ST. VRAIN CREEK NONPOINT SOURCE WATERSHED-BASED PLAN

DRAFT REPORT RSI-3522

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DECEMBER 2024

Project Number W0545.23001

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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.

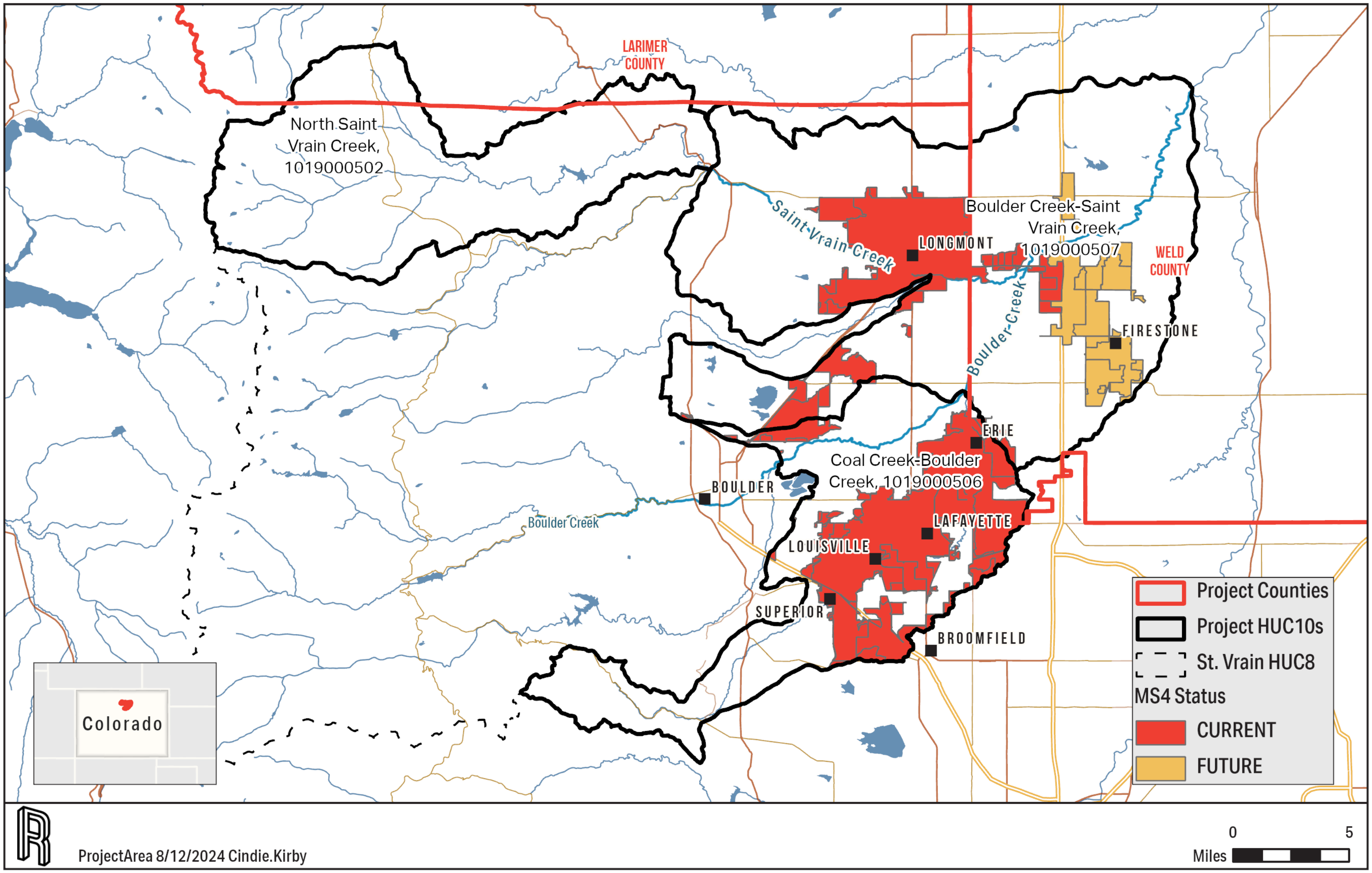

Figure 2-1. St. Vrain Creek HUC8 Project Area.

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].

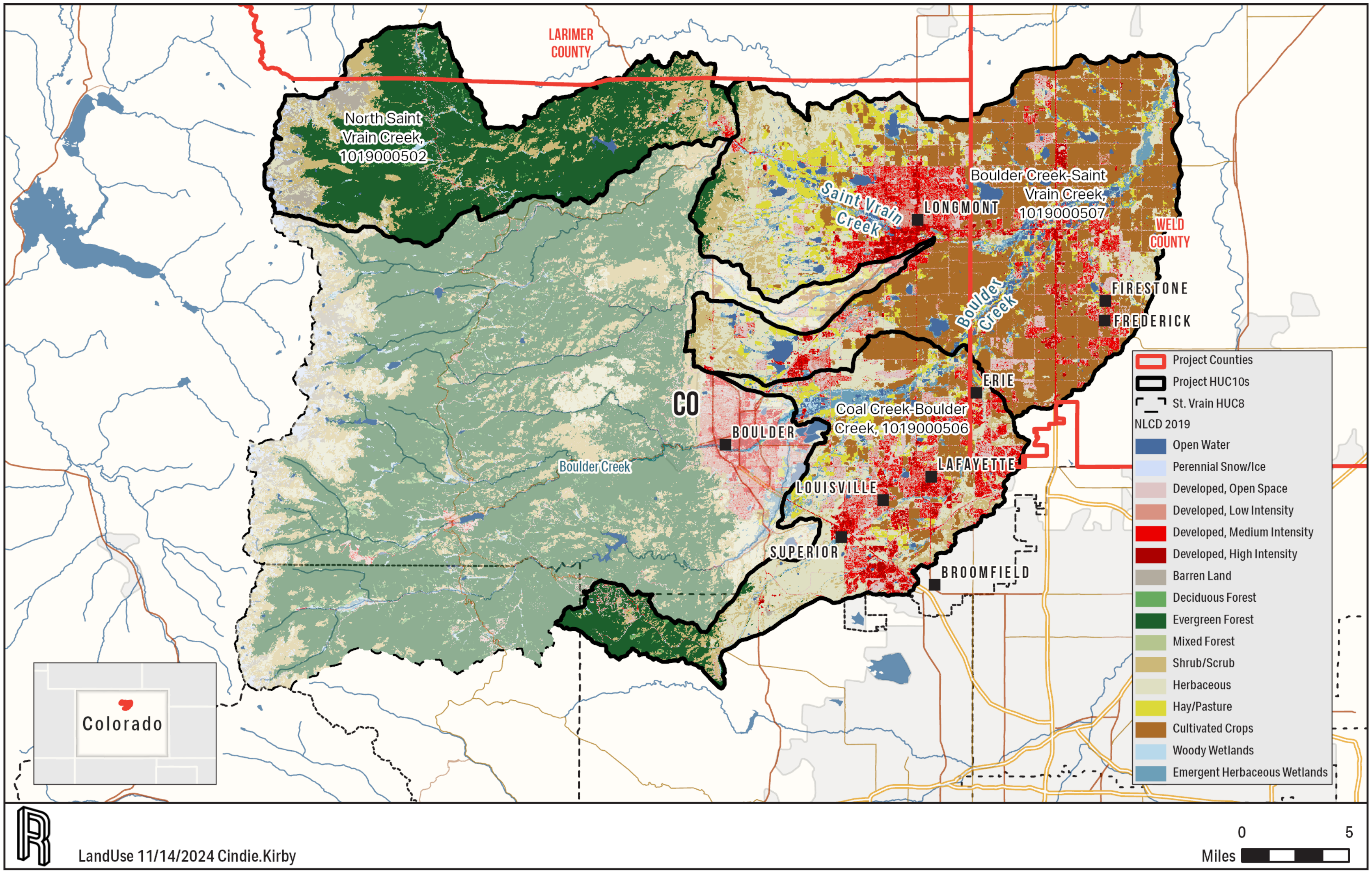

Figure 2-2. National Land Cover Dataset 2019 Land Use.

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].

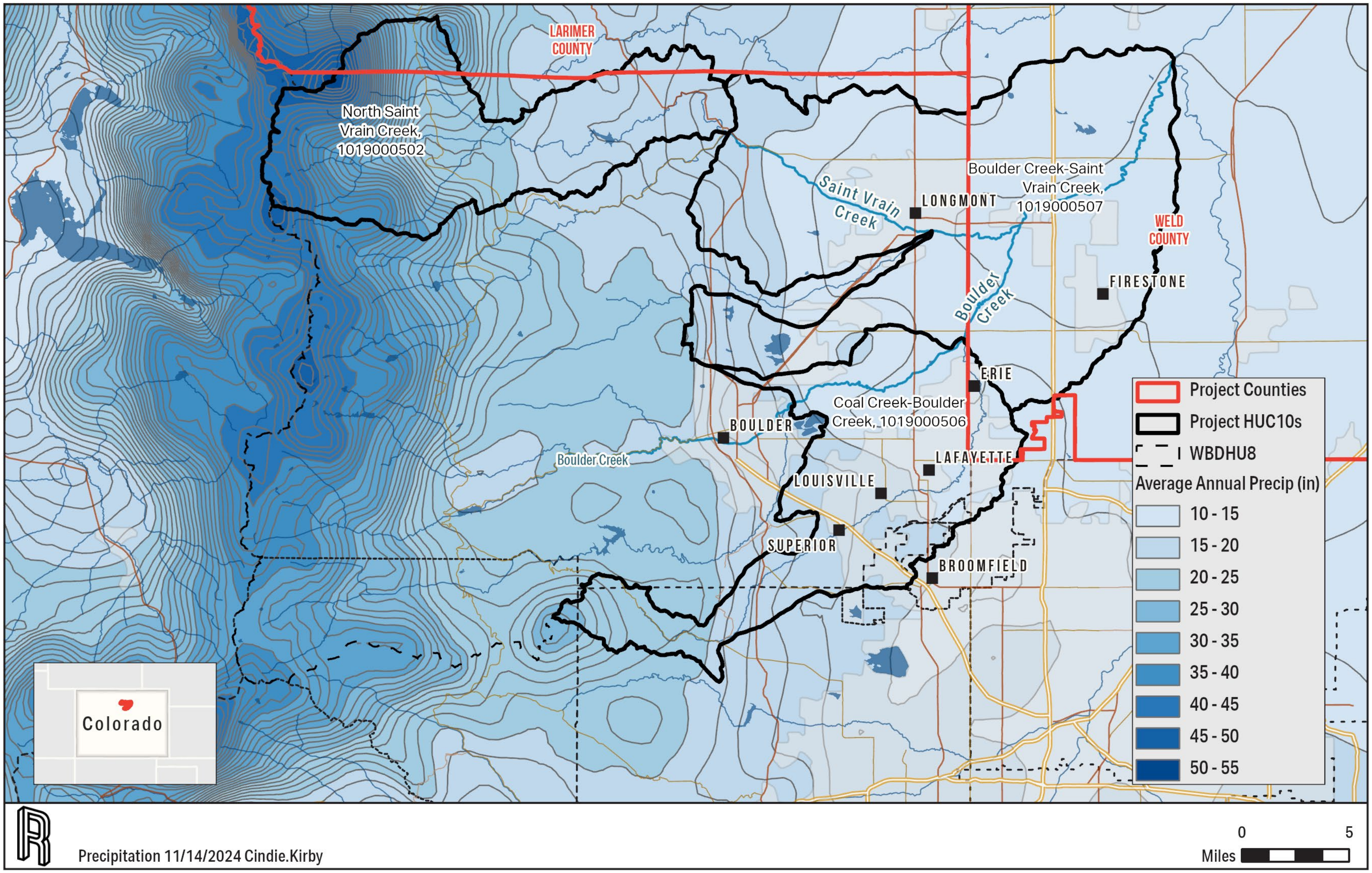

Figure 2-3. Average Annual Precipitation (1981 to 2010).

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].

