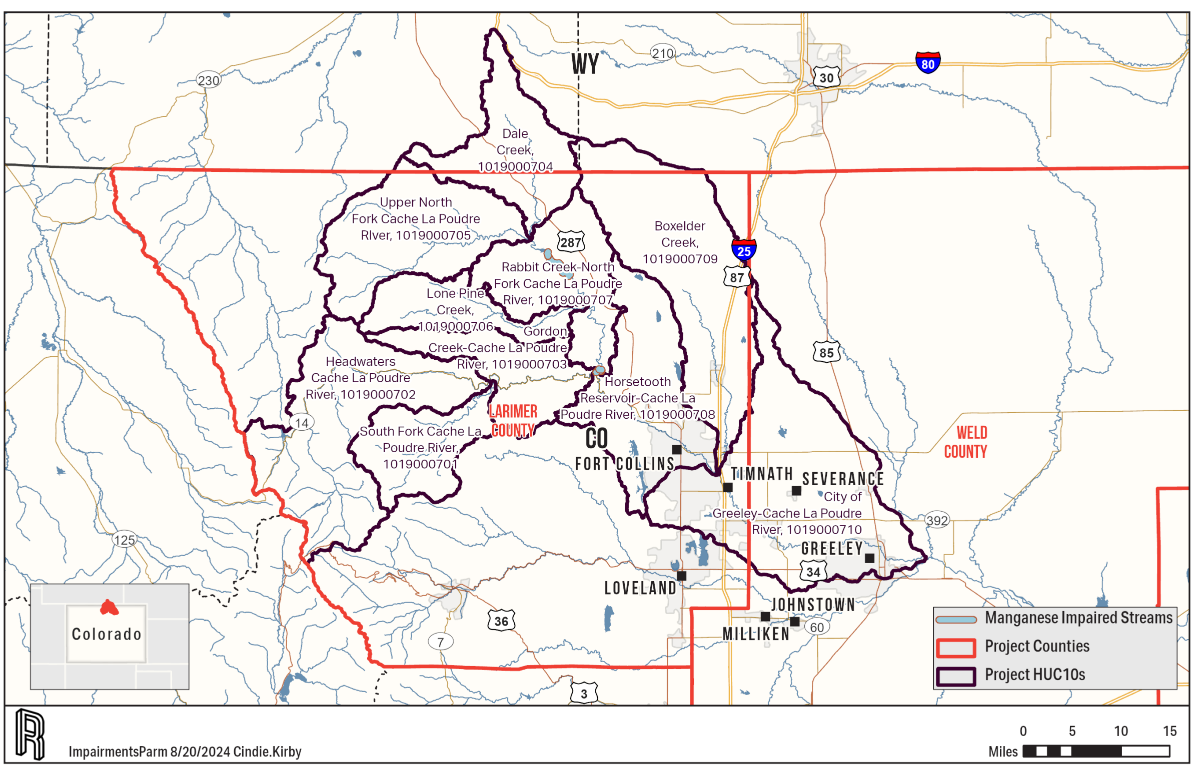


Figure B-8. Manganese Impairments.

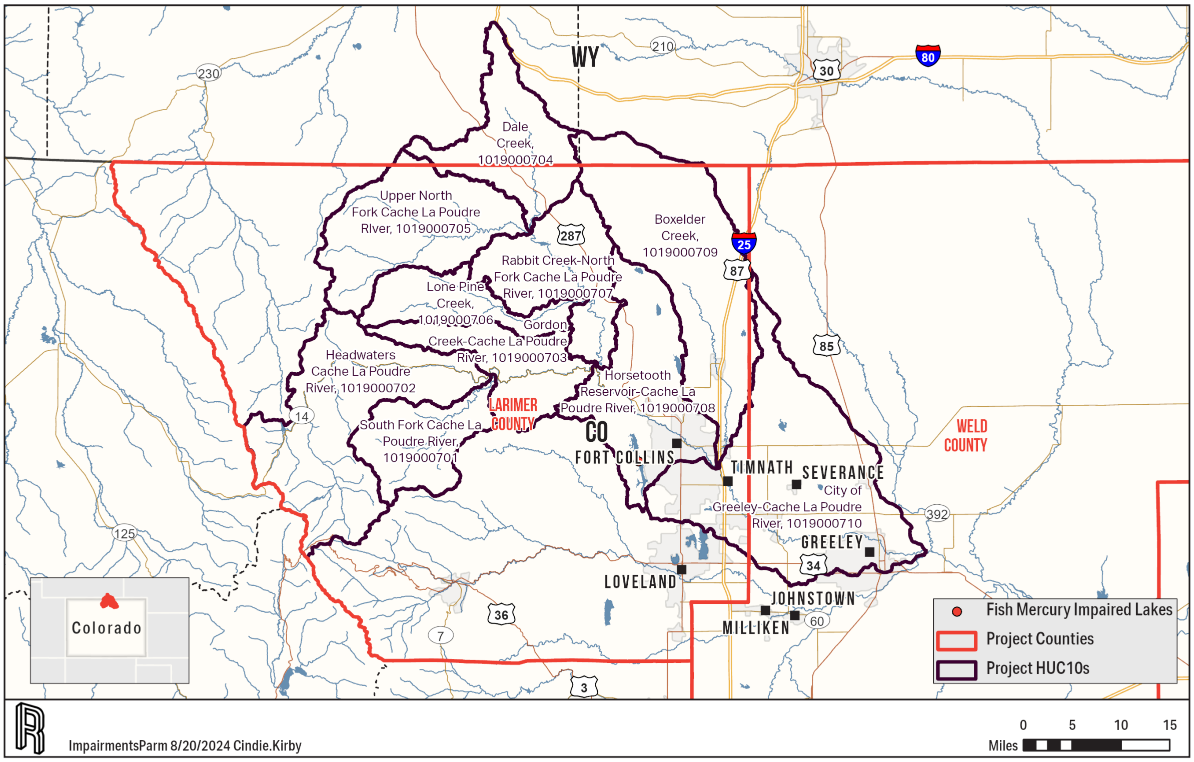


Figure B-9. Mercury Impairments.

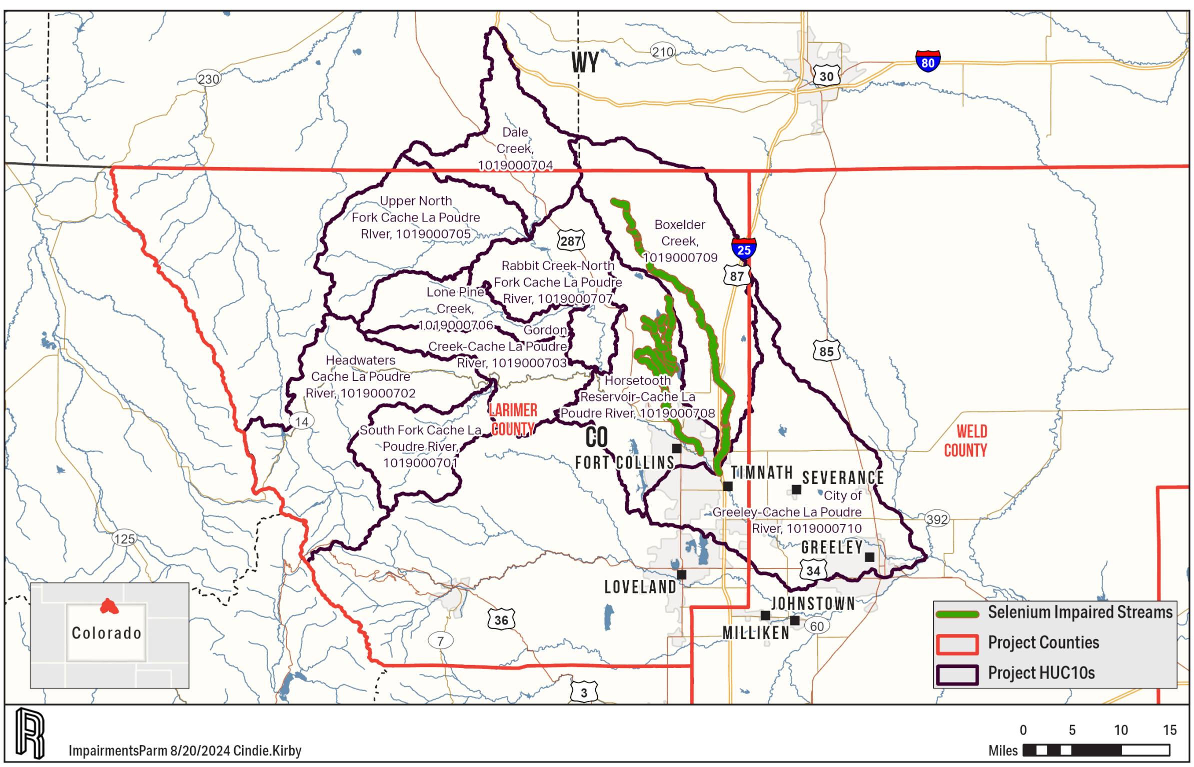


Figure B-10. Selenium Impairments.

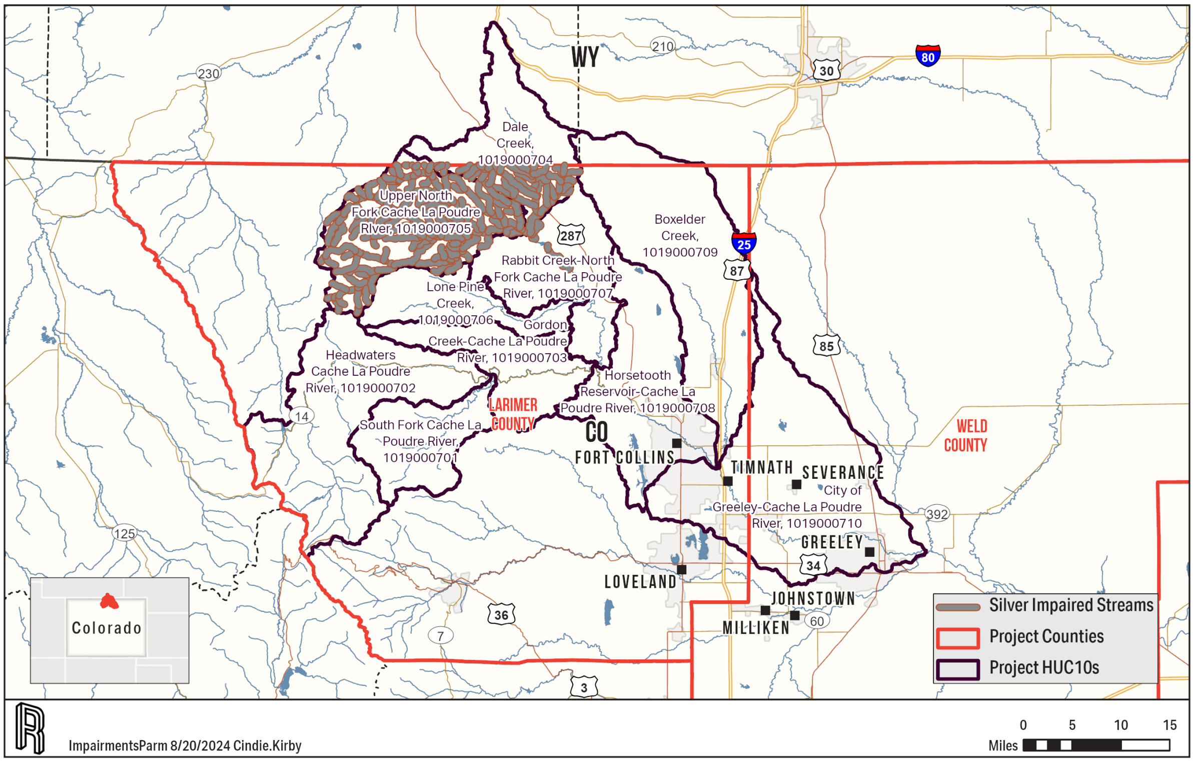


Figure B-11. Silver Impairments.

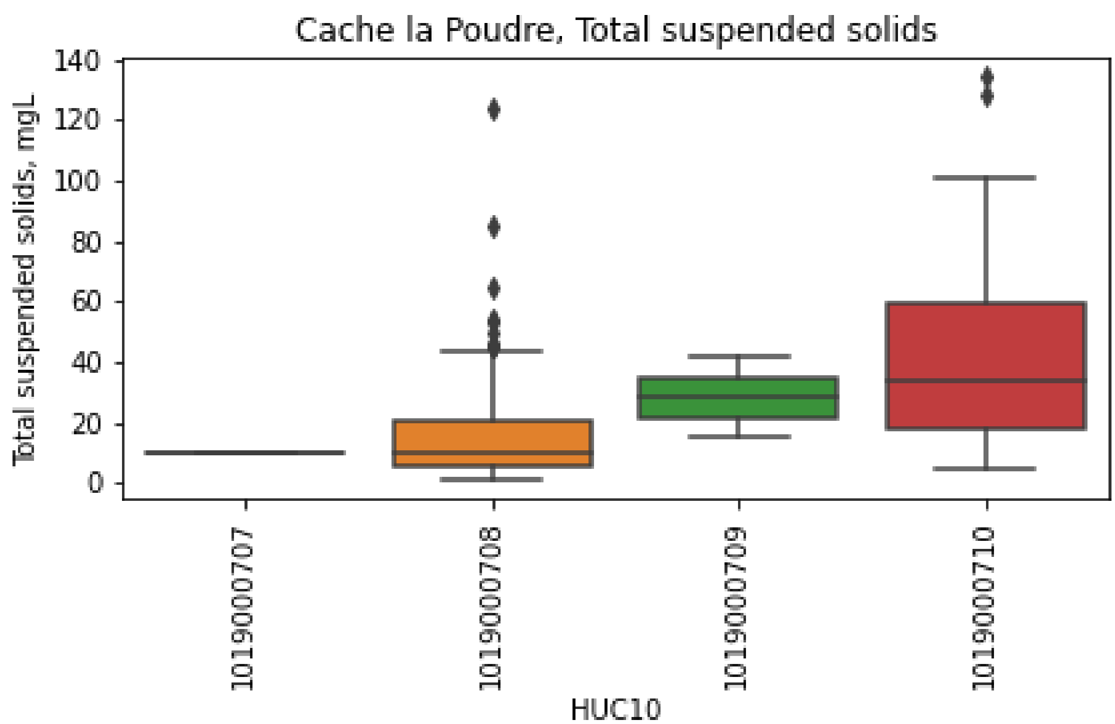
APPENDIX C

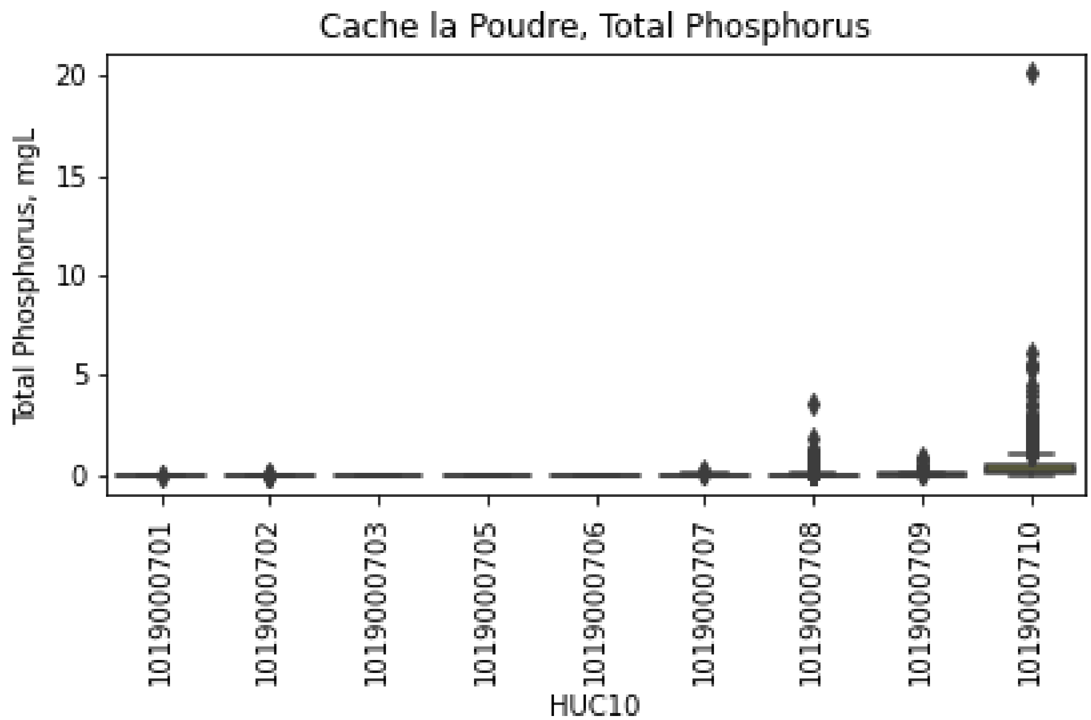
APPLICABLE WATER QUALITY BOX PLOTS BY HUC10

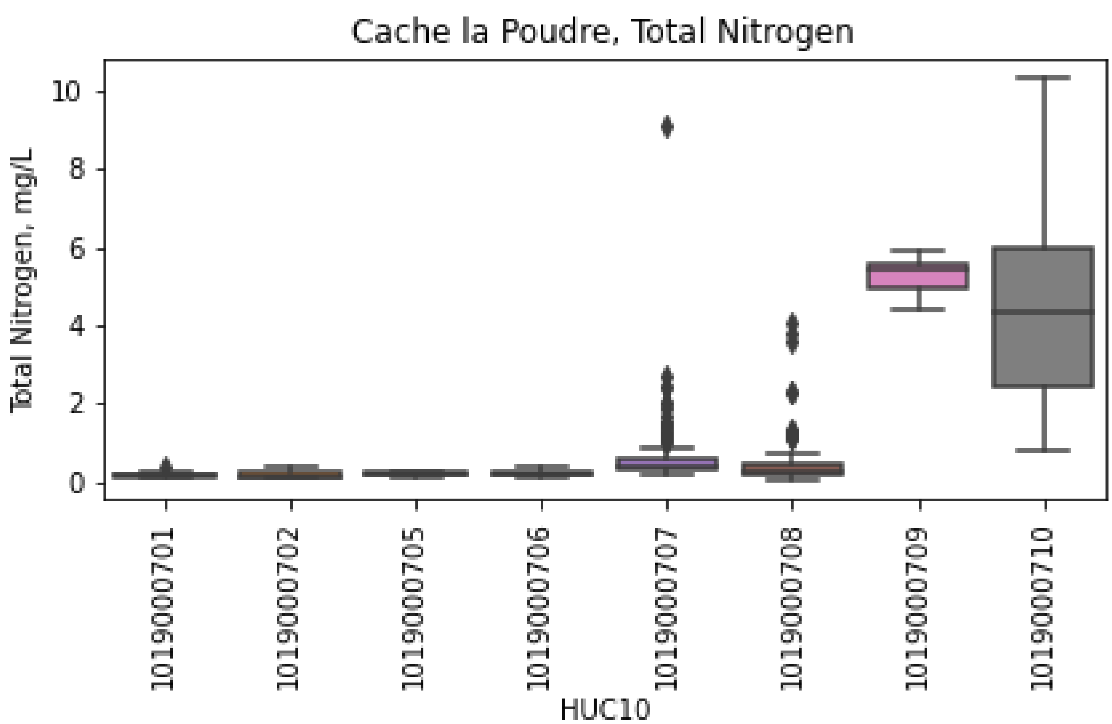
DATASET

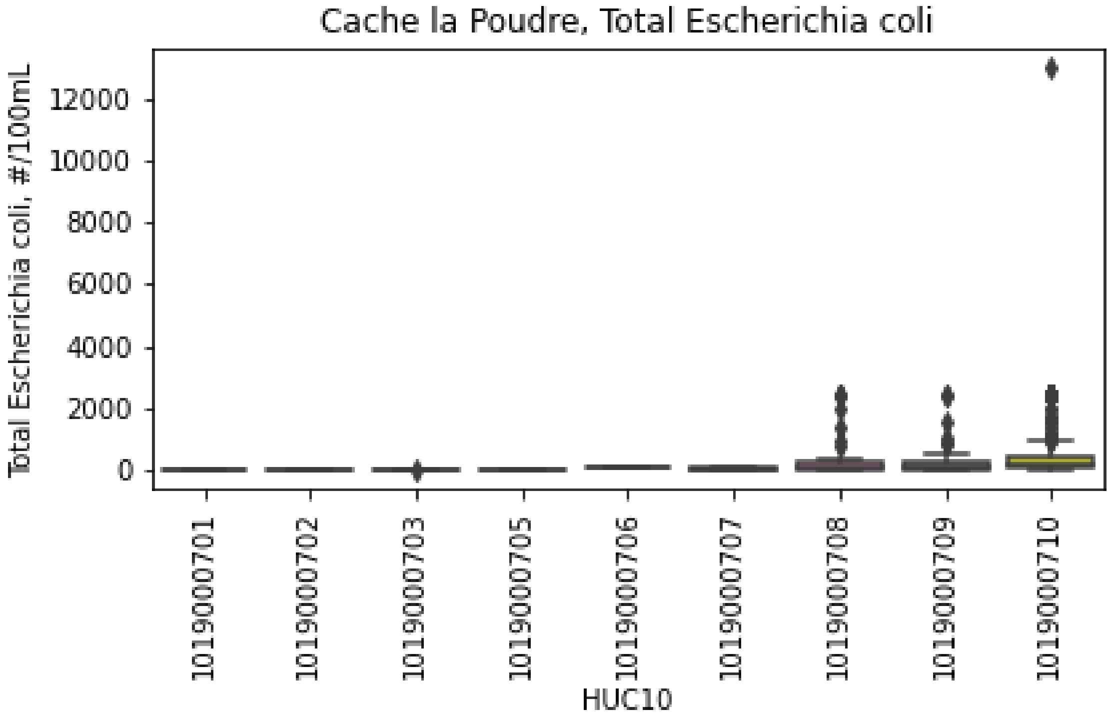
Data for boxplots were collected for the years 1990 through 2023 from various sources. Sources included the Water Quality Portal, the Colorado Data Sharing Network, Northern Water, ERAMS, and numerous individuals including Paul Bremser (St. Vrain), Andy Fayram (City of Loveland), Brian Hathaway (City of Greeley), and Jason Meier (Fossil Creek). Data were organized and grouped into a single file with consistent naming and units for applicable parameters and were assigned a "Y" or a "N" for an attribute representing if the monitoring point was located on a mainstem HUC10 reach. The boxplots only include data along the mainstem HUC10 reaches because water quality can vary greatly for headwater streams.

PLET PARAMETERS

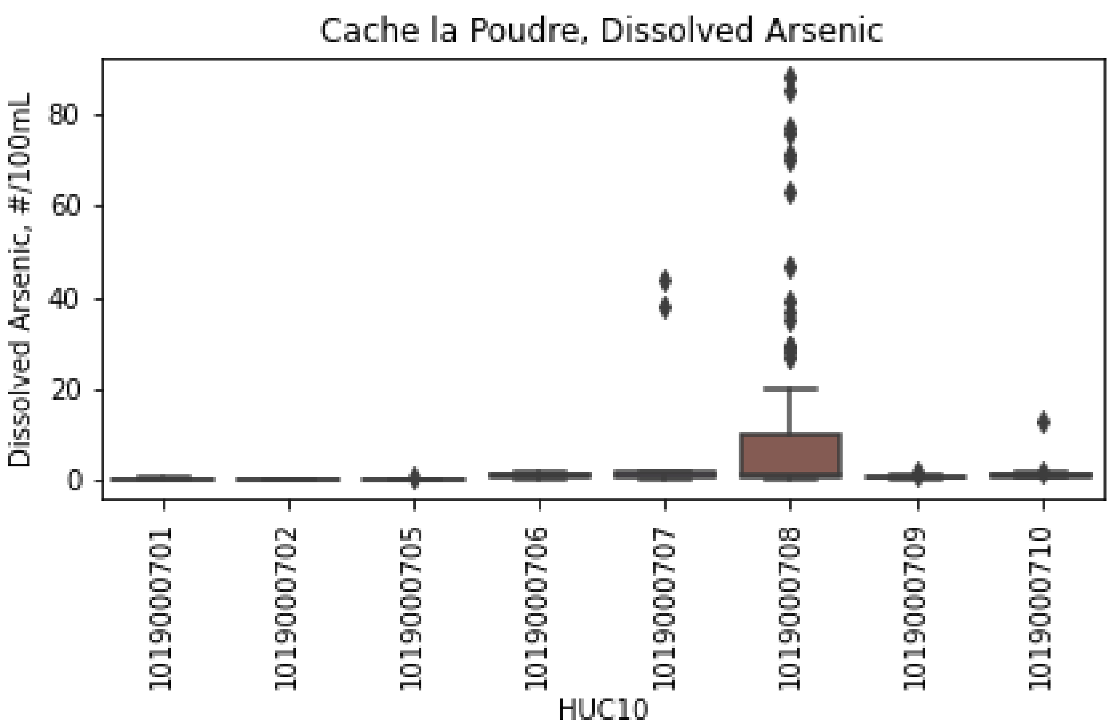


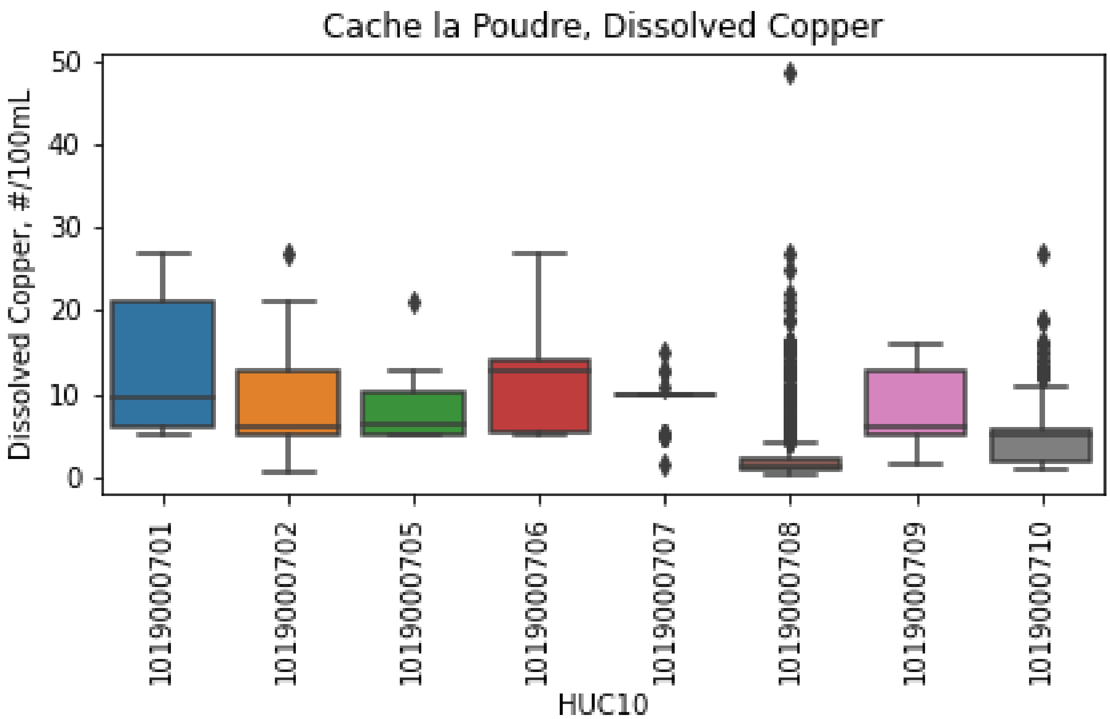

Cache la Poudre, Total Phosphorus
Total Phosphorus, mgL
20
15
10
5
0
1019000701
1019000702
1019000703
1019000705
1019000706
1019000707
1019000708
1019000709
1019000710
HUC10

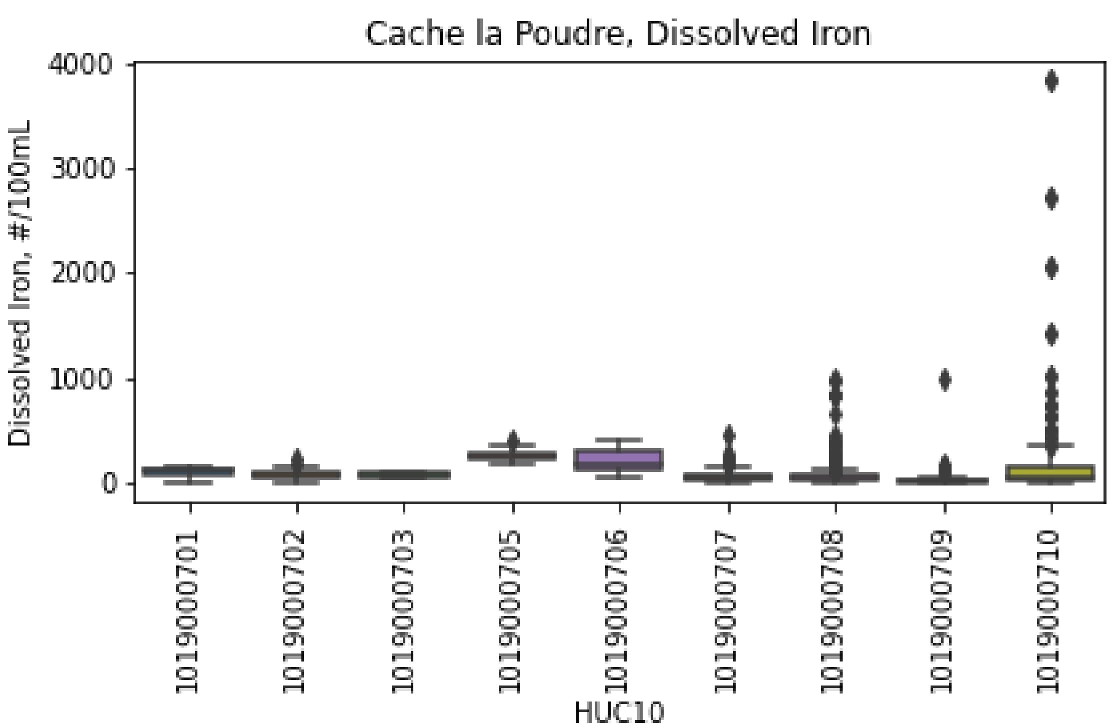

Cache la Poudre, Total Nitrogen
Total Nitrogen, mg/L
10
8
6
4
2
0
1019000701
1019000702
1019000705
1019000706
1019000707
1019000708
1019000709
1019000710
HUC10

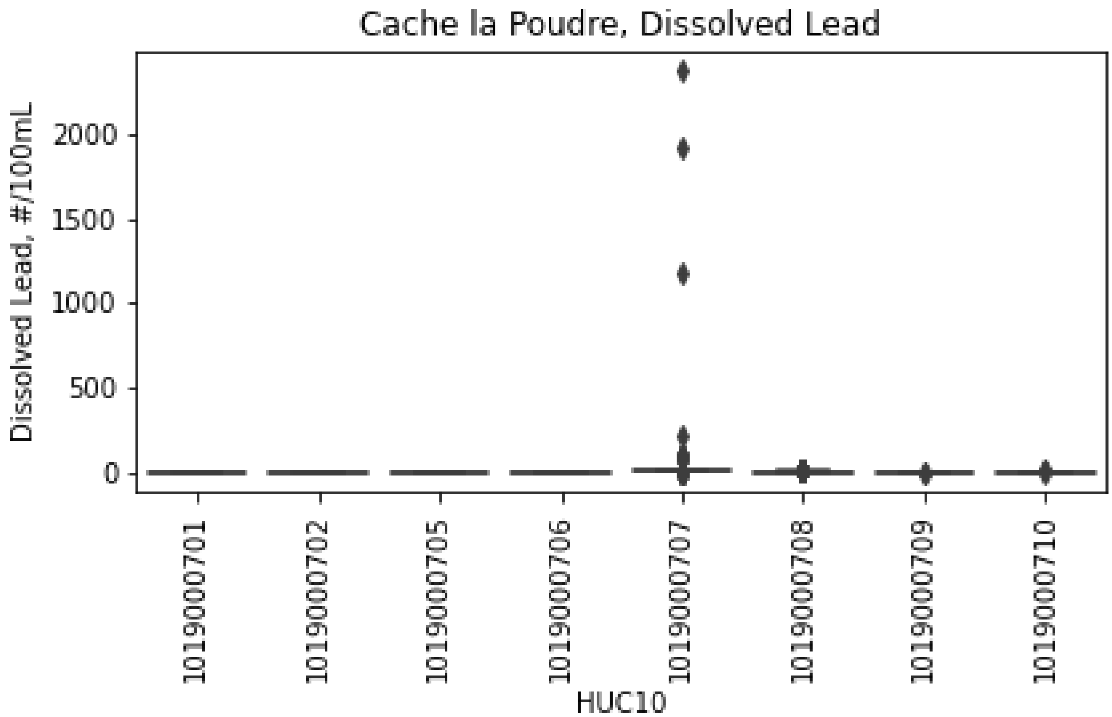


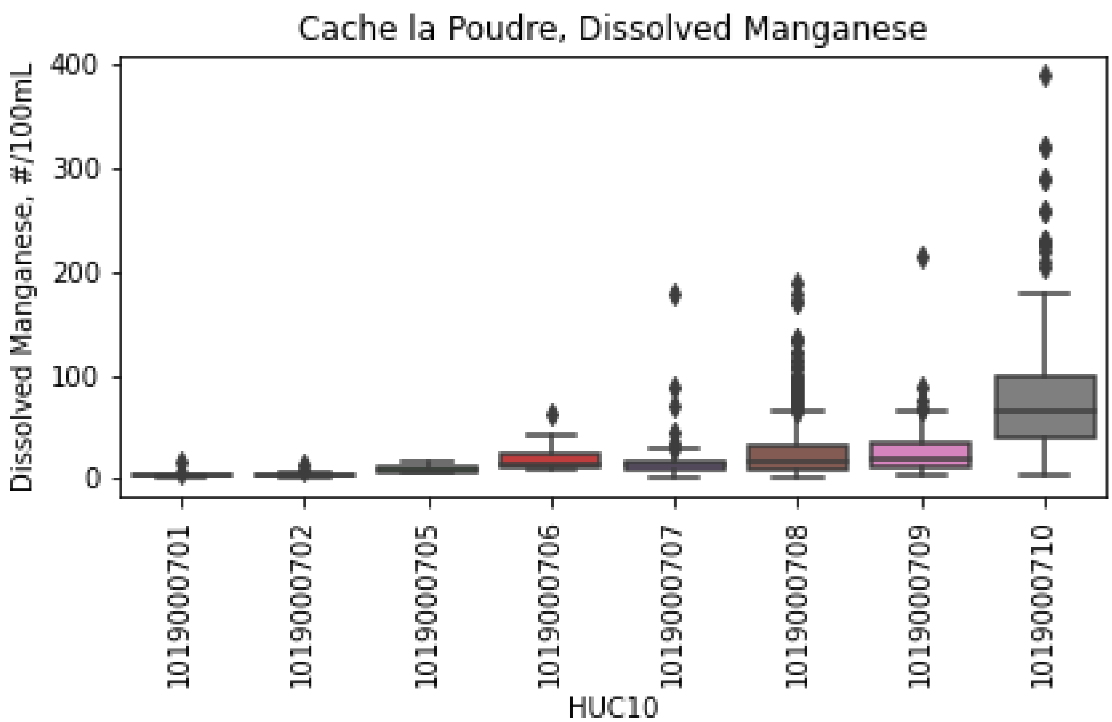
HEAVY METALS

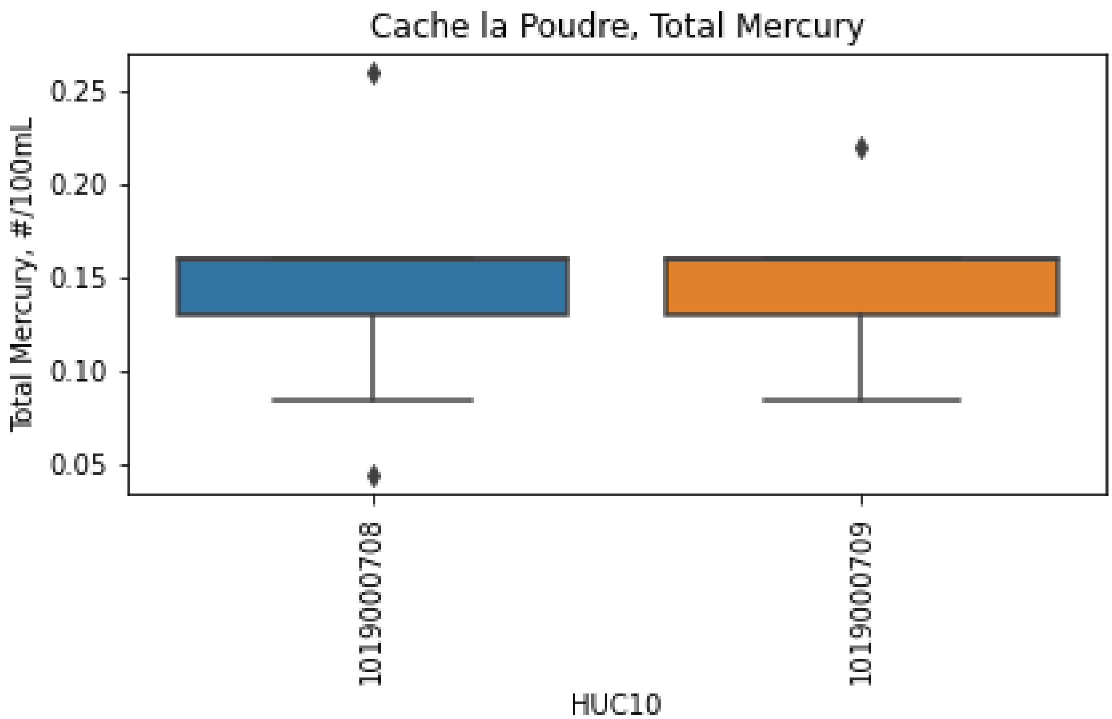


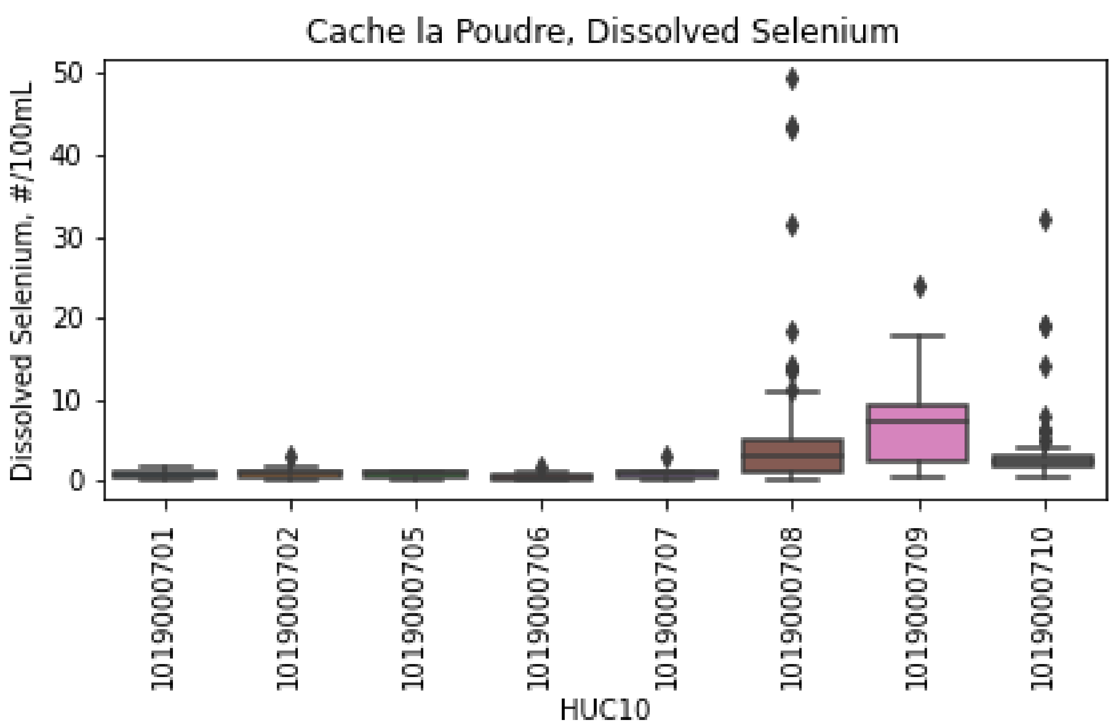

Cache la Poudre, Dissolved Copper
Dissolved Copper, #/100mL
50
40
30
20
10
0
1019000701
1019000702
1019000705
1019000706
1019000707
1019000708
1019000709
1019000710
HUC10

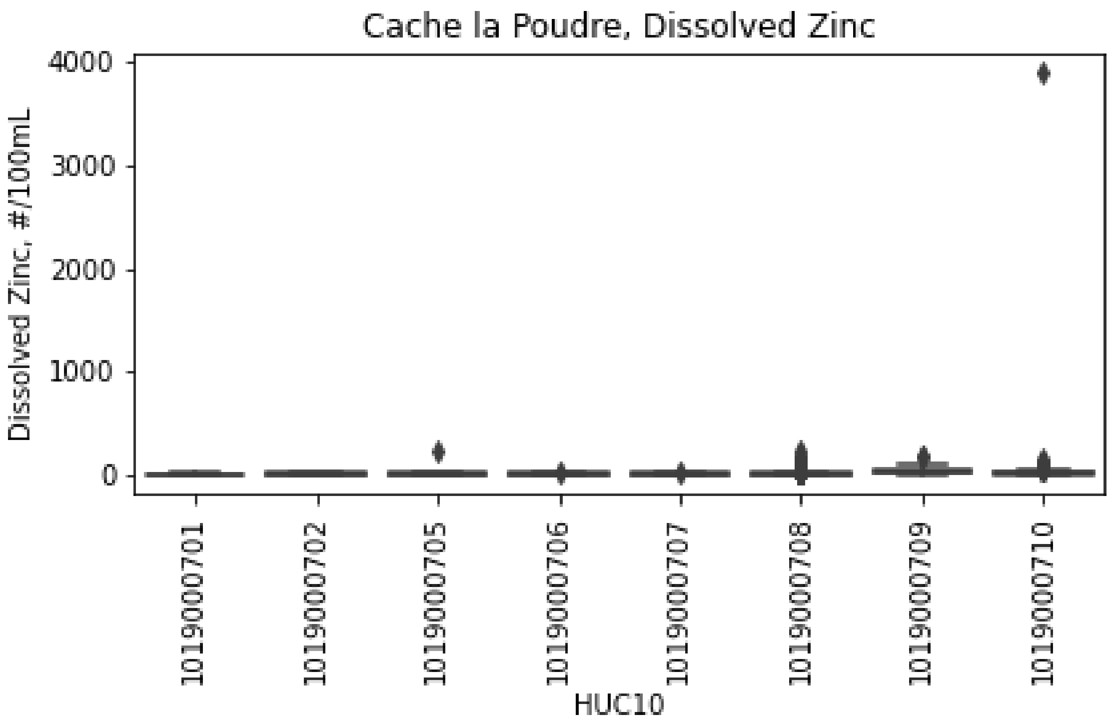

Cache la Poudre, Dissolved Iron
Dissolved Iron, #/100mL
4000
3000
2000
1000
0
1019000701
1019000702
1019000703
1019000705
1019000706
1019000707
1019000708
1019000709
1019000710
HUC10


Cache la Poudre, Dissolved Lead
Dissolved Lead, #/100mL
2000
1500
1000
500
0
1019000701
1019000702
1019000705
1019000706
1019000707
1019000708
1019000709
1019000710
HUC10


Cache la Poudre, Dissolved Manganese
Dissolved Manganese, #/100mL
400
300
200
100
0
1019000701
1019000702
1019000705
1019000706
1019000707
1019000708
1019000709
1019000710
HUC10


Cache la Poudre, Total Mercury
Total Mercury, #/100mL
0.25
0.20
0.15
0.10
0.05
1019000708
1019000709
HUC10


Cache la Poudre, Dissolved Selenium
Dissolved Selenium, #/100mL
50
40
30
20
10
0
1019000701
1019000702
1019000705
1019000706
1019000707
1019000708
1019000709
1019000710
HUC10


Cache la Poudre, Dissolved Zinc
Dissolved Zinc, #/100mL
4000
3000
2000
1000
0
1019000701
1019000702
1019000705
1019000706
1019000707
1019000708
1019000709
1019000710
HUC10

APPENDIX D

PLET SCENARIO REDUCTIONS

Table D-1. PLET Scenario Reductions (Page 1 of 4)

Land Use	Practice	HUC10	Nitrogen Reduction (%)	Phosphorus Reduction (%)	Sediment Reduction (%)
Cropland	Streambank Stabilization and Fencing	1019000701	0	0	0
Cropland	Streambank Stabilization and Fencing	1019000702	0	0	0
Cropland	Streambank Stabilization and Fencing	1019000703	0	0	0
Cropland	Streambank Stabilization and Fencing	1019000704	0	0	0
Cropland	Streambank Stabilization and Fencing	1019000705	0	0	0
Cropland	Streambank Stabilization and Fencing	1019000706	0.89	0.47	1.24
Cropland	Streambank Stabilization and Fencing	1019000707	2.96	1.63	3.46
Cropland	Streambank Stabilization and Fencing	1019000708	6.07	5.87	10.75
Cropland	Streambank Stabilization and Fencing	1019000709	9.27	9.47	13.9
Cropland	Streambank Stabilization and Fencing	1019000710	12.19	13.35	17.13
Cropland	35 ft Buffers	1019000701	0	0	0
Cropland	35 ft Buffers	1019000702	0	0	0
Cropland	35 ft Buffers	1019000703	0	0	0
Cropland	35 ft Buffers	1019000704	0	0	0
Cropland	35 ft Buffers	1019000705	0	0	0
Cropland	35 ft Buffers	1019000706	0.42	0.29	0.88
Cropland	35 ft Buffers	1019000707	1.4	0.99	2.44
Cropland	35 ft Buffers	1019000708	3.06	3.68	7.6
Cropland	35 ft Buffers	1019000709	4.75	5.98	9.82
Cropland	35 ft Buffers	1019000710	6.53	8.61	12.1
Pasture	Streambank Stabilization and Fencing	1019000701	0	0	0
Pasture	Streambank Stabilization and Fencing	1019000702	0.05	0.01	0.03
Pasture	Streambank Stabilization and Fencing	1019000703	0.19	0.04	0.09
Pasture	Streambank Stabilization and Fencing	1019000704	0.53	0.12	0.25

Table D-1. PLET Scenario Reductions (Page 2 of 4)

Land Use	Practice	HUC10	Nitrogen Reduction (%)	Phosphorus Reduction (%)	Sediment Reduction (%)
Pasture	Streambank Stabilization and Fencing	1019000705	0.2	0.04	0.12
Pasture	Streambank Stabilization and Fencing	1019000706	1.58	0.4	1.02
Pasture	Streambank Stabilization and Fencing	1019000707	0.52	0.14	0.28
Pasture	Streambank Stabilization and Fencing	1019000708	2.23	0.82	0.91
Pasture	Streambank Stabilization and Fencing	1019000709	0.96	0.38	0.37
Pasture	Streambank Stabilization and Fencing	1019000710	0.59	0.28	0.3
Pasture	35 ft Buffers	1019000701	0	0	0
Pasture	35 ft Buffers	1019000702	0.06	0.01	0.02
Pasture	35 ft Buffers	1019000703	0.22	0.05	0.08
Pasture	35 ft Buffers	1019000704	0.6	0.14	0.22
Pasture	35 ft Buffers	1019000705	0.24	0.05	0.11
Pasture	35 ft Buffers	1019000706	1.82	0.45	0.88
Pasture	35 ft Buffers	1019000707	0.6	0.16	0.24
Pasture	35 ft Buffers	1019000708	2.56	0.92	0.79
Pasture	35 ft Buffers	1019000709	1.1	0.42	0.32
Pasture	35 ft Buffers	1019000710	0.66	0.29	0.26
Pasture	Livestock Exclusion	1019000701	0	0	0
Pasture	Livestock Exclusion	1019000702	0.01	0.01	0.02
Pasture	Livestock Exclusion	1019000703	0.06	0.03	0.07
Pasture	Livestock Exclusion	1019000704	0.16	0.08	0.22
Pasture	Livestock Exclusion	1019000705	0.06	0.03	0.11
Pasture	Livestock Exclusion	1019000706	0.46	0.25	0.87
Pasture	Livestock Exclusion	1019000707	0.15	0.09	0.24
Pasture	Livestock Exclusion	1019000708	0.65	0.51	0.77
Pasture	Livestock Exclusion	1019000709	0.29	0.24	0.31
Pasture	Livestock Exclusion	1019000710	0.2	0.19	0.26
Feedlot	Waste Management System	1019000701	2.65	1.43	0
Feedlot	Waste Management System	1019000702	1.89	1.1	0
Feedlot	Waste Management System	1019000703	2.75	1.62	0

Table D-1. PLET Scenario Reductions (Page 3 of 4)

Land Use	Practice	HUC10	Nitrogen Reduction (%)	Phosphorus Reduction (%)	Sediment Reduction (%)
Feedlot	Waste Management System	1019000704	2.9	1.65	0
Feedlot	Waste Management System	1019000705	2.95	1.6	0
Feedlot	Waste Management System	1019000706	2.81	1.83	0
Feedlot	Waste Management System	1019000707	5.5	3.82	0
Feedlot	Waste Management System	1019000708	2.88	2.65	0
Feedlot	Waste Management System	1019000709	3.58	3.39	0
Feedlot	Waste Management System	1019000710	2.85	2.7	0
Forest	Site Preparation/Straw/Crimp/Net	1019000701	1.25	1.15	12.58
Forest	Site Preparation/Straw/Crimp/Net	1019000702	0.91	0.91	13.17
Forest	Site Preparation/Straw/Crimp/Net	1019000703	0.59	0.59	6.82
Forest	Site Preparation/Straw/Crimp/Net	1019000704	0.92	0.9	8.63
Forest	Site Preparation/Straw/Crimp/Net	1019000705	0.89	0.83	16.42
Forest	Site Preparation/Straw/Crimp/Net	1019000706	0.75	0.84	11.48
Forest	Site Preparation/Straw/Crimp/Net	1019000707	0.4	0.48	6.07
Forest	Site Preparation/Straw/Crimp/Net	1019000708	0.11	0.18	1.01
Forest	Site Preparation/Straw/Crimp/Net	1019000709	0.05	0.07	0.29
Forest	Site Preparation/Straw/Crimp/Net	1019000710	0	0	0.01
Forest	Site Preparation/Straw/Crimp Seed/Fertilizer/Transplant	1019000701	1.27	1.18	12.85
Forest	Site Preparation/Straw/Crimp Seed/Fertilizer/Transplant	1019000702	0.93	0.93	13.46
Forest	Site Preparation/Straw/Crimp Seed/Fertilizer/Transplant	1019000703	0.6	0.6	6.97
Forest	Site Preparation/Straw/Crimp Seed/Fertilizer/Transplant	1019000704	0.94	0.91	8.82
Forest	Site Preparation/Straw/Crimp Seed/Fertilizer/Transplant	1019000705	0.91	0.85	16.77
Forest	Site Preparation/Straw/Crimp Seed/Fertilizer/Transplant	1019000706	0.77	0.85	11.72
Forest	Site Preparation/Straw/Crimp Seed/Fertilizer/Transplant	1019000707	0.41	0.49	6.2
Forest	Site Preparation/Straw/Crimp Seed/Fertilizer/Transplant	1019000708	0.12	0.18	1.03
Forest	Site Preparation/Straw/Crimp Seed/Fertilizer/Transplant	1019000709	0.05	0.07	0.3

Table D-1. PLET Scenario Reductions (Page 4 of 4)

Land Use	Practice	HUC10	Nitrogen Reduction (%)	Phosphorus Reduction (%)	Sediment Reduction (%)
Forest	Site Preparation/Straw/Crimp Seed/Fertilizer/Transplant	1019000710	0	0.01	0.01
Urban	Extended Wet Detention	1019000701	1.33	0.63	2.65
Urban	Extended Wet Detention	1019000702	1.94	0.96	5.35
Urban	Extended Wet Detention	1019000703	2.09	1.08	4.81
Urban	Extended Wet Detention	1019000704	1.14	0.57	2.1
Urban	Extended Wet Detention	1019000705	1.33	0.64	4.86
Urban	Extended Wet Detention	1019000706	2.04	1.17	6.15
Urban	Extended Wet Detention	1019000707	0.88	0.54	2.62
Urban	Extended Wet Detention	1019000708	2.23	1.81	3.9
Urban	Extended Wet Detention	1019000709	1.12	0.93	1.42
Urban	Extended Wet Detention	1019000710	0.71	0.59	0.61
Urban	Infiltration Basin	1019000701	1.45	0.6	2.31
Urban	Infiltration Basin	1019000702	2.11	0.91	4.67
Urban	Infiltration Basin	1019000703	2.28	1.02	4.2
Urban	Infiltration Basin	1019000704	1.24	0.53	1.83
Urban	Infiltration Basin	1019000705	1.51	0.63	4.41
Urban	Infiltration Basin	1019000706	2.22	1.1	5.36
Urban	Infiltration Basin	1019000707	0.96	0.51	2.28
Urban	Infiltration Basin	1019000708	2.43	1.7	3.4
Urban	Infiltration Basin	1019000709	1.22	0.88	1.23
Urban	Infiltration Basin	1019000710	0.78	0.56	0.53
Urban	Concrete Grid Pavement	1019000701	2.18	0.83	2.77
Urban	Concrete Grid Pavement	1019000702	3.17	1.26	5.6
Urban	Concrete Grid Pavement	1019000703	3.42	1.41	5.04
Urban	Concrete Grid Pavement	1019000704	1.86	0.74	2.2
Urban	Concrete Grid Pavement	1019000705	2.18	0.83	5.08
Urban	Concrete Grid Pavement	1019000706	3.33	1.52	6.44
Urban	Concrete Grid Pavement	1019000707	1.44	0.7	2.74
Urban	Concrete Grid Pavement	1019000708	3.65	2.36	4.08
Urban	Concrete Grid Pavement	1019000709	1.83	1.22	1.48
Urban	Concrete Grid Pavement	1019000710	1.16	0.77	0.63

APPENDIX E
RESPEC STAKEHOLDER TOOLKIT

Stakeholder Toolkit
June 13, 2024

Introduction
The North Front Range Water Quality Planning Association (NFRWQPA) seeks to compile a stakeholder toolkit for the five regional Nonpoint Source (NPS) Watershed Plan areas in Larimer and Weld Counties.

This toolkit will help stakeholders reach, inform and partner with their networks on the NPS watershed educational resources. Here is a link to a final stakeholder toolkit formatting example.

Digital Communications
Digital communications can reach a large audience on a broad scale, with tactics including:

- **Press releases:** This document will serve as NFRWQPA's official statement on the NPS watersheds and respective plans. The press release can be distributed to industry-relevant publications as well as local news outlets.
  - Example
- **Social media:** Targeted social posts to reach industry-specific and locally relevant audiences. Content can vary based on NFRWQPA's needs, seasonality and other updates.
  - Example
- **Newsletters:** Regular updates to an email list of subscribers about the plans, NPS findings and other news.
  - Example
- **Website:** Content updates such as banner announcements, blog posts and home page edits upon project completion.
  - Example
- **Story Map:** Multimedia application to share plan findings, next steps and other dynamic information.
  - Example
- **"Report a Concern" button or website:** Dedicated resource for stakeholders to use when submitting an NPS issue to NFRWQPA (similar to a "contact us" button).
  - Example – Contact Info at bottom of webpage
- **Radio ads and interviews:** Reach stakeholders on a local and national level through a radio ad or securing a news station interview.
  - Example

Print Communications

Print communications can reach targeted, local audiences using the following tactics:

- **Signage:** Capture pedestrian, biking and other rolling traffic's attention with signage strategically placed in a given area. Informational signage can include water quality awareness signage in parks near streams, pet waste pickup stations, and general project information signage.
    - Example
- **Mailers:** Reach residents and businesses via postcard to communicate project benefits and updates, as well as solicit feedback.
    - Example

Community Outreach

Community outreach is a boots-on-the-ground approach to connecting with stakeholders and disseminating information. Community outreach also helps put a face to a project through the following tactics:

- **Educational campaign:** Increase awareness about the plan and NPS concerns in ways that are simplified and relatable for stakeholders.
    - Example
- **Volunteer cleanup program:** Foster community pride and engagement through organizing a park cleanup day.
    - Example
- **School visits, tours and field trips:** Create memories, connect with younger stakeholders and ignite a lifelong interest in the environment by inviting project team members to visit schools for presentations, organize park tours and host field trips.
    - Example – project engineers visited a local library to show students that popular game Fortnite had real-life applications and similarities to simulating virtual environments in the construction industry

APPENDIX C

ST. VRAIN CREEK NONPOINT SOURCE WATERSHED-BASED PLAN

RESPEC

ST. VRAIN CREEK NONPOINT SOURCE WATERSHED-BASED PLAN

DRAFT REPORT RSI-3522

PREPARED BY
Cindie Kirby
Seattle Briscoe
Natalie Acosta
Cathy McCague

RESPEC
3824 Jet Drive
Rapid City, South Dakota 57703

Communication Infrastructure Group
1660 Lincoln Street; Suite 1800
Denver, Colorado 80264

PREPARED FOR
North Front Range Water Quality Planning Association
257 Johnstown Center Drive; Unit 206
Johnstown, Colorado 80534

DECEMBER 2024

Project Number W0545.23001

TABLE OF CONTENTS

TABLE OF CONTENTS (CONTINUED)

LIST OF TABLES

LIST OF TABLES (CONTINUED)

LIST OF FIGURES

LIST OF ABBREVIATIONS

µg/L	micrograms per liter
ACEP	Agricultural Conservation Easement Program
AFA	Alternative Funding Arrangement
AFO	animal feeding operation
AFP	Announcement for Funding Proposals
AML	abandoned mine land
AWEP	Agricultural Water Enhancement Program
BMP	best management practices
BMPDB	International Stormwater Best Management Practices Database
CAFO	concentrated animal feed operation
CASTNET	Clean Air Status and Trends Network
CAWA	Colorado Ag Water Alliance
CCR	Code of Colorado Regulation
CDPHE	Colorado Department of Public Health and Environment
cfs	cubic feet per second
cfu/head/day	colony-forming units per head per day
CIG	Conservation Innovation Grants
CPPE	Conservation Practice Physical Effects
CPS	Conservation Practice Standard
CRP	Conservation Reserve Program
CSP	Conservation Stewardship Program
CSU	Colorado State University
CTA	Conservation Technical Assistance
CWA	Clean Water Act
CWCB	Colorado Water Conservation Board
CWSRF	Clean Water State Revolving Fund
DRUM	Defense-Related Uranium Mine
EPA	U.S. Environmental Protection Agency
EQIP	Environmental Quality Incentives Program
ESRI	Environmental Systems Research Institute, Inc.
EWP	Emergency Watershed Protection Program
FEMA	Federal Emergency Management Agency
FRPP	Farm and Ranch Lands Protection Program
GRP	Grass Reserve Program
HUC	Hydrologic Unit Code
lb/day	pounds per day
lb/year	pounds per year
LID	Low Impact Development
mg/L	milligrams per liter
mi^2	square miles
MIDS	Minimal Impact Design Standards
mL	milliliter

LIST OF ABBREVIATIONS (CONTINUED)

mpn	most probable number
MS4	Municipal Separate Storm Sewer System
NADP	National Atmospheric Deposition Program
NLCD	National Land Cover Dataset
NPS	nonpoint source
NRCS	Natural Resources Conservation Service
NWQI	National Water Quality Initiative
OHV	Off Highway Vehicle
OWTS	Onsite Wastewater Treatment System
PEPO	Public Education, Participation, and Outreach
PFAS	per- and polyfluoroalkyl substances
PLET	Pollutant Load Estimation Tool
RCD	Resource Conservation and Development
RCPP	Regional Conservation Partnership Program
SSURGO	Soil Survey Geographic Database
SWAP	Source Water Assessment and Protection
SWPPP	stormwater pollution prevention plan
TMDL	total maximum daily load
TSS	total suspended solids
USBR	U.S. Bureau of Reclamation
USDA	U.S. Department of Agriculture
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
WFPO	Watershed Protection and Flood Prevention Operations
WHIP	Wildlife Habitat Incentive Program
WHRB	Watershed Rehabilitation
WRP	Wetlands Reserve Program
WRSF	Water Supply Reserve Funds
WWTP	Wastewater Treatment Plant

1.0 INTRODUCTION

The primary purpose of this watershed-based plan is to recommend best management practices (BMPs) that would reduce pollutants of concern within the St. Vrain Creek Watershed (Hydrologic Unit Code [HUC] 10190005) in Larimer and Weld Counties from nonpoint sources (NPSs). The plan does not include areas upstream of Weld County. Although this watershed-based plan is a stand-alone NPS plan, water planning should be done in a holistic manner, with teamwork between point and NPSs of pollution. Pollution reductions from NPSs upstream of point sources reduce the strain on the point sources. Municipal, industrial, and agricultural entities working together toward the shared goal of protecting waterbodies before they become impaired will reduce future regulations on these entities.

The watershed-based plan is based on an adaptive approach that emphasizes making continued progress toward achieving milestones and load reduction by identifying the most impactful implementation measures for priority areas. This watershed-based plan summarizes past conservation accomplishments and recommends implementation actions that can assist residents, landowners, and stakeholders in the project area to improve water quality. Private, local, state, and federal partnership efforts should continue to support and promote the implementation of management measures while additional water quality monitoring is conducted to guide watershed plan revisions and assess adaptive implementation activities.

The watershed-based plan builds on past conservation accomplishments in the project area and complements water quality efforts by many organizations and local communities. Some organizations and local communities that would be applicable to help with conservation in the St. Vrain project area include the following:

- City of Dacono
- City of Longmont
- Colorado Ag Water Alliance (CAWA)
- Colorado Department of Public Health and Environment (CDPHE)
- Colorado Livestock Association
- Colorado Parks & Wildlife
- Colorado Rural Water Association
- Colorado State University (CSU)
- Colorado Watershed Assembly
- Colorado Wheat Administrative Committee
- Ducks Unlimited
- Farm Production and Conservation-NRCS, CO
- Fresh Water Trust
- Larimer County
- Left Hand Water District

- Peaks to People Water Fund
- RNC Consulting, LLC
- South Platte Basin Roundtable
- St. Vrain and Left Hand Water Conservancy District
- St. Vrain Sanitation District
- Town of Erie
- Town of Firestone
- Town of Frederick
- Town of Mead
- Trout Unlimited (Denver Chapter)
- Weld County
- Xcel Energy

This watershed-based plan also incorporates the strategies, goals, and objectives of CDPHE's *Colorado's Nonpoint Source Management Plan: 2022* and addresses the U.S. Environmental Protection Agency's (EPA's) nine key elements outlined in the management plan [CDPHE, 2022]. Table 1-1 describes these nine key elements and their corresponding locations within this watershed-based plan [EPA, 2008].

Table 1-1. Sections of the Watershed-Based Plan That Fulfill the U.S. Environmental Protection Agency's Nine Key Elements for Watershed Planning (Page 1 of 2)

EPA Element Number	EPA's Nine Key Elements Plan	Applicable Section of Watershed-Based Plan
1	Identify the causes and sources of pollution that need to be controlled to achieve load reductions and other goals (e.g., recreational, economic, ecological) identified in the plan.	5.0 Source Assessment 6.0 Priority Areas for Implementation
2	Estimate load reductions expected from the action strategy identified.	6.0 Priority Areas for Implementation 7.0 Best Management Practices Load Reductions
3	Describe NPS management measures, including operation/maintenance requirements, and targeted critical areas (i.e., action strategy) needed to achieve identified load reductions.	6.0 Priority Areas for Implementation 7.0 Best Management Practices Load Reductions 8.0 Past and Current Best Management Practices 9.0 Recommended Best Management Practices
4	Estimate technical and financial assistance needed, associated costs, and/or the sources and authorities that will be relied upon to implement the watershed-based plan.	13.0 Sources of Technical and Financial Assistance
5	Develop an information and education component that will be used to enhance public understanding of the NPS management measures and encourage their early and continued participation in selecting, designing, and implementing the Action Strategy.	10.0 Information, Education, and Outreach
6	Develop a project schedule.	11.0 Criteria to Assess Progress

Table 1-1. Sections of the Watershed-Based Plan That Fulfill the U.S. Environmental Protection Agency's Nine Key Elements for Watershed Planning (Page 2 of 2)

EPA Element Number	EPA's Nine Key Elements Plan	Applicable Section of Watershed-Based Plan
7	Describe interim, measurable milestones.	11.0 Criteria to Assess Progress
8	Identify a set of criteria to assess progress/effectiveness in achieving water quality standards or other appropriate end targets.	11.0 Criteria to Assess Progress
9	Develop a monitoring component to evaluate the effectiveness of the implementation efforts over time and measured against the criteria established to document load reductions.	12.0 Monitoring Best Management Practice Effectiveness

This watershed-based plan is not intended to identify which specific BMPs or remediation actions should be included in certain discharge permits, ordinances, stormwater pollution prevention plans (SWPPPs), or conservation plans. Rather, the plan provides an adaptive implementation approach with suggested structural and nonstructural BMPs necessary to address the NPSs of pollutants of concern. For the purposes of this watershed-based plan, BMPs refer to structural and nonstructural actions or measures installed or implemented to reduce the delivery of sediment and nutrients to waterbodies in the project area. Sources of available funding and technical assistance for and associated estimated costs of these BMPs are included to provide landowners, residents, stakeholders, community leaders, and public agencies perspectives on the technical and economic demands of this watershed plan.

Essential to the development of this watershed-based plan is ascertaining and collecting feedback and input from a cross section of stakeholders, including cities, counties, sanitation districts, towns, watershed organizations, and others who will identify, fund, and prioritize projects to implement these practices and BMPs. As a part of this project, two surveys were sent to stakeholders:

- Survey #1, in 2022, was more general and included questions related to pollutants, issues, and areas of concern.
- Survey #2, in 2024, was more specific and included questions regarding past and current planning, use of technical and financial assistance, and ideal BMPs.

Survey #1 was distributed to 96 organizations in 2022. The purpose of this survey was to better understand the stakeholders' concerns, issues, resources, and priorities. Building on the conclusions from this survey was the impetus for helping to develop a nine key elements plan.

Survey #2 was distributed to 48 organizations in March 2024 asking them to complete the following items:

- Characterize their existing watershed projects and sources of pollution
- Rank cropland, urban, pastureland, feedlot, and forest BMPs
- Identify benefits and impacts of existing BMPs
- Identify existing outreach and education efforts
- Identify technical and financial assistance needed and utilized

Table 1-2 is a comprehensive list of the stakeholders who received and participated in each survey. Results of the surveys are found throughout the report and more detail is included in Chapter 10.0, Information, Education, and Outreach. Survey responses are an integral part of this project. Survey questions are included in Appendix A.

To help promote the novel regional watershed plan, the project team participated in the annual American Water Resources Association – Colorado Groundwater Association Conference. The team discussed the project objectives, watershed characteristics, nine key elements, and outreach efforts.

Table 1-2. Stakeholder Recipients of Two Surveys With Responses Represented by an "X" (Page 1 of 3)

Organization	Took Survey #1 (2022)	Took Survey #2 (2024)
Big Thompson Watershed Coalition		
Boxelder Sanitation District	X	
Carestream		
CAWA		
CDPHE		
City & County of Broomfield	X	
City of Dacono		
City of Evans	X	X
City of Fort Collins		X
City of Longmont	X	
City of Fort Lupton	X	X
City of Greeley	X	X
City of Loveland	X	X
City of Northglenn		X
Coalition for the Poudre River Watershed		
Colorado Livestock Association		
Colorado Parks & Wildlife		
Colorado Rural Water Association	X	
Colorado Watershed Assembly		X
Colorado Wheat Administrative Committee		X
CSU	X	
Davies Mobile Home Park		X
Drala Mountain Center	X	
Ducks Unlimited		
Estes Park Sanitation District	X	
Estes Valley Watershed Coalition	X	X
Fox Acres Community Services	X	
FPAC-NRCS, CO		

Table 1-2. Stakeholder Recipients of Two Surveys With Responses Represented by an "X" (Page 2 of 3)

Organization	Took Survey #1 (2022)	Took Survey #2 (2024)
Fresh Water Trust	X	
Galeton Water & Sanitation District	X	
JBS Greeley Beef Plant		X
Larimer County		X
Left Hand Water District	X	
Little Thompson Watershed Coalition		
Los Rios Farm		X
Metro Water Recovery	X	
Northern Colorado Water Conservancy District	X	X
Peaks to People Water Fund		X
Poudre Heritage Alliance		
Resource Colorado Water & Sanitation Metro District		
RNC Consulting, LLC		X
South Fort Collins Sanitation District	X	X
South Platte Basin Roundtable		
St. Vrain and Left Hand Watershed Conservancy District		
St. Vrain Sanitation District	X	
Town of Ault	X	
Town of Berthoud	X	X
Town of Brighton		
Town of Eaton		
Town of Erie	X	
Town of Estes Park		X
Town of Firestone		
Town of Frederick		
Town of Hudson	X	
Town of Johnston	X	
Town of Keenesburg		
Town of LaSalle		
Town of Lochbuie	X	
Town of Mead	X	
Town of Milliken		
Town of Pierce	X	
Town of Platteville		X
Town of Severance	X	
Town of Timnath		

Table 1-2. Stakeholder Recipients of Two Surveys With Responses Represented by an "X" (Page 3 of 3)

Organization	Took Survey #1 (2022)	Took Survey #2 (2024)
Town of Wellington		X
Town of Windsor	X	
Trout Unlimited (Denver Chapter)		
Upper Thompson Sanitation District	X	
Water Quality Trading in the Cache la Poudre with Fort Collins		
Weld County	X	
Weld County Department of Public Health and Environment	X	
Wright Water Engineers/Cherry Creek Basin Water Quality Authority		X
Xcel Energy		X

2.0 WATERSHED CHARACTERIZATION

The project area for this watershed-based plan is shown in Figure 2-1, which includes the area within Larimer and Weld Counties that intersect the St. Vrain Creek Watershed (HUC 10190005) in north-central Colorado. St. Vrain Creek flows east to its confluence with the South Platte River. Seven HUC10 watersheds are in the St. Vrain HUC8—three of those overlap Larimer or Weld Counties and include a small portion of North St. Vrain Creek (1019000502), Coal Creek-Boulder Creek (1019000506), and Boulder Creek-St. Vrain Creek (1019000507). Although the figures in this document show information within the HUC10 watersheds overlapping Larimer and Weld Counties, the tables summarize only information from the HUC10 watersheds within Larimer and Weld Counties. The total area of the HUCs is 330,032 acres, but within Larimer and Weld Counties, it encompasses only 98,377 acres, according to GIS layer analysis. Figure 2-1 also shows areas that are designated as MS4s and those that are likely to be MS4s. Areas already designated as MS4s are not included in the analysis in this document because they are considered permitted sources.

RESPEC

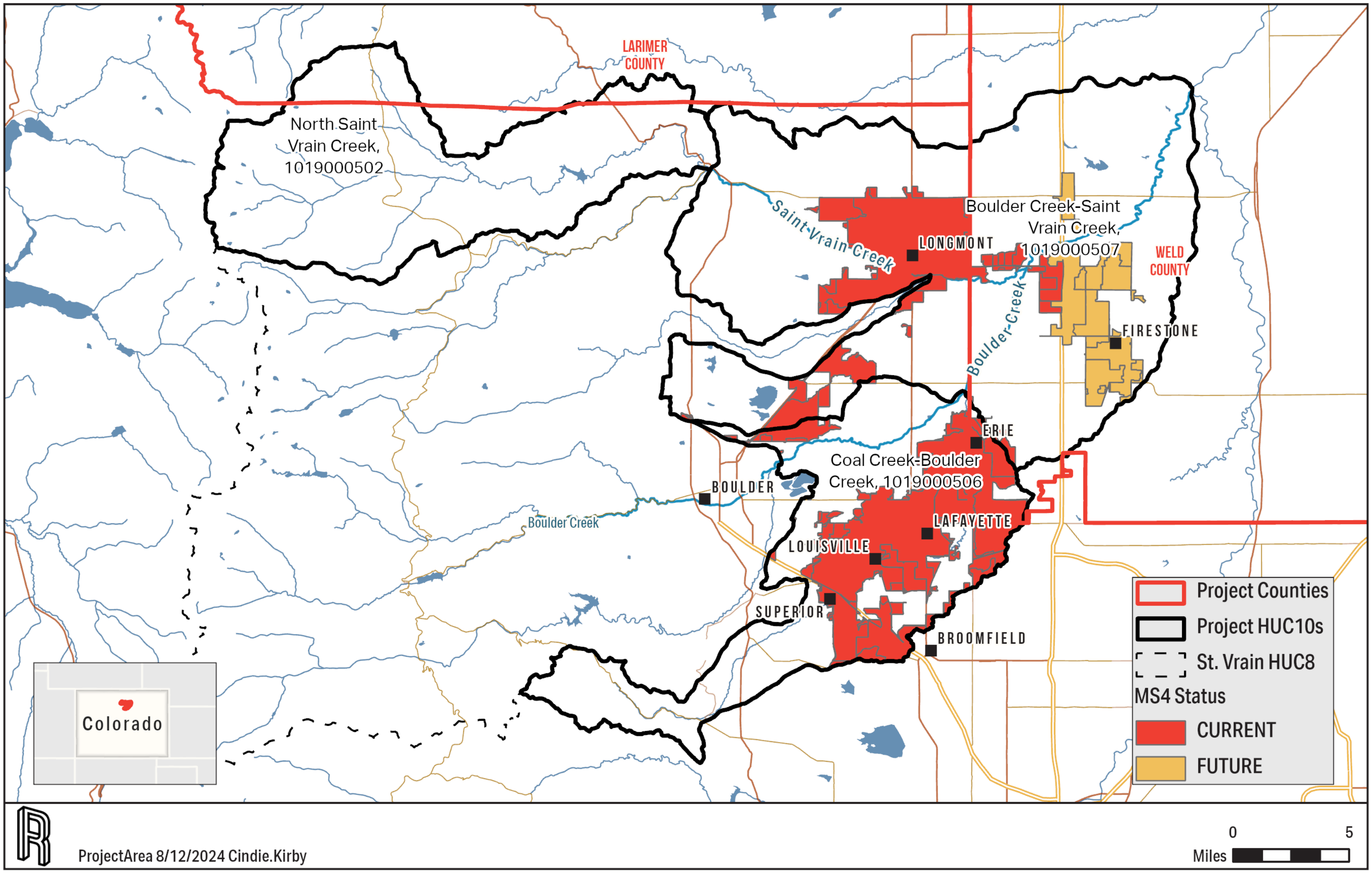


Figure 2-1. St. Vrain Creek HUC8 Project Area.

A summary of the project area's land cover characteristics was completed using the 2019 National Land Cover Dataset (NLCD). The NLCD is a 16-category, multilayer land cover classification dataset derived from Landsat imagery and ancillary data for consistent land cover data for all 50 states. The land cover is depicted in Figure 2-2 [Multi-Resolution Land Characteristics Consortium, 2019]. In the project area (including the Municipal Separate Storm Sewer Systems [MS4s]), approximately 53 percent of the area is cultivated crops; 17 percent is developed; 9 percent is herbaceous; and all other land uses make up less than 5 percent each. The watershed has a large area of interconnected cities that include Erie, Lafayette, Louisville, and Superior; much of this area in the watershed is upstream of the project area. Combined, the four cities make up 42.5 square miles (mi^2) and have a combined census population of 93,195 [U.S. Census Bureau, 2020]. Other populated areas in the watershed include the City of Longmont (mostly upstream of the project area) 98,979 people, 30.4 mi^2, growing at 1.5 percent annually); the northeast portion of the City of Boulder (upstream of the project area) 108,254 people, 26.3 mi^2, with the population declining slightly over the past few years); the Town of Frederick (15,427 people, 14.9 mi^2, growing at 7.8 percent annually); and the Town of Firestone (16,123 people, 14.2 mi^2, growing at 5.9 percent annually). Portions of many of these cities and towns are upstream of the project area. The watershed transitions from forest within higher elevations in the west to scrub/shrub/herbaceous within the mid-range elevations and crops and developed land within the lower elevations in the east. The City of Longmont and other more populated areas are located at the transition between the scrub/shrub/herbaceous and cropland/developed areas. Most of the land is privately owned (87 percent) with 0 percent being federally owned and other ownership categories making up 12 percent. This was calculated using a combination of public parcels [Colorado Geospatial Portal, 2024] and from the Environmental Systems Research Institute, Inc.'s (ESRI's) data portal for USA Federal Lands [ESRI, 2014].

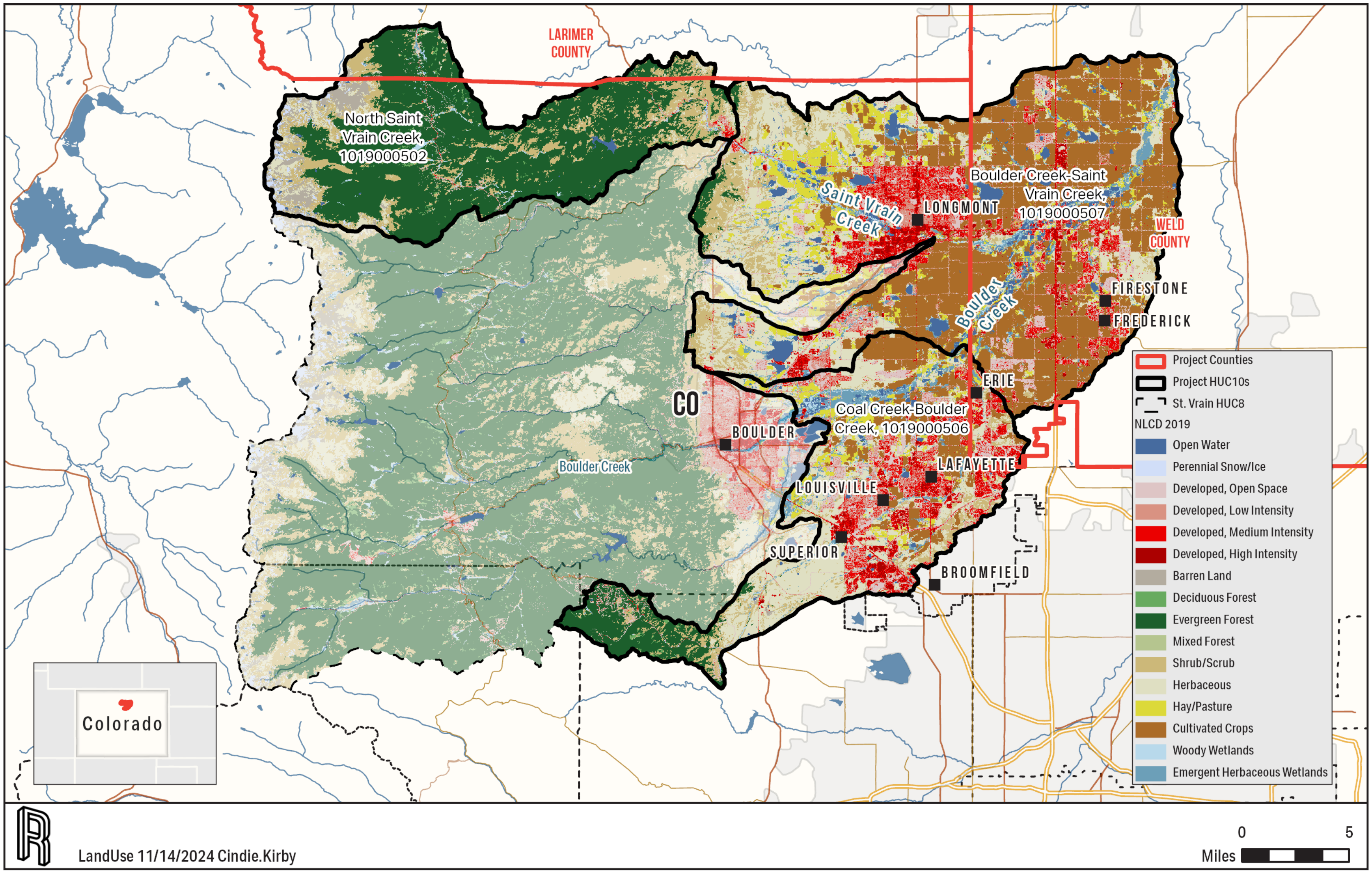


Figure 2-2. National Land Cover Dataset 2019 Land Use.

As indicated in Figure 2-3, precipitation varies throughout the project area. Typical annual precipitation is between 51 inches in the upper, western part of the watershed to 13 inches per year in the upper, eastern portion [PRISM Climate Group, 2024]. Maximum monthly average precipitation generally occurs in the summer months; however, the largest flows typically occur from winter snowmelt in the spring because the upper watershed is high-altitude mountainous terrain. Flows are usually lowest during the fall before snow has accumulated. During a typical year, approximately 1,225,000 acre-feet are used for irrigation in the South Platte Basin [Colorado Water Plan, 2015]. In 2013, extensive flooding along the Front Range caused significant damage. The flood-related damage led to restoration work, which is summarized in the *208 Region 2 – Regional Nonpoint Source Watershed-Based Plan* [Kirby et al., 2024].