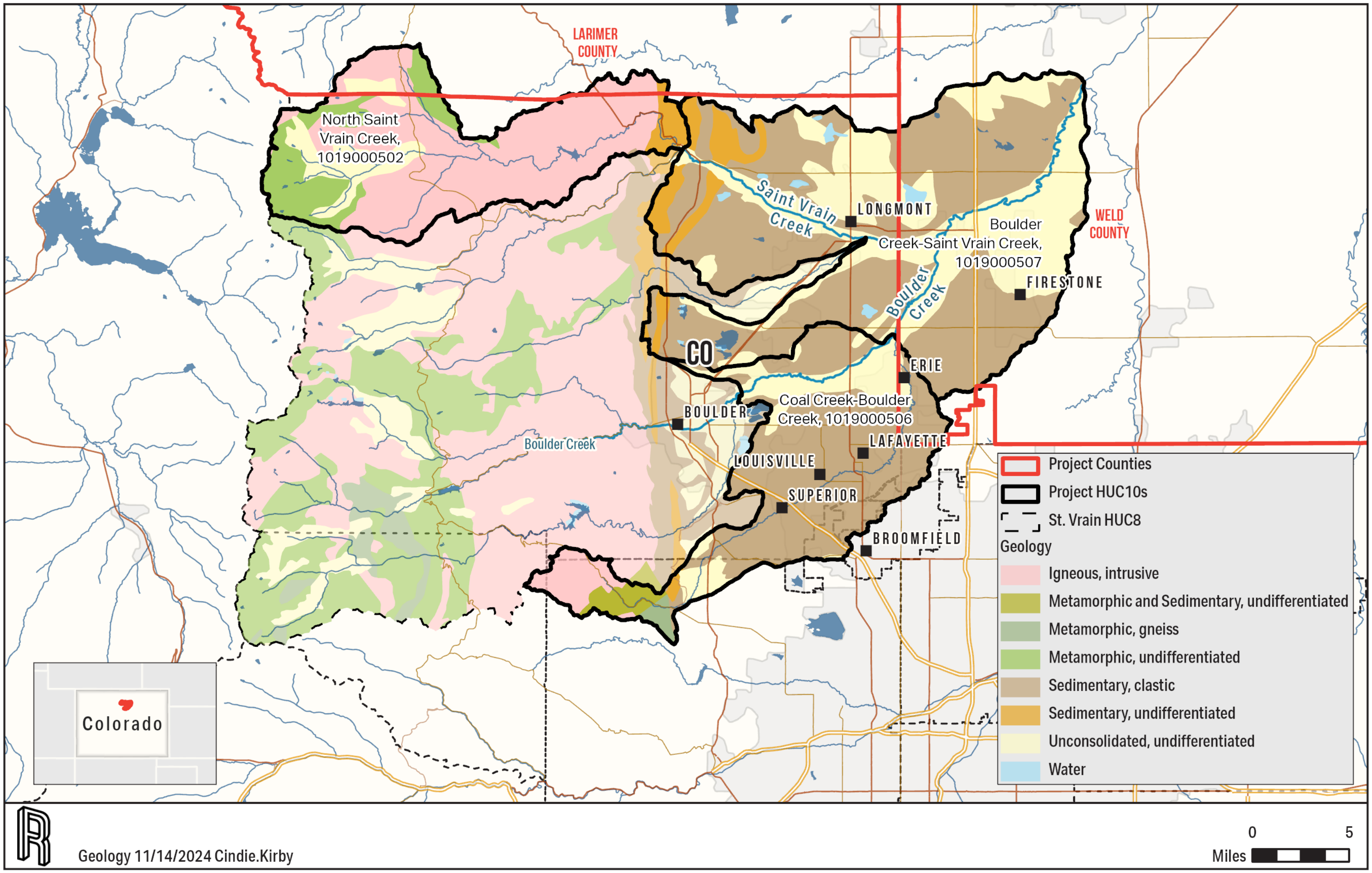

Figure 2-4. Geology.

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].

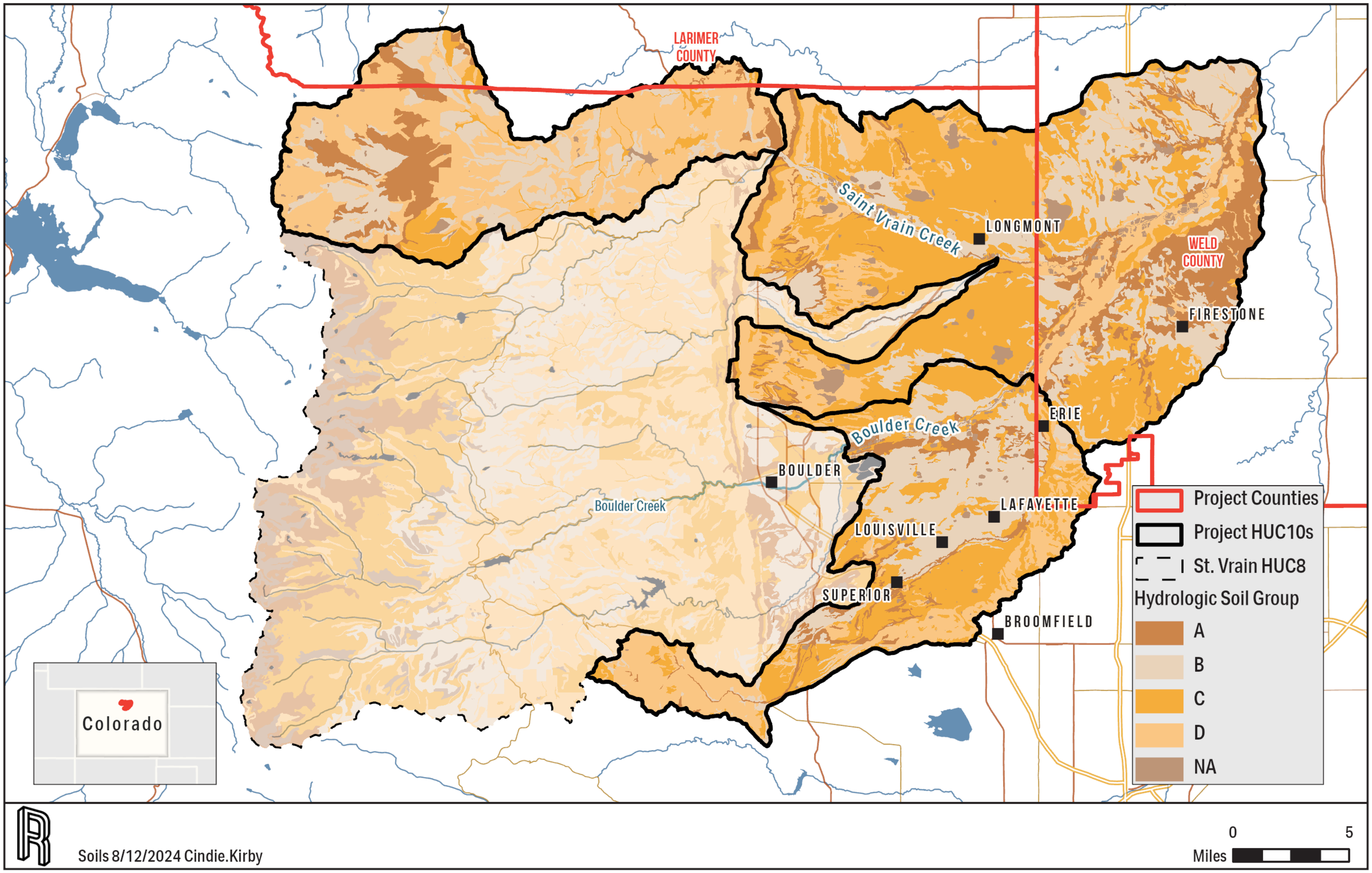

Figure 2-5. Hydrologic Soil Group.

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].

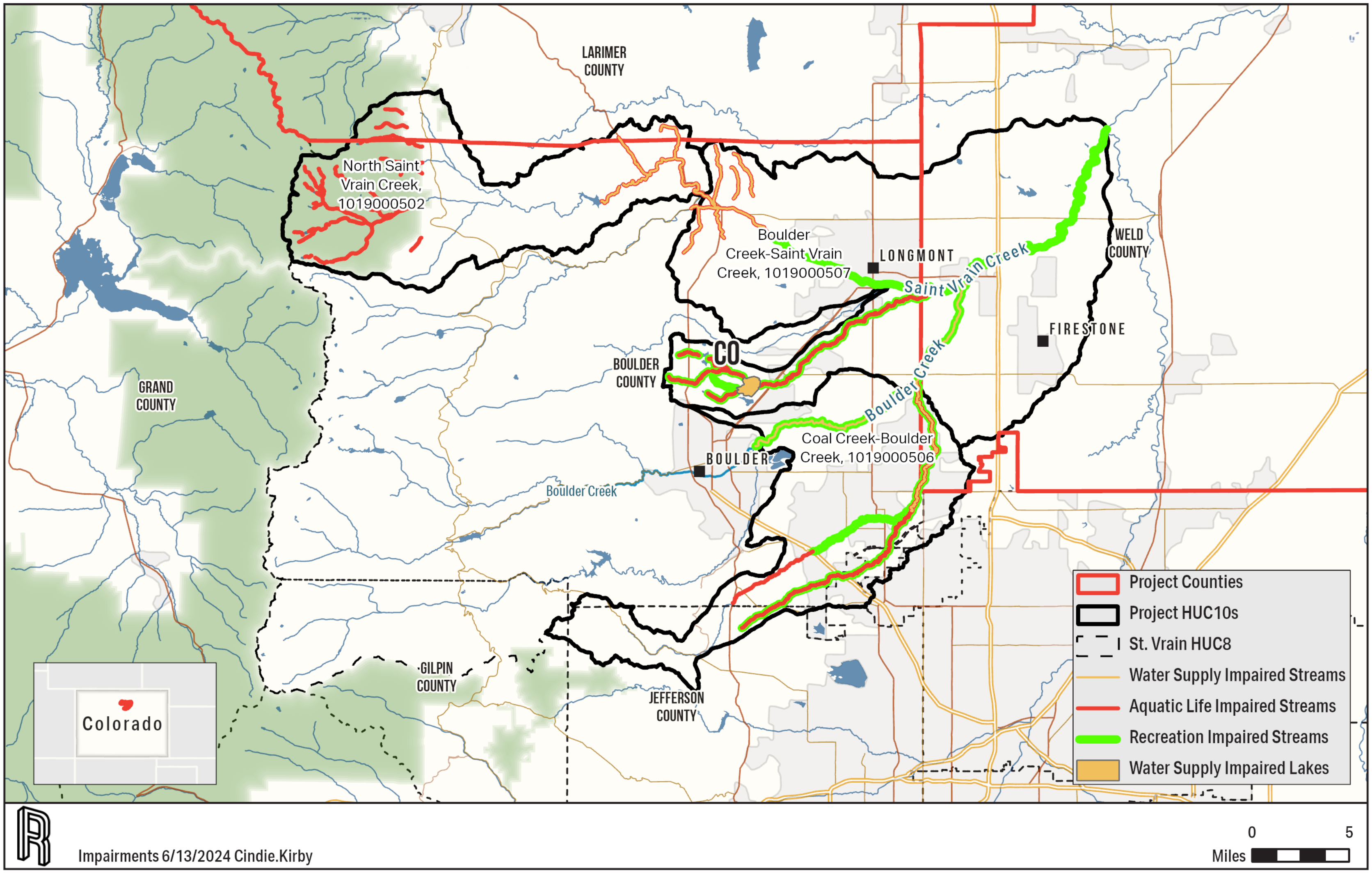

Figure 4-1. Impaired Waterbodies.

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 (mi²)	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 (mi²)	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 (mi²)	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.