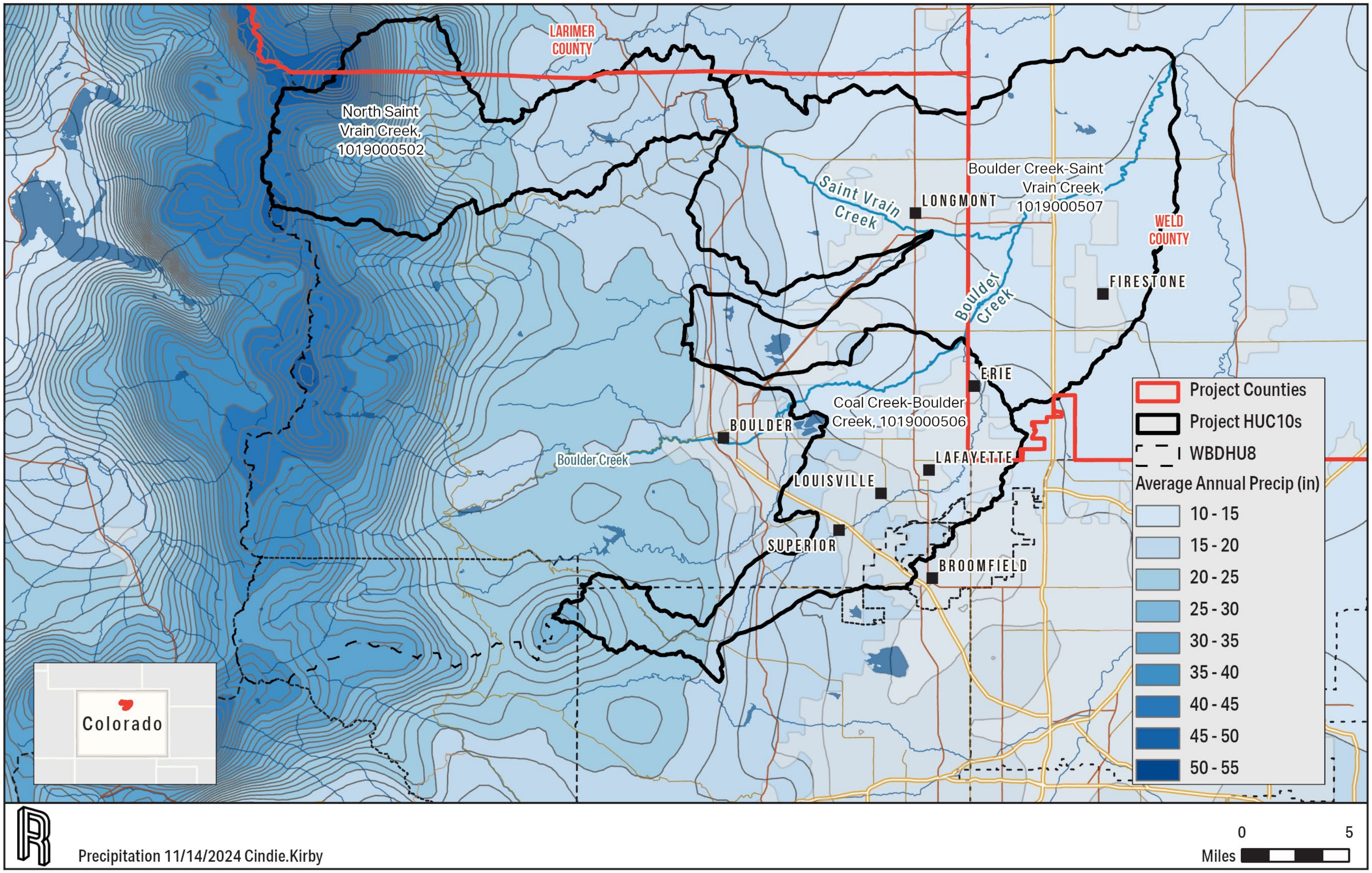


Figure 2-3. Average Annual Precipitation (1981 to 2010).

The bedrock geology of the project area is displayed in Figure 2-4 [Horton et al., 2017]. In the St. Vrain Creek HUC8, the mountainous portions consist mostly of intrusive igneous and undifferentiated metamorphic material, and the transitional area consists mostly of undifferentiated sedimentary material. The lower, agricultural area consists of clastic sedimentary and undifferentiated unconsolidated material. The South Platte River originates in the mountains of central Colorado at the Continental Divide and flows approximately 450 miles northeast across the Great Plains to its confluence with the North Platte River at North Platte, Nebraska. The basin includes two physiographic provinces: the Front Range Section of the Southern Rocky Mountain Province and the Colorado Piedmont Section of the Great Plains Province [USGS Colorado Water Science Center, 2000].

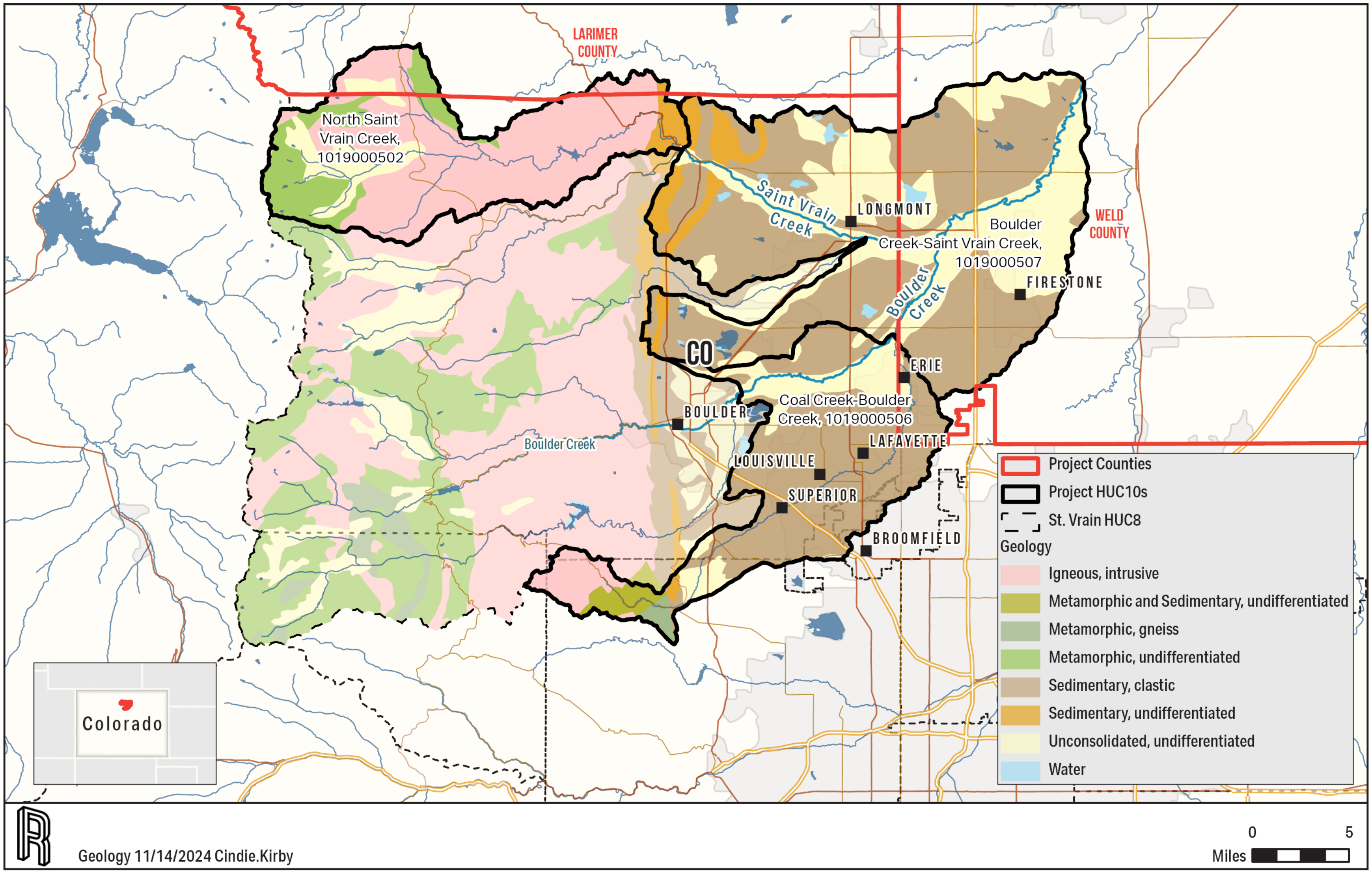


Figure 2-4. Geology.

Hydrologic soil groups can significantly impact the amount of water that infiltrates or runs off during precipitation events. Type A soils are generally sand or sandy loams with high infiltration rates; Type B soils are silt loam or loam soils with moderate rates; Type C soils are generally sandy, clay loams with low infiltration rates; and Type D soils are heavy soils; clay loams; and silty, clay soils with low infiltration rates. The project area comprises 21 percent A, 35 percent B, 26 percent C, and 18 percent D soil types. Figure 2-5 shows the distribution of hydrologic soil groups in the watershed using the Soil Survey Geographic Database (SSURGO) [NRCS, 2024a].

RESPEC

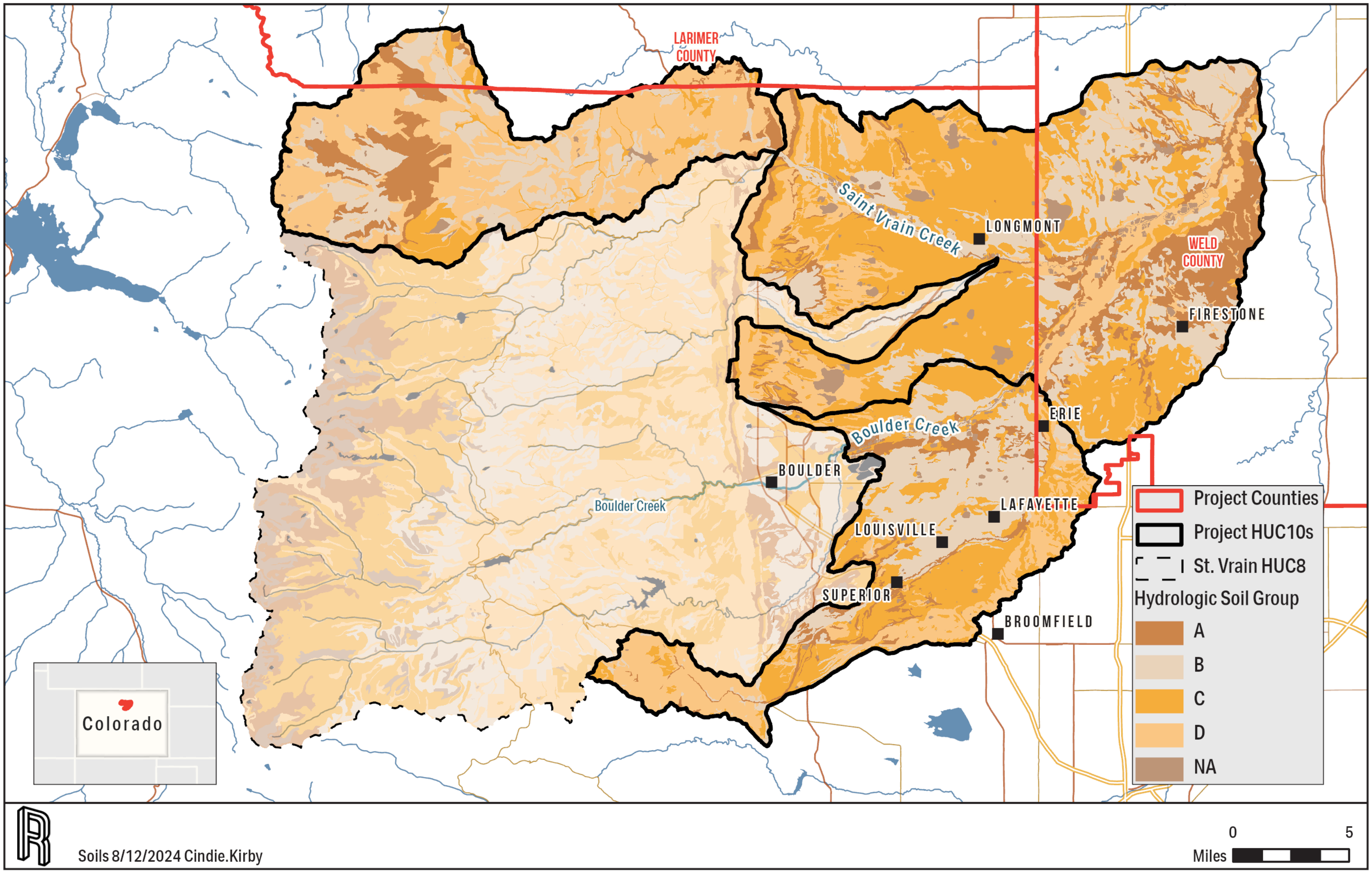


Figure 2-5. Hydrologic Soil Group.

3.0 EXISTING WATERSHED PLANS AND PROJECTS

Many conservation accomplishments have been achieved within the project area, which can be attributed to the local planning and implementation efforts of the community, state, and federal partners. Projects outlined on the Watershed Center website and the St. Vrain and Left Hand Water Conservancy District website are listed in Table 3-1 [Watershed Center, 2024]. More information about work done in the St. Vrain Creek Watershed is available on the Watershed Center website and the Keep It Clean Partnership website.

Table 3-1. Watershed Planning and Major Projects in the St. Vrain Creek HUC8 (Page 1 of 2)

Project Type	Name	Year Completed
Planning	Left Hand Creek Watershed Plan	2003
Planning	St. Vrain/Boulder Creek Watershed Plan	2014
Planning	St. Vrain and Left Hand Stream Management Plan	2020
Planning	St. Vrain and Left Hand Stream Management Plan Update	2024
Planning	Left Hand Creek Watershed Master Plan	2014
Planning	St. Vrain Watershed Master Plan	In Progress
Planning	Boulder Creek Restoration Master Plan	2015
River	Building Headwaters Resilience at Camp St. Malo	In Progress
River	Stream Stewardship and Recovery Handbook	2017
River	Left Hand Creek Adaptive Restoration	2024
River	Haldi and Left Hand Valley Diversion Projects	2023
River	Adaptive Management in River and Riparian Systems	2022
River	James Creek Restoration – Phase 1 and 2	2003
River	Left Hand Off Highway Vehicle (OHV) Area Restoration Phase 1 and 2	2008
River	North St. Vrain Creek Restoration Project	2015
River	South St. Vrain Creek Restoration Project	2017
River	Town of Lyons Streambank Restoration Project	In Progress
River	Left Hand Creek Feasibility Study	In Progress
River	Resilient St. Vrain	In Progress
Forest	St. Vrain Forest Health Partnership	In Progress
Forest	Forest Management Plan	In Progress
Wildfire	Wildfire Ready Watersheds in St. Vrain	In Progress
Wildfire	Building Post-Fire Resilience in the St. Vrain Watershed through Restoration	2022
Wildfire	Cal-Wood Seeding	2022
Wildfire	Left Hand Canyon Seeding	2022
Wildfire	Grassland Management in Boulder County	2023

Table 3-1. Watershed Planning and Major Projects in the St. Vrain Creek HUC8 (Page 2 of 2)

Project Type	Name	Year Completed
Wildfire	Jamestown Fire Mitigation Project	2023
Other	Beavers in the Watershed	In Progress
Other	Highland Fish Return Project	2019
Other	Passage Playbook	2022
Other	Meadow and South Ledge Diversion Reconstruction and Fish Passage Demonstration	2015
Other	Captain Jack Superfund Site	In Progress
Other	Flood Recovery	In Progress
Other	Climate Resilience on South St. Vrain	In Progress
Other	New Zealand Mudsnails	2024

St. Vrain Creek planning project documents available online can be found on the following websites:

- St. Vrain and Left Hand Stream Management Plan
- Watershed Management Plan for the Upper Lefthand Creek Watershed, Boulder County, CO
- Left Hand Creek Watershed Master Plan

Numerous conservation measures have been completed and are currently being implemented within the project area. These projects have been made possible through CDPHE with EPA's Section 319 NPS implementation grants, CDPHE grants, and St. Vrain and Left Hand Water Conservancy District funding. Previous conservation efforts have occurred in the project area, and each project helped improve water quality and make progress toward restoring and protecting local waterbodies. Tables 3-2 and 3-3 discuss these implementations within the project area [EPA, 2024a].

Table 3-2. Nonpoint Source Grants Implemented in the St. Vrain Creek HUC8 (Page 1 of 2)

Conservation Projects	Grant Number	Completion Year	Pollution Category	Section 319 Expenditures ($)	Total Expenditures ($)	Project Accomplishments
Left Hand Creek Watershed Plan	99818603	2007	Historical Pollutants; Resource Extraction	25,000	68,389	Identified stakeholders in the watershed and formed a network to facilitate communication and community involvement. Developed a watershed plan identifying key water quality issues, including sites of pollutant loading and analysis of relevant data. Identified projects with BMPs for watershed restoration, including site prioritization, technical feasibility, and community concerns.
James Creek Restoration - Phase II	99818603	2006	Other NPS Pollution	66,248	146,502	Improved riparian corridor by stabilizing eroded areas along James Creek in a 3-mile reach upstream of the Town of Jamestown. Protected the town water supply by reducing high turbidity in raw water. Project pre-planning and coordination. Stream corridor restoration using drainage and erosion control BMPs monitoring and evaluation of BMP treatments for stream improvements.
Left Hand OHV Area Restoration I	99818604	2008	Hydromodification	106,388	106,388	Reduced the amount of sediment loading sites into Left Hand Creek from the Left Hand OHV Area by 75%. Improved the water quality of Left Hand Creek for drinking water and aquatic life. Worked toward the restoration of the biological and chemical integrity of the Left Hand Watershed by decreasing NPS contamination of sediment loading from the Left Hand OHV Area. Identified and began implementation of BMPs to reduce the amount of sediment entering Left Hand and James Creeks that can be easily managed over the long term, and complement land management direction. Identified and ranked sources of sediment from the Left Hand OHV Area, and reduced their pollutant loading to Left Hand Creek. Aimed to implement BMPs that are sustainable and that require very little ongoing operation and maintenance.
Porphyry Mountain	99818607	2012	Resource Extraction	57,750	143,950	Cleaned up the Porphyry Mountain waste rock pile in the Left Hand Creek watershed in northwestern Boulder County; the Porphyry Mountain waste rock pile is located along Little James Creek, a 303(d)-listed stream just northwest of Jamestown.

Table 3-2. Nonpoint Source Grants Implemented in the St. Vrain Creek HUC8 (Page 2 of 2)

Conservation Projects	Grant Number	Completion Year	Pollution Category	Section 319 Expenditures ($)	Total Expenditures ($)	Project Accomplishments
Left Hand OHV Area Restoration II	99818608	2011	Other NPS Pollution	150,000	250,000	Reduced the amount of sediment loading sites into Left Hand Creek from the Left Hand OHV Area by 75%. Improved the water quality of Left Hand Creek for drinking water and aquatic life. Worked toward the restoration of the biological and chemical integrity of the Left Hand Watershed by decreasing NPS contamination of sediment loading from the Left Hand OHV Area. Identified and begin implementation of BMPs to reduce the amount of sediment entering Left Hand and James Creeks that can be easily managed over the long term, and complement land management direction. Identified and ranked sources of sediment from the Left Hand OHV Area, and reduced their pollutant loading to Left Hand Creek. Aimed to implement BMPs that are sustainable and that require very little ongoing operation and maintenance.
St. Vrain/Boulder Creek Watershed Plan	99818614	2015	Agriculture; Resource Extraction; Urban Runoff/Stormwater	45,000	89,548	Developed a watershed plan for the St. Vrain Creek Watershed to enable a coordinated approach to achieving a healthy stream; the plan addresses NPS pollution and includes EPA's nine key elements of a Watershed Plan.
Building Post-Fire Resilience in the St. Vrain Watershed Through Restoration	99818622	2026	Hydromodification; Other NPS Pollution; Silviculture; Urban Runoff/Stormwater	300,000	500,000	This project aims to build post-fire resilience and habitat enhancement through restoration in the St. Vrain Watershed following the 2020 Calwood Fire. The Calwood Fire burned over 10,000 acres in October 2020. Soil burn severity surveys by the U.S. Forest Service indicated that an estimated 46% of the burned area had moderate or high burn severity. Excessive erosion and sedimentation from these areas are now degrading water quality and aquatic habitat, as well as threatening critical water delivery infrastructure for the Town of Lyons and the City of Longmont, and Northern Water, and more than 50 ditch companies.

Table 3-3. Other Nonpoint Source Projects (South Platte and/or Statewide)

Project Title	Project Sponsor	Basin	NPS Funding ($)	Match on 09/30/2022 ($)	Status on 09/30/2022 (MM/YYYY)
Little Thompson and St. Vrain Watershed Resilience Initiative	CSU	South Platte	294,940	61,367	Expected Completion 03/2023
Water Quality, Soil Health and Regenerative Agriculture: A Nexus for Sustainability	CSU	South Platte	306,518	68,010	Expected Completion 06/2024
Implementing Agricultural BMPs in a Colorado Soil Health Pilot Program	Colorado Department of Agriculture	Various	34,4894	286,427	Expected Completion 06/2025
Brush Wetland Demonstration Project	Ducks Unlimited	South Platte	80,000	18,167	Expected Completion 06/2025
Nutrient Management on Irrigated Pastures	CAWA	Various	266,355	95,912	Expected Completion 01/2026

The *St. Vrain Basin Watershed-Based Plan* was completed in 2016 and was funded by Colorado NPS grants [Keep It Clean Partnership and Wright Water Engineers, 2016]. The plan focused on the western edge of the urbanized areas in the foothills eastward to Interstate 25. The primary water quality parameters addressed included nutrients, *E. coli*, and heavy metals. Aquatic life impairments were also addressed. The plan objectives were to develop a coordinated monitoring approach, to improve understanding of existing water quality issues, to identify steps to improve water quality, and develop a framework for implementing these measures. The project areas of the 2016 watershed-based plan differed significantly from this plan, which encompasses areas only in Larimer and Weld Counties. A watershed plan was also completed for Left Hand Creek in 2003; however, there was no overlap for that plan with Larimer or Weld County.

4.0 STANDARDS AND IMPAIRMENTS

Impairment locations throughout the project area are shown in Figure 4-1. Impaired stream segments and lakes in the project area are shown in Table 4-1, with impairments including heavy metals like selenium, arsenic, manganese, and zinc and other water quality parameters such as pH, temperature, ammonia, *E. coli*, and macroinvertebrates. Selenium is measured in fish tissue, as a standard, and in water quality samples. Individual maps and box plots of each impaired parameter are included in Appendices B and C, respectively [CDPHE, 2024]. Ammonia Total Maximum Daily Loads [TMDLs] exist in the project area; however, the reductions needed for the TMDLs are not specifically addressed in this document because point sources were determined to be the cause of these impairments [CDPHE, 2003].

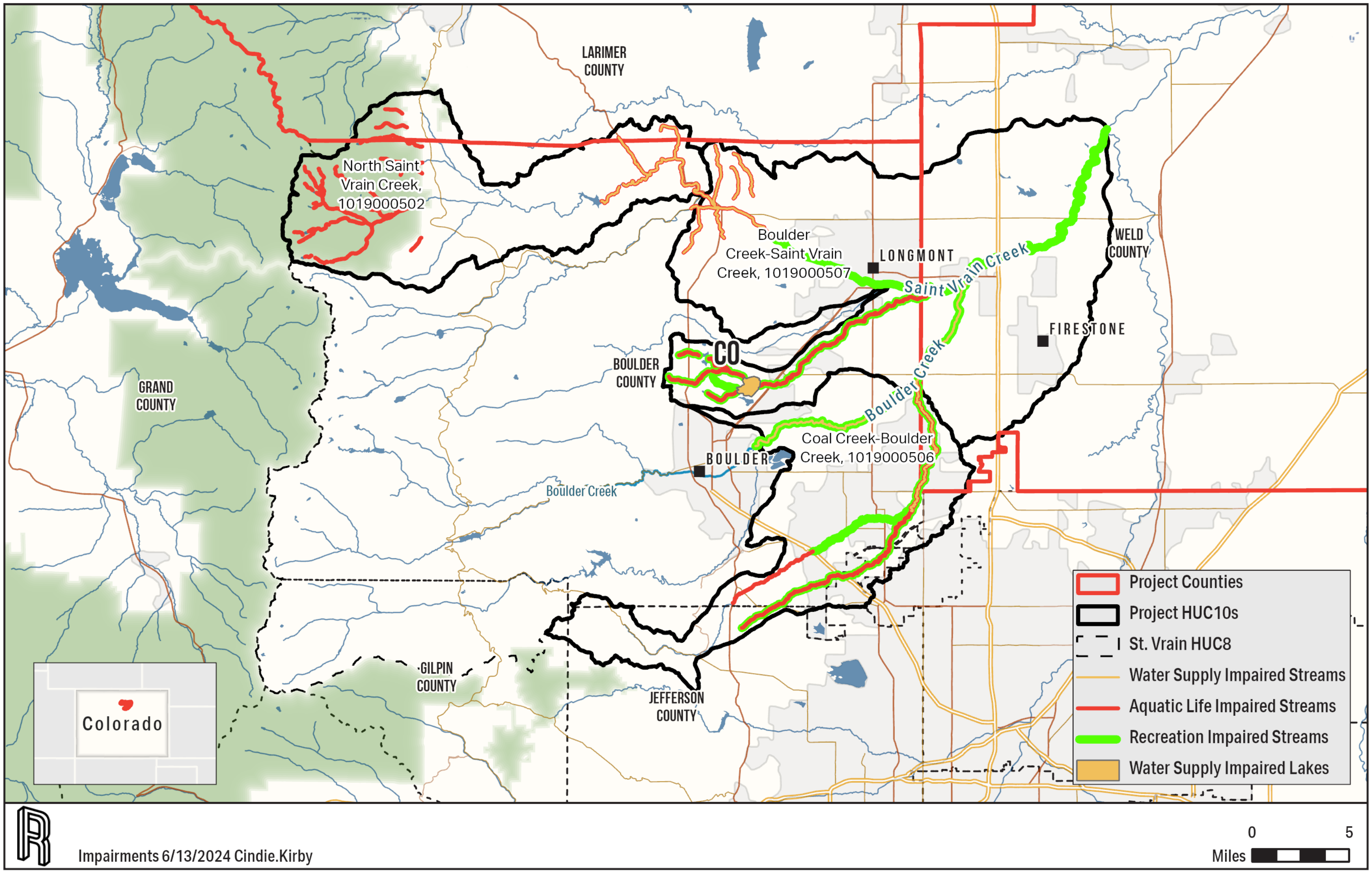


Figure 4-1. Impaired Waterbodies.

Table 4-1. Clean Water Act Section 303(d)-Impaired Waterbodies Summary

Impairment I.D./ HUC10s	Aquatic Life Tier/ Recreation Tier	Description	Aquatic Life Impairments	Recreation Impairment	Water Supply Impairment
COSPBO07a_A/ 1019000506	W1/E	Mainstem of Coal Creek from Highway 93 to Highway 36 (Boulder Turnpike)	Macroinvertebrates	N/A	N/A
COSPBO07b_B/ 1019000506	W2/E	Mainstem of Coal Creek from Rock Creek to Boulder Creek	Selenium (D)	*E. coli*	Manganese (D)
COSPBO10_A/ 1019000507	W1/E	Mainstem of Boulder Creek from the confluence with Coal Creek to the confluence with St. Vrain Creek	Ammonia (TMDL)	*E. coli*	Arsenic (T)
COSPSV01_C/ 1019000502	C1/E	All tributaries to St. Vrain Creek, including all wetlands, which are within the Indian Peaks Wilderness Area and Rocky Mountain National Park, except the mainstem of South St. Vrain	Zinc (D), pH	N/A	N/A
COSPSV02a_A/ 1019000502	C1/E	Mainstem of St. Vrain Creek, including all tributaries and wetlands, from the boundary of the Indian Peaks Wilderness Area and Rocky Mountain National Park to the eastern boundary of Roosevelt National Forest	N/A	N/A	N/A
COSPSV02b_A/ 1019000502	C1/E	Mainstem of St. Vrain Creek, including all tributaries and wetlands, from the eastern boundary of Roosevelt National Forest to Hygiene Road, except part of South St. Vrain Creek	Temperature	N/A	Arsenic (T)
COSPSV03_B/ 1019000507	W1/E	Mainstem of St. Vrain Creek from the confluence with Left Hand Creek to the confluence with Boulder Creek	Ammonia (TMDL)	*E. coli*	N/A
COSPSV03_C/ 1019000507	W1/E	Mainstem of St. Vrain Creek from Hover Road to Left Hand Creek	N/A	*E. coli*	N/A
COSPSV03_D/ 1019000507	W1/E	Mainstem of St. Vrain Creek from Hygiene Road to Hover Road and St. Vrain Creek from I-25 to the confluence with the South Platte River	N/A	*E. coli*	N/A
COSPSV03_E/ 1019000507	W1/E	Mainstem of St. Vrain Creek from Boulder Creek to I-25	Ammonia (TMDL)	*E. coli*	N/A
COSPSV07_B 1019000507	W1/E	Boulder Reservoir	N/A	N/A	Arsenic (T)

D = dissolved
T = total
TMDL = total maximum daily load

In Survey #1, local stakeholders noted their primary parameters of concern. Each parameter occurrence was counted, and the four parameters that appeared the most were nitrogen, phosphorus, total suspended solids (TSS), and *E. coli*. Others that showed up less than the most predominant parameters included temperature, emerging contaminants, metals, and per- and polyfluoroalkyl substances (PFAS). Emerging contaminants are the different types of chemicals (e.g., medication, personal care products, home cleaning products, lawn care products, and agricultural products, such as insecticides and herbicides) that end up in waterbodies but are not generally treated in wastewater facilities. PFAS and emerging contaminants of concern are not included in this report. Some emerging contaminants are treated by drinking water and/or wastewater facilities, but these chemicals are not well regulated or understood. A new EPA limit for PFAS of 4 parts per trillion was released in 2024 [EPA, 2024b].

Water quality standards for parameters of concern are based on beneficial-use tiers. For more information on these standards and tiers, visit the CDPHE's Water Quality Control Commission's 5 Codes of Colorado Regulation (CCR) 1002-31 website, last updated June 14, 2023. Access the CDPHE's Water Quality Control Commission Regulation No. 38 website, last updated April 30, 2024, for information on classifications and numeric standards for South Platte River Basin, Laramie River Basin, Republican River Basin, and Smoky Hill River Basin (5 CCR 1002-38).

The beneficial-use tiers for aquatic life, recreation, and domestic water supply are listed as follows:

- Aquatic Life
  - C1 – Class 1 Cold Water
  - C2 – Class 2 Cold Water
  - W1 – Class 1 Warm Water
  - W2 – Class 2 Warm Water
- Recreation
  - E – Existing Primary Contact Use (since November 28, 1975)
  - P – Potential Primary Contact Use
  - N – Not Primary Contact Use
  - U – Undetermined Use
- Domestic Water Supply
  - Direct Use Water Supply Lakes and Reservoirs

Current loads were determined for *E. coli*, dissolved selenium, total nitrogen, and total phosphorus using flow and water quality monitoring data collected along the mainstem of the most downstream HUC10 of the Saint Vrain project area (1019000507). The U.S. Geological Survey (USGS) site used for flow was USGS-06731000, which had data available from 1927 through 1998. The average annual flow was calculated using flow from 1990 through 1998 (the last year with data available) to be approximately 274.6 cubic feet per second (cfs). Numerous water quality sites were along the mainstem in the HUC10, and all available *E. coli*, selenium, total nitrogen, and total phosphorus data were used. The geometric mean from all *E. coli* data collected from 1990 through 2024 was used to represent the *E. coli* concentration; the 85th percentile from all dissolved selenium from 1990 through 2024 was used to represent the current selenium concentration; and for both phosphorus and nitrogen, the annual median was averaged for all data from 1990 through 2024 to represent the current concentrations. Current loads were then calculated as the product of flow, concentration, and a conversion factor for each. Needed loads based on water quality standards were also calculated using the product of the same average annual flow, each water quality standard, and a conversion factor. The *E. coli* water quality standard was 126 most probable number (mpn) per 100 milliliters (mL), the selenium standard was 4.6 micrograms per liter (µg/L), the nitrogen standard was 2.01 milligrams per liter (mg/L), and the phosphorus standard was 0.17 mg/L. Current and needed flows, concentrations, and loads are shown in Table 4-2, as well as the load reduction needed at in the HUC10. At this location, reductions are needed to reach goal loads for dissolved selenium, total nitrogen, and total phosphorus. As flow and concentration data are collected at this location, they can be incorporated into the load estimations.

Table 4-2. Flows, Current Loads, Goal Loads, and Reductions to Reach Goals in Most Downstream HUC10 of the Project Area

Flow	Average Annual Flow (cfs)	274.6
Current Concentrations	*E. coli* Geomean (org/100 mL)	106.7
	Dissolved Selenium (85th Percentile)	5.0
	Average of Median Annual Nitrogen (mg/L)	2.9
	Average of Median Annual Phosphorus (mg/L)	0.3
Current Loads	*E. coli* (billion org/day)	716.9
	Selenium (lb/day)	7.4
	Nitrogen (lb/day)	4,292.7
	Phosphorus (lb/day)	489.9
Goal Loads	*E. coli* (billion org/day)	846.6
	Selenium (lb/day)	6.8
	Nitrogen (lb/day)	2,977.5
	Phosphorus (lb/day)	251.8
Reductions to Achieve Goal Loads	*E. coli*	0%
	Selenium	8%
	Nitrogen	31%
	Phosphorus	49%

cfs = cubic feet per second
lb/day = pound per day
mg/L = milligrams per liter
mL = milliliters

5.0 SOURCE ASSESSMENT

Only NPS pollutants are addressed in this report. Point sources and areas with MS4s are addressed in the *208 Areawide Water Quality Management Plan, 2022 Update* [NFRWQPA, 2022]. Outside of MS4-permitted areas, NPSs of nutrients are generally related to runoff from cropland, pastureland, developed land, and other similar lands. NPSs of sediment consist of sediment contributions through wash off, as well as bed and bank erosion during high flows. NPSs of *E. coli* are typically from livestock, pets, wildlife, and human sources that can occur in agricultural and developed areas. NPSs of heavy metals vary by metal, but are often from abandoned mine lands (AMLs) or runoff from irrigated agricultural lands. Sometimes sources are from natural causes. Natural causes are the physical, chemical, or biological conditions that would exist in a waterbody in the absence of measurable impacts from human activity or influence. More information about the sources of each pollutant are described in this section.

5.1 NUTRIENTS AND SEDIMENT

The EPA's Pollutant Load Estimation Tool (PLET) was used to estimate nutrient and sediment loads from different land uses by HUC10 and later to evaluate load reductions that would result from the implementation of various BMPs [EPA, 2022].

For the St. Vrain Creek HUC8 in PLET, three HUC10 watersheds were represented: North St. Vrain Creek (1019000502), Coal Creek-Boulder Creek (1019000506), and Boulder Creek-St. Vrain Creek (1019000507). The following inputs to the PLET model were included for each HUC10:

- Watershed land-use areas (acres) [Multi-Resolution Land Characteristics Consortium, 2019]
  - Urban (non-MS4)
  - Cropland
  - Pastureland
  - Forest
  - Feedlots
  - Other (all other land uses)
- Prominent hydrologic soil group (A-D) [NRCS, 2024a]
- Average annual rainfall (inches) [EPA, 2022]
- Rain days/year [EPA, 2022]
- Number of agricultural animals [EPA, 2022]
  - Beef cattle
  - Dairy cattle
  - Swine
  - Sheep
  - Horse

- Chicken
- Turkey
- Duck

/ Number of septic systems [Larimer County, 2024; Fischer, 2023]

/ Population per septic system [Thomas, 2024]

/ Septic rate failure [EPA, 2022]

/ Urban land-use distribution [Multi-Resolution Land Characteristics Consortium, 2019]

/ Irrigated cropland [Colorado's Decision Support Systems, 2024]

/ Water depth per irrigation (inches) [EPA, 2022]

/ Irrigation days/year [EPA, 2022]

Sediment erosion can be estimated in PLET; however, gullies and streambank erosion were not included because of a lack of data. Wildlife density (animals per square mile) was also not included because of a lack of data and because wildlife is considered a natural source.

Source assessment modeling results for the six HUC10 watersheds are summarized using the following categories: urban areas (excluding permitted MS4 areas), cropland, pastureland, forest (including scrub/shrub), feedlots, and a combination of all other land uses. The other land uses consist of barren, herbaceous, and wetlands, which typically are not the highest contributors per acre; therefore, BMP planning does not generally focus on these land uses even though they can make up a fairly large portion of the area. Because this is a NPS plan, permitted MS4s, which have limits to meet, are exempt from inclusion in this plan. The permitted MS4s in the project area not included are Erie, Lafayette, Longmont, and Louisville, Colorado. MS4 areas were developed using a combination of the MS4 layer from ERAMS [Catena Analytics, 2024] (developed with the 2010 Census urban areas), the 2020 urban areas [U.S. Census Bureau, 2020], and a layer sent from the Town of Timnath [Smith, 2024]. The excluded area (within Weld County) used to represent the MS4 areas was approximately 11.7 mi^2, and included Erie, Lafayette, Longmont, and Louisville. The expected future MS4 is the Towns of Firestone/Frederick area (16.6 mi^2). Table 5-1 shows the percentage of each land-use source per HUC10 (in Larimer and Weld Counties only). The only source not associated with an area is septic systems. The quantified sources of nitrogen, phosphorus, and sediment are listed in Tables 5-2, 5-3, and 5-4 in order of the HUC10 watersheds. The northwestern watershed (North St. Vrain Creek) is dominated by forest, and the lower watersheds (Coal Creek-Boulder Creek and Boulder Creek-St. Vrain Creek) are dominated by croplands.

In the northwestern watershed, North St. Vrain Creek, the primary land cover is forest, which dominates the source loads for nutrients and sediment. In the lower watersheds, Coal Creek-Boulder Creek and Boulder Creek-St. Vrain Creek, the primary land cover is cropland, which dominates the source loads for nutrients and sediment.

Table 5-1. Land Cover

HUC10	Description	Area (mi^2)	Urban Non-MS4 (%)	Cropland (%)	Pastureland (%)	Forest (%)	Feedlots (%)	Other Land Uses (%)
1019000502	North St. Vrain Creek	14	4	0	0	89	<1	7
1019000506	Coal Creek-Boulder Creek	1	20	40	1	12	<1	27
1019000507	Boulder Creek-St. Vrain Creek	121	19	62	4	1	<1	14

Table 5-2. Nitrogen Sources

HUC10	Description	Area (mi^2)	Urban Non-MS4 (%)	Cropland (%)	Pastureland (%)	Forest (%)	Feedlots (%)	Other Land Uses (%)	Septic (%)
1019000502	North St. Vrain Creek	14	21	0	0	64	9	3	4
1019000506	Coal Creek-Boulder Creek	1	7	65	1	<1	5	<1	22
1019000507	Boulder Creek-St. Vrain Creek	121	13	80	3	<1	3	<1	1

Table 5-3. Phosphorus Sources

HUC10	Description	Area (mi^2)	Urban Non-MS4 (%)	Cropland (%)	Pastureland (%)	Forest (%)	Feedlots (%)	Other Land Uses (%)	Septic (%)
1019000502	North St. Vrain Creek	14	10	0	0	78	5	3	4
1019000506	Coal Creek-Boulder Creek	1	3	68	1	<1	3	<1	24
1019000507	Boulder Creek-St. Vrain Creek	121	7	88	2	<1	2	<1	1

Table 5-4. Sediment Sources

HUC10	Description	Area (mi^2)	Urban Non-MS4 (%)	Cropland (%)	Pastureland (%)	Forest (%)	Feedlots (%)	Other Land Uses (%)	Septic (%)
1019000502	North St. Vrain Creek	14	4	0	0	94	0	3	0
1019000506	Coal Creek-Boulder Creek	1	1	97	1	<1	0	<1	0
1019000507	Boulder Creek-St. Vrain Creek	121	2	96	2	<1	0	<1	0

A less obvious contributor of nutrients and sediment to waterbodies is wildfire. Wildfire significantly reduce well-established root systems in areas impacted and, as a result, soil erosion is much more likely during precipitation events, carrying nutrients with it. The St. Vrain Creek Watershed has already experienced post-wildfire flooding, debris flows, and associated economic impacts from several fires in the area: Coffintop and Calwood in the mid-north, and Marshall in the mid-south. Table 5-5 provides the total number of fire acres for each year past 2000 where any existed per HUC10 [National Interagency Fire Center, 2024]. The *St. Vrain and Left Hand State of the Watershed 2021* report states several adaptive management priorities are being implemented regarding wildfire impacts such as forest health and sediment catchment. The report also explains the "Wildfire Mitigation Planning Areas" [Left Hand Watershed Center, 2021].

Table 5-5. Total Fire Acres per HUC10 per Year (2000-2021)

HUC10	1019000502	1019000506	1019000507
2011	<1		
2020			2,170
2021		4,368	

Three locations are impaired for ammonia, a form of nitrogen, in HUC10 1019000507: COSPBO10_A, COSPSV03_B, and COSPSV03_E. Ammonia, commonly produced for agricultural and industrial applications, causes direct toxic effects on aquatic organisms. It can enter waterbodies via municipal effluent discharges, animal waste, nitrogen fixation, and runoff [EPA, 2024c]. No other nutrient- or sediment-impaired waterbodies occur in the St. Vrain Creek HUC8, but nutrients and sediment were identified as priority parameters of concern.

Atmospheric deposition is also a source of nutrients. EPA's Clean Air Status and Trends Network (CASTNET) and the National Atmospheric Deposition Program (NADP) monitor nitrogen deposition (ammonia and nitrate) at locations throughout the United States. The SPARROW model published by the USGS estimated that in the St. Vrain Creek Watershed, more than 170,000 pounds of nitrogen were delivered to the stream from atmospheric deposition [USGS, 2019]. Some practices can help reduce nutrients in atmospheric deposition; however, these are not a focus in this plan because their impacts are less local than other BMPs.

5.2 E. COLI

Bacteria comes from the intestines of humans and warm-blooded animals. NPSs of bacteria consist primarily of waste that is transported through wash off from cropland, pastureland, and developed land, as well as septic systems and direct defecation from livestock and wildlife. For the purposes of this project, bacteria from wildlife are assumed to be a natural background source and are not included in the assessment.

E. coli from human and animal waste are dispersed throughout the landscape, spread by humans, and/or treated in facilities. Once *E. coli* are in the environment, their accumulation on land and delivery to the stream are affected by die-off and decay, surface imperviousness, detention time, ultraviolet exposure, and other mechanisms. Quantifying *E. coli* sources using PLET is not recommended [Tetra Tech, Inc., 2022], so an assessment of bacteria production within the watershed was completed per HUC10. This assessment included humans (Wastewater Treatment Plants [WWTPs] and Onsite Wastewater Treatment Systems [OWTSs]), pets (dogs and cats), and livestock (cattle, horses, poultry, sheep, and hogs); however, wildlife was not included because wildlife was assumed to be a natural source of bacteria. Publicly owned WWTPs are highly regulated and are not a significant source of *E. coli*. In some cases, WWTPs even provide dilution from other sources. OWTS contributions are largely dependent on soil and geology in an area, as well as their proximity to a waterbody. Additionally, point sources are not a focus of this study; therefore, WWTP estimates were added primarily as a comparison to the production of bacteria sent to an OWTS.

Livestock contribute *E. coli* loads directly by defecating in streams and indirectly by defecating on cropland or pastures where *E. coli* can wash off during precipitation events, snowmelt, or irrigation. Spreading livestock manure on cropland or pasture also contributes *E. coli* to waterbodies. The livestock in the project area mainly consists of cattle, poultry, hogs, horses, sheep, and goats, which are grazed and/or confined, and manure is spread on crops and pastures.

Pet waste is another potential source of *E. coli*. Pet waste is often left in yards, in parks, and along trails, and can be carried with stormwater to local storm drains, waterbodies, and groundwater.

Natural background sources are inputs that would be expected under natural, undisturbed conditions and include *E. coli* loading from wildlife in the area. Wildlife (e.g., waterfowl and large-game species) also contribute *E. coli* loads directly by defecating while wading or swimming in a stream and indirectly by defecating on lands that produce watershed runoff during precipitation events.

A GIS-based assessment was completed within each impaired drainage area to estimate livestock, wildlife, human, and pet populations. Animal populations were multiplied by average excretion rates from scientific literature to estimate the amount of *E. coli* produced by each source type in each HUC10 watershed. The reported literature values for fecal coliform excretion were converted to *E. coli* excretion by using a fecal coliform to *E. coli* ratio of 200:126 mpn per 100 milliliters (mL). The loads produced by humans are usually treated by WWTPs and OWTSs.

Annual excretion estimates for livestock (excluding hogs) and wildlife were obtained from "BSLC: A Tool for Bacteria Source Characterization for Watershed Management" [Zeckoski et al., 2005], and bacteria estimates for humans and hogs were obtained from *Wastewater Engineering: Treatment, Disposal, and Reuse* [Metcalf and Eddy, 1991]. Annual excretion rates for dogs and cats were sourced from

Identification and Evaluation of Nutrient and Bacterial Loadings to Maquoit Bay, New Brunswick and Freeport, Maine [Horsley and Witten, Inc., 1996]. Literature values for bacteria excretion rates are estimates and do not represent all sources and dynamics of bacteria in a natural system. Table 5-6 provides the literature rates of *E. coli* (converted from fecal coliform) produced by each animal per day, as well as the respective sources.

Table 5-6. *E. coli* Production Rates From Literature Sources

Category	Subcategory	*E. coli* Production Rate (cfu/head/day)	Source
Humans	WWTP	1,260,000,000	Metcalf and Eddy, 1991
Humans	OWTS	1,260,000,000	Metcalf and Eddy, 1991
Pets	Cats	3,150,000,000	Horsley and Witten, Inc., 1996
Pets	Dogs	3,150,000,000	Horsley and Witten, Inc., 1996
Livestock	Cattle	20,790,000,000	Zeckoski et al., 2005
Livestock	Horses	26,460,000,000	Zeckoski et al., 2005
Livestock	Poultry	58,590,000	Zeckoski et al., 2005
Livestock	Sheep	7,560,000,000	Zeckoski et al., 2005
Livestock	Goats	17,640,000,000	Zeckoski et al., 2005
Livestock	Hogs	5,607,000,000	Metcalf and Eddy, 1991
Wildlife	Deer	220,500,000	Zeckoski et al., 2005
Wildlife	Ducks	1,512,000,000	Zeckoski et al., 2005
Wildlife	Geese	504,000,000	Zeckoski et al., 2005

cfu/head/day = colony-forming units per head per day

Livestock numbers were obtained from the PLET database by HUC12 and aggregated up to the HUC10 level. Livestock counts available in PLET included cattle, horses, poultry, sheep, and hogs. PLET animal data are from the U.S. Department of Agriculture (USDA) National Agricultural Statistics Service, for which county animal data are summarized at the HUC12 level based on the pastureland area weighted ratio [EPA, 2022].

Hogs and poultry are typically kept in a total confinement facility, with their manure collected in a liquid manure storage area and later spread and/or incorporated on or into agricultural land. Grazed animals can also be kept in sheltered areas but are more likely to be pastured or have access to waterbodies than hogs and poultry. Manure that has been incorporated or spread into or on agricultural fields can contribute *E. coli* to waterways, but incorporation decreases the likelihood of transport. Livestock numbers include both animal feeding operations (AFOs) and concentrated animal feed operations (CAFOs); both are relevant because manure is applied to croplands and pasturelands and reaches surface waters even when the manure comes from a zero-runoff feedlot.

Individuals on domestic wastewater sewers within each HUC10 were estimated by summing the population for all of the 2020 U.S. Census Block Centroid Population points that fall within census urban areas, which were assumed to be connected to the WWTPs in applicable drainage areas [U.S. Census Bureau, 2020]. Bacteria within wastewater in urban areas with a WWTP were assumed to be treated according to the WWTP's permit requirement. Unhoused populations are a potential source of *E. coli* that are not accounted for in this plan.

People using an OWTS were estimated by Larimer and Weld Counties' OWTS [Larimer County, 2024; Fischer, 2023] within each HUC10 and multiplying the total by 3.31, which is the number of individuals assumed to be on each OWTS in the applicable counties [Thomas, 2024]. This evaluation represents all OWTSs, including compliant systems.

Pet populations were estimated by calculating the number of households from the 2020 U.S. Census Block Centroid Population points within each applicable impairment drainage area and assuming 0.58 dogs (36.5 percent of households times 1.6 dogs per household) and 0.64 cats (30.4 percent of households times 2.1 cats per household) per household [American Veterinary Medical Association, 2016].

Table 5-7 summarizes the number of animals, estimated *E. coli* produced, and percent of the total *E. coli* from each animal type within each HUC10. These estimates provide watershed managers with the relative magnitudes of total production by source and do not account for treatment by WWTPs or OWTSs, wash off, delivery, instream growth, or die-off dynamics that occur with *E. coli* and substantially affect their delivery to surface waters. Because of water treatment, far less *E. coli* are generally discharged from WWTPs than what is produced and sent to them.

Several factors affect whether *E. coli* reach a stream. The analysis illustrates that across the entire project area, the amount of *E. coli* produced by livestock is substantially greater than the *E. coli* produced by humans or pets. Only one HUC10, 1019000506 (Coal Creek-Boulder Creek), has a higher production from humans or pets than from livestock. Both Larimer and Weld Counties are Right-to-Farm counties, which protects certain types of operations from nuisance suits when their activities impact neighboring property through activities like noise or odor.

Table 5-7. Estimated Number of Animals, *E. coli* Produced, and Percent of *E. coli* Produced in Each HUC10 (Page 1 of 2)

HUC10	Description	Category	Subcategory	Count	Total *E. coli* Produced (cfu/day)	Total *E. coli* Produced (%)
1019000502	North St. Vrain Creek	Humans	OWTS	1,225	1.5E+12	29
1019000502	North St. Vrain Creek	Humans	WWTP	0	0.0E+00	0
1019000502	North St. Vrain Creek	Pets	Dogs	215	6.8E+11	13
1019000502	North St. Vrain Creek	Pets	Cats	237	7.5E+11	14
1019000502	North St. Vrain Creek	Livestock	Cattle	78	1.6E+12	30
1019000502	North St. Vrain Creek	Livestock	Horses	26	6.9E+11	13
1019000502	North St. Vrain Creek	Livestock	Poultry	7	4.3E+08	0
1019000502	North St. Vrain Creek	Livestock	Sheep	7	5.0E+10	1
1019000502	North St. Vrain Creek	Livestock	Goats	0	0.0E+00	0
1019000502	North St. Vrain Creek	Livestock	Hogs	3	1.9E+10	0
1019000506	Coal Creek-Boulder Creek	Humans	OWTS	751	9.5E+11	3
1019000506	Coal Creek-Boulder Creek	Humans	WWTP	11,986	1.5E+13	41
1019000506	Coal Creek-Boulder Creek	Pets	Dogs	2,232	7.0E+12	19
1019000506	Coal Creek-Boulder Creek	Pets	Cats	2,463	7.8E+12	21
1019000506	Coal Creek-Boulder Creek	Livestock	Cattle	204	4.2E+12	11
1019000506	Coal Creek-Boulder Creek	Livestock	Horses	70	1.9E+12	5
1019000506	Coal Creek-Boulder Creek	Livestock	Poultry	268	1.6E+10	0
1019000506	Coal Creek-Boulder Creek	Livestock	Sheep	30	2.3E+11	1
1019000506	Coal Creek-Boulder Creek	Livestock	Goats	0	0.0E+00	0
1019000506	Coal Creek-Boulder Creek	Livestock	Hogs	8	4.7E+10	0

Table 5-7. Estimated Number of Animals, *E. coli* Produced, and Percent of *E. coli* Produced in Each HUC10 (Page 2 of 2)

HUC10	Description	Category	Subcategory	Count	Total *E. coli* Produced (cfu/day)	Total *E. coli* Produced (%)
1019000507	Boulder Creek-St. Vrain Creek	Humans	OWTS	11,155	1.4E+13	5
1019000507	Boulder Creek-St. Vrain Creek	Humans	WWTP	32,037	4.0E+13	15
1019000507	Boulder Creek-St. Vrain Creek	Pets	Dogs	7,568	2.4E+13	9
1019000507	Boulder Creek-St. Vrain Creek	Pets	Cats	8,351	2.6E+13	9
1019000507	Boulder Creek-St. Vrain Creek	Livestock	Cattle	6,473	1.3E+14	48
1019000507	Boulder Creek-St. Vrain Creek	Livestock	Horses	791	2.1E+13	8
1019000507	Boulder Creek-St. Vrain Creek	Livestock	Poultry	30,460	1.8E+12	1
1019000507	Boulder Creek-St. Vrain Creek	Livestock	Sheep	2,063	1.6E+13	6
1019000507	Boulder Creek-St. Vrain Creek	Livestock	Goats	0	0.0E+00	0
1019000507	Boulder Creek-St. Vrain Creek	Livestock	Hogs	140	7.8E+11	0

5.3 HEAVY METALS

Heavy metal sources are typically from abandoned mines, runoff from developed areas, and contributions from soils. Heavy metals that can be sourced from irrigation on Pierre Shale areas (selenium and arsenic) would also benefit from changing irrigation practices. Flood irrigation typically results in substantial irrigation return flows, which can be high in selenium or arsenic when soils in the irrigated fields have high selenium or arsenic content. The conversion to more modern center-pivot and side-roll sprinkler systems would help decrease the volume of selenium- or arsenic-rich return flows entering waterbodies [Hawley and Rodriguez-Jeangros, 2021].

Heavy metals are also not addressed with PLET. Larimer and Weld Counties have a rich mining history dating back to the mid-1800s. Commodities consisting of beryllium, coal, copper, gold, iron, lead, manganese, molybdenum, rare earth elements, silica, silver, tungsten, uranium, vanadium, and zinc were mined [The Diggings, 2024].

Sources of some heavy metals, according to a publication within Heliyon on ScienceDirect [Briffa et al., 2020] and the *Big Thompson State of the Watershed 2021 Final Report* [Hawley and Rodriguez-Jeangros, 2021], also include:

- Zinc – mining and metal/paint/cosmetic/energy/hygiene/plastic/textile/supplement production
- Selenium – animal feed/supplement production, manufacturing processes, fossil fuel combustion, and irrigation return flows in areas with Pierre Shale
- Arsenic – pressure-treated wood, glass/pesticide production, doping, pyrotechnics, and Pierre Shale
- Manganese – alloy manufacturing processes, metal/fertilizer/firework/pesticide/cosmetic production

The CDPHE Water Quality Control Commission has designated several streams within both counties as impaired (see Clean Water Act [CWA] Section 303(d) list and 5 CCR 1002-93) for these elements (Table 4-1), suggesting that mined lands or AMLs are a potential source of NPS pollution. Several federal and state agencies have mapped and cataloged abandoned mines within Colorado and quantified the AMLs in Larimer and Weld Counties. To determine areas most likely polluted by AMLs, known AML locations were summarized per HUC10. Although not all AMLs have been discovered and mapped, an assumption was made that the more points in a HUC10, the more likely that HUC10 was polluted by AMLs. Table 5-8 lists the number of AMLs for each HUC10 [Graves, 2024].

Table 5-8. Number of Identified Abandoned Mine Lands per HUC10

HUC10	Description	Count
1019000502	North St. Vrain Creek	5
1019000506	Coal Creek-Boulder Creek	160
1019000507	Boulder Creek-St. Vrain Creek	50

In *Colorado's Nonpoint Source Program: 2022 Annual Report* [Moore, 2022], the recommended BMPs associated with pollution from AMLs are hydrologic controls (diversion ditches, mine tailings removal, erosion and sediment control, and revegetation) and passive treatments (aerobic wetlands, anaerobic wetlands, and aeration and settling ponds).

In the St. Vrain project area, the detailed geology layers mapping Pierre Shale did not intersect HUC10 1019000502 or HUC10 1019000506. The geology layers [Brandt and Colgan, 2023; Workman et al., 2018] include the majority of Pierre Shale in Larimer and Weld Counties. Of the watersheds where layers are available, most of the Pierre Shale is not irrigated. Every HUC10 in the project area has selenium and/or arsenic impairments. Non-irrigated Pierre Shale is also likely to be contributing to the impairments, or other unknown sources are likely present. Table 5-9 summarizes the acres of irrigation, irrigation type, and Pierre Shale (where information was available) throughout the project area.

Table 5-9. Acres of Irrigation and Pierre Shale

HUC10	Irrigated, Flood (acres)	Not Pierre Shale Sprinkler (acres)	Irrigated, Flood (acres)	Pierre Shale Sprinkler (acres)	Not Irrigated, Pierre Shale
1019000506	110	0	N/A	N/A	N/A
1019000507	18,974	7,075	1,710	374	3,091

6.0 PRIORITY AREAS FOR IMPLEMENTATION

Priority areas are locations that significantly contribute to the water quality parameters identified as pollutants of concern. The following sources were used to identify priority areas for BMP implementation:

- PLET model (for nutrients and sediment)
- Production per HUC10 assessment (for *E. coli*)
- AML density assessment (for heavy metals)

Point source permittees should compare the cost options of upstream NPS BMPs to the cost of mechanical treatment. Such collaborations and coordinated efforts may improve economic feasibility for improving water quality regionally.

6.1 NUTRIENTS AND SEDIMENT

The PLET model indicates that throughout the entire St. Vrain Creek HUC8 within Larimer and Weld Counties, the primary source of nutrients and sediment is cropland, which makes up approximately 53 percent of the total area. Figures 6-1, 6-2, and 6-3 show the total daily loads per HUC10 of nitrogen, phosphorus, and TSS, respectively, from PLET [EPA, 2022]. Priority areas for the reduction of nutrients and sediment are HUC10s 1019000506 (Coal Creek-Boulder Creek) and 1019000507 (Boulder Creek-St. Vrain Creek) on cropland. The source figures from PLET only represent areas that are not MS4s. Planning actions within Left Hand Watershed Center [2021] suggest similar trends for nutrients and sediment as PLET results, with nutrients and sediment increasing. No reaches are impaired for total nitrogen, total phosphorus, or sediment (Table 4-1); however, all reaches should be protected so that they do not become impaired over time.

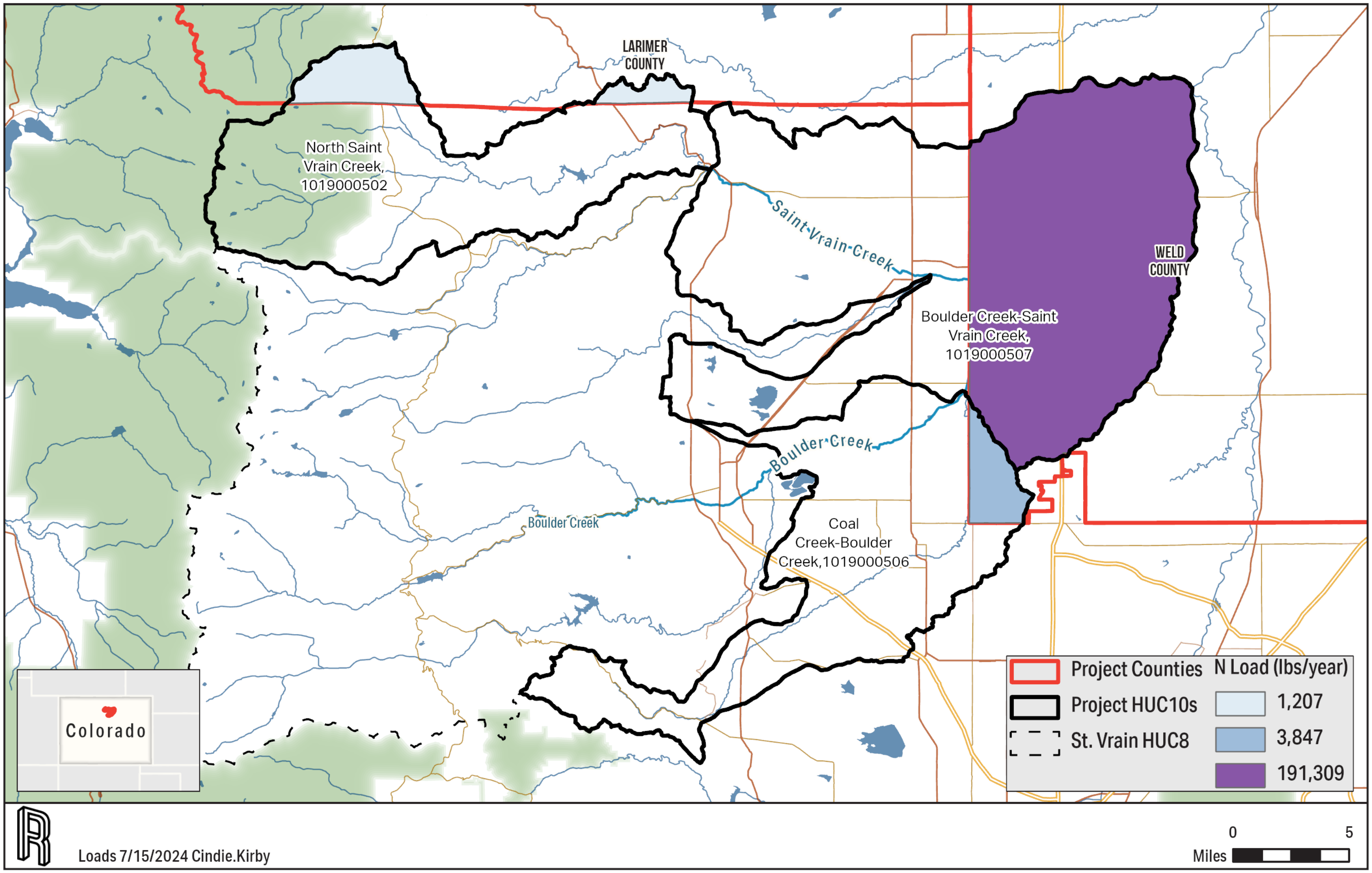


Figure 6-1. Nitrogen Contributions per HUC10.

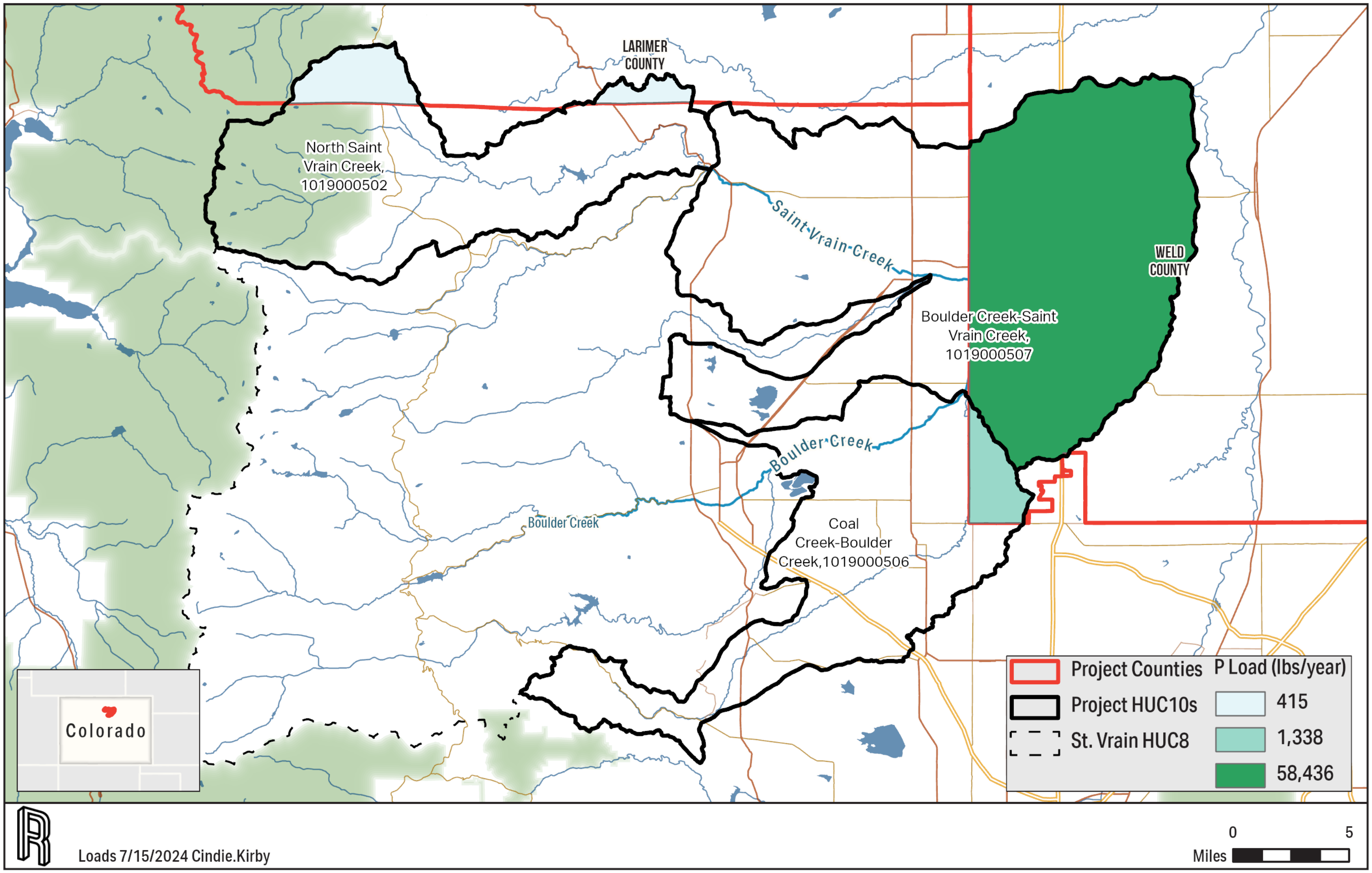


Figure 6-2. Phosphorus Contributions per HUC10.

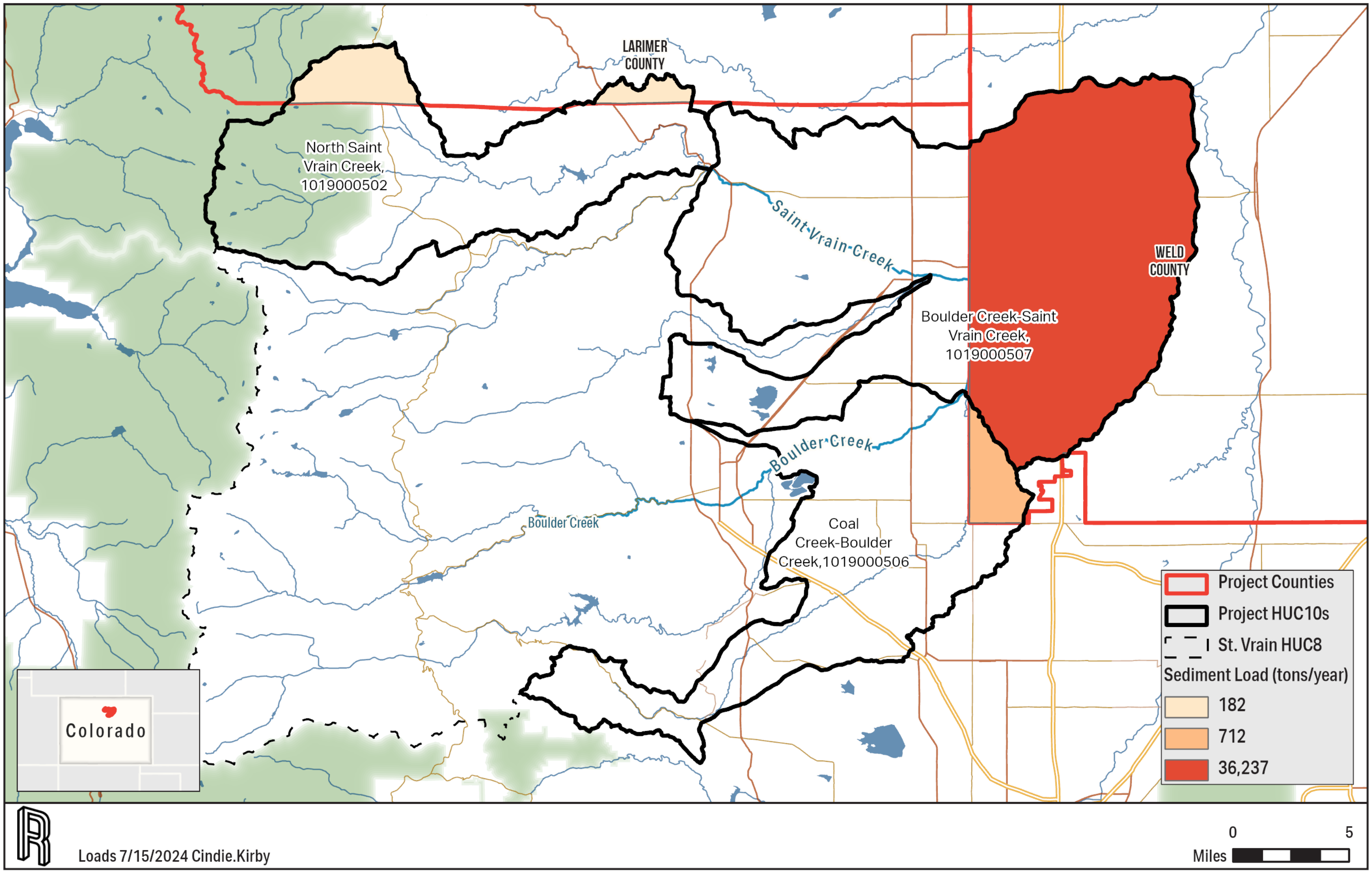


Figure 6-3. Sediment Contributions per HUC10.

6.2 E. COLI

The bacteria production assessment revealed that, overall, in the St. Vrain Creek HUC8, livestock are the primary producers of bacteria. Figure 6-4 provides the total production of bacteria per HUC10 based on the assessment within GIS. Priority areas for reduction of *E. coli* are HUC10s 1019000502 (North St. Vrain Creek) and 1019000506 (Coal Creek-Boulder Creek), and 1019000507 (Boulder Creek-St. Vrain Creek). North St. Vrain Creek and Coal Creek-Boulder Creek have the highest production rates from humans and pets, and Boulder Creek-St. Vrain Creek has the highest production rate from livestock; therefore, practices related to septic systems being added to wastewater facilities, improvements to failing septic systems, pet waste pickup, and urban buffers should be priorities in 1019000502 and 1019000506, and cattle exclusion from streams, such as fencing, off-stream watering, and seasonal riparian area management, should be a priority in 1019000507. The *E. coli*-impaired waterbodies align well with the bacteria production analysis. Because only a very small area of 101900506 (Coal Creek-Boulder Creek) is in a project county, the HUC10 does not appear to have high *E. coli* production, as shown in Figure 6-4; however, it is impaired and has a relatively high load produced per acre. The impaired status of 1019000507 (Boulder Creek-St. Vrain Creek) aligns well with the large production rate. Areas draining to the *E. coli*-impaired waterbodies (Table 4-1) should be priority areas.

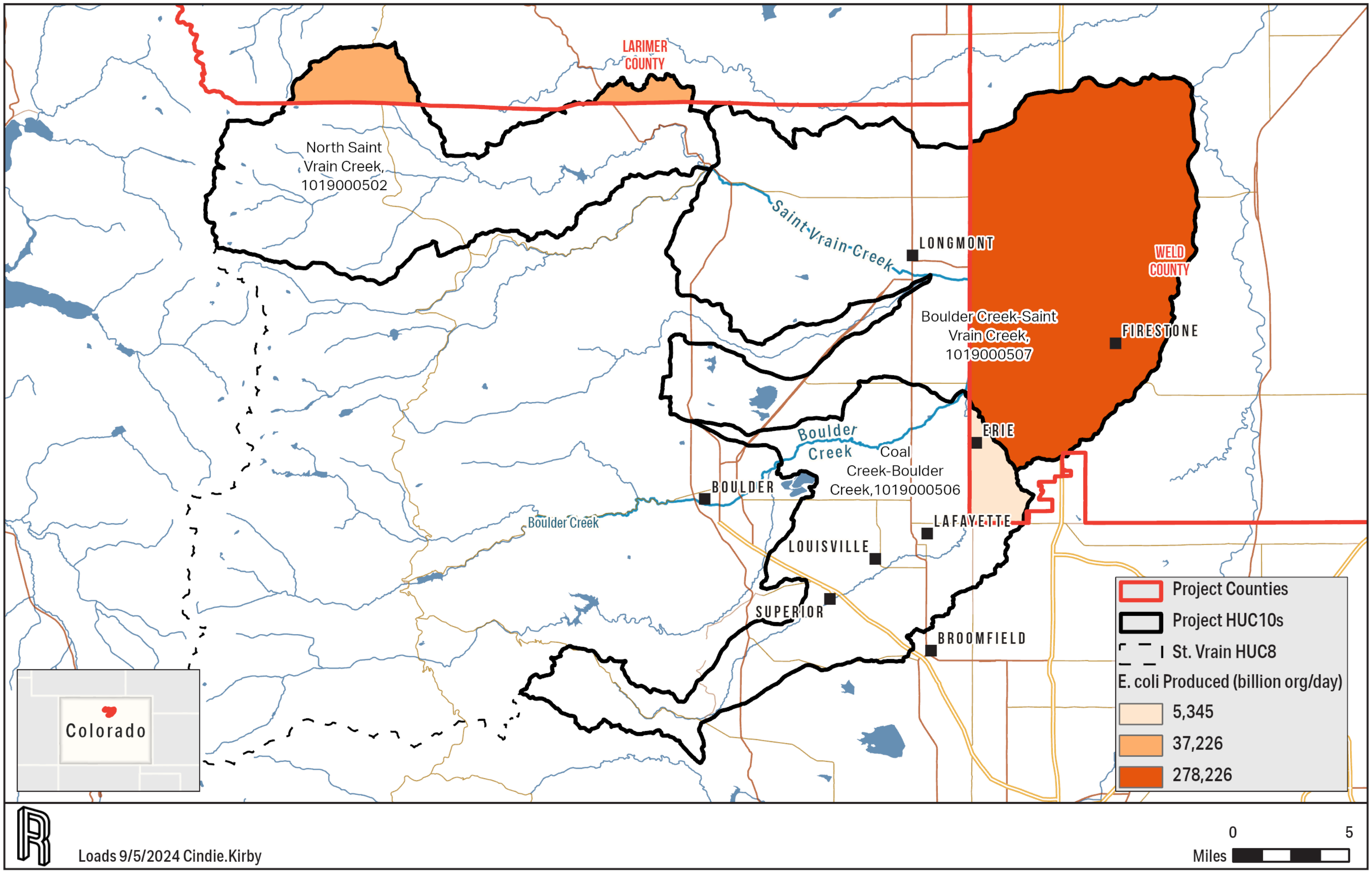


Figure 6-4. Bacteria Produced per HUC10.

6.3 HEAVY METALS

The AML density identified HUC10 1019000506 (Coal Creek-Boulder Creek) as the highest of the three watersheds; therefore, it should be the primary target (priority areas) in continuing AML identification and practice implementation to reduce heavy metals in waters. Waterbodies impaired with heavy metals for aquatic life constituents (dissolved selenium and zinc) align somewhat well with the AML density analysis and exist in two HUC10 watersheds with identified AMLs. Similarly, waterbodies impaired with heavy metals for water supply constituents (dissolved manganese and total arsenic) occur in all HUC10 watersheds, whether or not AMLs were identified. The density of AMLs per square mile is illustrated in Figure 6-5 [Graves, 2024]. Priority watersheds for heavy metal-reducing BMPs should be the areas with the highest density of AMLs. Additionally, where selenium- and arsenic-impaired waters exist with high levels of irrigated lands on Pierre Shale, more efficient irrigation practices should be a priority, especially in the areas draining to the arsenic/selenium-impaired waters (Table 4-1).

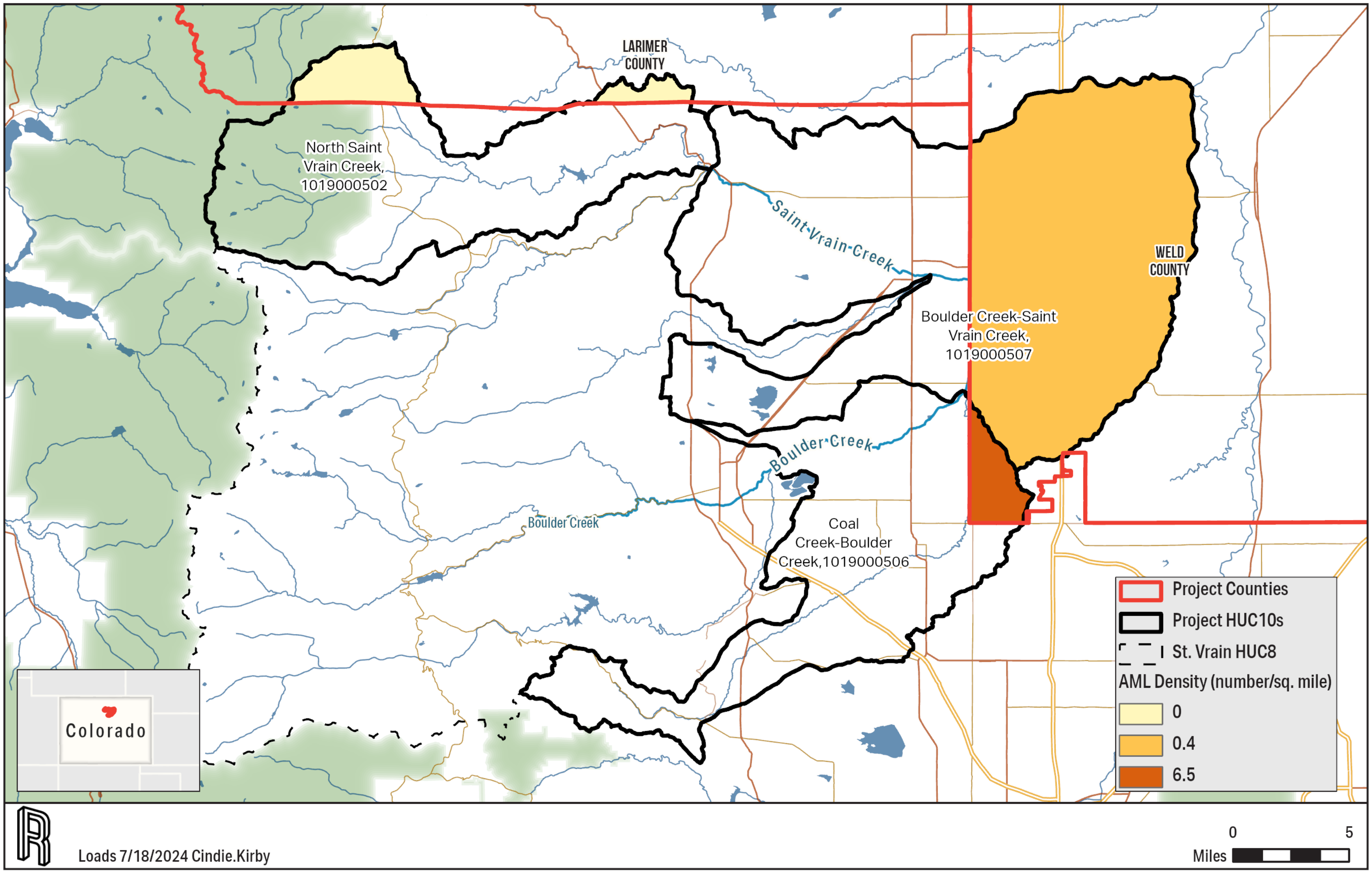


Figure 6-5. Density of Abandoned Mine Lands for Each HUC10.

7.0 BEST MANAGEMENT PRACTICES LOAD REDUCTIONS

Numerous resources exist in Colorado and nationally that provide information on BMPs. Some give data about implementation, and others inform on expected load reductions. Understanding that most BMPs require maintenance over time to remain effective is important. Some BMPs also need individuals to operate them for effectiveness. The Community-enabled Lifecycle Analysis of Stormwater Infrastructure Costs (CLASIC) tool is available on the CLASIC website and provides more information about life cycles of some stormwater BMPs. The following websites were used to summarize the overall BMP options:

- Colorado Department of Agriculture BMPs
- Colorado Water Conservation Board Floodplain Stormwater and Criteria Manual
- Colorado Water Conservation Board BMPs
- Colorado Waterwise Guidebook of Best Practices for Municipal Water Conservation in Colorado
- Colorado Ag Water Quality BMPs for Colorado
- Colorado Forestry Best Management Practices 2018 Field Monitoring Report
- Colorado Wetland Information Center Wetland BMPs
- Colorado Stormwater Center
- Colorado Department of Transportation Permanent Water Quality Program
- Upper South Platte BMPs for Protecting Source Water Quality
- International Stormwater BMP Database
- One Water Solutions Institute
- EPA Menu of Stormwater BMPs
- USDA Stream Restoration Manual
- Natural Resources Conservation Service Conservation Practice Standards
- USDA Colorado Field Office Technical Guide
- Pollution Load Estimator Tool

7.1 NUTRIENTS AND SEDIMENT

For this project, nutrient and sediment BMPs available in PLET were prioritized using multiple metrics, including stakeholder input and BMP effectiveness. The BMP reduction factors for PLET BMPs are listed in Tables 7-1 through 7-5 for cropland, pastureland, feedlots, forest, and urban lands. The average of the nitrogen, phosphorus, and sediment reduction factors was the first metric used for prioritization. The average survey score based on Survey #2 results was the second metric. The final score, the reduction survey, was the product of the two metrics. The following practices were chosen and run in PLET based on reduction survey scores: the top two cropland, top two pasture, top feedlot, top two forest, and top three urban. These priority PLET practices for each respective land use are in bold under the column headings of Tables 7-1 through 7-5. The priority PLET practices were run on

25 percent of the modeled land cover they were developed for (i.e., cropland, pasture, feedlot, forest, urban). Associated reductions for each PLET practice run are provided in Table 7-6. Reductions at the HUC10 level are included in Appendix D. Several of the practice reduction factors suggest that reducing sediment loading would simultaneously reduce nutrient loading. PLET BMP descriptions and the reduction fractions can be found in the "Best Management Practice Definition Document for Pollution Load Estimation Tool" [EPA, 2023].

Table 7-1. PLET Cropland Best Management Practices and Average Reduction Metric

Practice	Nitrogen Reduction (Fraction)	Phosphorus Reduction (Fraction)	Sediment Reduction (Fraction)	Average Reduction (Fraction)(a)	Average Survey Score(b)	Reduction Survey Score(c)
Streambank Stabilization and Fencing	**0.75**	**0.75**	**0.75**	**0.75**	**2.0**	**1.5**
Buffer - Grass (35 feet wide)	**0.34**	**0.44**	**0.53**	**0.44**	**3.0**	**1.3**
Contour Farming	0.34	0.46	0.41	0.40	2.0	0.8
Terrace	0.27	0.31	0.41	0.33	2.0	0.7
Controlled Drainage	0.39	0.35	0	0.25	2.5	0.6
Conservation tillage 1 (30-59% residue)	0.07	0.36	0.46	0.30	2.0	0.6
Conservation Tillage 2 (equal or more than 30% residue)	0.13	0.69	0.79	0.54	1.0	0.5
Nutrient Management 2 (determined rate plus additional considerations)	0.22	0.56	0	0.26	2.0	0.5
Buffer – Forest (100 feet wide)	0.49	0.47	0.6	0.52	1.0	0.5
Nutrient Management 1 (determined rate)	0.15	0.45	0	0.20	2.0	0.4
Bioreactor	0.45	0	0	0.15	1.0	0.2
Two-Stage Ditch	0.12	0.28	0	0.13	1.0	0.1
Cover Crop 1 (group A commodity; high till only for sediment)	0.0078	0	0	0.00	0.0	0.0
Cover Crop 2 (group A traditional normal planting time; high till only for total phosphorus and sediment)	0.2	0.07	0.1	0.12	0.0	0.0
Cover Crop 3 (group A traditional early planting time) (high till only for total phosphorus and sediment)	0.2	0.15	0.2	0.18	0.0	0.0

(a) Average Reduction is the product of the nitrogen, phosphorus, and sediment reduction.

(b) Average Survey Score is the average of the survey prioritization from Survey #2.

(c) The Survey Reduction Score is the product of the average reduction and the average survey score.

Table 7-2. PLET Pasture Best Management Practices and Average Reduction Metric

Practice	Nitrogen Reduction (Fraction)	Phosphorus Reduction (Fraction)	Sediment Reduction (Fraction)	Average Reduction[(a)] (Fraction)	Average Survey Score[(b)]	Reduction Survey Score[(c)]
Streambank Stabilization and Fencing	**0.75**	**0.75**	**0.75**	**0.75**	**3.0**	**2.3**
Buffer – Grass (minimum 35 feet wide)	**0.87**	**0.89**	**0.65**	**0.80**	**2.8**	**2.2**
Livestock Exclusion Fencing	0.2	0.43	0.64	0.42	3.4	1.4
Buffer – Forest (minimum 35 feet wide)	0.45	0.4	0.53	0.46	2.2	1.0
Streambank Protection Without Fencing	0.15	0.22	0.58	0.32	2.8	0.9
Critical Area Planting	0.18	0.2	0.42	0.27	3.3	0.9
Grazing Land Management (rotational grazing with fenced areas)	0.43	0.26	0	0.23	3.8	0.9
Heavy Use Area Protection	0.18	0.19	0.33	0.23	3.5	0.8
Prescribed Grazing	0.41	0.23	0.33	0.32	2.5	0.8
Multiple Practices	0.25	0.2	0.22	0.22	3.6	0.8
Winter Feeding Facility	0.35	0.4	0.4	0.38	2.0	0.8
Use Exclusion	0.43	0.08	0.51	0.34	1.7	0.6
30-meter Buffer With Optimal Grazing	0.16	0.65	0	0.27	1.5	0.4
Alternative Water Supply	0.18	0.13	0.2	0.17	2.0	0.3
Pasture and Hayland Planting (also called Forage Planting)	0.18	0.15	0	0.11	3.0	0.3
Litter Storage and Management	0.14	0.14	0	0.09	3.4	0.3

(a) Average Reduction is the product of the nitrogen, phosphorus, and sediment reduction.

(b) Average Survey Score is the average of the survey prioritization from Survey #2.

(c) The Survey Reduction Score is the product of the average reduction and the average survey score.

Table 7-3. PLET Feedlot Best Management Practices and Average Reduction Metric

Practice	Nitrogen Reduction (Fraction)	Phosphorus Reduction (Fraction)	Sediment Reduction (Fraction)	Average Reduction[a] (Fraction)	Average Survey Score[b]	Reduction Survey Score[c]
Waste Management System	**0.8**	**0.9**	**0**	**0.57**	**3.6**	**2.0**
Waste Storage Facility	0.65	0.6	0	0.42	3.6	1.5
Diversion	0.45	0.7	0	0.38	3.5	1.3
Terrace	0.55	0.85	0	0.47	2.8	1.3
Filter Strip	0	0.85	0	0.28	4.0	1.1
Runoff Management System	0	0.83	0	0.28	3.3	0.9
Solids Separation Basin With Infiltration Bed	0	0.8	0	0.27	3.0	0.8
Solids Separation Basin	0.35	0.31	0	0.22	3.0	0.7

(a) Average Reduction is the product of the nitrogen, phosphorus, and sediment reduction.

(b) Average Survey Score is the average of the survey prioritization from Survey #2.

(c) The Survey Reduction Score is the product of the average reduction and the average survey score.

Table 7-4. PLET Forest Best Management Practices and Average Reduction Metric

Practice	Nitrogen Reduction (Fraction)	Phosphorus Reduction (Fraction)	Sediment Reduction (Fraction)	Average Reduction[a] (Fraction)	Average Survey Score[b]	Reduction Survey Score[c]
Site Preparation/Straw/Crimp Seed/Net	**0**	**0**	**0.93**	**0.31**	**3.7**	**1.1**
Site Preparation/Straw/Crimp Seed/Fertilizer/Transplants	**0**	**0**	**0.95**	**0.32**	**3.0**	**1.0**
Road Grass and Legume Seeding	0	0	0.71	0.24	3.7	0.9
Site Preparation/Straw/ Polymer/Seed/Fertilizer/ Transplants	0	0	0.86	0.29	3.0	0.9
Site Preparation/Hydro Mulch/ Seed/Fertilizer	0	0	0.71	0.24	3.5	0.8
Site Preparation/Steep Slope Seeder/ Transplants	0	0	0.81	0.27	3.0	0.8
Site Preparation/Straw/ Net/Seed/Fertilizer/Transplants	0	0	0.83	0.28	2.8	0.8
Site Preparation/Hydro Mulch/ Seed/Fertilizer/Transplants	0	0	0.69	0.23	3.2	0.7
Road Hydro Mulch	0	0	0.41	0.14	4.3	0.6
Road Tree Planting	0	0	0.5	0.17	3.4	0.6
Road Straw Mulch	0	0	0.41	0.14	4.0	0.5
Road Dry Seeding	0	0	0.41	0.14	3.6	0.5

(a) Average Reduction is the product of the nitrogen, phosphorus, and sediment reduction.

(b) Average Survey Score is the average of the survey prioritization from Survey #2.

(c) The Survey Reduction Score is the product of the average reduction and the average survey score.

Table 7-5. PLET Urban Best Management Practices and Average Reduction Metric (Page 1 of 2)

Practice	Nitrogen Reduction (Fraction)	Phosphorus Reduction (Fraction)	Sediment Reduction (Fraction)	Average Reduction[a] (Fraction)	Average Survey Score[b]	Reduction Survey Score[c]
Extended Wet Detention	**0.55**	**0.69**	**0.86**	**0.70**	**3.8**	**2.7**
Infiltration Basin	**0.6**	**0.65**	**0.75**	**0.67**	**3.3**	**2.2**
Concrete Grid Pavement	**0.9**	**0.9**	**0.9**	**0.90**	**2.3**	**2.1**
Low Impact Development - Infiltration Swale	0.5	0.65	0.9	0.68	2.9	2.0
Porous Pavement	0.85	0.65	0.9	0.80	2.2	1.8
Bioretention Facility	0.63	0.8	0	0.48	3.6	1.7
Infiltration Trench	0.55	0.6	0.75	0.63	2.6	1.6
Infiltration Devices	0	0.83	0.94	0.59	2.7	1.6
Vegetated Filter Strips	0.4	0.45	0.73	0.53	2.9	1.5
Settling Basin	0	0.52	0.82	0.45	3.3	1.5
Low Impact Development - Infiltration Trench	0.5	0.5	0.9	0.63	2.3	1.4
Dry Detention	0.3	0.26	0.58	0.38	3.7	1.4
Wetland Detention	0.2	0.44	0.78	0.47	2.9	1.4
Sand Filter/Infiltration Basin	0.35	0.5	0.8	0.55	2.5	1.4
Low Impact Development - Filter/Buffer Strip	0.3	0.3	0.6	0.40	3.3	1.3
Low Impact Development - Bioretention	0.43	0.81	0	0.41	3.1	1.3
Low Impact Development - Dry Well	0.5	0.5	0.9	0.63	1.9	1.2
Grass Swales	0.1	0.25	0.65	0.33	3.5	1.2
Alum Treatment	0.6	0.9	0.95	0.82	1.4	1.1
Wet Pond	0.35	0.45	0.6	0.47	2.3	1.1
Sand Filters	0	0.38	0.83	0.40	2.6	1.0
Low Impact Development - Wet Swale	0.4	0.2	0.8	0.47	2.1	1.0
Water Quality Inlet With Sand Filter	0.35	0	0.8	0.38	2.5	1.0
Low Impact Development - Vegetated Swale	0.08	0.18	0.48	0.25	3.3	0.8

Table 7-5. PLET Urban Best Management Practices and Average Reduction Metric (Page 2 of 2)

Practice	Nitrogen Reduction (Fraction)	Phosphorus Reduction (Fraction)	Sediment Reduction (Fraction)	Average Reduction[a] (Fraction)	Average Survey Score[b]	Reduction Survey Score[c]
Filter Strip – Agricultural	0.53	0.61	0.65	0.60	1.3	0.8
Water Quality Inlets	0.2	0.09	0.37	0.22	3.3	0.7
Oil/Grit Separator	0.05	0.05	0.15	0.08	3.7	0.3
Weekly Street Sweeping	0	0.06	0.16	0.07	2.9	0.2

(a) Average Reduction is the product of the nitrogen, phosphorus, and sediment reduction.

(b) Average Survey Score is the average of the survey prioritization from Survey #2.

(c) The Survey Reduction Score is the product of the average reduction and the average survey score.

Table 7-6. Reductions From Priority PLET Best Management Practices Run on 25 Percent of Each Applicable Land Cover

Land Use	Percent of Total Area	Practice	Nitrogen Load (lb/year)	Percent Nitrogen Reduction	Phosphorus Load (lb/year)	Percent Phosphorus Reduction	Sediment Load (tons/year)	Percent Sediment Reduction
All	N/A	Base Load (no BMPs)	196,363	N/A	60,189	N/A	37,131	N/A
Cropland	55	Stream Stabilization and Fencing	167,101	14.9	50,415	16.2	30,491	17.9
Cropland	55	Buffer - Grass (35 feet wide)	177,715	9.5	53,473	11.2	32,439	12.6
Pasture	4	Stream Stabilization and Fencing	195,349	0.5	59,954	0.4	36,971	0.4
Pasture	4	Livestock Exclusion Fencing	195,791	0.3	59,999	0.3	36,994	0.4
Feedlot	<1	Waste Management System	195,084	0.7	59,901	0.5	37,131	0.0
Forest	10	Site Prep/Straw/ Crimp Seed/Net	196,227	0.1	60,137	0.1	37,089	0.1
Forest	10	Site Prep/Straw/ Crimp Seed/Fertilizer/ Transplants	196,224	0.1	60,136	0.1	37,088	0.1
Urban	17	Extended Wet Detention	195,286	0.6	59,986	0.3	37,068	0.2
Urban	17	Infiltration Basin	195,188	0.6	59,998	0.3	37,076	0.2
Urban	17	Concrete Grid Pavement	194,601	0.9	59,924	0.4	37,065	0.2

lb/year = pounds per year

Numerous BMPs that reduce nutrient and sediment NPS loads exist from other sources not included in PLET. Nutrient and sediment load reductions from BMPs are ranked in the Natural Resources Conservation Service (NRCS) Conservation Practice Physical Effects (CPPE) [NRCS, 2024b] as substantial, moderate to substantial, moderate, slight to moderate, and slight. Similarly, reductions expected from urban practices are provided in the International Stormwater BMP Database (BMPDB) [The Water Research Foundation, 2024]. Tables 7-7 and 7-8 list the most effective CPPE practices (i.e., substantial, moderate to substantial, and moderate reductions) and urban practices for sediment reduction. Table 7-9 shows the most effective CPPE practices (i.e., substantial, moderate to substantial, and moderate reductions) for nutrient reduction, and Tables 7-10 and 7-11 provide the urban practices for nitrogen and phosphorus reduction, respectively [NRCS, 2024b]. Irrigation practices are important in the project area for the reduction of nutrients and sediment but were not available in PLET. The NRCS Irrigation Water Management practice code Number 449 has slight to moderate improvement (less than every other practice listed in CPPE practices tables) for sediment and nutrients. However, the NRCS Irrigation Water Management practice code Number 449 has been added to these tables because of its high usage in the project area. Other practices with slight to moderate improvement should not be discouraged, even though they are not included in the tables in this section.

Table 7-7. Most Effective Sediment to Surface Water Reducing Agricultural Best Management Practices From the Colorado Natural Resources Conservation Service Conservation Practice Physical Effects (Page 1 of 2)

Practice	Practice Code	Unit	Effect	Rationale
Constructed Wetland	656	Acre	Substantial Improvement	The system traps and holds suspended materials from entering surface waters.
Filter Strip	393	Acre	Substantial Improvement	Vegetation protects the soil surface and traps sediment, nutrients, and other materials.
Grassed Waterway	412	Acre	Substantial Improvement	Erosion is controlled, vegetation traps sediment, and runoff is delivered at a safe velocity.
Lined Waterway or Outlet	468	Feet	Substantial Improvement	Erosion is controlled, vegetation traps sediment, and runoff is delivered at a safe velocity.
Riparian Forest Buffer	391	Acre	Substantial Improvement	Vegetation protects the soil surface and traps sediment, nutrients, and other materials.
Anionic Polyacrylamide Erosion Control	450	Acre	Moderate to Substantial Improvement	The action reduces erosion and sediment load.
Conservation Cover	327	Acre	Moderate to Substantial Improvement	Less erosion and runoff reduce sediment.
Critical Area Planting	342	Acre	Moderate to Substantial Improvement	Vegetation reduces erosion and sediment delivery.
Forest Farming	379	Acre	Moderate to Substantial Improvement	Varied canopy layers and surface cover and organic matter management reduce sediment-laden runoff from reaching surface water conveyances.
Grazing Land Mechanical Treatment	548	Acre	Moderate to Substantial Improvement	Improved hydrologic indicators increase infiltration and decrease runoff.
Land Reclamation, Abandoned Mined Land	543	Acre	Moderate to Substantial Improvement	Erosion control and revegetation reduces concerns about sediments.
Land Reclamation, Currently Mined Land	544	Acre	Moderate to Substantial Improvement	Erosion control and revegetation reduces concerns about sediments.
Land Reclamation, Landslide Treatment	453	N/A	Moderate to Substantial Improvement	Erosion control and increased cover reduces runoff and sediment.
Residue and Tillage Management, No Till	329	Acre	Moderate to Substantial Improvement	Less erosion and runoff reduce the transport of sediment.
Riparian Herbaceous Cover	390	Acre	Moderate to Substantial Improvement	Vegetation protects the soil surface and traps sediment, nutrients, and other materials.
Sediment Basin	350	N/A	Moderate to Substantial Improvement	The basin retains sediment, decreasing runoff turbidity.
Stormwater Runoff Control	570	N/A	Moderate to Substantial Improvement	Controlling erosion and runoff reduces off-site sediment.
Vegetative Barrier	601	Feet	Moderate to Substantial Improvement	Vegetation slows runoff and filters sediment.
Water and Sediment Control Basin	638	N/A	Moderate to Substantial Improvement	The basin retains sediment and minimizes turbidity.
Access Control	472	Acre	Moderate Improvement	Excluding animals, people, and vehicles influences the vigor and health of vegetation and soil conditions, reducing sediment supply to surface waters when applied with other management practices.
Alley Cropping	311	Acre	Moderate Improvement	Vegetation inhibits sediment-laden water to allow it to drop sediment load.
Conservation Crop Rotation	328	Acre	Moderate Improvement	Depending on crop rotation and biomass produced, crop rotation reduces erosion and runoff, which reduces transport of sediment.
Contour Buffer Strips	332	Acre	Moderate Improvement	Contour buffer strips reduce sheet and rill erosion and slow the velocity of runoff, thereby reducing the transport of sediment to surface water.

Table 7-7. Most Effective Sediment to Surface Water Reducing Agricultural Best Management Practices From the Colorado Natural Resources Conservation Service Conservation Practice Physical Effects (Page 2 of 2)

Practice	Practice Code	Unit	Effect	Rationale
Contour Orchard and Other Perennial Crops	331	Acre	Moderate Improvement	Contouring reduces sheet and rill erosion and slows the velocity of runoff, thereby reducing the transport of sediment to surface water.
Field Border	386	Feet	Moderate Improvement	Vegetation protects the soil surface and traps sediment.
Residue and Tillage Management, Reduced Till	345	Acre	Moderate Improvement	Less erosion and runoff reduce the transport of sediment.
Road/Trail/Landing Closure and Treatment	654	Feet	Moderate Improvement	Vegetation and other treatments reduce erosion and sediment delivery.
Silvopasture	381	Acre	Moderate Improvement	On sites that previously lacked permanent vegetation, establishing a combination of trees or shrubs and compatible forages reduces the erosive force of water and reduces sedimentation.
Stripcropping	585	Acre	Moderate Improvement	Stripcropping reduces erosion and slows water and wind velocities, increasing infiltration.
Surface Roughening	609	Acre	Moderate Improvement	The formation of clods reduces wind-borne sediment.
Tree/Shrub Establishment	612	Acre	Moderate Improvement	Vegetation provides cover reduces wind velocities, and increases infiltration.
Wetland Wildlife Habitat Management	644	Acre	Moderate Improvement	Improved vegetative cover reduces runoff and sedimentation.
Irrigation Water Management	449	Acre	Slight to Moderate Improvement	Water is applied at rates that minimize soil erosion.

Table 7-8. Most Effective Sediment (Greater Than 10 Percent) Reducing Urban Best Management Practices From the International Best Management Practice Database

BMP Category	Concentration In (mg/L)	Concentration Out (mg/L)	Reduction (%)
High-Rate Biofiltration	30.8	3.8	88
Media Filter	44	7.2	84
Bioretention	44	10	77
Retention Pond	49	12	76
Porous Pavement	77	22	71
Detention Basin	65.1	22	66
Wetland Basin	35.5	14	61
High-Rate Media Filtration	44	18	59
Oil-Grit Separator	36	15.5	57
Grass Strip	48	23	52
Grass Swale	26	13.7	47
Hydrodynamic Separator	63.9	39	39

mg/L = milligrams per liter

Table 7-9. Most Effective Nutrient to Surface Water Reducing Agricultural Best Management Practices From the Colorado Natural Resources Conservation Service Conservation Practice Physical Effects (Page 1 of 2)

Practice	Practice Code	Unit	Effect	Rationale
Filter Strip	393	Acre	Substantial Improvement	Solid organics and sediment-attached nutrients are filtered out; soluble nutrients infiltrate the soil and may be taken up by plants or used by soil organisms.
Nutrient Management	590	Acre	Substantial Improvement	The right amount, source, placement, and timing (4Rs) provide nutrients when plants need them most.
Riparian Forest Buffer	391	Acre	Substantial Improvement	Plants and soil organisms in the buffer will use nutrients; the buffer will filter out suspended particles to which nutrients are attached.
Riparian Herbaceous Cover	390	Acre	Substantial Improvement	Permanent vegetation will uptake excess nutrients.
Saturated Buffer	604	Feet	Substantial Improvement	The buffer removes 60-100% of nitrogen from drain pipe discharge.
Sediment Basin	350	N/A	Substantial Improvement	The action will tend to accumulate contaminants attached to sediments, and infiltrating waters will remove soluble contaminants.
Conservation Cover	327	Acre	Moderate to Substantial Improvement	Less erosion and runoff reduce the transport of nutrients; permanent cover can take up excess nutrients and convert them to stable organic forms.
Constructed Wetland	656	Acre	Moderate to Substantial Improvement	The action traps nutrients and organics, which are broken down and used by wetland plants.
Short-Term Storage of Animal Waste and Byproducts	318	Cu. Yard	Moderate to Substantial Improvement	Short-term storage provides flexibility in rate, timing, and location of waste application, with the potential for reductions of contaminants available for transport.
Vegetated Treatment Area	635	Acre	Moderate to Substantial Improvement	Infiltration and plant uptake in the treatment area will remove contaminants from polluted runoff and wastewater.
Waste Storage Facility	313	#	Moderate to Substantial Improvement	Storage provides flexibility in rate, timing, and location of waste application, with the potential for reductions of contaminants available for transport.
Waste Treatment Lagoon	359	#	Moderate to Substantial Improvement	Storage provides flexibility in rate, timing, and location of waste application, with the potential for reductions of contaminants available for transport.
Watering Facility	614	#	Moderate to Substantial Improvement	When used in place of an instream water source, this action decreases manure deposition in the stream.
Alley Cropping	311	Acre	Moderate Improvement	Plants and soil organisms uptake nutrients.
Conservation Crop Rotation	328	Acre	Moderate Improvement	Nitrogen-demanding or deep-rooted crops can remove excess nitrogen; legumes in rotation will provide slow-release nitrogen and reduce the need for additional nitrogen.
Denitrifying Bioreactor	605	#	Moderate Improvement	Reactors remove 30 to 60% of the nitrogen load coming from a drain pipe.
Diversion	362	Feet	Moderate Improvement	The action diverts surface water away from feedlots and reduces 5-day Biological Oxygen Demand (BOD5); total phosphorous and total nitrogen load to receiving surface waters.

Table 7-9. Most Effective Nutrient to Surface Water Reducing Agricultural Best Management Practices From the Colorado Natural Resources Conservation Service Conservation Practice Physical Effects (Page 2 of 2)

Practice	Practice Code	Unit	Effect	Rationale
Grazing Land Mechanical Treatment	548	Acre	Moderate Improvement	Modifications to soil conditions will increase infiltration and reduce runoff; improved plant growth will better use nutrients, decreasing the potential for losses in runoff.
Livestock Shelter Structure	576	#	Moderate Improvement	Moving livestock away from streams and riparian areas will decrease the probability of excess manure nutrients in the water.
Silvopasture	381	Acre	Moderate Improvement	Depending on previous vegetative conditions, whether forestland or pasture, the permanent silvopasture vegetation may take up comparatively greater amounts of nutrients.
Wetland Creation	658	Acre	Moderate Improvement	Wetland systems will use dissolved nutrients and trap sediment-attached nutrients and organics.
Wetland Enhancement	659	Acre	Moderate Improvement	Wetland systems will use dissolved nutrients and trap sediment-attached nutrients and organics.
Wetland Restoration	657	Acre	Moderate Improvement	Wetland systems will use dissolved nutrients and trap sediment-attached nutrients and organics.
Irrigation Water Management	449	Acre	Slight to Moderate Improvement	Water is applied at rates that reduce the potential for erosion and detachment, and minimize nutrient transport to surface water.

Table 7-10. Most Effective Nitrogen (Greater Than 10 Percent) Reducing Urban Best Management Practices From the International Best Management Practice Database

BMP Category	Concentration In (mg/L)	Concentration Out (mg/L)	Reduction (%)
High-Rate Media Filtration	1.88	1	47
Retention Pond	1.63	1.2	26
Bioretention	1.26	0.96	24
Wetland Channel	1.76	1.45	18
Media Filter	1.06	0.89	16
Grass Strip	1.47	1.27	14
Grass Swale	0.71	0.63	11

Table 7-11. Most Effective Phosphorus (Greater Than 10 Percent) Reducing Urban Best Management Practices From the International Best Management Practice Database

BMP Category	Concentration In (mg/L)	Concentration Out (mg/L)	Reduction (%)
Oil-Grit Separator	0.316	0.115	64
Retention Pond	0.246	0.12	51
High-Rate Biofiltration	0.099	0.05	49
Media Filter	0.165	0.09	45
Porous Pavement	0.17	0.1	41
High-Rate Media Filtration	0.12	0.08	33
Wetland Basin	0.17	0.122	28
Detention Basin	0.25	0.186	26
Hydrodynamic Separator	0.23	0.176	23

Practices associated with reducing wildfire impacts include susceptibility and post-fire hazard analyses and pre-disaster planning and mitigation. The susceptibility analysis includes determining the assets at risk from fire and the risk severity of post-fire impacts, such as flooding, loss of life, loss of property, damage to infrastructure, utility interruptions, and water quality and quantity issues. Post-fire hazards consist of flooding, sediment/hillslope erosion, debris flow, fluvial hazard zones, water quality issues, and risk to water infrastructure. Post-fire BMPs should involve slope stabilization and reforestation.

7.2 E. COLI

E. coli load reductions from BMPs are ranked in the NRCS CPPE as substantial, moderate to substantial, moderate, slight to moderate, and slight. Table 7-12 lists the most effective practices (i.e., substantial, moderate to substantial, and moderate reductions) [NRCS, 2024b]. *E. coli* reductions expected from the BMPDB's urban practices are summarized in Table 7-13 [The Water Research Foundation, 2024]. Unlike the sediment and nutrient reductions, *E. coli* reductions are not quantified using the PLET model; therefore, priority BMPs should be those with the highest amount of reduction in the priority areas on the relative land cover. The NRCS Irrigation Water Management practice code Number 449 has slight to moderate improvement for bacteria, and it was included in Table 7-12 because of its high probability of installation. Practices with slight to moderate improvement should not be discouraged, even though they are not included in the tables in this section.

Table 7-12. Most Effective Bacteria (Pathogen) to Surface Water Reducing Agricultural Best Management Practices From the Colorado Natural Resources Conservation Service Conservation Practice Physical Effects

Practice	Practice Code	Unit	Effect	Rationale
Vegetated Treatment Area	635	Acre	Substantial Improvement	Infiltration and plant uptake in the treatment area will remove contaminants from polluted runoff and wastewater.
Constructed Wetland	656	Acre	Moderate to Substantial Improvement	Pathogens are trapped in the wetland.
Filter Strip	393	Acre	Moderate to Substantial Improvement	Filter strips capture and delay pathogen movement, but mortality may also be delayed because vegetative cover may protect pathogens from desiccation.
Nutrient Management	590	Acre	Moderate to Substantial Improvement	Proper application of manure, compost, and bio-solids should reduce or eliminate pathogens and/or chemicals (if present in source material) from moving into surface water.
Waste Treatment Lagoon	359	N/A	Moderate to Substantial Improvement	Storage provides flexibility in rate, timing, and location of waste application, with the potential for reductions of contaminants available for transport.
Alley Cropping	311	Acre	Moderate Improvement	Ground vegetation captures and delays pathogen movement and thereby increases their mortality.
Forest Farming	379	Acre	Moderate Improvement	Management of multi-layered canopy cover and organic matter impedes the movement of harmful pathogens.
Land Reclamation, Abandoned Mined Land	543	Acre	Moderate Improvement	Reconstructed mine land provides reduced runoff and erosion, and the filtering effects of vegetation reduce the risk of harmful levels of pathogens entering surface water.
Land Reclamation, Currently Mined Land	544	Acre	Moderate Improvement	Reconstructed mine land provides reduced runoff and erosion, and the filtering effects of vegetation reduce the risk of harmful levels of pathogens entering surface water.
Riparian Forest Buffer	391	Acre	Moderate Improvement	Riparian areas capture and delay pathogen movement and thereby increase their mortality.
Riparian Herbaceous Cover	390	Acre	Moderate Improvement	Vegetation traps pathogens providing increased opportunity for solar and microbial action to destroy some.
Irrigation Water Management	449	Acre	Slight to Moderate Improvement	Water is applied at rates that minimize pathogens transport to surface water.

Table 7-13. Most Effective *E. coli* (Greater Than 10 Percent) Reducing Urban Best Management Practices From the International Best Management Practice Database

BMP Category	Concentration In (mpn/100 mL)	Concentration Out (mpn/100 mL)	Reduction (%)
Wetland Basin	6,210	884	86
Retention Pond	4,110	708	83
Media Filter	570	215	62
Detention Basin	900	500	44
Bioretention	275	158	43
Hydrodynamic Separator	2,400	1,700	29

7.3 HEAVY METALS

Several risks are associated with abandoned mines. To prioritize public safety, specific locations of abandoned mines are not disclosed; however, taking action to mitigate potential dangers is important. The efforts of groups like Defense-Related Uranium Mines (DRUMs) are crucial in sealing off dangerous openings, identifying hazards, and implementing safety measures to protect the public and environment. This approach balances transparency with the need to safeguard communities from potential harm and is more focused on water quality and heavy-metal-impaired waterbodies. When waters are exposed to rocks containing sulfide minerals, they tend to become acid-rich. This occurrence is called acid rock drainage and is prevalent in mined areas where spent materials were left unclaimed. When the waters become acidic, they are more capable of gathering up and carrying heavy metals, including those that impair the waterbodies on the 303(d) list within the project area. Readers that would like more information on mining in the project area can contact the Left Hand Watershed Center, which has been monitoring mines on Left Hand Creek for decades.

The AML implementation should be guided by the NRCS Code 543 practices. The NRCS Conservation Practice Standard (CPS) states the following options for land reclamation of AML [NRCS, 2024c]:

> **Public health and safety:** Prior to beginning onsite investigations, identify possible hazards and implement appropriate safety precautions.
>
> **Erosion and sediment control practices:** Control or treat runoff and sedimentation from treatment areas, soil material stockpiles, access roads, and permanent impoundments. Use sediment-trapping practices, such as filter strips, riparian forest buffers, contour buffer strips, silt fences, sediment basins, or similar practices. Include temporary practices necessary during earth moving activities and permanent practices necessary to stabilize the site and control runoff from the site after reclamation.
>
> Control the generation of particulate matter and fugitive dust during removal and replacement of soil and other materials.
>
> **Site preparation:** Identify areas for preservation during construction. Include areas containing desirable trees, shrubs, grasses, stream corridors, natural springs, historic structures, or other important features that will be protected during construction activities.

Remove trees, logs, brush, rubbish, and other debris that interfere with reclamation operations. Dispose of debris material in a way that does not create a resource problem or interfere with reclamation activities and the planned land use.

Storage of soil materials: Stockpile soil or fill materials until needed for reclamation. Protect stockpiles from wind and water erosion, dust generation, unnecessary compaction, and contamination by noxious weeds, invasive species, or other undesirable materials.

Highwall treatment: Prior to backfilling, rock walls should have horizontal:vertical slopes of 0.5:1 or less. before placing backfill against the wall. Determine the thickness and density of lifts for fill material to limit the deep infiltration of precipitation and to limit settlement of the completed fill to acceptable levels, based on the available fill material and planned land use.

Shafts and adits: Use NRCS Conservation Practice Standard (CPS) Mine Shaft and Adit Closing (Code 457) to close/seal a shaft or adit. Divert runoff away from the shaft or adit.

Placement of surface material: Develop a grading plan that returns the site, including any off-site borrow areas, to contours that are suitable for the planned land use and control soil loss. Include the spreading of stockpiled topsoil material as the final layer. Treat graded areas to eliminate slippage surfaces and promote root penetration before spreading surface material. Spread surface soil without causing over-compaction.

Shape the land surface to provide adequate surface drainage and to blend into the surrounding topography. Use erosion control practices to reduce slope lengths where sheet and rill erosion exceeds acceptable levels. If settlement is likely to interfere with the planned land use, develop surface drainage or water disposal plans that compensate for the expected settlement.

If the subsurface material is not a source of contamination, improve soil permeability after placing backfill material by using deep ripping tools to decrease compaction, promote infiltration, and encourage root development. Do not plan practices that promote infiltration if seepage through cover materials has the potential to develop or exacerbate acid mine drainage loading or treatment.

Restoration of borrow material: If cover or fill material is taken from areas outside the reclamation site, stockpile the topsoil from the borrow area separately, and replace it on the borrow area after the area is restored for its intended purpose. Grade and shape the borrow area for proper drainage, and revegetate the site to control erosion.

Establishment of vegetation: Prepare a revegetation plan for the treated areas. Select plant materials suitable for the specified end land use according to local climate potential, site conditions, and local NRCS criteria. Use native species where possible. Avoid use of invasive species.

Use the criteria in NRCS CPS Critical Area Planting (Code 342) to establish grasses and forbs. Use NRCS CPS Tree-Shrub Establishment (Code 612) for the establishment of trees and shrubs. If vegetation cannot be established, use NRCS CPS Mulching (Code 484).

Control of toxic aqueous discharge: Identify and document water quality and quantity and releases from seeps, overland, and mine shafts. Quantify water impacts such as low pH, arsenic, etc. Identify measures that may affect treatment such as dissolved oxygen, iron, aluminum, magnesium, manganese, etc.

Methods for treatment of toxic aqueous discharge depend upon the type and extent of the contamination. When control of toxic mine drainage is needed, use BMPs that comply with state regulatory requirements. Evaluate the consequences of each potential treatment method to avoid creating a secondary problem. Select a method that can adequately treat the water based on the quantity and chemistry of the mine water and that is suitable for the planned level of operation and maintenance. Size the treatment area and settling basin(s) to allow for the volume of flow and treatment rate. Include a plan for disposal of the precipitated metals and spent treatment material.

Reduce the volume of contaminated water by diverting clean water away from the contaminated area or by limiting the opportunity for water to contact contaminated soil materials. Install practices, such as diversions, underground outlets, lined waterways, or grade stabilization structures, to control surface runoff. To the extent possible, divert clean upslope runoff away from the treated area.

- **Contaminated soil materials:** Remove, bury, or treat soil materials that adversely affect or have the potential to adversely affect water quality or plant growth. Bury materials containing heavy metals below the root zone, add suitable soil amendments, or both, to minimize the negative effect of this material. Separate soils with high electrical conductivity, calcium carbonate, sodium, or other restrictive properties, and treat, if practicable.
- Add a layer of compacted clay or a landfill cover over the contaminated material to deter infiltration. Place an earthfill blanket over the compacted clay to support plant growth. For each layer, identify the lift thickness and density needed to limit deep infiltration of precipitation and excessive settlement of the completed fill.
- **Mine sealing:** If clean water is entering a mine opening, divert the water away. If contaminated water is exiting the mine, it may be necessary to seal the mine to prevent water movement. Use NRCS CPS Mine Shaft and Adit Closing (Code 457) to design the mine seal. Divert surface water away from the mine seal.
- **Neutralization and precipitation:** Precipitate toxic metals and neutralize acidity in mine drainage using chemical or biological treatment. Select a method that can adequately treat the water based on the quantity and chemistry of the mine water and that is suitable for the planned level of operation and maintenance. Size the treatment area and settling basin(s) to allow for the volume of flow and treatment rate. Include a plan for disposal of the precipitated metals and spent treatment material.

Aside from AMLs, heavy metals also come from agricultural lands and urbanized areas. Heavy metal load reductions from BMPs are ranked in the NRCS CPPE as substantial, moderate to substantial, moderate, slight to moderate, and slight. Table 7-14 lists the most effective practices (i.e., substantial, moderate to substantial, and moderate reductions) [NRCS, 2024b]. Heavy metal reductions expected from the BMPDB's urban practices are summarized in Table 7-15 [The Water Research Foundation, 2024]. Heavy metal reductions are not quantified using the PLET model; therefore, priority BMPs should be those with the highest amount of reduction in the priority areas on the relative land cover. The NRCS Irrigation Water Management practice code Number 449 has slight to moderate improvement for heavy metals. Irrigation management is the only NRCS practice included with less than moderate improvement. It was included because of its high probability of installation in the project area. Practices with slight to moderate improvement should not be discouraged, even though they are not included in the tables in this section.

Table 7-14. Most Effective Heavy Metals to Surface Water Reducing Agricultural Best Management Practices From the Colorado Natural Resources Conservation Service Conservation Practice Physical Effects

Practice	Practice Code	Unit	Effect	Rationale
On-Farm Secondary Containment Facility	319	N/A	Substantial Improvement	Provides for spill containment of petroleum products.
Constructed Wetland	656	Acre	Moderate to Substantial Improvement	Vegetation and anaerobic conditions trap heavy metals.
Irrigation and Drainage Tailwater Recovery	447	N/A	Moderate to Substantial Improvement	The action captures irrigation and/or drainage runoff and associated metal-laden sediment.
Land Reclamation, Landslide Treatment	453	N/A	Moderate to Substantial Improvement	Increased vegetation increases infiltration and reduces runoff and erosion.
Land Reclamation, Toxic Discharge Control	455	N/A	Moderate to Substantial Improvement	Control of discharge and reduction in infiltration reduce off-site movement of contaminated water.
Riparian Forest Buffer	391	Acre	Moderate Improvement	The action filters sediment, and some plants may uptake heavy metals.
Road/Trail/Landing Closure and Treatment	654	Feet	Moderate Improvement	Decreased erosion and runoff reduce heavy metal delivery to surface water; increased soil organic matter increases the capacity of soils to retain heavy metals; permanent vegetation can uptake heavy metals.
Irrigation Water Management	449	Acre	Slight to Moderate Improvement	Water is applied at rates that minimize heavy metals transport to surface water.

Table 7-15. Most Effective Heavy Metal (Greater Than 10 Percent) Reducing Urban Best Management Practices From the International Best Management Practice Database

Category	BMP Category	Concentration In (µg/L)	Concentration Out (µg/L)	Reduction (%)
Arsenic (T)	Media Filter	0.9	0.765	15
Arsenic (T)	Retention Pond	1	0.87	13
Arsenic (T)	Grass Swale	1.11	1	10
Cadmium (D)	Grass Swale	0.2	0.116	42
Cadmium (D)	Grass Strip	0.114	0.07	39
Cadmium (D)	Media Filter	0.2	0.128	36
Cadmium (D)	Oil-Grit Separator	0.155	0.101	35
Cadmium (D)	Hydrodynamic Separator	0.137	0.0933	32
Cadmium (D)	Retention Pond	0.163	0.125	23
Cadmium (D)	Detention Basin	0.117	0.0942	19
Copper (D)	Wetland Basin	3.95	2.29	42
Copper (D)	Grass Strip	12	7.4	38
Copper (D)	Retention Pond	5.08	3.5	31
Copper (D)	Detention Basin	3.96	2.99	24
Copper (D)	High-Rate Biofiltration	4.5	3.4	24
Copper (D)	Media Filter	3.86	3	22
Copper (D)	Grass Swale	6.5	5.63	13
Iron (T)	Retention Pond	1050	285	73
Iron (T)	Media Filter	685	195	72
Iron (T)	Grass Strip	746	320	57
Iron (T)	Grass Swale	216	136	37
Zinc (D)	Media Filter	32	7.15	78
Zinc (D)	Porous Pavement	17.8	4.09	77
Zinc (D)	Wetland Basin	22.6	8.35	63
Zinc (D)	High-Rate Biofiltration	189	79	58
Zinc (D)	Grass Strip	33.6	17	49
Zinc (D)	Grass Swale	34.2	19.8	42
Zinc (D)	Bioretention	20.8	12.5	40
Zinc (D)	Retention Pond	23.4	16	32
Zinc (D)	Detention Basin	12.1	9.38	22

µg/L = micrograms per liter

D = dissolved

T = total

8.0 PAST AND CURRENT BEST MANAGEMENT PRACTICES

A significant amount of BMPs have been, and are currently being, implemented in the St. Vrain Creek HUC8 Watershed. Based on Survey #2 provided to the stakeholders, the following BMPs have been or are being implemented in the St. Vrain Creek Watershed Project Area:

- Extended Detention Basins
- Rain Gardens (Bioretention)
- Manufactured Treatment Devices
- Grass Swales
- Grass Buffers
- Constructed Wetlands
- Wetland Channels
- Permeable Pavers
- Porous Landscape Detention
- Retention Ponds
- Sand Filters
- Other Permanent Stormwater Control Measures
- Construction BMPs

Although this list includes some of the implementation accomplishments within the project area, it does not include all the BMPs that have been or are currently being implemented.

Practices implemented by watershed and/or county were not available from the NRCS; however, they were available for the State of Colorado. An assumption was made that the more likely a practice is to be implemented in Colorado, the more likely it would be implemented in the project area. Funding sources and programs involved in implementing practices in Colorado include the Agricultural Conservation Easement Program (ACEP), Agricultural Water Enhancement Program (AWEP) Conservation Reserve Program (CRP), Conservation Stewardship Program (CSP), Conservation Technical Assistance (CTA), Emergency Watershed Protection Program (EWP), Environmental Quality Incentives Program (EQIP), Farm and Ranch Lands Protection Program (FRPP), Grass Reserve Program (GRP), Regional Conservation Partnership Program (RCPP), Resource Conservation and Development (RCD) Program, Watershed Protection and Flood Prevention Operations (WFPO) Program, Watershed Rehabilitation (WHRB), Wetlands Reserve Program (WRP), and Wildlife Habitat Incentive Program (WHIP). Table 8-1 lists the practices implemented on more than 50 mi^2 in Colorado since 2005 that should continue to be implemented for water quality improvement [USDA, 2024].

Table 8-1. Best Management Practices Implemented Annually on More Than 50 Square Miles in Colorado Since 2005 (Page 1 of 2)

Practice Name	Practice Code	Colorado (mi^2)	Associated Land Use	Percent of Associated Area	Project Area Land Use (mi^2)	Project Area Practice (Available Remaining) (mi^2)
Prescribed Grazing	528	1,169	Pasture	100	5.2	0.0
Upland Wildlife Habitat Management	645	433	Pasture	38	5.2	2.0
Conservation Crop Rotation	328	287	Cropland	2	75.5	1.7
Watering Facility	614	286	Pasture	25	5.2	1.3
Livestock Pipeline	516	210	Pasture	18	5.2	1.0
Fence	382	194	Pasture	17	5.2	0.9
Pest Management Conservation System	595	180	Cropland	1	75.5	1.1
Conservation Cover	327	154	Cropland	1	75.5	0.9
Access Control	472	154	Pasture	13	5.2	0.7
Nutrient Management	590	134	Cropland	1	75.5	0.8
Pumping Plant	533	121	Cropland	1	75.5	0.7
Brush Management	314	118	Forest	<1	9.6	0.0
Residue and Tillage Management, Reduced Till	345	104	Cropland	<1	75.5	0.6
Residue and Tillage Management, No Till	329	99	Cropland	<1	75.5	0.6
Irrigation Water Management	449	98	Cropland	<1	75.5	0.6
Residue Management, Seasonal	344	85	Cropland	<1	75.5	0.5
Prescribed Grazing - Enhancements	E528	81	Pasture	7	5.2	0.4
Early Successional Habitat Development - Management	647	72	Other	<1	22.9	0.1
Pest Management Conservation System - Enhancements	E595	68	Cropland	<1	75.5	0.4
Herbaceous Weed Treatment	315	66	Cropland	<1	75.5	0.4
Nutrient Management - Enhancements	E590	57	Cropland	<1	75.5	0.3
Water Well	642	55	Cropland	<1	75.5	0.3

Table 8-1. Best Management Practices Implemented Annually on More Than 50 Square Miles in Colorado Since 2005 (Page 2 of 2)

Practice Name	Practice Code	Colorado mi^2	Associated Land Use	Percent of Associated Area	Project Area Land Use (mi^2)	Project Area Practice (Available Remaining) (mi^2)
Range Planting	550	51	Pasture	4	5.2	0.2
Cover Crop	340	49	Cropland	<1	75.5	0.3
Forage Harvest Management	511	47	Forest	<1	9.6	0.0
Structure for Water Control	587	33	Cropland	<1	75.5	0.2
Irrigation Pipeline	430	30	Cropland	<1	75.5	0.2
Forest Stand Improvement	666	27	Forest	<1	9.6	0.0

9.0 RECOMMENDED BEST MANAGEMENT PRACTICES

This watershed-based plan provides recommendations for NPS implementation practices to reduce loads of pollutants of concern. The recommended implementation practices are based on practices that are the most likely to be implemented and most impactful in reducing pollutants of concern.

9.1 FUTURE MUNICIPAL SEPARATE STORM SEWER SYSTEM AREAS

Stormwater resulting from rainfall, snowmelt, or other surface water runoff and drainage originates from impervious areas in towns; cities; residential developments; and industrial, manufacturing, or agricultural facilities. Stormwater flows accumulate from streets, parking lots, rooftops, catch basins, curbs, gutters, ditches, drainage channels, storm drains, and other impervious surfaces that may play a role in the contribution of pollutant loading because of the proximity of these impervious areas to the impaired waterbodies. Stormwater discharges are permitted under numerous MS4 permits in Colorado, which include the statewide standard MS4 general permit (COR090000) and statewide nonstandard MS4 general permit (COR070000). Areas covered by MS4 permits are not considered NPSs.

The Towns of Firestone/Frederick area (approximately 16.6 mi^2) makes up an urban cluster within the St. Vrain Creek HUC8 and has not yet been designated as an MS4; however, this is one of the areas identified to become one within the near future (5 to 15 years). The Towns of Firestone/Frederick area was identified using the same sources as in Section 5.1 [Catena Analytics, 2024; U.S. Census Bureau, 2020; Smith, 2024]. Therefore, the town's decision-makers should be proactive by using development practices that will minimally impact water quality. Less effort will be needed to retrofit BMPs after the area becomes a designated MS4 if more implementation is completed upfront. Low Impact Development (LID) is an approach to stormwater management that mimics a site's natural hydrology while the landscape is developed and preserves and protects environmentally sensitive site features, such as riparian buffers, wetlands, steep slopes, valuable (mature) trees, floodplains, woodlands, and highly permeable soils. Minimal Impact Design Standards (MIDS) is a new concept being used in the state of Minnesota, which emphasizes keeping a raindrop where it falls to minimize stormwater runoff and pollution as well as preserve natural resources. Because Minnesota has been successful in implementing water quality practices using MIDS, developing communities in the North Front Range Water Quality Planning Association (NFRWQPA) watersheds would likely also benefit from evaluation of the following four main elements of MIDS [Minnesota Pollution Control Agency, 2024]:

- Stormwater volume performance goals for new development, redevelopment, and linear projects
- New credit calculations that standardize the use of a range of structural stormwater techniques
- Design specifications for a variety of green infrastructure BMPs
- An ordinance guidance package to help developers and communities implement MIDS

9.2 DEVELOPED

Throughout the St. Vrain Creek project area, approximately 24 mi^2 of non-MS4 developed land exist. MS4 areas are not represented in the project models. BMPs recommended for MS4 and non-MS4 developed areas are like those outlined in Section 9.1. For nutrients and sediment, priority developed practices from PLET (Table 7-5) should be those with the highest rankings and reduction scores (i.e., extended wet detention, infiltration basins, and concrete gird pavement). For *E. coli*, priority developed practices should be those resulting in the largest reductions within the BMPDB (i.e., wetland basin and retention pond), as shown in Table 7-13. For heavy metals, priority developed practices should also be practices that resulted in the largest reductions of heavy metals in the BMPDB (depending on pollutants of concern in downstream waterbodies), as shown in Table 7-15. Practices do not need to be limited to these recommendations, and any practice resulting in reductions of pollutants of concern can be considered.

9.3 AGRICULTURAL (CROPLAND, PASTURELAND, AND FEEDLOT BMPS)

Throughout the St. Vrain Creek project area, approximately 76 mi^2 of cropland exist and are all within the easternmost HUC8 watersheds. Similarly, approximately 5 mi^2 of pastureland exist, primarily in the easternmost project area watersheds. Less than 1 mi^2 consists of feedlots. For nutrients and sediment, priority agricultural practices from PLET (Tables 7-1 through 7-3) should be those with the highest rankings and reduction scores (i.e., streambank stabilization and fencing and 35-foot grass buffers for cropland, 35-foot grass buffers and livestock exclusion fencing for pasture, and waste management systems for feedlots). For *E. coli* , priority agricultural practices should be the most effective agricultural BMPs from the Colorado NRCS CPPE for reducing *E. coli* (i.e., vegetated treatment area, constructed wetland, filter strip, nutrient management, and waste treatment lagoon) as shown in Table 7-12. For heavy metals, priority agricultural practices should be the most effective agricultural BMPs from the Colorado NRCS CPPE for reducing heavy metals (i.e., on-farm secondary containment facility, constructed wetland, irrigation and drainage tailwater recovery, land reclamation (landslide treatment or toxic discharge control), as shown in Table 7-14. Additionally, practices that switch from flood irrigation to more efficient irrigation methods would be beneficial in reducing both *E. coli* and heavy metals such as selenium and arsenic. Although these practices are the most effective, BMPs do not need to be limited to these recommendations.

9.4 FOREST

Throughout the St. Vrain Creek project area, approximately 14 mi^2 of forest land exist. Although forest land is less likely to contribute sediment, nutrients, and bacteria per acre of contributing area, BMPs are still beneficial, especially when considering historical fires, fire potential, abandoned mines, recreation, and grazing activities. For nutrients and sediment, priority forest practices from PLET (Table 7-4) should be those with the highest ranking and reduction scores (i.e., a combination of site preparation/straw/crimp seed/net/fertilizer/transplants). For *E. coli*, priority forest practices are not prioritized but should include those that exclude forest-grazing livestock from accessing streams and septic assessments. Forest practices should also focus on the relevant adaptive management priorities within the *Saint Vrain and Left Hand State of the Watershed 2021* [Left Hand Watershed Center, 2021] and other local watershed documents summarized in Chapter 3.0.

9.5 ABANDONED MINE LANDS

Most AMLs in the watershed have not yet been identified because several are located on private land or in very remote locations. The primary practice completed on identified AMLs is to seal off dangerous openings, identify hazards, and implement safety measures to protect the public and environment. To improve water quality, identifying AMLs should become a higher priority. Although AML BMPs are not prioritized because of the variable nature of AML lands, each site should be assessed, and practices should be chosen that target specific issues related to each site. For heavy metals, priority practices should focus on AMLs, as outlined in Section 7.3.

10.0 INFORMATION, EDUCATION, AND OUTREACH

Current communication, education, and outreach efforts established in the St. Vrain Creek HUC8 should continue and be expanded to incorporate effectiveness and user feedback surveys that would complement current area outreach programs. Coordinated outreach efforts should increase the awareness of specific audiences regarding water quality problems and solutions, as well as available BMP technical and financial assistance programs for urban/residential areas, cropland, pasture lands, AMLs, and riparian areas. Stakeholders should continue to expand on their public outreach efforts and communications with the public by implementing inclusive and new engagement tactics to reach a broad audience. Education and outreach activities should target individuals and groups to evaluate effective outreach methods.

Stakeholder responses to Survey #2 were used to rank a list of information, education, and outreach options. The following survey ranking is from highest to lowest:

1. Water Quality Awareness Signage in Parks by Streams
2. Social Media Posts (Sent to Partners)
3. Website Updates
4. Educational Campaigns
5. Newsletters and Mailers
6. Pet-Waste Pickup Stations
7. Volunteer Cleanup Programs
8. School Visits
9. Project Story Map
10. Report a Concern Website
11. Radio Advertisements and Interviews
12. Tours and Field Trips

St. Vrain and Left Hand Water Conservancy District and the Watershed Center are currently doing collaboration work within the area. Other entities within the watershed that are interested in collaborating with other stakeholder groups and hosting or participating in events include the Colorado Watershed Assembly, the Colorado Wheat Administrative Committee, and RNC Consulting, LLC. Participating in existing events can also expand outreach efforts. Northern Water has an annual water quality efficiency stakeholder meeting in the spring, as well as a spring and fall water symposium and a children's water festival.

The NFRWQPA is compiling a "Stakeholder Toolkit" for the plans. This toolkit will help stakeholders reach, inform, and partner with their networks on the NPS watershed educational resources. Some of the options included in the toolkit include digital communications, print communications, and community outreach. The stakeholders will decide which tools will be chosen during the next round of funding. Examples of these and more information about the Stakeholder Toolkit is included in Appendix E.

11.0 CRITERIA TO ASSESS PROGRESS

Milestones toward progress can be demonstrated in many different ways. In these watersheds, options for measurable milestones can include progress toward meeting water quality criteria set by the state, trends towards improvement, and progress in the installation of implementation practices that are expected to improve water quality parameters of concern. Table 11-1 in the previous chapter shows practices that could be implemented to make progress and count as measurable milestones. Because goals in this watershed for this plan are very broad (the plan is not being written as a part of a specific TMDL with a specified goal), milestones are more general than specific. Any practice implemented will be a part of progress toward the ultimate goal of improving water quality and ensuring water quality does not worsen. Relative implementation should be tracked, and this plan should be revisited after the first 5 years to ensure progress is being made. Reductions from NPS loadings will most likely require a significant, increased amount of technical and financial program assistance; BMP implementation through on-the-ground projects; proper watershed planning; and cooperation with willing landowners and land management agencies. Successfully achieving load reductions depends on several factors such as the amount of voluntary participation, availability of technical and financial assistance, and effectiveness of BMPs intended to reduce applicable loads.

In Survey #2, organizations were asked about interim measurable criteria/goals and what progress would look like after 5 and 10 years. The Colorado Wheat Administrative Committee advised that monitoring water quality, reducing pollutants of concern loads, and meeting water quality criteria would display progress. RNC Consulting, LLC plans for TMDL implementation within the next 5 years to reduce pollutant loads. The City of Longmont strives to comply with existing environmental permits and, in the next 5 years, hopes to better understand BMP load reduction capabilities for monitoring efforts. Within 10 years, the City also hopes to begin installing the most effective BMPs.

An implementation schedule is recommended to reduce pollutants of concern by implementing NPS BMPs. Table 11-1 provides a list of BMPs that would be most likely to benefit the area over the next 10 years by land-use category. Tables 11-2, 11-3, and 11-4 provide the top two sources for each parameter group and the top practices for implementation.

Table 11-1. Best Management Practices (Page 1 of 2)

Land-Use Category	Source	Recommended Implementation Activity
Future Stormwater/Developed/ Urban/Residential	PLET and Survey	Extended Wet Detention Ponds
Future Stormwater/Developed/ Urban/Residential	PLET and Survey	Infiltration Basins
Future Stormwater/Developed/ Urban/Residential	PLET and Survey	Concrete Grid Pavement
Future Stormwater/Developed/ Urban/Residential	BMPDB	High-Rate Biofiltration
Future Stormwater/Developed/ Urban/Residential	BMPDB	Media Filter
Future Stormwater/Developed/ Urban/Residential	BMPDB	Oil-Grit Separator
Future Stormwater/Developed/ Urban/Residential	BMPDB	Retention Pond
Future Stormwater/Developed/ Urban/Residential	BMPDB	High-Rate Media Filtration
Future Stormwater/Developed/ Urban/Residential	BMPDB	Wetland Basin
Future Stormwater/Developed/ Urban/Residential	BMPDB	Grass Swale
Future Stormwater/Developed/ Urban/Residential	Other	LID Practices
Future Stormwater/Developed/ Urban/Residential	Other	Septic Upgrades
Ag - Cropland	PLET and Survey	Streambank Stabilization and Fencing
Ag - Cropland	PLET and Survey	Buffer - Grass (35 feet wide)
Ag - Cropland	NRCS	Constructed Wetland (656)
Ag - Cropland	NRCS	Filter Strip (393)
Ag - Cropland	NRCS	Vegetated Treatment Area (635)
Ag - Cropland	NRCS	On-Farm Secondary Containment Area (319)
Ag - Cropland	NRCS	Irrigation Water Management (449)
Ag - Pasture	PLET	Buffer - Grass (35 feet wide)
Ag - Pasture	PLET	Livestock Exclusion Fencing
Ag - Pasture	PLET and Survey	Streambank Stabilization and Fencing
Ag - Feedlot	PLET and Survey	Waste Management System
Forest	PLET and Survey	Site Preparation/Straw/Crimp Seed/Net
Forest	PLET and Survey	Site Preparation/Straw/Crimp Seed/ Fertilizer/Transplants

Table 11-1. Best Management Practices (Page 2 of 2)

Land-Use Category	Source	Recommended Implementation Activity
AML	NRCS	Storage of Soil Materials
AML	NRCS	Placement of Surface Material
AML	NRCS	Restoration of Borrow Material
AML	NRCS	Establishment of Vegetation
AML	NRCS	Control of Toxic Aqueous Discharge
Monitoring	Other	Water Quality Sampling (base and storm events)
Monitoring	Other	Discharge Measurement (base and storm events)
Monitoring	Other	Monitor Implemented Agricultural BMP Effectiveness
Monitoring	Other	Monitor Implemented Urban BMP Effectiveness
Monitoring	Other	Monitor Implemented AML BMP Effectiveness
Outreach	Survey	Social Media Posts
Outreach	Survey	Website Updates
Outreach	Survey	Educational Campaigns
Outreach	Survey	Newsletters and Mailers
Outreach	Survey	Pet-Waste Pickup Stations
Outreach	Survey	Volunteer Cleanup Programs
Outreach	Survey	School Visits
Outreach	Survey	Project Story Map
Outreach	Survey	Report a Concern Website

Table 11-2. Dominant Land Uses, Sources, and Priority Practices by HUC10 for Nutrients and Sediment

Watershed	Dominant Land Uses	Top Sediment Sources	Top Phosphorus Sources	Top Nitrogen Sources	Priority Practices
1019000502 North St. Vrain Creek	Forest and Urban non-MS4	Forest and Urban non-MS4	Forest and Urban non-MS4	Forest and Urban non-MS4	/ Site Preparation/Straw/Crimp Seed/Net / Site Preparation/Straw/Crimp Seed/Fertilizer/Transplants / Extended Wet Detention / Infiltration Basins
1019000506 Coal Creek-Boulder Creek	Cropland and Urban non-MS4	Cropland and Urban non-MS4	Cropland and Septic	Cropland and Septic	/ Streambank Stabilization and Fencing / Buffer-Grass (35 feet wide) / Extended Wet Detention / Infiltration Basin / Septic Upgrades / WWTF Connections
1019000507 Boulder Creek-St. Vrain Creek	Cropland and Urban non-MS4	Cropland and Pastureland	Cropland and Urban non-MS4	Cropland and Urban non-MS4	/ Streambank Stabilization and Fencing (Crops and Pasture) / Buffer-Grass (35 feet wide, Crops and Pasture)) / Livestock Exclusion / Extended Wet Detention / Infiltration Basin

Table 11-3. *E. coli* Impairment Status, Primary Sources, Associated Land Use, and Priority Practices by HUC10

Watershed	*E. coli* Impaired	Primary *E. coli* Sources	Associated Land Use (*E. coli*)	Priority Practices
1019000502 North St. Vrain Creek	N	/ Livestock (more Cattle) / Humans (more OWTS)	/ Agricultural Land / Urban non-MS4	/ Vegetated Treatment Area / Constructed Wetlands / Septic Upgrades / WWTF Connections
1019000506 Coal Creek-Boulder Creek	Y	/ Humans (more WWTP) / Pets (more Cats)	/ Urban non-MS4	/ Wetland Basin / Retention Pond
1019000507 Boulder Creek-St. Vrain Creek	Y	/ Livestock (more Cattle) / Humans (more WWTP)	/ Agricultural Land / Urban non-MS4	/ Vegetated Treatment Area / Constructed Wetlands / Wetland Basin / Retention Pond

Table 11-4. Dominant Land Uses, Metal Impairments, Associated Causes, and Priority Practices by HUC10

Watershed	Dominant Land Uses	Metal Impairments	Associated Cause	Priority Practices
1019000502 North St. Vrain Creek	Forest and Urban non-MS4	Arsenic	Pressure-Treated Wood, Material Production, Pierre Shale, etc.	Irrigation Water Management
1019000502 North St. Vrain Creek	Forest and Urban non-MS4	Zinc	Mining, Material Production	AML BMPs
1019000506 Coal Creek-Boulder Creek	Cropland and Urban non-MS4	Selenium	Material Production, Manufacturing Processes, Gas Combustion, Pierre Shale	Irrigation Water Management
1019000506 Coal Creek-Boulder Creek	Cropland and Urban non-MS4	Manganese	Manufacturing Processes, Material Production	AML BMPs
1019000507 Boulder Creek-St. Vrain Creek	Cropland and Urban non-MS4	Arsenic	Pressure-Treated Wood, Material Production, Pierre Shale, etc.	Irrigation Water Management

Implementation practices were run in the PLET model on 25 percent of each applicable land cover. This number represents the acres affected by the practice, not the acres of the practice implemented. Cropland practices typically resulted in the highest reductions of nitrogen and phosphorus; therefore, these are the practices incorporated in the schedule. As shown in Table 11-5, incorporating stream stabilization and fencing on 25 percent of the cropland and 35-foot buffers on an additional 25 percent of the cropland in the project area did not result in the needed nitrogen and phosphorus reductions. Reductions required were calculated for the entire area draining to the outlet HUC10. The reduction required for the specific project area was not calculated because project areas were drawn using county lines; therefore, the following cost estimates were made assuming that all reductions had to come from within the project area, which is not ideal for the St. Vrain watershed (over 85 percent of the drainage area is not in the project area). These practices would need to be implemented in nearly half of cropland in the project area to meet the load reductions needed. Some of the loads are assumed to come from areas outside of Larimer and Weld counties and from other land uses. Table 11-6 shows the proposed schedule for implementation in the St. Vrain Creek project area. These practices will also help with *E. coli* and heavy metals. Load reductions for heavy metals came from the PLET model and, therefore, were not run for *E. coli* and heavy metals. Because the current load reductions from PLET were not calibrated and did not include areas outside of Larimer and Weld Counties or MS4 areas, they should be considered relative and should not be compared to actual loads calculated with observed data.

Table 11-5. Reductions Achieved by Implementation of Priority Cropland Practices

Practice	Nitrogen Load (lb/yr)	Nitrogen Reduction (%)	Nitrogen Reduction Needed (lb/yr)	Phosphorus Load (lb/yr)	Phosphorus Reduction (%)	Phosphorus Reduction Needed (lb/yr)
Base Load	196,363	N/A	31	60,189	N/A	49
Stream Stabilization and Fencing on 25% of Cropland (12,084 acres)	29,262	14.9		9,774	16.2	
Buffer - Grass (35 feet wide) on 25% of Cropland (12,084 acres)	18,648	9.5		6,716	11.2	
Total Reduction	47,910	24.4		16,490	27.4	

Table 11-6. Schedule for Primary Cropland Practices to Achieve Nutrient Goals

Practices	5-Year Goal	10-Year Goal	Ultimate Goal
Stream Stabilization and Fencing on Cropland	10,000 acres	20,000 acres	30,000 acres
Buffer - Grass (35 feet wide) on Cropland	10,000 acres	20,000 acres	30,000 acres

In general, 35-foot buffers cost about $10.37 per acre impacted per year, fencing costs about $22.66 per acre impacted per year, and streambank stabilization costs $13,472 per mile. If a mile of streambank stabilization impacted a square mile of the watershed area, it would cost approximately $21.05 per acre impacted per year; therefore, every 5,000 acres impacted by buffers would cost approximately $51,838 and with the rough streambank stabilization estimate every 5,000 acres impacted by stream stabilization would cost approximately $218,549.

12.0 MONITORING BEST MANAGEMENT PRACTICE EFFECTIVENESS

Monitoring should be completed before and after implementing BMPs to evaluate the effectiveness of priority practices. Monitoring BMP effectiveness (up- and downstream of BMPs) helps evaluate the adequacy of the implementation strategies targeted to reduce loads or transport. BMP effectiveness data will improve the understanding of implementation and management measures. Other ideal locations for monitoring include areas that have been monitored historically near the HUC10 watershed outlets and along impaired waterbodies. More information about monitoring NPSs is included on EPA's Nonpoint Source Monitoring: TechNOTES webpage. Existing water quality monitoring occurring for the NFRWQPA's 208 Areawide Water Quality Management Plan is available on its website.

Additional monitoring and evaluation efforts should occur within the communities that are the most likely to become MS4 areas. Monitoring sites up- and downstream of areas where storm drains and tributaries enter the St. Vrain Creek would help evaluate contributions. Monitoring locations in storm drains throughout urbanized areas where two possible sources come together would also help isolate sources of pollution. A detailed monitoring plan that identifies the locations of additional monitoring sites should be compiled.

Continuous discharge data across a broad range of flows are helpful for calculating loads. Future monitoring should include instantaneous discharge measurements at water quality sampling areas. Continuous stage recorders should be installed at key locations in the watershed and stage-discharge relationships should be developed to convert continuous stage data to continuous flow data. Relatively low-cost, low-maintenance technologies are available to record continuous stage data. Instantaneous and continuous flow data will increase the accuracy of future load calculations and the evaluation of BMPs and implementation practices.

Survey #2 had a question regarding in-stream monitoring activities that different entities would consider implementing. The City of Longmont and RNC Consulting, LCC would be interested in quarterly sampling, as well as the installation, maintenance, and operation of a monitoring station. The Town of Frederick and Colorado Wheat Administrative Committee would be interested in quarterly sampling to be analyzed by a local laboratory. The Colorado Watershed Assembly would be interested in the installation, maintenance, and operation of a monitoring station. The Watershed Center is already performing monitoring and will continue doing so.

13.0 TECHNICAL AND FINANCIAL ASSISTANCE SOURCES

Technical and financial assistance sources are available to implement BMPs. Numerous private companies and organizations as well as local, state, and federal agencies provide technical assistance to address NPS pollution. A few of these organizations and agencies also provide financial assistance. Table 13-1 lists the agencies and organizations with technical and financial programs that may assist with conservation and water quality implementation projects and what type of technical or financial assistance they offer (based on the land use of interest) as denoted by Xs. The following sections describe the information regarding incentive programs and funding to implement NPS projects identified in this plan. Funding includes but is not limited to the CDPHE's NPS Program and its annual grants, the South Platte Basin Roundtable grants, the CAWA programs, and the St. Vrain and Left Hand Water Conservancy District's Partner Funding Program, which is available in the request guidance online. The NPS Program funds support staffing costs and programmatic priorities including the Mini Grant Program, the NPS Watershed Planning and Tool Development Program, and the NPS Program's Success Story Initiative.

Table 13-1. Sources of Technical and Financial Assistance (Page 1 of 4)

Agency or Organization	Website	Assistance	BMP Category						
			Developed Non-MS4	Cropland	Pasture	Feedlot	Forest	Stream	Outreach
LOCAL									
City of Broomfield	www.broomfield.org	Financial, Technical	X					X	X
City of Boulder	bouldercolorado.gov	Financial, Technical	X					X	X
City of Lafayette	www.lafayetteco.gov	Financial, Technical	X					X	X
City of Longmont	www.longmontcolorado.gov	Financial, Technical	X					X	X
City of Louisville	www.louisvilleco.gov	Financial, Technical	X					X	X
Town of Erie	erieco.gov	Financial, Technical	X					X	X
Town of Firestone	www.firestoneco.gov	Financial, Technical	X					X	X
Town of Frederick	frederickco.gov	Financial, Technical	X					X	X
Town of Superior	www.superiorcolorado.gov	Financial, Technical	X					X	X
Larimer County	www.larimer.gov	Financial, Technical	X	X	X	X	X	X	X
Weld County	www.weld.gov	Financial, Technical	X	X	X	X	X	X	X
St. Vrain and Left Hand Water Conservancy District Partner Funding Program	svlh.gov	Financial, Technical	X	X	X	X	X	X	X
Keep it Clean Partnership	www.keepitcleanpartnership.or g	Technical	X	X	X	X	X	X	X
South Platte Basin Roundtable	www.southplattebasin.com	Technical	X	X	X	X	X	X	X
Longmont and Boulder Valley Conservation District	https://bouldervalley-longmontcd.colorado.gov/	Financial, Technical		X	X	X	X	X	X

Table 13-1. Sources of Technical and Financial Assistance (Page 2 of 4)

Agency or Organization	Website	Assistance	BMP Category						
			Developed Non-MS4	Cropland	Pasture	Feedlot	Forest	Stream	Outreach
LOCAL (cont.)									
Platte Valley Conservation District	www.coloradolandcan.org/local-resources/Platte-Valley-Conservation-District/3610	Financial, Technical		X	X	X	X	X	X
Southeast Weld Conservation District	seweldcd-co.org	Financial, Technical		X	X	X	X	X	X
STATE									
CSU Extension	extension.colostate.edu	Technical	X	X	X	X	X	X	X
CSU	www.colostate.edu	Technical	X	X	X	X	X	X	X
Colorado Association of Conservation Districts	coloradoacd.org	Financial, Technical	X	X	X	X	X	X	X
CDPHE	cdphe.colorado.gov	Financial, Technical	X	X	X	X	X	X	X
Colorado Parks and Wildlife	cpw.state.co.us	Financial, Technical					X	X	X
Colorado Livestock Association	www.coloradolivestock.org	Technical				X		X	X
Colorado Department of Agriculture	ag.colorado.gov	Financial, Technical		X	X	X		X	X
Colorado Water Center	watercenter.colostate.edu	Technical						X	X
Colorado Water Conservation Board	cwcb.colorado.gov	Financial, Technical	X	X	X	X	X	X	X
Colorado Rural Water Association	www.crwa.net	Technical						X	X
Colorado Department of Natural Resources	dnr.colorado.gov	Financial, Technical	X	X	X	X	X	X	X
Colorado Energy and Carbon Management Commission	ecmc.state.co.us	Financial, Technical		X	X	X			

Table 13-1. Sources of Technical and Financial Assistance (Page 3 of 4)

Agency or Organization	Website	Assistance	BMP Category Developed Non-MS4	Cropland	Pasture	Feedlot	Forest	Stream	Outreach
STATE (cont.)									
Colorado Geological Survey	coloradogeologicalsurvey.org	Financial, Technical						X	
Colorado Bureau of Land Management	www.blm.gov	Financial, Technical					X	X	X
Colorado Division of Reclamation, Mining, and Safety	drms.colorado.gov	Financial, Technical					X	X	X
Colorado State Land Board	slb.colorado.gov	Financial							X
FEDERAL									
U.S. Army Corps of Engineers	www.usace.army.mil	Financial, Technical						X	X
USDA–NRCS	www.nrcs.usda.gov	Financial, Technical		X	X	X	X	X	X
USDA–Farm Service Agency	www.fsa.usda.gov	Financial, Technical		X	X	X		X	X
USDA–Rural Development	www.rurdev.usda.gov	Financial, Technical						X	X
USDA–Bureau of Land Management	www.blm.gov	Financial, Technical					X	X	X
U.S. Department of Interior–Bureau of Reclamation	www.usbr.gov	Financial, Technical	X	X			X	X	X
EPA	www.epa.gov	Financial, Technical	X	X	X	X	X	X	X
USDA–Forest Service	www.fs.fed.us	Financial, Technical					X	X	X
USFWS	www.fws.gov	Financial, Technical						X	X
USGS	www.usgs.gov	Technical						X	X

Table 13-1. Sources of Technical and Financial Assistance (Page 3 of 4)

Agency or Organization	Website	Assistance	BMP Category						
			Developed Non-MS4	Cropland	Pasture	Feedlot	Forest	Stream	Outreach
PRIVATE									
Ducks Unlimited	www.ducks.org	Financial, Technical						X	X
Colorado Trout Unlimited	coloradotu.org	Financial, Technical						X	X
Fresh Water Trust	www.thefreshwatertrust.org	Financial, Technical	X	X	X	X	X	X	X
Mule Deer Foundation	www.muledeer.org	Financial, Technical					X	X	X
Rocky Mountain Elk Foundation	www.rmef.org	Financial, Technical					X	X	X
National Fish and Wildlife Foundation	www.nfwf.org	Financial, Technical						X	X

13.1 INCENTIVE PROGRAMS

Incentive programs are formal programs used to promote specific actions or behaviors. Participation in incentive programs is voluntary. Various mechanisms can be used to conduct incentive programs, including financial assistance or providing benefits for enrolling in programs. The following programs are relatively easy for users to take advantage of, and the money for them is generally allocated annually.

13.1.1 COST-SHARE PROGRAMS

In a cost-share program, the costs of systems or practices for water quality improvements are shared between the landowner, state (percentage), or federal programs (flat rate). State-funded nonstructural land management cost sharing is also typically based on a flat rate. Landowners seeking cost-share assistance should contact their county conservation district office for information on available programs. The BMPs and conservation practices that are typically eligible are those that avoid, control, and trap nutrients, sediment, and *E. coli* from entering surface water and groundwater. Eligibility may vary depending on local priorities and needs.

13.1.2 FEE DISCOUNTS

Local governments or nonprofit entities may offer reduced fees for implementing projects and practices that align with program goals. For instance, stormwater fees could be reduced if a landowner voluntarily converts cropped acres to a permanent vegetative cover.

13.1.3 LOW-INTEREST LOANS

Low-interest loans may be available through various state agencies to landowners for agricultural BMPs, septic system updates/replacement, or other projects that meet funding eligibility criteria.

13.1.4 WATER QUALITY TRADING

Point source permittees should be mindful that options are available to use money available for upstream NPS implementation to improve water quality for a smaller potential cost. These options need to be further evaluated and quantified.

13.2 POTENTIAL FUNDING

Funding is available from private, local, county, state, and federal sources to implement projects for improving water quality. The following sections discuss these sources. Other funding sources not noted here may be available. The state of Colorado maintains a Grants Information page on its website.

13.2.1 CITIES

Municipalities often collect stormwater utility fees to build, repair, operate, and maintain stormwater management systems. Such fees should be set using reasonable calculations based on runoff volume or pollution quantities, property classifications, or both.

13.2.2 COUNTIES, WATERSHED DISTRICTS, AND AUTHORITIES

In other areas of Colorado, authorities have been developed, such as the Cherry Creek Basin Water Quality Authority and the Chatfield Watershed Authority. These authorities can levy funds for priority projects and assist with program implementation. The NFRWQPA and other 208 planning agencies cannot levy funds or tax for projects, but they have voluntary fees and dues that contribute to planning and implementation. One example of this type of funding is Chatfield adding an entrance fee to the Chatfield State Park to assist with protecting water quality as well. The St. Vrain and Left Hand Water Conservancy District Partner Funding Program is also available, per the request guidance online.

13.2.3 STATE

The State of Colorado funds watershed management programs through various capacities, programs, and agencies.

The CDPHE has numerous NPS funding opportunities, which include watershed implementation projects (restoration and protection), watershed planning and tool development, and education and outreach. The primary CDPHE opportunities consist of the Source Water Assessment and Protection (SWAP) Program; the Water Quality Grants and Loans Unit; CSU's Colorado Wetland Information Center; CSU's Colorado State Forest Service; the Department of Natural Resources' Colorado Water Conservation Board (CWCB); Colorado Water Plan Grants; and Colorado Watershed Restoration Grants. More information regarding each program is provided in CDPHE [2022]. Funds from the Water Supply Reserve Fund (WSRF) are issued through the South Platte Basin Roundtable. CDPHE has a state revolving fund that includes a Water Pollution Control revolving fund that completes many OWTS to sewer projects.

Under the Colorado Natural Resources Department, the CWCB also administers the Federal Technical Assistance Grant Program, consisting of Local Capacity Grants and Technical Assistance Grants. Federal American Rescue Plan Act funding of $5 million is available for these two grants in Colorado. The grantee must provide a minimum of 25 percent matching funds. Grants will be awarded on a rolling basis through December 2024; grant funds must be fully expended by December 2026. Local Capacity Grants are direct awards to grantees to secure the resources needed (contractors or otherwise) to develop projects and submit competitive federal grant applications. Technical Assistance Grants are awards to grantees who want to use a contractor hired by the CWCB. This contractor can provide a wide variety of water project services, such as federal grant opportunity research, project design, partial engineering, cost estimation, and federal application development/grant writing.

Statewide education grants and outreach initiative grants are available through the Public Education, Participation, and Outreach (PEPO) Grant Program, which is administered through the CWCB. The PEPO Grant Program also financially supports designated individual coordinators who support basin-specific outreach and education efforts alongside each of the state's basin roundtables. The Colorado Department of Natural Resources also maintains a Water Funding Opportunity Navigator, which lists potential federal and state grant opportunities.

Other state funding opportunities include the Colorado Healthy Rivers Fund. This program grants money to local watershed organizations to provide clean water, protect habitat, and improve recreation and accessibility throughout Colorado. Project grants and planning grants are available under the program.

13.2.4 FEDERAL

Federal agencies can provide funding and technical assistance for projects and monitoring. These agencies include the U.S. Fish and Wildlife Service (USFWS), USGS, NRCS, Farm Service Agency, EPA, and others. The USGS is more likely to support data acquisition and monitoring programs and the USFWS may provide land retirement program funds. The NRCS helps with applying conservation practices, and the EPA assists with studies to identify more localized sources of pollution in impaired waterbodies. The following sections provide information regarding federal NPS funding.

13.2.4.1 U.S. ENVIRONMENTAL PROTECTION AGENCY

The EPA provides funding opportunities for watershed restoration and protection on its funding resource webpage for NPS pollution. Additional EPA funding opportunities are available online on the Equity Action Plan webpage and Environmental Justice Grants, Funding and Technical Assistance webpage.

The EPA also has a funding opportunity through the Office of Wetlands, Oceans, and Watersheds' Fiscal Year 2024 Building Partner Capacity and Promoting Resiliency and Equity under the CWA. The EPA is soliciting applications from eligible applicants to provide support for training and related activities to build the capacity of agricultural partners; state, territorial, and Tribal officials; and nongovernmental stakeholders in support of the goals of the CWA Section 319 Nonpoint Source Management Program.

The EPA also has funding from the Clean Water State Revolving Fund (CWSRF) accessible via the About the Clean Water State Revolving Fund (CWSRF) webpage. The funds are generally for municipal wastewater facility construction, control of NPS pollution, decentralized wastewater treatment systems, green infrastructure projects, project estuaries, and other water quality projects.

13.2.4.2 U.S. DEPARTMENT OF AGRICULTURE'S NATURAL RESOURCES CONSERVATION SERVICE

The NRCS's natural resources conservation programs help individuals reduce soil erosion, enhance water supplies, improve water quality, increase wildlife habitat, and reduce damage caused by floods and other natural disasters. More information is available on the USDA Programs & Initiatives webpage.

The following technical and financial assistance programs are generally awarded annually through NRCS:

- **Agricultural Conservation Easement Program (ACEP).** Applications are accepted from April through December. ACEP easement agreements are typically awarded annually by the fall.
- **Conservation Stewardship Program (CSP).** The CSP helps agricultural producers maintain and improve existing conservation systems and adopt additional conservation activities to address priority resource concerns. Participants earn CSP payments for conservation performance—the higher the performance, the higher the payment. Different enrollment opportunities are available for CSP Classic, CSP Renewals and CSP Grasslands. Applications are accepted from April through December. CSP contracts are awarded by June or July.

- **Conservation Technical Assistance (CTA).** The CTA provides the nation's farmers, ranchers, and forestland owners with the knowledge and tools they need to conserve, maintain, and restore the natural resources on their lands and improve the health of their operations for the future. NRCS offers this assistance at no cost to the producers served.
- **Environmental Quality Incentives Program (EQIP).** EQIP provides financial and technical assistance to agricultural producers to address natural resource concerns and deliver environmental benefits, such as improved water and air quality; conserved ground and surface water; increased soil health; reduced soil erosion and sedimentation; improved or created wildlife habitat; and mitigation against increasing weather volatility. Applications are accepted on a continuous basis, with application cutoff for funding evaluation typically set in November of each year. EQIP contracts are typically awarded by April or May.
- **Regional Conservation Partnership Program (RCPP).** RCPP promotes coordination of NRCS conservation activities with partners that offer valuable contributions to expand the collective ability to address on-farm, watershed, and regional natural resource concerns. Announcements for Funding Proposals (AFPs) for RCPP Classic are typically advertised in October through November and awarded in June through August. RCPP Alternative Funding Arrangement (AFA) AFPs are typically announced March through May, with agreements awarded by September and, in some cases, the funds are carried over and awarded from October to December of the following fiscal year.
- **National Water Quality Initiative (NWQI).** NWQI provides a way to accelerate voluntary, on-farm conservation investments focused on water quality monitoring and assessment resources where they can deliver the greatest benefits for clean water. The NWQI is a partnership among NRCS, state water quality agencies, and EPA to identify and address impaired waterbodies through voluntary conservation.
- **Watershed Operations PL-566 Program.** The Watershed Protection and Flood Prevention Act (PL-566) authorizes the USDA-NRCS to help local organizations and units of government plan and implement watershed projects. PL-566 watershed projects are locally led to solve natural and human resource problems in watersheds up to 250,000 acres (less than 400 mi^2). At least 20 percent of any project benefits must relate directly to agriculture, including rural communities. A local sponsoring organization is needed to carry out, maintain, and operate works of improvement. The program has two main components, and each is funded separately: (1) watershed surveys and planning and (2) watershed and flood prevention operations and construction.
- **Conservation Innovation Grants (CIG)**. CIG is a competitive program that supports the development of new tools, approaches, practices, and technologies to further natural resource conservation on private lands. Through creative problem-solving and innovation, CIG partners work to address the nation's water quality, air quality, soil health, and wildlife habitat challenges while improving agricultural operations. Three program types are available: (1) national, (2) state, and (3) CIG On-Farm Conservation Innovation Trials.
- **Rural Development**. For OWTS funding, USDA Rural Development has a 504 Single Family Program, a Community Development Program, a Home Repair Loan/Grant Program, a Community Pass-through Program, and Water Well Trust Program. Income eligibility for these programs is often a sliding scale.

Other federal agency funding includes the U.S. Bureau of Reclamation (USBR) WaterSMART. Through WaterSMART, the USBR leverages federal and nonfederal funding to work cooperatively with states, tribes, and local entities as they plan for and implement actions to increase water supply sustainability through investments in existing infrastructure and attention to local water conflicts.

13.2.5 PRIVATE/OTHER SOURCES

Foundations, nonprofit organizations, and private contributions, including those from landowners and corporate entities, will be sought for plan implementation activities. Local foundations may fund education, civic engagement, and other local priority efforts. Such organizations acquire their own funding and may have project dollars and technical assistance that can be used. Major cooperators and funding sources include private landowners who typically contribute a percentage of project costs and may donate land, services, or equipment for projects or programs.