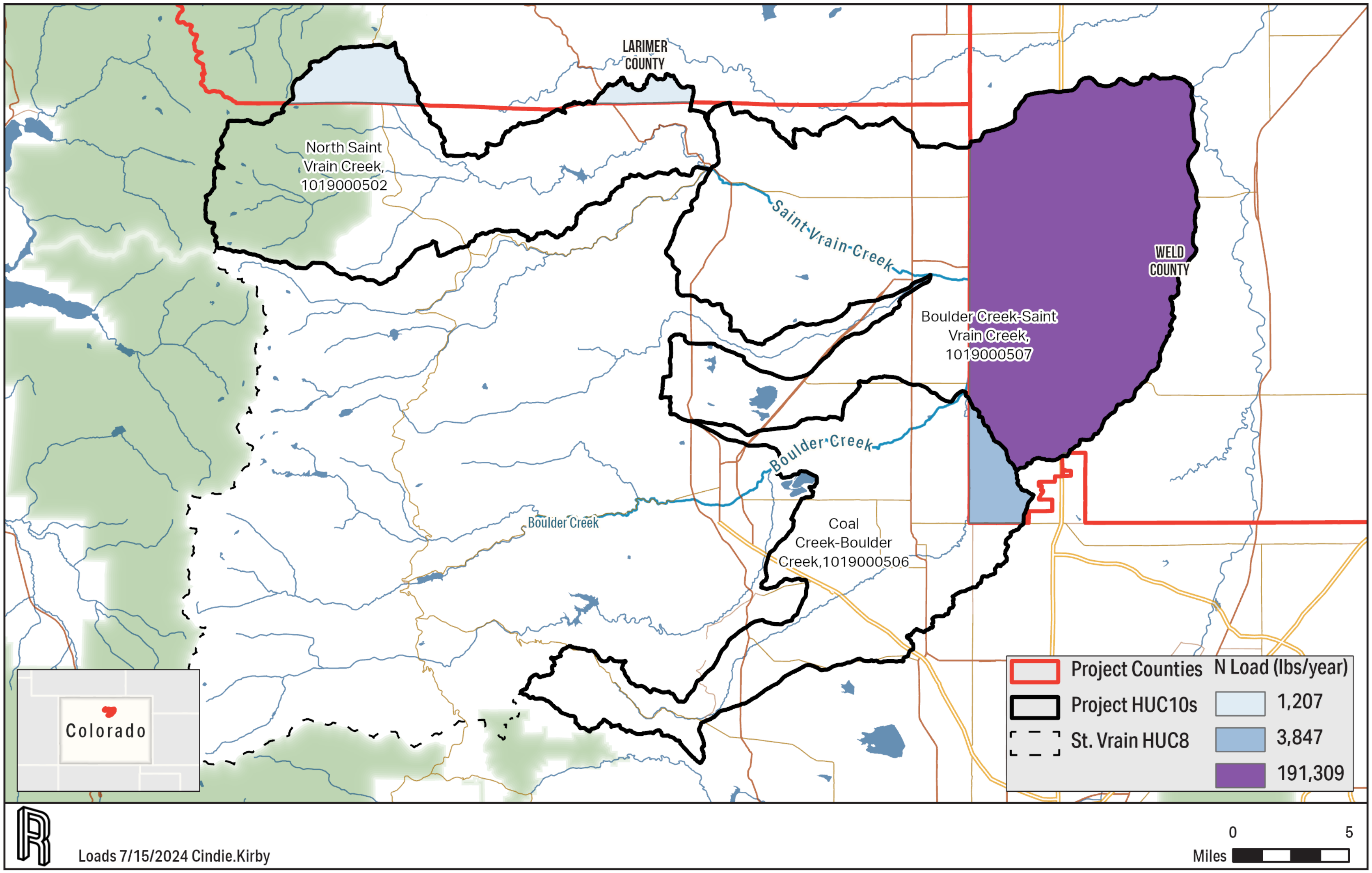

Figure 6-1. Nitrogen Contributions per HUC10.

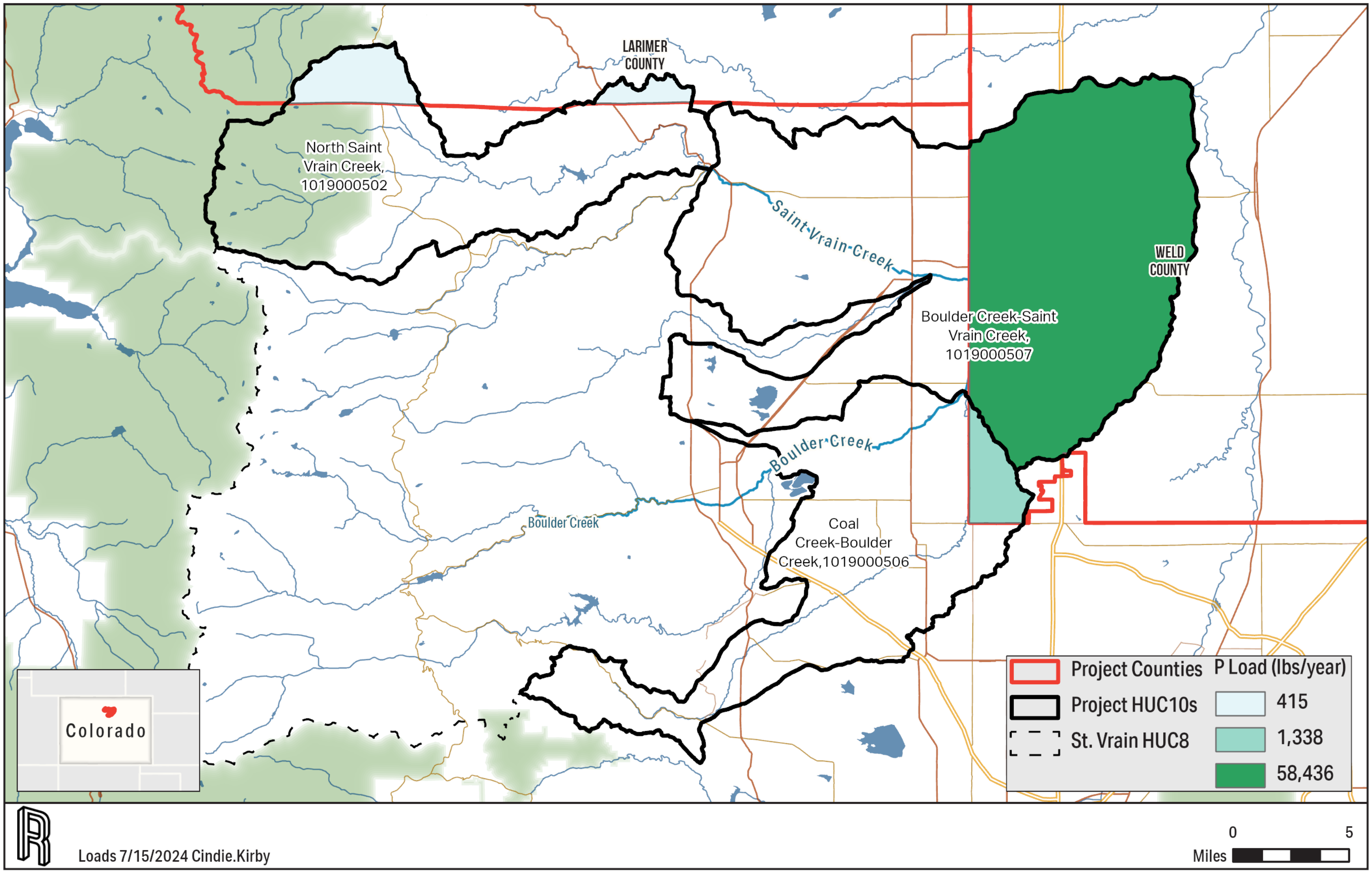

Figure 6-2. Phosphorus Contributions per HUC10.

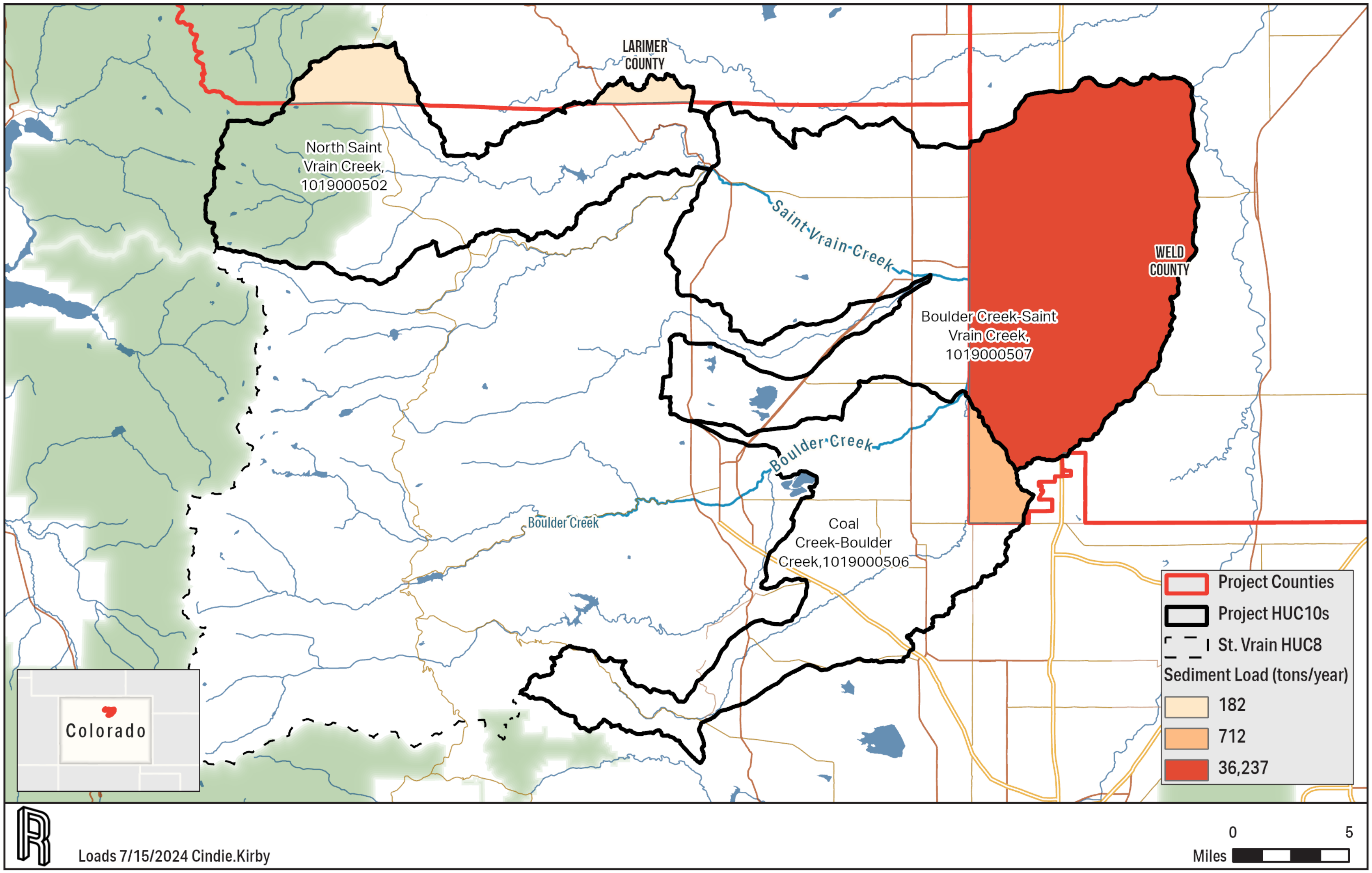

Figure 6-3. Sediment Contributions per HUC10.

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.