Some of the stakeholder questions asked in Survey #2 were related to the technical and financial assistance needed or used and how they used it. The Colorado Watershed Assembly has received CWCB and NPS funds and other funds from the Cherry Creek Basin Water Quality Authority and Great Outdoors Colorado, as well as county and municipal funding and technical assistance. The Colorado Watershed Assembly tracks various federal grant opportunities and has used the CWCB and NPS Program for technical assistance. The Colorado Wheat Administrative Committee is aware of financial assistance from the conservation districts, and NRCS and has yet to secure funding but has previously received it from crop consultants and the NRCS Agricultural Research Service. RNC Consulting, LLC stated it does not need assistance for in-stream monitoring or BMP implementation but has used the cost share program and state and local grants. Although they have not used federal grants, they are aware of them too. The City of Longmont needs funding for in-stream monitoring but has only relied on consultants and staff for assistance in the past. The City is aware of grants but has yet to secure funding.

The following are private foundations with available funding programs:

- The Laura Jane Musser Fund, a foundation based in Minnesota, assists public or not-for-profit entities to initiate or implement projects that enhance the ecological integrity of publicly owned open spaces while encouraging compatible human activities. The fund's goal is to promote public use of open space that improves a community's quality of life and public health, while also ensuring the protection of healthy, viable, and sustainable ecosystems by defending or restoring habitat for the diversity of plant and animal species.
- The Moore Charitable Foundation works to preserve and protect natural resources for future generations. This foundation and its affiliates support nonprofit organizations that protect land, wildlife, habitat, and water resources in several regional planning areas, including Colorado. The foundation also supports educational and community programs in these areas.
- The Colorado River Basin Salinity Control Act, established in 1974, provides authorization for enhancing and protecting numerous salinity control projects in Colorado and other states. High levels of salinity in water can reduce crop yields, limit the choice of crops that can be grown, and, at higher concentrations over long periods, can kill trees and make the land unsuitable for agricultural purposes. Through strong partnerships between the NRCS, private landowners, USBR, CWCB, water conservancy districts, and several local conservation districts, financial

and technical assistance funds have been used to install irrigation improvements, such as the installation of pipelines, more efficient irrigation systems, and lining of ditches and small laterals.

- The Colorado Watershed Assembly routinely posts funding opportunities through its bimonthly newsletter available on the Colorado Watershed Assembly homepage.
- The South Platte Basin Roundtable offers two funding cycles annually, and information is available on the South Platte Basin homepage.

14.0 REFERENCES

American Veterinary Medical Association, 2016. "U.S. Pet Ownership Statistics," *avma.org*, accessed June 30, 2016, from *https://www.avma.org/KB/Resources/Statistics/Pages/Market-research-statistics-US-pet-ownership.aspx*

Brandt, T. R. and J. P. Colgan, 2023. Digital database of the previously published geologic map of the Boulder-Fort Collins-Greeley area, Colorado: U.S. Geological Survey data release, available online at *https://doi.org/10.5066/P95MSFVF*.

Briffa, J., E. Sinagra, and R. Blundell, 2020. "Heavy Metal Pollution in the Environment and Their Toxicological Effects on Humans", *Heliyon*, Volume 6, Issue 9, e04691, ISSN 2405-8440, available online at *https://doi.org/10.1016/j.heliyon.2020.e04691*

Catena Analytics, 2024. "eRAMS Online," accessed August 13, 2024, from *https://erams.com/catena/*

Colorado's Decision Support Systems, 2024. "GIS Data by Category," accessed August 13, 2024 at *https://cdss.colorado.gov/gis-data/gis-data-by-category*

Colorado Department of Public Health and Environment, 2003. *Total Maximum Daily Load Assessment Ammonia, Boulder Creek, South Boulder Creek to Coal Creek - Segment 9, Boulder Creek, Coal Creek to St. Vrain Creek, Segment 10, St. Vrain Creek, Hygiene Rd to S. Platte River - Segment 3 Boulder and Weld Counties*, Colorado, prepared by CDPHE Water Quality Control Division, Denver, CO, for U.S. Environmental Protection Agency, Denver, CO.

Colorado Department of Public Health and Environment, 2022. *Colorado's Nonpoint Source Management Plan: 2022,* prepared by Colorado Department of Public Health and Environment Water Quality Control Division, Denver, CO, available online at *https://drive.google.com/file/d/1nrZ1D4yp2LGHUxrNsyjwGbu3w1ZCs9wz/view*

Colorado Geospatial Portal, 2024. *2024 State of Colorado Public Parcels*, CO Office of Information Technology, Enterprise GIS, accessed August 14, 2024, from https://geodata.colorado.gov

Colorado Water Plan, 2015. "South Platte/Metro Analysis and Technical Update," accessed May 30, 2024, from *https://dnrftp.state.co.us/CWCB/Technical%20Update%20to%20Water%20Plan/1.%20Technical%20Update%20Documentation/Volume%201-Section%204.8-S%20Platte%20Metro%20Republican%20Results.pdf*

The Diggings, 2024. "Mining In Weld County, Colorado," accessed August 15, 2024, from *https://thediggings.com/usa/colorado/weld-co123*

Environmental Systems Research Institute, Inc., 2014. "USA Federal Lands," accessed August 14, 2024, from *https://www.arcgis.com/home/item.html?id=c959f521c02f4f64abf4d39019c5ccd5*

Fischer, J., 2023. Personal communication between J. Fischer, Invision GIS, CO, and C. Kirby, RESPEC, Rapid City, SD, December 14.

Graves, J., 2024. Personal communication between J. Graves, Colorado Division of Reclamation, Mining, and Safety, Denver, CO, and N. Acosta, RESPEC, Colorado Springs, CO, March 8.

Hawley, C. and N. Rodriquez-Jeangros, 2021. *Big Thompson State of the Watershed 2021 Final Report*, prepared by Hydros Consulting, Boulder, CO, for Big Thompson Watershed Forum, Fort Collins, CO.

Horsley and Witten, Inc., 1996. *Identification and Evaluation of Nutrient and Bacterial Loadings to Maquoit Bay, New Brunswick, and Freeport, Maine*, prepared by Horsley & Witten, Inc., Barnstable, MA, for Casco Bay Estuary Project, Portland, ME.

Horton, J.D., C. A. San Juan, and D. B. Stoeser, 2017. "The State Geologic Map Compilation (SGMC) Geodatabase of the Conterminous United States," *US Geological Survey Data Series 1052,* Ver. 1.1, August 2017, p. 46.

Larimer County, 2024. "Larimer County GIS Digital Data," accessed August 14, 2024, from *https://www.larimer.gov/it/gis/digital-data*

Left Hand Watershed Center, 2021. *Saint Vrain and Left Hand State of the Watershed 2021: Restoring to the Future with Adaptive Management*," accessed August 22, 2024, from *https://watershed.center/wp-content/uploads/2021/08/2021_Watershed_Report_v2-1.pdf*

Metcalf and Eddy, Inc., 1991. *Wastewater Engineering: Treatment, Disposal and Reuse*, 3rd Edition, McGraw-Hill, New York, NY.

Minnesota Pollution Control Agency, 2024. "Minnesota Stormwater Manual Overview of Minimal Impact Design Standards (MIDS)," accessed May 6, 2024, from *https://stormwater.pca.state.mn.us/index.php/Overview_of_Minimal_Impact_Design_Standards_(MIDS)*

Moore, E., 2022. *Colorado's Nonpoint Source Program: 2022 Annual Report*, prepared by Colorado Department of Public Health and Environment Water Quality Control Division, Denver, CO, available online at *https://storymaps.arcgis.com/stories/e7212fd7f8224b839b669fd8bbd058a4*

Multi-Resolution Land Characteristics Consortium, 2019. "National Land Cover Database 2019 - Landcover & Imperviousness (NLCD2019)," accessed August 14, 2024, from *https://www.mrlc.gov/data?f%5B0%5D=category%3ALand%20Cover&f%5B1%5D=year%3A2019*

National Interagency Fire Center, 2024. "InterAgencyFirePerimeterHistory All Years View," accessed August 14, 2024, from *https://data-nifc.opendata.arcgis.com/datasets/e02b85c0ea784ce7bd8add7ae3d293d0_0/explore?location=39.994103%2C-103.924962%2C8.89*

Natural Resources Conservation Service, 2024a. "Soil Survey Geographic Database (SSURGO)," accessed August 13, 2024, from *https://www.nrcs.usda.gov/resources/data-and-reports/soil-survey-geographic-database-ssurgo*

Natural Resources Conservation Service, 2024b. "Conservation Practices Physical Effects (CPPE) – FY24 National Template-Version 2," accessed May 14, 2024, from *https://www.nrcs.usda.gov/resources/guides-and-instructions/conservation-practice-physical-effects*

Natural Resources Conservation Service, 2024c. "Conservation Practice Standard Land Reclamation, Abandoned Mined Land Code 543," accessed May 30, 2024, from *https://www.nrcs.usda.gov/sites/default/files/2022-09/Land_Reclamation_Abandoned_Mined_Land_543_NHCP_CPS.pdf*

North Front Range Water Quality Planning Association, 2022. *208 Areawide Water Quality Management Plan 2022 – 208 AWQMP Update (Region 2)*, prepared by the North Front Range Water Quality Planning Association, Johnstown, CO.

PRISM Climate Group, 2024. "Average Monthly and Average Annual Precipitation 1961-1990, 1971-2000 and 1981-2010 by State," accessed May 14, 2024, from *https://gdg.sc.egov.usda.gov/Catalog/ProductDescription/PRCIP.html*

Kirby, C., S. Briscoe, N. Acosta, and A. Leak, 2024. *208 Region 2 – Regional Nonpoint Source Watershed-Based Plan,* RSI-3527, prepared by RESPEC, Denver, CO, for North Front Range Water Quality Planning Association, Johnstown, CO (draft).

Smith, E., 2024. *2023 Zoning Boundary.zip,* attachment from personal communication between E. Smith, Town of Timnath, CO, and C. Kirby, RESPEC, Rapid City, SD, January 29.

Tetra Tech, Inc., 2022. *User's Guide Pollution Load Estimation Tool Version 1.0*, developed for the U.S. Environmental Protection Agency by Tetra Tech, Inc. Fairfax, VA.

The Water Research Foundation, 2024, "International Stormwater BMP Database," accessed August 14, 2024, from *https://bmpdatabase.org/*

Thomas, M., 2024. Personal communication between M. Thomas, North Front Range Water Quality Planning Association, Johnstown, CO, and C. Kirby, RESPEC, Rapid City, SD, May 2.

U.S. Census Bureau, 2020. "QuickFacts: Loveland City, Colorado; United States" accessed July 29, 2024, from *https://www.census.gov/quickfacts/fact/table/lovelandcitycolorado,US/PST045222*

U.S. Department of Agriculture, 2024. "Farmers.gov," accessed May 30, 2024, from *www.farmers.gov*

U.S. Environmental Protection Agency, 2008. "Handbook for Developing Watershed Plans to Restore and Protect Our Waters," accessed August 13, 2024, from *https://www.epa.gov/nps/handbook-developing-watershed-plans-restore-and-protect-our-waters*

U.S. Environmental Protection Agency, 2022. "User's Guide Pollutant Load Estimation Tool (PLET) Version 1.0," accessed August 1, 2024, from *https://www.epa.gov/system/files/documents/2022-04/user-guide-final-04-18-22_508.pdf*

U.S. Environmental Protection Agency, 2023. "Best Management Practice Definitions Document for Pollutant Load Estimation Tool," accessed May 1, 2024, from *https://www.epa.gov/system/files/documents/2023-04/BMP_Description_revised%203-9-23_final%20with%20alt%20text_508.pdf*

U.S. Environmental Protection Agency, 2024a, "Nonpoint Source (NPS) Watershed Projects Data Explorer," accessed August 14, 2024, from *https://ordspub.epa.gov/ords/grts/f?p=109:940::::940::*

U.S. Environmental Protection Agency, 2024b. "Per- and Polyfluoroalkyl Substances (PFAS) Final PFAS National Primary Drinking Water Regulation," accessed August 14, 2024, from *https://www.epa.gov/sdwa/and-polyfluoroalkyl-substances-pfas*

U.S. Environmental Protection Agency, 2024c. "Aquatic Life Criteria – Ammonia", accessed August 22, 2024, from https://www.epa.gov/wqc/aquatic-life-criteria-ammonia#:~:text=When%20ammonia%20is%20present%20in%20water%20at%20high,temperature%2C%20can%20affect%20ammonia%20toxicity%20to%20aquatic%20animals.

U.S. Geological Survey, 2019. "SPARROW Modeling Program," accessed August 14, 2024, from *https://www.usgs.gov/software/sparrow-modeling-program*

U.S. Geological Survey Colorado Water Science Center, 2000. "NAWQA South Platte River Basin Study," accessed May 30, 2024, from *https://www.usgs.gov/centers/colorado-water-science-center/science/nawqa-south-platte-river-basin-study*

Watershed Center, 2024. "Our Work," accessed August 13, 2024, from *https://watershed.center/our-work/*

Keep It Clean Partnership and Wright Water Engineers, 2016. *St. Vrain Basin Watershed-Based Plan: Boulder Creek, St. Vrain Creek Tributaries*, prepared by the Keep it Clean Partnership and Wright Water Engineers, Inc., available online at: *https://www.keepitcleanpartnership.org/wp-content/uploads/partner-pdfs/319toCDPHE/Boulder%20St%20Vrain%20Watershed%20Plan%203-2016final.pdf*

Workman, J. B., J. C. Cole, R. R. Shroba, K. S. Kellogg, and W. R. Premo, 2018. Geologic Map of the Fort Collins 30'×60' quadrangle, Larimer and Jackson Counties, Colorado, and Albany and Laramie Counties, Wyoming, available online at *https://ngmdb.usgs.gov/Prodesc/proddesc_108070.htm*

Zeckoski, R. W., B. L. Benham, S. B. Shah, and C. D. Heatwole, 2005. "BSLC: A Tool for Bacteria Source Characterization for Watershed Management," *Applied Engineering in Agriculture*, Vol. 21, No. 5, pp. 879–889.

APPENDIX A
SURVEY QUESTIONS

2022 SURVEY

1. Agency/organization's name
2. Website URL
3. Contact person(s), name(s)
4. Email address(s)
5. Phone number(s)
6. Which of the following watersheds is/are the focus of your organization
    a. Big and Little Thompson
    b. Middle South Platte
    c. Cache la Poudre
    d. St. Vrain Creek
    e. Other
7. If known, please list the waterbody name and segment identification (AUID) (i.e., COSPUS15) if it was selected from question #6, please provide the watershed name.
8. Does your agency have an existing watershed plan, source water plan, NPS plan, or other?
9. Please provide the link to the watershed plan(s) if available below or send a copy to Mark Thomas at: mthomas@nfrwqpa.org
10. Is the plan under development if you agency does not have an existing watershed plan identified in question #8?
11. What level of impact do the following nonpoint sources have on water quality in your watershed? (check one for each row)
    a. Abandoned mine lands
    b. Agriculture (including agricultural return flows and agricultural stormwater runoff)
    c. Hydromodification (diversions including transbasin diversions)
    d. Habitat alteration
    e. Urbanization
    f. Onsite wastewater systems (aka septic systems)
    g. Runoff from roadways
    h. Post wildfire impacts (includes post-wildfire flooding)
    i. Climate change
    j. Hazardous household or industrial wastes (pharmaceuticals, oil, paint, acids, pesticides, etc.)
12. What are the major pollutants of concern? (check all that apply)
    a. Sediment (includes ash from wildfire)
    b. Total suspended solids (TSS)
    c. Nitrogen
    d. Phosphorus
    e. Temperature
    f. Metals
    g. *E. coli*
    h. Emerging contaminants
    i. Other
13. Please check all water quality parameters/analytes that your group measures:
    a. Sediment (includes ash from wildfire)
    b. Total suspended solids (TSS)

c. Nitrogen
d. Phosphorus
e. Temperature
f. Metals
g. E. coli
h. Emerging contaminants
i. Other

14. If known, what is the period of record for each of the analytes listed above?
15. Is the data publicly available on the Colorado Data Sharing Network (CDSN)?
16. If the data is not publicly available, would you be willing to share your data with NFRWQPA?
17. What types of watershed projects have been completed?
    a. Habitat improvements
    b. Bank stabilization - grading
    c. Bank stabilization – vegetation
    d. Installation of drop or other in rivers
    e. Vegetation buffers
    f. Agricultural tailwater BMPs
    g. Unknown
18. What projects are high priority for your organization/watershed group?
19. What barriers from question (#18) may be preventing the project?
    a. Funding
    b. Technical resources
    c. Instrumentation
    d. Staffing/volunteer time
    e. No barriers are preventing the project
    f. Other
20. Does your organization/agency provide any of the following services:
    a. BMP recommendations
    b. Technical advice
    c. Water quality sampling
    d. Public education
    e. Other
21. Do you have policies, guidelines, or governing codes related to nonpoint source water quality adoption? Please, provide sources or weblinks.
22. Does your jurisdiction's county/municipal code reference the NFRWQPA 208 Areawide Water Quality Management Plan?
23. What can a regional NPS watershed plan help your watershed organization accomplish?
24. If known, provide or identify areas of special interest that need to be protected from NPS pollutants.
25. Why does your watershed organization value water quality?
26. What is the public perception of your watershed's water quality?
27. What other issues or concerns would you like NFRWQPA to be aware of?
28. If you want to be added to the email/ notification/distribution list regarding meetings and updates concerning the Regional NPS Watershed Plan, please provide your email below.

2024 SURVEY

1. Email address
2. First name
3. Last name
4. Please provide your contact information
5. Are you interested in participating with the NFRWQPA Technical Advisory Committee in guiding the Nonpoint Source plan best management practices (BMPs) for the Larimer and Weld County region and participating in the final report review for this project? If yes, please provide your name and email address.
6. What watershed are you most concerned with? Select all that apply.
    a. Middle South Platte - Cherry (Area of Concern: 10190003)
    b. St. Vrain (Area of Concern: 10190005)
    c. Big Thompson (Area of Concern: 10190006)
    d. Cache La Poudre (Area of Concern: 10190007)
    e. Lone Tree-Owl (Area of Concern: 10190008)
    f. Crow (Area of Concern: 10190009)
    g. Middle South Platte Sterling (Area of Concern: 10190012)
    h. Other (please specify)
7. Aside from watershed plans, what other major projects have you done or are you aware of that has or may improve water quality in the watershed?
8. When were they completed?
9. What is the approximate area impacted by the project?
10. What is the approximate area impacted by the project? Please describe.
11. Are there current plans for a watershed plan or update of an existing plan in your area?
12. How many months a year do agriculture producers typically apply manure on crops?
13. Rank the likelihood of each following cropland BMPs to be implemented in your area from 1 to 5, with 1 being unlikely and 5 being very likely
    a. List of BMPs from PLET
14. Does your watershed have BMPs for non-point source pollution? The following would be important to attain if available (including list/count estimate).
15. What BMPs have been implemented in your watershed? Please describe.
16. Approximately how many of each BMP type/technology (many are included in Section 5 questions) have been implemented in your HUC8?
17. What area of concern and/or water bodies are benefiting from the implemented BMPs? Please describe.
18. What land use(s) are the BMPs developed for? Select all that apply.
    a. Cropland
    b. Pasture
    c. Forest
    d. Urban
    e. Feedlot
    f. Other (please specify)
19. Please estimate the approximate area impacted by the implemented BMPs.

20. Is there any monitoring associated with determining pollutant load reductions and/or do the BMPs have estimated pollutant load reductions?
21. If you answered no, do you need technical and financial assistance to conduct monitoring?
22. What were the costs associated with the BMPs?
23. Are there noticeable improvements associated with implementing the BMPs? If yes, please describe.
24. Are there other BMPs you would like to see in addition to those currently constructed or implemented?
25. Please list any funded projects, activities, or next steps for non-point source pollution in your watershed in the next five years.
26. What types of information/education/outreach do you see being the most effective? Please check all that apply.
    a. Water Quality Awareness Signage in Parks by Streams
    b. Educational Campaign
    c. Social Media
    d. Story Map
    e. Newsletters, Mailers, Blurbs
    f. Website Update
    g. Park Signage
    h. "Report a Concern" Website
    i. Volunteer Cleanup Programs
    j. School Visits
    k. Pet-waste Pickup Stations
    l. Other (please specify)
27. Are you interested in collaboration with other stakeholder groups and hosting/participation in events?
28. Do you have any annual events/activities we could attend? If yes, please provide date/time/location/contact information.
29. Please describe what interim measurable criteria/milestones are used to determine goal achievement.
30. In 5 years, what does progress look like to you regarding pollution loading reduction in your area of concern?
31. In 10 years, what does progress look like to you regarding pollution loading reduction in your area of concern?
32. Which of the following in-stream monitoring activities would you likely consider implementing in your area of concern? Please select one or both options.
33. Do you need technical and financial assistance to conduct in-stream monitoring? If yes, please describe.
34. To develop/implement BMPs, do you need any financial assistance? If yes, please describe.
35. What financial assistance have you received for watershed improvement projects?
36. What are sources of financial assistance you know of but have not used?
37. What technical resources are needed to develop/implement BMPs?
38. What sources of technical assistance have you received in the past?
39. What are sources of technical assistance you know of but have not used?

40. Are there point discharges you are concerned about in your watershed (even in areas that are MS4 permitted)? If yes, please explain.
41. Are there non-point sources that you are concerned about in your watershed (even in areas that are MS4 permitted)? If yes, please explain.
42. Are you aware of abandoned mined land in your area?
43. If yes, are you aware of abandoned mined land BMP strategies implemented in your area?
44. What are the results of implementing such abandoned mined land BMP strategies?
45. Are you aware of agricultural practices (Cropland, Pasture, and/or Feedlot) in your area?
46. From the highest concern to the lowest, please rank the following agricultural concerns with 1 being the largest and 3 being the smallest: Cropland, Pasture, Feedlot.
47. Are you aware of agricultural BMP strategies implemented in your area?
48. If yes, what are the results of implementing such agricultural BMP strategies?
49. Are you aware of atmospheric deposition in your area?
50. If yes, are you aware of atmospheric deposition BMP strategies implemented in your area?
51. What are the results of implementing such atmospheric deposition BMP strategies?
52. Are you aware of forestry non-point source in your area?
53. If yes, are you aware of forestry non-point source BMP strategies implemented in your area?
54. Are you aware of hydromodification and habitat alteration in your area?
55. If yes, are you aware of hydromodification and habitat alteration BMP strategies implemented in your area?
56. If yes, what are the results of implementing such hydromodification and habitat alteration BMP strategies?
57. Are you aware of urbanization in your area?
58. If yes, are you aware of urbanization BMP strategies implemented in your area?
59. If yes, what are the results of implementing such urbanization BMP strategies?

APPENDIX B
MAPS OF IMPAIRED PARAMETERS

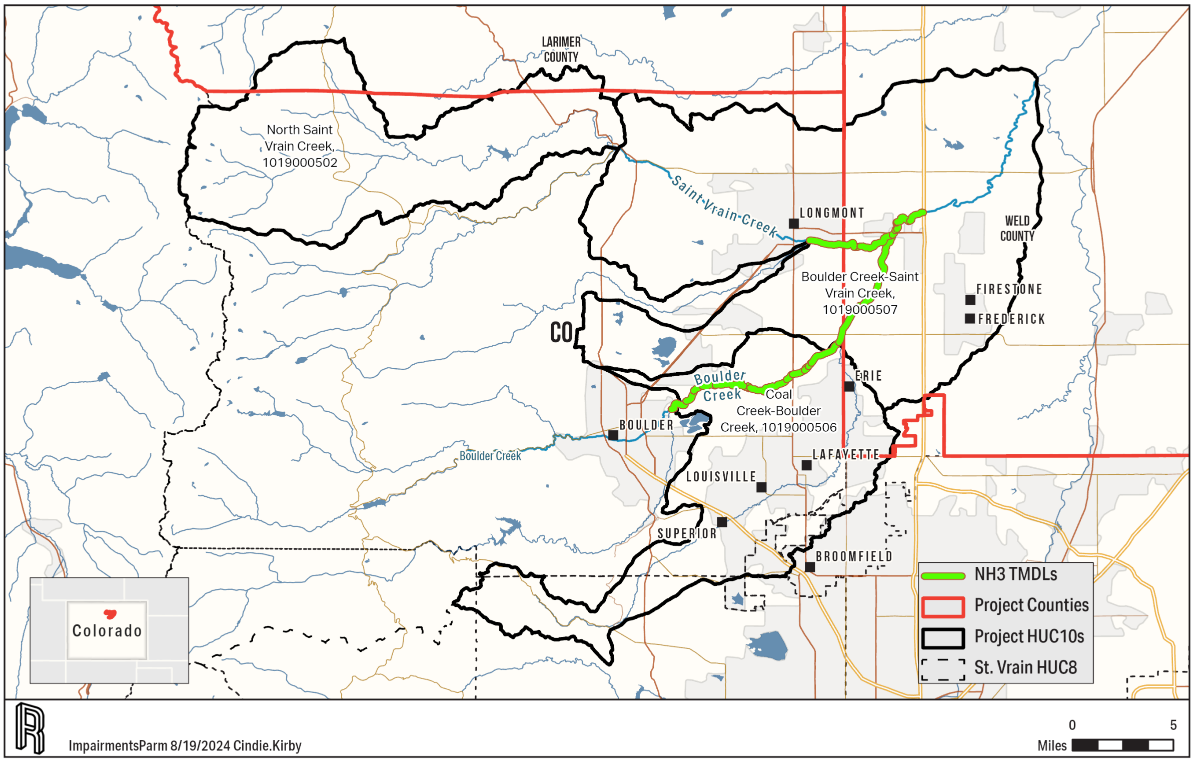


Figure B-1. Ammonia TMDLs.

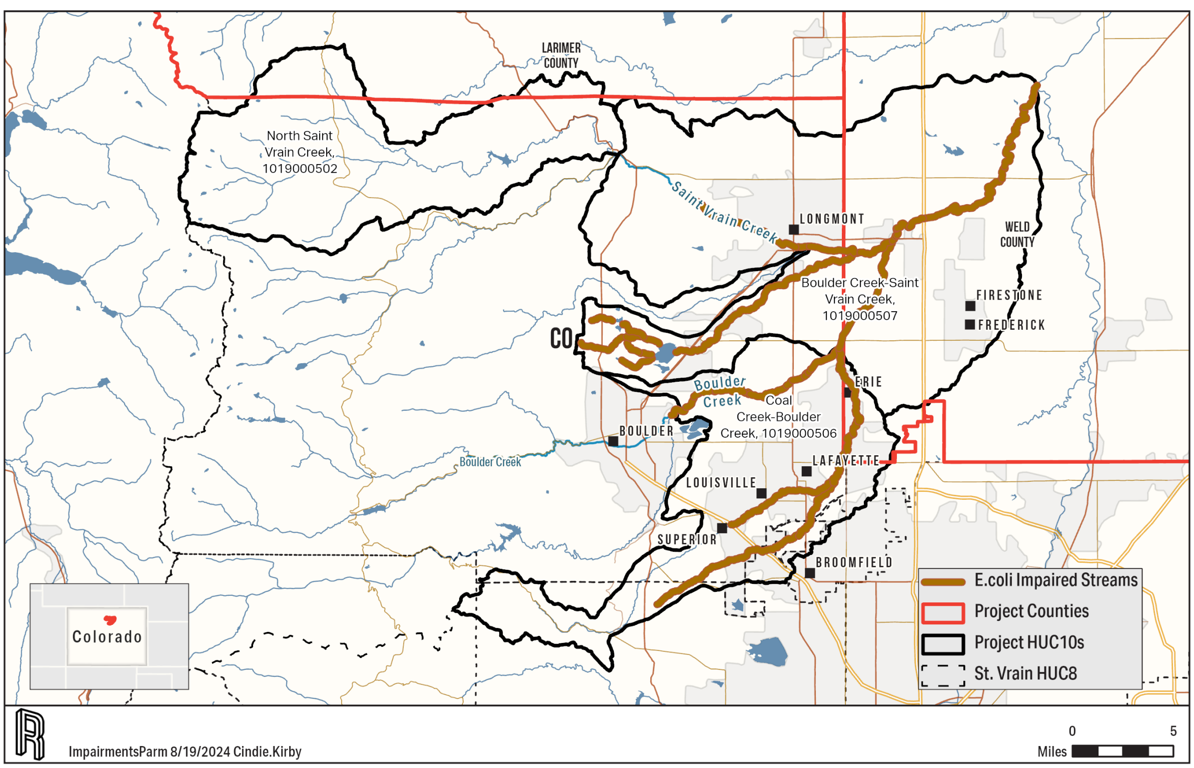


Figure B-2. *E. coli* Impairments.

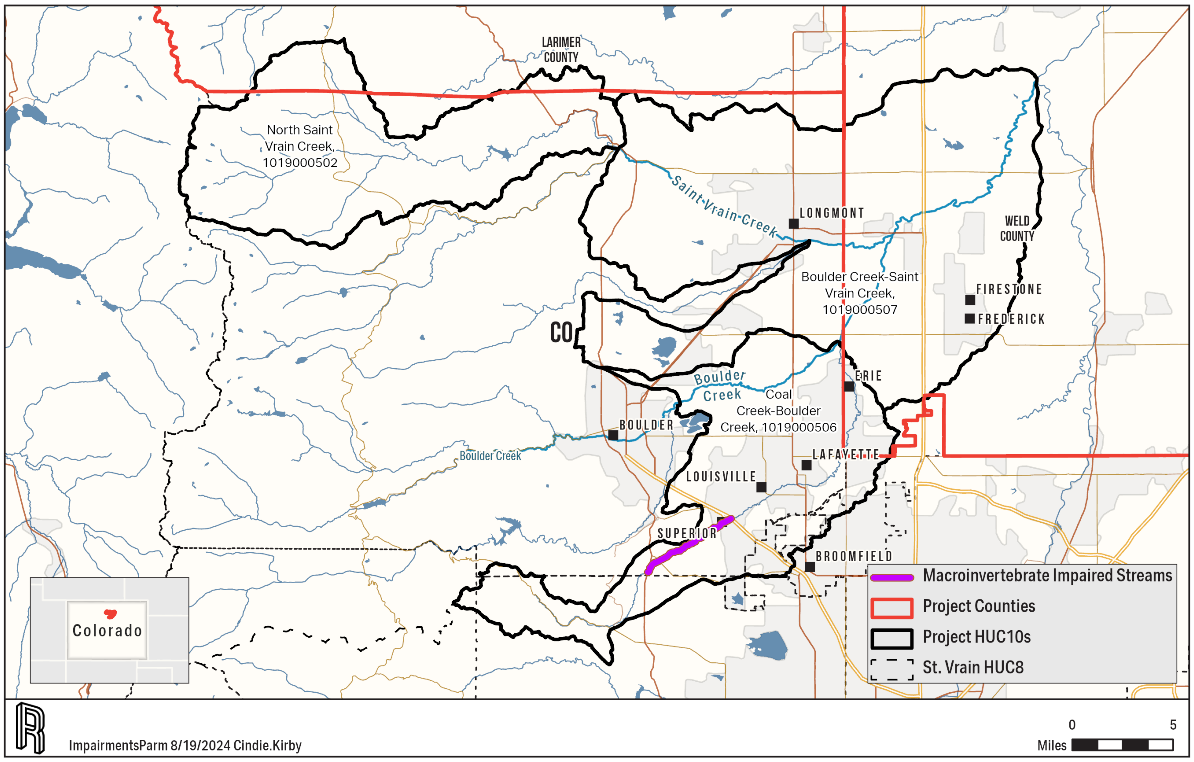


Figure B-3. Macroinvertebrate Impairments.

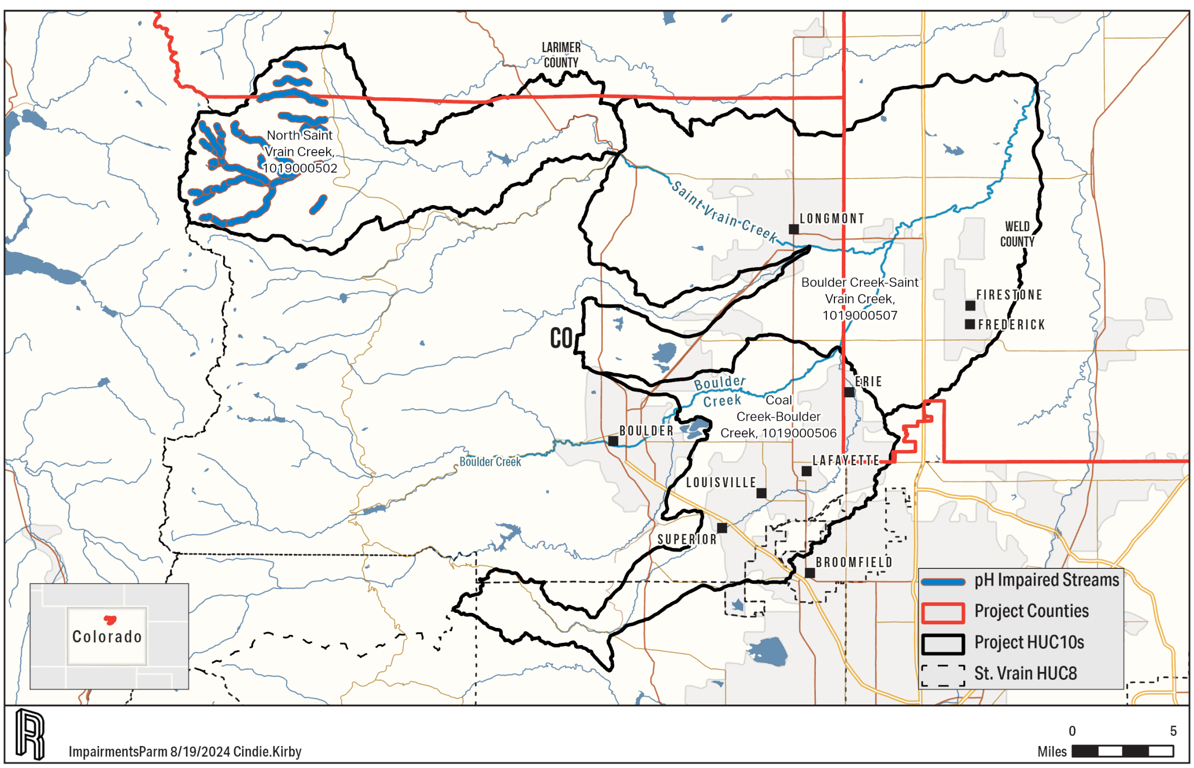


Figure B-4. pH Impairments.

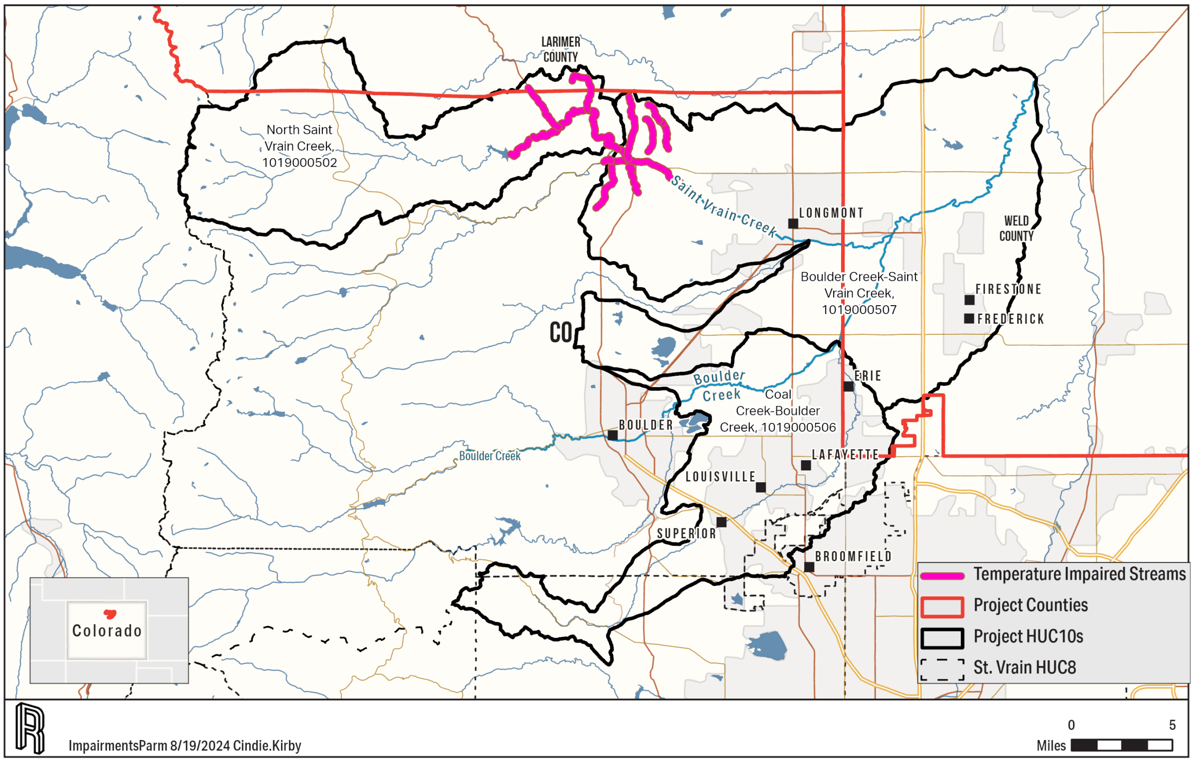


Figure B-5. Temperature Impairments.

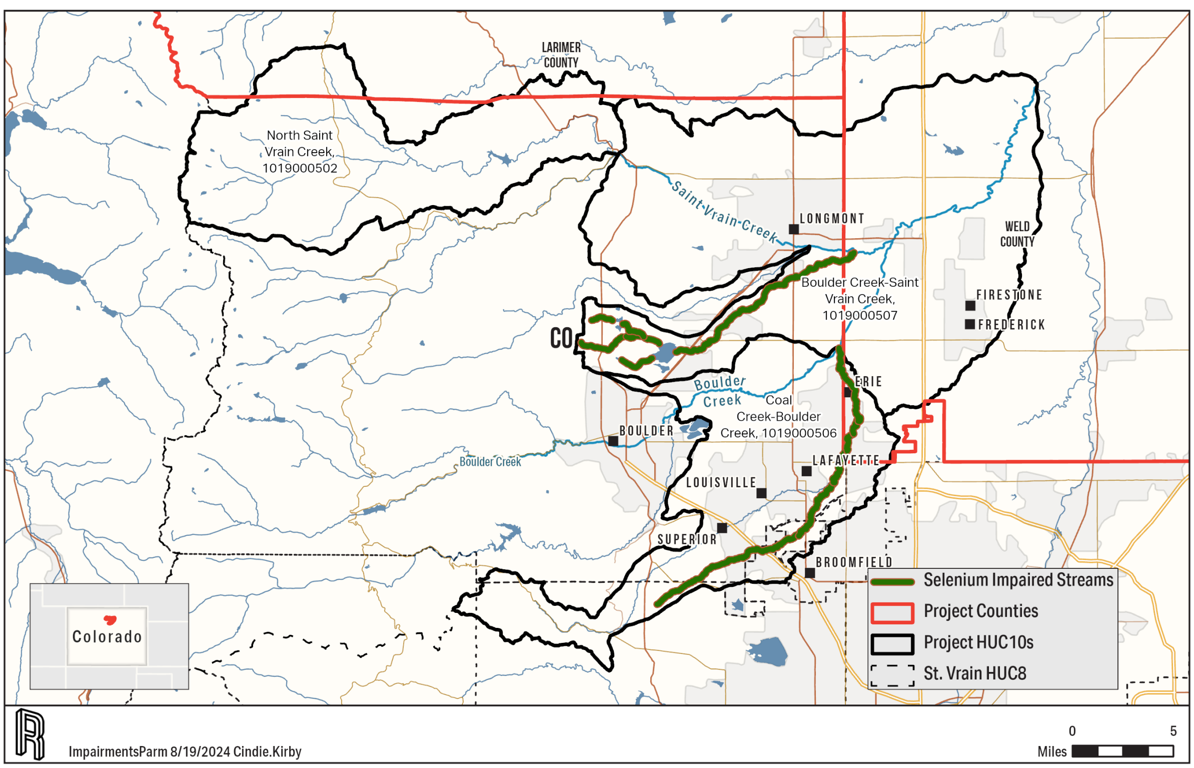


Figure B-6. Selenium Impairments.

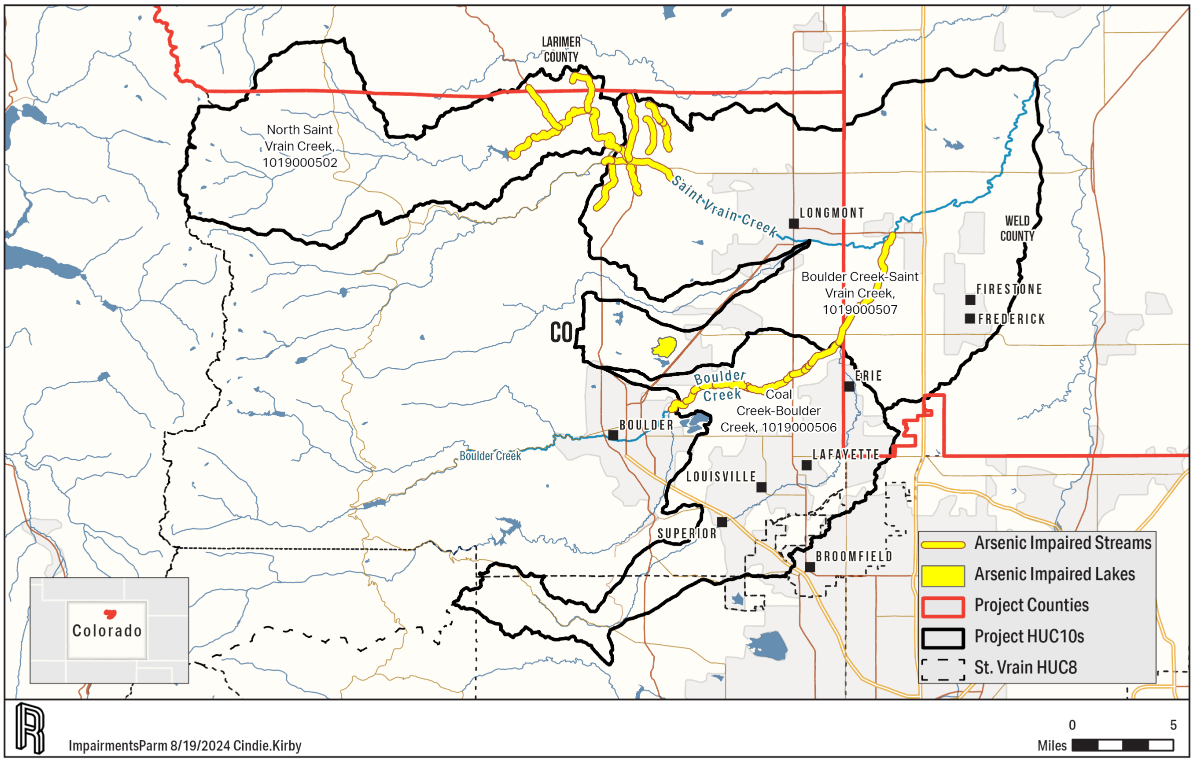


Figure B-7. Arsenic Impairments.

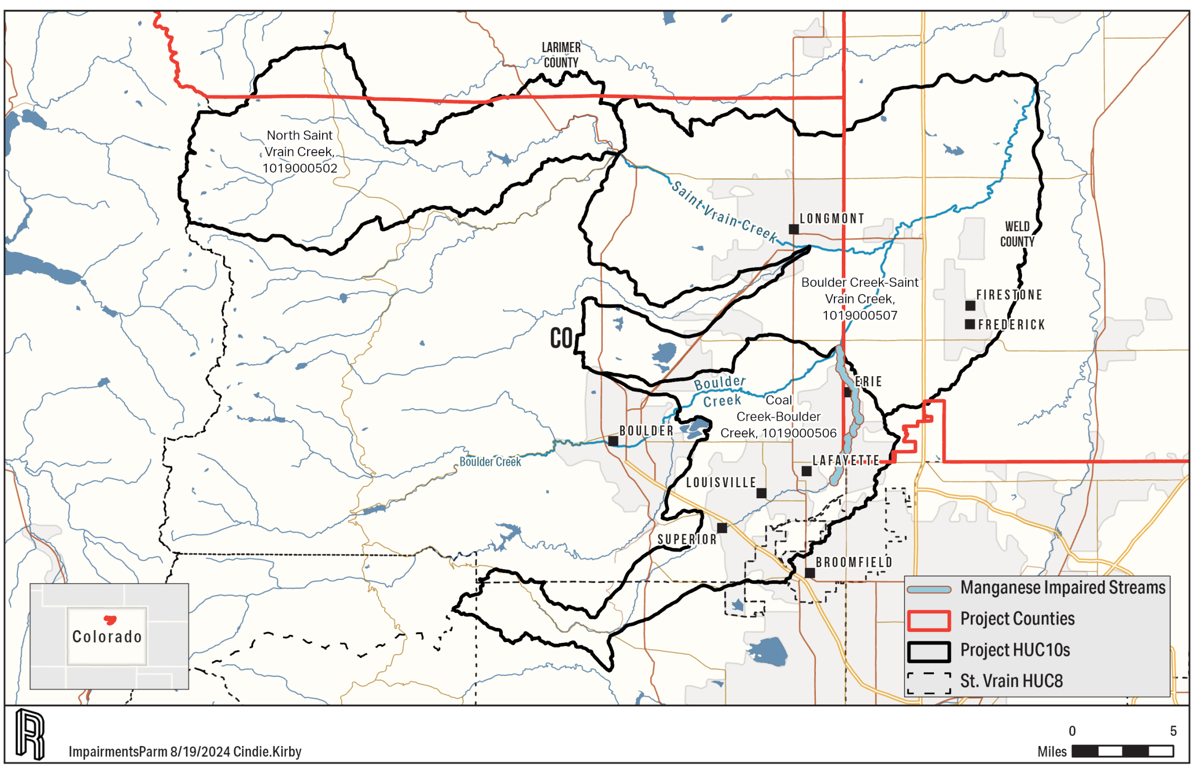


Figure B-8. Manganese Impairments.

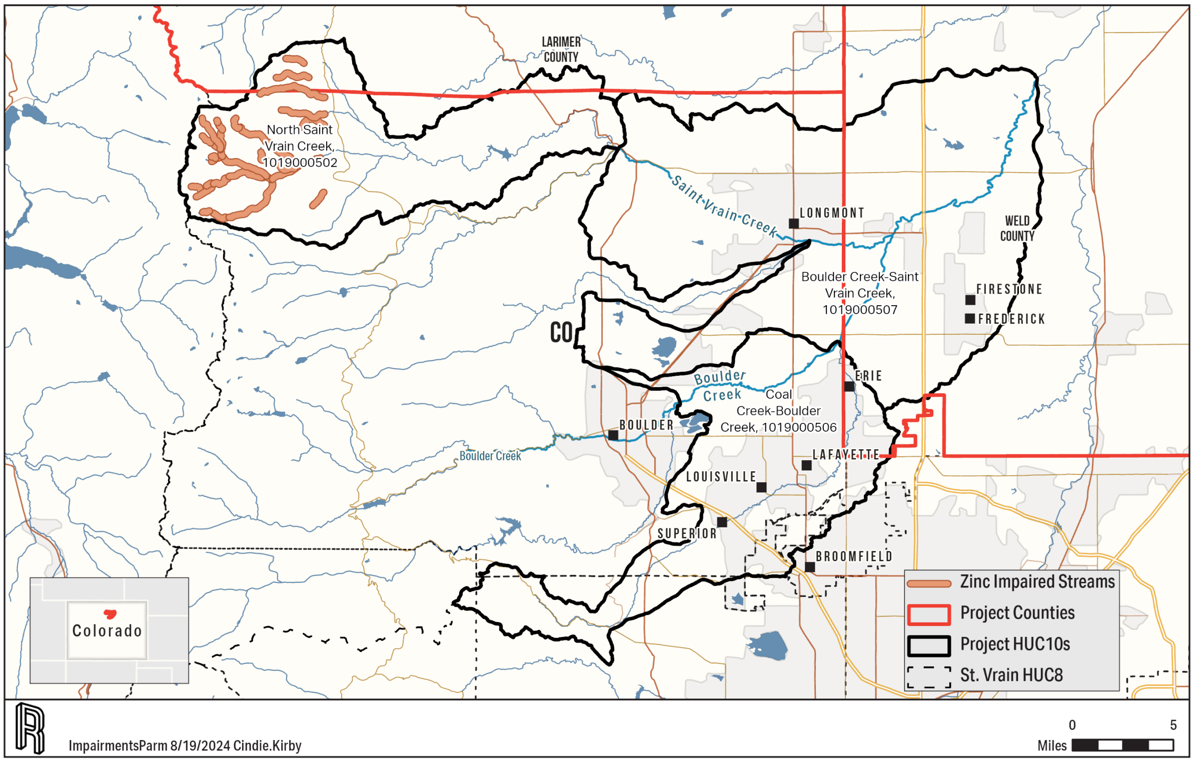


Figure B-9. Zinc Impairments.

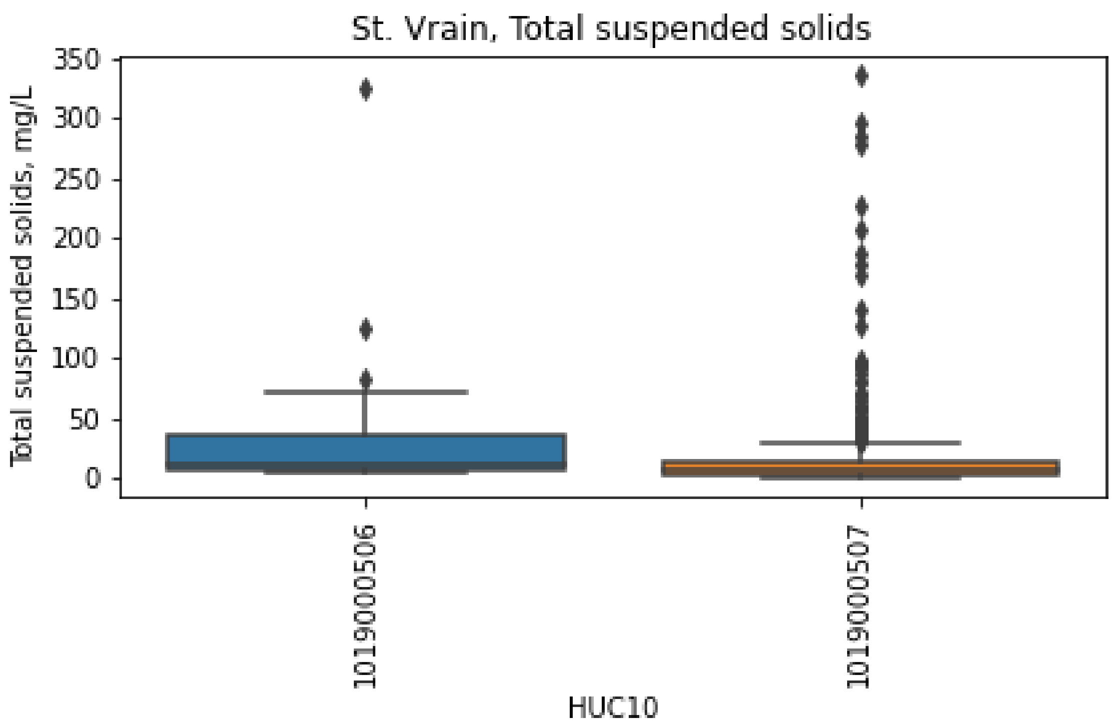
APPENDIX C

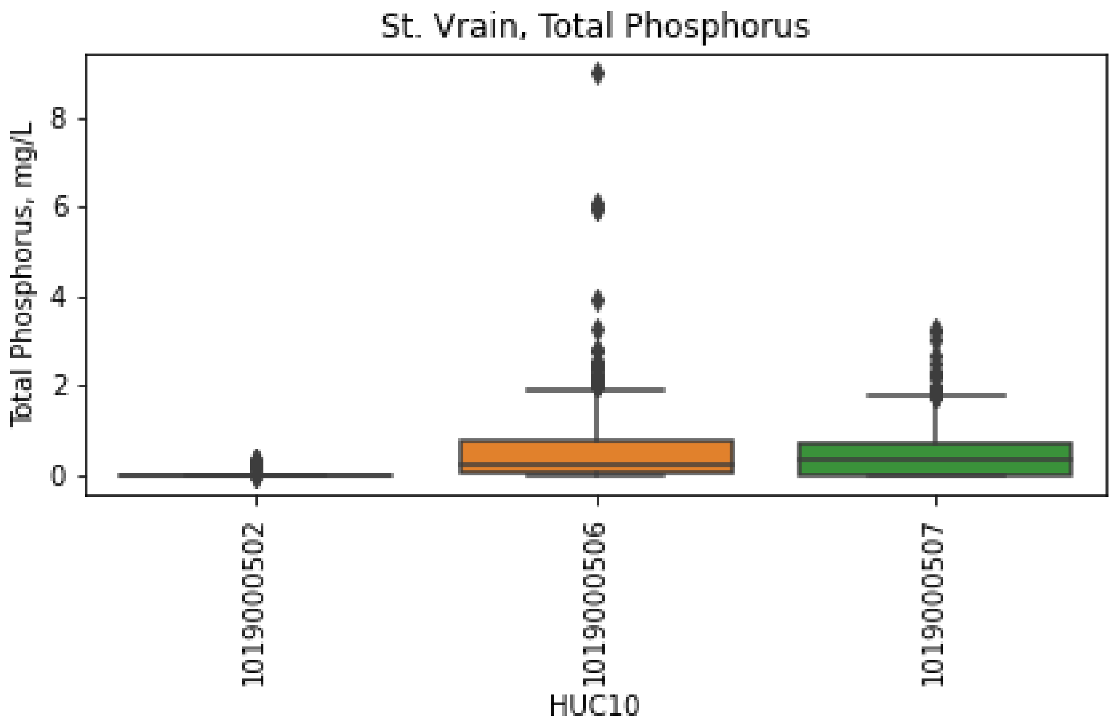
APPLICABLE WATER QUALITY BOX PLOTS BY HUC10

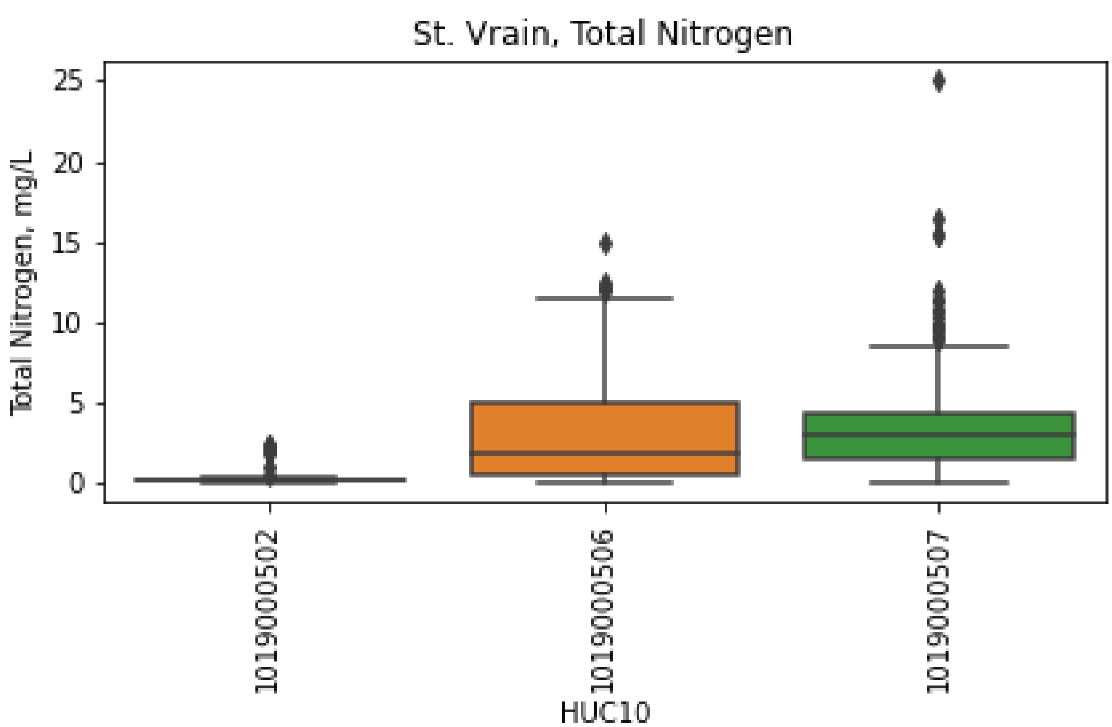
DATASET

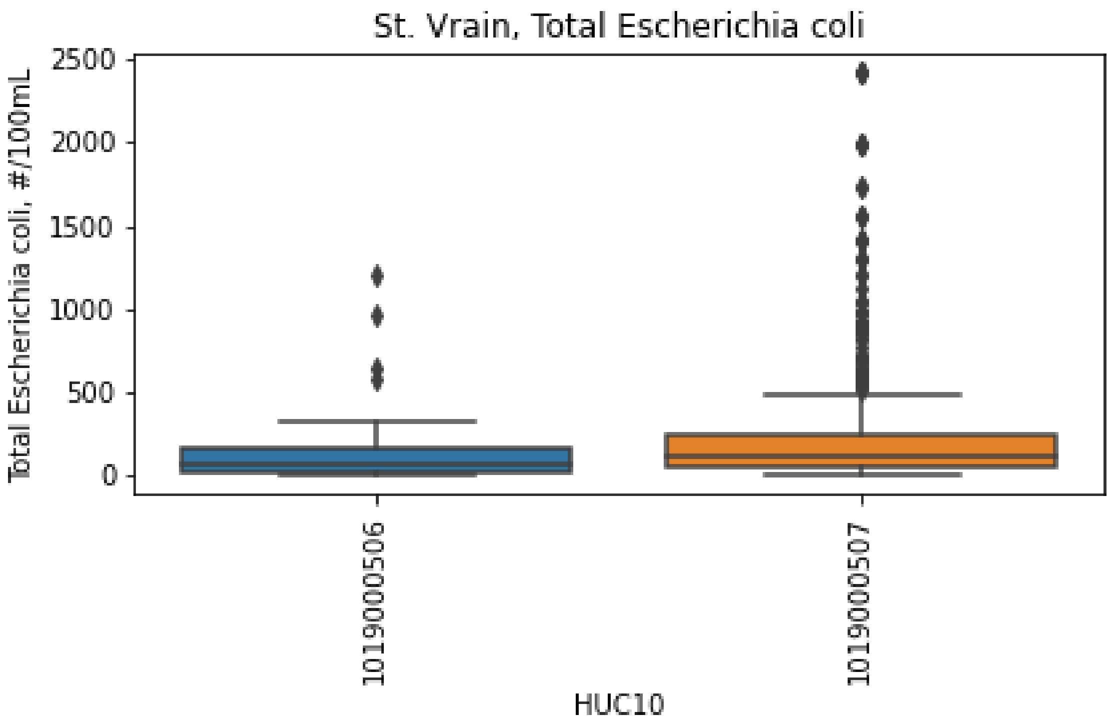
Data for boxplots were collected for the years 1990 through 2023 from various sources. Sources included the Water Quality Portal, the Colorado Data Sharing Network, Northern Water, ERAMS, and numerous individuals including Paul Bremser (St. Vrain), Andy Fayram (City of Loveland), Brian Hathaway (City of Greeley), and Jason Meier (Fossil Creek). Data were organized and grouped into a single file with consistent naming and units for applicable parameters and were assigned a "Y" or a "N" for an attribute representing if the monitoring point was located on a mainstem HUC10 reach. The boxplots only include data along the mainstem HUC10 reaches because water quality can vary greatly for headwater streams.

PLET PARAMETERS

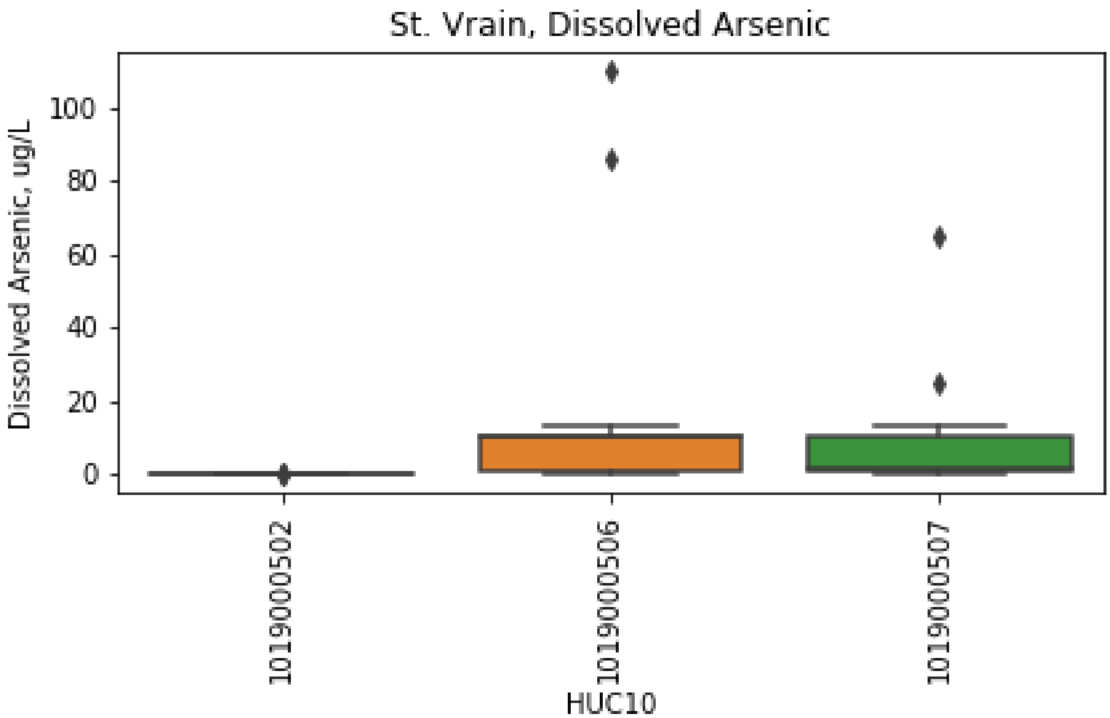


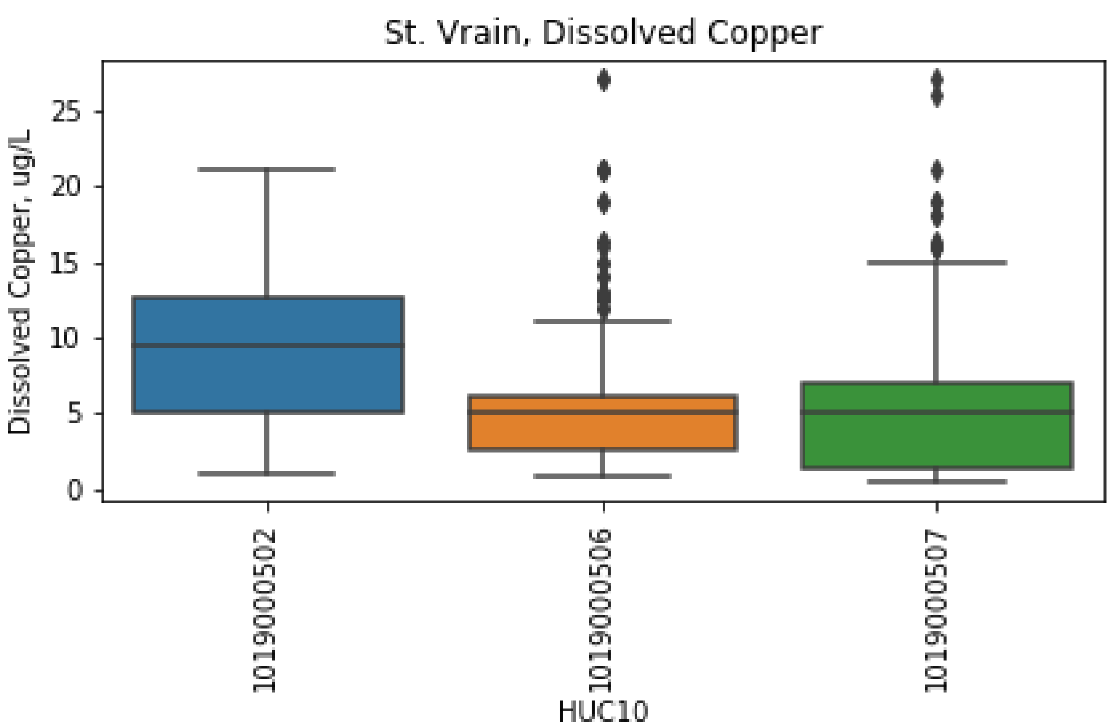

St. Vrain, Total Phosphorus
Total Phosphorus, mg/L
0
2
4
6
8
1019000502
1019000506
1019000507
HUC10

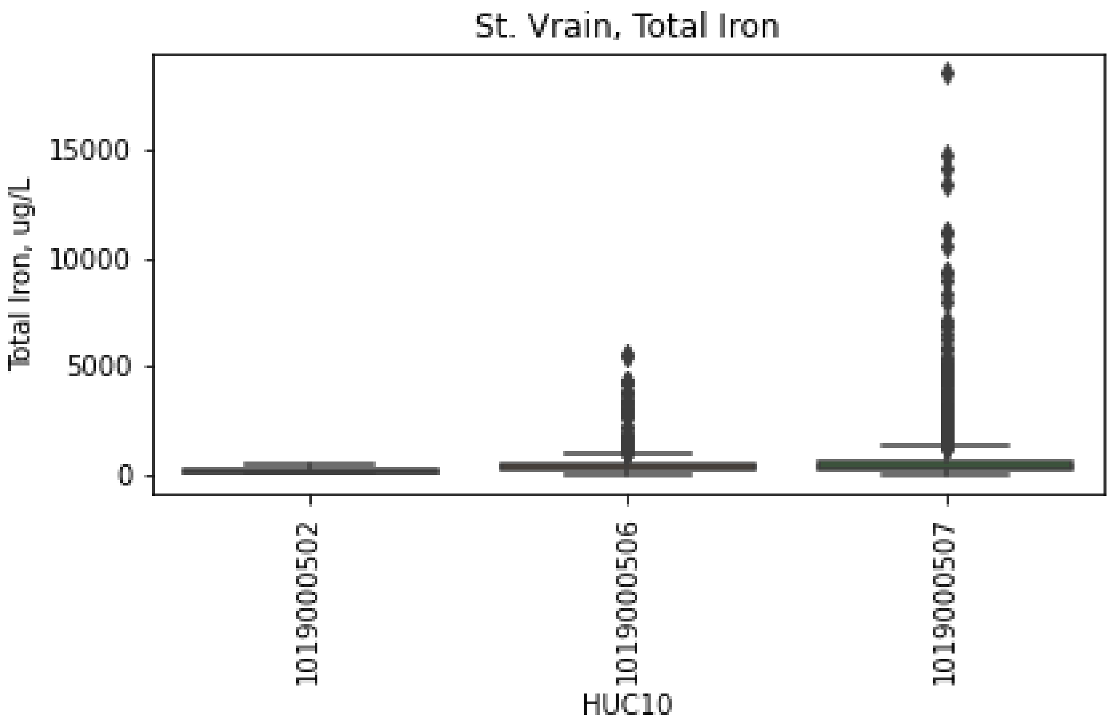

St. Vrain, Total Nitrogen
Total Nitrogen, mg/L
0
5
10
15
20
25
1019000502
1019000506
1019000507
HUC10

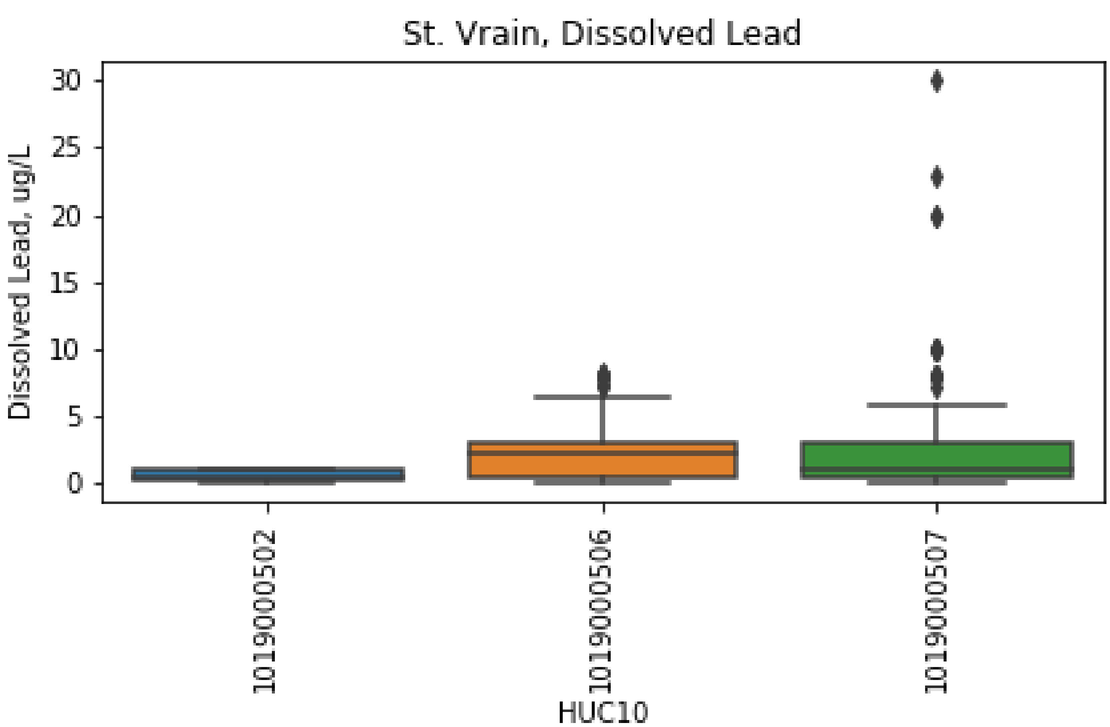

St. Vrain, Total Escherichia coli
Total Escherichia coli, #/100mL
2500
2000
1500
1000
500
0
1019000506
1019000507
HUC10

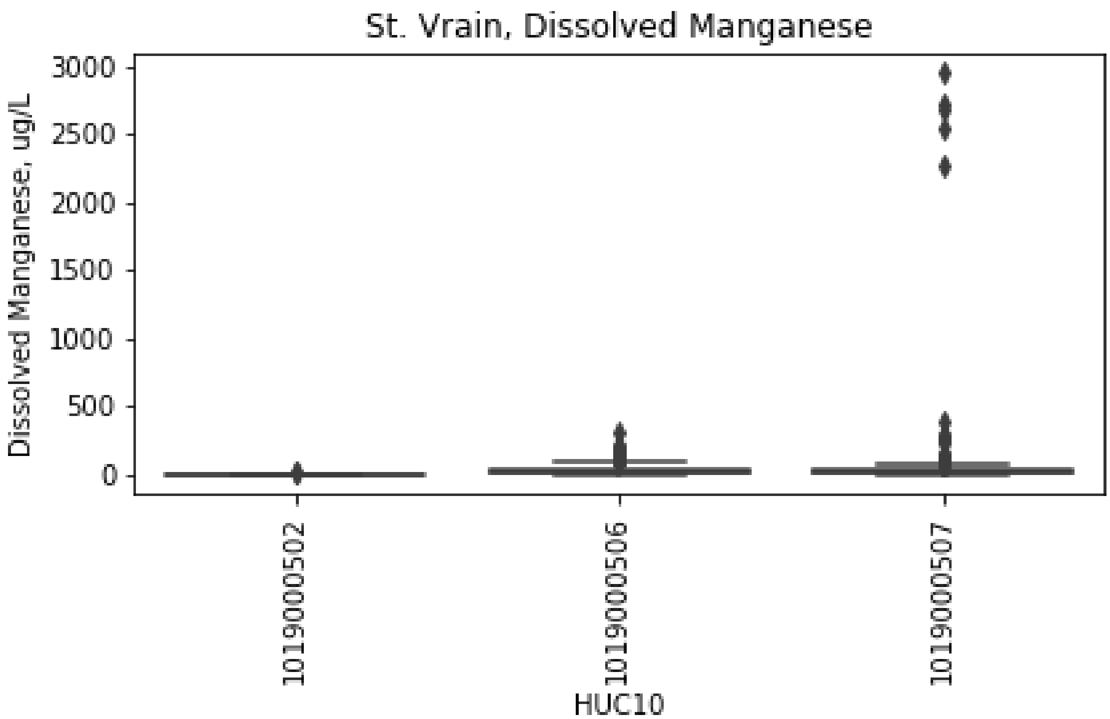
HEAVY METALS

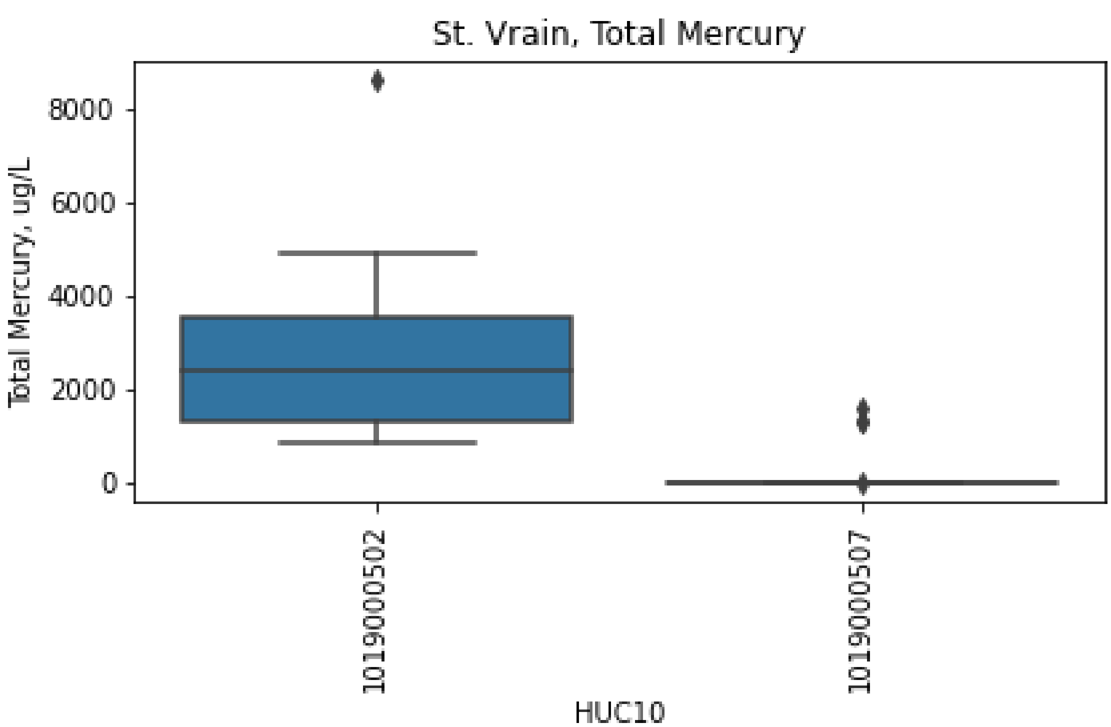


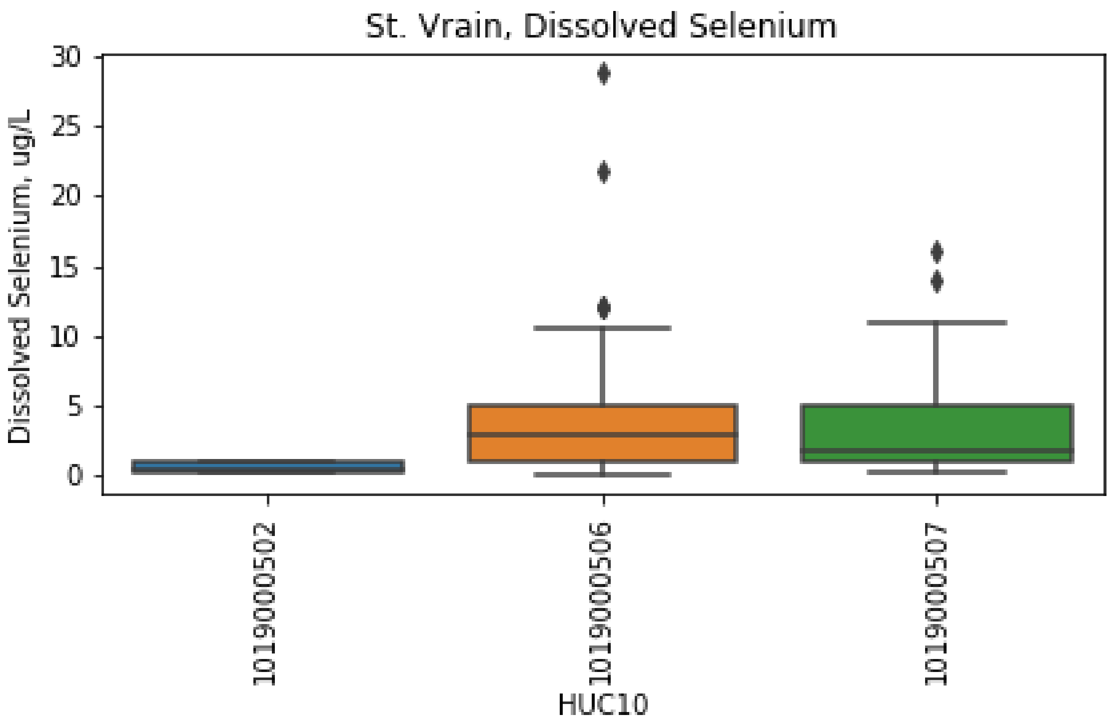


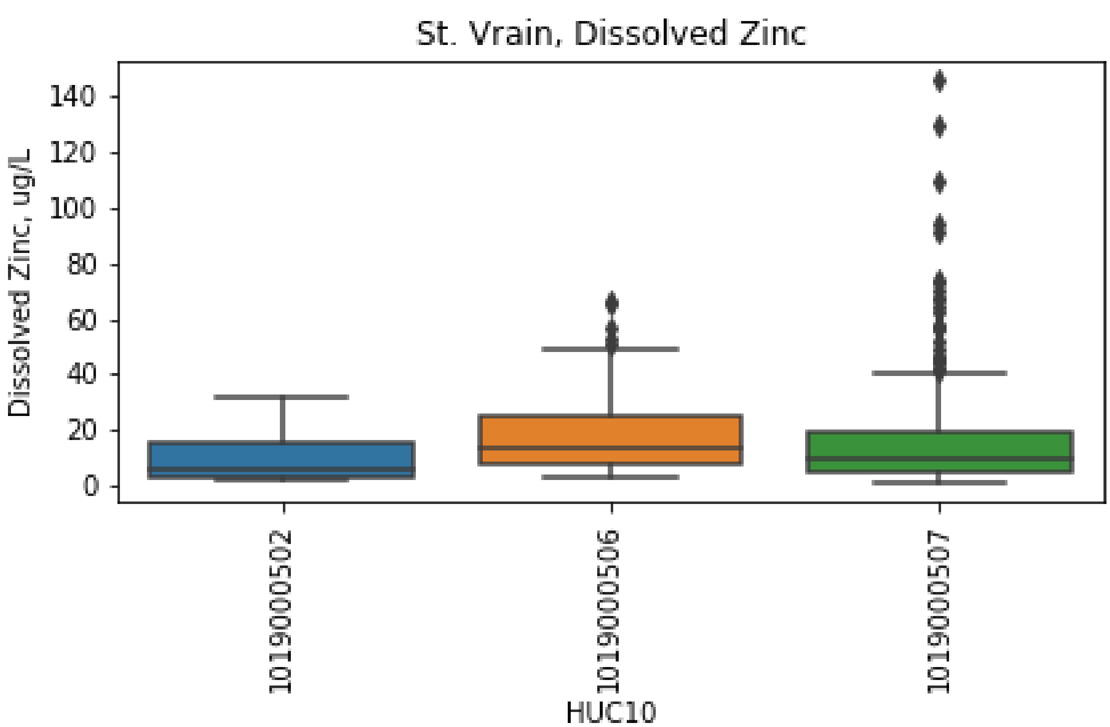

St. Vrain, Total Iron
Total Iron, ug/L
15000
10000
5000
0
1019000502
1019000506
1019000507
HUC10


St. Vrain, Dissolved Lead
Dissolved Lead, ug/L
30
25
20
15
10
5
0
1019000502
1019000506
1019000507
HUC10


St. Vrain, Dissolved Manganese
Dissolved Manganese, ug/L
3000
2500
2000
1500
1000
500
0
1019000502
1019000506
1019000507
HUC10


St. Vrain, Total Mercury
Total Mercury, ug/L
8000
6000
4000
2000
0
1019000502
1019000507
HUC10


St. Vrain, Dissolved Selenium
Dissolved Selenium, ug/L
30
25
20
15
10
5
0
1019000502
1019000506
1019000507
HUC10


St. Vrain, Dissolved Zinc
Dissolved Zinc, ug/L
140
120
100
80
60
40
20
0
1019000502
1019000506
1019000507
HUC10

APPENDIX D
PLET SCENARIO REDUCTIONS

Table D-1. PLET Scenario Reductions (Page 1 of 2)

Land Use	Practice	HUC10	Nitrogen Reduction (%)	Phosphorus Reduction (%)	Sediment Reduction (%)
Cropland	Streambank Stabilization and Fencing	1019000502	0.0	0.0	0.0
Cropland	Streambank Stabilization and Fencing	1019000506	12.2	12.7	18.3
Cropland	Streambank Stabilization and Fencing	1019000507	15.1	16.4	18.0
Cropland	35 ft Buffers	1019000502	0.0	0.0	0.0
Cropland	35 ft Buffers	1019000506	8.3	8.9	12.9
Cropland	35 ft Buffers	1019000507	9.6	11.3	12.7
Pasture	Streambank Stabilization and Fencing	1019000502	0.0	0.0	0.0
Pasture	Streambank Stabilization and Fencing	1019000506	0.1	0.1	0.2
Pasture	Streambank Stabilization and Fencing	1019000507	0.5	0.4	0.4
Pasture	35 ft Buffers	1019000502	0.0	0.0	0.0
Pasture	35 ft Buffers	1019000506	0.1	0.1	0.1
Pasture	35 ft Buffers	1019000507	0.5	0.4	0.4
Pasture	Livestock Exclusion	1019000502	0.0	0.0	0.0
Pasture	Livestock Exclusion	1019000506	0.1	0.1	0.1
Pasture	Livestock Exclusion	1019000507	0.3	0.3	0.4
Feedlot	Waste Management System	1019000502	1.7	1.1	0.0
Feedlot	Waste Management System	1019000506	1.1	0.7	0.0
Feedlot	Waste Management System	1019000507	0.6	0.5	0.0
Forest	Site Preparation/Straw/Crimp/Net	1019000502	10.5	11.8	21.8
Forest	Site Preparation/Straw/Crimp/Net	1019000506	0.1	0.1	0.1
Forest	Site Preparation/Straw/Crimp/Net	1019000507	0.0	0.0	0.0
Forest	Site Preparation/Straw/Crimp Seed/Fertilizer/Transplant	1019000502	10.8	12.1	22.2
Forest	Site Preparation/Straw/Crimp Seed/Fertilizer/Transplant	1019000506	0.1	0.1	0.1
Forest	Site Preparation/Straw/Crimp Seed/Fertilizer/Transplant	1019000507	0.0	0.0	0.0

Table D-1. PLET Scenario Reductions (Page 2 of 2)

Land Use	Practice	HUC10	Nitrogen Reduction (%)	Phosphorus Reduction (%)	Sediment Reduction (%)
Urban	Extended Wet Detention	1019000502	2.3	1.3	0.9
Urban	Extended Wet Detention	1019000506	0.3	0.1	0.1
Urban	Extended Wet Detention	1019000507	0.5	0.3	0.2
Urban	Infiltration Basin	1019000502	2.5	1.2	0.8
Urban	Infiltration Basin	1019000506	0.3	0.1	0.1
Urban	Infiltration Basin	1019000507	0.6	0.3	0.2
Urban	Concrete Grid Pavement	1019000502	3.7	1.7	1.0
Urban	Concrete Grid Pavement	1019000506	0.4	0.2	0.1
Urban	Concrete Grid Pavement	1019000507	0.9	0.4	0.2

APPENDIX E
RESPEC STAKEHOLDER TOOLKIT

Stakeholder Toolkit
June 13, 2024

Introduction
The North Front Range Water Quality Planning Association (NFRWQPA) seeks to compile a stakeholder toolkit for the five regional Nonpoint Source (NPS) Watershed Plan areas in Larimer and Weld Counties.

This toolkit will help stakeholders reach, inform and partner with their networks on the NPS watershed educational resources. Here is a link to a final stakeholder toolkit formatting example.

Digital Communications
Digital communications can reach a large audience on a broad scale, with tactics including:

- **Press releases:** This document will serve as NFRWQPA's official statement on the NPS watersheds and respective plans. The press release can be distributed to industry-relevant publications as well as local news outlets.
  - Example
- **Social media:** Targeted social posts to reach industry-specific and locally relevant audiences. Content can vary based on NFRWQPA's needs, seasonality and other updates.
  - Example
- **Newsletters:** Regular updates to an email list of subscribers about the plans, NPS findings and other news.
  - Example
- **Website:** Content updates such as banner announcements, blog posts and home page edits upon project completion.
  - Example
- **Story Map:** Multimedia application to share plan findings, next steps and other dynamic information.
  - Example
- **"Report a Concern" button or website:** Dedicated resource for stakeholders to use when submitting an NPS issue to NFRWQPA (similar to a "contact us" button).
  - Example – Contact Info at bottom of webpage
- **Radio ads and interviews:** Reach stakeholders on a local and national level through a radio ad or securing a news station interview.
  - Example

Print Communications

Print communications can reach targeted, local audiences using the following tactics:

- **Signage:** Capture pedestrian, biking and other rolling traffic's attention with signage strategically placed in a given area. Informational signage can include water quality awareness signage in parks near streams, pet waste pickup stations, and general project information signage.
  - Example
- **Mailers:** Reach residents and businesses via postcard to communicate project benefits and updates, as well as solicit feedback.
  - Example

Community Outreach

Community outreach is a boots-on-the-ground approach to connecting with stakeholders and disseminating information. Community outreach also helps put a face to a project through the following tactics:

- **Educational campaign:** Increase awareness about the plan and NPS concerns in ways that are simplified and relatable for stakeholders.
  - Example
- **Volunteer cleanup program:** Foster community pride and engagement through organizing a park cleanup day.
  - Example
- **School visits, tours and field trips:** Create memories, connect with younger stakeholders and ignite a lifelong interest in the environment by inviting project team members to visit schools for presentations, organize park tours and host field trips.
  - Example – project engineers visited a local library to show students that popular game Fortnite had real-life applications and similarities to simulating virtual environments in the construction industry

APPENDIX D

MIDDLE SOUTH PLATTE RIVER NONPOINT SOURCE WATERSHED-BASED PLAN

RESPEC

MIDDLE SOUTH PLATTE RIVER NONPOINT SOURCE WATERSHED-BASED PLAN

DRAFT REPORT RSI-3523

PREPARED BY
Cindie Kirby
Seattle Briscoe
Natalie Acosta
Cathy McCague

RESPEC
3824 Jet Drive
Rapid City, South Dakota 57703

Communication Infrastructure Group
1660 Lincoln Street; Suite 1800
Denver, Colorado 80264

PREPARED FOR
North Front Range Water Quality Planning Association
257 Johnstown Center Drive; Unit 206
Johnstown, Colorado 80534

DECEMBER 2024

Project Number W0545.23001

RESPEC

TABLE OF CONTENTS

TABLE OF CONTENTS (CONTINUED)

LIST OF TABLES

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

µg/L	micrograms per liter
ACEP	Agricultural Conservation Easement Program
AFA	Alternative Funding Arrangement
AFO	animal feeding operation
AFP	Announcement for Funding Proposals
AML	abandoned mine land
AWEP	Agricultural Water Enhancement Program
BMP	best management practices
BMPDB	International Stormwater Best Management Practices Database
CAFO	concentrated animal feed operation
CASTNET	Clean Air Status and Trends Network
CAWA	Colorado Ag Water Alliance
CCR	Code of Colorado Regulation
cfu/head/day	colony-forming units per head per day
CDPHE	Colorado Department of Public Health and Environment
cfs	cubic feet per second
CIG	Conservation Innovation Grants
CPPE	Conservation Practice Physical Effects
CPS	Conservation Practice Standard
CRP	Conservation Reserve Program
CSP	Conservation Stewardship Program
CSU	Colorado State University
CTA	Conservation Technical Assistance
CWA	Clean Water Act
CWCB	Colorado Water Conservation Board
CWSRF	Clean Water State Revolving Fund
DRUM	Defense-Related Uranium Mine
EPA	U.S. Environmental Protection Agency
EQIP	Environmental Quality Incentives Program
ESRI	Environmental Systems Research Institute, Inc.
EWP	Emergency Watershed Protection Program
FEMA	Federal Emergency Management Agency
FRPP	Farm and Ranch Lands Protection Program
GRP	Grass Reserve Program
HUC	Hydrologic Unit Code
lb/day	pounds per day
lb/year	pounds per year
mg/L	milligrams per liter
mi^2	square miles
MIDS	Minimal Impact Design Standards
mL	milliliter
mpn	most probable number

LIST OF ABBREVIATIONS (CONTINUED)

MS4	Municipal Separate Storm Sewer System
NADP	National Atmospheric Deposition Program
NFRWQPA	North Front Range Water Quality Planning Association
NLCD	National Land Cover Dataset
NPS	Nonpoint Source
NRCS	Natural Resources Conservation Service
NWQI	National Water Quality Initiative
OWTS	Onsite Wastewater Treatment System
PEPO	Public Education, Participation, and Outreach
PFAS	per- and polyfluoroalkyl substances
PLET	Pollutant Load Estimation Tool
RCD	Resource Conservation and Development
RCPP	Regional Conservation Partnership Program
SSURGO	Soil Survey Geographic Database
SWAP	Source Water Assessment and Protection
SWPPP	stormwater pollution prevention plan
TMDL	total maximum daily load
TSS	total suspended solids
USBR	U.S. Bureau of Reclamation
USDA	U.S. Department of Agriculture
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
WFPO	Watershed Protection and Flood Prevention Operations
WHIP	Wildlife Habitat Incentive Program
WHRB	Watershed Rehabilitation
WRP	Wetlands Reserve Program
WRSF	Water Supply Reserve Fund
WWTF	Wastewater Treatment Facility
WWTP	Wastewater Treatment Plant

1.0 INTRODUCTION

The primary purpose of this watershed-based plan is to recommend best management practices (BMPs) that would reduce pollutants of concern within the Middle South Platte Watershed, including portions of Hydrologic Unit Code [HUC] 8 watersheds 10190003 (Middle South Platte-Cherry Creek), 10190008 (Lone Tree-Owl), 10190009 (Crow), and 10190012 (Middle South Platte-Sterling), from nonpoint sources (NPSs). Although this watershed-based plan is a stand-alone NPS plan, water planning should be done in a holistic manner, with teamwork between point and NPSs of pollution. Pollution reductions from NPSs upstream of point sources reduce the strain on the point sources. Municipal, industrial, and agricultural entities working together toward the shared goal of protecting waterbodies before they become impaired will reduce future regulations on these entities.

The watershed-based plan is based on an adaptive approach that emphasizes making continued progress toward achieving milestones and load reduction by identifying the most impactful implementation measures for priority areas. This watershed-based plan summarizes past conservation accomplishments and recommends implementation actions that can assist residents, landowners, and stakeholders in the project area to improve water quality. Private, local, state, and federal partnership efforts should continue to support and promote the implementation of management measures while additional water quality monitoring is conducted to guide watershed plan revisions and assess adaptive implementation activities.

The watershed-based plan builds on past conservation accomplishments in the project area and complements water quality efforts by the following organizations, as well as the local communities:

- Colorado Ag Water Alliance (CAWA)
- Colorado Department of Public Health and Environment (CDPHE)
- Colorado Livestock Association
- Colorado Parks & Wildlife
- Colorado Rural Water Association
- Colorado State University (CSU)
- Colorado Watershed Assembly
- Colorado Wheat Administrative Committee
- Ducks Unlimited
- FPAC-NRCS, CO
- Fresh Water Trust
- Larimer County
- Northern Colorado Water Conservancy District
- Peaks to People Water Fund
- South Platte Basin Roundtable
- Town of Evans

- Town of La Salle
- Town of Kersey
- Town of Keenesburg
- Town of Gilcrest
- Town of Pierce
- Trout Unlimited
- Weld County
- Xcel Energy

This watershed-based plan also incorporates the strategies, goals, and objectives of CDPHE's *Colorado's Nonpoint Source Management Plan: 2022* and addresses the U.S. Environmental Protection Agency's (EPA's) nine key elements outlined in the management plan [CDPHE, 2022]. Table 1-1 describes these nine key elements and their corresponding locations within this watershed-based plan [EPA, 2008].

Table 1-1. Sections of the Watershed-Based Plan That Fulfill the U.S. Environmental Protection Agency's Nine Key Elements for Watershed Planning

EPA Element Number	EPA's Nine Key Elements Plan	Applicable Section of Watershed-Based Plan
1	Identify the causes and sources of pollution that need to be controlled to achieve load reductions and other goals (e.g., recreational, economic, ecological) identified in the plan.	5.0 Source Assessment 6.0 Priority Areas for Implementation
2	Estimate load reductions expected from the action strategy identified.	6.0 Priority Areas for Implementation 7.0 Best Management Practices Load Reductions
3	Describe NPS management measures, including operation/maintenance requirements, and targeted critical areas (i.e., action strategy) needed to achieve identified load reductions.	6.0 Priority Areas for Implementation 7.0 Best Management Practices Load Reductions 8.0 Past and Current Best Management Practices 9.0 Recommended Best Management Practices
4	Estimate technical and financial assistance needed, associated costs, and/or the sources and authorities that will be relied upon to implement the watershed-based plan.	13.0 Technical and Financial Assistance Sources
5	Develop an information and education component that will be used to enhance public understanding of the NPS management measures and encourage their early and continued participation in selecting, designing, and implementing the Action Strategy.	10.0 Information, Education, and Outreach
6	Develop a project schedule.	11.0 Criteria to Assess Progress
7	Describe interim, measurable milestones.	11.0 Criteria to Assess Progress
8	Identify a set of criteria to assess progress/effectiveness in achieving water quality standards or other appropriate end targets.	11.0 Criteria to Assess Progress
9	Develop a monitoring component to evaluate the effectiveness of the implementation efforts over time and measured against the criteria established to document load reductions.	12.0 Monitoring Best Management Practices Effectiveness

This watershed-based plan is not intended to identify which specific BMPs or remediation actions should be included in certain discharge permits, ordinances, stormwater pollution prevention plans (SWPPPs), or conservation plans. Rather, the plan provides an adaptive implementation approach with suggested structural and nonstructural BMPs necessary to address the NPSs of pollutants of concern. For the purposes of this watershed-based plan, BMPs refer to structural and nonstructural actions or measures installed or implemented to reduce the delivery of sediment and nutrients to waterbodies in the project area. Sources of available funding and technical assistance for and associated estimated costs of these BMPs are included to provide landowners, residents, stakeholders, community leaders, and public agencies perspectives on the technical and economic demands of this watershed plan.

Essential to the development of this watershed-based plan is ascertaining and collecting feedback and input from a cross section of stakeholders, including cities, counties, sanitation districts, towns, watershed organizations, and others who will identify, fund, and prioritize projects to implement these practices and BMPs. As a part of this project, two surveys were sent to stakeholders:

- Survey #1, in 2022, was more general and included questions related to pollutants, issues, and areas of concern.
- Survey #2, in 2024, was more specific and included questions regarding past and current planning, use of technical and financial assistance, and ideal BMPs.

Survey #1 was distributed to 96 organizations in 2022. The purpose of this survey was to better understand the stakeholders' concerns, issues, resources, and priorities. Building on the conclusions from this survey was the impetus for helping to develop a nine key elements plan.

Survey #2 was distributed to 48 organizations in March 2024 asking them to complete the following items:

- Characterize their existing watershed projects and sources of pollution
- Rank cropland, urban, pastureland, feedlot, and forest BMPs
- Identify benefits and impacts of existing BMPs
- Identify existing outreach and education efforts
- Identify technical and financial assistance needed and utilized

Table 1-2 lists the stakeholders who received and participated in each survey. Results of the survey are found throughout the report and in more detail in Chapter 10.0, Information, Education, and Outreach. Survey responses are an integral part of this project. Survey questions are included in Appendix A.

To help promote the novel regional watershed plan, the project team participated in the annual American Water Resources Association – Colorado Groundwater Association Conference. The team discussed the project objectives, watershed characteristics, nine key elements, and outreach efforts.

Table 1-2. Stakeholder Recipients of Two Surveys With Responses Represented by an "X" (Page 1 of 3)

Organization	Took Survey #1 (2022)	Took Survey #2 (2024)
Big Thompson Watershed Coalition		
Boxelder Sanitation District	X	
Carestream		
CAWA		
CDPHE		
City & County of Broomfield	X	
City of Dacono		
City of Evans	X	X
City of Fort Collins		X
City of Fort Lupton	X	X
City of Greeley	X	X
City of Longmont	X	
City of Loveland	X	X
City of Northglenn		X
Coalition for the Poudre River Watershed		
Colorado Livestock Association		
Colorado Parks & Wildlife		
Colorado Rural Water Association	X	
Colorado Watershed Assembly		X
Colorado Wheat Administrative Committee		X
CSU	X	
Davies Mobile Home Park		X
Drala Mountain Center	X	
Ducks Unlimited		
Estes Park Sanitation District	X	
Estes Valley Watershed Coalition	X	X
Fox Acres Community Services	X	
FPAC-NRCS, CO		
Fresh Water Trust	X	
Galeton Water & Sanitation District	X	
JBS Greeley Beef Plant		X
Larimer County		X
Left Hand Water District	X	
Little Thompson Watershed Coalition		
Los Rios Farm		X
Metro Water Recovery	X	

Table 1-2. Stakeholder Recipients of Two Surveys With Responses Represented by an "X" (Page 2 of 3)

Organization	Took Survey #1 (2022)	Took Survey #2 (2024)
Northern Colorado Water Conservancy District	X	X
Peaks to People Water Fund		X
Poudre Heritage Alliance		
Resource Colorado Water & Sanitation Metro District		
RNC Consulting, LLC		X
South Fort Collins Sanitation District	X	X
South Platte Basin Roundtable		
St. Vrain Creek & Boulder Creek Watershed		
St. Vrain Sanitation District	X	
Thompson School District		X
Town of Ault	X	
Town of Berthoud	X	X
Town of Brighton		
Town of Eaton		
Town of Erie	X	
Town of Estes Park		X
Town of Firestone		
Town of Frederick		
Town of Hudson	X	
Town of Johnston	X	
Town of Keenesburg		
Town of LaSalle		
Town of Lochbuie	X	
Town of Mead	X	
Town of Milliken		
Town of Pierce	X	
Town of Platteville		X
Town of Severance	X	
Town of Timnath		
Town of Wellington		X
Town of Windsor	X	
Trout Unlimited		
Upper Thompson Sanitation District	X	
Water Quality Trading in the Cache la Poudre with Fort Collins		
Weld County	X	

Table 1-2. Stakeholder Recipients of Two Surveys With Responses Represented by an "X" (Page 3 of 3)

Organization	Took Survey #1 (2022)	Took Survey #2 (2024)
Weld County Department of Public Health and Environment	X	
Wright Water Engineers/Cherry Creek Basin Water Quality Authority		X
Xcel Energy		X

2.0 WATERSHED CHARACTERIZATION

The project area for this watershed-based plan is shown in Figure 2-1 and includes the area within Larimer and Weld Counties that intersect the Middle South Platte River Watersheds in north-central Colorado. The South Platte River flows east into Nebraska, eventually flowing into the Missouri River south of Omaha, Nebraska. The following 18 HUC10 watersheds are in the represented HUC8s:

- 1019000305 (Beebe Seep Canal)
- 1019000306 (Little Dry Creek-South Platte River)
- 1019000308 (Outlet Box Elder Creek)
- 1019000309 (Lost Creek)
- 1019000310 (Sanborn Draw-South Platte River)
- 1019000311 (Greasewood Draw-South Platte River)
- 1019000312 (Cottonwood Draw-South Platte River)
- 1019000801 (Upper Lone Tree Creek)
- 1019000802 (Spring Creek-Lone Tree Creek)
- 1019000803 (Owl Creek-Lone Tree Creek)
- 1019000902 (Little Crow Creek)
- 1019000903 (Middle Crow Creek)
- 1019000904 (Coal Creek)
- 1019000905 (Sand Creek-Crow Creek)
- 1019000906 (Outlet Coal Creek)
- 1019001203 (Wildcat Creek)
- 1019001205 (City of Raymer)
- 1019001206 (Camp Creek South Platte River)

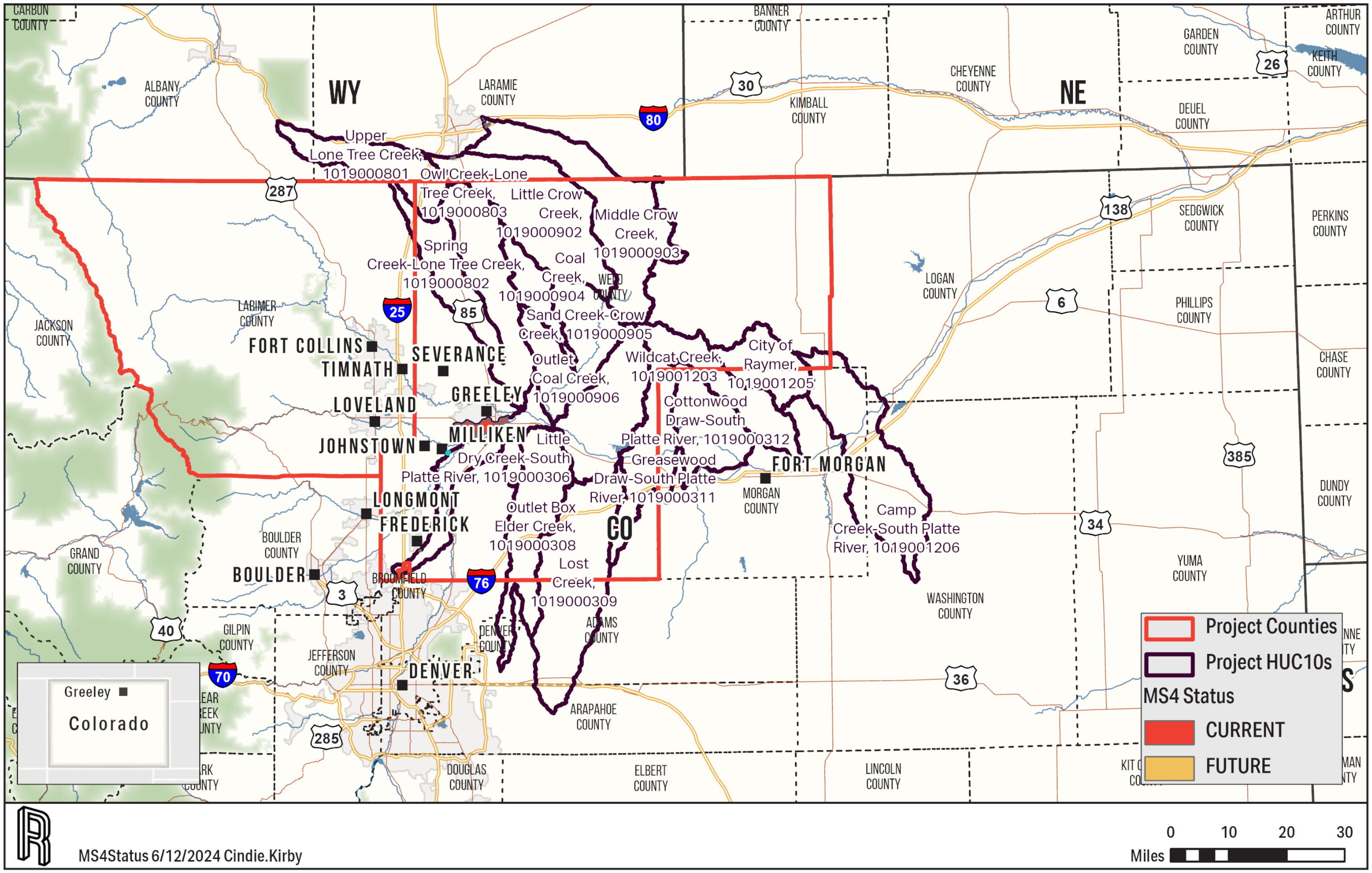


Figure 2-1. Project Area (Within Larimer and Weld Counties).

Portions of 1019000304 (Big Dry Creek-South Platte River), 1019000305 (Beebe Seep Canal), and 1019000306 (Little Dry Creek-South Platte River) were excluded. Numerous plans for the South Platte River do not occur in Larimer and Weld Counties. Although the figures in this document show information within the HUC10 watersheds overlapping Larimer and Weld Counties, the tables summarize only information from the HUC10 watersheds within Larimer and Weld Counties. The total area of the HUCs is 2,376,000 acres, but within Larimer and Weld Counties, it encompasses 1,525,791 acres according to GIS layer analysis. Figure 2-1 also shows areas that are designated as Municipal Separate Storm Sewer System (MS4s) and those that are likely to be MS4s. Areas already designated as MS4s are not included in the analysis in this document because they are considered permitted sources.

A summary of the project area's land cover characteristics was completed using the 2019 National Land Cover Dataset (NLCD). The NLCD is a 16-category, multilayer land cover classification dataset derived from Landsat imagery and ancillary data for consistent land cover data for all 50 states. The land cover is depicted in Figure 2-2 [Multi-Resolution Land Characteristics Consortium, 2019]. In the project area, approximately 68 percent of the area is herbaceous; 23 percent is cultivated crops; 3 percent is developed; and other land uses (open water, barren, forest, scrub/shrub, hay/pasture, and wetlands) each make up 2 percent or less. The project area consists of smaller towns and very little urban area. Smaller towns exist within the project area. Towns with a population of more than 1,000 include Evans, La Salle, Kersey, Keenesburg, Gilcrest, and Pierce [U.S. Census Bureau, 2020]. The project area is a combination of primarily crops and herbaceous land, with very little developed, forest, wetlands, or hay/pasture. More cropland is in the Middle South Platte-Cherry Creek HUC8 than the other two HUC8s. Most of the land is privately owned (99 percent) with less than 1 percent being federally or state owned. This was calculated using a combination of public parcels [Colorado Geospatial Portal, 2024] and from the Environmental Systems Research Institute, Inc.'s (ESRI's) data portal for USA Federal Lands [ESRI, 2014].

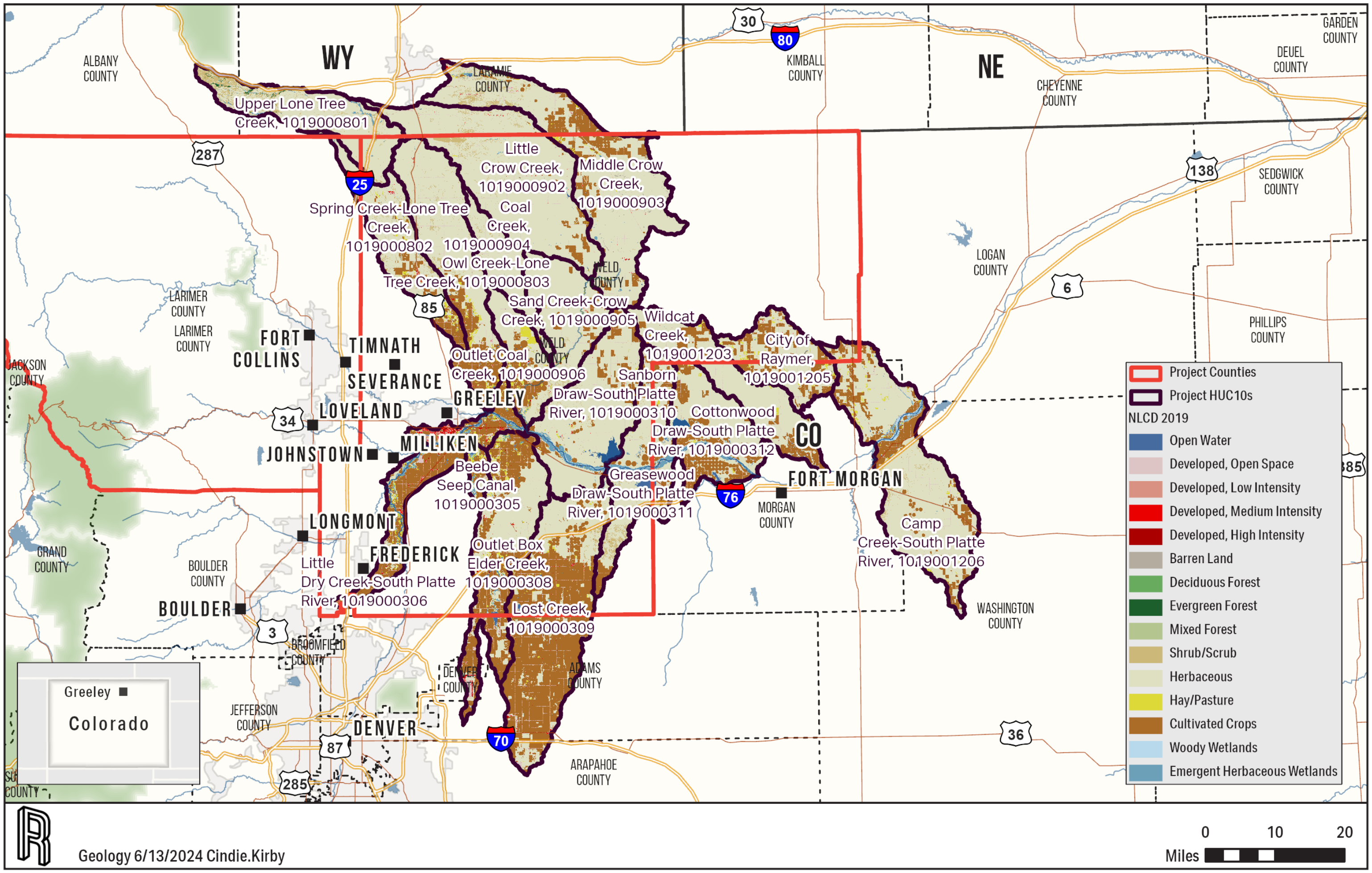


Figure 2-2. National Land Cover Dataset 2019 Land Use.

As indicated in Figure 2-3, precipitation is fairly consistent throughout the project area. Typical annual precipitation is approximately 15 inches [PRISM Climate Group, 2024]. Maximum monthly average precipitation generally occurs in the summer months, with large flows occurring from winter snowmelt in the spring. Upstream irrigation diversions, municipal water diversions, and wastewater effluent impact the flow. During a typical year, approximately 1,225,000 acre-feet are used for irrigation in the South Platte Basin [Colorado Water Plan, 2015]. In 2013, extensive flooding along the Front Range caused significant damage. The flood led to restoration work and continues to cause sediment movement.

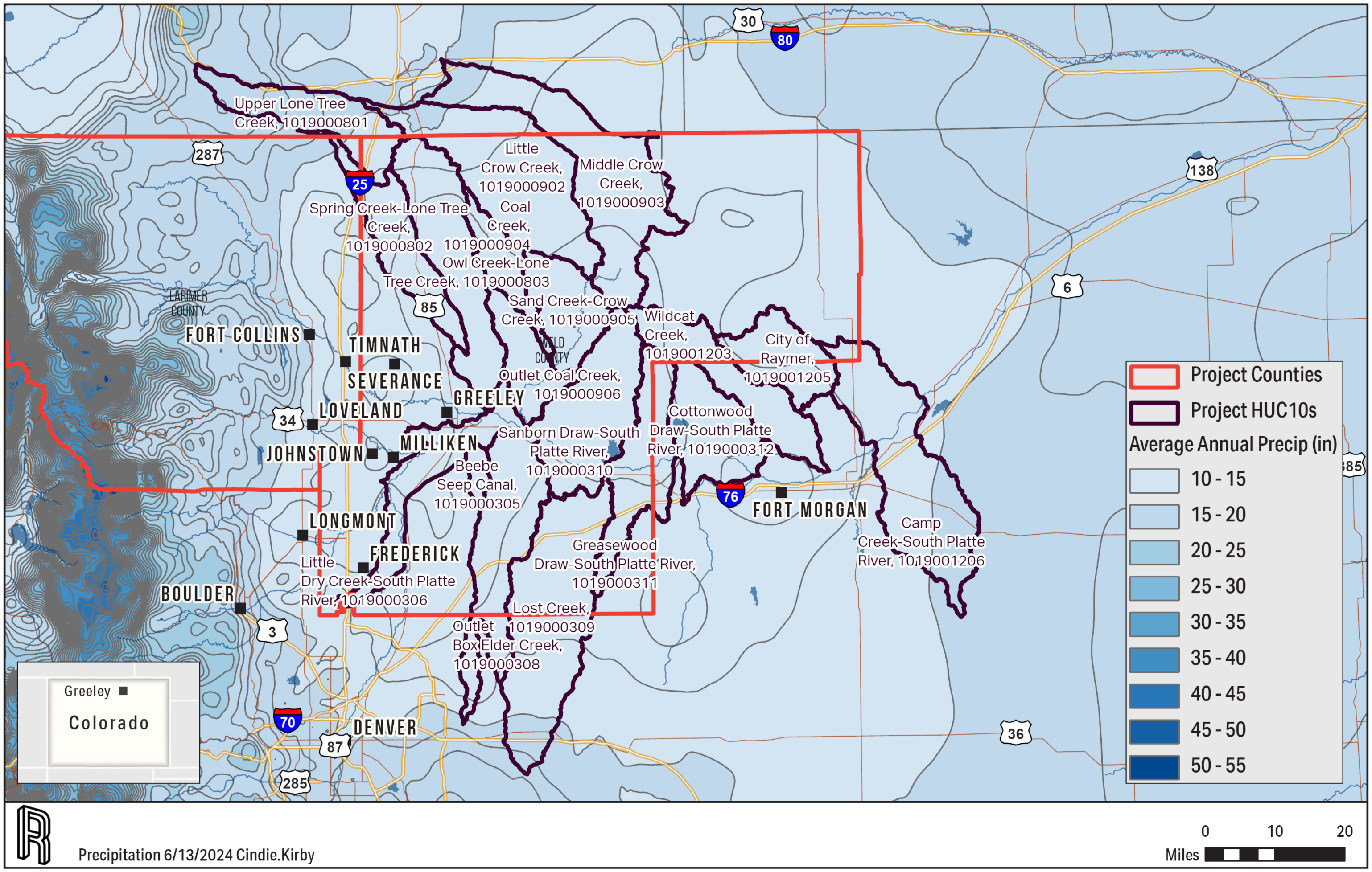


Figure 2-3. Average Annual Precipitation (1981 to 2010).

The bedrock geology of the project area is displayed in Figure 2-4 [Horton et al., 2017]. The geology of the project area consists of clastic sedimentary and undifferentiated unconsolidated material. Hydrologic soil groups can significantly impact the amount of water that infiltrates or runs off during precipitation events. Type A soils are generally sand or sandy loams with high infiltration rates; Type B soils are silt loam or loam soils with moderate rates; Type C soils are generally sandy, clay loams with low infiltration rates; and Type D soils are heavy soils; clay loams; and silty, clay soils with low infiltration rates. The project area comprises 33 percent Type A, 38 percent Type B, 18 percent Type C, and 11 percent Type D soil types. Figure 2-5 shows the distribution of hydrologic soil groups in the watershed using the Soil Survey Geographic Database (SSURGO) [NRCS, 2024a].

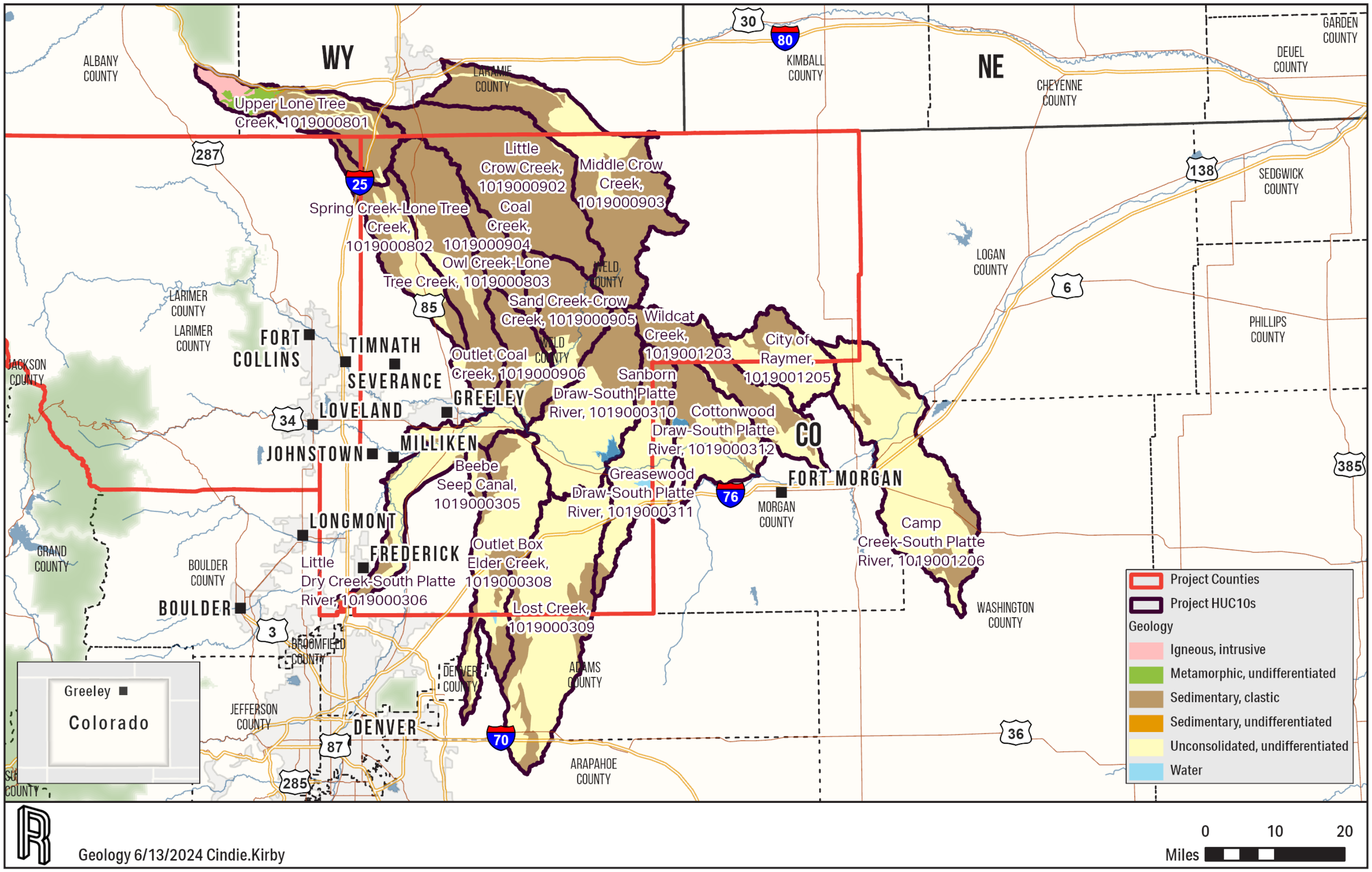


Figure 2-4. Geology.

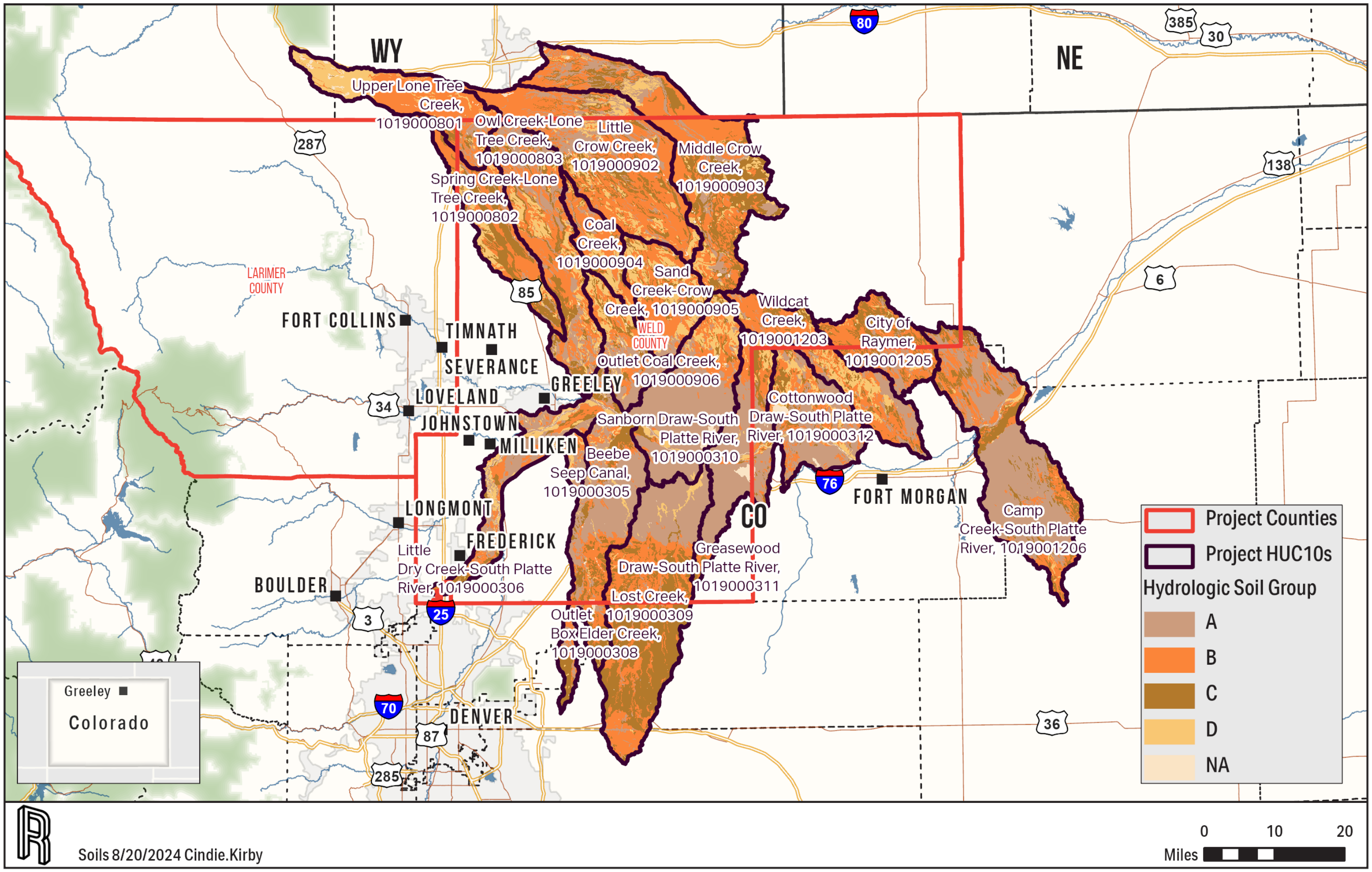


Figure 2-5. Hydrologic Soil Group.

The South Platte River originates in the mountains of central Colorado at the Continental Divide and flows approximately 450 miles northeast across the Great Plains to its confluence with the North Platte River at North Platte, Nebraska. The basin includes two physiographic provinces: the Front Range Section of the Southern Rocky Mountain Province and the Colorado Piedmont Section of the Great Plains Province [USGS Colorado Water Science Center, 2000].

Survey #2 inquired about what concerns stakeholders had with the watershed, including issues related to wastewater discharges and MS4 areas. Specifically relating to the Middle South Platte River project area, stakeholders mentioned concerns for both point sources and NPSs. The City of Greeley mentioned concerns with individual permitted industrial users discharging into Greeley's MS4 and that the City's Wastewater Treatment Facility (WWTF) permit is modeled alongside a discharge permit for a large dairy processing facility, Leprino Foods, and the City's permit may see impacts based on these nearby dischargers. They are concerned with *E. coli* and nutrients/algae growth in the city. The Colorado Wheat Administrative Committee mentioned concerns

with the urbanization along the South Platte River and where to source drinking water as the area continues to grow. The City of Evans mentioned having concerns with locations with large discharges to the South Platte River at Highway 85 and at 23rd Avenue.

3.0 EXISTING WATERSHED PLANS AND PROJECTS

Many conservation accomplishments have been achieved within the project area, which can be attributed to the local planning and implementation efforts of the community, state, and federal partners. Projects outlined on the South Platte Basin website are listed in Table 3-1 [South Platte Basin, 2024]; more information about work done in the South Platte Basin can be found on the site.

Table 3-1. Watershed Planning and Major Projects in the Middle South Platte River Project Area (Page 1 of 2)

Project Type	Name	Year Completed
Planning	BIP - South Platte & Metro Integrated Basin Implementation Plan - Consumptive Development of Decision Support Model for Identifying and Ranking Waterfowl and Wildlife Related Recharge Projects along the South Platte River	2013
River	Agricultural Land/Water Buffer Feasibility Analysis in the South Platte River Basin	2017
River	Designing River Basin Storage Along The Lower South Platte Using StateMod And Optimization	2018
River	South Platte River Recreation and Habitat Feasibility Study	2009
River	South Platte River Recreation & Habitat Improvements	2012
River	South Platte River Diurnal Flow Study	2015
River	Colorado Agricultural Water Alliance Workshop	2016
Community Outreach	South Platte Basin Education Coordinator	2019
Community Outreach	Poudre Learning Center Water Education and Outreach in the South Platte River Basin	2020
Community Outreach	Water Information / Real Estate Disclosure Tool – H2infO	2020
Community Outreach	Colorado Agricultural Meteorological Network (CoAgMet)	2012
Community Outreach	Stage Discharge Data Loggers and Telemetry	2014
Community Outreach	South Platte Basin Roundtable Data Platform	2018
Monitoring	Lost Creek Designated Basin Instrumentation	2019
Monitoring	Zero Liquid Discharge Pilot Study	2007
Monitoring	FMRICo Recharge & Wetlands Project	2012
Monitoring	South Platte Regional Water Development Concept Feasibility	2016
Monitoring	State Land Board South Platte Recharge Study	2016
Monitoring	Advancing Direct Potable Reuse to Optimize Water Supplies & Meet Future Needs	2018

Table 3-1. Watershed Planning and Major Projects in the Middle South Platte River Project Area (Page 2 of 2)

Project Type	Name	Year Completed
Other	Feasibility Study for Bureau of Reclamation Funding from the National Rural Water Supply Act	2013
Other	Water Development of the Bureau of Reclamation properties, known as the Narrows Tract, along the South Platte River	2017
Other	South Platte Storage Study	2017
Other	Central South Platte Wetland Partnership	2012
Other	BIP - South Platte & Metro Integrated Basin Implementation Plan - Consumptive	2013
Other	Development of Decision Support Model for Identifying and Ranking Waterfowl and Wildlife Related Recharge Projects along the South Platte River	2013

Middle South Platte River planning projects can be found on the following website:

- South Platte Basin Implementation Plan

Numerous conservation measures have been completed and are currently being implemented within the project area. These projects have been made possible through CDPHE with EPA's Section 319 NPS implementation grants and CDPHE grants. Previous conservation efforts have occurred in the project area, and each project helped improve water quality and make progress toward restoring and protecting local waterbodies. Tables 3-2 and 3-3 discuss these implementations within the project area [EPA, 2024a].

Table 3-2. Nonpoint Source Grants Implemented in the Project Middle South Platte River Project Area (Page 1 of 4)

Conservation Projects	Grant Number	Completion Year	Pollution Category	Section 319 Expenditures ($)	Total Expenditures ($)	Project Accomplishments
Implementing BMPs in Crow Creek Watershed	863001	2005	All Sources	252,432	422,554	Provided technical and financial assistance to implement land management changes resulting in water quality improvement.
Water Quality Improvement Through Volunteer Participation	863002	2003	All Sources; Urban Runoff/Stormwater	8,378	16,947	Implemented a plan to improve water quality on Crow Creek and Dry Creek by using a series of strategies.
City of Cheyenne Wetlands	863002	2009	Urban Runoff/Stormwater	119,913	204,748	Improved water quality in Crow Creek and its tributaries through passive water quality treatment through the construction of wetland stormwater retention features on two Crow Creek tributary streams industrial development.
Cherry Creek Total Maximum Annual Load Actions	99818604	2008	Construction; Urban Runoff/Stormwater	27,718	55,637	The Colorado Water Quality Control Commission adopted the control regulation as a phased total maximum annual load that provides for the implementation of point and NPS requirements and controls while concurrent required investigations were implemented to better define hydrology, phosphorus sources, chemical processes, and relative loads to the watershed and reservoir.
Addressing New Listings in the Crow Creek Watershed	863004	2008	Agriculture; Urban Runoff/Stormwater	113,532	215,197	Incorporated the upper reaches of the Crow Creek Watershed into the Crow Creek Watershed Plan. Implemented pollution reduction BMPs in the watershed. Continued with a water quality information and education program. Measured the effectiveness of the project tasks through the continuation and expansion of the surface water monitoring program.

Table 3-2. Nonpoint Source Grants Implemented in the Project Middle South Platte River Project Area (Page 2 of 4)

Conservation Projects	Grant Number	Completion Year	Pollution Category	Section 319 Expenditures ($)	Total Expenditures ($)	Project Accomplishments
Lower South Platte Watershed Plan	99818606	2010	All Sources	50,000	255,300	Developed a watershed management plan through stakeholder collaboration and data review to encourage watershed management including prioritizing future projects within the basin that will ultimately improve water quality.
Public Outreach in the Crow Creek Watershed	863008	2011	All Sources	32,003	56,152	Reduced NPS pollution (specifically pathogens) contributions to Crow Creek through an effective implementation and education program that resulted in the public's awareness to result in a change in behavior
Historic Sunrise Creamery Rain Gardens	863009	2012	Urban Runoff/Stormwater	3,993	15,928	Reduced NPS pollution such as fecal coliform, nitrates, and phosphates from entering into the Crow Creek Watershed by reducing localized urban runoff. Included creating a series of rain gardens to allow stormwater runoff to remain and infiltrate on site and not flow into Crow Creek through the Cheyenne storm drainage system.
Lower Dry Creek Wetlands	863010	2011	Urban Runoff/Stormwater	131,154	256,848	Improved the water quality in Crow Creek and Dry Creek tributary through passive water quality treatment by the construction of wetland in lower Dry Creek basin.
Greenway PURE Trash Reduction Campaign	99818611	2014	Urban Runoff/Stormwater	50,000	95,707	Defined a collaborative structure and system to support project planning and implementation. Characterized trash found in the South Platte River, Segment 14, Denver, and identified potential NPSs of the trash. Developed an information and education plan and implement targeted actions from the plan to begin promoting behavior change in order to reduce and prevent trash from NPSs in the South Platte River, Segment 14, Denver.

Table 3-2. Nonpoint Source Grants Implemented in the Project Middle South Platte River Project Area (Page 3 of 4)

Conservation Projects	Grant Number	Completion Year	Pollution Category	Section 319 Expenditures ($)	Total Expenditures ($)	Project Accomplishments
Middle Fork Crow Creek TMDL Development	863011	2016	Agriculture	77,000	77,000	Developed *E. coli* TMDL for Middle Fork Crow Creek.
Tools to Address Agricultural Nutrient Nonpoint Source Contamination	99818612	2017	Agriculture	80,138	263,261	Improved the access, reliability, and understanding of nutrient management (non-structural) and structural BMPs. Enabled users of the nutrient management clearinghouse to assess the suitability, economic feasibility, and practicality of BMPs using a site-specific, user-friendly GIS platform. Identified nutrient practices, tools, and procedures that do not currently have a sufficient research base to support their recommendation and adoption for conditions in Colorado.
Lower Capitol Basin Sediment Trap/Wetland	863013	2017	Urban Runoff/Stormwater	419,600	699,333	Designed and constructed a sediment trap/wetland BMP for the Lower Capitol Basin to address excess sediment and *E. coli* bacteria loading into Crow Creek that resulted from urban storm drainage runoff from the City's Lower Capitol Basin.
NPS Pollution Reduction Action Plan for the South Platte River	99818620	2022	Agriculture; Urban Runoff/Stormwater	56,997	94,915	Improved water quality in the South Platte River downstream of Denver by identifying NPS BMPs to reduce NPS pollution of *E. coli*.
Crow Creek Revival Phase I Implementation	863020	2022	Hydromodification; Urban Runoff/Stormwater	200,000	337,823	Improved water quality by addressing current *E. coli* and sediment impairments through channel manipulations—to better allow the transport of *E. coli* and sediment through the system. Known BMPs were employed to address *E. coli* impairment. Enhanced floodplain connectivity to allow for sediment to be trapped and deposited on the floodplain. Reduced the occurrence of other urban pollutants through the addition of floodplain and treatment wetland facilities. Set a positive example of urban restoration in Wyoming by restoring Crow Creek and educating the public on its historical and public health value.

Table 3-2. Nonpoint Source Grants Implemented in the Project Middle South Platte River Project Area (Page 4 of 4)

Conservation Projects	Grant Number	Completion Year	Pollution Category	Section 319 Expenditures ($)	Total Expenditures ($)	Project Accomplishments
Dry Creek Phase II - Channel Redesign	863020	2021	Hydromodification; Urban Runoff/Stormwater	15,750	21,000	Moved the channel of Dry Creek, obtained dynamic equilibrium, allowed for more natural sinuosity of the creek, and obtained decreased soil erosion.
Forestry BMPs Implementation, Statewide BMP Monitoring and Manual/Forest Roads Field Handbook Revision	99818620	2025	Silviculture	210,156	292,010	Improved water quality both throughout the state of Colorado and in the chosen BMP location (to be determined) by identifying and implementing BMPs to reduce and protect waterbodies from NPS pollution of nutrients (nitrogen and phosphorus) and sediment.

Table 3-3. Other Nonpoint Source Projects (South Platte and/or Statewide)

Project Title	Project Sponsor	Basin	NPS Funding ($)	Match on 09/30/2022 ($)	Status on 09/30/2022 (MM/YYYY)
Water Quality, Soil Health and Regenerative Agriculture: A Nexus for Sustainability	CSU	South Platte	306,518	68,010	Expected Completion 06/2024
Implementing Agricultural BMPs in a Colorado Soil Health Pilot Program	Colorado Department of Agriculture	Various	34,4894	286,427	Expected Completion 06/2025
Brush Wetland Demonstration Project	Ducks Unlimited	South Platte	80,000	18,167	Expected Completion 06/2025
Nutrient Management on Irrigated Pastures	CAWA	Various	266,355	95,912	Expected Completion 01/2026

4.0 STANDARDS AND IMPAIRMENTS

Impairment locations throughout the project area are shown in Figure 4-1. Impaired stream segments and lakes in the project area are shown in Table 4-1, with impairments including heavy metals like arsenic, cadmium, mercury, and uranium and other water quality parameters such as sulfate and *E. coli*. Mercury is measured in fish tissue, as a standard, and in water quality samples. Individual maps and box plots of each impaired parameter are included in Appendices B and C, respectively.

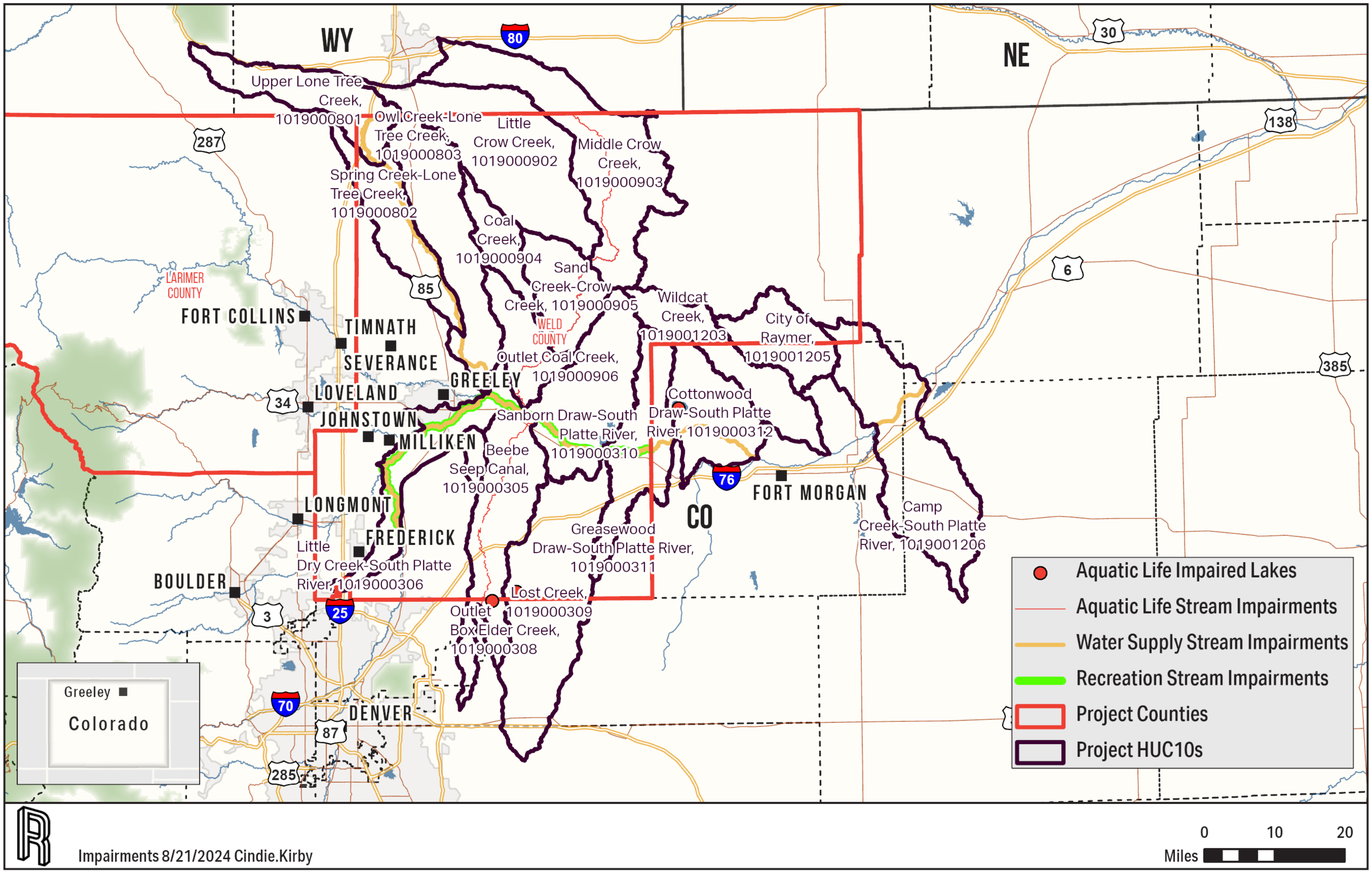


Figure 4-1. Impaired Waterbodies.

Table 4-1. Clean Water Act Section 303(d)-Impaired Waterbodies Summary

Impairment I.D./ HUC10s	Aquatic Life Tier/ Recreation Tier	Description	Aquatic Life Impairments	Recreation Impairment	Water Supply Impairment
COSPLS01a_A 1019000311, 101900312, and 1019001206	W2/E	Mainstem of the South Platte River from the Weld/Morgan County line to the Morgan/Washington County line	N/A	N/A	Uranium (T), Sulfate, Arsenic (T)
COSPLS01b_A	W2/E	Mainstem of the South Platte River from the Morgan/Washington County line to the Colorado/Nebraska Border	N/A	N/A	Uranium (T), Sulfate, Arsenic (T)
COSPMS01a_A 1019000306	W2/E	Mainstem of the South Platte River from a point immediately below the confluence with Big Dry Creek to the confluence with St. Vrain Creek	N/A	*E. coli*	Arsenic (T)
COSPMS01b_A 1019000306, 1019000310, and 1019000311	W2/E	Mainstem of the South Platte River from a point immediately below the confluence with St. Vrain Creek to the Weld/Morgan County Line	N/A	*E. coli*	Arsenic (T)
COSPMS05a_A 1019000802 and 1019000803	W2/N	Mainstem of Lone Tree Creek from the source to the confluence with the South Platte River	N/A	N/A	Nitrate
COSPMS05c_A 101900308, 101900903, 101900905, and101900906	W2/N	Mainstem of Crow Creek and Box Elder Creek from their sources to their confluences with the South Platte River, except for listings in Segment 5b	Cadmium (D)	N/A	N/A
COSPLS03_D 1019000312	W1/E	Jackson Reservoir	pH	N/A	N/A
COSPMS07_C 1019000308	W2/E	Horse Creek Reservoir	pH	N/A	N/A

D = dissolved

T = total

In Survey #1, local stakeholders noted their primary parameters of concern. Each parameter occurrence was counted, and the four parameters that appeared the most were nitrogen, phosphorus, total suspended solids (TSS), and *E. coli*. Others that showed up less than the most predominant parameters included temperature, emerging contaminants, metals, and per- and polyfluoroalkyl substances (PFAS). Emerging contaminants are the different types of chemicals (e.g., medication, personal care products, home cleaning products, lawn care products, and agricultural products, such as insecticides and herbicides) that end up in waterbodies but are not generally treated in wastewater facilities. PFAS and emerging contaminants of concern are not included in this report. Some emerging contaminants are treated by drinking water and/or wastewater facilities, but these chemicals are not well regulated or understood. A new EPA limit for PFAS of 4 parts per trillion was released in 2024 [EPA, 2024b].

Water quality standards for parameters of concern are based on beneficial-use tiers. For more information on these standards and tiers, visit the CDPHE's Water Quality Control Commission's 5 Codes of Colorado Regulation (CCR) 1002-31 website, last updated June 14, 2023. Access the CDPHE's Water Quality Control Commission Regulation No. 38 website, last updated April 30, 2024, for information on classifications and numeric standards for South Platte River Basin, Laramie River Basin, Republican River Basin, and Smoky Hill River Basin (5 CCR 1002-38).

The beneficial-use tiers for aquatic life, recreation, and domestic water supply are listed as follows:

- Aquatic Life
  - C1 – Class 1 Cold Water
  - C2 – Class 2 Cold Water
  - W1 – Class 1 Warm Water
  - W2 – Class 2 Warm Water
- Recreation
  - E – Existing Primary Contact Use (since November 28, 1975)
  - P – Potential Primary Contact Use
  - N – Not Primary Contact Use
  - U – Undetermined Use
- Domestic Water Supply
  - Direct Use Water Supply Lakes and Reservoirs

Current loads were determined for *E. coli*, dissolved selenium, total nitrogen, and total phosphorus using flow and water quality monitoring data collected along the mainstem of the most downstream HUC10 of the Middle South Platte project area (1019001206). The U.S. Geological Survey (USGS) site used for flow was USGS-06759910, and it had data available from 1992 through 1998. The average annual flow was calculated using flow from 1992 through 1998 (the last year with data available) to be approximately 847.1 cubic feet per second (cfs). There were numerous water quality sites along the mainstem in the HUC10, and all available *E. coli*, selenium, total nitrogen, total phosphorus data were used. The geometric mean from all *E. coli* data collected from 1990 through 2024 was used to represent the *E. coli* concentration; the 85th percentile from all dissolved selenium from 1990 through

2024 was used to represent the current selenium concentration; and for both phosphorus and nitrogen, the annual median was averaged for all data from 1990 through 2024 to represent the current concentrations. Current loads were then calculated as the product of flow, concentration, and a conversion factor for each. Needed loads based on water quality standards were also calculated using the product of the same average annual flow, each water quality standard, and a conversion factor. The *E. coli* water quality standard was 126 most probable number (mpn) per 100 milliliters (mL), the selenium standard was 4.6 micrograms per liter (µg/L), the nitrogen standard was 2.01 milligrams per liter (mg/L), and the phosphorus standard was 0.17 mg/L. Current and needed flows, concentrations, and loads are shown in Table 4-2, as well as the load reduction needed at in the HUC10. At this location, reductions are needed to reach goal loads for dissolved selenium, total nitrogen, and total phosphorus. As flow and concentration data are collected at this location, they can be incorporated into the load estimations.

Table 4-2. Flows, Current Loads, Goal Loads, and Reductions to Reach Goals in Most Downstream HUC10 of the Project Area

Flow	Average Annual Flow (cfs)	847.1
Current Concentrations	*E. coli* Geomean (org/100 mL)	32.5
	Dissolved Selenium (85th Percentile)	6.0
	Average of Median Annual Nitrogen (mg/L)	5.2
	Average of Median Annual Phosphorus (mg/L)	0.4
Current Loads	*E. coli* (billion org/day)	674.4
	Selenium (lb/day)	27.4
	Nitrogen (lb/day)	23,835.8
	Phosphorus (lb/day)	1,999.2
Goal Loads	*E. coli* (billion org/day)	2,611.4
	Selenium (lb/day)	21.0
	Nitrogen (lb/day)	9,184.0
	Phosphorus (lb/day)	776.8
Reductions to Achieve Goal Loads	*E. coli*	0%
	Selenium	23%
	Nitrogen	61%
	Phosphorus	61%

cfs = cubic feet per second
lb/day = pounds per day
mg/L = milligrams per liter
mL = milliliters

5.0 SOURCE ASSESSMENT

Only NPS pollutants are addressed in this report. Point sources and areas with MS4s are addressed in the *208 Areawide Water Quality Management Plan, 2022 Update* [NFRWQPA, 2022]. Outside of MS4-permitted areas, NPSs of nutrients are generally related to runoff from cropland, pastureland, developed land, and other similar lands. NPSs of sediment consist of sediment contributions through wash off, as well as bed and bank erosion during high flows. NPSs of *E. coli* are typically from livestock, pets, wildlife, and human sources that can occur in agricultural and developed areas. NPSs of heavy metals vary by metal, but are often from abandoned mine lands (AMLs) or runoff from irrigated agricultural lands. Sometimes sources are from natural causes. Natural causes are the physical, chemical, or biological conditions that would exist in a waterbody in the absence of measurable impacts from human activity or influence. More information about the sources of each pollutant are described in this section.

5.1 NUTRIENTS AND SEDIMENT

The EPA's Pollutant Load Estimation Tool (PLET) was used to estimate nutrient and sediment loads from different land uses by HUC10 and later to evaluate load reductions that would result from the implementation of various BMPs [EPA, 2022].

For the Middle South Platte River project area in PLET, the following 18 HUC10 watersheds were represented:

- 1019000305 (Beebe Seep Canal)
- 1019000306 (Little Dry Creek-South Platte River)
- 1019000308 (Outlet Box Elder Creek)
- 1019000309 (Lost Creek)
- 1019000310 (Sanborn Draw-South Platte River)
- 1019000311 (Greasewood Draw-South Platte River)
- 1019000312 (Cottonwood Draw-South Platte River)
- 1019000801 (Upper Lone Tree Creek)
- 1019000802 (Spring Creek-Lone Tree Creek)
- 1019000803 (Owl Creek-Lone Tree Creek)
- 1019000902, (Little Crow Creek)
- 1019000903 (Middle Crow Creek)
- 1019000904 (Coal Creek)
- 1019000905 (Sand Creek-Crow Creek)
- 1019000906 (Outlet Coal Creek)
- 1019001203 (Wildcat Creek)
- 1019001205 (City of Raymer)

- 1019001206 (Camp Creek South Platte River)

Portions of 1019000304 (Big Dry Creek-South Platte River), 1019000305 (Beebe Seep Canal), and 1019000306 (Little Dry Creek-South Platte River) were excluded. The following inputs to the PLET model were included for each HUC10:

- Watershed land-use areas (acres) [Multi-Resolution Land Characteristics Consortium, 2019]
  - Urban (non-MS4)
  - Cropland
  - Pastureland
  - Forest
  - Feedlots
  - Other (all other land uses)
- Prominent hydrologic soil group (A-D) [NRCS, 2024a]
- Average annual rainfall (inches) [EPA, 2022]
- Rain days/year [EPA, 2022]
- Number of agricultural animals [EPA, 2022]
  - Beef cattle
  - Dairy cattle
  - Swine
  - Sheep
  - Horse
  - Chicken
  - Turkey
  - Duck
- Number of septic systems [Larimer County, 2024; Fischer, 2023]
- Population per septic system [Thomas, 2024]
- Septic rate failure [EPA, 2022]
- Urban land-use distribution [Multi-Resolution Land Characteristics Consortium, 2019]
- Irrigated cropland [Colorado's Decision Support Systems, 2024]
- Water depth per irrigation (inches) [EPA, 2022]
- Irrigation days/year [EPA, 2022]

Sediment erosion can be estimated in PLET; however, gullies and streambank erosion were not included because of a lack of data. Wildlife density (animals per square mile) was also not included because of a lack of data and because wildlife is considered a natural source.

Source assessment modeling results for the 18 HUC10 watersheds are summarized using the following categories: urban areas (excluding permitted MS4 areas), cropland, pastureland, forest (including scrub/shrub), feedlots, and a combination of all other land uses. The other land uses consist of barren, herbaceous, and wetlands, which typically are not the highest contributors per acre; therefore, BMP planning does not generally focus on these land uses even though they can make up a fairly large portion of the area. Because this is a NPS plan, permitted MS4s, which have limits to meet, are exempt from inclusion in this plan. MS4 areas were developed using a combination of the MS4 layer from ERAMS [Catena Analytics, 2024] (developed with the 2010 Census urban areas), the 2020 urban areas [U.S. Census Bureau, 2020], and a layer sent from the Town of Timnath [Smith, 2024]. The excluded area used to represent Greeley was approximately 15.3 mi^2, located in the Little Dry Creek-South Platte River HUC10 (1019000306). Table 5-1 shows the percentage of each land-use source per HUC10 (in Larimer and Weld Counties only). The only source not associated with an area is septic systems. The quantified sources of nitrogen, phosphorus, and sediment are listed in Tables 5-2, 5-3, and 5-4 in order of the HUC10 watersheds. The watersheds throughout the project area are dominated by cropland and herbaceous land.

Cropland is the dominant land use in Beebe Seep Canal, Little Dry Creek-South Platte River, and Lost Creek HUC8 watersheds. In the remaining HUC8 watersheds, the other land uses are dominant. However, because land uses included in the other category are not likely to benefit as much as those in the cropland category, and because the second-most dominant land use in each is cropland, cropland is considered the dominant source of loads of parameters modeled in PLET. Urban areas are very small in the watershed and, therefore, loads do not show up.

Table 5-1. Land Cover

HUC10	Description	Area (mi^2)	Urban Non-MS4 (%)	Cropland (%)	Pastureland (%)	Forest (%)	Feedlots (%)	Other Land Uses (%)
1019000305	Beebe Seep Canal	21	5	48	10	2	<1	35
1019000306	Little Dry Creek-South Platte River	141	8	68	6	<1	<1	17
1019000308	Outlet Box Elder Creek	189	4	39	4	<1	<1	53
1019000309	Lost Creek	193	3	52	1	1	<1	43
1019000310	Sanborn Draw-South Platte River	244	2	11	<1	<1	<1	86
1019000311	Greasewood Draw-South Platte River	122	1	19	<1	6	<1	74
1019000312	Cottonwood Draw-South Platte River	3	3	47	0	<1	<1	50
1019000801	Upper Lone Tree Creek	37	1	0	0	3	<1	96
1019000802	Spring Creek-Lone Tree Creek	153	4	21	3	4	<1	69
1019000803	Owl Creek-Lone Tree Creek	253	3	23	2	2	<1	71
1019000902	Little Crow Creek	271	1	4	<1	2	<1	92
1019000903	Middle Crow Creek	247	3	15	1	<1	<1	81
1019000904	Coal Creek	84	2	0	<1	2	<1	96
1019000905	Sand Creek-Crow Creek	134	2	8	<1	<1	<1	90
1019000906	Outlet Coal Creek	106	3	28	7	2	<1	60
1019001203	Wildcat Creek	66	2	21	<1	<1	<1	76
1019001205	City of Raymer	73	3	35	3	<1	<1	60
1019001206	Camp Creek South Platte River	12	3	45	1	<1	<1	50

Table 5-2. Nitrogen Sources

HUC10	Description	Area (mi^2)	Urban Non-MS4 (%)	Cropland (%)	Pastureland (%)	Forest (%)	Feedlots (%)	Other Land Uses (%)	Septic (%)
1019000305	Beebe Seep Canal	21	0	95	4	<1	0	1	<1
1019000306	Little Dry Creek-South Platte River	141	0	97	2	0	0	<1	1
1019000308	Outlet Box Elder Creek	189	0	96	2	0	0	2	<1
1019000309	Lost Creek	193	0	98	<1	0	0	1	<1
1019000310	Sanborn Draw-South Platte River	244	0	89	<1	<1	0	10	<1
1019000311	Greasewood Draw-South Platte River	122	0	94	<1	<1	0	5	<1
1019000312	Cottonwood Draw-South Platte River	3	0	98	0	0	0	1	0
1019000801	Upper Lone Tree Creek	37	0	0	0	3	0	96	<1
1019000802	Spring Creek-Lone Tree Creek	153	0	91	2	<1	0	4	2
1019000803	Owl Creek-Lone Tree Creek	253	0	93	2	<1	0	4	1
1019000902	Little Crow Creek	271	0	74	<1	<1	0	25	<1
1019000903	Middle Crow Creek	247	0	92	1	0	0	7	<1
1019000904	Coal Creek	84	0	0	6	2	0	89	3
1019000905	Sand Creek-Crow Creek	134	0	83	2	0	0	14	1
1019000906	Outlet Coal Creek	106	0	92	4	<1	0	3	<1
1019001203	Wildcat Creek	66	0	95	<1	0	0	5	0
1019001205	City of Raymer	73	0	96	1	0	0	2	<1
1019001206	Camp Creek South Platte River	12	0	98	<1	0	0	2	0

Table 5-3. Phosphorus Sources

HUC10	Description	Area (mi^2)	Urban Non-MS4 (%)	Cropland (%)	Pastureland (%)	Forest (%)	Feedlots (%)	Other Land Uses (%)	Septic (%)
1019000305	Beebe Seep Canal	21	0	95	4	<1	0	1	<1
1019000306	Little Dry Creek-South Platte River	141	0	97	2	0	0	<1	1
1019000308	Outlet Box Elder Creek	189	0	96	2	0	0	2	<1
1019000309	Lost Creek	193	0	98	<1	0	0	1	<1
1019000310	Sanborn Draw-South Platte River	244	0	89	<1	<1	0	10	<1
1019000311	Greasewood Draw-South Platte River	122	0	94	<1	<1	0	5	<1
1019000312	Cottonwood Draw-South Platte River	3	0	98	0	0	0	1	0
1019000801	Upper Lone Tree Creek	37	0	0	0	3	0	96	<1
1019000802	Spring Creek-Lone Tree Creek	153	0	91	2	<1	0	4	2
1019000803	Owl Creek-Lone Tree Creek	253	0	93	2	<1	0	4	1
1019000902	Little Crow Creek	271	0	74	<1	<1	0	25	<1
1019000903	Middle Crow Creek	247	0	92	1	0	0	7	<1
1019000904	Coal Creek	84	0	0	6	2	0	89	3
1019000905	Sand Creek-Crow Creek	134	0	83	2	0	0	14	1
1019000906	Outlet Coal Creek	106	0	92	4	<1	0	3	<1
1019001203	Wildcat Creek	66	0	95	<1	0	0	5	0
1019001205	City of Raymer	73	0	96	1	0	0	2	<1
1019001206	Camp Creek South Platte River	12	0	98	<1	0	0	2	0

Table 5-4. Sediment Sources

HUC10	Description	Area (mi^2)	Urban Non-MS4 (%)	Cropland (%)	Pastureland (%)	Forest (%)	Feedlots (%)	Other Land Uses (%)	Septic (%)
1019000305	Beebe Seep Canal	21	0	95	4	<1	0	1	0
1019000306	Little Dry Creek-South Platte River	141	0	98	2	0	0	<1	0
1019000308	Outlet Box Elder Creek	189	0	96	2	0	0	2	0
1019000309	Lost Creek	193	0	98	<1	0	0	1	0
1019000310	Sanborn Draw-South Platte River	244	0	90	<1	<1	0	10	0
1019000311	Greasewood Draw-South Platte River	122	0	94	<1	<1	0	5	0
1019000312	Cottonwood Draw-South Platte River	3	0	99	0	0	0	1	0
1019000801	Upper Lone Tree Creek	37	0	0	0	3	0	97	0
1019000802	Spring Creek-Lone Tree Creek	153	0	93	2	<1	0	4	0
1019000803	Owl Creek-Lone Tree Creek	253	0	94	2	<1	0	4	0
1019000902	Little Crow Creek	271	0	74	<1	<1	0	25	0
1019000903	Middle Crow Creek	247	0	92	1	0	0	7	0
1019000904	Coal Creek	84	0	0	7	2	0	92	0
1019000905	Sand Creek-Crow Creek	134	0	84	2	0	0	14	0
1019000906	Outlet Coal Creek	106	0	93	4	<1	0	3	0
1019001203	Wildcat Creek	66	0	95	<1	0	0	5	0
1019001205	City of Raymer	73	0	96	1	0	0	2	0
1019001206	Camp Creek South Platte River	12	0	98	<1	0	0	2	0

A less obvious contributor of nutrients and sediment to waterbodies is wildland fires. Wildland fires significantly reduce well-established root systems in areas impacted and, as a result, soil erosion is much more likely during precipitation events, carrying nutrients with it. The Middle South Platte River watershed has experienced post-wildfire flooding, debris flows, and associated economic impacts from past upstream wildfires and wildfires within the project boundaries. Table 5-5 provides the total number of fire acres for each year past 2000 where any existed per HUC10 [National Interagency Fire Center, 2024].

Table 5-5. Total Fire Acres per HUC10 per Year (2000-2021)

HUC10	1019000803	1019000902	1019000904	1019000905	1019000906
2001		229,060			
2009		229,060		171,202	
2010			161,711	599,207	68,585
2011			323,422	1,027,213	
2012			592,940	513,606	
2013			107,807		
2015			53,904	171,202	137,170
2016		229,060	215,614	1,369,617	
2017	162,349		53,904	941,612	
2018		229,060	107,807		
2019				1,027,213	
2020				342,404	
2021		229,060	269,518	85,601	

One reach in the project area, COSPMS05a_A, is impaired for nitrates, a form of nitrogen; the reach is located in both HUC10 1019000802 and HUC10 1019000803. Nitrates are a sensitive parameter for water supply because they cause cyanosis (i.e., blue baby syndrome), which causes skin to appear blue because of poorly oxygenated blood and can cause abnormalities in the heart, lungs, and blood [WebMD, 2024]. Nitrates can enter surface waters from animal manure, nitrogen fertilizers, wastewater, and decomposed plant residues and organic matter [University of Missouri Extension, 2024]. No other nutrient- or sediment-impaired waterbodies occur in the Middle South Platte River project area, but nutrients and sediment were identified as priority parameters of concern.

Atmospheric deposition is also a source of nutrients. EPA's Clean Air Status and Trends Network (CASTNET) and the National Atmospheric Deposition Program (NADP) monitor nitrogen deposition (ammonia and nitrate) at locations throughout the United States. The SPARROW model published by the USGS estimated that, in the Middle South Platte River project area, more than 190,000 pounds of nitrogen were delivered to the stream from atmospheric deposition [USGS, 2019]. Some practices can help reduce nutrients in atmospheric deposition; however, these practices are not a focus in this plan because their impacts are less local than other BMPs.

5.2 E. COLI

Bacteria comes from the intestines of humans and warm-blooded animals. NPSs of bacteria consist primarily of waste that is transported through wash off from cropland, pastureland, and developed land, as well as septic systems and direct defecation from livestock and wildlife. For the purposes of this project, bacteria from wildlife are assumed to be a natural background source and are not included in the assessment.

E. coli from human and animal waste are dispersed throughout the landscape, spread by humans, and/or treated in facilities. Once *E. coli* are in the environment, their accumulation on land and delivery to the stream are affected by die-off and decay, surface imperviousness, detention time, ultraviolet exposure, and other mechanisms. Quantifying *E. coli* sources using PLET is not recommended [Tetra Tech, Inc., 2022], so an assessment of bacteria production within the watershed was completed per HUC10. This assessment included humans (Wastewater Treatment Plants [WWTPs] and Onsite Wastewater Treatment Systems [OWTSs]), pets (dogs and cats), and livestock (cattle, horses, poultry, sheep, and hogs); however, wildlife was not included because wildlife was assumed to be a natural source of bacteria. Publicly owned WWTPs are highly regulated and are not a significant source of *E. coli*. In some cases, WWTPs even provide dilution from other sources. OWTS contributions are largely dependent on soil and geology in an area, as well as their proximity to a waterbody. Additionally, point sources are not a focus of this study; therefore, WWTP estimates were added primarily as a comparison to the production of bacteria sent to an OWTS.

Livestock contribute *E. coli* loads directly by defecating in streams and indirectly by defecating on cropland or pastures where *E. coli* can wash off during precipitation events, snowmelt, or irrigation. Spreading livestock manure on cropland or pasture also contributes *E. coli* to waterbodies. The livestock in the project area mainly consists of cattle, poultry, hogs, horses, sheep, and goats, which are grazed and/or confined, and manure is spread on crops and pastures.

Pet waste is another potential source of *E. coli*. Pet waste is often left in yards, in parks, and along trails, and can be carried with stormwater to local storm drains and waterbodies.

Natural background sources are inputs that would be expected under natural, undisturbed conditions and include *E. coli* loading from wildlife in the area. Wildlife (e.g., waterfowl and large-game species) also contribute *E. coli* loads directly by defecating while wading or swimming in a stream and indirectly by defecating on lands that produce watershed runoff during precipitation events.

A GIS-based assessment was completed within each impaired drainage area to estimate livestock, wildlife, human, and pet populations. Animal populations were multiplied by average excretion rates from scientific literature to estimate the amount of *E. coli* produced by each source type in each HUC10 watershed. The reported literature values for fecal coliform excretion were converted to *E. coli* excretion by using a fecal coliform to *E. coli* ratio of 200:126 mpn per 100 mL. The loads produced by humans are usually treated by WWTPs and OWTSs.

Annual excretion estimates for livestock (excluding hogs) and wildlife were obtained from "BSLC: A Tool for Bacteria Source Characterization for Watershed Management" [Zeckoski et al., 2005], and bacteria estimates for humans and hogs were obtained from *Wastewater Engineering: Treatment, Disposal, and Reuse* [Metcalf and Eddy, 1991]. Annual excretion rates for dogs and cats were sourced from

Identification and Evaluation of Nutrient and Bacterial Loadings to Maquoit Bay, New Brunswick and Freeport, Maine [Horsley and Witten, Inc., 1996]. Literature values for bacteria excretion rates are estimates and do not represent all sources and dynamics of bacteria in a natural system. Table 5-6 provides the literature rates of *E. coli* (converted from fecal coliform) produced by each animal per day, as well as the respective sources.