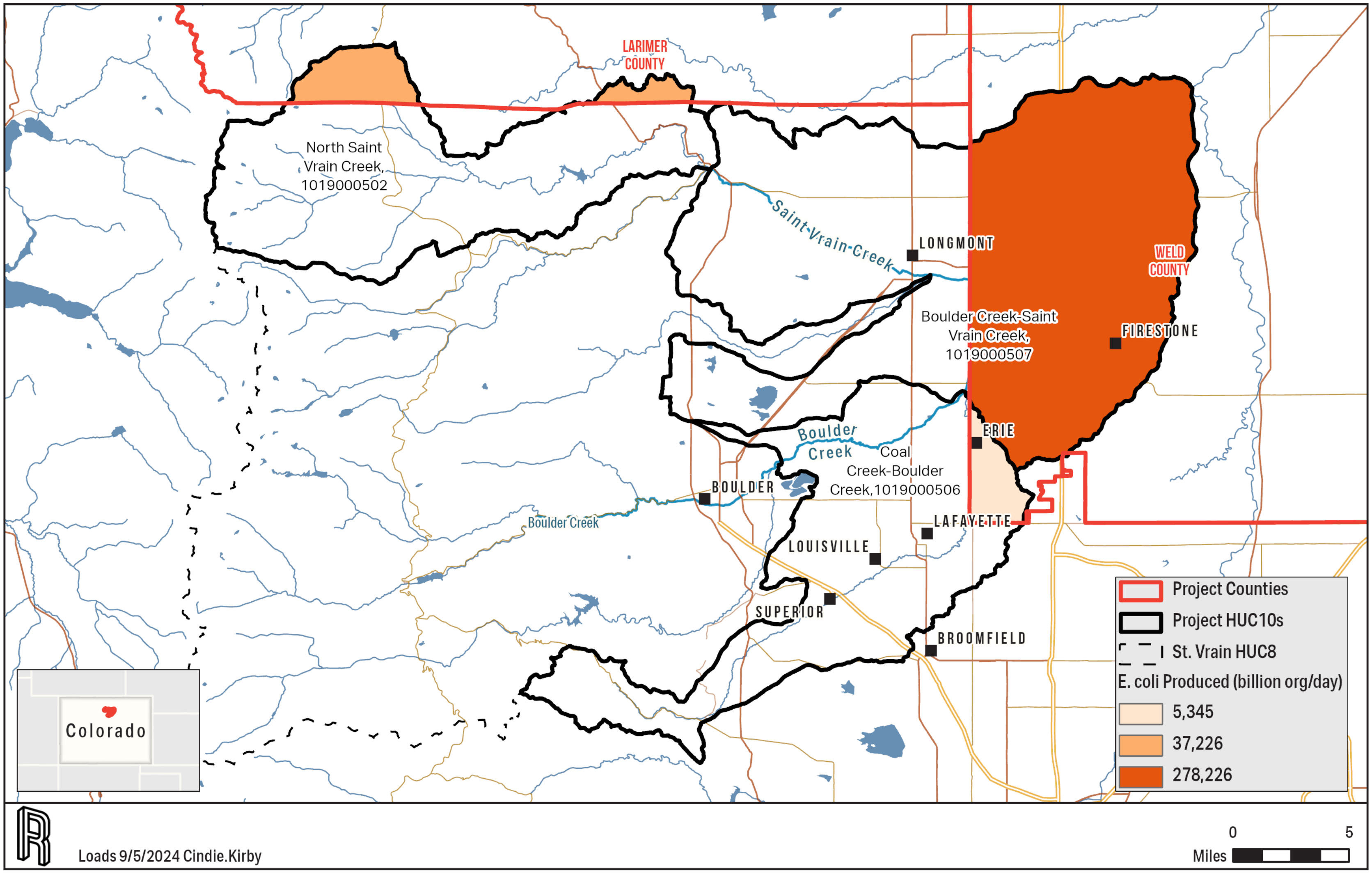

Figure 6-4. Bacteria Produced per HUC10.

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).

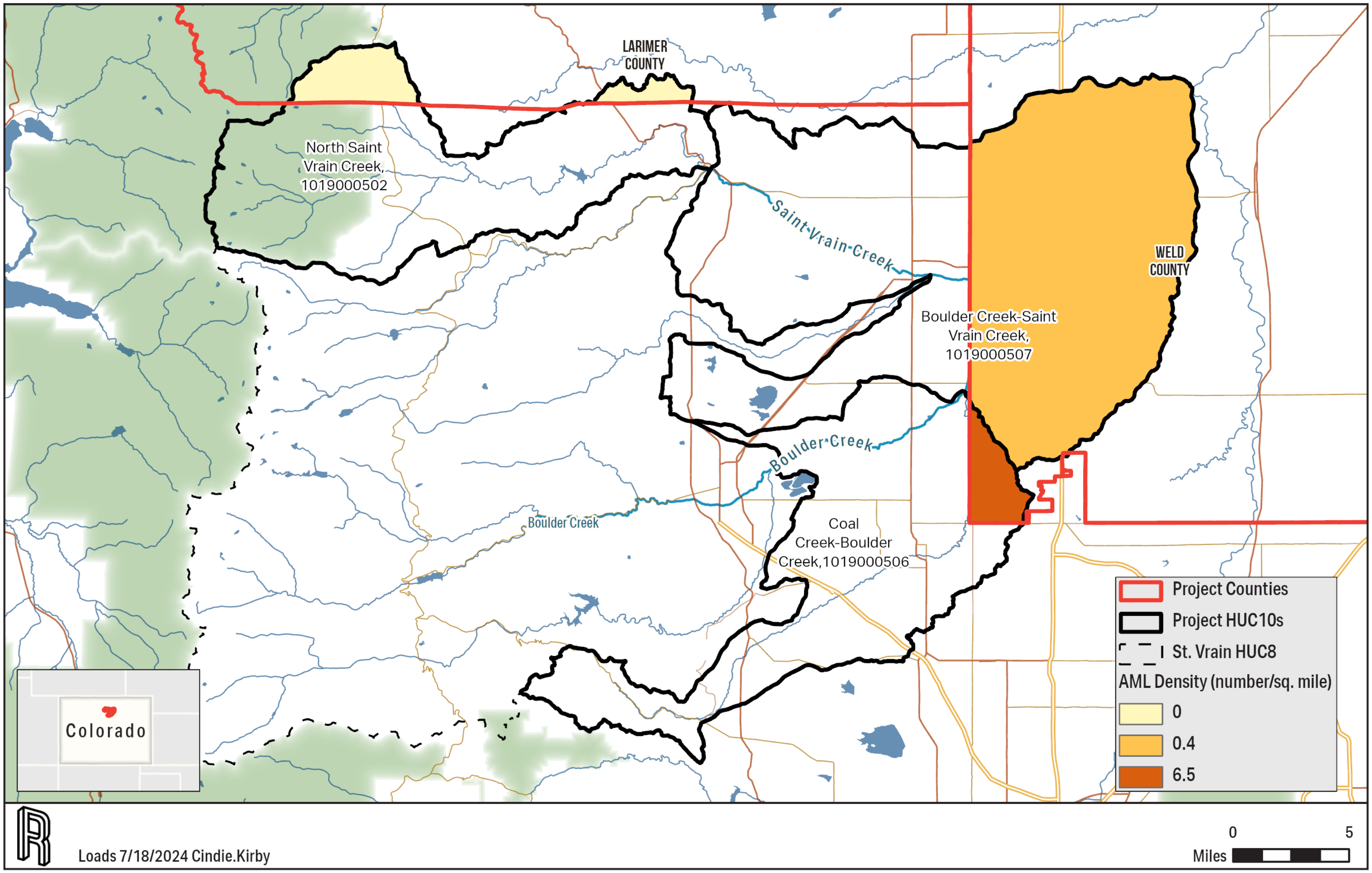

Figure 6-5. Density of Abandoned Mine Lands for Each HUC10.

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

<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>196,363</td><td>N/A</td><td rowspan="4">31</td><td>60,189</td><td>N/A</td><td rowspan="4">49</td></tr>
<tr><td>Stream Stabilization and Fencing on 25% of Cropland (12,084 acres)</td><td>29,262</td><td>14.9</td><td>9,774</td><td>16.2</td></tr>
<tr><td>Buffer - Grass (35 feet wide) on 25% of Cropland (12,084 acres)</td><td>18,648</td><td>9.5</td><td>6,716</td><td>11.2</td></tr>
<tr><td>Total Reduction</td><td>47,910</td><td>24.4</td><td>16,490</td><td>27.4</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	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.

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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

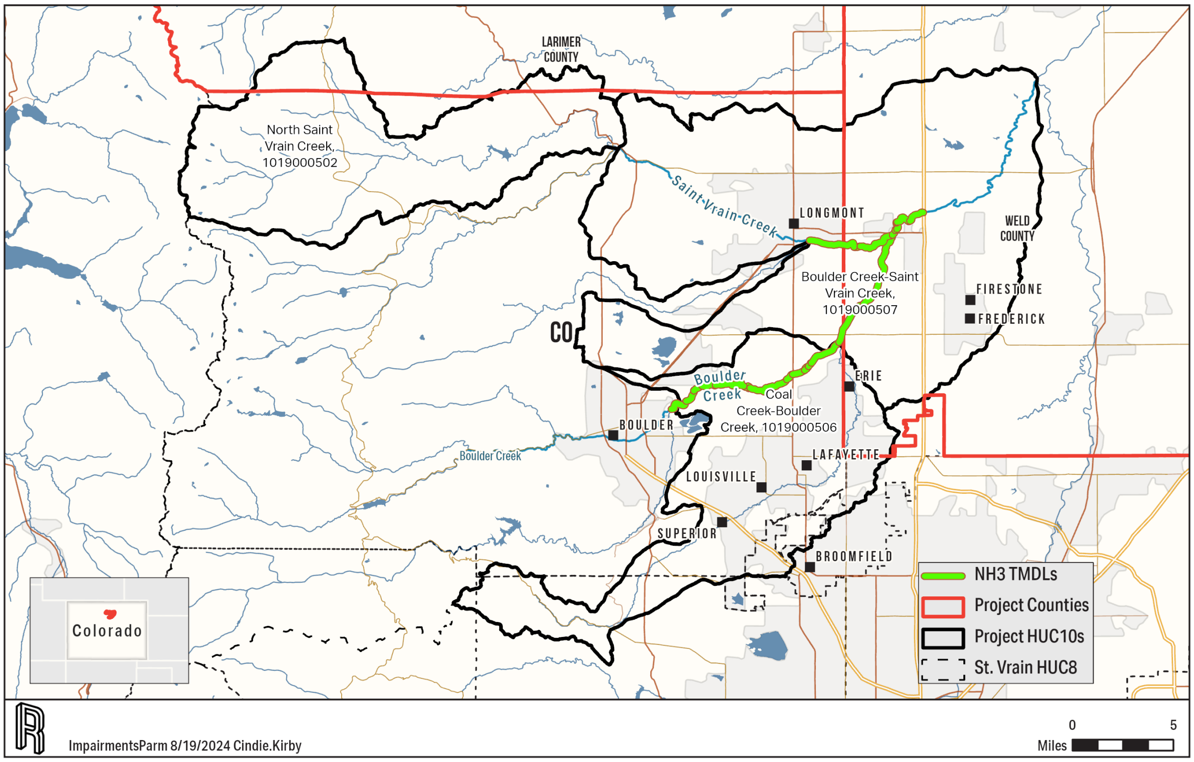


Figure B-1. Ammonia TMDLs.

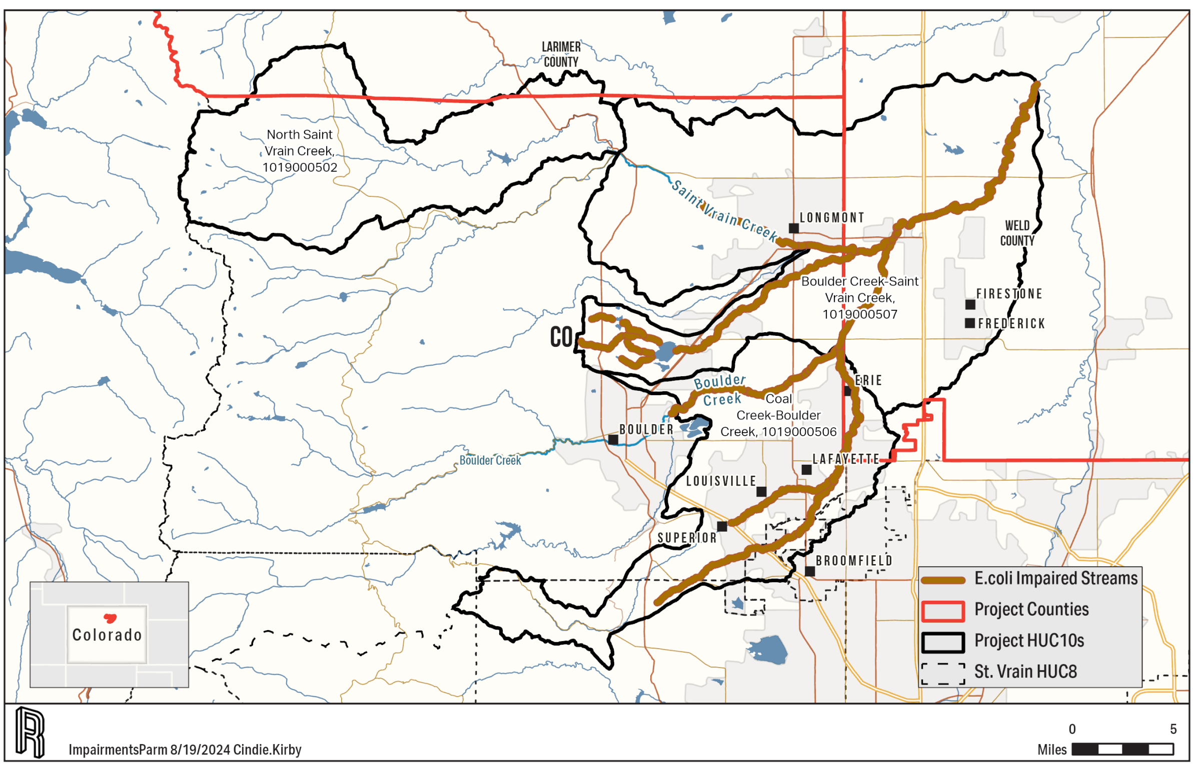


Figure B-2. *E. coli* Impairments.