Table 5-6. *E. coli* Production Rates From Literature Sources

Category	Subcategory	*E. coli* Production Rate (cfu/head/day)	Source
Humans	WWTP	1,260,000,000	Metcalf and Eddy, 1991
	OWTS	1,260,000,000	Metcalf and Eddy, 1991
Pets	Cats	3,150,000,000	Horsley and Witten, Inc., 1996
	Dogs	3,150,000,000	Horsley and Witten, Inc., 1996
Livestock	Cattle	20,790,000,000	Zeckoski et al., 2005
	Horses	26,460,000,000	Zeckoski et al., 2005
	Poultry	58,590,000	Zeckoski et al., 2005
	Sheep	7,560,000,000	Zeckoski et al., 2005
	Goats	17,640,000,000	Zeckoski et al., 2005
	Hogs	5,607,000,000	Metcalf and Eddy, 1991
Wildlife	Deer	220,500,000	Zeckoski et al., 2005
	Ducks	1,512,000,000	Zeckoski et al., 2005
	Geese	504,000,000	Zeckoski et al., 2005

cfu/head/day = colony-forming units per head per day

Livestock numbers were obtained from the PLET database by HUC12 and aggregated up to the HUC10 level. Livestock counts available in PLET included cattle, horses, poultry, sheep, and hogs. PLET animal data are from the U.S. Department of Agriculture (USDA) National Agricultural Statistics Service, for which county animal data are summarized at the HUC12 level based on the pastureland area weighted ratio [EPA, 2022].

Hogs and poultry are typically kept in a total confinement facility, with their manure collected in a liquid manure storage area and later spread and/or incorporated on or into agricultural land. Grazed animals can also be kept in sheltered areas but are more likely to be pastured or have access to waterbodies than hogs and poultry. Manure that has been incorporated or spread into or on agricultural fields can contribute *E. coli* to waterways, but incorporation decreases the likelihood of transport. Livestock numbers include both animal feeding operations (AFOs) and concentrated animal feeding operations (CAFOs); both are relevant because manure is applied to croplands and pasturelands and reaches surface waters even when the manure comes from a zero-runoff feedlot.

Individuals on domestic wastewater sewers within each HUC10 were estimated by summing the population for all of the 2020 U.S. Census Block Centroid Population points that fall within census urban areas, which were assumed to be connected to the WWTPs in applicable drainage areas [U.S. Census

Bureau, 2020]. Bacteria within wastewater in urban areas with a WWTP were assumed to be treated according to the WWTP's permit requirement.

People using an OWTS were estimated by Larimer and Weld Counties' OWTS [Larimer County, 2024; Fischer, 2023] within each HUC10 and multiplying the total by 3.31, which is the number of individuals assumed to be on each OWTS in the applicable counties [Thomas, 2024]. This evaluation represents all OWTSs, including compliant systems.

Pet populations were estimated by calculating the number of households from the 2020 U.S. Census Block Centroid Population points within each applicable impairment drainage area and assuming 0.58 dogs (36.5 percent of households times 1.6 dogs per household) and 0.64 cats (30.4 percent of households times 2.1 cats per household) per household [American Veterinary Medical Association, 2016].

Table 5-7 summarizes the number of animals, estimated *E. coli* produced, and percent of the total *E. coli* from each animal type within each HUC10. These estimates provide watershed managers with the relative magnitudes of total production by source and do not account for treatment by WWTPs or OWTSs, wash off, delivery, instream growth, or die-off dynamics that occur with *E. coli* and substantially affect their delivery to surface waters. Because of water treatment, far less *E. coli* are generally discharged from WWTPs than what is produced and sent to them.

Several factors affect whether *E. coli* reach a stream. The analysis illustrates that across the entire project area, the amount of *E. coli* produced by livestock is substantially greater than the *E. coli* produced by humans or pets. Both Larimer and Weld Counties are Right-to-Farm counties, which protects certain types of operations from nuisance suits when their activities impact neighboring property through activities like noise or odor.

Table 5-7. Estimated Number of Animals, *E. coli* Produced, and Percent of *E. coli* Produced in Each HUC10 (Page 1 of 8)

HUC10	Description	Category	Subcategory	Count	Total *E. coli* Produced (cfu/day)	Total *E. coli* Produced (%)
1019000305	Beebe Seep Canal	Humans	OWTS	748	9.4E+11	0
1019000305	Beebe Seep Canal	Humans	WWTP	—	0.0E+00	0
1019000305	Beebe Seep Canal	Pets	Dogs	131	4.1E+11	0
1019000305	Beebe Seep Canal	Pets	Cats	145	4.6E+11	0
1019000305	Beebe Seep Canal	Livestock	Cattle	13,316	2.8E+14	83
1019000305	Beebe Seep Canal	Livestock	Horses	318	8.4E+12	3
1019000305	Beebe Seep Canal	Livestock	Poultry	86,271	5.1E+12	2
1019000305	Beebe Seep Canal	Livestock	Sheep	5,399	4.1E+13	12
1019000305	Beebe Seep Canal	Livestock	Goats	3	5.3E+10	0
1019000305	Beebe Seep Canal	Livestock	Hogs	143	8.0E+11	0
1019000306	Little Dry Creek-South Platte River	Humans	OWTS	11,085	1.4E+13	2
1019000306	Little Dry Creek-South Platte River	Humans	WWTP	52,483	6.6E+13	11
1019000306	Little Dry Creek-South Platte River	Pets	Dogs	11,139	3.5E+13	6
1019000306	Little Dry Creek-South Platte River	Pets	Cats	12,291	3.9E+13	7
1019000306	Little Dry Creek-South Platte River	Livestock	Cattle	17,437	3.6E+14	62
1019000306	Little Dry Creek-South Platte River	Livestock	Horses	339	9.0E+12	2
1019000306	Little Dry Creek-South Platte River	Livestock	Poultry	113,834	6.7E+12	1
1019000306	Little Dry Creek-South Platte River	Livestock	Sheep	7,104	5.4E+13	9
1019000306	Little Dry Creek-South Platte River	Livestock	Goats	4	7.1E+10	0
1019000306	Little Dry Creek-South Platte River	Livestock	Hogs	168	9.4E+11	0
1019000308	Outlet Box Elder Creek	Humans	OWTS	5,574	7.0E+12	2
1019000308	Outlet Box Elder Creek	Humans	WWTP	189	2.4E+11	0
1019000308	Outlet Box Elder Creek	Pets	Dogs	1,010	3.2E+12	1
1019000308	Outlet Box Elder Creek	Pets	Cats	1,114	3.5E+12	1
1019000308	Outlet Box Elder Creek	Livestock	Cattle	17,006	3.5E+14	81

Table 5-7. Estimated Number of Animals, *E. coli* Produced, and Percent of *E. coli* Produced in Each HUC10 (Page 2 of 8)

HUC10	Description	Category	Subcategory	Count	Total *E. coli* Produced (cfu/day)	Total *E. coli* Produced (%)
1019000308	Outlet Box Elder Creek	Livestock	Horses	430	1.1E+13	3
1019000308	Outlet Box Elder Creek	Livestock	Poultry	110,400	6.5E+12	1
1019000308	Outlet Box Elder Creek	Livestock	Sheep	6,905	5.2E+13	12
1019000308	Outlet Box Elder Creek	Livestock	Goats	5	8.8E+10	0
1019000308	Outlet Box Elder Creek	Livestock	Hogs	180	1.0E+12	0
1019000309	Lost Creek	Humans	OWTS	3,922	4.9E+12	1
1019000309	Lost Creek	Humans	WWTP	1,533	1.9E+12	0
1019000309	Lost Creek	Pets	Dogs	956	3.0E+12	1
1019000309	Lost Creek	Pets	Cats	1,055	3.3E+12	1
1019000309	Lost Creek	Livestock	Cattle	16,767	3.5E+14	80
1019000309	Lost Creek	Livestock	Horses	593	1.6E+13	4
1019000309	Lost Creek	Livestock	Poultry	105,201	6.2E+12	1
1019000309	Lost Creek	Livestock	Sheep	6,625	5.0E+13	12
1019000309	Lost Creek	Livestock	Goats	6	1.1E+11	0
1019000309	Lost Creek	Livestock	Hogs	231	1.3E+12	0
1019000310	Sanborn Draw-South Platte River	Humans	OWTS	976	1.2E+12	0
1019000310	Sanborn Draw-South Platte River	Humans	WWTP	—	0.0E+00	0
1019000310	Sanborn Draw-South Platte River	Pets	Dogs	171	5.4E+11	0
1019000310	Sanborn Draw-South Platte River	Pets	Cats	189	5.9E+11	0
1019000310	Sanborn Draw-South Platte River	Livestock	Cattle	26,514	5.5E+14	83
1019000310	Sanborn Draw-South Platte River	Livestock	Horses	516	1.4E+13	2
1019000310	Sanborn Draw-South Platte River	Livestock	Poultry	173,389	1.0E+13	2
1019000310	Sanborn Draw-South Platte River	Livestock	Sheep	10,823	8.2E+13	12
1019000310	Sanborn Draw-South Platte River	Livestock	Goats	7	1.2E+11	0
1019000310	Sanborn Draw-South Platte River	Livestock	Hogs	258	1.4E+12	0

Table 5-7. Estimated Number of Animals, *E. coli* Produced, and Percent of *E. coli* Produced in Each HUC10 (Page 3 of 8)

HUC10	Description	Category	Subcategory	Count	Total *E. coli* Produced (cfu/day)	Total *E. coli* Produced (%)
1019000311	Greasewood Draw-South Platte River	Humans	OWTS	523	6.6E+11	0
1019000311	Greasewood Draw-South Platte River	Humans	WWTP	—	0.0E+00	0
1019000311	Greasewood Draw-South Platte River	Pets	Dogs	92	2.9E+11	0
1019000311	Greasewood Draw-South Platte River	Pets	Cats	101	3.2E+11	0
1019000311	Greasewood Draw-South Platte River	Livestock	Cattle	17,000	3.5E+14	88
1019000311	Greasewood Draw-South Platte River	Livestock	Horses	241	6.4E+12	2
1019000311	Greasewood Draw-South Platte River	Livestock	Poultry	69,529	4.1E+12	1
1019000311	Greasewood Draw-South Platte River	Livestock	Sheep	4,371	3.3E+13	8
1019000311	Greasewood Draw-South Platte River	Livestock	Goats	8	1.4E+11	0
1019000311	Greasewood Draw-South Platte River	Livestock	Hogs	233	1.3E+12	0
1019000312	Cottonwood Draw-South Platte River	Humans	OWTS	13	1.7E+10	0
1019000312	Cottonwood Draw-South Platte River	Humans	WWTP	—	0.0E+00	0
1019000312	Cottonwood Draw-South Platte River	Pets	Dogs	2	7.3E+09	0
1019000312	Cottonwood Draw-South Platte River	Pets	Cats	3	8.1E+09	0
1019000312	Cottonwood Draw-South Platte River	Livestock	Cattle	505	1.1E+13	97
1019000312	Cottonwood Draw-South Platte River	Livestock	Horses	3	7.4E+10	1
1019000312	Cottonwood Draw-South Platte River	Livestock	Poultry	49	2.9E+09	0
1019000312	Cottonwood Draw-South Platte River	Livestock	Sheep	5	4.1E+10	0
1019000312	Cottonwood Draw-South Platte River	Livestock	Goats	9	1.6E+11	1
1019000312	Cottonwood Draw-South Platte River	Livestock	Hogs	10	5.7E+10	1
1019000801	Upper Lone Tree Creek	Humans	OWTS	86	1.1E+11	0
1019000801	Upper Lone Tree Creek	Humans	WWTP	—	0.0E+00	0
1019000801	Upper Lone Tree Creek	Pets	Dogs	15	4.8E+10	0
1019000801	Upper Lone Tree Creek	Pets	Cats	17	5.2E+10	0
1019000801	Upper Lone Tree Creek	Livestock	Cattle	1,806	3.8E+13	81

Table 5-7. Estimated Number of Animals, *E. coli* Produced, and Percent of *E. coli* Produced in Each HUC10 (Page 4 of 8)

HUC10	Description	Category	Subcategory	Count	Total *E. coli* Produced (cfu/day)	Total *E. coli* Produced (%)
1019000801	Upper Lone Tree Creek	Livestock	Horses	78	2.1E+12	4
1019000801	Upper Lone Tree Creek	Livestock	Poultry	7,284	4.3E+11	1
1019000801	Upper Lone Tree Creek	Livestock	Sheep	750	5.7E+12	12
1019000801	Upper Lone Tree Creek	Livestock	Goats	10	1.8E+11	0
1019000801	Upper Lone Tree Creek	Livestock	Hogs	12	6.7E+10	0
1019000802	Spring Creek-Lone Tree Creek	Humans	OWTS	5,763	7.3E+12	2
1019000802	Spring Creek-Lone Tree Creek	Humans	WWTP	1,784	2.2E+12	1
1019000802	Spring Creek-Lone Tree Creek	Pets	Dogs	1,322	4.2E+12	1
1019000802	Spring Creek-Lone Tree Creek	Pets	Cats	1,459	4.6E+12	1
1019000802	Spring Creek-Lone Tree Creek	Livestock	Cattle	15,065	3.1E+14	80
1019000802	Spring Creek-Lone Tree Creek	Livestock	Horses	418	1.1E+13	3
1019000802	Spring Creek-Lone Tree Creek	Livestock	Poultry	92,267	5.4E+12	1
1019000802	Spring Creek-Lone Tree Creek	Livestock	Sheep	5,830	4.4E+13	11
1019000802	Spring Creek-Lone Tree Creek	Livestock	Goats	11	1.9E+11	0
1019000802	Spring Creek-Lone Tree Creek	Livestock	Hogs	145	8.1E+11	0
1019000803	Owl Creek-Lone Tree Creek	Humans	OWTS	5,260	6.6E+12	1
1019000803	Owl Creek-Lone Tree Creek	Humans	WWTP	53	6.7E+10	0
1019000803	Owl Creek-Lone Tree Creek	Pets	Dogs	931	2.9E+12	0
1019000803	Owl Creek-Lone Tree Creek	Pets	Cats	1,027	3.2E+12	0
1019000803	Owl Creek-Lone Tree Creek	Livestock	Cattle	35,222	7.3E+14	82
1019000803	Owl Creek-Lone Tree Creek	Livestock	Horses	686	1.8E+13	2
1019000803	Owl Creek-Lone Tree Creek	Livestock	Poultry	230,332	1.3E+13	2
1019000803	Owl Creek-Lone Tree Creek	Livestock	Sheep	14,378	1.1E+14	12
1019000803	Owl Creek-Lone Tree Creek	Livestock	Goats	12	2.1E+11	0
1019000803	Owl Creek-Lone Tree Creek	Livestock	Hogs	341	1.9E+12	0

Table 5-7. Estimated Number of Animals, *E. coli* Produced, and Percent of *E. coli* Produced in Each HUC10 (Page 5 of 8)

HUC10	Description	Category	Subcategory	Count	Total *E. coli* Produced (cfu/day)	Total *E. coli* Produced (%)
1019000902	Little Crow Creek	Humans	OWTS	205	2.6E+11	0
1019000902	Little Crow Creek	Humans	WWTP	—	0.0E+00	0
1019000902	Little Crow Creek	Pets	Dogs	36	1.1E+11	0
1019000902	Little Crow Creek	Pets	Cats	40	1.2E+11	0
1019000902	Little Crow Creek	Livestock	Cattle	27,466	5.7E+14	83
1019000902	Little Crow Creek	Livestock	Horses	625	1.7E+13	2
1019000902	Little Crow Creek	Livestock	Poultry	166,711	9.8E+12	1
1019000902	Little Crow Creek	Livestock	Sheep	11,551	8.7E+13	13
1019000902	Little Crow Creek	Livestock	Goats	13	2.3E+11	0
1019000902	Little Crow Creek	Livestock	Hogs	247	1.4E+12	0
1019000903	Middle Crow Creek	Humans	OWTS	381	4.8E+11	0
1019000903	Middle Crow Creek	Humans	WWTP	298	3.8E+11	0
1019000903	Middle Crow Creek	Pets	Dogs	119	3.7E+11	0
1019000903	Middle Crow Creek	Pets	Cats	131	4.1E+11	0
1019000903	Middle Crow Creek	Livestock	Cattle	31,192	6.5E+14	83
1019000903	Middle Crow Creek	Livestock	Horses	669	1.8E+13	2
1019000903	Middle Crow Creek	Livestock	Poultry	195,079	1.1E+13	1
1019000903	Middle Crow Creek	Livestock	Sheep	12,967	9.8E+13	13
1019000903	Middle Crow Creek	Livestock	Goats	14	2.5E+11	0
1019000903	Middle Crow Creek	Livestock	Hogs	288	1.6E+12	0
1019000904	Coal Creek	Humans	OWTS	348	4.4E+11	0
1019000904	Coal Creek	Humans	WWTP	—	0.0E+00	0
1019000904	Coal Creek	Pets	Dogs	61	1.9E+11	0
1019000904	Coal Creek	Pets	Cats	67	2.1E+11	0
1019000904	Coal Creek	Livestock	Cattle	14,109	2.9E+14	83

Table 5-7. Estimated Number of Animals, *E. coli* Produced, and Percent of *E. coli* Produced in Each HUC10 (Page 6 of 8)

HUC10	Description	Category	Subcategory	Count	Total *E. coli* Produced (cfu/day)	Total *E. coli* Produced (%)
1019000904	Coal Creek	Livestock	Horses	274	7.3E+12	2
1019000904	Coal Creek	Livestock	Poultry	92,261	5.4E+12	2
1019000904	Coal Creek	Livestock	Sheep	5,760	4.4E+13	12
1019000904	Coal Creek	Livestock	Goats	15	2.6E+11	0
1019000904	Coal Creek	Livestock	Hogs	137	7.7E+11	0
1019000905	Sand Creek-Crow Creek	Humans	OWTS	1,238	1.6E+12	0
1019000905	Sand Creek-Crow Creek	Humans	WWTP	—	0.0E+00	0
1019000905	Sand Creek-Crow Creek	Pets	Dogs	217	6.8E+11	0
1019000905	Sand Creek-Crow Creek	Pets	Cats	239	7.5E+11	0
1019000905	Sand Creek-Crow Creek	Livestock	Cattle	14,109	2.9E+14	83
1019000905	Sand Creek-Crow Creek	Livestock	Horses	274	7.3E+12	2
1019000905	Sand Creek-Crow Creek	Livestock	Poultry	92,261	5.4E+12	2
1019000905	Sand Creek-Crow Creek	Livestock	Sheep	5,760	4.4E+13	12
1019000905	Sand Creek-Crow Creek	Livestock	Goats	15	2.6E+11	0
1019000905	Sand Creek-Crow Creek	Livestock	Hogs	137	7.7E+11	0
1019000906	Outlet Coal Creek	Humans	OWTS	2,334	2.9E+12	1
1019000906	Outlet Coal Creek	Humans	WWTP	—	0.0E+00	0
1019000906	Outlet Coal Creek	Pets	Dogs	409	1.3E+12	0
1019000906	Outlet Coal Creek	Pets	Cats	451	1.4E+12	0
1019000906	Outlet Coal Creek	Livestock	Cattle	13,690	2.8E+14	82
1019000906	Outlet Coal Creek	Livestock	Horses	266	7.0E+12	2
1019000906	Outlet Coal Creek	Livestock	Poultry	89,528	5.2E+12	2
1019000906	Outlet Coal Creek	Livestock	Sheep	5,588	4.2E+13	12
1019000906	Outlet Coal Creek	Livestock	Goats	17	3.0E+11	0
1019000906	Outlet Coal Creek	Livestock	Hogs	133	7.5E+11	0

Table 5-7. Estimated Number of Animals, *E. coli* Produced, and Percent of *E. coli* Produced in Each HUC10 (Page 7 of 8)

HUC10	Description	Category	Subcategory	Count	Total *E. coli* Produced (cfu/day)	Total *E. coli* Produced (%)
1019001203	Wildcat Creek	Humans	OWTS	46	5.8E+10	0
1019001203	Wildcat Creek	Humans	WWTP	—	0.0E+00	0
1019001203	Wildcat Creek	Pets	Dogs	8	2.6E+10	0
1019001203	Wildcat Creek	Pets	Cats	9	2.8E+10	0
1019001203	Wildcat Creek	Livestock	Cattle	11,885	2.5E+14	93
1019001203	Wildcat Creek	Livestock	Horses	116	3.1E+12	1
1019001203	Wildcat Creek	Livestock	Poultry	24,103	1.4E+12	1
1019001203	Wildcat Creek	Livestock	Sheep	1,543	1.2E+13	4
1019001203	Wildcat Creek	Livestock	Goats	—	0.0E+00	0
1019001203	Wildcat Creek	Livestock	Hogs	203	1.1E+12	0
1019001205	City of Raymer	Humans	OWTS	152	1.9E+11	0
1019001205	City of Raymer	Humans	WWTP	182	2.3E+11	0
1019001205	City of Raymer	Pets	Dogs	59	1.8E+11	0
1019001205	City of Raymer	Pets	Cats	65	2.0E+11	0
1019001205	City of Raymer	Livestock	Cattle	10,355	2.2E+14	91
1019001205	City of Raymer	Livestock	Horses	123	3.3E+12	1
1019001205	City of Raymer	Livestock	Poultry	31,381	1.8E+12	1
1019001205	City of Raymer	Livestock	Sheep	1,985	1.5E+13	6
1019001205	City of Raymer	Livestock	Goats	1	1.8E+10	0
1019001205	City of Raymer	Livestock	Hogs	160	9.0E+11	0
1019001206	Camp Creek South Platte River	Humans	OWTS	17	2.1E+10	0
1019001206	Camp Creek South Platte River	Humans	WWTP	—	0.0E+00	0
1019001206	Camp Creek South Platte River	Pets	Dogs	3	9.1E+09	0
1019001206	Camp Creek South Platte River	Pets	Cats	3	1.0E+10	0
1019001206	Camp Creek South Platte River	Livestock	Cattle	1,191	2.5E+13	97

Table 5-7. Estimated Number of Animals, *E. coli* Produced, and Percent of *E. coli* Produced in Each HUC10 (Page 8 of 8)

HUC10	Description	Category	Subcategory	Count	Total *E. coli* Produced (cfu/day)	Total *E. coli* Produced (%)
1019001206	Camp Creek South Platte River	Livestock	Horses	9	2.3E+11	1
1019001206	Camp Creek South Platte River	Livestock	Poultry	334	2.0E+10	0
1019001206	Camp Creek South Platte River	Livestock	Sheep	26	2.0E+11	1
1019001206	Camp Creek South Platte River	Livestock	Goats	2	3.5E+10	0
1019001206	Camp Creek South Platte River	Livestock	Hogs	23	1.3E+11	0

5.3 HEAVY METALS

Heavy metal sources are typically from abandoned mines, runoff from developed areas, and contributions from soils. Heavy metals that can be sourced from irrigation on Pierre Shale areas (selenium and arsenic) would also benefit from changing irrigation practices. Flood irrigation typically results in substantial irrigation return flows, which can be high in selenium or arsenic when soils in the irrigated fields have high selenium or arsenic content. The conversion to more modern center-pivot and side-roll sprinkler systems would help decrease the volume of selenium- or arsenic-rich return flows entering waterbodies [Hawley and Rodriguez-Jeangros, 2021].

Heavy metals are also not addressed with PLET. Larimer and Weld Counties have a rich mining history dating back to the mid-1800s. Commodities consisting of beryllium, coal, copper, gold, iron, lead, manganese, molybdenum, rare earth elements, silica, silver, tungsten, uranium, vanadium, and zinc were mined [The Diggings, 2024].

Sources of some heavy metals, according to a publication within Heliyon on ScienceDirect [Briffa et al., 2020] and the *Big Thompson State of the Watershed 2021 Final Report* [Hawley and Rodriguez-Jeangros, 2021], also include:

- Zinc – mining and metal/paint/cosmetic/energy/hygiene/plastic/textile/supplement production
- Lead – metal/infrastructure/paint/glass production, manufacturing processes, and combustion of gas
- Selenium – animal feed/supplement production, manufacturing processes, fossil fuel combustion, and irrigation return flows in areas with Pierre Shale
- Arsenic – pressure-treated wood, glass/pesticide production, doping, pyrotechnics, and Pierre Shale
- Copper – copper sulfate algicide, alloy manufacturing processes, metal/fertilizer/chemical/jewelry production, and wood/fabric preservation
- Iron – mining, manufacturing processes, and metal/supplement/food production
- Manganese – alloy manufacturing processes, metal/fertilizer/firework/pesticide/cosmetic production
- Mercury – chemistry, chemical manufacturing processes, and pesticide/paint/energy production

The CDPHE Water Quality Control Commission has designated several streams within both counties as impaired (see Clean Water Act [CWA] Section 303(d) list and 5 CCR 1002-93) for these elements (Table 4-1), suggesting that mined lands or AMLs are a potential source of NPS pollution. Several federal and state agencies have mapped and cataloged abandoned mines within Colorado and quantified the AMLs in Larimer and Weld Counties. To determine areas most likely polluted by AMLs, known AML locations were summarized per HUC10. Although not all AMLs have been discovered and mapped, an assumption was made that the more points in a HUC10, the more likely that HUC10 was polluted by AMLs. Table 5-8 lists the number of AMLs for each HUC10 [Graves, 2024].

Table 5-8. Number of Identified Abandoned Mine Lands per HUC10

HUC10	Description	Count
1019000305	Beebe Seep Canal	0
1019000306	Little Dry Creek-South Platte River	5
1019000308	Outlet Box Elder Creek	0
1019000309	Lost Creek	0
1019000310	Sanborn Draw-South Platte River	0
1019000311	Greasewood Draw-South Platte River	0
1019000312	Cottonwood Draw-South Platte River	0
1019000801	Upper Lone Tree Creek	0
1019000802	Spring Creek-Lone Tree Creek	0
1019000803	Owl Creek-Lone Tree Creek	0
1019000902	Little Crow Creek	0
1019000903	Middle Crow Creek	0
1019000904	Coal Creek	0
1019000905	Sand Creek-Crow Creek	0
1019000906	Outlet Coal Creek	0
1019001203	Wildcat Creek	0

In *Colorado's Nonpoint Source Program: 2022 Annual Report* [Moore, 2022], the recommended BMPs associated with pollution from AMLs are hydrologic controls (diversion ditches, mine tailings removal, erosion and sediment control, and revegetation) and passive treatments (aerobic wetlands, anaerobic wetlands, and aeration and settling ponds).

The Middle South Platte project area contains very little Pierre Shale, which explains why the arsenic impairments only occur along the mainstem, and no selenium impairment occurs in the project area. Therefore, the majority of arsenic and selenium is assumed to be coming from upstream sources.

6.0 PRIORITY AREAS FOR IMPLEMENTATION

Priority areas are locations that significantly contribute to the water quality parameters identified as pollutants of concern. The following sources were used to identify priority areas for BMP implementation:

- PLET model (for nutrients and sediment)
- Production per HUC10 assessment (for *E. coli*)
- AML density assessment (for heavy metals)

Point source permittees should compare the cost options of upstream NPS BMPs to the cost of mechanical treatment. Such collaborations and coordinated efforts may improve economic feasibility for improving water quality regionally.

6.1 NUTRIENTS AND SEDIMENT

The PLET model indicates that throughout the overall Middle South Platte River project area within Larimer and Weld Counties, the primary source of nutrients and sediment is cropland; however, cropland only makes up approximately 23 percent of the total area and other land uses are the dominant source overall. Only 3 HUC10 watersheds have more cropland than other land uses: 1019000305 (Beebe Seep Canal), 1019000306 (Little Dry Creek-South Platte River) and 1019000309 (Lost Creek). Two of the HUC10s have other as their primary source of nutrients and sediment over cropland—1019000801 (Upper Lone Tree Creek) and 1019000904 (Coal Creek). Figures 6-1, 6-2, and 6-3 show the total daily loads per HUC10 of nitrogen, phosphorus, and TSS, respectively, from PLET [EPA, 2022]. Priority areas for the reduction of nutrients and sediment are the southern HUC10s in Weld County, including HUC10s 1019000306 (Little Dry Creek-South Platte River) and 1019000308 (Outlet Box Elder Creek), and 1019000309 (Lost Creek) on cropland. The source figures from PLET only represent areas that are not MS4s.

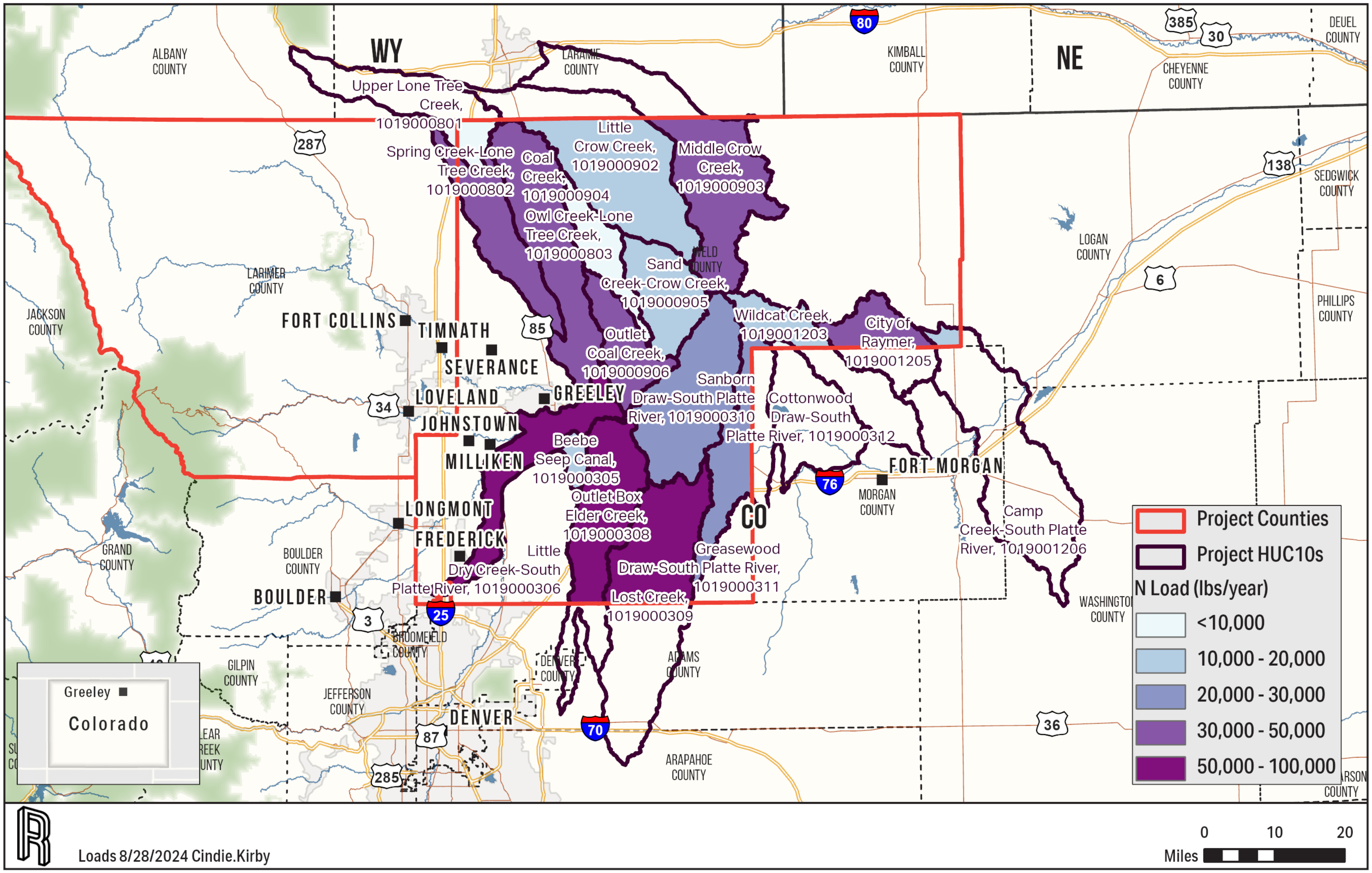


Figure 6-1. Nitrogen Contributions per HUC10.

RESPEC

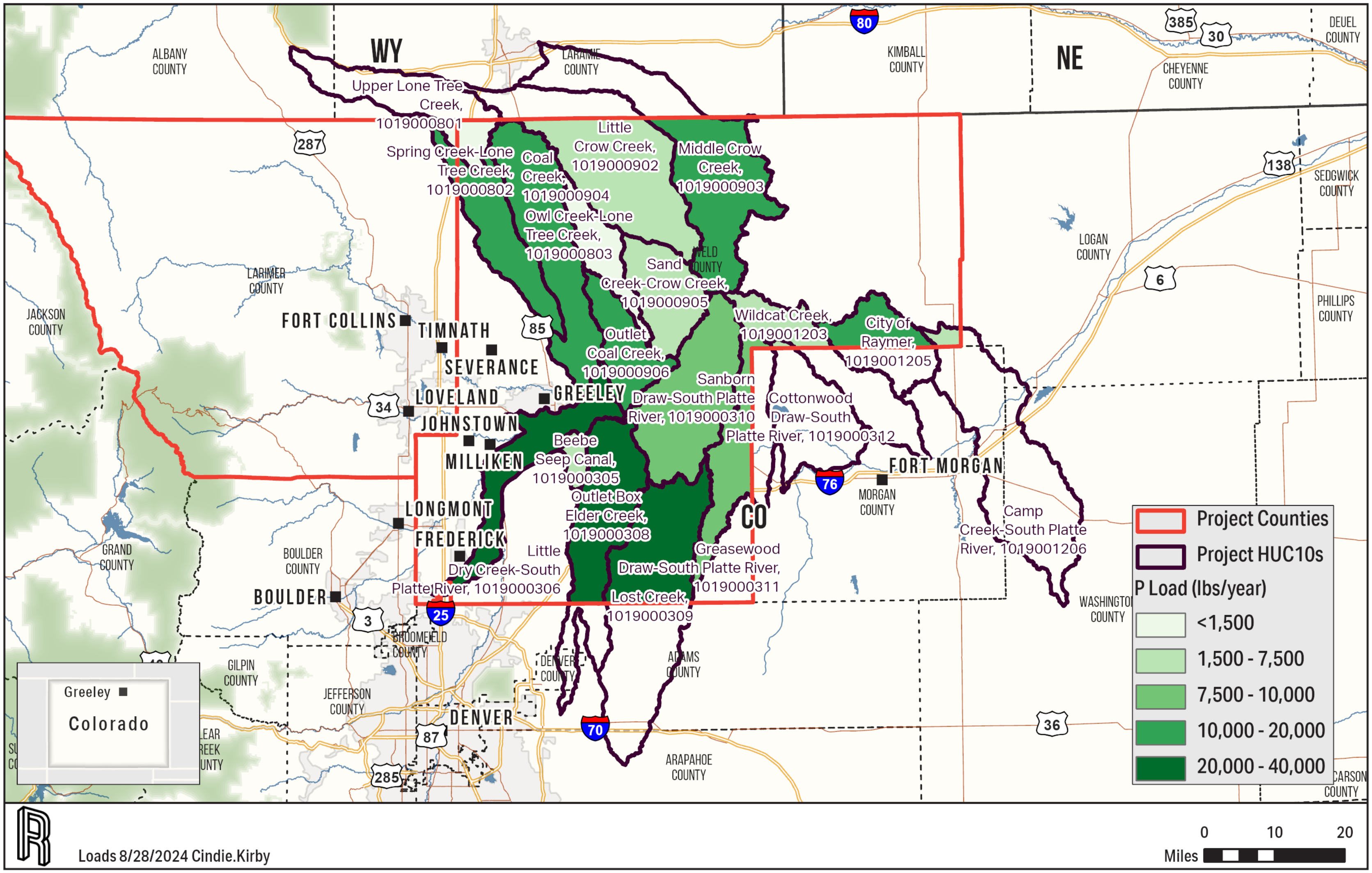


Figure 6-2. Phosphorus Contributions per HUC10.

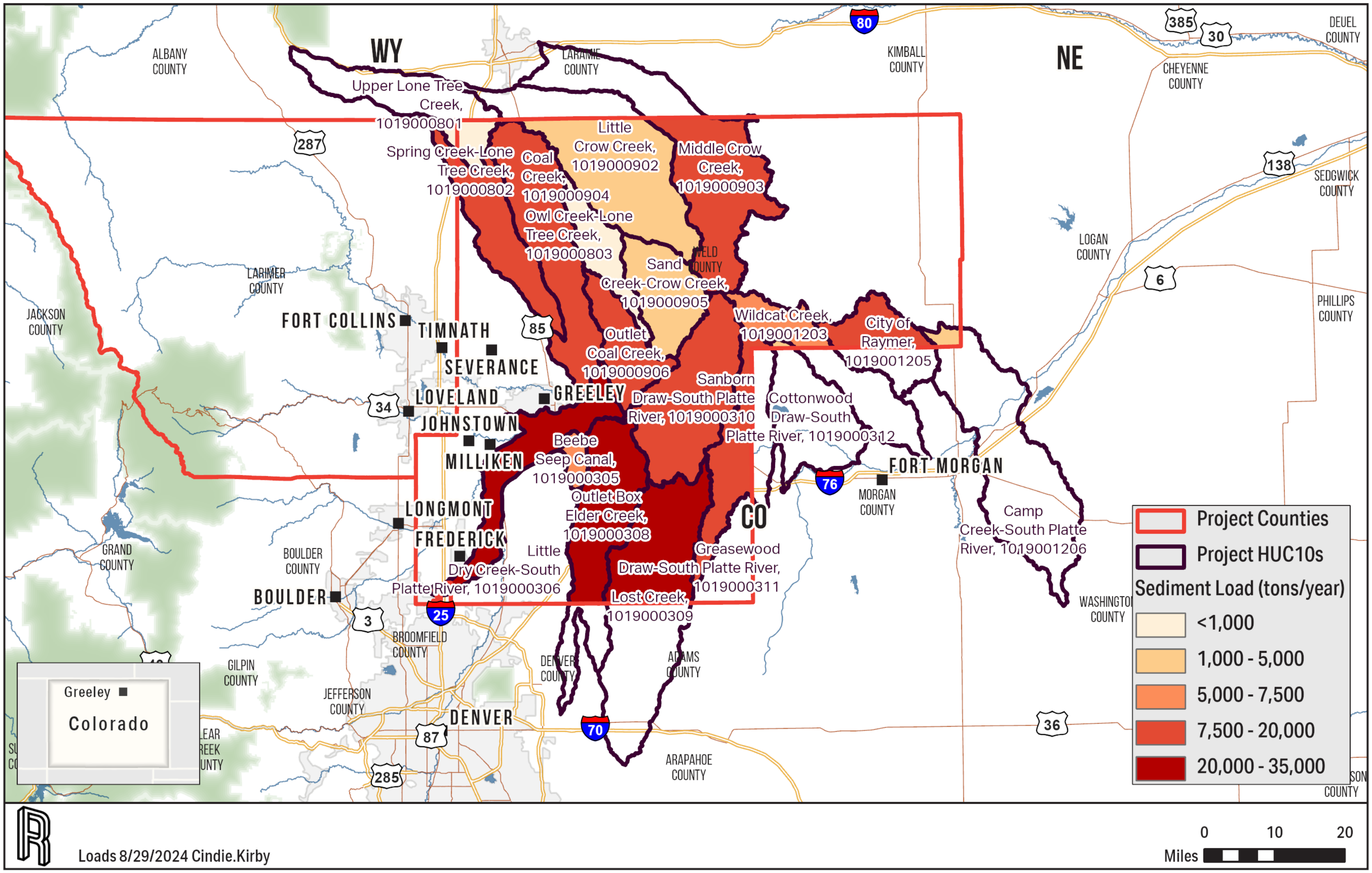


Figure 6-3. Sediment Contributions per HUC10.

6.2 E. COLI

The bacteria production assessment revealed that, overall, throughout the overall Middle South Platte River project area within Larimer and Weld Counties, cattle are the primary producers of bacteria. Figure 6-4 provides the total production of bacteria per HUC10 based on the assessment within GIS. Priority areas for reduction of *E. coli* are HUC10s 1019000803 (Coal Creek) and 1019000903 (Middle Crow Creek) because they have the highest production rates overall. Practices related to cattle exclusion from streams, such as fencing, off-stream watering, and seasonal riparian area management, should be a priority in this watershed. The *E. coli* impairments are located in HUC10s 1019000306 (Little Dry Creek-South Platte River), 1019000310 (Sanborn Draw-South Platte River), and 1019000311 (Greasewood Draw-South Platte River), and therefore, these should also be priorities for *E. coli* reductions. However, it is possible that these loads are coming from upstream.

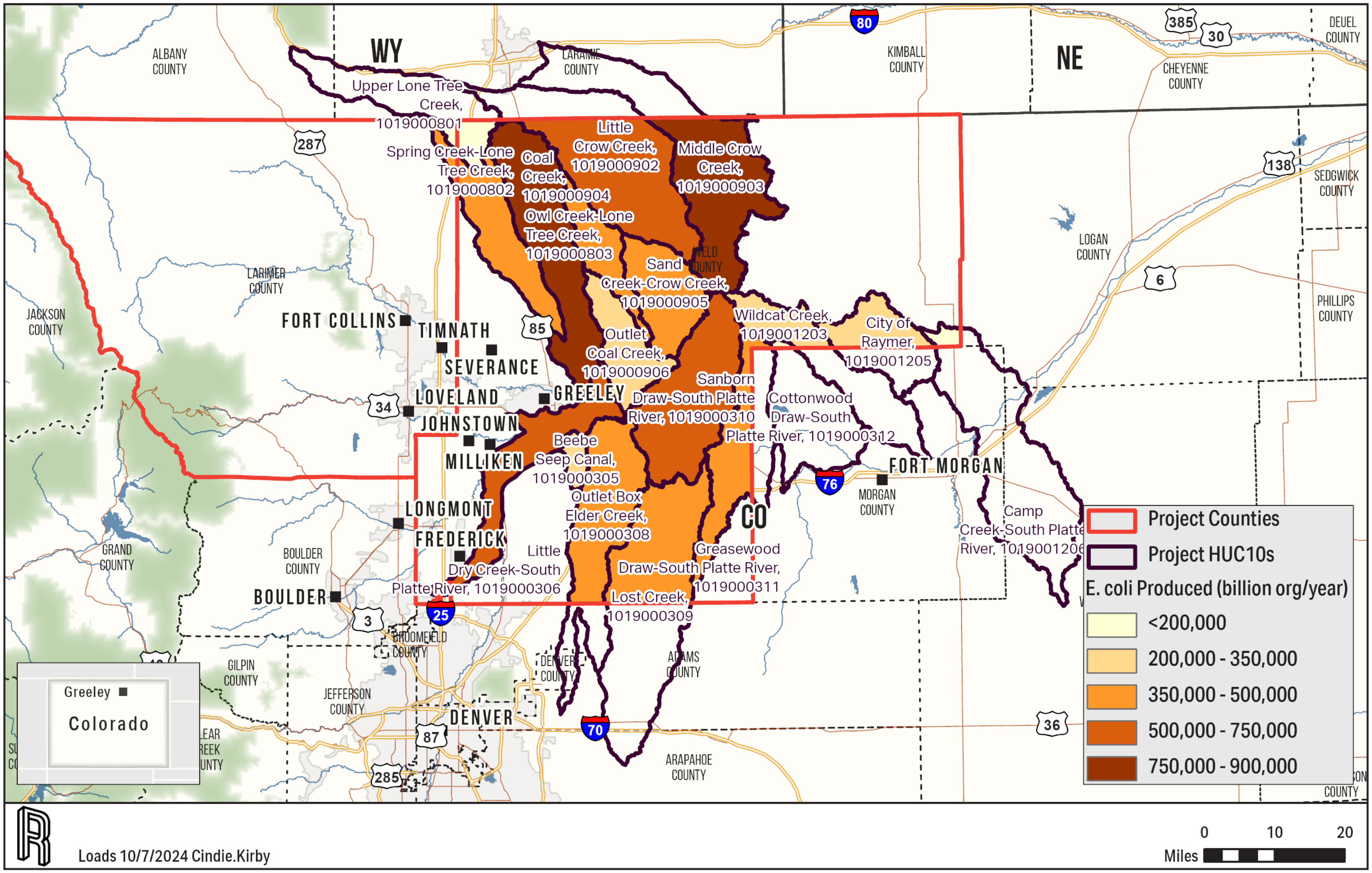


Figure 6-4. Bacteria Produced per HUC10.

6.3 HEAVY METALS

The AML density identified HUC10 1019000306 (Little Dry Creek-South Platte River) as the only HUC10 watershed with the identified AMLs; therefore, it should be the primary target (priority area) in continuing AML identification and practice implementation to reduce heavy metals in waters. Waterbodies impaired with total arsenic align with the AML density analysis and exist in and downstream of the HUC10 watersheds with identified AMLs; however, waterbodies impaired with uranium and cadmium occur in HUC10 watersheds where AMLs were not identified. The density of AMLs per square mile is illustrated in Figure 6-5 [Graves, 2024]. Priority watersheds for heavy metal-reducing BMPs should be the areas with the highest density of AMLs. For the Middle South Platte project area, arsenic and selenium are not a significant issue because any impairments (Table 4-1) seem to be coming for upstream. Transitioning from flood irrigation to more efficient irrigation methods will still be a priority for other parameters.

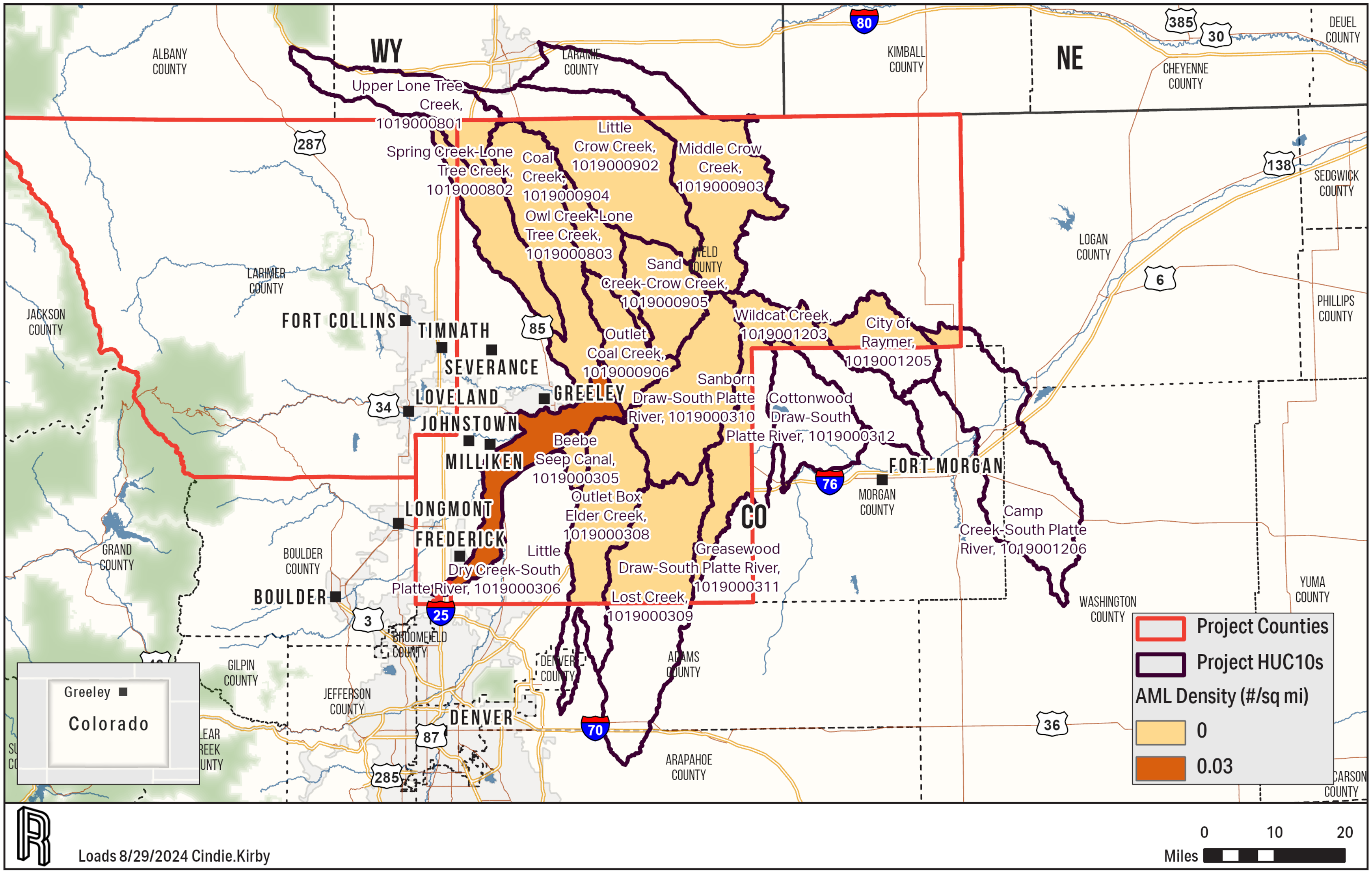


Figure 6-5. Density of Abandoned Mine Lands for Each HUC10.

7.0 BEST MANAGEMENT PRACTICES LOAD REDUCTIONS

Numerous resources exist in Colorado and nationally that provide information on BMPs. Some give data about implementation, and others inform on expected load reductions. Understanding that most BMPs require maintance over time to remain effective is important. Some BMPs also need individuals to operate them for effectiveness. The Community-enabled Lifecycle Analysis of Stormwater Infrastructure Costs (CLASIC) tool is available on the CLASIC website and provides more information about life cycles of some stormwater BMPs. The following websites were used to summarize the overall BMP options:

- Colorado Department of Agriculture BMPs
- Colorado Water Conservation Board Floodplain Stormwater and Criteria Manual
- Colorado Water Conservation Board BMPs
- Colorado Waterwise Guidebook of Best Practices for Municipal Water Conservation in Colorado
- Colorado Ag Water Quality BMPs for Colorado
- Colorado Forestry Best Management Practices 2018 Field Monitoring Report
- Colorado Wetland Information Center Wetland BMPs
- Colorado Stormwater Center
- Colorado Department of Transportation Permanent Water Quality Program
- Upper South Platte BMPs for Protecting Source Water Quality
- International Stormwater BMP Database
- One Water Solutions Institute
- EPA Menu of Stormwater BMPs
- USDA Stream Restoration Manual
- Natural Resources Conservation Service Conservation Practice Standards
- USDA Colorado Field Office Technical Guide
- Pollution Load Estimator Tool

7.1 NUTRIENTS AND SEDIMENT

For this project, nutrient and sediment BMPs available in PLET were prioritized using multiple metrics, including stakeholder input and BMP effectiveness. The BMP reduction factors for PLET BMPs are listed in Tables 7-1 through 7-5 for cropland, pastureland, feedlots, forest, and urban lands. The average of the nitrogen, phosphorus, and sediment reduction factors was the first metric used for prioritization. The average survey score based on Survey #2 results was the second metric. The final score, the reduction survey, was the product of the two metrics. The following practices were chosen and run in PLET based on reduction survey scores: the top two cropland, top two pasture, top feedlot, top two forest, and top three urban. These priority PLET practices for each respective land use are in bold under the column headings of Tables 7-1 through 7-5. The priority PLET practices were run on

25 percent of the modeled land cover they were developed for (i.e., cropland, pasture, feedlot, forest, urban). Associated reductions for each PLET practice run are provided in Table 7-6. Reductions at the HUC10 level are included in Appendix D. Several of the practice reduction factors suggest that reducing sediment loading would simultaneously reduce nutrient loading. PLET BMP descriptions and the reduction fractions can be found in the "Best Management Practice Definition Document for Pollution Load Estimation Tool" [EPA, 2023].

Table 7-1. PLET Cropland Best Management Practices and Average Reduction Metric

Practice	Nitrogen Reduction (Fraction)	Phosphorus Reduction (Fraction)	Sediment Reduction (Fraction)	Average Reduction[a] (Fraction)	Average Survey Score[b]	Reduction Survey Score[c]
Streambank Stabilization and Fencing	**0.75**	**0.75**	**0.75**	**0.75**	**2.0**	**1.5**
Buffer - Grass (35 feet wide)	**0.34**	**0.44**	**0.53**	**0.44**	**3.0**	**1.3**
Contour Farming	0.34	0.46	0.41	0.40	2.0	0.8
Terrace	0.27	0.31	0.41	0.33	2.0	0.7
Controlled Drainage	0.39	0.35	0	0.25	2.5	0.6
Conservation Tillage 1 (30-59% residue)	0.07	0.36	0.46	0.30	2.0	0.6
Conservation Tillage 2 (equal or more than 30% residue)	0.13	0.69	0.79	0.54	1.0	0.5
Nutrient Management 2 (determined rate plus additional considerations)	0.22	0.56	0	0.26	2.0	0.5
Buffer – Forest (100 feet wide)	0.49	0.47	0.6	0.52	1.0	0.5
Nutrient Management 1 (determined rate)	0.15	0.45	0	0.20	2.0	0.4
Bioreactor	0.45	0	0	0.15	1.0	0.2
Two-Stage Ditch	0.12	0.28	0	0.13	1.0	0.1
Cover Crop 1 (group A commodity; high till only for sediment)	0.0078	0	0	0.00	0.0	0.0
Cover Crop 2 (group A traditional normal planting time; high till only for total phosphorus and sediment)	0.2	0.07	0.1	0.12	0.0	0.0
Cover Crop 3 (group A traditional early planting time) (high till only for total phosphorus and sediment)	0.2	0.15	0.2	0.18	0.0	0.0

(a) Average Reduction is the product of the nitrogen, phosphorus, and sediment reduction.
(b) Average Survey Score is the average of the survey prioritization from Survey #2.
(c) The Survey Reduction Score is the product of the average reduction and the average survey score.

Table 7-2. PLET Pasture Best Management Practices and Average Reduction Metric

Practice	Nitrogen Reduction (Fraction)	Phosphorus Reduction (Fraction)	Sediment Reduction (Fraction)	Average Reduction [a] (Fraction)	Average Survey Score[b]	Reduction Survey Score[c]
Streambank Stabilization and Fencing	**0.75**	**0.75**	**0.75**	**0.75**	**3.0**	**2.3**
Buffer – Grass (minimum 35 feet wide)	**0.87**	**0.89**	**0.65**	**0.80**	**2.8**	**2.2**
Livestock Exclusion Fencing	0.2	0.43	0.64	0.42	3.4	1.4
Buffer – Forest (minimum 35 feet wide)	0.45	0.4	0.53	0.46	2.2	1.0
Streambank Protection Without Fencing	0.15	0.22	0.58	0.32	2.8	0.9
Critical Area Planting	0.18	0.2	0.42	0.27	3.3	0.9
Grazing Land Management (rotational grazing with fenced areas)	0.43	0.26	0	0.23	3.8	0.9
Heavy Use Area Protection	0.18	0.19	0.33	0.23	3.5	0.8
Prescribed Grazing	0.41	0.23	0.33	0.32	2.5	0.8
Multiple Practices	0.25	0.2	0.22	0.22	3.6	0.8
Winter Feeding Facility	0.35	0.4	0.4	0.38	2.0	0.8
Use Exclusion	0.43	0.08	0.51	0.34	1.7	0.6
30-meter Buffer With Optimal Grazing	0.16	0.65	0	0.27	1.5	0.4
Alternative Water Supply	0.18	0.13	0.2	0.17	2.0	0.3
Pasture and Hayland Planting (also called Forage Planting)	0.18	0.15	0	0.11	3.0	0.3
Litter Storage and Management	0.14	0.14	0	0.09	3.4	0.3

(a) Average Reduction is the product of the nitrogen, phosphorus, and sediment reduction.

(b) Average Survey Score is the average of the survey prioritization from Survey #2.

(c) The Survey Reduction Score is the product of the average reduction and the average survey score.

Table 7-3. PLET Feedlot Best Management Practices and Average Reduction Metric

Practice	Nitrogen Reduction (Fraction)	Phosphorus Reduction (Fraction)	Sediment Reduction (Fraction)	Average Reduction(a) (Fraction)	Average Survey Score[b]	Reduction Survey Score[c]
Waste Management System	**0.8**	**0.9**	**0**	**0.57**	**3.6**	**2.0**
Waste Storage Facility	0.65	0.6	0	0.42	3.6	1.5
Diversion	0.45	0.7	0	0.38	3.5	1.3
Terrace	0.55	0.85	0	0.47	2.8	1.3
Filter Strip	0	0.85	0	0.28	4.0	1.1
Runoff Management System	0	0.83	0	0.28	3.3	0.9
Solids Separation Basin With Infiltration Bed	0	0.8	0	0.27	3.0	0.8
Solids Separation Basin	0.35	0.31	0	0.22	3.0	0.7

(a) Average Reduction is the product of the nitrogen, phosphorus, and sediment reduction.

(b) Average Survey Score is the average of the survey prioritization from Survey #2.

(c) The Survey Reduction Score is the product of the average reduction and the average survey score.

Table 7-4. PLET Forest Best Management Practices and Average Reduction Metric

Practice	Nitrogen Reduction (Fraction)	Phosphorus Reduction (Fraction)	Sediment Reduction (Fraction)	Average Reduction[a] (Fraction)	Average Survey Score[b]	Reduction Survey Score[c]
Site Preparation/Straw/Crimp Seed/Net	0	0	0.93	0.31	3.7	1.1
Site Preparation/Straw/Crimp Seed/Fertilizer/Transplants	0	0	0.95	0.32	3.0	1.0
Road Grass and Legume Seeding	0	0	0.71	0.24	3.7	0.9
Site Preparation/Straw/ Polymer/Seed/Fertilizer/ Transplants	0	0	0.86	0.29	3.0	0.9
Site Preparation/Hydro Mulch/ Seed/Fertilizer	0	0	0.71	0.24	3.5	0.8
Site Preparation/Steep Slope Seeder/ Transplants	0	0	0.81	0.27	3.0	0.8
Site Preparation/Straw/ Net/Seed/Fertilizer/Transplants	0	0	0.83	0.28	2.8	0.8
Site Preparation/Hydro Mulch/ Seed/Fertilizer/Transplants	0	0	0.69	0.23	3.2	0.7
Road Hydro Mulch	0	0	0.41	0.14	4.3	0.6
Road Tree Planting	0	0	0.5	0.17	3.4	0.6
Road Straw Mulch	0	0	0.41	0.14	4.0	0.5
Road Dry Seeding	0	0	0.41	0.14	3.6	0.5

(a) Average Reduction is the product of the nitrogen, phosphorus, and sediment reduction.

(b) Average Survey Score is the average of the survey prioritization from Survey #2.

(c) The Survey Reduction Score is the product of the average reduction and the average survey score.

Table 7-5. PLET Urban Best Management Practices and Average Reduction Metric (Page 1 of 2)

Practice	Nitrogen Reduction (Fraction)	Phosphorus Reduction (Fraction)	Sediment Reduction (Fraction)	Average Reduction[a] (Fraction)	Average Survey Score[b]	Reduction Survey Score[c]
Extended Wet Detention	**0.55**	**0.69**	**0.86**	**0.70**	**3.8**	**2.7**
Infiltration Basin	**0.6**	**0.65**	**0.75**	**0.67**	**3.3**	**2.2**
Concrete Grid Pavement	**0.9**	**0.9**	**0.9**	**0.90**	**2.3**	**2.1**
Low Impact Development - Infiltration Swale	0.5	0.65	0.9	0.68	2.9	2.0
Porous Pavement	0.85	0.65	0.9	0.80	2.2	1.8
Bioretention Facility	0.63	0.8	0	0.48	3.6	1.7
Infiltration Trench	0.55	0.6	0.75	0.63	2.6	1.6
Infiltration Devices	0	0.83	0.94	0.59	2.7	1.6
Vegetated Filter Strips	0.4	0.45	0.73	0.53	2.9	1.5
Settling Basin	0	0.52	0.82	0.45	3.3	1.5
Low Impact Development - Infiltration Trench	0.5	0.5	0.9	0.63	2.3	1.4
Dry Detention	0.3	0.26	0.58	0.38	3.7	1.4
Wetland Detention	0.2	0.44	0.78	0.47	2.9	1.4
Sand Filter/Infiltration Basin	0.35	0.5	0.8	0.55	2.5	1.4
Low Impact Development - Filter/Buffer Strip	0.3	0.3	0.6	0.40	3.3	1.3
Low Impact Development - Bioretention	0.43	0.81	0	0.41	3.1	1.3
Low Impact Development - Dry Well	0.5	0.5	0.9	0.63	1.9	1.2
Grass Swales	0.1	0.25	0.65	0.33	3.5	1.2
Alum Treatment	0.6	0.9	0.95	0.82	1.4	1.1
Wet Pond	0.35	0.45	0.6	0.47	2.3	1.1
Sand Filters	0	0.38	0.83	0.40	2.6	1.0
Low Impact Development - Wet Swale	0.4	0.2	0.8	0.47	2.1	1.0
Water Quality Inlet With Sand Filter	0.35	0	0.8	0.38	2.5	1.0
Low Impact Development - Vegetated Swale	0.08	0.18	0.48	0.25	3.3	0.8
Filter Strip – Agricultural	0.53	0.61	0.65	0.60	1.3	0.8

Table 7-5. PLET Urban Best Management Practices and Average Reduction Metric (Page 2 of 2)

Practice	Nitrogen Reduction (Fraction)	Phosphorus Reduction (Fraction)	Sediment Reduction (Fraction)	Average Reduction[a] (Fraction)	Average Survey Score[b]	Reduction Survey Score[c]
Water Quality Inlets	0.2	0.09	0.37	0.22	3.3	0.7
Oil/Grit Separator	0.05	0.05	0.15	0.08	3.7	0.3
Weekly Street Sweeping	0	0.06	0.16	0.07	2.9	0.2

(a) Average Reduction is the product of the nitrogen, phosphorus, and sediment reduction.

(b) Average Survey Score is the average of the survey prioritization from Survey #2.

(c) The Survey Reduction Score is the product of the average reduction and the average survey score.

Table 7-6. Reductions From Priority PLET Best Management Practices Run on 25 Percent of Each Applicable Land Cover

Land Use	Percent of Total Area	Practice	Nitrogen Load (lb/year)	Nitrogen Reduction (%)	Phosphorus Load (lb/year)	Phosphorus Reduction (%)	Sediment Load (tons/year)	Sediment Reduction (%)
All	N/A	Base Load (no BMPs)	568,871	N/A	219,044	N/A	176,414	N/A
Cropland	24	Stream Stabilization and Fencing	468,761	17.6	180,502	17.6	145,130	17.7
Cropland	24	Buffer - Grass (35 feet wide)	498,127	12.4	191,808	12.4	154,306	12.5
Pasture	2	Stream Stabilization and Fencing	567,294	0.3	218,437	0.3	175,921	0.3
Pasture	2	Livestock Exclusion Fencing	567,525	0.2	218,526	0.2	175,993	0.2
Feedlot	<1	Waste Management System	568,871	0.0	219,044	0.0	176,414	0.0
Forest	2	Site Prep/Straw/ Crimp Seed/Net	568,752	0.0	218,999	0.0	176,377	0.0
Forest	2	Site Prep/Straw/Crimp Seed/ Fertilizer/Transplants	568,750	0.0	218,998	0.0	176,376	0.0
Urban	3	Extended Wet Detention	568,871	0.0	219,044	0.0	176,414	0.0
Urban	3	Infiltration Basin	568,871	0.0	219,044	0.0	176,414	0.0
Urban	3	Concrete Grid Pavement	568,871	0.0	219,044	0.0	176,414	0.0

lb/year = pounds per year

Numerous BMPs that reduce nutrient and sediment NPS loads exist from other sources not included in PLET. Nutrient and sediment load reductions from BMPs are ranked in the Natural Resources Conservation Service (NRCS) Conservation Practice Physical Effects (CPPE) [NRCS, 2024b] as substantial, moderate to substantial, moderate, slight to moderate, and slight. Similarly, reductions expected from urban practices are provided in the International Stormwater BMP Database (BMPDB) [The Water Research Foundation, 2024]. Tables 7-7 and 7-8 list the most effective CPPE practices (i.e., substantial, moderate to substantial, and moderate reductions) and urban practices for sediment reduction. Table 7-9 shows the most effective CPPE practices (i.e., substantial, moderate to substantial, and moderate reductions) for nutrient reduction, and Tables 7-10 and 7-11 provide the urban practices for nitrogen and phosphorus reduction, respectively [NRCS, 2024b]. Irrigation practices are important in the project area for the reduction of nutrients and sediment but were not available in PLET. The NRCS Irrigation Water Management practice code Number 449 has slight to moderate improvement (less than every other practice listed in CPPE practices tables) for sediment and nutrients. However, the NRCS Irrigation Water Management practice code Number 449 has been added to these tables because of its high usage in the project area. Other practices with slight to moderate improvement should not be discouraged, even though they are not included in the tables in this section.

Table 7-7. Most Effective Sediment to Surface Water Reducing Agricultural Best Management Practices From the Colorado Natural Resources Conservation Service Conservation Practice Physical Effects (Page 1 of 2)

Practice	Practice Code	Unit	Effect	Rationale
Constructed Wetland	656	Acre	Substantial Improvement	The system traps and holds suspended materials from entering surface waters.
Filter Strip	393	Acre	Substantial Improvement	Vegetation protects the soil surface and traps sediment, nutrients, and other materials.
Grassed Waterway	412	Acre	Substantial Improvement	Erosion is controlled, vegetation traps sediment, and runoff is delivered at a safe velocity.
Lined Waterway or Outlet	468	Feet	Substantial Improvement	Erosion is controlled, vegetation traps sediment, and runoff is delivered at a safe velocity.
Riparian Forest Buffer	391	Acre	Substantial Improvement	Vegetation protects the soil surface and traps sediment, nutrients, and other materials.
Anionic Polyacrylamide Erosion Control	450	Acre	Moderate to Substantial Improvement	The action reduces erosion and sediment load.
Conservation Cover	327	Acre	Moderate to Substantial Improvement	Less erosion and runoff reduce sediment.
Critical Area Planting	342	Acre	Moderate to Substantial Improvement	Vegetation reduces erosion and sediment delivery.
Forest Farming	379	Acre	Moderate to Substantial Improvement	Varied canopy layers and surface cover and organic matter management reduce sediment-laden runoff from reaching surface water conveyances.
Grazing Land Mechanical Treatment	548	Acre	Moderate to Substantial Improvement	Improved hydrologic indicators increase infiltration and decrease runoff.
Land Reclamation, Abandoned Mined Land	543	Acre	Moderate to Substantial Improvement	Erosion control and revegetation reduces concerns about sediments.
Land Reclamation, Currently Mined Land	544	Acre	Moderate to Substantial Improvement	Erosion control and revegetation reduces concerns about sediments.
Land Reclamation, Landslide Treatment	453	N/A	Moderate to Substantial Improvement	Erosion control and increased cover reduces runoff and sediment.
Residue and Tillage Management, No Till	329	Acre	Moderate to Substantial Improvement	Less erosion and runoff reduce the transport of sediment.
Riparian Herbaceous Cover	390	Acre	Moderate to Substantial Improvement	Vegetation protects the soil surface and traps sediment, nutrients, and other materials.
Sediment Basin	350	N/A	Moderate to Substantial Improvement	The basin retains sediment, decreasing runoff turbidity.
Stormwater Runoff Control	570	N/A	Moderate to Substantial Improvement	Controlling erosion and runoff reduces off-site sediment.
Vegetative Barrier	601	Feet	Moderate to Substantial Improvement	Vegetation slows runoff and filters sediment.
Water and Sediment Control Basin	638	N/A	Moderate to Substantial Improvement	The basin retains sediment and minimizes turbidity.
Access Control	472	Acre	Moderate Improvement	Excluding animals, people, and vehicles influences the vigor and health of vegetation and soil conditions, reducing sediment supply to surface waters when applied with other management practices.
Alley Cropping	311	Acre	Moderate Improvement	Vegetation inhibits sediment-laden water to allow it to drop sediment load.
Conservation Crop Rotation	328	Acre	Moderate Improvement	Depending on crop rotation and biomass produced, crop rotation reduces erosion and runoff, which reduces transport of sediment.
Contour Buffer Strips	332	Acre	Moderate Improvement	Contour buffer strips reduce sheet and rill erosion and slow the velocity of runoff, thereby reducing the transport of sediment to surface water.

Table 7-7. Most Effective Sediment to Surface Water Reducing Agricultural Best Management Practices From the Colorado Natural Resources Conservation Service Conservation Practice Physical Effects (Page 2 of 2)

Practice	Practice Code	Unit	Effect	Rationale
Contour Orchard and Other Perennial Crops	331	Acre	Moderate Improvement	Contouring reduces sheet and rill erosion and slows the velocity of runoff, thereby reducing the transport of sediment to surface water.
Field Border	386	Feet	Moderate Improvement	Vegetation protects the soil surface and traps sediment.
Residue and Tillage Management, Reduced Till	345	Acre	Moderate Improvement	Less erosion and runoff reduce the transport of sediment.
Road/Trail/Landing Closure and Treatment	654	Feet	Moderate Improvement	Vegetation and other treatments reduce erosion and sediment delivery.
Silvopasture	381	Acre	Moderate Improvement	On sites that previously lacked permanent vegetation, establishing a combination of trees or shrubs and compatible forages reduces the erosive force of water and reduces sedimentation.
Stripcropping	585	Acre	Moderate Improvement	Stripcropping reduces erosion and slows water and wind velocities, increasing infiltration.
Surface Roughening	609	Acre	Moderate Improvement	The formation of clods reduces wind-borne sediment.
Tree/Shrub Establishment	612	Acre	Moderate Improvement	Vegetation provides cover, reduces wind velocities, and increases infiltration.
Wetland Wildlife Habitat Management	644	Acre	Moderate Improvement	Improved vegetative cover reduces runoff and sedimentation.
Irrigation Water Management	449	Acre	Slight to Moderate Improvement	Water is applied at rates that minimize soil erosion.

Table 7-8. Most Effective Sediment (Greater Than 10 Percent) Reducing Urban Best Management Practices From the International Best Management Practice Database

BMP Category	Concentration In (mg/L)	Concentration Out (mg/L)	Reduction (%)
High-Rate Biofiltration	30.8	3.8	88
Media Filter	44	7.2	84
Bioretention	44	10	77
Retention Pond	49	12	76
Porous Pavement	77	22	71
Detention Basin	65.1	22	66
Wetland Basin	35.5	14	61
High-Rate Media Filtration	44	18	59
Oil-Grit Separator	36	15.5	57
Grass Strip	48	23	52
Grass Swale	26	13.7	47
Hydrodynamic Separator	63.9	39	39

mg/L = milligrams per liter

Table 7-9. Most Effective Nutrient to Surface Water Reducing Agricultural Best Management Practices From the Colorado Natural Resources Conservation Service Conservation Practice Physical Effects (Page 1 of 2)

Practice	Practice Code	Unit	Effect	Rationale
Filter Strip	393	Acre	Substantial Improvement	Solid organics and sediment-attached nutrients are filtered out; soluble nutrients infiltrate the soil and may be taken up by plants or used by soil organisms.
Nutrient Management	590	Acre	Substantial Improvement	The right amount, source, placement, and timing provide nutrients when plants need them most.
Riparian Forest Buffer	391	Acre	Substantial Improvement	Plants and soil organisms in the buffer use nutrients; the buffer filters out suspended particles to which nutrients are attached.
Riparian Herbaceous Cover	390	Acre	Substantial Improvement	Permanent vegetation uptakes excess nutrients.
Saturated Buffer	604	Feet	Substantial Improvement	The buffer removes 60 to 100% of nitrogen from drain pipe discharge.
Sediment Basin	350	N/A	Substantial Improvement	The action tends to accumulate contaminants attached to sediments, and infiltrating waters removes soluble contaminants.
Conservation Cover	327	Acre	Moderate to Substantial Improvement	Less erosion and runoff reduce the transport of nutrients; permanent cover can take up excess nutrients and convert them to stable organic forms.
Constructed Wetland	656	Acre	Moderate to Substantial Improvement	The action traps nutrients and organics, which are broken down and used by wetland plants.
Short-Term Storage of Animal Waste and Byproducts	318	Cubic Yard	Moderate to Substantial Improvement	Short-term storage provides flexibility in rate, timing, and location of waste application, with the potential for reductions of contaminants available for transport.
Vegetated Treatment Area	635	Acre	Moderate to Substantial Improvement	Infiltration and plant uptake in the treatment area removes contaminants from polluted runoff and wastewater.
Waste Storage Facility	313	#	Moderate to Substantial Improvement	Storage provides flexibility in rate, timing, and location of waste application, with the potential for reductions of contaminants available for transport.
Waste Treatment Lagoon	359	#	Moderate to Substantial Improvement	Storage provides flexibility in rate, timing, and location of waste application, with the potential for reductions of contaminants available for transport.
Watering Facility	614	#	Moderate to Substantial Improvement	When used in place of an instream water source, this action decreases manure deposition in the stream.
Alley Cropping	311	Acre	Moderate Improvement	Plants and soil organisms uptake nutrients.
Conservation Crop Rotation	328	Acre	Moderate Improvement	Nitrogen-demanding or deep-rooted crops can remove excess nitrogen; legumes in rotation provides slow-release nitrogen and reduce the need for additional nitrogen.
Denitrifying Bioreactor	605	#	Moderate Improvement	Reactors remove 30 to 60% of the nitrogen load coming from a drain pipe.
Diversion	362	Feet	Moderate Improvement	The action diverts surface water away from feedlots and reduces 5-day Biological Oxygen Demand; total phosphorous and total nitrogen load to receiving surface waters.

Table 7-9. Most Effective Nutrient to Surface Water Reducing Agricultural Best Management Practices From the Colorado Natural Resources Conservation Service Conservation Practice Physical Effects (Page 2 of 2)

Practice	Practice Code	Unit	Effect	Rationale
Grazing Land Mechanical Treatment	548	Acre	Moderate Improvement	Modifications to soil conditions increase infiltration and reduce runoff; improved plant growth better uses nutrients, decreasing the potential for losses in runoff.
Livestock Shelter Structure	576	#	Moderate Improvement	Moving livestock away from streams and riparian areas decreases the probability of excess manure nutrients in the water.
Silvopasture	381	Acre	Moderate Improvement	Depending on previous vegetative conditions, whether forestland or pasture, the permanent silvopasture vegetation may take up comparatively greater amounts of nutrients.
Wetland Creation	658	Acre	Moderate Improvement	Wetland systems use dissolved nutrients and trap sediment-attached nutrients and organics.
Wetland Enhancement	659	Acre	Moderate Improvement	Wetland systems use dissolved nutrients and trap sediment-attached nutrients and organics.
Wetland Restoration	657	Acre	Moderate Improvement	Wetland systems use dissolved nutrients and trap sediment-attached nutrients and organics.
Irrigation Water Management	449	Acre	Slight to Moderate Improvement	Water is applied at rates that reduce the potential for erosion and detachment, and minimize nutrient transport to surface water.

Table 7-10. Most Effective Nitrogen (Greater Than 10 Percent) Reducing Urban Best Management Practices From the International Best Management Practice Database

BMP Category	Concentration In (mg/L)	Concentration Out (mg/L)	Reduction (%)
High-Rate Media Filtration	1.88	1	47
Retention Pond	1.63	1.2	26
Bioretention	1.26	0.96	24
Wetland Channel	1.76	1.45	18
Media Filter	1.06	0.89	16
Grass Strip	1.47	1.27	14
Grass Swale	0.71	0.63	11

Table 7-11. Most Effective Phosphorus (Greater Than 10 Percent) Reducing Urban Best Management Practices From the International Best Management Practice Database

BMP Category	Concentration In (mg/L)	Concentration Out (mg/L)	Reduction (%)
Oil-Grit Separator	0.316	0.115	64
Retention Pond	0.246	0.12	51
High-Rate Biofiltration	0.099	0.05	49
Media Filter	0.165	0.09	45
Porous Pavement	0.17	0.1	41
High-Rate Media Filtration	0.12	0.08	33
Wetland Basin	0.17	0.122	28
Detention Basin	0.25	0.186	26
Hydrodynamic Separator	0.23	0.176	23

Practices associated with reducing wildfire impacts include susceptibility and post-fire hazard analyses and pre-disaster planning and mitigation. The susceptibility analysis includes determining the assets at risk from fire and the risk severity of post-fire impacts, such as flooding, loss of life, loss of property, damage to infrastructure, utility interruptions, and water quality and quantity issues. Post-fire hazards consist of flooding, sediment/hillslope erosion, debris flow, fluvial hazard zones, water quality issues, and risk to water infrastructure. Post-fire BMPs should involve slope stabilization and reforestation.

7.2 E. COLI

E. coli load reductions from BMPs are ranked in the NRCS CPPE as substantial, moderate to substantial, moderate, slight to moderate, and slight. Table 7-12 lists the most effective practices (i.e., substantial, moderate to substantial, and moderate reductions) [NRCS, 2024b]. *E. coli* reductions expected from the BMPDB's urban practices are summarized in Table 7-13 [The Water Research Foundation, 2024]. Unlike the sediment and nutrient reductions, *E. coli* reductions are not quantified using the PLET model; therefore, priority BMPs should be those with the highest amount of reduction in the priority areas on the relative land cover. The NRCS Irrigation Water Management practice code Number 449 has slight to moderate improvement for bacteria, and it was included in Table 7-12 because of its high probability of installation. Practices with slight to moderate improvement should not be discouraged, even though they are not included in the tables in this section.

Table 7-12. Most Effective Bacteria (Pathogen) to Surface Water Reducing Agricultural Best Management Practices From the Colorado Natural Resources Conservation Service Conservation Practice Physical Effects

Practice	Practice Code	Unit	Effect	Rationale
Vegetated Treatment Area	635	Acre	Substantial Improvement	Infiltration and plant uptake in the treatment area remove contaminants from polluted runoff and wastewater.
Constructed Wetland	656	Acre	Moderate to Substantial Improvement	Pathogens are trapped in the wetland.
Filter Strip	393	Acre	Moderate to Substantial Improvement	Filter strips capture and delay pathogen movement, but mortality may also be delayed because vegetative cover may protect pathogens from desiccation.
Nutrient Management	590	Acre	Moderate to Substantial Improvement	Proper application of manure, compost, and bio-solids should reduce or eliminate pathogens and/or chemicals (if present in source material) from moving into surface water.
Waste Treatment Lagoon	359	N/A	Moderate to Substantial Improvement	Storage provides flexibility in rate, timing, and location of waste application, with the potential for reductions of contaminants available for transport.
Alley Cropping	311	Acre	Moderate Improvement	Ground vegetation captures and delays pathogen movement and thereby increases their mortality.
Forest Farming	379	Acre	Moderate Improvement	Management of multilayered canopy cover and organic matter impedes the movement of harmful pathogens.
Land Reclamation, Abandoned Mined Land	543	Acre	Moderate Improvement	Reconstructed mine land provides reduced runoff and erosion, and the filtering effects of vegetation reduce the risk of harmful levels of pathogens entering surface water.
Land Reclamation, Currently Mined Land	544	Acre	Moderate Improvement	Reconstructed mine land provides reduced runoff and erosion, and the filtering effects of vegetation reduce the risk of harmful levels of pathogens entering surface water.
Riparian Forest Buffer	391	Acre	Moderate Improvement	Riparian areas capture and delay pathogen movement and thereby increase their mortality.
Riparian Herbaceous Cover	390	Acre	Moderate Improvement	Vegetation traps pathogens providing increased opportunity for solar and microbial action to destroy some.
Irrigation Water Management	449	Acre	Slight to Moderate Improvement	Water is applied at rates that minimize pathogens transport to surface water.

Table 7-13. Most Effective *E. coli* (Greater Than 10 Percent) Reducing Urban Best Management Practices From the International Best Management Practice Database

BMP Category	Concentration In (mpn/100 mL)	Concentration Out (mpn/100 mL)	Reduction (%)
Wetland Basin	6,210	884	86
Retention Pond	4,110	708	83
Media Filter	570	215	62
Detention Basin	900	500	44
Bioretention	275	158	43
Hydrodynamic Separator	2,400	1,700	29

mpn = most probable number

7.3 HEAVY METALS

Several risks are associated with abandoned mines. To prioritize public safety, specific locations of abandoned mines are not disclosed; however, taking action to mitigate potential dangers is important. The efforts of groups like Defense-Related Uranium Mines (DRUMs) are crucial in sealing off dangerous openings, identifying hazards, and implementing safety measures to protect the public and environment. This approach balances transparency with the need to safeguard communities from potential harm and is more focused on water quality and heavy-metal-impaired waterbodies. When waters are exposed to rocks containing sulfide minerals, they tend to become acid-rich. This occurrence is called acid rock drainage and is prevalent in mined areas where spent materials were left unclaimed. When the waters become acidic, they are more capable of gathering up and carrying heavy metals, including those that impair the waterbodies on the 303(d) list within the project area.

The AML implementation should be guided by the NRCS Code 543 practices. The NRCS Conservation Practice Standard states the following options for land reclamation of AML [NRCS, 2024c]:

Public health and safety: Prior to beginning onsite investigations, identify possible hazards and implement appropriate safety precautions.

Erosion and sediment control practices: Control or treat runoff and sedimentation from treatment areas, soil material stockpiles, access roads, and permanent impoundments. Use sediment-trapping practices, such as filter strips, riparian forest buffers, contour buffer strips, silt fences, sediment basins, or similar practices. Include temporary practices necessary during earth moving activities and permanent practices necessary to stabilize the site and control runoff from the site after reclamation.

Control the generation of particulate matter and fugitive dust during removal and replacement of soil and other materials.

Site preparation: Identify areas for preservation during construction. Include areas containing desirable trees, shrubs, grasses, stream corridors, natural springs, historic structures, or other important features that will be protected during construction activities.

Remove trees, logs, brush, rubbish, and other debris that interfere with reclamation operations. Dispose of debris material in a way that does not create a resource problem or interfere with reclamation activities and the planned land use.

Storage of soil materials: Stockpile soil or fill materials until needed for reclamation. Protect stockpiles from wind and water erosion, dust generation, unnecessary compaction, and contamination by noxious weeds, invasive species, or other undesirable materials.

Highwall treatment: Prior to backfilling, rock walls should have horizontal:vertical slopes of 0.5:1 or less. before placing backfill against the wall. Determine the thickness and density of lifts for fill material to limit the deep infiltration of precipitation and to limit settlement of the completed fill to acceptable levels, based on the available fill material and planned land use.

Shafts and adits: Use NRCS Conservation Practice Standard (CPS) Mine Shaft and Adit Closing (Code 457) to close/seal a shaft or adit. Divert runoff away from the shaft or adit.