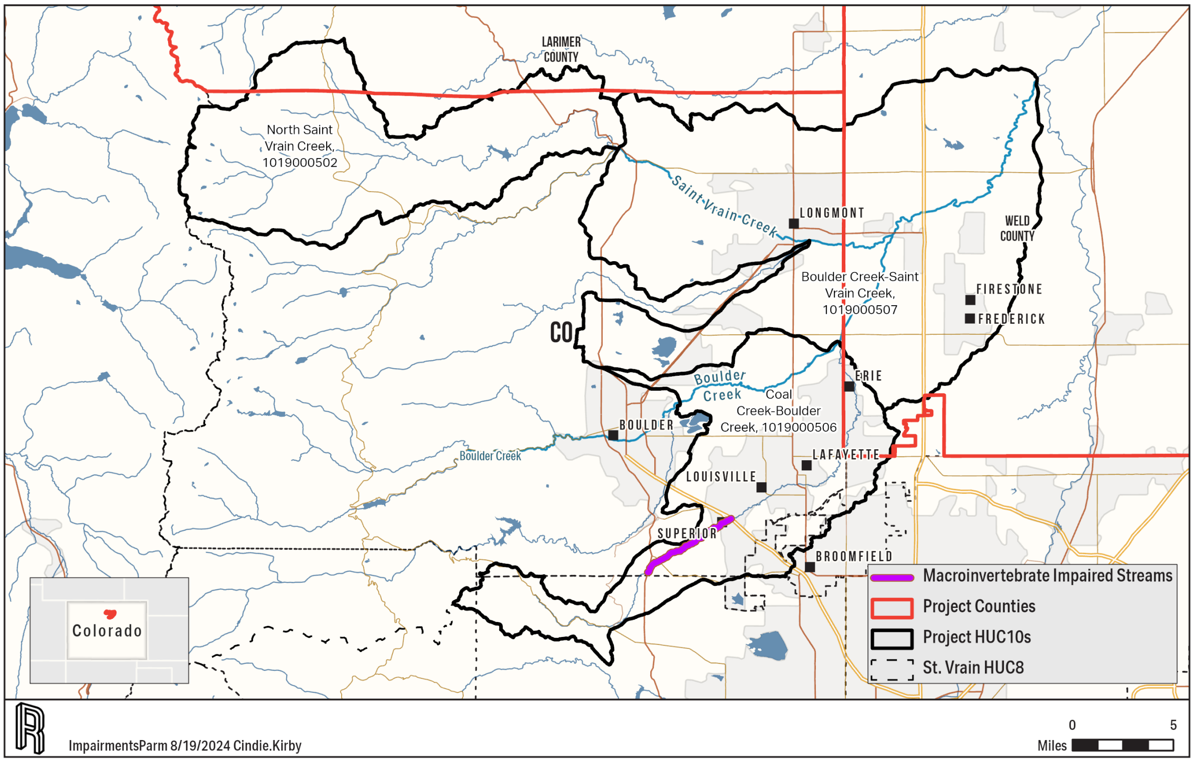


Figure B-3. Macroinvertebrate Impairments.

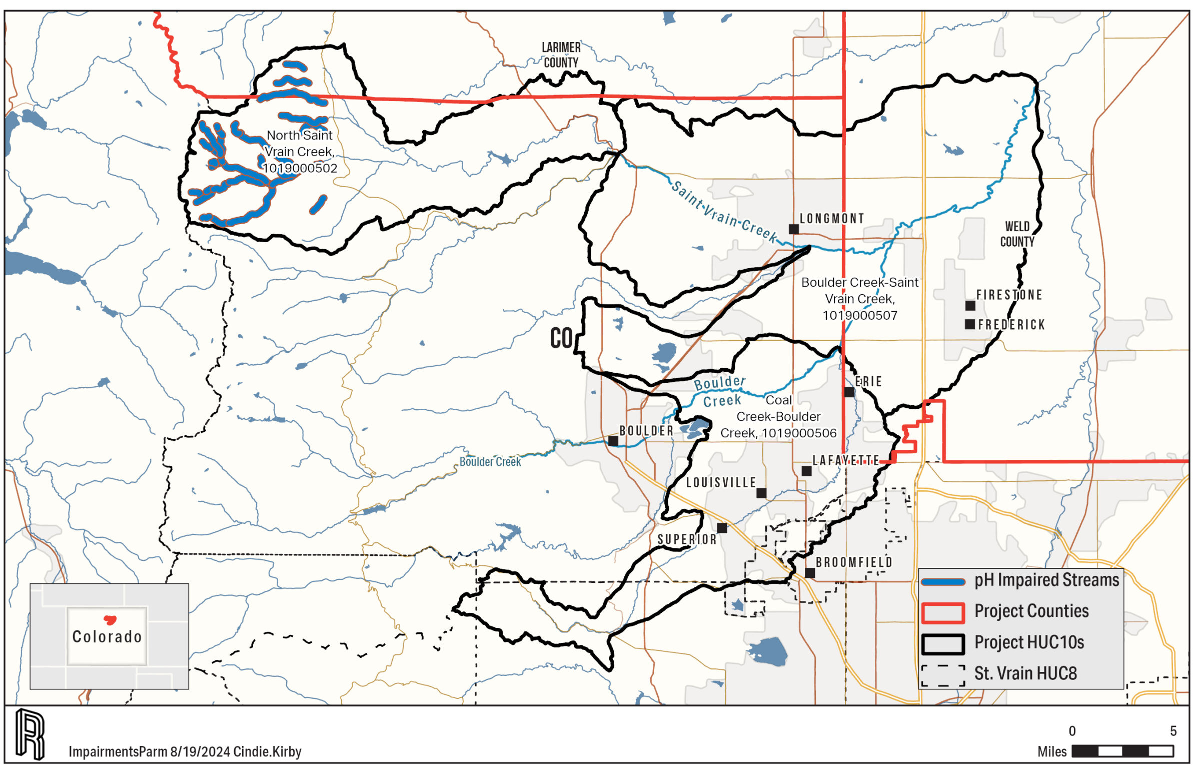


Figure B-4. pH Impairments.

RESPEC

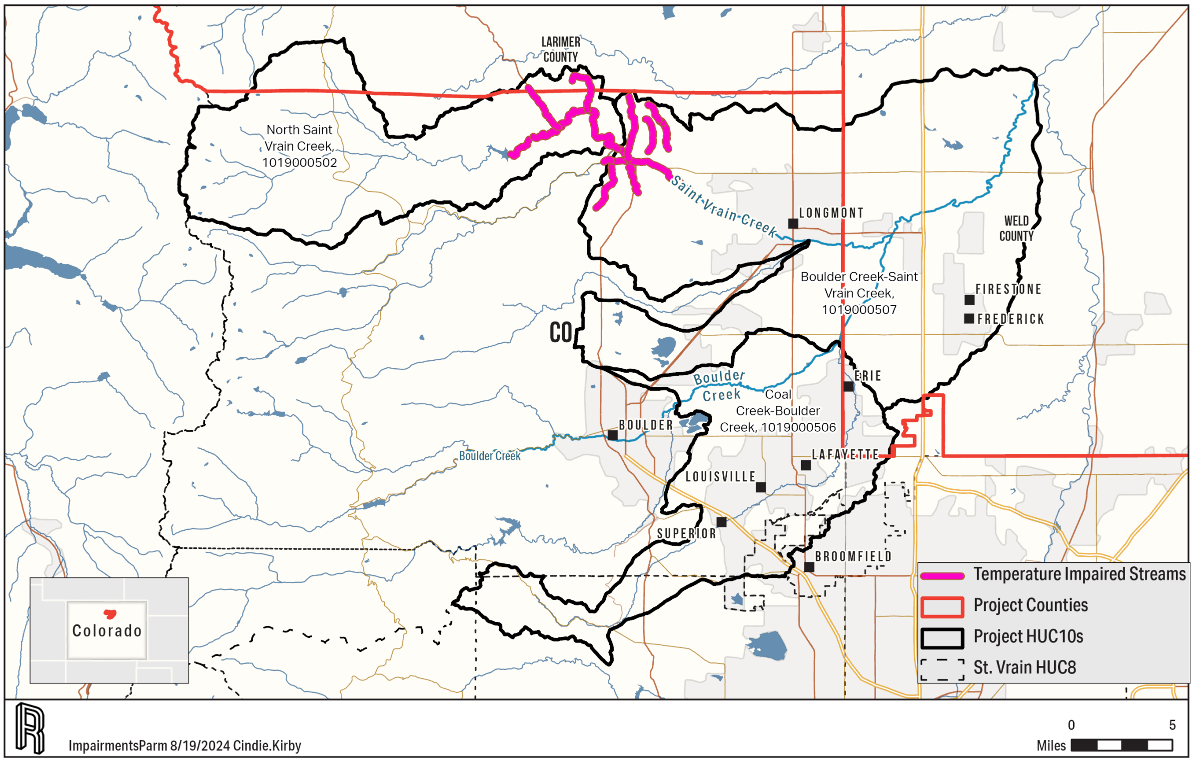


Figure B-5. Temperature Impairments.

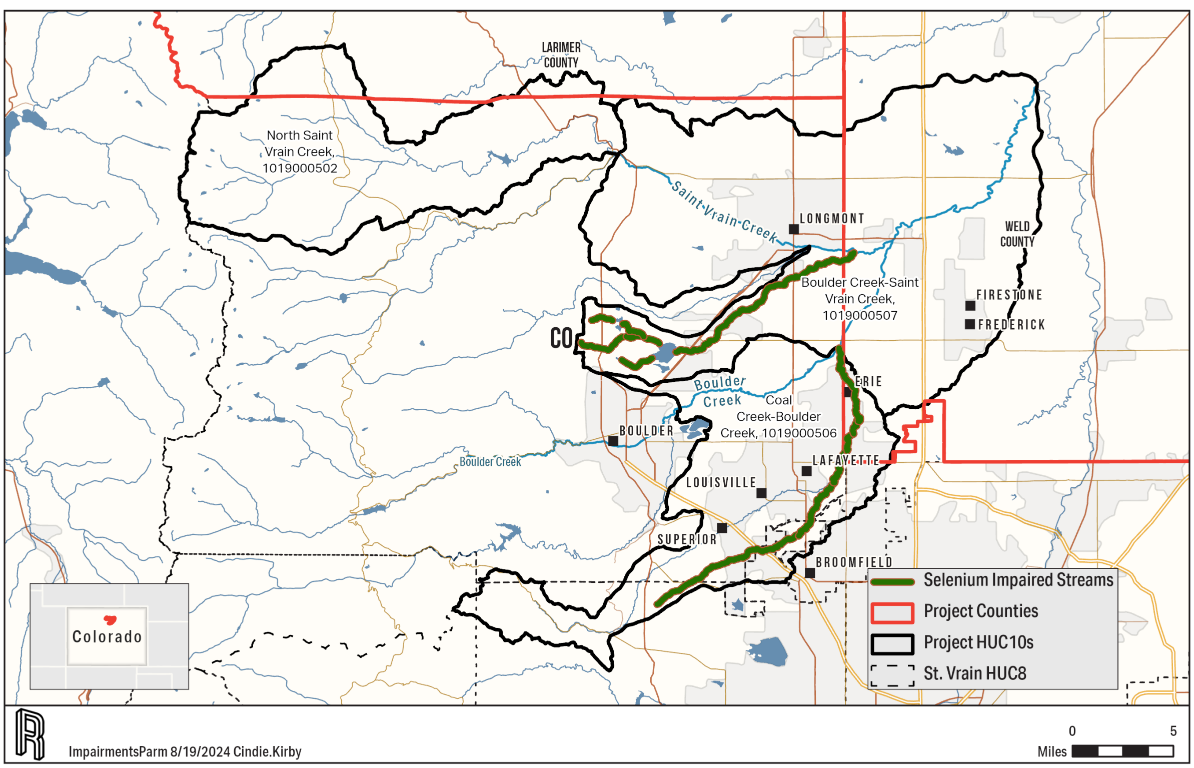


Figure B-6. Selenium Impairments.