Placement of surface material: Develop a grading plan that returns the site, including any off-site borrow areas, to contours that are suitable for the planned land use and control soil loss. Include the spreading of stockpiled topsoil material as the final layer. Treat graded areas to eliminate slippage surfaces and promote root penetration before spreading surface material. Spread surface soil without causing over-compaction.

Shape the land surface to provide adequate surface drainage and to blend into the surrounding topography. Use erosion control practices to reduce slope lengths where sheet and rill erosion exceeds acceptable levels. If settlement is likely to interfere with the planned land use, develop surface drainage or water disposal plans that compensate for the expected settlement.

If the subsurface material is not a source of contamination, improve soil permeability after placing backfill material by using deep ripping tools to decrease compaction, promote infiltration, and encourage root development. Do not plan practices that promote infiltration if seepage through cover materials has the potential to develop or exacerbate acid mine drainage loading or treatment.

Restoration of borrow material: If cover or fill material is taken from areas outside the reclamation site, stockpile the topsoil from the borrow area separately, and replace it on the borrow area after the area is restored for its intended purpose. Grade and shape the borrow area for proper drainage, and revegetate the site to control erosion.

Establishment of vegetation: Prepare a revegetation plan for the treated areas. Select plant materials suitable for the specified end land use according to local climate potential, site conditions, and local NRCS criteria. Use native species where possible. Avoid use of invasive species.

Use the criteria in NRCS CPS Critical Area Planting (Code 342) to establish grasses and forbs. Use NRCS CPS Tree-Shrub Establishment (Code 612) for the establishment of trees and shrubs. If vegetation cannot be established, use NRCS CPS Mulching (Code 484).

Control of toxic aqueous discharge: Identify and document water quality and quantity and releases from seeps, overland, and mine shafts. Quantify water impacts such as low pH, arsenic, etc. Identify measures that may affect treatment such as dissolved oxygen, iron, aluminum, magnesium, manganese, etc.

Methods for treatment of toxic aqueous discharge depend upon the type and extent of the contamination. When control of toxic mine drainage is needed, use BMPs that comply with state regulatory requirements. Evaluate the consequences of each potential treatment method to avoid creating a secondary problem. Select a method that can adequately treat the water based on the quantity and chemistry of the mine water and that is suitable for the planned level of operation and maintenance. Size the treatment area and settling basin(s) to allow for the volume of flow and treatment rate. Include a plan for disposal of the precipitated metals and spent treatment material.

Reduce the volume of contaminated water by diverting clean water away from the contaminated area or by limiting the opportunity for water to contact contaminated soil materials. Install practices, such as diversions, underground outlets, lined waterways, or grade stabilization structures, to control surface runoff. To the extent possible, divert clean upslope runoff away from the treated area.

- **Contaminated soil materials:** Remove, bury, or treat soil materials that adversely affect or have the potential to adversely affect water quality or plant growth. Bury materials containing heavy metals below the root zone, add suitable soil amendments, or both, to minimize the negative effect of this material. Separate soils with high electrical conductivity, calcium carbonate, sodium, or other restrictive properties, and treat, if practicable.
- Add a layer of compacted clay or a landfill cover over the contaminated material to deter infiltration. Place an earthfill blanket over the compacted clay to support plant growth. For each layer, identify the lift thickness and density needed to limit deep infiltration of precipitation and excessive settlement of the completed fill.
- **Mine sealing:** If clean water is entering a mine opening, divert the water away. If contaminated water is exiting the mine, it may be necessary to seal the mine to prevent water movement. Use NRCS CPS Mine Shaft and Adit Closing (Code 457) to design the mine seal. Divert surface water away from the mine seal.
- **Neutralization and precipitation:** Precipitate toxic metals and neutralize acidity in mine drainage using chemical or biological treatment. Select a method that can adequately treat the water based on the quantity and chemistry of the mine water and that is suitable for the planned level of operation and maintenance. Size the treatment area and settling basin(s) to allow for the volume of flow and treatment rate. Include a plan for disposal of the precipitated metals and spent treatment material.

Aside from AMLs, heavy metals also come from agricultural lands and urbanized areas. Heavy metal load reductions from BMPs are ranked in the NRCS CPPE as substantial, moderate to substantial, moderate, slight to moderate, and slight. Table 7-14 lists the most effective practices (i.e., substantial, moderate to substantial, and moderate reductions) [NRCS, 2024b]. Heavy metal reductions expected from the BMPDB's urban practices are summarized in Table 7-15 [The Water Research Foundation, 2024]. Heavy metal reductions are not quantified using the PLET model; therefore, priority BMPs should be those with the highest amount of reduction in the priority areas on the relative land cover. The NRCS Irrigation Water Management practice code Number 449 has slight to moderate improvement for heavy metals. Irrigation management is the only NRCS practice included with less than moderate improvement. It was included because of its high probability of installation in the project area. Practices with slight to moderate improvement should not be discouraged, even though they are not included in the tables in this section.

Table 7-14. Most Effective Heavy Metals to Surface Water Reducing Agricultural Best Management Practices From the Colorado Natural Resources Conservation Service Conservation Practice Physical Effects

Practice	Practice Code	Unit	Effect	Rationale
On-Farm Secondary Containment Facility	319	N/A	Substantial Improvement	Provides for spill containment of petroleum products.
Constructed Wetland	656	Acre	Moderate to Substantial Improvement	Vegetation and anaerobic conditions trap heavy metals.
Irrigation and Drainage Tailwater Recovery	447	N/A	Moderate to Substantial Improvement	The action captures irrigation and/or drainage runoff and associated metal-laden sediment.
Land Reclamation, Landslide Treatment	453	N/A	Moderate to Substantial Improvement	Increased vegetation increases infiltration and reduces runoff and erosion.
Land Reclamation, Toxic Discharge Control	455	N/A	Moderate to Substantial Improvement	Control of discharge and reduction in infiltration reduce off-site movement of contaminated water.
Riparian Forest Buffer	391	Acre	Moderate Improvement	The action filters sediment, and some plants may uptake heavy metals.
Road/Trail/Landing Closure and Treatment	654	Feet	Moderate Improvement	Decreased erosion and runoff reduce heavy metal delivery to surface water; increased soil organic matter increases the capacity of soils to retain heavy metals; permanent vegetation can uptake heavy metals.
Irrigation Water Management	449	Acre	Slight to Moderate Improvement	Water is applied at rates that minimize heavy metals transport to surface water.

Table 7-15. Most Effective Heavy Metal (Greater Than 10 Percent) Reducing Urban Best Management Practices From the International Best Management Practice Database

Category	BMP Category	Concentration In (µg/L)	Concentration Out (µg/L)	Reduction (%)
Arsenic (T)	Media Filter	0.9	0.765	15
Arsenic (T)	Retention Pond	1	0.87	13
Arsenic (T)	Grass Swale	1.11	1	10
Cadmium (D)	Grass Swale	0.2	0.116	42
Cadmium (D)	Grass Strip	0.114	0.07	39
Cadmium (D)	Media Filter	0.2	0.128	36
Cadmium (D)	Oil-Grit Separator	0.155	0.101	35
Cadmium (D)	Hydrodynamic Separator	0.137	0.0933	32
Cadmium (D)	Retention Pond	0.163	0.125	23
Cadmium (D)	Detention Basin	0.117	0.0942	19
Copper (D)	Wetland Basin	3.95	2.29	42
Copper (D)	Grass Strip	12	7.4	38
Copper (D)	Retention Pond	5.08	3.5	31
Copper (D)	Detention Basin	3.96	2.99	24
Copper (D)	High-Rate Biofiltration	4.5	3.4	24
Copper (D)	Media Filter	3.86	3	22
Copper (D)	Grass Swale	6.5	5.63	13
Iron (T)	Retention Pond	1050	285	73
Iron (T)	Media Filter	685	195	72
Iron (T)	Grass Strip	746	320	57
Iron (T)	Grass Swale	216	136	37
Zinc (D)	Media Filter	32	7.15	78
Zinc (D)	Porous Pavement	17.8	4.09	77
Zinc (D)	Wetland Basin	22.6	8.35	63
Zinc (D)	High-Rate Biofiltration	189	79	58
Zinc (D)	Grass Strip	33.6	17	49
Zinc (D)	Grass Swale	34.2	19.8	42
Zinc (D)	Bioretention	20.8	12.5	40
Zinc (D)	Retention Pond	23.4	16	32
Zinc (D)	Detention Basin	12.1	9.38	22

µg/L = micrograms per liter

D = dissolved

T = total

8.0 PAST AND CURRENT BEST MANAGEMENT PRACTICES

According to stakeholder Survey #2, few BMPs have been implemented in the Middle South Platte River project area. However, many BMPs have been implemented in watersheds that drain to the Middle South Platte River, including the St. Vrain, Big and Little Thompson Rivers, and Cache la Poudre Watersheds [Kirby et al., 2024a, 2024b, 2024c].

Practices implemented by watershed and/or county were not available from the NRCS; however, they were available for the State of Colorado. An assumption was made that, the more likely a practice is to be implemented in Colorado, the more likely it would be implemented in the project area. Funding sources and programs involved in implementing practices in Colorado include the Agricultural Conservation Easement Program (ACEP), Agricultural Water Enhancement Program (AWEP) Conservation Reserve Program (CRP), Conservation Stewardship Program (CSP), Conservation Technical Assistance (CTA), Emergency Watershed Protection Program (EWP), Environmental Quality Incentives Program (EQIP), Farm and Ranch Lands Protection Program (FRPP), Grass Reserve Program (GRP), Regional Conservation Partnership Program (RCPP), Resource Conservation and Development Program (RCD), Watershed Protection and Flood Prevention Operations (WFPO) Program, Watershed Rehabilitation (WHRB), Wetlands Reserve Program (WRP), and Wildlife Habitat Incentive Program (WHIP). Table 8-1 lists the practices implemented on more than 50 mi^2 in Colorado since 2005 that should continue to be implemented for water quality improvement [USDA, 2024].

Table 8-1. Best Management Practices Implemented Annually on More Than 50 Square Miles in Colorado Since 2005 (Page 1 of 2)

Practice Name	Practice Code	Colorado mi^2	Associated Land Use	Percent of Associated Area	Project Area Land Use (mi^2)	Project Area Practice (Available Remaining) (mi^2)
Prescribed Grazing	528	1,169	Pasture	100	44.9	—
Upland Wildlife Habitat Management	645	433	Pasture	38	44.9	16.9
Conservation Crop Rotation	328	287	Cropland	2	554.1	12.7
Watering Facility	614	286	Pasture	25	44.9	11.1
Livestock Pipeline	516	210	Pasture	18	44.9	8.2
Fence	382	194	Pasture	17	44.9	7.6
Pest Management Conservation System	595	180	Cropland	1	554.1	7.9
Conservation Cover	327	154	Cropland	1	554.1	6.8
Access Control	472	154	Pasture	13	44.9	6.0
Nutrient Management	590	134	Cropland	1	554.1	5.9
Pumping Plant	533	121	Cropland	1	554.1	5.3
Brush Management	314	118	Forest	<1	0.3	0.0
Residue and Tillage Management, Reduced Till	345	104	Cropland	<1	554.1	4.6
Residue and Tillage Management, No Till	329	99	Cropland	<1	554.1	4.4
Irrigation Water Management	449	98	Cropland	<1	554.1	4.3
Residue Management, Seasonal	344	85	Cropland	<1	554.1	3.8
Prescribed Grazing - Enhancements	E528	81	Pasture	7	44.9	3.2
Early Successional Habitat Development - Management	647	72	Other	<1	1,689.6	3.7
Pest Management Conservation System - Enhancements	E595	68	Cropland	<1	554.1	3.0
Herbaceous Weed Treatment	315	66	Cropland	<1	554.1	2.9
Nutrient Management - Enhancements	E590	57	Cropland	<1	554.1	2.5
Water Well	642	55	Cropland	<1	554.1	2.4

Table 8-1. Best Management Practices Implemented Annually on More Than 50 Square Miles in Colorado Since 2005 (Page 2 of 2)

Practice Name	Practice Code	Colorado (mi^2)	Associated Land Use	Percent of Associated Area	Project Area Land Use (mi^2)	Project Area Practice (Available Remaining) (mi^2)
Range Planting	550	51	Pasture	4	44.9	2.0
Cover Crop	340	49	Cropland	<1	554.1	2.2
Forage Harvest Management	511	47	Forest	<1	0.3	0.0
Structure for Water Control	587	33	Cropland	<1	554.1	1.5
Irrigation Pipeline	430	30	Cropland	<1	554.1	1.3
Forest Stand Improvement	666	27	Forest	<1	0.3	0.0

9.0 RECOMMENDED BEST MANAGEMENT PRACTICES

This implementation plan provides recommendations for NPS implementation practices to reduce loads of pollutants of concern. The recommended implementation practices are based on practices that are the most likely to be implemented and most impactful in reducing pollutants of concern.

9.1 FUTURE MUNICIPAL SEPARATE STORM SEWER SYSTEM AREAS

Stormwater resulting from rainfall, snowmelt, or other surface water runoff and drainage originates from impervious areas in towns; cities; residential developments; and industrial, manufacturing, or agricultural facilities. Stormwater flows accumulate from streets, parking lots, rooftops, catch basins, curbs, gutters, ditches, drainage channels, storm drains, and other impervious surfaces that may play a role in the contribution of pollutant loading because of the proximity of these impervious areas to the impaired waterbodies. Stormwater discharges are permitted under numerous MS4 permits in Colorado, which include the statewide standard MS4 general permit (COR090000) and statewide nonstandard MS4 general permit (COR070000). Areas covered by MS4 permits are not considered NPSs.

No communities in the Middle South Platte have been designated as an MS4, nor are any expected to become one within the near future (5 to 15 years). The areas expected to become MS4s were identified using the same sources as in Section 5.1 [Catena Analytics, 2024; U.S. Census Bureau, 2020; Smith, 2024].

9.2 DEVELOPED

Throughout the Middle South Platte River project area, approximately 64 mi^2 of non-MS4 developed land exist. MS4 areas are not represented in the project models. Only a very small area of MS4s exist in the project area (15.2 mi^2 in Greeley). BMPs recommended for MS4 and non-MS4 developed areas are similar to those outlined in Section 9.1. For nutrients and sediment, priority developed practices from PLET (Table 7-5) should be those with the highest rankings and reduction scores (i.e., extended wet detention, infiltration basins, and concrete gird pavement). For *E. coli*, priority developed practices should be those resulting in the largest reductions within the BMPDB (i.e., wetland basin and retention pond), as shown in Table 7-13. For heavy metals, priority developed practices should also be practices that resulted in the largest reductions of heavy metals in the BMPDB (depending on pollutants of concern in downstream waterbodies), as shown in Table 7-15. Practices do not need to be limited to these recommendations, and any practice that reduces pollutants of concern can be considered.

9.3 AGRICULTURAL (CROPLAND, PASTURELAND, AND FEEDLOT BEST MANAGEMENT PRACTICES)

Throughout the Middle South Platte River project area, approximately 554 mi^2 of cropland exist, approximately 45 mi^2 of pastureland exist, and approximately 251 acres are feedlots. For nutrients and sediment, priority agricultural practices from PLET (Tables 7-1 through 7-3) should be those with the highest rankings and reduction scores (i.e., streambank stabilization and fencing and 35-foot grass buffers for cropland, 35-foot grass buffers and livestock exclusion fencing for pasture, and waste management systems for feedlots). For *E. coli*, priority agricultural practices should be the most effective agricultural BMPs from the Colorado NRCS CPPE for reducing *E. coli* (i.e., vegetated treatment area, constructed wetland, filter strip, nutrient management, and waste treatment lagoon), as shown in Table 7-12. For heavy metals, priority agricultural practices should be the most effective agricultural BMPs from the Colorado NRCS CPPE for reducing heavy metals (i.e., on-farm secondary containment facility, constructed wetland, irrigation and drainage tailwater recovery, land reclamation (landslide treatment or toxic discharge control), as shown in Table 7-14. Additionally, practices that switch from flood irrigation to more efficient irrigation methods would be beneficial in reducing both *E. coli* and heavy metals such as arsenic. Although these practices are the most effective, BMPs do not need to be limited to these recommendations.

9.4 FOREST

Throughout the Middle South Platte River project area, approximately 38 mi^2 of forest land exist. Although forest land is less likely to contribute sediment, nutrients, and bacteria per acre of contributing area, BMPs are still beneficial, especially when considering historical fires, fire potential, abandoned mines, recreation, and grazing activities. For nutrients and sediment, priority forest practices from PLET (Table 7-4) should be those with the highest ranking and reduction scores (i.e., a combination of site preparation/straw/crimp seed/net/fertilizer/transplants). For *E. coli*, priority forest practices are not prioritized but should include those that exclude forest-grazing livestock from accessing streams and septic assessments.

9.5 ABANDONED MINE LANDS

Most AMLs in the watershed have not yet been identified because several are located on private land or in very remote locations. The primary practice completed on identified AMLs is to seal off dangerous openings, identify hazards, and implement safety measures to protect the public and environment. To improve water quality, identifying AMLs should become a higher priority. Although AML BMPs are not prioritized because of the variable nature of AML lands, each site should be assessed, and practices should be chosen that target specific issues related to each site. For heavy metals, priority practices should focus on AMLs, as outlined in Section 7.3.

10.0 INFORMATION, EDUCATION, AND OUTREACH

Current communication, education, and outreach efforts established in the Middle South Platte River project area should continue and be expanded to incorporate effectiveness and user feedback surveys that would complement current area outreach programs. Coordinated outreach efforts should increase the awareness of specific audiences regarding water quality problems and solutions, as well as available BMP technical and financial assistance programs for urban/residential areas, cropland, pasture lands, AMLs, and riparian areas. Stakeholders should continue to expand on their public outreach efforts and communications with the public by implementing inclusive and new engagement tactics to reach a broad audience. Education and outreach activities should target individuals and groups to evaluate effective outreach methods.

Stakeholder responses to Survey #2 were used to rank a list of information, education, and outreach options. The following survey ranking is from highest to lowest:

1. Water Quality Awareness Signage in Parks by Streams
2. Social Media Posts (Sent to Partners)
3. Website Updates
4. Educational Campaigns
5. Newsletters and Mailers
6. Pet-Waste Pickup Stations
7. Volunteer Cleanup Programs
8. School Visits
9. Project Story Map
10. Report a Concern Website
11. Radio Advertisements and Interviews
12. Tours and Field Trips

Entities within the watershed that are interested in collaborating with other stakeholder groups and hosting or participating in events include the Metro Water Recovery, City of Greeley, Northern Colorado Water Conservancy District, Colorado Watershed Assembly, Colorado Wheat Administrative Committee, and City of Evans. Participating in existing events can also expand outreach efforts. Northern Water has an annual water quality efficiency stakeholder meeting in the spring, as well as a spring and fall water symposium and a children's water festival. Each fall, a Sustaining Colorado Watersheds conference is held in Avon, Colorado. A Lower South Platte River Water Festival is also held for children in the community.

The NFRWQPA is compiling a "Stakeholder Toolkit" for the plans. This toolkit will help stakeholders reach, inform, and partner with their networks on the NPS watershed educational resources. Some of the options included in the toolkit include digital communications, print communications, and community outreach. The stakeholders will decide which tools will be chosen during the next round of funding. Examples of these and more information about the Stakeholder Toolkit are included in Appendix E.

11.0 CRITERIA TO ASSESS PROGRESS

Milestones toward progress can be demonstrated in many different ways. In these watersheds, options for measurable milestones can include progress toward meeting water quality criteria set by the state, trends toward improvement, and progress in the installation of implementation practices that are expected to improve water quality parameters of concern. Table 11-1 in the previous chapter shows practices that could be implemented to make progress and count as measurable milestones. Because goals in this watershed for this plan are very broad (the plan is not being written as a part of a specific Total Maximum Daily Load [TMDL] with a specified goal), milestones are more general than specific. Any practice implemented will be a part of progress toward the ultimate goal of improving water quality and ensuring water quality does not worsen. Relative implementation should be tracked, and this plan should be revisited after the first 5 years to ensure progress is being made. Reductions from NPS loadings will most likely require a significant, increased amount of technical and financial program assistance; BMP implementation through on-the-ground projects; proper watershed planning; and cooperation with willing landowners and land management agencies. Successfully achieving load reductions depends on several factors, such as the amount of voluntary participation, availability of technical and financial assistance, and effectiveness of BMPs intended to reduce applicable loads.

In Survey #2, organizations were asked about interim measurable criteria/goals and what progress would look like after 5 and 10 years. The Colorado Wheat Administrative Committee advised that monitoring water quality, reducing pollutants of concern loads, and meeting water quality criteria would display progress. The City of Greeley mentioned that continued localized improvements with respect to reducing *E. coli* and nutrient loads to ponds/lands and rivers would signify improvement. The City also mentioned that continued outreach with NPS dischargers and a successfully implemented plan beginning to take shape across the areawide watersheds would indicate progress. The City also mentioned that ultimate improvements to water quality that align with CDPHE goals and help share the load responsibility between point and NPS dischargers would be ideal. The City of Evans indicated that monitoring and more BMPs would be an indicator of progress within the next 5 to 10 years.

An implementation schedule is recommended to reduce pollutants of concern by implementing NPS BMPs. Table 11-1 provides a list of BMPs that would be most likely to benefit the area over the next 10 years options by land-use category. Tables 11-2, 11-3, and 11-4 provide the top two sources for each parameter group and the top practices to implement for each.

Table 11-1. Best Management Practices (Page 1 of 2)

Land-Use Category	Source	Recommended Implementation Activity
Future Stormwater/ Developed/Urban/Residential	PLET and Survey	Extended Wet Detention Ponds
Future Stormwater/ Developed/Urban/Residential	PLET and Survey	Infiltration Basins
Future Stormwater/ Developed/Urban/Residential	PLET and Survey	Concrete Grid Pavement
Future Stormwater/ Developed/Urban/Residential	BMPDB	High-Rate Biofiltration
Future Stormwater/ Developed/Urban/Residential	BMPDB	Media Filter
Future Stormwater/ Developed/Urban/Residential	BMPDB	Oil-Grit Separator
Future Stormwater/ Developed/Urban/Residential	BMPDB	Retention Pond
Future Stormwater/ Developed/Urban/Residential	BMPDB	High-Rate Media Filtration
Future Stormwater/ Developed/Urban/Residential	BMPDB	Wetland Basin
Future Stormwater/ Developed/Urban/Residential	BMPDB	Grass Swale
Future Stormwater/ Developed/Urban/Residential	Other	Low Impact Development Practices
Future Stormwater/ Developed/Urban/Residential	Other	Septic Upgrades
Ag - Cropland	PLET and Survey	Streambank Stabilization and Fencing
Ag - Cropland	PLET and Survey	Buffer - Grass (35 feet wide)
Ag - Cropland	NRCS	Constructed Wetland (656)
Ag - Cropland	NRCS	Filter Strip (393)
Ag - Cropland	NRCS	Vegetated Treatment Area (635)
Ag - Cropland	NRCS	On-Farm Secondary Containment Area (319)
Ag - Cropland	NRCS	Irrigation Water Management (449)
Ag - Pasture	PLET	Buffer - Grass (35 feet wide)
Ag - Pasture	PLET	Livestock Exclusion Fencing
Ag - Pasture	PLET and Survey	Streambank Stabilization and Fencing
Ag - Feedlot	PLET and Survey	Waste Management System
Forest	PLET and Survey	Site Preparation/ Straw/Crimp Seed/Net
Forest	PLET and Survey	Site Preparation/Straw/Crimp Seed/ Fertilizer/Transplants

Table 11-1. Best Management Practices (Page 2 of 2)

Land-Use Category	Source	Recommended Implementation Activity
AML	NRCS	Storage of Soil Materials
AML	NRCS	Placement of Surface Material
AML	NRCS	Restoration of Borrow Material
AML	NRCS	Establishment of Vegetation
AML	NRCS	Control of Toxic Aqueous Discharge
Monitoring	Other	Water Quality Sampling (base and storm events)
Monitoring	Other	Discharge Measurement (base and storm events)
Monitoring	Other	Monitor Implemented Agricultural BMP Effectiveness
Monitoring	Other	Monitor Implemented Urban BMP Effectiveness
Monitoring	Other	Monitor Implemented AML BMP Effectiveness
Outreach	Survey	Social Media Posts
Outreach	Survey	Website Updates
Outreach	Survey	Educational Campaigns
Outreach	Survey	Newsletters and Mailers
Outreach	Survey	Pet-Waste Pickup Stations
Outreach	Survey	Volunteer Cleanup Programs
Outreach	Survey	School Visits
Outreach	Survey	Project Story Map
Outreach	Survey	Report a Concern Website

Table 11-2. Dominant Land Uses, Sources, and Priority Practices by HUC10 for Nutrients and Sediment (Page 1 of 3)

Watershed	Dominant Land Uses	Top Sediment Sources	Top Phosphorus Sources	Top Nitrogen Sources	Priority Practices
1019000305 Beebe Seep Canal	Cropland and Pastureland	Cropland and Pastureland	Cropland and Pastureland	Cropland and Pastureland	/ Streambank Stabilization and Fencing / Buffer-Grass (35 feet wide) / Livestock Exclusion Fencing
1019000306 Little Dry Creek-South Platte River	Cropland and Pastureland	Cropland and Pastureland	Cropland and Pastureland	Cropland and Pastureland	/ Streambank Stabilization and Fencing / Buffer-Grass (35 feet wide) / Livestock Exclusion Fencing
1019000308 Outlet Box Elder Creek	Cropland and Urban Non-MS4	Cropland and Pastureland	Cropland and Pastureland	Cropland and Pastureland	/ Streambank Stabilization and Fencing / Buffer-Grass (35 feet wide) / Livestock Exclusion Fencing
1019000309 Lost Creek	Cropland and Urban Non-MS4	Cropland and Pastureland	Cropland and Pastureland	Cropland and Pastureland	/ Streambank Stabilization and Fencing / Buffer-Grass (35 feet wide) / Livestock Exclusion Fencing
1019000310 Sanborn Draw-South Platte River	Cropland and Urban Non-MS4	Cropland and Pastureland	Cropland and Pastureland	Cropland and Pastureland	/ Streambank Stabilization and Fencing / Buffer-Grass (35 feet wide) / Livestock Exclusion Fencing
1019000311 Greasewood Draw-South Platte River	Cropland and Forest	Cropland and Forest	Cropland and Forest	Cropland and Forest	/ Streambank Stabilization and Fencing / Buffer-Grass (35 feet wide) / Site Preparation/Straw/Crimp Seed/Net / Site Preparation/Straw/Crimp Seed/Fertilizer/Transplants
1019000312 Cottonwood Draw-South Platte River	Cropland and Urban Non-MS4	Cropland and Forest	Cropland and Forest	Cropland and Forest	/ Streambank Stabilization and Fencing / Buffer-Grass (35 feet wide) / Site Preparation/Straw/Crimp Seed/Net / Site Preparation/Straw/Crimp Seed/Fertilizer/Transplants
1019000801 Upper Lone Tree Creek	Forest and Urban Non-MS4	Forest	Forest	Forest	/ Site Preparation/Straw/Crimp Seed/Net / Site Preparation/Straw/Crimp Seed/Fertilizer/Transplants

Table 11-2. Dominant Land Uses, Sources, and Priority Practices by HUC10 for Nutrients and Sediment (Page 2 of 3)

Watershed	Dominant Land Uses	Top Sediment Sources	Top Phosphorus Sources	Top Nitrogen Sources	Priority Practices
1019000802 Spring Creek-Lone Tree Creek	Cropland and Forest	Cropland and Pastureland	Cropland and Pastureland	Cropland and Pastureland	/ Streambank Stabilization and Fencing / Buffer-Grass (35 feet wide) / Livestock Exclusion Fencing
1019000803 Owl Creek-Lone Tree Creek	Cropland and Urban Non-MS4	Cropland and Pastureland	Cropland and Pastureland	Cropland and Pastureland	/ Streambank Stabilization and Fencing / Buffer-Grass (35 feet wide) / Livestock Exclusion Fencing
1019000902 Little Crow Creek	Cropland and Urban Non-MS4	Cropland and Forest	Cropland and Forest	Cropland and Forest	/ Streambank Stabilization and Fencing / Buffer-Grass (35 feet wide) / Site Preparation/Straw/Crimp Seed/Net / Site Preparation/Straw/Crimp Seed/Fertilizer/Transplants
1019000903 Middle Crow Creek	Cropland and Urban Non-MS4	Cropland and Pastureland	Cropland and Pastureland	Cropland and Pastureland	/ Streambank Stabilization and Fencing / Buffer-Grass (35 feet wide) / Livestock Exclusion Fencing
1019000904 Coal Creek	Forest and Urban Non-MS4	Pastureland and Forest	Pastureland and Forest	Pastureland and Forest	/ Buffer-Grass (35 feet wide) / Livestock Exclusion Fencing / Site Preparation/Straw/Crimp Seed/Net / Site Preparation/Straw/Crimp Seed/Fertilizer/Transplants
1019000905 Sand Creek-Crow Creek	Cropland and Urban Non-MS4	Cropland and Pastureland	Cropland and Pastureland	Cropland and Pastureland	/ Streambank Stabilization and Fencing / Buffer-Grass (35 feet wide) / Livestock Exclusion Fencing
1019000906 Outlet Coal Creek	Cropland and Pastureland	Cropland and Pastureland	Cropland and Pastureland	Cropland and Pastureland	/ Streambank Stabilization and Fencing / Buffer-Grass (35 feet wide) / Livestock Exclusion Fencing
1019001203 Wildcat Creek	Cropland and Urban Non-MS4	Cropland and Pastureland	Cropland and Pastureland	Cropland and Pastureland	/ Streambank Stabilization and Fencing / Buffer-Grass (35 feet wide) / Livestock Exclusion Fencing

Table 11-2. Dominant Land Uses, Sources, and Priority Practices by HUC10 for Nutrients and Sediment (Page 3 of 3)

Watershed	Dominant Land Uses	Top Sediment Sources	Top Phosphorus Sources	Top Nitrogen Sources	Priority Practices
1019001205 City of Raymer	Cropland and Urban Non-MS4	Cropland and Pastureland	Cropland and Pastureland	Cropland and Pastureland	/ Streambank Stabilization and Fencing / Buffer-Grass (35 feet wide) / Livestock Exclusion Fencing
1019001206 Camp Creek South Platte River	Cropland and Urban Non-MS4	Cropland and Pastureland	Cropland and Pastureland	Cropland and Pastureland	/ Streambank Stabilization and Fencing / Buffer-Grass (35 feet wide) / Livestock Exclusion Fencing

Table 11-3. *E. coli* Impairment Status, Primary Sources, Associated Land Use, and Priority Practices by HUC10 (Page 1 of 2)

Watershed	*E. coli* Impaired	Primary *E. coli* Sources	Associated Land Use	Priority Practices
1019000305 Beebe Seep Canal	N	Livestock (more Cattle)	Agricultural Land	/ Vegetated Treatment Area / Constructed Wetlands
1019000306 Little Dry Creek-South Platte River	Y	Livestock (More Cattle) and Humans (More WWTP)	Agricultural Land and Urban non-MS4	/ Vegetated Treatment Area / Constructed Wetlands / Wetland Basin / Retention Pond
1019000308 Outlet Box Elder Creek	N	Livestock (More Cattle) and Humans (More OWTS)	Agricultural Land and Urban non-MS4	/ Vegetated Treatment Area / Constructed Wetlands / Septic Upgrades / WWTF Connections
1019000309 Lost Creek	N	Livestock (More Cattle) and Humans (More OWTS)	Agricultural Land and Urban non-MS4	/ Vegetated Treatment Area / Constructed Wetlands / Septic Upgrades / WWTF Connections
1019000310 Sanborn Draw-South Platte River	Y	Livestock (more Cattle)	Agricultural Land	/ Vegetated Treatment Area / Constructed Wetlands
1019000311 Greasewood Draw-South Platte River	Y	Livestock (more Cattle)	Agricultural Land	/ Vegetated Treatment Area / Constructed Wetlands
1019000312 Cottonwood Draw-South Platte River	N	Livestock (more Cattle)	Agricultural Land	/ Vegetated Treatment Area / Constructed Wetlands
1019000801 Upper Lone Tree Creek	N	Livestock (more Cattle)	Agricultural Land	/ Vegetated Treatment Area / Constructed Wetlands
1019000802 Spring Creek-Lone Tree Creek	N	Livestock (More Cattle) and Humans (More OWTS)	Agricultural Land and Urban non-MS4	/ Vegetated Treatment Area / Constructed Wetlands / Septic Upgrades / WWTF Connections
1019000803 Owl Creek-Lone Tree Creek	N	Livestock (More Cattle) and Humans (More OWTS)	Agricultural Land and Urban non-MS4	/ Vegetated Treatment Area / Constructed Wetlands / Septic Upgrades / WWTF Connections
1019000902 Little Crow Creek	N	Livestock (more Cattle)	Agricultural Land	/ Vegetated Treatment Area / Constructed Wetlands
1019000903 Middle Crow Creek	N	Livestock (more Cattle)	Agricultural Land	/ Vegetated Treatment Area / Constructed Wetlands
1019000904 Coal Creek	N	Livestock (more Cattle)	Agricultural Land	/ Vegetated Treatment Area / Constructed Wetlands

Table 11-3. *E. coli* Impairment Status, Primary Sources, Associated Land Use, and Priority Practices by HUC10 (Page 2 of 2)

Watershed	*E. coli* Impaired	Primary *E. coli* Sources	Associated Land Use	Priority Practices
1019000905 Sand Creek-Crow Creek	N	Livestock (more Cattle)	Agricultural Land	/ Vegetated Treatment Area / Constructed Wetlands
1019000906 Outlet Coal Creek	N	Livestock (More Cattle) and Humans (More OWTS)	Agricultural Land and Urban non-MS4	/ Vegetated Treatment Area / Constructed Wetlands
1019001203 Wildcat Creek	N	Livestock (more Cattle)	Agricultural Land	/ Vegetated Treatment Area / Constructed Wetlands
1019001205 City of Raymer	N	Livestock (more Cattle)	Agricultural Land	/ Vegetated Treatment Area / Constructed Wetlands
1019001206 Camp Creek South Platte River	N	Livestock (more Cattle)	Agricultural Land	/ Vegetated Treatment Area / Constructed Wetlands

Table 11-4. Dominant Land Uses, Metal Impairments, Associated Causes, and Priority Practices by HUC10 (Page 1 of 2)

Watershed	Dominant Land Uses	Metal Impairments	Associated Cause	Priority Practices
1019000305 Beebe Seep Canal	Cropland and Pastureland	None	NA	NA
1019000306 Little Dry Creek-South Platte River	Cropland and Pastureland	Arsenic	Pressure-Treated Wood, Pesticides, Piere Shale	Irrigation Water Management
1019000308 Outlet Box Elder Creek	Cropland and Urban Non-MS4	Cadmium	Mining	AML BMPs
1019000309 Lost Creek	Cropland and Urban Non-MS4	None	NA	NA
1019000310 Sanborn Draw-South Platte River	Cropland and Urban Non-MS4	Arsenic	Pressure-Treated Wood, Pesticides, Piere Shale	Irrigation Water Management
1019000311 Greasewood Draw-South Platte River	Cropland and Forest	Uranium, Arsenic	Mining, Pressure-Treated Wood, Pesticides, Piere Shale	AML BMPs, Irrigation Water Management
1019000312 Cottonwood Draw-South Platte River	Cropland and Urban Non-MS4	Uranium, Arsenic	Mining, Pressure-Treated Wood, Pesticides, Piere Shale	AML BMPs, Irrigation Water Management
1019000801 Upper Lone Tree Creek	Forest and Urban Non-MS4	None	NA	NA
1019000802 Spring Creek-Lone Tree Creek	Cropland and Forest	None	NA	NA
1019000803 Owl Creek-Lone Tree Creek	Cropland and Urban Non-MS4	None	NA	NA
1019000902 Little Crow Creek	Cropland and Urban Non-MS4	None	NA	NA
1019000903 Middle Crow Creek	Cropland and Urban Non-MS4	Cadmium	Mining	AML BMPs

Table 11-4. Dominant Land Uses, Metal Impairments, Associated Causes, and Priority Practices by HUC10 (Page 2 of 2)

Watershed	Dominant Land Uses	Metal Impairments	Associated Cause	Priority Practices
1019000904 Coal Creek	Forest and Urban Non-MS4	None	NA	NA
1019000905 Sand Creek-Crow Creek	Cropland and Urban Non-MS4	Cadmium	Mining	AML BMPs
1019000906 Outlet Coal Creek	Cropland and Pastureland	Cadmium	Mining	AML BMPs
1019001203 Wildcat Creek	Cropland and Urban Non-MS4	Cadmium	Mining	AML BMPs
1019001205 City of Raymer	Cropland and Urban Non-MS4	Cadmium	Mining	AML BMPs
1019001206 Camp Creek South Platte River	Cropland and Urban Non-MS4	Cadmium	Mining	AML BMPs

Implementation practices were run in the PLET model on 25 percent of each applicable land cover. This number represents the acres affected by the practice, not the acres of the practice implemented. Cropland practices typically resulted in the highest reductions of nitrogen and phosphorus; therefore, these are the practices incorporated in the schedule. As shown in Table 11-5, incorporating stream stabilization and fencing on 25 percent of the cropland and 35-foot buffers on an additional 25 percent of the cropland in the project area did not result in the needed nitrogen and phosphorus reductions. Reductions required were calculated for the entire area draining to the outlet HUC10. The reduction required for the specific project area was not calculated because project areas were drawn using county lines; therefore, the following cost estimates were made assuming that all reductions had to come from within the project area, which is not ideal for the Middle South Platte watershed (over 90 percent of the drainage area is not in the project area). These practices need to be implemented in half of the cropland in the project area to meet the load reductions needed. Some of the loads are assumed to come from areas outside of Larimer and Weld counties and from other land uses. Table 11-6 shows the proposed schedule for implementation in the Middle South Platte River project area. These practices will also help with *E. coli* and heavy metals. Load reductions for heavy metals came from the PLET model and, therefore, were not run for *E. coli* and heavy metals. Because the current load reductions from PLET were not calibrated and did not include areas outside of Larimer and Weld Counties or MS4 areas, they should be considered relative and should not be compared to actual loads calculated with observed data.

Table 11-5. Reductions Achieved by Implementation of Priority Cropland Practices

<table>
<tr><th>Practice</th><th>Nitrogen Load (lb/yr)</th><th>Nitrogen Reduction (%)</th><th>Nitrogen Reduction Needed (lb/yr)</th><th>Phosphorus Load (lb/yr)</th><th>Phosphorus Reduction (%)</th><th>Phosphorus Reduction Needed (lb/yr)</th></tr>
<tr><td>Base Load</td><td>568,871</td><td>N/A</td><td rowspan="4">61</td><td>219,044</td><td>N/A</td><td rowspan="4">61</td></tr>
<tr><td>Stream Stabilization and Fencing on 25% of Cropland (88,651 acres)</td><td>100,110</td><td>17.6</td><td>38,542</td><td>17.6</td></tr>
<tr><td>Buffer - Grass (35 feet wide) on 25% of Cropland (88,651 acres)</td><td>70,744</td><td>12.4</td><td>27,236</td><td>12.4</td></tr>
<tr><td>Total Reduction</td><td>170,854</td><td>30</td><td>65,778</td><td>30</td></tr>
</table>

Table 11-6. Schedule for Primary Cropland Practices to Achieve Nutrient Goals

Practices	5-Year Goal	10-Year Goal	Ultimate Goal
Stream Stabilization and Fencing on Cropland	50,000 acres	100,000 acres	150,000 acres
Buffer - Grass (35 feet wide) on Cropland	50,000 acres	100,000 acres	150,000 acres

RESPEC

In general, 35-foot buffers cost about $10.37 per acre impacted per year, fencing costs about $22.66 per acre impacted per year, and streambank stabilization costs $13,472 per mile. If a mile of streambank stabilization impacted a square mile of the watershed area, it would cost approximately $21.05 per acre impacted per year; therefore, every 5,000 acres impacted by buffers would cost approximately $51,838 and with the rough streambank stabilization estimate every 5,000 acres impacted by stream stabilization would cost approximately $218,549.

12.0 MONITORING BEST MANAGEMENT PRACTICES EFFECTIVENESS

Monitoring should be completed before and after implementing BMPs to evaluate the effectiveness of priority practices. Monitoring BMP effectiveness (up- and downstream of BMPs) helps evaluate the adequacy of the implementation strategies targeted to reduce loads or transport. BMP effectiveness data will improve the understanding of implementation and management measures. Other ideal locations for monitoring include areas that have been monitored historically near the HUC10 watershed outlets and along impaired waterbodies. More information about monitoring NPSs is included on EPA's Nonpoint Source Monitoring: TechNOTES webpage. Existing water quality monitoring occurring for the North Front Range Water Quality Planning Association's (NFRWQPA) 208 Areawide Water Quality Management Plan is available on its website.

Additional monitoring and evaluation efforts should occur within the communities that are the most likely to become MS4 areas. Monitoring sites up- and downstream of areas where storm drains and tributaries enter the mainstem Middle South Platte River would help evaluate contributions. Monitoring locations in storm drains throughout urbanized areas where two possible sources come together would also help isolate sources of pollution. A detailed monitoring plan that identifies the locations of additional monitoring sites should be compiled.

Continuous discharge data across a broad range of flows are helpful for calculating loads. Future monitoring should include instantaneous discharge measurements at water quality sampling areas. Continuous stage recorders should be installed at key locations in the watershed, and stage-discharge relationships should be developed to convert continuous stage data to continuous flow data. Relatively low-cost, low-maintenance technologies are available to record continuous stage data. Instantaneous and continuous flow data will increase the accuracy of future load calculations and the evaluation of BMPs and implementation practices.

Survey #2 had a question regarding in-stream monitoring activities that different entities would consider implementing. The Northern Colorado Water Conservancy District, Colorado Wheat Administrative Committee, and City of Evans would be interested in quarterly sampling and the installation, maintenance, and operation of a monitoring station. The Colorado Watershed Assembly would be interested in the installation, maintenance, and operation of a monitoring station. The City of Greeley would be interested in the quarterly sampling.

13.0 TECHNICAL AND FINANCIAL ASSISTANCE SOURCES

Technical and financial assistance sources are available to implement BMPs. Numerous private companies and organizations as well as local, state, and federal agencies provide technical assistance to address NPS pollution. A few of these organizations and agencies also provide financial assistance. Table 13-1 lists the agencies and organizations with technical and financial programs that may assist with conservation and water quality implementation projects and what type of technical or financial assistance they offer (based on the land use of interest) as denoted by Xs. The following sections describe the information regarding incentive programs and funding to implement NPS projects identified in this plan. Funding includes but is not limited to the CDPHE's NPS Program and its annual grants, South Platte Basin Roundtable grants, and CAWA programs. The NPS Program funds support staffing costs and programmatic priorities, including the Mini Grant Program, the NPS Watershed Planning and Tool Development Program, and the NPS Program's Success Story Initiative.

Table 13-1. Sources of Technical and Financial Assistance (Page 1 of 3)

Agency or Organization	Website	Assistance	BMP Category						
			Developed Non-MS4	Cropland	Pasture	Feedlot	Forest	Stream	Outreach
LOCAL									
Larimer County	www.larimer.gov	Financial, Technical	X	X	X	X	X	X	X
Weld County	www.weld.gov	Financial, Technical	X	X	X	X	X	X	X
South Platte Basin Roundtable	www.southplattebasin.com	Technical	X	X	X	X	X	X	X
Southeast Weld Conservation District	seweldcd-co.org	Financial, Technical		X	X	X	X	X	X
STATE									
CSU Extension	extension.colostate.edu	Technical	X	X	X	X	X	X	X
CSU	www.colostate.edu	Technical	X	X	X	X	X	X	X
Colorado Association of Conservation Districts	coloradoacd.org	Financial, Technical	X	X	X	X	X	X	X
CDPHE	cdphe.colorado.gov	Financial, Technical	X	X	X	X	X	X	X
Colorado Parks and Wildlife	cpw.state.co.us	Financial, Technical					X	X	X
Colorado Livestock Association	www.coloradolivestock.org	Technical				X		X	X
Colorado Department of Agriculture	ag.colorado.gov	Financial, Technical		X	X	X		X	X
Colorado Water Center	watercenter.colostate.edu	Technical						X	X
Colorado Rural Water Association	www.crwa.net	Technical						X	X
Colorado Department of Natural Resources	dnr.colorado.gov	Financial, Technical	X	X	X	X	X	X	X

Table 13-1. Sources of Technical and Financial Assistance (Page 2 of 3)

Agency or Organization	Website	Assistance	BMP Category						
			Developed Non-MS4	Cropland	Pasture	Feedlot	Forest	Stream	Outreach
STATE									
Colorado Energy and Carbon Management Commission	ecmc.state.co.us	Financial, Technical		X	X	X			
Colorado Geological Survey	coloradogeologicalsurvey.org	Financial, Technical						X	
Colorado Bureau of Land Management	www.blm.gov	Financial, Technical					X	X	X
Colorado Division of Reclamation, Mining, and Safety	drms.colorado.gov	Financial, Technical					X	X	X
Colorado State Land Board	slb.colorado.gov	Financial							X
FEDERAL									
U.S. Army Corps of Engineers	www.usace.army.mil	Financial, Technical						X	X
USDA–NRCS	www.nrcs.usda.gov	Financial, Technical		X	X	X	X	X	X
USDA–Farm Service Agency	www.fsa.usda.gov	Financial, Technical		X	X	X		X	X
USDA–Rural Development	www.rurdev.usda.gov	Financial, Technical						X	X
USDA–Bureau of Land Management	www.blm.gov	Financial, Technical					X	X	X
U.S. Department of Interior–Bureau of Reclamation	www.usbr.gov	Financial, Technical	X	X			X	X	X
EPA	www.epa.gov	Financial, Technical	X	X	X	X	X	X	X
USDA–Forest Service	www.fs.fed.us	Financial, Technical					X	X	X
USFWS	www.fws.gov	Financial, Technical						X	X
USGS	www.usgs.gov	Technical						X	X

Table 13-1. Sources of Technical and Financial Assistance (Page 3 of 3)

Agency or Organization	Website	Assistance	BMP Category						
			Developed Non-MS4	Cropland	Pasture	Feedlot	Forest	Stream	Outreach
PRIVATE									
Ducks Unlimited	www.ducks.org	Financial, Technical						X	X
Colorado Trout Unlimited	coloradotu.org	Financial, Technical						X	X
Fresh Water Trust	www.thefreshwatertrust.org	Financial, Technical	X	X	X	X	X	X	X
Mule Deer Foundation	www.muledeer.org	Financial, Technical					X	X	X
Rocky Mountain Elk Foundation	www.rmef.org	Financial, Technical					X	X	X
National Fish and Wildlife Foundation	www.nfwf.org	Financial, Technical						X	X

13.1 INCENTIVE PROGRAMS

Incentive programs are formal programs used to promote specific actions or behaviors. Participation in incentive programs is voluntary. Various mechanisms can be used to conduct incentive programs, including financial assistance or providing benefits for enrolling in programs. The following programs are relatively easy for users to take advantage of, and the money for them is generally allocated annually.

13.1.1 COST-SHARE PROGRAMS

In a cost-share program, the costs of systems or practices for water quality improvements are shared between the landowner, state (percentage), or federal programs (flat rate). State-funded nonstructural land management cost sharing is also typically based on a flat rate. Landowners seeking cost-share assistance should contact their county conservation district office for information on available programs. The BMPs and conservation practices that are typically eligible are those that avoid, control, and trap nutrients, sediment, and *E. coli* from entering surface water and groundwater. Eligibility may vary depending on local priorities and needs.

13.1.2 FEE DISCOUNTS

Local governments or nonprofit entities may offer reduced fees for implementing projects and practices that align with program goals. For instance, stormwater fees could be reduced if a landowner voluntarily converts cropped acres to a permanent vegetative cover.

13.1.3 LOW-INTEREST LOANS

Low-interest loans may be available through various state agencies to landowners for agricultural BMPs, septic system updates/replacement, or other projects that meet funding eligibility criteria.

13.1.4 WATER QUALITY TRADING

Point source permittees should be mindful that options are available to use money available for upstream NPS implementation to improve water quality for a smaller potential cost. These options need to be further evaluated and quantified.

13.2 POTENTIAL FUNDING

Funding is available from private, local, county, state, and federal sources to implement projects for improving water quality. The following sections discuss these sources. Other funding sources not noted here may be available. The state of Colorado maintains a Grants Information page on its website.

13.2.1 CITIES

Municipalities often collect stormwater utility fees to build, repair, operate, and maintain stormwater management systems. Such fees should be set using reasonable calculations based on runoff volume or pollution quantities, property classifications, or both.

13.2.2 COUNTIES, WATERSHED DISTRICTS, AND AUTHORITIES

In other areas of Colorado, authorities have been developed, such as the Cherry Creek Basin Water Quality Authority and the Chatfield Watershed Authority. These authorities can levy funds for priority projects and assist with program implementation. The NFRWQPA and other 208 planning agencies cannot levy funds or taxes for projects, but they have voluntary fees and dues that contribute to planning and implementation. Recently, the Chatfield Watershed Authority also added an entrance fee to the Chatfield State Park to assist with protecting water quality.

13.2.3 STATE

The State of Colorado funds watershed management programs through various capacities, programs, and agencies.

The CDPHE has numerous NPS funding opportunities, which include watershed implementation projects (restoration and protection), watershed planning and tool development, and education and outreach. The primary CDPHE opportunities consist of the Source Water Assessment and Protection (SWAP) Program; the Water Quality Grants and Loans Unit; CSU's Colorado Wetland Information Center; CSU's Colorado State Forest Service; the Department of Natural Resources' Colorado Water Conservation Board (CWCB); Colorado Water Plan Grants; and Colorado Watershed Restoration Grants. More information regarding each program is provided in CDPHE [2022]. Funds from the Water Supply Reserve Fund (WSRF) are issued through the South Platte Basin Roundtable. CDPHE has a state revolving fund that includes a Water Pollution Control revolving fund that completes many OWTS to sewer projects.

Under the Colorado Natural Resources Department, the CWCB also administers the Federal Technical Assistance Grant Program, consisting of Local Capacity Grants and Technical Assistance Grants. Federal American Rescue Plan Act funding of $5 million is available for these two grants in Colorado. The grantee must provide a minimum of 25 percent matching funds. Grants will be awarded on a rolling basis through December 2024; grant funds must be fully expended by December 2026. Local Capacity Grants are direct awards to grantees to secure the resources needed (contractors or otherwise) to develop projects and submit competitive federal grant applications. Technical Assistance Grants are awards to grantees who want to use a contractor hired by the CWCB. This contractor can provide a wide variety of water project services, such as federal grant opportunity research, project design, partial engineering, cost estimation, and federal application development/grant writing.

Statewide education grants and outreach initiative grants are available through the Public Education, Participation, and Outreach (PEPO) Grant Program, which is administered through the CWCB. The PEPO Grant Program also financially supports designated individual coordinators who support basin-specific outreach and education efforts alongside each of the state's basin roundtables. The Colorado Department of Natural Resources also maintains a Water Funding Opportunity Navigator, which lists potential federal and state grant opportunities.

Other state funding opportunities include the Colorado Healthy Rivers Fund. This program grants money to local watershed organizations to provide clean water, protect habitat, and improve recreation and accessibility throughout Colorado. Project grants and planning grants are available under the program.

13.2.4 FEDERAL

Federal agencies can provide funding and technical assistance for projects and monitoring. These agencies include the U.S. Fish and Wildlife Service (USFWS), USGS, NRCS, Farm Service Agency, EPA, and others. The USGS is more likely to support data acquisition and monitoring programs, and the USFWS may provide land retirement program funds. The NRCS helps with applying conservation practices, and the EPA assists with studies to identify more localized sources of pollution in impaired waterbodies. The following sections provide information regarding federal NPS funding.

13.2.4.1 U.S. ENVIRONMENTAL PROTECTION AGENCY

The EPA provides funding opportunities for watershed restoration and protection on its funding resource webpage for NPS pollution. Additional EPA funding opportunities are available online on the Equity Action Plan webpage and Environmental Justice Grants, Funding and Technical Assistance webpage.

The EPA also has a funding opportunity through the Office of Wetlands, Oceans, and Watersheds' Fiscal Year 2024 Building Partner Capacity and Promoting Resiliency and Equity under the CWA. The EPA is soliciting applications from eligible applicants to provide support for training and related activities to build the capacity of agricultural partners; state, territorial, and Tribal officials; and nongovernmental stakeholders in support of the goals of the CWA Section 319 Nonpoint Source Management Program.

The EPA also has funding from the Clean Water State Revolving Fund (CWSRF) accessible via the About the Clean Water State Revolving Fund (CWSRF) webpage. The funds are generally for municipal wastewater facility construction, control of NPS pollution, decentralized wastewater treatment systems, green infrastructure projects, project estuaries, and other water quality projects.

13.2.4.2 U.S. DEPARTMENT OF AGRICULTURE'S NATURAL RESOURCES CONSERVATION SERVICE

The NRCS's natural resources conservation programs help individuals reduce soil erosion, enhance water supplies, improve water quality, increase wildlife habitat, and reduce damage caused by floods and other natural disasters. More information is available on the USDA Programs & Initiatives webpage. The following technical and financial assistance programs are generally awarded annually through NRCS:

- **Agricultural Conservation Easement Program (ACEP).** Applications are accepted from April through December. ACEP easement agreements are typically awarded annually by the fall.
- **Conservation Stewardship Program (CSP).** The CSP helps agricultural producers maintain and improve existing conservation systems and adopt additional conservation activities to address priority resource concerns. Participants earn CSP payments for conservation performance—the higher the performance, the higher the payment. Different enrollment opportunities are available for CSP Classic, CSP Renewals, and CSP Grasslands. Applications are accepted from April through December. CSP contracts are awarded by June or July.
- **Conservation Technical Assistance (CTA).** The CTA provides the nation's farmers, ranchers, and forestland owners with the knowledge and tools they need to conserve, maintain, and restore the natural resources on their lands and improve the health of their operations for the future. NRCS offers this assistance at no cost to the producers served.

- **Environmental Quality Incentives Program (EQIP).** EQIP provides financial and technical assistance to agricultural producers to address natural resource concerns and deliver environmental benefits, such as improved water and air quality; conserved ground and surface water; increased soil health; reduced soil erosion and sedimentation; improved or created wildlife habitat; and mitigation against increasing weather volatility. Applications are accepted on a continuous basis, with application cutoff for funding evaluation typically set in November of each year. EQIP contracts are typically awarded by April or May.
- **Regional Conservation Partnership Program (RCPP).** RCPP promotes coordination of NRCS conservation activities with partners that offer valuable contributions to expand the collective ability to address on-farm, watershed, and regional natural resource concerns. Announcements for Funding Proposals (AFPs) for RCPP Classic are typically advertised in October through November and awarded in June through August. RCPP Alternative Funding Arrangement (AFA) AFPs are typically announced March through May, with agreements awarded by September, and, in some cases, the funds are carried over and awarded from October to December of the following fiscal year.
- **National Water Quality Initiative (NWQI).** NWQI provides a way to accelerate voluntary, on-farm conservation investments focused on water quality monitoring and assessment resources, where they can deliver the greatest benefits for clean water. The NWQI is a partnership among NRCS, state water quality agencies, and EPA to identify and address impaired waterbodies through voluntary conservation.
- **Watershed Operations PL-566 Program.** The Watershed Protection and Flood Prevention Act (PL-566) authorizes the USDA-NRCS to help local organizations and units of government plan and implement watershed projects. PL-566 watershed projects are locally led to solve natural and human resource problems in watersheds up to 250,000 acres (less than 400 mi^2). At least 20 percent of any project benefits must relate directly to agriculture, including rural communities. A local sponsoring organization is needed to carry out, maintain, and operate works of improvement. The program has two main components, and each is funded separately: (1) watershed surveys and planning and (2) watershed and flood prevention operations and construction.
- **Conservation Innovation Grants (CIG)**. CIG is a competitive program that supports the development of new tools, approaches, practices, and technologies to further natural resource conservation on private lands. Through creative problem-solving and innovation, CIG partners work to address the nation's water quality, air quality, soil health, and wildlife habitat challenges while improving agricultural operations. Three program types are available: (1) national, (2) state, and (3) CIG On-Farm Conservation Innovation Trials.
- **Rural Development.** For OWTS funding, USDA Rural Development has a 504 Single Family Program, a Community Development Program, a Home Repair Loan/Grant Program, a Community Pass-through Program, and Water Well Trust Program. Income eligibility for these programs is often a sliding scale.

Other federal agency funding includes the U.S. Bureau of Reclamation (USBR) WaterSMART. Through WaterSMART, the USBR leverages federal and nonfederal funding to work cooperatively with states, tribes, and local entities as they plan for and implement actions to increase water supply sustainability through investments in existing infrastructure and attention to local water conflicts.

13.2.5 PRIVATE/OTHER SOURCES

Foundations, nonprofit organizations, and private contributions, including those from landowners and corporate entities, will be sought for plan implementation activities. Local foundations may fund education, civic engagement, and other local priority efforts. Such organizations acquire their own funding and may have project dollars and technical assistance that can be used. Major cooperators and funding sources include private landowners who typically contribute a percentage of project costs and may donate land, services, or equipment for projects or programs.

Some of the stakeholder questions asked in Survey #2 were related to the technical and financial assistance needed or used and how they used it. The Northern Colorado Water Conservancy District mentioned that it has an extensive, long-term water quality monitoring program in the lower South Platte River. The Metro Water Recovery, Northern Colorado Water Conservancy District, and Colorado Wheat Administrative Committee all said they do not currently need financial or technical assistance for monitoring. The Metro Water Recovery mentioned that it conducts bimonthly water quality monitoring of the South Platte River and its tributaries from North Denver to Platteville at 20 different sites. The Northern Colorado Water Conservancy District has extensive, long-term water quality monitoring throughout the Colorado-Big Thompson system, Poudre River, and lower South Platte River. The City of Greeley has received financial assistance for fire recovery and would be willing to use any financial assistance available to them for monitoring and BMP implementation. The Colorado Wheat Administrative would like to receive financial assistance for public meetings/outreach. The City of Evans mentioned they would like technical and financial assistance for monitoring and BMP implementation. The Colorado Watershed Assembly has received CWCB and NPS funds and other funds from the Cherry Creek Basin Water Quality Authority and Great Outdoors Colorado, as well as county and municipal funding and technical assistance. The Colorado Watershed Assembly tracks various federal grant opportunities and has used the CWCB and NPS Program for technical assistance. The Colorado Wheat Administrative Committee is aware of financial assistance from the conservation districts, NRCS, crop consultants, and NRCS Agricultural Research Service but has yet to secure funding.

The following are private foundations with available funding programs:

- The Laura Jane Musser Fund, a foundation based in Minnesota, assists public or not-for-profit entities to initiate or implement projects that enhance the ecological integrity of publicly owned open spaces while encouraging compatible human activities. The fund's goal is to promote public use of open space that improves a community's quality of life and public health, while also ensuring the protection of healthy, viable, and sustainable ecosystems by defending or restoring habitat for the diversity of plant and animal species.
- The Moore Charitable Foundation works to preserve and protect natural resources for future generations. This foundation and its affiliates support nonprofit organizations that protect land, wildlife, habitat, and water resources in several regional planning areas, including Colorado. The foundation also supports educational and community programs in these areas.
- The Colorado River Basin Salinity Control Act, established in 1974, provides authorization for enhancing and protecting numerous salinity control projects in Colorado and other states. High levels of salinity in water can reduce crop yields, limit the choice of crops that can be grown, and, at higher concentrations over long periods, can kill trees and make the land unsuitable for agricultural purposes. Through strong partnerships between the NRCS, private landowners, USBR, CWCB, and several local conservation districts, financial and technical assistance funds

have been used to install irrigation improvements, such as the installation of pipelines, more efficient irrigation systems, and lining of ditches and small laterals.

- The Colorado Watershed Assembly routinely posts funding opportunities through its bimonthly newsletter available on the Colorado Watershed Assembly homepage.
- The South Platte Basin Roundtable offers two funding cycles annually, and information is available on the South Platte Basin homepage.

14.0 REFERENCES

American Veterinary Medical Association, 2016. "U.S. Pet Ownership Statistics," *avma.org*, accessed June 30, 2016, from *https://www.avma.org/KB/Resources/Statistics/Pages/Market-research-statistics-US-pet-ownership.aspx*

Big Thompson Watershed Coalition, 2024. "All BTWC Projects," accessed May 30, 2024, from *https://bigthompson.co/big-thompson-projects/*

Briffa, J., E. Sinagra, and R. Blundell, 2020. "Heavy Metal Pollution in the Environment and Their Toxicological Effects on Humans", *Heliyon*, Volume 6, Issue 9, e04691, ISSN 2405-8440, available online at *https://doi.org/10.1016/j.heliyon.2020.e04691*

Catena Analytics, 2024. "eRAMS Online," accessed August 13, 2024, from *https://erams.com/catena/*

Colorado's Decision Support Systems, 2024. "GIS Data by Category," accessed August 13, 2024, from *https://cdss.colorado.gov/gis-data/gis-data-by-category*

Colorado Department of Public Health and Environment, 2022. *Colorado's Nonpoint Source Management Plan: 2022,* prepared by Colorado Department of Public Health and Environment Water Quality Control Division, Glendale, CO, available online at *https://drive.google.com/file/d/1nrZ1D4yp2LGHUxrNsyjwGbu3w1ZCs9wz/view*

Colorado Geospatial Portal, 2024. *2024 State of Colorado Public Parcels*, CO Office of Information Technology, Enterprise GIS, accessed August 14, 2024, from *https://geodata.colorado.gov*

Colorado Water Plan, 2015. "South Platte/Metro Analysis and Technical Update," accessed May 30, 2024, from *https://dnrftp.state.co.us/CWCB/Technical%20Update%20to%20Water%20Plan/1.%20Technical%20Update%20Documentation/Volume%201-Section%204.8-S%20Platte%20Metro%20Republican%20Results.pdf*

The Diggings, 2024. "Mining In Weld County, Colorado," accessed August 15, 2024, from *https://thediggings.com/usa/colorado/weld-co123*

Environmental Systems Research Institute, Inc., 2014. "USA Federal Lands," accessed August 14, 2024, from *https://www.arcgis.com/home/item.html?id=c959f521c02f4f64abf4d39019c5ccd5*

Fischer, J., 2023. Personal communication between J. Fischer, Invision GIS, CO, and C. Kirby, RESPEC, Rapid City, SD, December 14.

Graves, J., 2024. Personal communication between J. Graves, Colorado Division of Reclamation, Mining, and Safety, Denver, CO, and N. Acosta, RESPEC, Colorado Springs, CO, March 8.

Hawley, C. and N. Rodriquez-Jeangros, 2021. *Big Thompson State of the Watershed 2021 Final Report*, prepared by Hydros Consulting, Boulder, CO, for Big Thompson Watershed Forum, Fort Collins, CO.

Horsley and Witten, Inc., 1996. *Identification and Evaluation of Nutrient and Bacterial Loadings to Maquoit Bay, New Brunswick, and Freeport, Maine*, prepared by Horsley & Witten, Inc., Barnstable, MA, for Casco Bay Estuary Project, Portland, ME.

Horton, J.D., C. A. San Juan, and D. B. Stoeser, 2017. "The State Geologic Map Compilation (SGMC) Geodatabase of the Conterminous United States," *US Geological Survey Data Series 1052,* Ver. 1.1, August 2017, p. 46.

Kirby, C., S. Briscoe, N. Acosta, and C. McCague, 2024a. *St. Vrain Creek Nonpoint Source Watershed-Based Plan,* RSI-3522, prepared by RESPEC, Rapid City, SD, and Communication Infrastructure Group, Denver, CO, for North Front Range Water Quality Planning Association, Johnstown, CO (draft).

Kirby, C., N. Acosta, C. McCague, and M. Thomas, 2024b. *Big and Little Thompson Rivers Nonpoint Source Watershed-Based Plan*, RSI-3425, prepared by RESPEC, Rapid City, SD, and Communication Infrastructure Group, Denver, CO, for North Front Range Water Quality Planning Association, Johnstown, CO (draft).

Kirby, C., S. Briscoe, N. Acosta, and C. McCague, 2024c. *Cache La Poudre River Nonpoint Source Watershed-Based Plan,* RSI-3521, prepared by RESPEC, Rapid City, SD, and Communication Infrastructure Group, Denver, CO, for North Front Range Water Quality Planning Association, Johnstown, CO (draft).

Larimer County, 2024. "Larimer County GIS Digital Data," accessed August 14, 2024, from *https://www.larimer.gov/it/gis/digital-data*

Metcalf and Eddy, Inc., 1991. *Wastewater Engineering: Treatment, Disposal and Reuse*, 3rd Edition, McGraw-Hill, New York.

Moore, E., 2022. *Colorado's Nonpoint Source Program: 2022 Annual Report*, prepared by Colorado Department of Public Health and Environment Water Quality Control Division, Denver, CO, available online at *https://storymaps.arcgis.com/stories/e7212fd7f8224b839b669fd8bbd058a4*

Multi-Resolution Land Characteristics Consortium, 2019. "National Land Cover Database 2019 - Landcover & Imperviousness (NLCD2019)," accessed August 14, 2024, from *https://www.mrlc.gov/data?f%5B0%5D=category%3ALand%20Cover&f%5B1%5D=year%3A2019*

National Interagency Fire Center, 2024. "InterAgencyFirePerimeterHistory All Years View," accessed August 14, 2024, from *https://data-nifc.opendata.arcgis.com/datasets/e02b85c0ea784ce7bd8add7ae3d293d0_0/explore?location=39.994103%2C-103.924962%2C8.89*

Natural Resources Conservation Service, 2024a. "Soil Survey Geographic Database (SSURGO)," accessed August 13, 2024, from *https://www.nrcs.usda.gov/resources/data-and-reports/soil-survey-geographic-database-ssurgo*

Natural Resources Conservation Service, 2024b. "Conservation Practices Physical Effects (CPPE) – FY24 National Template-Version 2," accessed May 14, 2024, from *https://www.nrcs.usda.gov/resources/guides-and-instructions/conservation-practice-physical-effects*

Natural Resources Conservation Service, 2024c. "Conservation Practice Standard Land Reclamation, Abandoned Mined Land Code 543," accessed May 30, 2024, from *https://www.nrcs.usda.gov/sites/default/files/2022-09/Land_Reclamation_Abandoned_Mined_Land_543_NHCP_CPS.pdf*

North Front Range Water Quality Planning Association, 2022. *208 Areawide Water Quality Management Plan 2022 – 208 AWQMP Update (Region 2)*, prepared by the North Front Range Water Quality Planning Association, Johnstown, CO.

PRISM Climate Group, 2024. "Average Monthly and Average Annual Precipitation 1961-1990, 1971-2000 and 1981-2010 by State," accessed May 14, 2024, from *https://gdg.sc.egov.usda.gov/Catalog/ProductDescription/PRCIP.html*

Smith, E., 2024. *2023 Zoning Boundary.zip,* attachment from personal communication between E. Smith, Town of Timnath, CO, and C. Kirby, RESPEC, Rapid City, SD, January 29.

South Platte Basin, 2024. "The South Platte Basin," accessed August 23, 2024, from *https://www.southplattebasin.com/home*

Tetra Tech, Inc., 2022. *User's Guide Pollution Load Estimation Tool Version 1.0*, developed for the U.S. Environmental Protection Agency by Tetra Tech, Inc. Fairfax, VA.

The Water Research Foundation, 2024. "International Stormwater BMP Database," accessed August 14, 2024, from *https://bmpdatabase.org/*

Thomas, M., 2024. Personal communication between M. Thomas, North Front Range Water Quality Planning Association, Johnstown, CO, and C. Kirby, RESPEC, Rapid City, SD, May 2.

University of Missouri Extension, 2024. "Nitrogen in the Environment: Nitrogen's Most Common Forms," accessed June 5, 2024, from *https://extension.missouri.edu/publications/wq253*

U.S. Census Bureau, 2020. "QuickFacts: Loveland City, Colorado; United States" accessed July 29, 2024, from *https://www.census.gov/quickfacts/fact/table/lovelandcitycolorado,US/PST045222*

U.S. Department of Agriculture, 2024. "Farmers.gov," accessed May 30, 2024, from *www.farmers.gov*

U.S. Environmental Protection Agency, 2008. "Handbook for Developing Watershed Plans to Restore and Protect Our Waters," accessed August 13, 2024, from *https://www.epa.gov/nps/handbook-developing-watershed-plans-restore-and-protect-our-waters*

U.S. Environmental Protection Agency, 2022. "User's Guide Pollutant Load Estimation Tool (PLET) Version 1.0," accessed August 1, 2024, from *https://www.epa.gov/system/files/documents/2022-04/user-guide-final-04-18-22_508.pdf*

U.S. Environmental Protection Agency, 2023. "Best Management Practice Definitions Document for Pollutant Load Estimation Tool," accessed May 1, 2024, from *https://www.epa.gov/system/files/documents/2023-04/BMP_Description_revised%203-9-23_final%20with%20alt%20text_508.pdf*

U.S. Environmental Protection Agency, 2024a. "Nonpoint Source (NPS) Watershed Projects Data Explorer," accessed August 14, 2024, from *https://ordspub.epa.gov/ords/grts/f?p=109:940::::940::*

U.S. Environmental Protection Agency, 2024b. "Per- and Polyfluoroalkyl Substances (PFAS) Final PFAS National Primary Drinking Water Regulation," accessed August 14, 2024, from *https://www.epa.gov/sdwa/and-polyfluoroalkyl-substances-pfas*

U.S. Geological Survey, 2019. "SPARROW Modeling Program," accessed August 14, 2024, from *https://www.usgs.gov/software/sparrow-modeling-program*

U.S. Geological Survey Colorado Water Science Center, 2000. "NAWQA South Platte River Basin Study," accessed May 30, 2024, from *https://www.usgs.gov/centers/colorado-water-science-center/science/nawqa-south-platte-river-basin-study*

WebMD, 2024. "Blue Baby Syndrome: What Is It?," accessed May 30, 2024, from *https://www.webmd.com/baby/what-is-blue-baby-syndrome*

Zeckoski, R. W., B. L. Benham, S. B. Shah, and C. D. Heatwole, 2005. "BSLC: A Tool for Bacteria Source Characterization for Watershed Management," *Applied Engineering in Agriculture*, Vol. 21, No. 5, pp. 879–889.

APPENDIX A
SURVEY QUESTIONS

2022 SURVEY

1. Agency/organization's name
2. Website URL
3. Contact person(s), name(s)
4. Email address(s)
5. Phone number(s)
6. Which of the following watersheds is/are the focus of your organization
    a. Big and Little Thompson
    b. Middle South Platte
    c. Cache la Poudre
    d. St. Vrain Creek
    e. Other
7. If known, please list the waterbody name and segment identification (AUID) (i.e., COSPUS15) if it was selected from question #6, please provide the watershed name.
8. Does your agency have an existing watershed plan, source water plan, NPS plan, or other?
9. Please provide the link to the watershed plan(s) if available below or send a copy to Mark Thomas at: mthomas@nfrwqpa.org
10. Is the plan under development if you agency does not have an existing watershed plan identified in question #8?
11. What level of impact do the following nonpoint sources have on water quality in your watershed? (check one for each row)
    a. Abandoned mine lands
    b. Agriculture (including agricultural return flows and agricultural stormwater runoff)
    c. Hydromodification (diversions including transbasin diversions)
    d. Habitat alteration
    e. Urbanization
    f. Onsite wastewater systems (aka septic systems)
    g. Runoff from roadways
    h. Post wildfire impacts (includes post-wildfire flooding)
    i. Climate change
    j. Hazardous household or industrial wastes (pharmaceuticals, oil, paint, acids, pesticides, etc.)
12. What are the major pollutants of concern? (check all that apply)
    a. Sediment (includes ash from wildfire)
    b. Total suspended solids (TSS)
    c. Nitrogen
    d. Phosphorus
    e. Temperature
    f. Metals
    g. E. coli
    h. Emerging contaminants
    i. Other
13. Please check all water quality parameters/analytes that your group measures:
    a. Sediment (includes ash from wildfire)
    b. Total suspended solids (TSS)

RESPEC

   c. Nitrogen
   d. Phosphorus
   e. Temperature
   f. Metals
   g. *E. coli*
   h. Emerging contaminants
   i. Other
14. If known, what is the period of record for each of the analytes listed above?
15. Is the data publicly available on the Colorado Data Sharing Network (CDSN)?
16. If the data is not publicly available, would you be willing to share your data with NFRWQPA?
17. What types of watershed projects have been completed?
   a. Habitat improvements
   b. Bank stabilization - grading
   c. Bank stabilization – vegetation
   d. Installation of drop or other in rivers
   e. Vegetation buffers
   f. Agricultural tailwater BMPs
   g. Unknown
18. What projects are high priority for your organization/watershed group?
19. What barriers from question (#18) may be preventing the project?
   a. Funding
   b. Technical resources
   c. Instrumentation
   d. Staffing/volunteer time
   e. No barriers are preventing the project
   f. Other
20. Does your organization/agency provide any of the following services:
   a. BMP recommendations
   b. Technical advice
   c. Water quality sampling
   d. Public education
   e. Other
21. Do you have policies, guidelines, or governing codes related to nonpoint source water quality adoption? Please, provide sources or weblinks.
22. Does your jurisdiction's county/municipal code reference the NFRWQPA 208 Areawide Water Quality Management Plan?
23. What can a regional NPS watershed plan help your watershed organization accomplish?
24. If known, provide or identify areas of special interest that need to be protected from NPS pollutants.
25. Why does your watershed organization value water quality?
26. What is the public perception of your watershed's water quality?
27. What other issues or concerns would you like NFRWQPA to be aware of?
28. If you want to be added to the email/ notification/distribution list regarding meetings and updates concerning the Regional NPS Watershed Plan, please provide your email below.

2024 SURVEY

1. Email address
2. First name
3. Last name
4. Please provide your contact information
5. Are you interested in participating with the NFRWQPA Technical Advisory Committee in guiding the Nonpoint Source plan best management practices (BMPs) for the Larimer and Weld County region and participating in the final report review for this project? If yes, please provide your name and email address.
6. What watershed are you most concerned with? Select all that apply.
    a. Middle South Platte - Cherry (Area of Concern: 10190003)
    b. St. Vrain (Area of Concern: 10190005)
    c. Big Thompson (Area of Concern: 10190006)
    d. Cache La Poudre (Area of Concern: 10190007)
    e. Lone Tree-Owl (Area of Concern: 10190008)
    f. Crow (Area of Concern: 10190009)
    g. Middle South Platte Sterling (Area of Concern: 10190012)
    h. Other (please specify)
7. Aside from watershed plans, what other major projects have you done or are you aware of that has or may improve water quality in the watershed?
8. When were they completed?
9. What is the approximate area impacted by the project?
10. What is the approximate area impacted by the project? Please describe.
11. Are there current plans for a watershed plan or update of an existing plan in your area?
12. How many months a year do agriculture producers typically apply manure on crops?
13. Rank the likelihood of each following cropland BMPs to be implemented in your area from 1 to 5, with 1 being unlikely and 5 being very likely
    a. List of BMPs from PLET
14. Does your watershed have BMPs for non-point source pollution? The following would be important to attain if available (including list/count estimate).
15. What BMPs have been implemented in your watershed? Please describe.
16. Approximately how many of each BMP type/technology (many are included in Section 5 questions) have been implemented in your HUC8?
17. What area of concern and/or water bodies are benefiting from the implemented BMPs? Please describe.
18. What land use(s) are the BMPs developed for? Select all that apply.
    a. Cropland
    b. Pasture
    c. Forest
    d. Urban
    e. Feedlot
    f. Other (please specify)
19. Please estimate the approximate area impacted by the implemented BMPs.

20. Is there any monitoring associated with determining pollutant load reductions and/or do the BMPs have estimated pollutant load reductions?
21. If you answered no, do you need technical and financial assistance to conduct monitoring?
22. What were the costs associated with the BMPs?
23. Are there noticeable improvements associated with implementing the BMPs? If yes, please describe.
24. Are there other BMPs you would like to see in addition to those currently constructed or implemented?
25. Please list any funded projects, activities, or next steps for non-point source pollution in your watershed in the next five years.
26. What types of information/education/outreach do you see being the most effective? Please check all that apply.
    a. Water Quality Awareness Signage in Parks by Streams
    b. Educational Campaign
    c. Social Media
    d. Story Map
    e. Newsletters, Mailers, Blurbs
    f. Website Update
    g. Park Signage
    h. "Report a Concern" Website
    i. Volunteer Cleanup Programs
    j. School Visits
    k. Pet-waste Pickup Stations
    l. Other (please specify)
27. Are you interested in collaboration with other stakeholder groups and hosting/participation in events?
28. Do you have any annual events/activities we could attend? If yes, please provide date/time/location/contact information.
29. Please describe what interim measurable criteria/milestones are used to determine goal achievement.
30. In 5 years, what does progress look like to you regarding pollution loading reduction in your area of concern?
31. In 10 years, what does progress look like to you regarding pollution loading reduction in your area of concern?
32. Which of the following in-stream monitoring activities would you likely consider implementing in your area of concern? Please select one or both options.
33. Do you need technical and financial assistance to conduct in-stream monitoring? If yes, please describe.
34. To develop/implement BMPs, do you need any financial assistance? If yes, please describe.
35. What financial assistance have you received for watershed improvement projects?
36. What are sources of financial assistance you know of but have not used?
37. What technical resources are needed to develop/implement BMPs?
38. What sources of technical assistance have you received in the past?
39. What are sources of technical assistance you know of but have not used?

40. Are there point discharges you are concerned about in your watershed (even in areas that are MS4 permitted)? If yes, please explain.
41. Are there non-point sources that you are concerned about in your watershed (even in areas that are MS4 permitted)? If yes, please explain.
42. Are you aware of abandoned mined land in your area?
43. If yes, are you aware of abandoned mined land BMP strategies implemented in your area?
44. What are the results of implementing such abandoned mined land BMP strategies?
45. Are you aware of agricultural practices (Cropland, Pasture, and/or Feedlot) in your area?
46. From the highest concern to the lowest, please rank the following agricultural concerns with 1 being the largest and 3 being the smallest: Cropland, Pasture, Feedlot.
47. Are you aware of agricultural BMP strategies implemented in your area?
48. If yes, what are the results of implementing such agricultural BMP strategies?
49. Are you aware of atmospheric deposition in your area?
50. If yes, are you aware of atmospheric deposition BMP strategies implemented in your area?
51. What are the results of implementing such atmospheric deposition BMP strategies?
52. Are you aware of forestry non-point source in your area?
53. If yes, are you aware of forestry non-point source BMP strategies implemented in your area?
54. Are you aware of hydromodification and habitat alteration in your area?
55. If yes, are you aware of hydromodification and habitat alteration BMP strategies implemented in your area?
56. If yes, what are the results of implementing such hydromodification and habitat alteration BMP strategies?
57. Are you aware of urbanization in your area?
58. If yes, are you aware of urbanization BMP strategies implemented in your area?
59. If yes, what are the results of implementing such urbanization BMP strategies?

APPENDIX B
MAPS OF IMPAIRED PARAMETERS

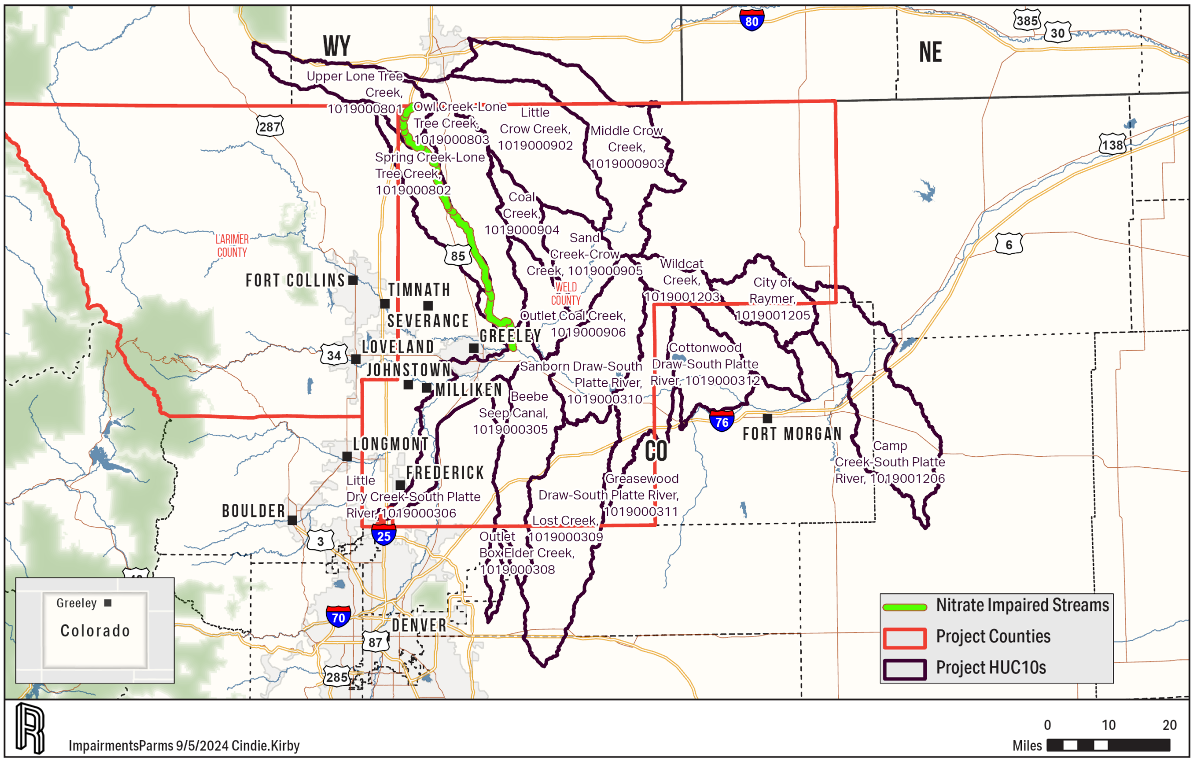


Figure B-1. Nitrate Impairments.

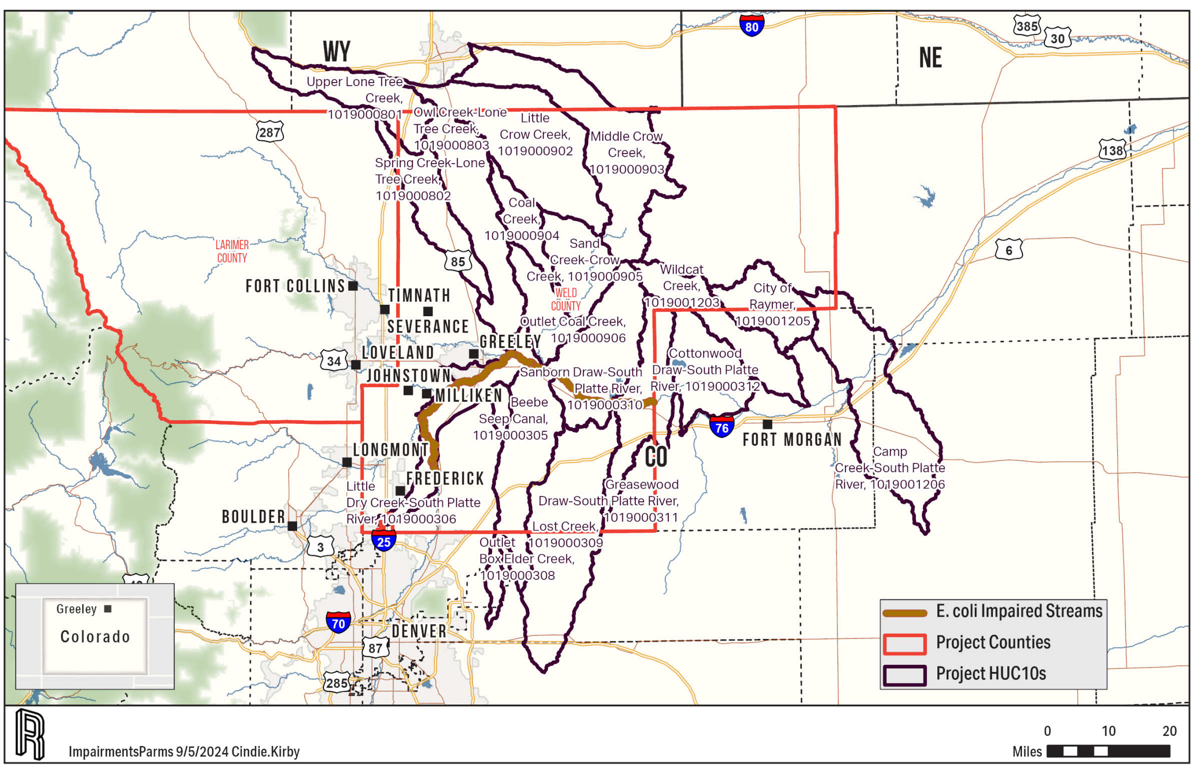


Figure B-2. *E. coli* Impairments.

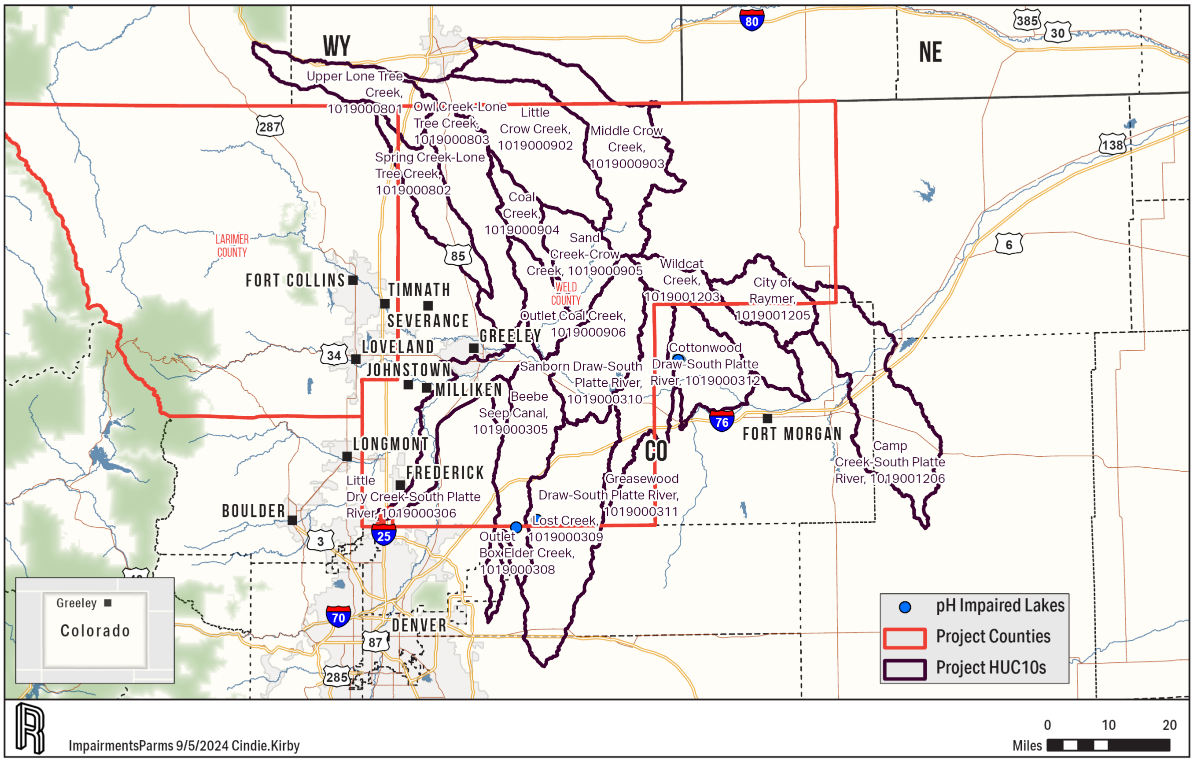


Figure B-3. pH Impairments.

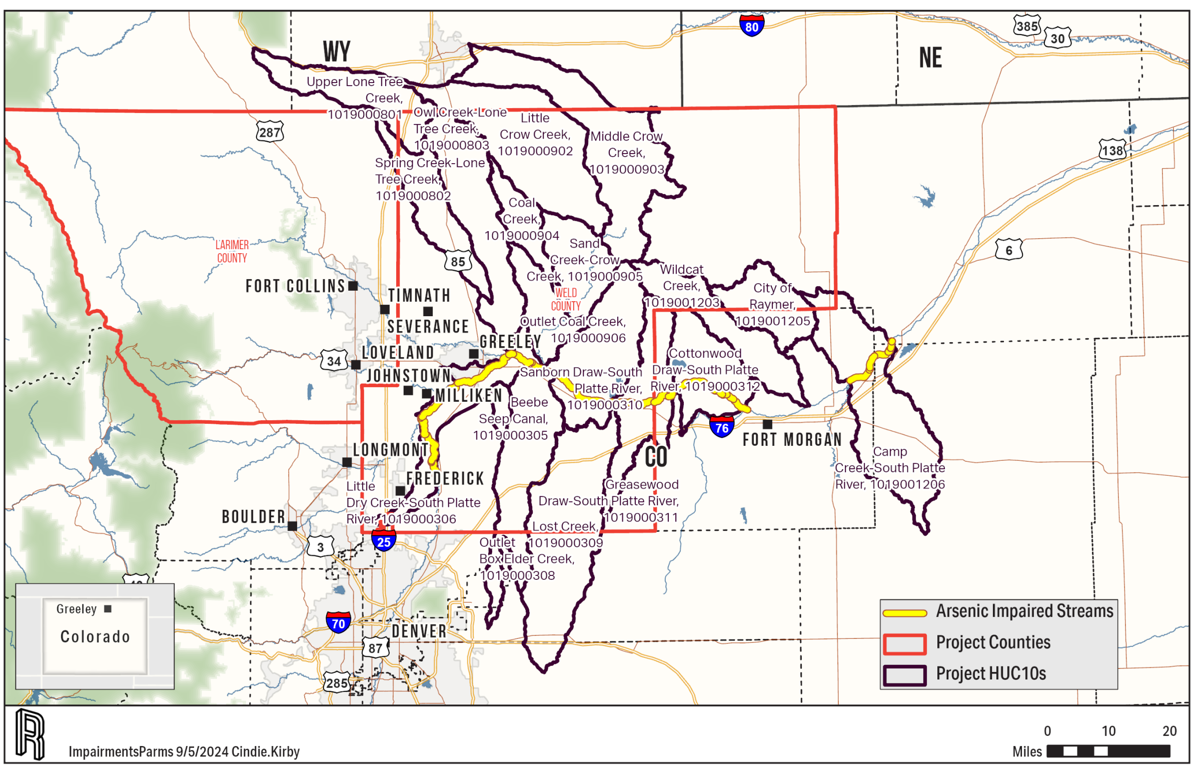


Figure B-4. Arsenic Impairments.

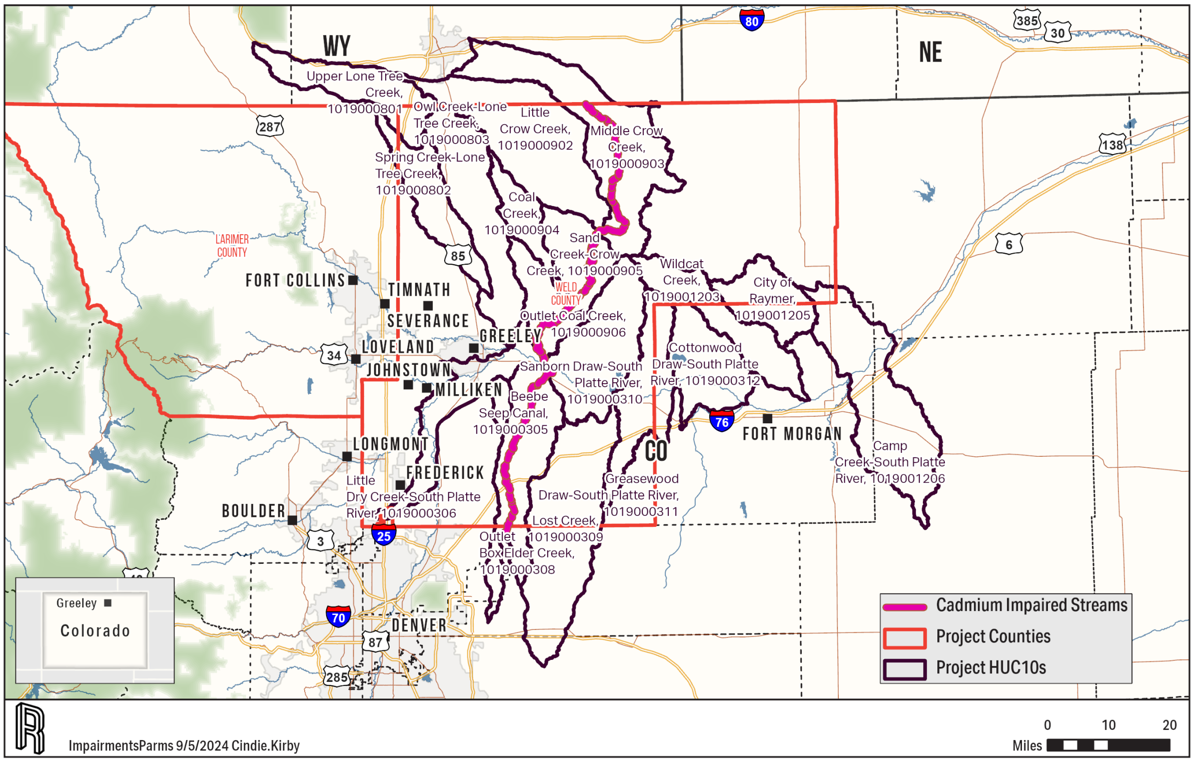


Figure B-5. Cadmium Impairments.

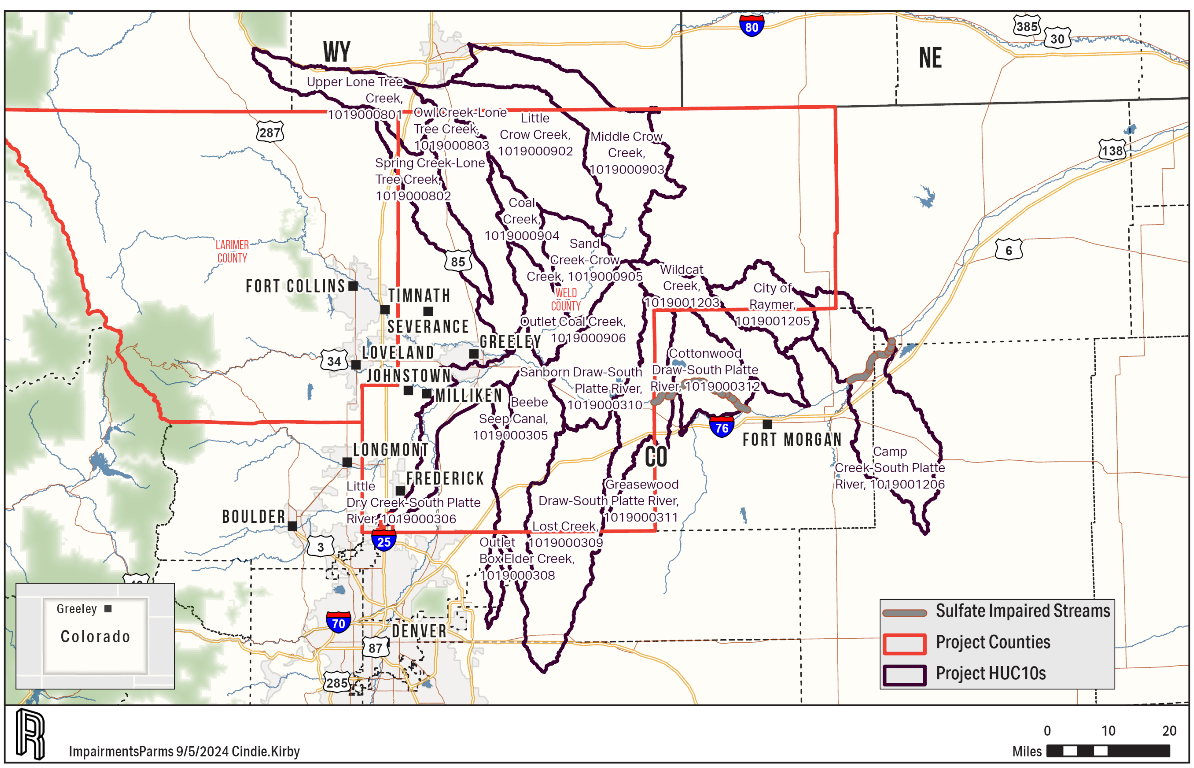


Figure B-6. Sulfate Impairments.

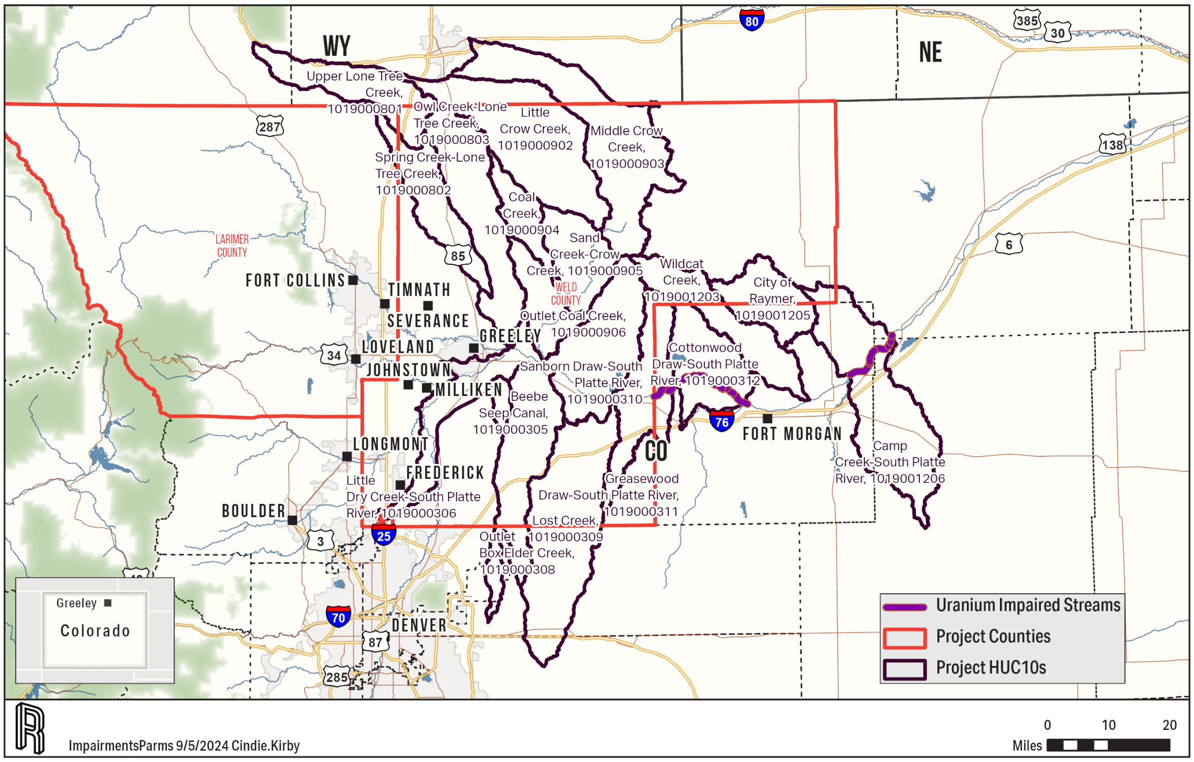


Figure B-7. Uranium Impairments.

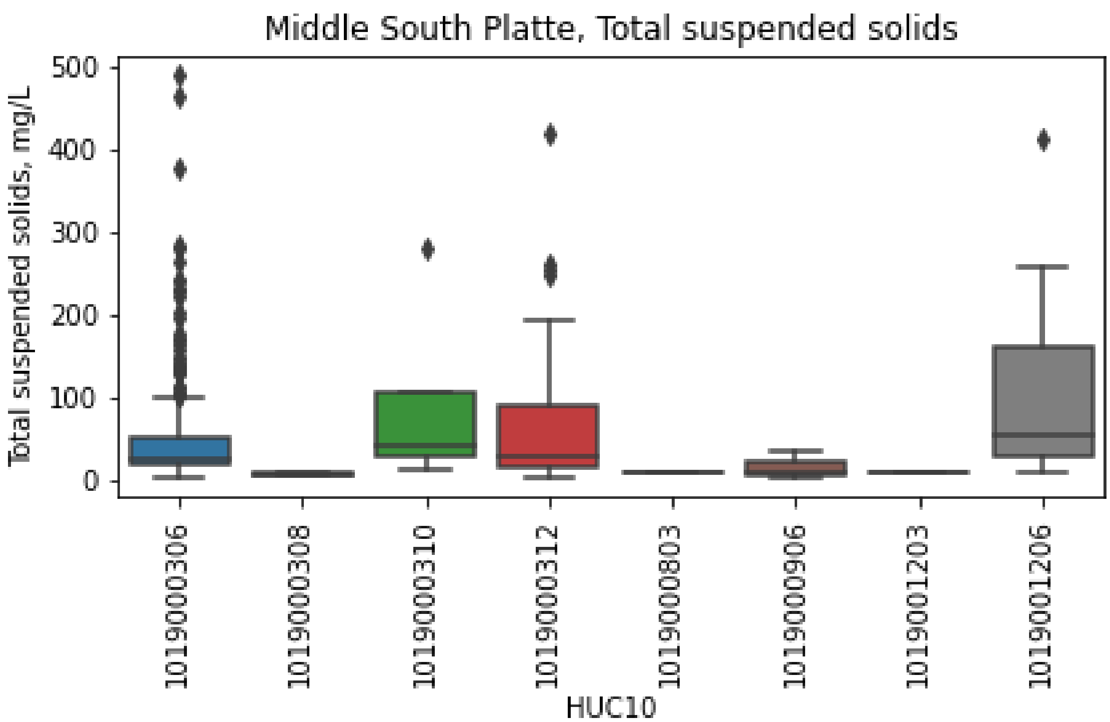
APPENDIX C

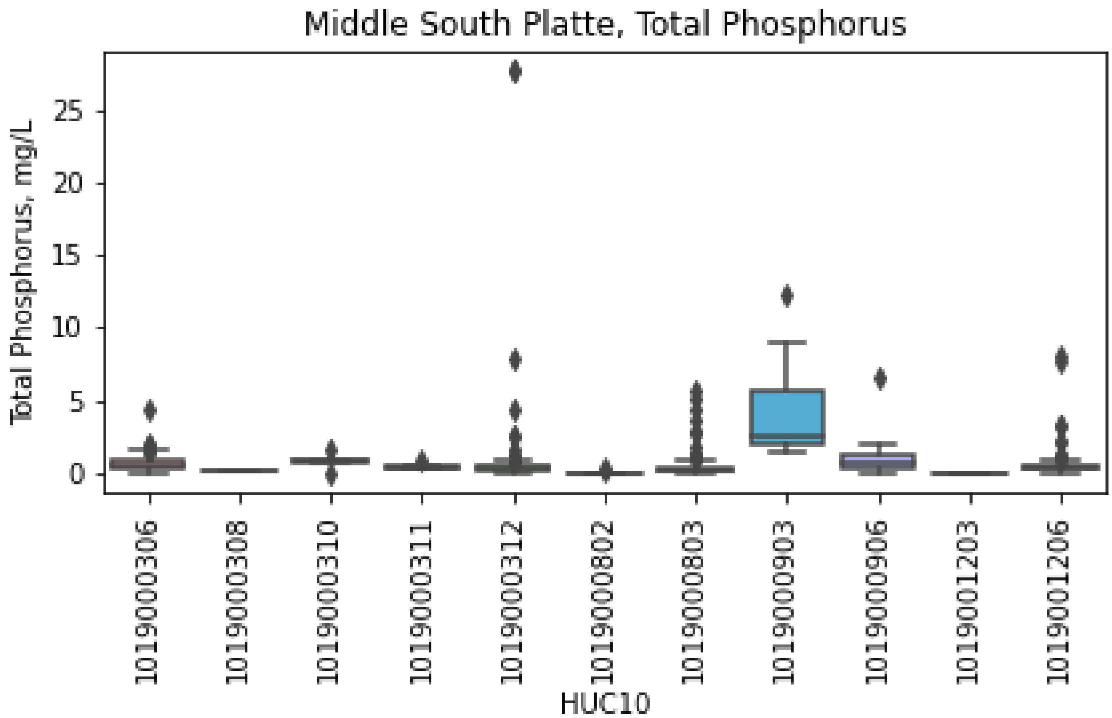
APPLICABLE WATER QUALITY BOX PLOTS BY HUC10

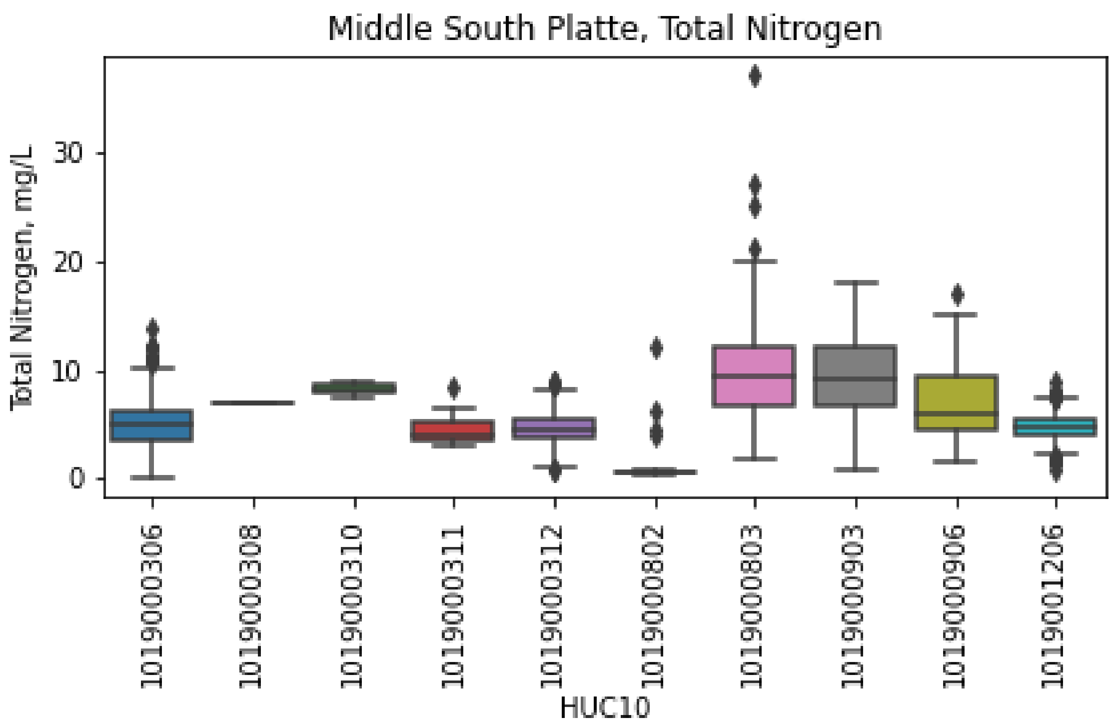
DATASET

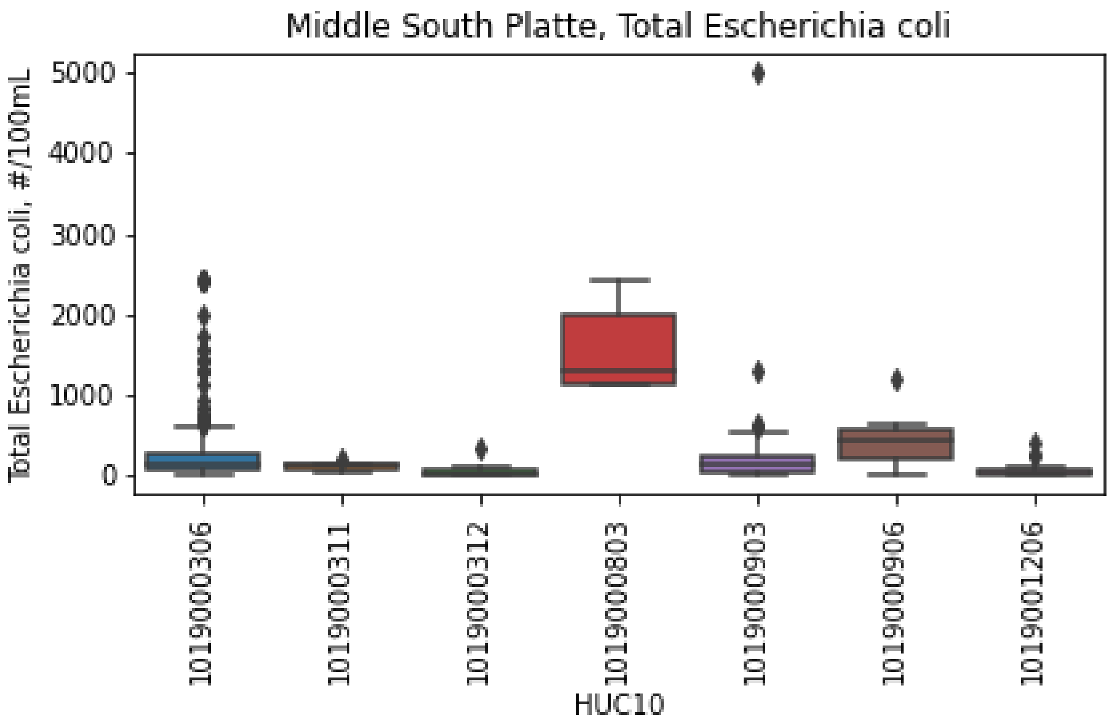
Data for boxplots were collected for the years 1990 through 2023 from various sources. Sources included the Water Quality Portal, the Colorado Data Sharing Network, Northern Water, ERAMS, and numerous individuals including Paul Bremser (St. Vrain), Andy Fayram (City of Loveland), Brian Hathaway (City of Greeley), and Jason Meier (Fossil Creek). Data were organized and grouped into a single file with consistent naming and units for applicable parameters, and were assigned a "Y" or a "N" for an attribute representing if the monitoring point was located on a mainstem HUC10 reach. The boxplots only include data along the mainstem HUC10 reaches because water quality can vary greatly for headwater streams.

PLET PARAMETERS



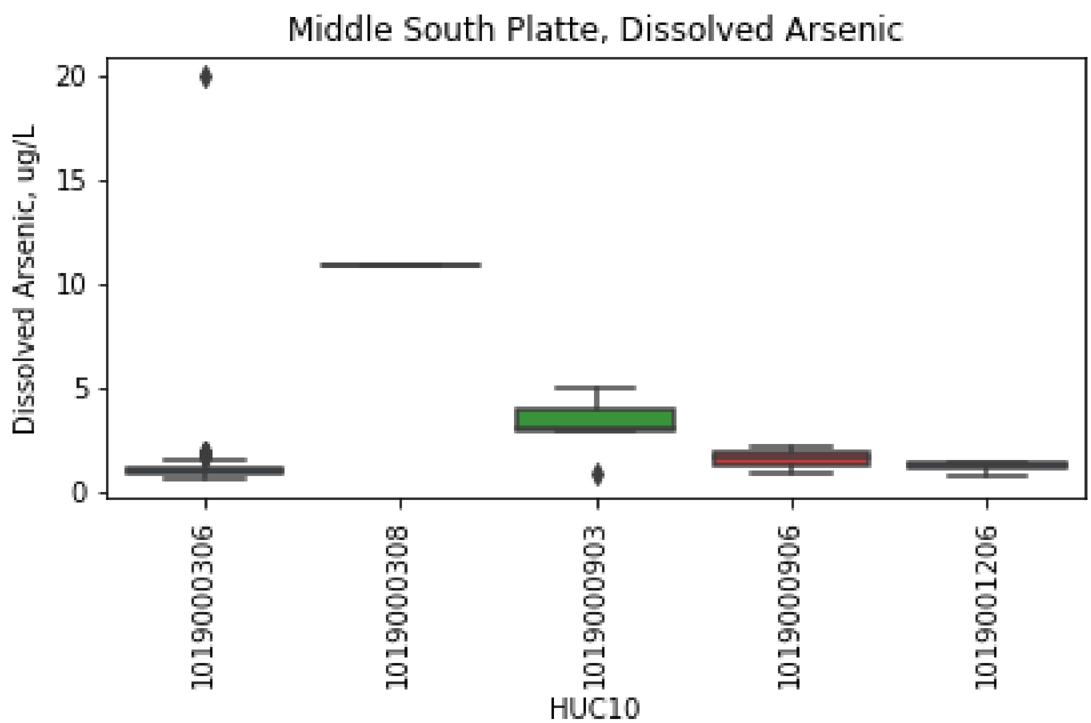

Middle South Platte, Total Phosphorus
Total Phosphorus, mg/L
25
20
15
10
5
0
1019000306
1019000308
1019000310
1019000311
1019000312
1019000802
1019000803
1019000903
1019000906
1019001203
1019001206
HUC10

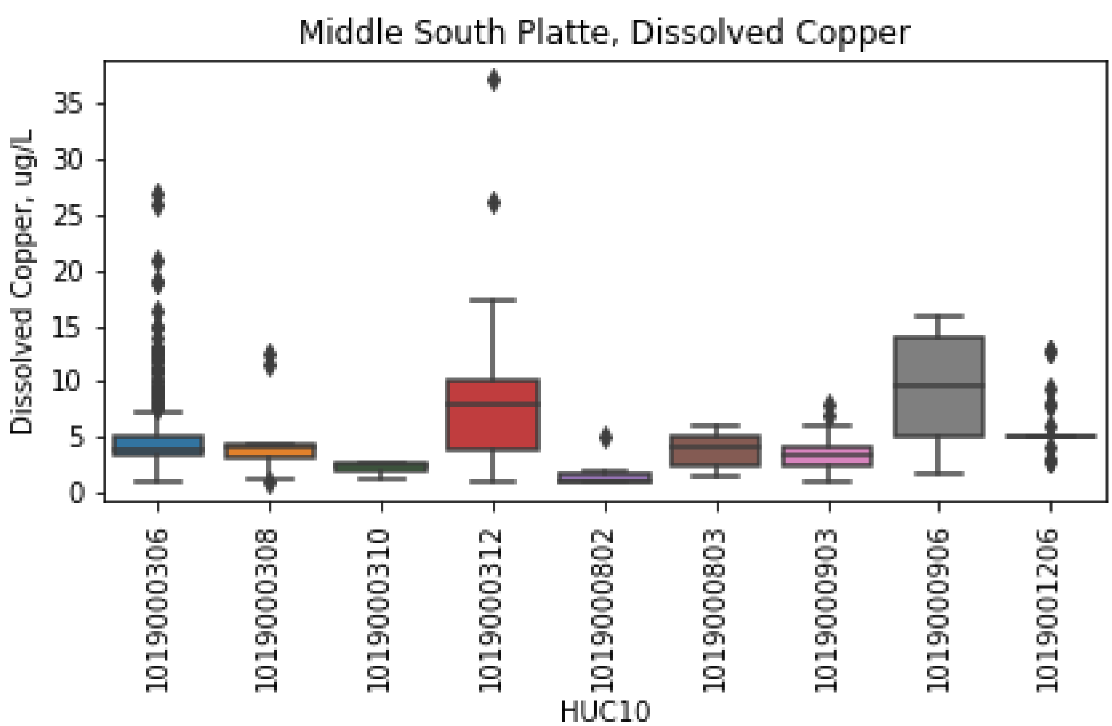

Middle South Platte, Total Nitrogen
Total Nitrogen, mg/L
30
20
10
0
1019000306
1019000308
1019000310
1019000311
1019000312
1019000802
1019000803
1019000903
1019000906
1019001206
HUC10

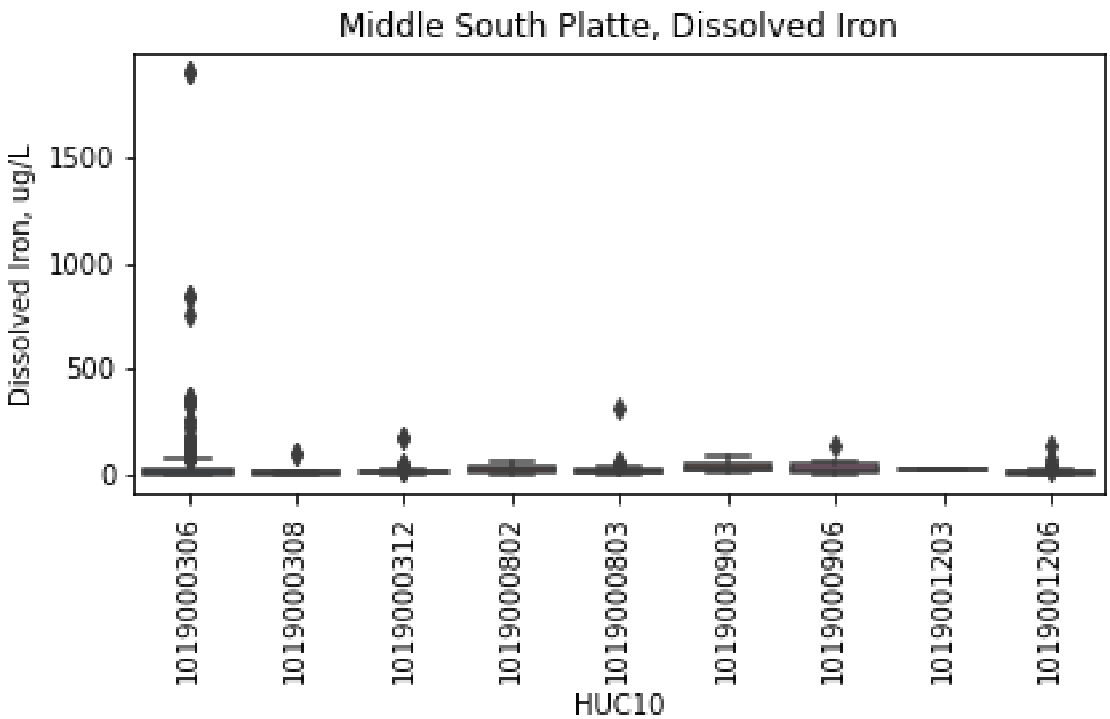


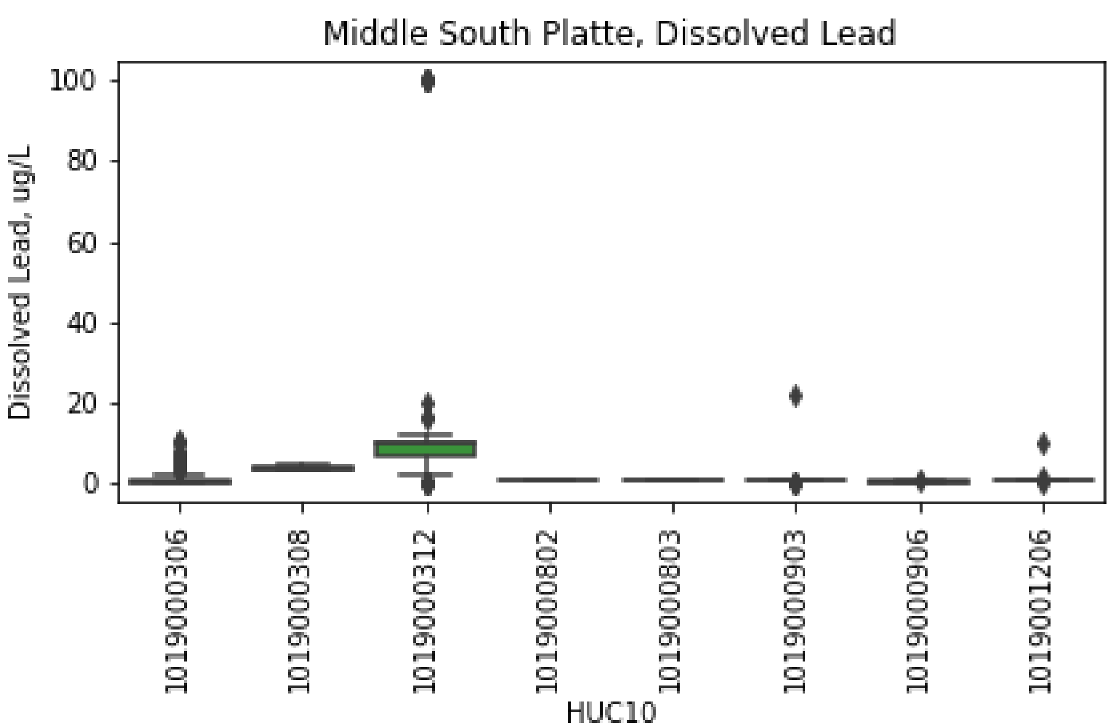
Middle South Platte, Total Escherichia coli
Total Escherichia coli, #/100mL
5000
4000
3000
2000
1000
0
1019000306
1019000311
1019000312
1019000803
1019000903
1019000906
1019001206
HUC10

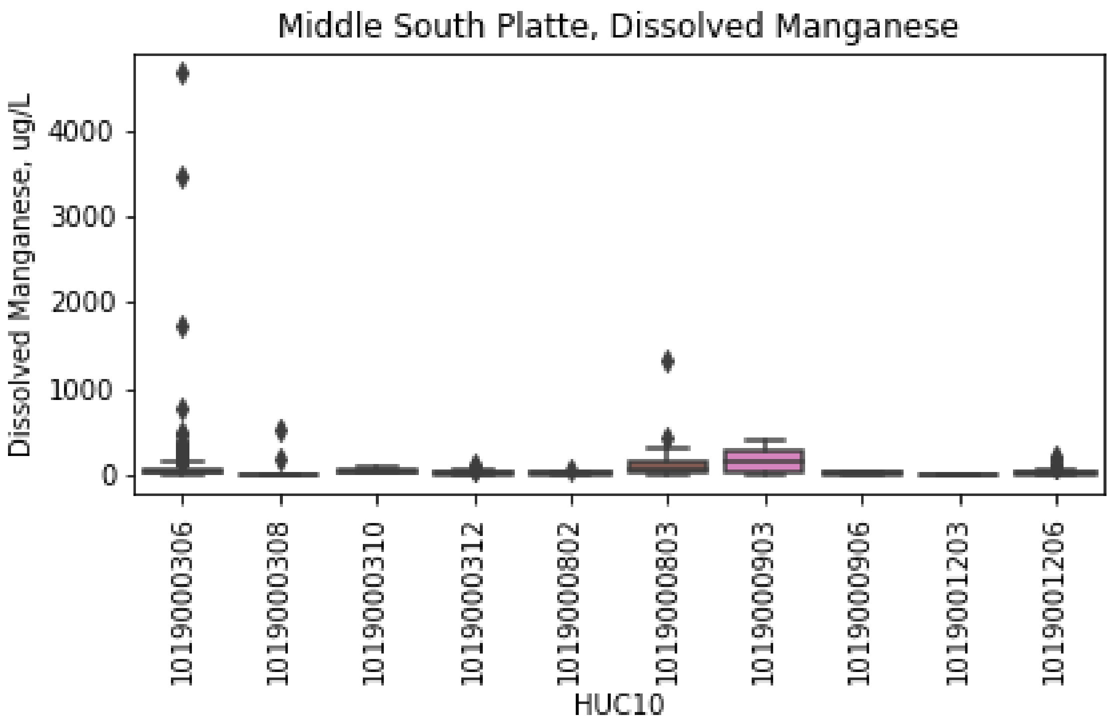
HEAVY METALS

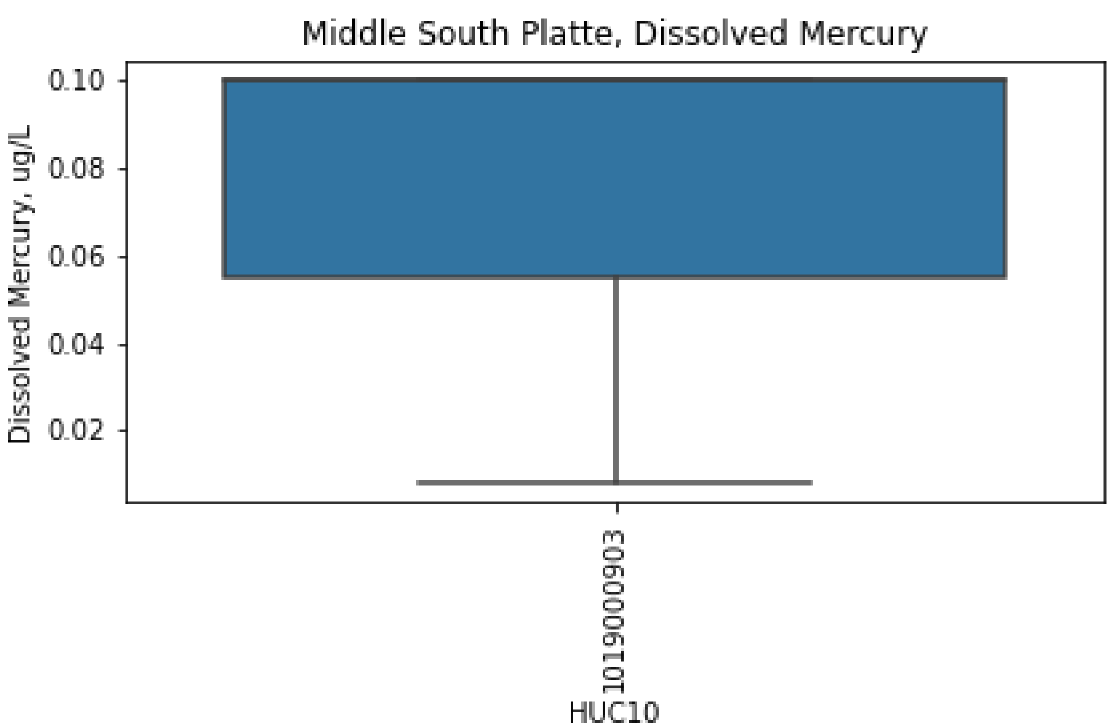


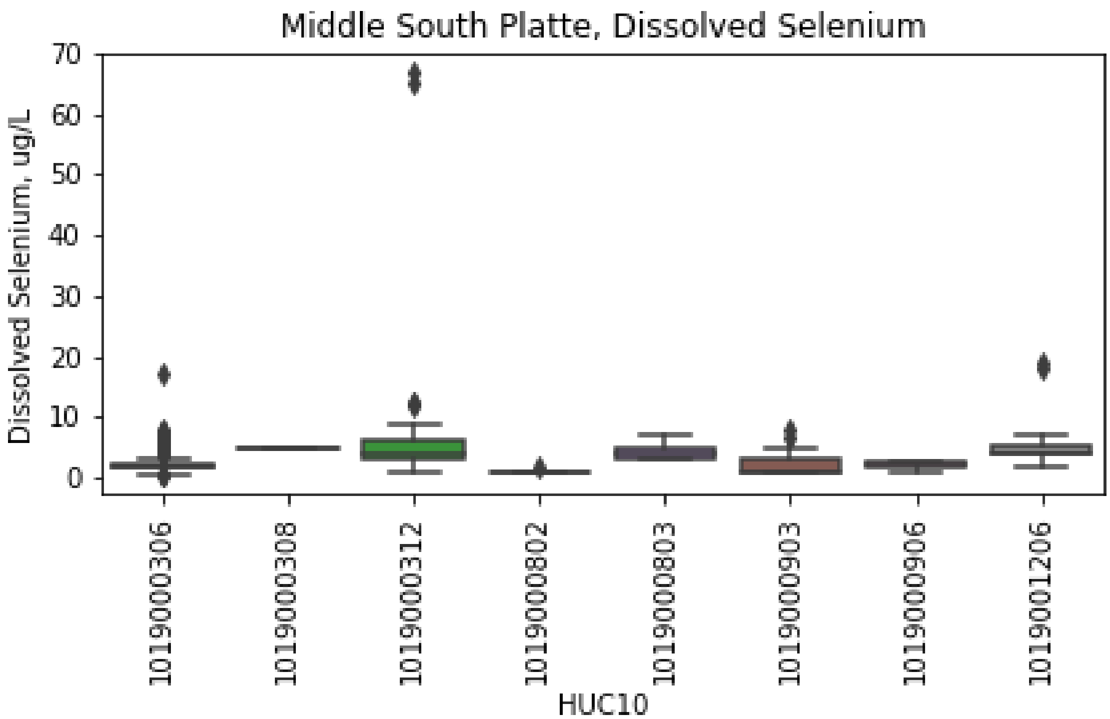


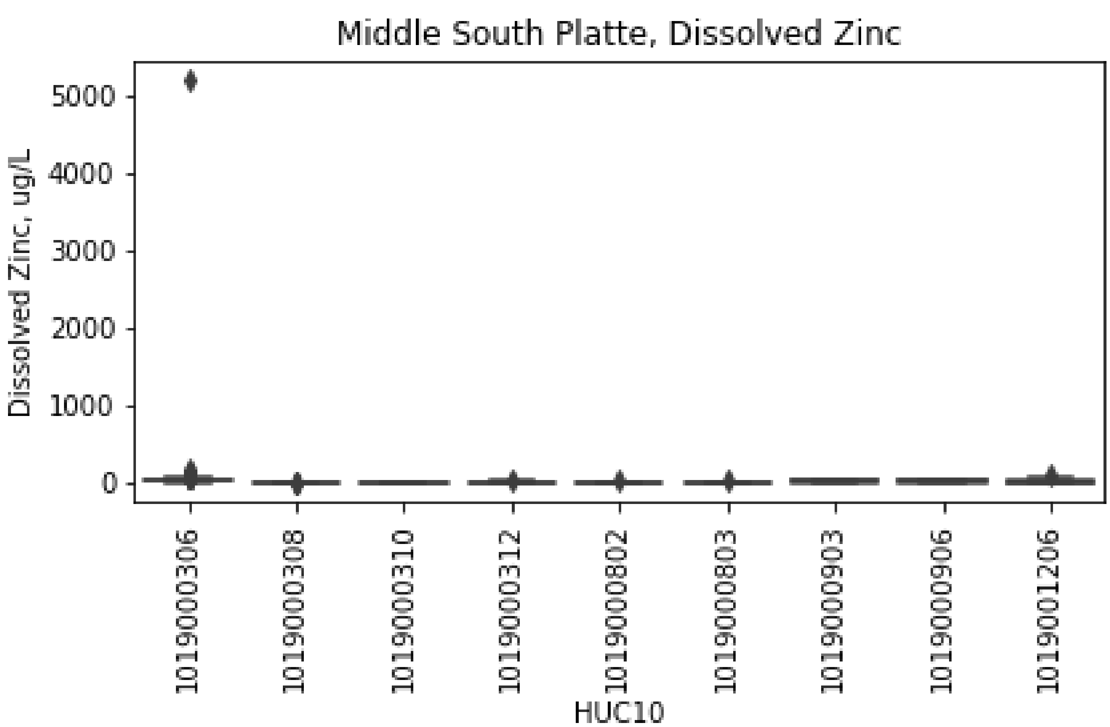

Middle South Platte, Dissolved Iron
Dissolved Iron, ug/L
1500
1000
500
0
1019000306
1019000308
1019000312
1019000802
1019000803
1019000903
1019000906
1019001203
1019001206
HUC10

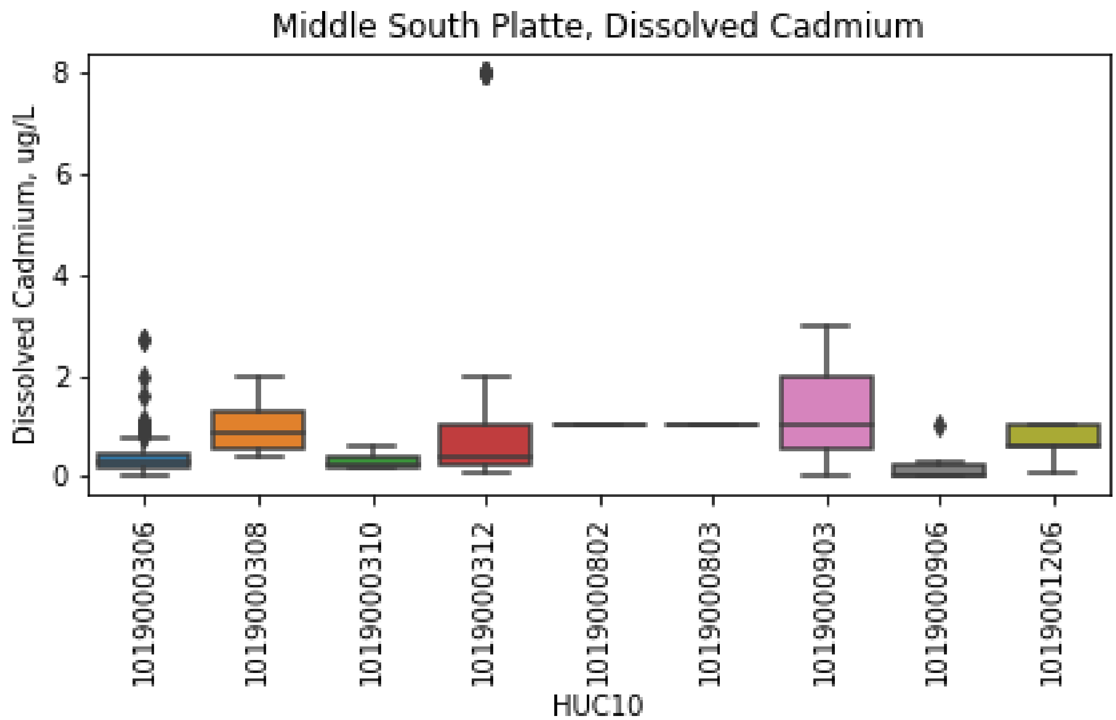

Middle South Platte, Dissolved Lead
Dissolved Lead, ug/L
100
80
60
40
20
0
1019000306
1019000308
1019000312
1019000802
1019000803
1019000903
1019000906
1019001206
HUC10

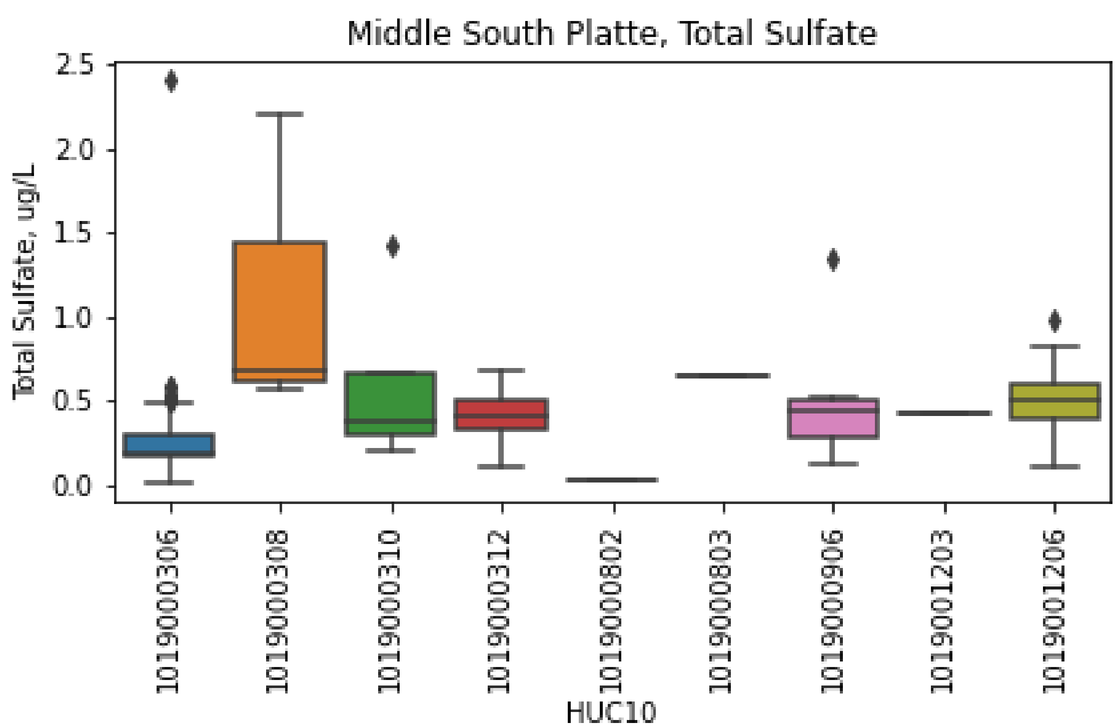

Middle South Platte, Dissolved Manganese
Dissolved Manganese, ug/L
0
1000
2000
3000
4000
1019000306
1019000308
1019000310
1019000312
1019000802
1019000803
1019000903
1019000906
1019001203
1019001206
HUC10

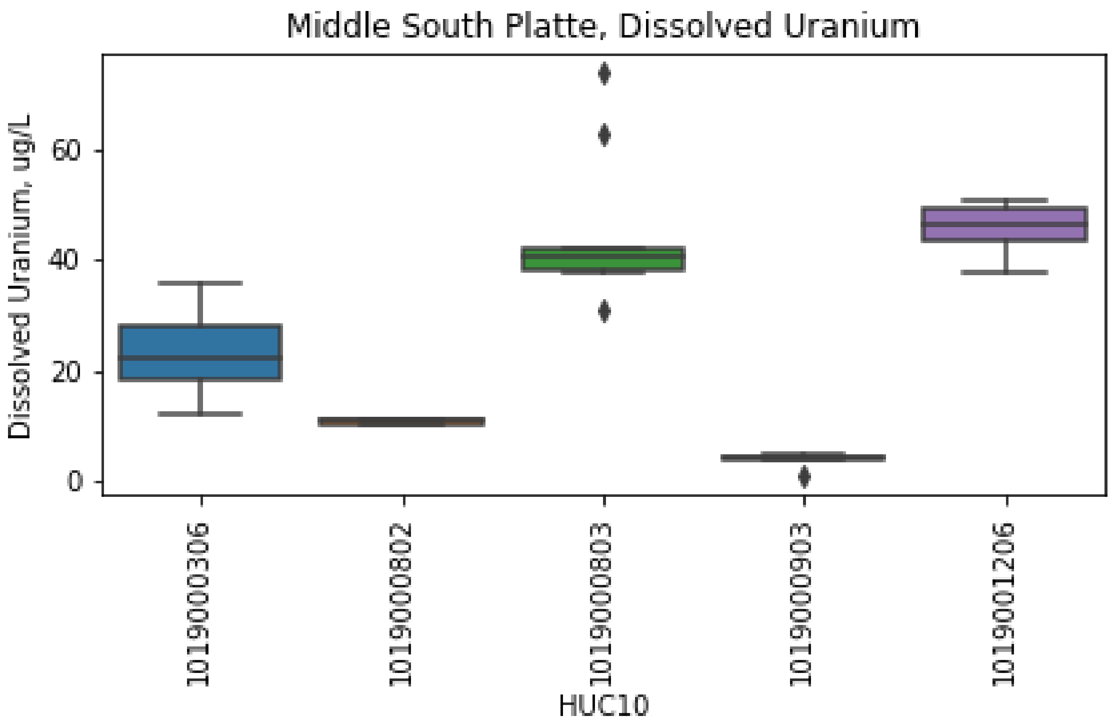

Middle South Platte, Dissolved Mercury
Dissolved Mercury, ug/L
0.02
0.04
0.06
0.08
0.10
1019000903
HUC10


Middle South Platte, Dissolved Selenium
Dissolved Selenium, ug/L
70
60
50
40
30
20
10
0
1019000306
1019000308
1019000312
1019000802
1019000803
1019000903
1019000906
1019001206
HUC10


Middle South Platte, Dissolved Zinc
Dissolved Zinc, ug/L
5000
4000
3000
2000
1000
0
1019000306
1019000308
1019000310
1019000312
1019000802
1019000803
1019000903
1019000906
1019001206
HUC10


Middle South Platte, Dissolved Cadmium
Dissolved Cadmium, ug/L
0
2
4
6
8
1019000306
1019000308
1019000310
1019000312
1019000802
1019000803
1019000903
1019000906
1019001206
HUC10


Middle South Platte, Total Sulfate
Total Sulfate, ug/L
0.0
0.5
1.0
1.5
2.0
2.5
1019000306
1019000308
1019000310
1019000312
1019000802
1019000803
1019000906
1019001203
1019001206
HUC10


Middle South Platte, Dissolved Uranium
Dissolved Uranium, ug/L
0
20
40
60
1019000306
1019000802
1019000803
1019000903
1019001206
HUC10

APPENDIX D
PLET SCENARIO REDUCTIONS

RESPEC

Table D-1. PLET Scenario Reductions (Page 1 of 8)

Land Use	Practice	HUC10	Nitrogen Reduction (%)	Phosphorus Reduction (%)	Sediment Reduction (%)
Cropland	Streambank Stabilization and Fencing	1019000305	17.2	17.2	17.9
Cropland	Streambank Stabilization and Fencing	1019000306	17.4	17.4	18.4
Cropland	Streambank Stabilization and Fencing	1019000308	17.4	17.4	18.1
Cropland	Streambank Stabilization and Fencing	1019000309	18.1	18.1	18.5
Cropland	Streambank Stabilization and Fencing	1019000310	16.6	16.6	16.8
Cropland	Streambank Stabilization and Fencing	1019000311	17.4	17.4	17.6
Cropland	Streambank Stabilization and Fencing	1019000312	18.4	18.4	18.5
Cropland	Streambank Stabilization and Fencing	1019000801	0.0	0.0	0.0
Cropland	Streambank Stabilization and Fencing	1019000802	16.0	16.0	17.4
Cropland	Streambank Stabilization and Fencing	1019000803	16.9	16.9	17.6
Cropland	Streambank Stabilization and Fencing	1019000902	13.8	13.8	13.9
Cropland	Streambank Stabilization and Fencing	1019000903	17.1	17.1	17.2
Cropland	Streambank Stabilization and Fencing	1019000904	0.0	0.0	0.0
Cropland	Streambank Stabilization and Fencing	1019000905	15.0	15.0	15.8
Cropland	Streambank Stabilization and Fencing	1019000906	16.8	16.8	17.4
Cropland	Streambank Stabilization and Fencing	1019001203	17.7	17.7	17.7
Cropland	Streambank Stabilization and Fencing	1019001205	18.0	18.0	18.1
Cropland	Streambank Stabilization and Fencing	1019001206	18.3	18.3	18.4
Cropland	35 ft Buffers	1019000305	12.6	12.6	12.6
Cropland	35 ft Buffers	1019000306	12.8	12.8	13.0
Cropland	35 ft Buffers	1019000308	12.7	12.7	12.8
Cropland	35 ft Buffers	1019000309	13.0	13.0	13.0
Cropland	35 ft Buffers	1019000310	11.9	11.8	11.9
Cropland	35 ft Buffers	1019000311	12.4	12.4	12.5
Cropland	35 ft Buffers	1019000312	13.1	13.1	13.1
Cropland	35 ft Buffers	1019000801	0.0	0.0	0.0
Cropland	35 ft Buffers	1019000802	12.1	12.1	12.3
Cropland	35 ft Buffers	1019000803	12.3	12.3	12.5
Cropland	35 ft Buffers	1019000902	9.8	9.8	9.8

Table D-1. PLET Scenario Reductions (Page 2 of 8)

Land Use	Practice	HUC10	Nitrogen Reduction (%)	Phosphorus Reduction (%)	Sediment Reduction (%)
Cropland	35 ft Buffers	1019000903	12.1	12.1	12.2
Cropland	35 ft Buffers	1019000904	0.0	0.0	0.0
Cropland	35 ft Buffers	1019000905	11.0	11.0	11.2
Cropland	35 ft Buffers	1019000906	12.2	12.2	12.3
Cropland	35 ft Buffers	1019001203	12.5	12.5	12.5
Cropland	35 ft Buffers	1019001205	12.8	12.8	12.8
Cropland	35 ft Buffers	1019001206	13.0	13.0	13.0
Pasture	Streambank Stabilization and Fencing	1019000305	0.7	0.7	0.7
Pasture	Streambank Stabilization and Fencing	1019000306	0.3	0.3	0.3
Pasture	Streambank Stabilization and Fencing	1019000308	0.3	0.3	0.3
Pasture	Streambank Stabilization and Fencing	1019000309	0.1	0.1	0.1
Pasture	Streambank Stabilization and Fencing	1019000310	0.1	0.1	0.1
Pasture	Streambank Stabilization and Fencing	1019000311	0.1	0.1	0.1
Pasture	Streambank Stabilization and Fencing	1019000312	0.0	0.0	0.0
Pasture	Streambank Stabilization and Fencing	1019000801	0.0	0.0	0.0
Pasture	Streambank Stabilization and Fencing	1019000802	0.4	0.4	0.4
Pasture	Streambank Stabilization and Fencing	1019000803	0.3	0.3	0.3
Pasture	Streambank Stabilization and Fencing	1019000902	0.1	0.1	0.1
Pasture	Streambank Stabilization and Fencing	1019000903	0.2	0.2	0.2
Pasture	Streambank Stabilization and Fencing	1019000904	1.2	1.2	1.2
Pasture	Streambank Stabilization and Fencing	1019000905	0.3	0.3	0.3
Pasture	Streambank Stabilization and Fencing	1019000906	0.8	0.8	0.8
Pasture	Streambank Stabilization and Fencing	1019001203	0.1	0.1	0.1
Pasture	Streambank Stabilization and Fencing	1019001205	0.3	0.3	0.3
Pasture	Streambank Stabilization and Fencing	1019001206	0.1	0.1	0.1
Pasture	35 ft Buffers	1019000305	0.6	0.6	0.6
Pasture	35 ft Buffers	1019000306	0.3	0.3	0.3
Pasture	35 ft Buffers	1019000308	0.3	0.3	0.3
Pasture	35 ft Buffers	1019000309	0.1	0.1	0.1

Table D-1. PLET Scenario Reductions (Page 3 of 8)

Land Use	Practice	HUC10	Nitrogen Reduction (%)	Phosphorus Reduction (%)	Sediment Reduction (%)
Pasture	35 ft Buffers	1019000310	0.1	0.1	0.1
Pasture	35 ft Buffers	1019000311	0.1	0.1	0.1
Pasture	35 ft Buffers	1019000312	0.0	0.0	0.0
Pasture	35 ft Buffers	1019000801	0.0	0.0	0.0
Pasture	35 ft Buffers	1019000802	0.4	0.4	0.4
Pasture	35 ft Buffers	1019000803	0.3	0.3	0.3
Pasture	35 ft Buffers	1019000902	0.1	0.1	0.1
Pasture	35 ft Buffers	1019000903	0.2	0.2	0.2
Pasture	35 ft Buffers	1019000904	1.0	1.0	1.1
Pasture	35 ft Buffers	1019000905	0.3	0.3	0.3
Pasture	35 ft Buffers	1019000906	0.7	0.7	0.7
Pasture	35 ft Buffers	1019001203	0.1	0.1	0.1
Pasture	35 ft Buffers	1019001205	0.1	0.1	0.1
Pasture	35 ft Buffers	1019001206	0.1	0.1	0.1
Pasture	Livestock Exclusion	1019000305	0.6	0.6	0.6
Pasture	Livestock Exclusion	1019000306	0.3	0.3	0.3
Pasture	Livestock Exclusion	1019000308	0.3	0.3	0.3
Pasture	Livestock Exclusion	1019000309	0.1	0.1	0.1
Pasture	Livestock Exclusion	1019000310	0.1	0.1	0.1
Pasture	Livestock Exclusion	1019000311	0.1	0.1	0.1
Pasture	Livestock Exclusion	1019000312	0.0	0.0	0.0
Pasture	Livestock Exclusion	1019000801	0.0	0.0	0.0
Pasture	Livestock Exclusion	1019000802	0.4	0.4	0.4
Pasture	Livestock Exclusion	1019000803	0.3	0.3	0.3
Pasture	Livestock Exclusion	1019000902	0.1	0.1	0.1
Pasture	Livestock Exclusion	1019000903	0.2	0.2	0.2
Pasture	Livestock Exclusion	1019000904	1.0	1.0	1.1
Pasture	Livestock Exclusion	1019000905	0.3	0.3	0.3
Pasture	Livestock Exclusion	1019000906	0.7	0.7	0.7

Table D-1. PLET Scenario Reductions (Page 4 of 8)

Land Use	Practice	HUC10	Nitrogen Reduction (%)	Phosphorus Reduction (%)	Sediment Reduction (%)
Pasture	Livestock Exclusion	1019001203	0.1	0.1	0.1
Pasture	Livestock Exclusion	1019001205	0.2	0.2	0.2
Pasture	Livestock Exclusion	1019001206	0.1	0.1	0.1
Feedlot	Waste Management System	1019000305	0.0	0.0	0.0
Feedlot	Waste Management System	1019000306	0.0	0.0	0.0
Feedlot	Waste Management System	1019000308	0.0	0.0	0.0
Feedlot	Waste Management System	1019000309	0.0	0.0	0.0
Feedlot	Waste Management System	1019000310	0.0	0.0	0.0
Feedlot	Waste Management System	1019000311	0.0	0.0	0.0
Feedlot	Waste Management System	1019000312	0.0	0.0	0.0
Feedlot	Waste Management System	1019000801	0.0	0.0	0.0
Feedlot	Waste Management System	1019000802	0.0	0.0	0.0
Feedlot	Waste Management System	1019000803	0.0	0.0	0.0
Feedlot	Waste Management System	1019000902	0.0	0.0	0.0
Feedlot	Waste Management System	1019000903	0.0	0.0	0.0
Feedlot	Waste Management System	1019000904	0.0	0.0	0.0
Feedlot	Waste Management System	1019000905	0.0	0.0	0.0
Feedlot	Waste Management System	1019000906	0.0	0.0	0.0
Feedlot	Waste Management System	1019001203	0.0	0.0	0.0
Feedlot	Waste Management System	1019001205	0.0	0.0	0.0
Feedlot	Waste Management System	1019001206	0.0	0.0	0.0
Forest	Site Preparation/Straw/Crimp/Net	1019000305	0.0	0.0	0.0
Forest	Site Preparation/Straw/Crimp/Net	1019000306	0.0	0.0	0.0
Forest	Site Preparation/Straw/Crimp/Net	1019000308	0.0	0.0	0.0
Forest	Site Preparation/Straw/Crimp/Net	1019000309	0.0	0.0	0.0
Forest	Site Preparation/Straw/Crimp/Net	1019000310	0.0	0.0	0.0
Forest	Site Preparation/Straw/Crimp/Net	1019000311	0.1	0.1	0.1
Forest	Site Preparation/Straw/Crimp/Net	1019000312	0.0	0.0	0.0
Forest	Site Preparation/Straw/Crimp/Net	1019000801	0.8	0.8	0.8

Table D-1. PLET Scenario Reductions (Page 5 of 8)

Land Use	Practice	HUC10	Nitrogen Reduction (%)	Phosphorus Reduction (%)	Sediment Reduction (%)
Forest	Site Preparation/Straw/Crimp/Net	1019000802	0.1	0.1	0.1
Forest	Site Preparation/Straw/Crimp/Net	1019000803	0.0	0.0	0.0
Forest	Site Preparation/Straw/Crimp/Net	1019000902	0.2	0.2	0.2
Forest	Site Preparation/Straw/Crimp/Net	1019000903	0.0	0.0	0.0
Forest	Site Preparation/Straw/Crimp/Net	1019000904	0.4	0.4	0.4
Forest	Site Preparation/Straw/Crimp/Net	1019000905	0.0	0.0	0.0
Forest	Site Preparation/Straw/Crimp/Net	1019000906	0.0	0.0	0.0
Forest	Site Preparation/Straw/Crimp/Net	1019001203	0.0	0.0	0.0
Forest	Site Preparation/Straw/Crimp/Net	1019001205	0.0	0.0	0.0
Forest	Site Preparation/Straw/Crimp/Net	1019001206	0.0	0.0	0.0
Forest	Site Preparation/Straw/Crimp Seed/Fertilizer/Transplant	1019000305	0.0	0.0	0.0
Forest	Site Preparation/Straw/Crimp Seed/Fertilizer/Transplant	1019000306	0.0	0.0	0.0
Forest	Site Preparation/Straw/Crimp Seed/Fertilizer/Transplant	1019000308	0.0	0.0	0.0
Forest	Site Preparation/Straw/Crimp Seed/Fertilizer/Transplant	1019000309	0.0	0.0	0.0
Forest	Site Preparation/Straw/Crimp Seed/Fertilizer/Transplant	1019000310	0.0	0.0	0.0
Forest	Site Preparation/Straw/Crimp Seed/Fertilizer/Transplant	1019000311	0.1	0.1	0.1
Forest	Site Preparation/Straw/Crimp Seed/Fertilizer/Transplant	1019000312	0.0	0.0	0.0
Forest	Site Preparation/Straw/Crimp Seed/Fertilizer/Transplant	1019000801	0.8	0.8	0.8
Forest	Site Preparation/Straw/Crimp Seed/Fertilizer/Transplant	1019000802	0.1	0.1	0.1
Forest	Site Preparation/Straw/Crimp Seed/Fertilizer/Transplant	1019000803	0.0	0.0	0.0
Forest	Site Preparation/Straw/Crimp Seed/Fertilizer/Transplant	1019000902	0.2	0.2	0.2

Table D-1. PLET Scenario Reductions (Page 6 of 8)

Land Use	Practice	HUC10	Nitrogen Reduction (%)	Phosphorus Reduction (%)	Sediment Reduction (%)
Forest	Site Preparation/Straw/Crimp Seed/Fertilizer/Transplant	1019000903	0.0	0.0	0.0
Forest	Site Preparation/Straw/Crimp Seed/Fertilizer/Transplant	1019000904	0.4	0.4	0.4
Forest	Site Preparation/Straw/Crimp Seed/Fertilizer/Transplant	1019000905	0.0	0.0	0.0
Forest	Site Preparation/Straw/Crimp Seed/Fertilizer/Transplant	1019000906	0.0	0.0	0.0
Forest	Site Preparation/Straw/Crimp Seed/Fertilizer/Transplant	1019001203	0.0	0.0	0.0
Forest	Site Preparation/Straw/Crimp Seed/Fertilizer/Transplant	1019001205	0.0	0.0	0.0
Forest	Site Preparation/Straw/Crimp Seed/Fertilizer/Transplant	1019001206	0.0	0.0	0.0
Urban	Extended Wet Detention	1019000305	0.0	0.0	0.0
Urban	Extended Wet Detention	1019000306	0.0	0.0	0.0
Urban	Extended Wet Detention	1019000308	0.0	0.0	0.0
Urban	Extended Wet Detention	1019000309	0.0	0.0	0.0
Urban	Extended Wet Detention	1019000310	0.0	0.0	0.0
Urban	Extended Wet Detention	1019000311	0.0	0.0	0.0
Urban	Extended Wet Detention	1019000312	0.0	0.0	0.0
Urban	Extended Wet Detention	1019000801	0.0	0.0	0.0
Urban	Extended Wet Detention	1019000802	0.0	0.0	0.0
Urban	Extended Wet Detention	1019000803	0.0	0.0	0.0
Urban	Extended Wet Detention	1019000902	0.0	0.0	0.0
Urban	Extended Wet Detention	1019000903	0.0	0.0	0.0
Urban	Extended Wet Detention	1019000904	0.0	0.0	0.0
Urban	Extended Wet Detention	1019000905	0.0	0.0	0.0
Urban	Extended Wet Detention	1019000906	0.0	0.0	0.0
Urban	Extended Wet Detention	1019001203	0.0	0.0	0.0
Urban	Extended Wet Detention	1019001205	0.0	0.0	0.0

Table D-1. PLET Scenario Reductions (Page 7 of 8)

Land Use	Practice	HUC10	Nitrogen Reduction (%)	Phosphorus Reduction (%)	Sediment Reduction (%)
Urban	Extended Wet Detention	1019001206	0.0	0.0	0.0
Urban	Infiltration Basin	1019000305	0.0	0.0	0.0
Urban	Infiltration Basin	1019000306	0.0	0.0	0.0
Urban	Infiltration Basin	1019000308	0.0	0.0	0.0
Urban	Infiltration Basin	1019000309	0.0	0.0	0.0
Urban	Infiltration Basin	1019000310	0.0	0.0	0.0
Urban	Infiltration Basin	1019000311	0.0	0.0	0.0
Urban	Infiltration Basin	1019000312	0.0	0.0	0.0
Urban	Infiltration Basin	1019000801	0.0	0.0	0.0
Urban	Infiltration Basin	1019000802	0.0	0.0	0.0
Urban	Infiltration Basin	1019000803	0.0	0.0	0.0
Urban	Infiltration Basin	1019000902	0.0	0.0	0.0
Urban	Infiltration Basin	1019000903	0.0	0.0	0.0
Urban	Infiltration Basin	1019000904	0.0	0.0	0.0
Urban	Infiltration Basin	1019000905	0.0	0.0	0.0
Urban	Infiltration Basin	1019000906	0.0	0.0	0.0
Urban	Infiltration Basin	1019001203	0.0	0.0	0.0
Urban	Infiltration Basin	1019001205	0.0	0.0	0.0
Urban	Infiltration Basin	1019001206	0.0	0.0	0.0
Urban	Concrete Grid Pavement	1019000305	0.0	0.0	0.0
Urban	Concrete Grid Pavement	1019000306	0.0	0.0	0.0
Urban	Concrete Grid Pavement	1019000308	0.0	0.0	0.0
Urban	Concrete Grid Pavement	1019000309	0.0	0.0	0.0
Urban	Concrete Grid Pavement	1019000310	0.0	0.0	0.0
Urban	Concrete Grid Pavement	1019000311	0.0	0.0	0.0
Urban	Concrete Grid Pavement	1019000312	0.0	0.0	0.0
Urban	Concrete Grid Pavement	1019000801	0.0	0.0	0.0
Urban	Concrete Grid Pavement	1019000802	0.0	0.0	0.0
Urban	Concrete Grid Pavement	1019000803	0.0	0.0	0.0

Table D-1. PLET Scenario Reductions (Page 8 of 8)

Land Use	Practice	HUC10	Nitrogen Reduction (%)	Phosphorus Reduction (%)	Sediment Reduction (%)
Urban	Concrete Grid Pavement	1019000902	0.0	0.0	0.0
Urban	Concrete Grid Pavement	1019000903	0.0	0.0	0.0
Urban	Concrete Grid Pavement	1019000904	0.0	0.0	0.0
Urban	Concrete Grid Pavement	1019000905	0.0	0.0	0.0
Urban	Concrete Grid Pavement	1019000906	0.0	0.0	0.0
Urban	Concrete Grid Pavement	1019001203	0.0	0.0	0.0
Urban	Concrete Grid Pavement	1019001205	0.0	0.0	0.0
Urban	Concrete Grid Pavement	1019001206	0.0	0.0	0.0

APPENDIX E

RESPEC STAKEHOLDER TOOLKIT

RESPEC

Stakeholder Toolkit
June 13, 2024

Introduction
The North Front Range Water Quality Planning Association (NFRWQPA) seeks to compile a stakeholder toolkit for the five regional Nonpoint Source (NPS) Watershed Plan areas in Larimer and Weld Counties.

This toolkit will help stakeholders reach, inform and partner with their networks on the NPS watershed educational resources. Here is a link to a final stakeholder toolkit formatting example.

Digital Communications
Digital communications can reach a large audience on a broad scale, with tactics including:

- **Press releases:** This document will serve as NFRWQPA's official statement on the NPS watersheds and respective plans. The press release can be distributed to industry-relevant publications as well as local news outlets.
    - Example
- **Social media:** Targeted social posts to reach industry-specific and locally relevant audiences. Content can vary based on NFRWQPA's needs, seasonality and other updates.
    - Example
- **Newsletters:** Regular updates to an email list of subscribers about the plans, NPS findings and other news.
    - Example
- **Website:** Content updates such as banner announcements, blog posts and home page edits upon project completion.
    - Example
- **Story Map:** Multimedia application to share plan findings, next steps and other dynamic information.
    - Example
- **"Report a Concern" button or website:** Dedicated resource for stakeholders to use when submitting an NPS issue to NFRWQPA (similar to a "contact us" button).
    - Example – Contact Info at bottom of webpage
- **Radio ads and interviews:** Reach stakeholders on a local and national level through a radio ad or securing a news station interview.
    - Example

Print Communications

Print communications can reach targeted, local audiences using the following tactics:

- **Signage:** Capture pedestrian, biking and other rolling traffic's attention with signage strategically placed in a given area. Informational signage can include water quality awareness signage in parks near streams, pet waste pickup stations, and general project information signage.
  - Example
- **Mailers:** Reach residents and businesses via postcard to communicate project benefits and updates, as well as solicit feedback.
  - Example

Community Outreach

Community outreach is a boots-on-the-ground approach to connecting with stakeholders and disseminating information. Community outreach also helps put a face to a project through the following tactics:

- **Educational campaign:** Increase awareness about the plan and NPS concerns in ways that are simplified and relatable for stakeholders.
  - Example
- **Volunteer cleanup program:** Foster community pride and engagement through organizing a park cleanup day.
  - Example
- **School visits, tours and field trips:** Create memories, connect with younger stakeholders and ignite a lifelong interest in the environment by inviting project team members to visit schools for presentations, organize park tours and host field trips.
  - Example – project engineers visited a local library to show students that popular game Fortnite had real-life applications and similarities to simulating virtual environments in the construction industry

APPENDIX E

MAPS OF FLOW AND WATER QUALITY DATA

APPENDIX F

RESPEC STAKEHOLDER TOOLKIT

Stakeholder Toolkit
June 13, 2024

Introduction
The North Front Range Water Quality Planning Association (NFRWQPA) seeks to compile a stakeholder toolkit for the five regional Nonpoint Source (NPS) Watershed Plan areas in Larimer and Weld Counties.

This toolkit will help stakeholders reach, inform and partner with their networks on the NPS watershed educational resources. Here is a link to a final stakeholder toolkit formatting example.

Digital Communications
Digital communications can reach a large audience on a broad scale, with tactics including:

- **Press releases:** This document will serve as NFRWQPA's official statement on the NPS watersheds and respective plans. The press release can be distributed to industry-relevant publications as well as local news outlets.
    - Example
- **Social media:** Targeted social posts to reach industry-specific and locally relevant audiences. Content can vary based on NFRWQPA's needs, seasonality and other updates.
    - Example
- **Newsletters:** Regular updates to an email list of subscribers about the plans, NPS findings and other news.
    - Example
- **Website:** Content updates such as banner announcements, blog posts and home page edits upon project completion.
    - Example
- **Story Map:** Multimedia application to share plan findings, next steps and other dynamic information.
    - Example
- **"Report a Concern" button or website:** Dedicated resource for stakeholders to use when submitting an NPS issue to NFRWQPA (similar to a "contact us" button).
    - Example – Contact Info at bottom of webpage
- **Radio ads and interviews:** Reach stakeholders on a local and national level through a radio ad or securing a news station interview.
    - Example

Print Communications

Print communications can reach targeted, local audiences using the following tactics:

- **Signage:** Capture pedestrian, biking and other rolling traffic's attention with signage strategically placed in a given area. Informational signage can include water quality awareness signage in parks near streams, pet waste pickup stations, and general project information signage.
  - Example
- **Mailers:** Reach residents and businesses via postcard to communicate project benefits and updates, as well as solicit feedback.
  - Example

Community Outreach

Community outreach is a boots-on-the-ground approach to connecting with stakeholders and disseminating information. Community outreach also helps put a face to a project through the following tactics:

- **Educational campaign:** Increase awareness about the plan and NPS concerns in ways that are simplified and relatable for stakeholders.
  - Example
- **Volunteer cleanup program:** Foster community pride and engagement through organizing a park cleanup day.
  - Example
- **School visits, tours and field trips:** Create memories, connect with younger stakeholders and ignite a lifelong interest in the environment by inviting project team members to visit schools for presentations, organize park tours and host field trips.
  - Example – project engineers visited a local library to show students that popular game Fortnite had real-life applications and similarities to simulating virtual environments in the construction industry