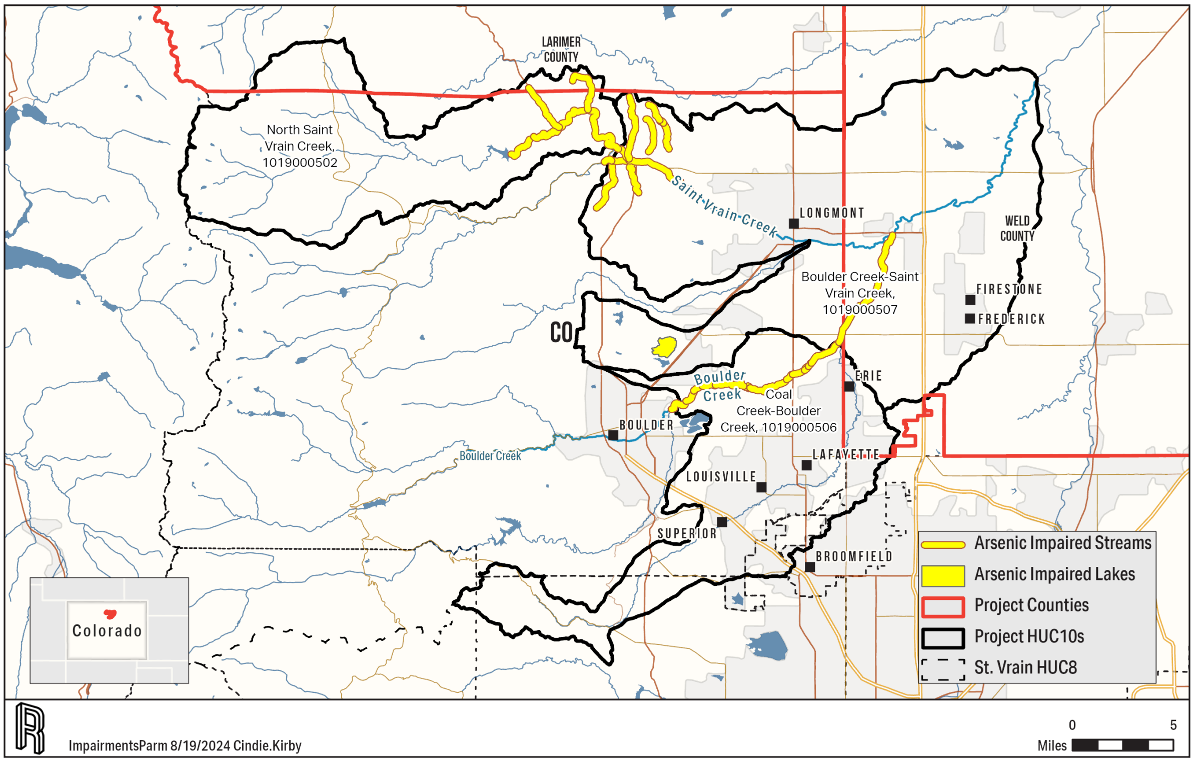


Figure B-7. Arsenic Impairments.

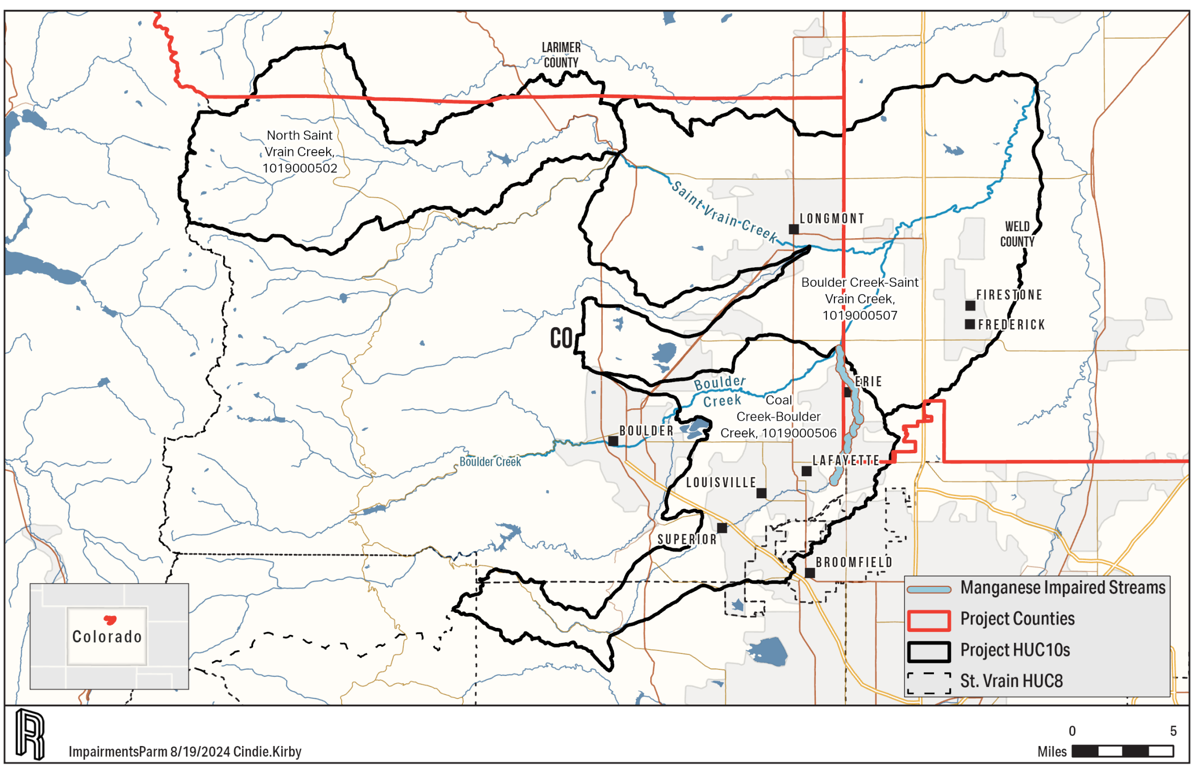


Figure B-8. Manganese Impairments.

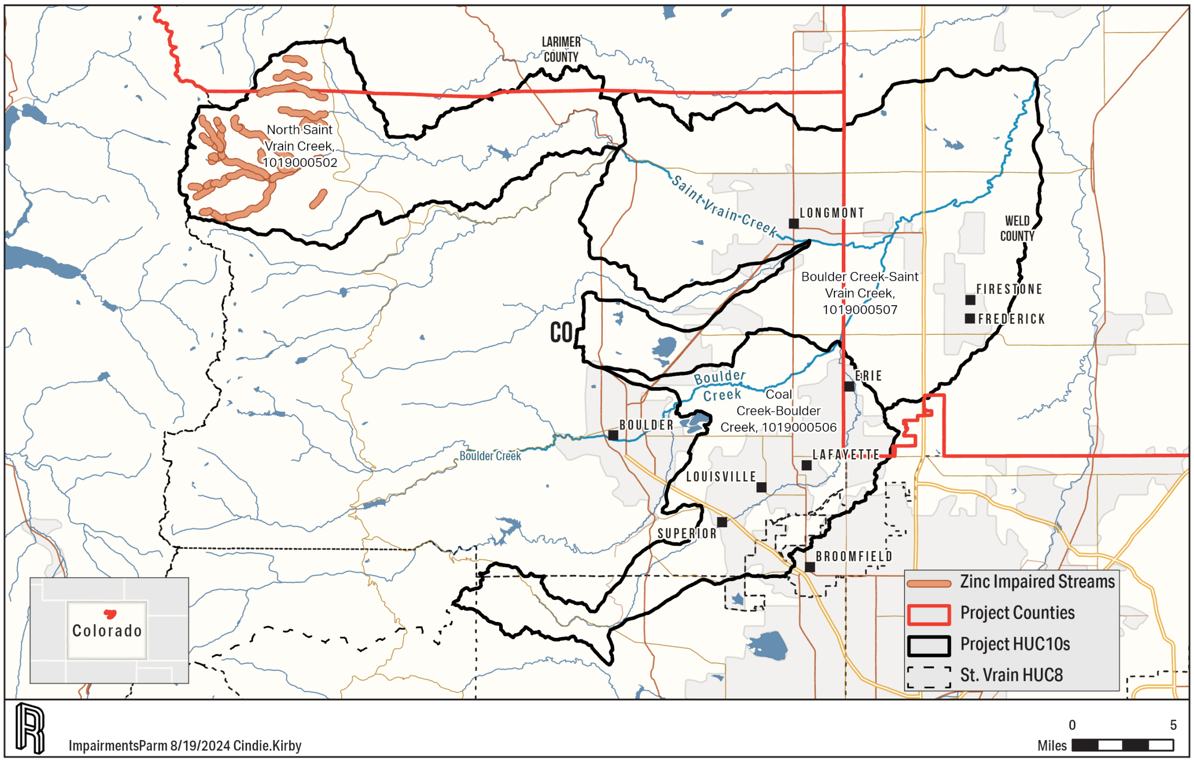


Figure B-9. Zinc Impairments.

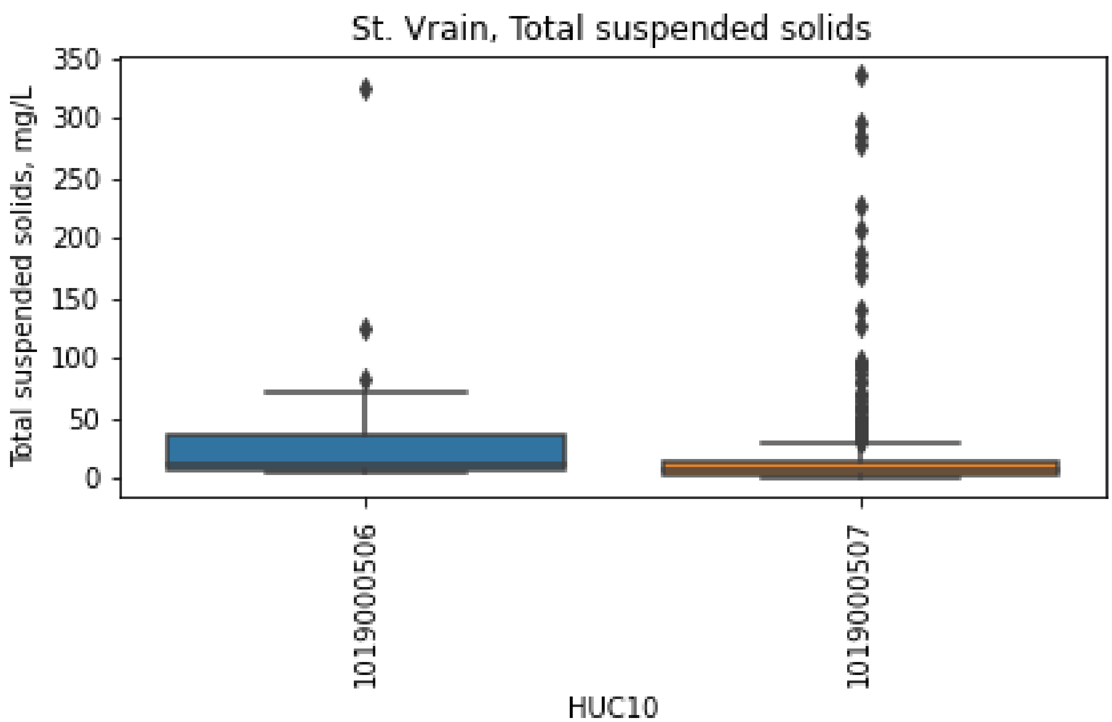
APPENDIX C

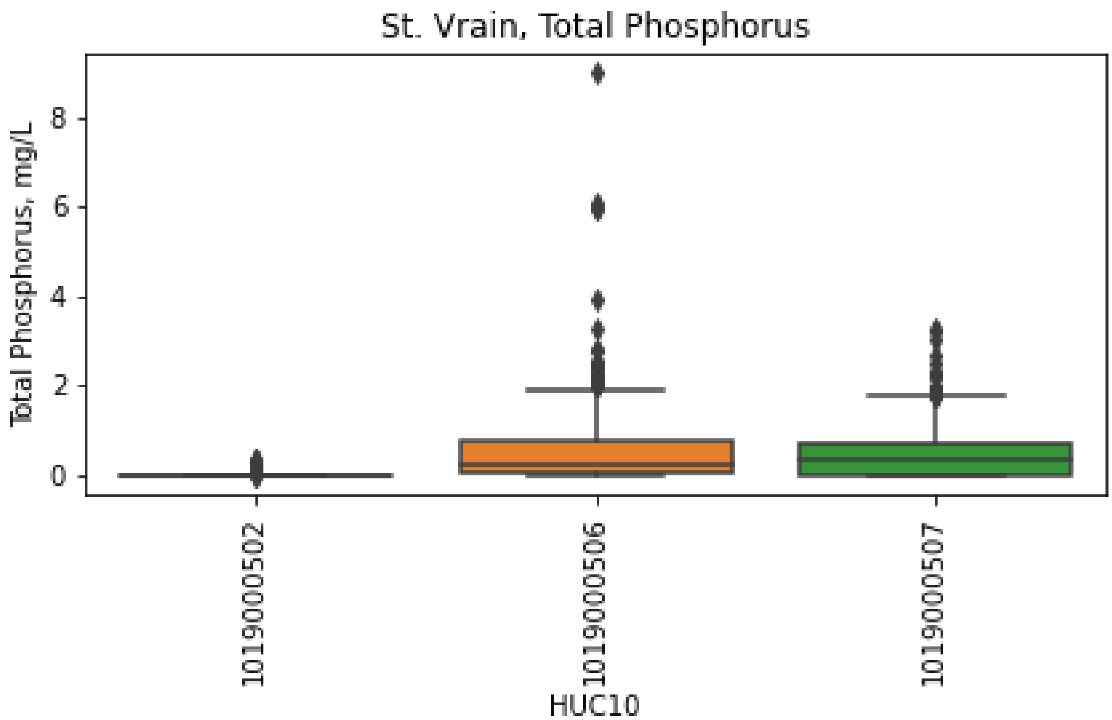
APPLICABLE WATER QUALITY BOX PLOTS BY HUC10

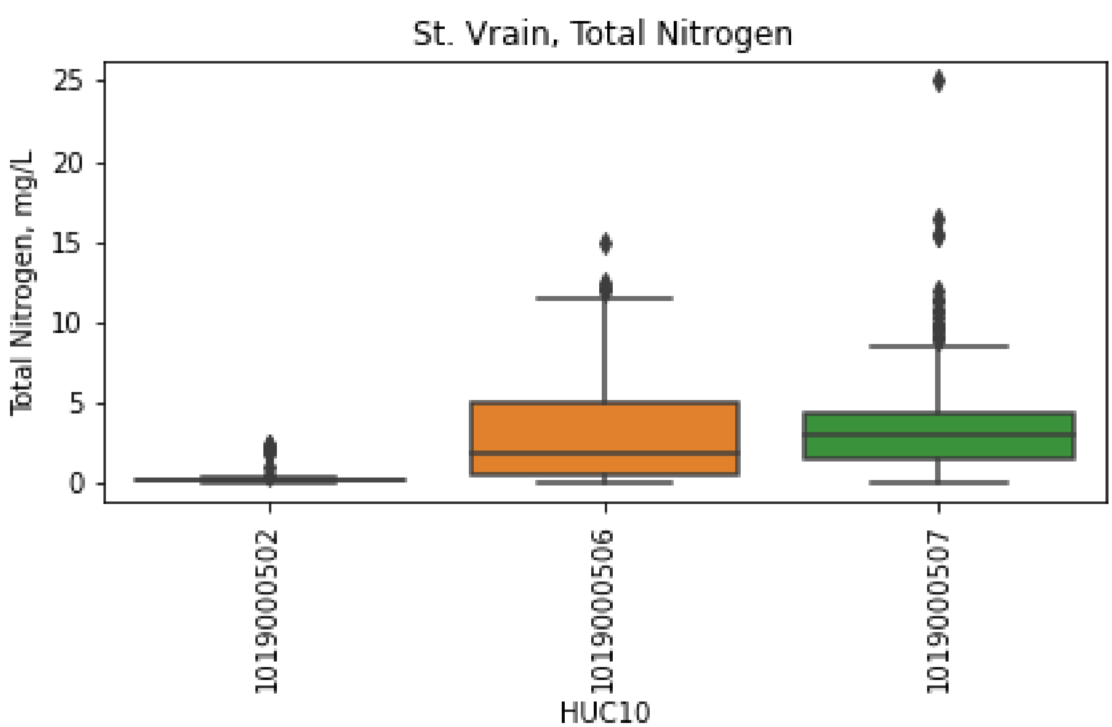
DATASET

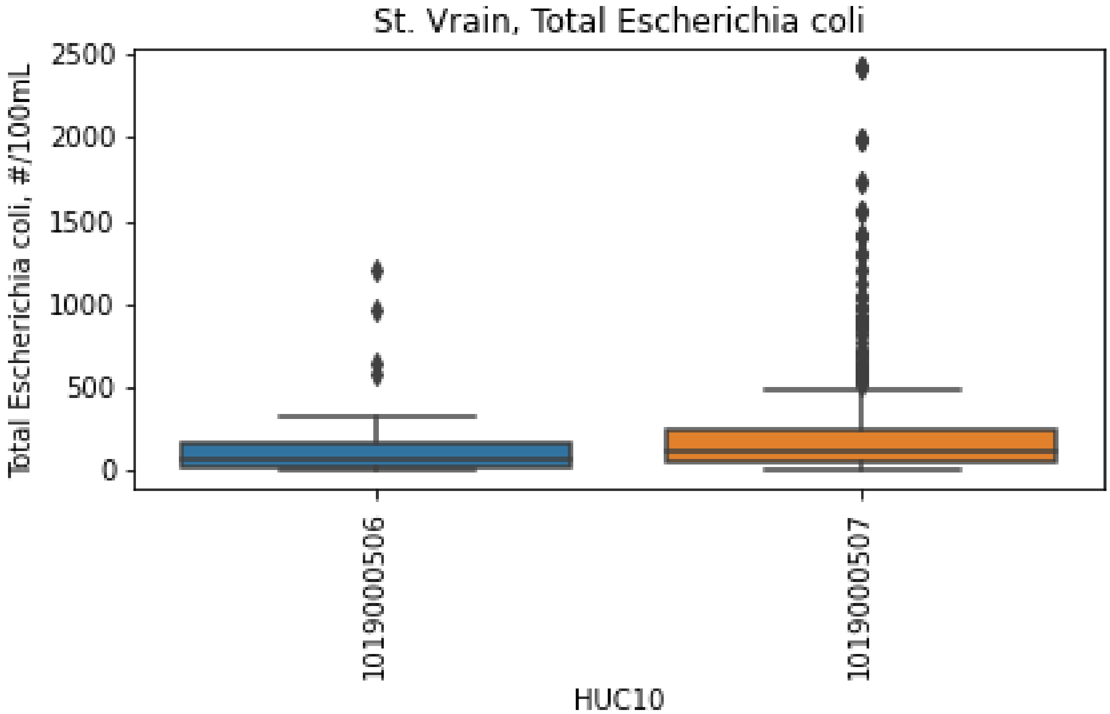
Data for boxplots were collected for the years 1990 through 2023 from various sources. Sources included the Water Quality Portal, the Colorado Data Sharing Network, Northern Water, ERAMS, and numerous individuals including Paul Bremser (St. Vrain), Andy Fayram (City of Loveland), Brian Hathaway (City 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

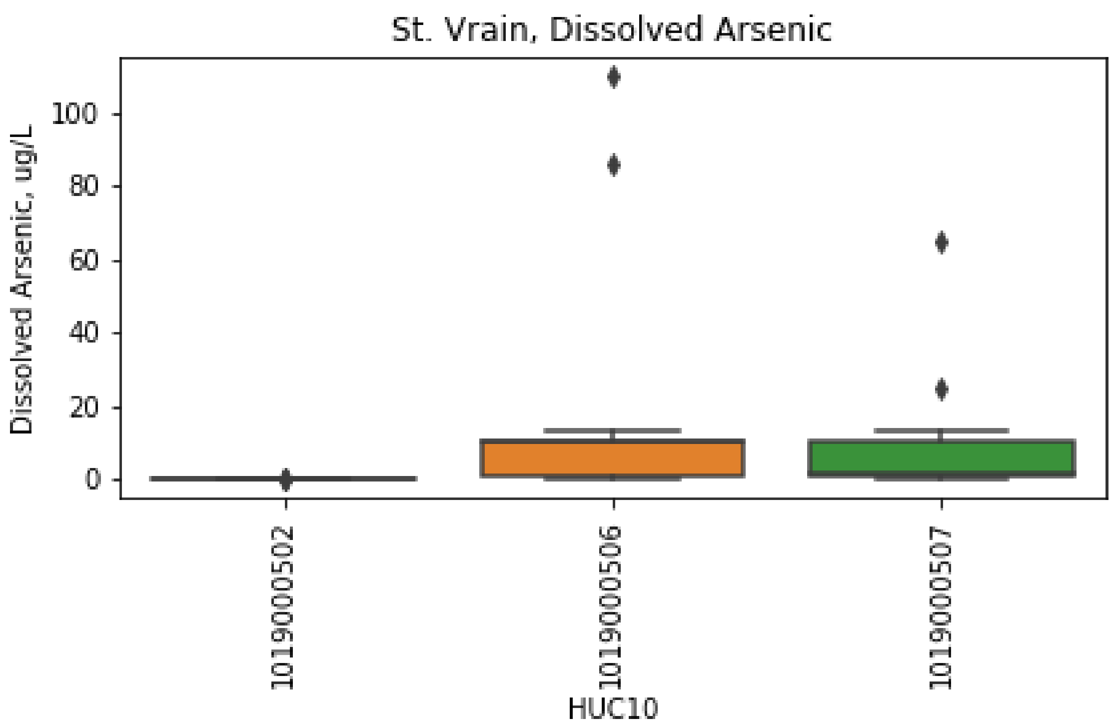


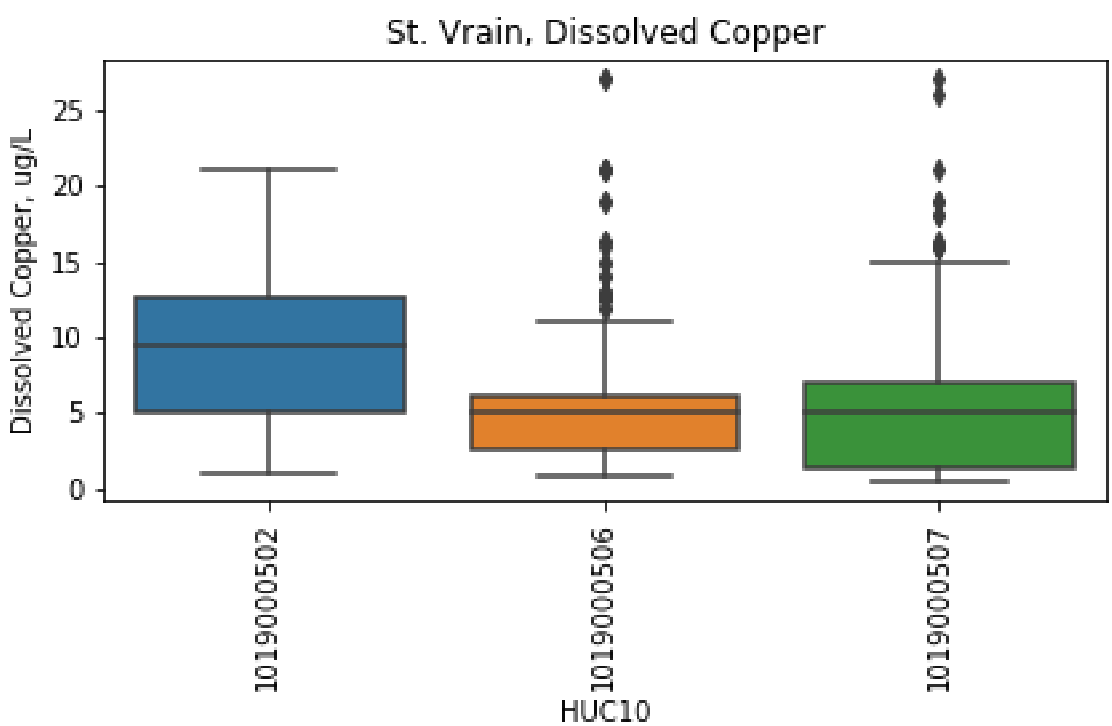

St. Vrain, Total Phosphorus
Total Phosphorus, mg/L
0
2
4
6
8
1019000502
1019000506
1019000507
HUC10

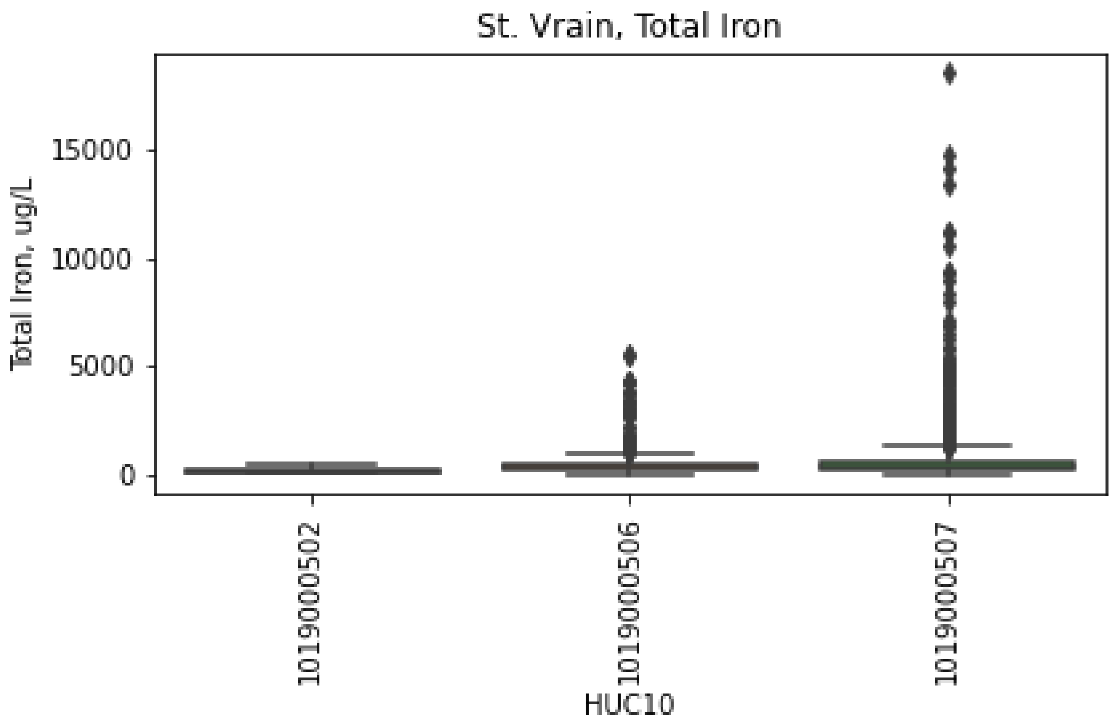

St. Vrain, Total Nitrogen
Total Nitrogen, mg/L
0
5
10
15
20
25
1019000502
1019000506
1019000507
HUC10

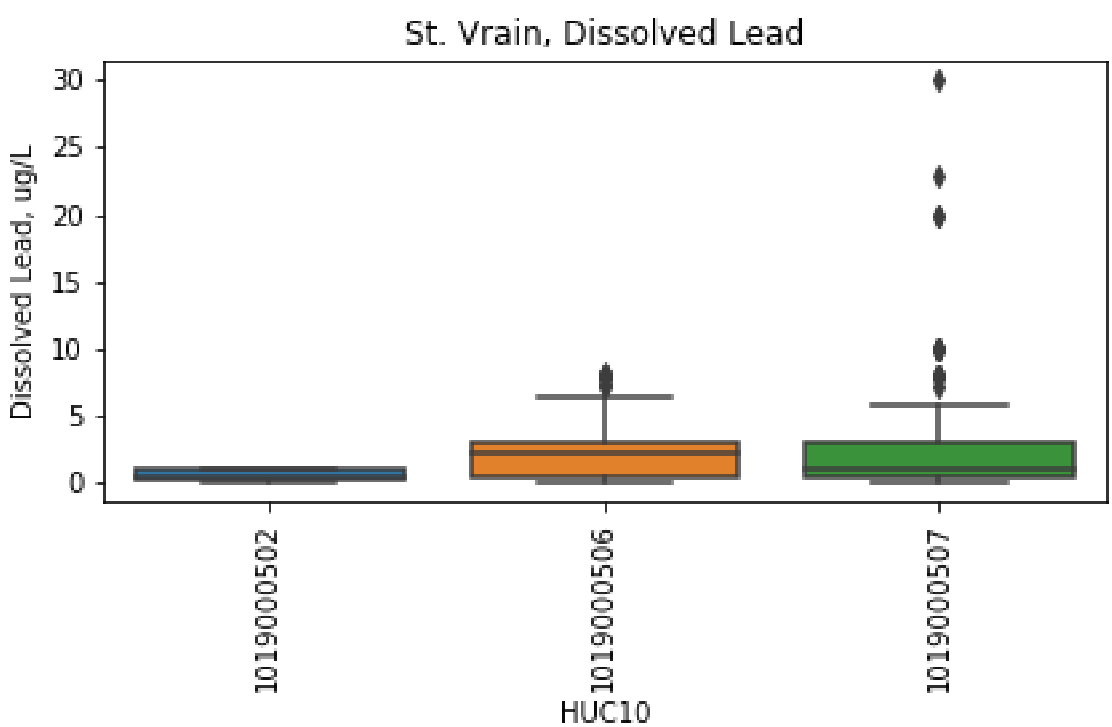

St. Vrain, Total Escherichia coli
Total Escherichia coli, #/100mL
2500
2000
1500
1000
500
0
1019000506
1019000507
HUC10

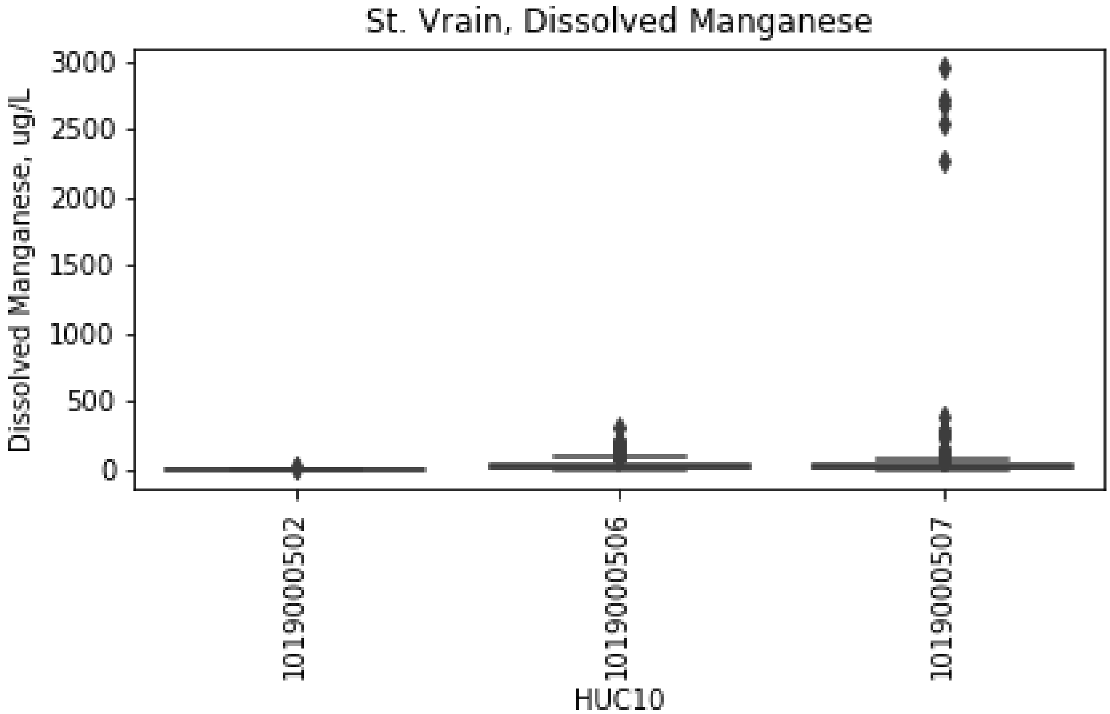
HEAVY METALS

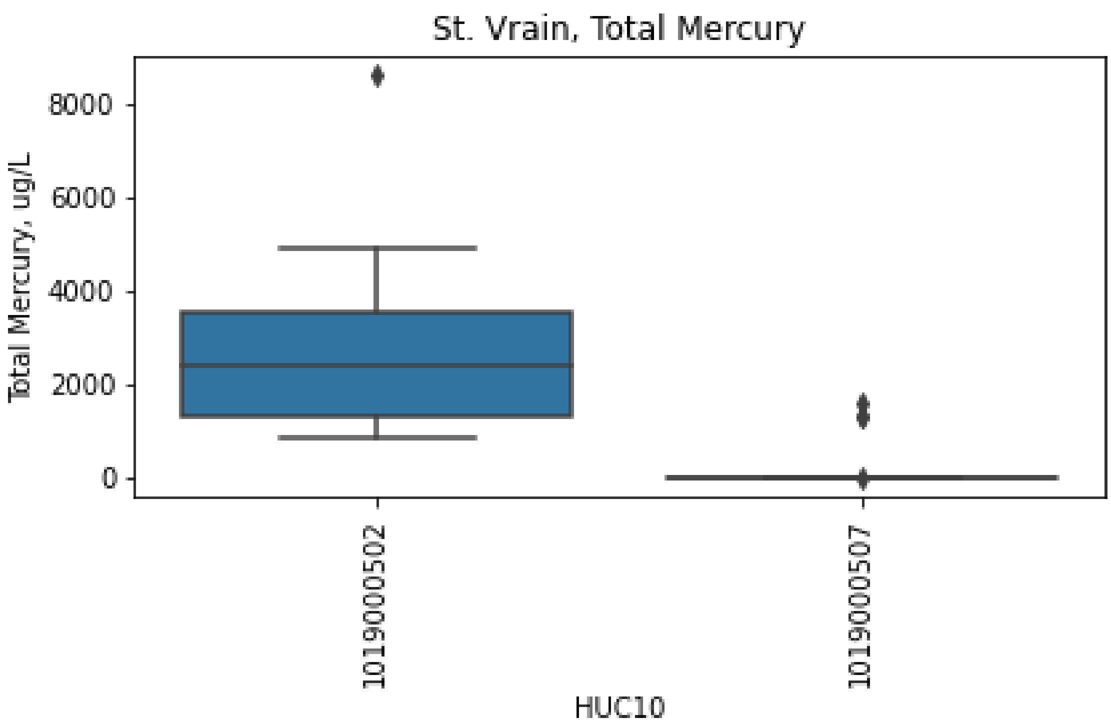


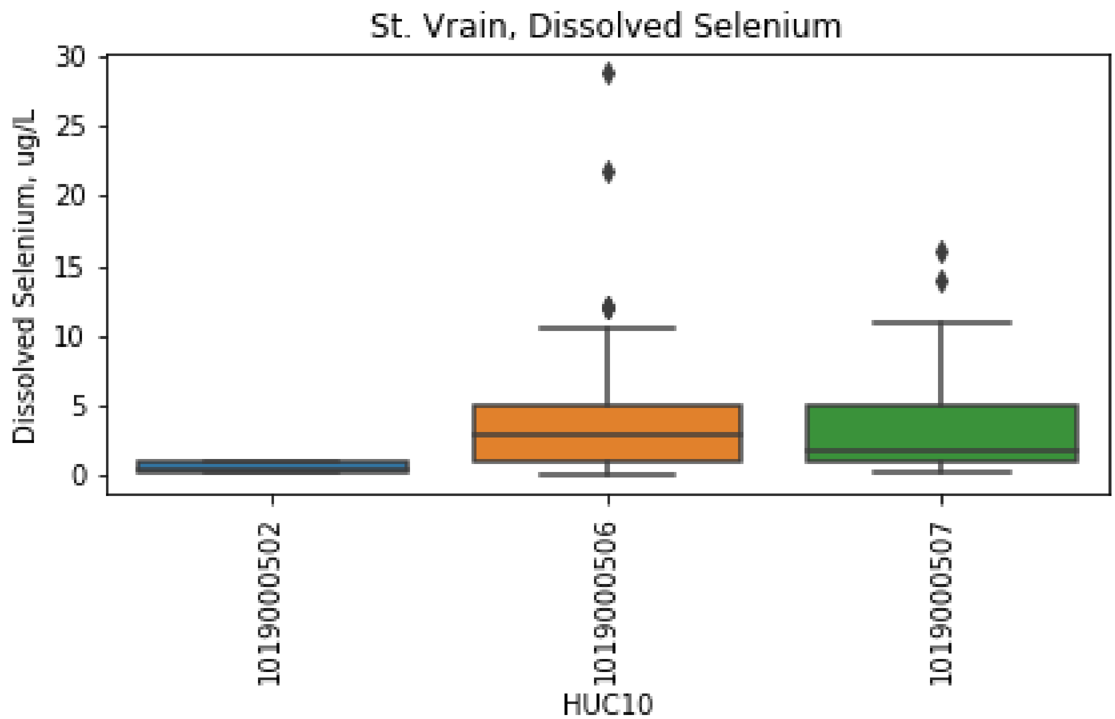


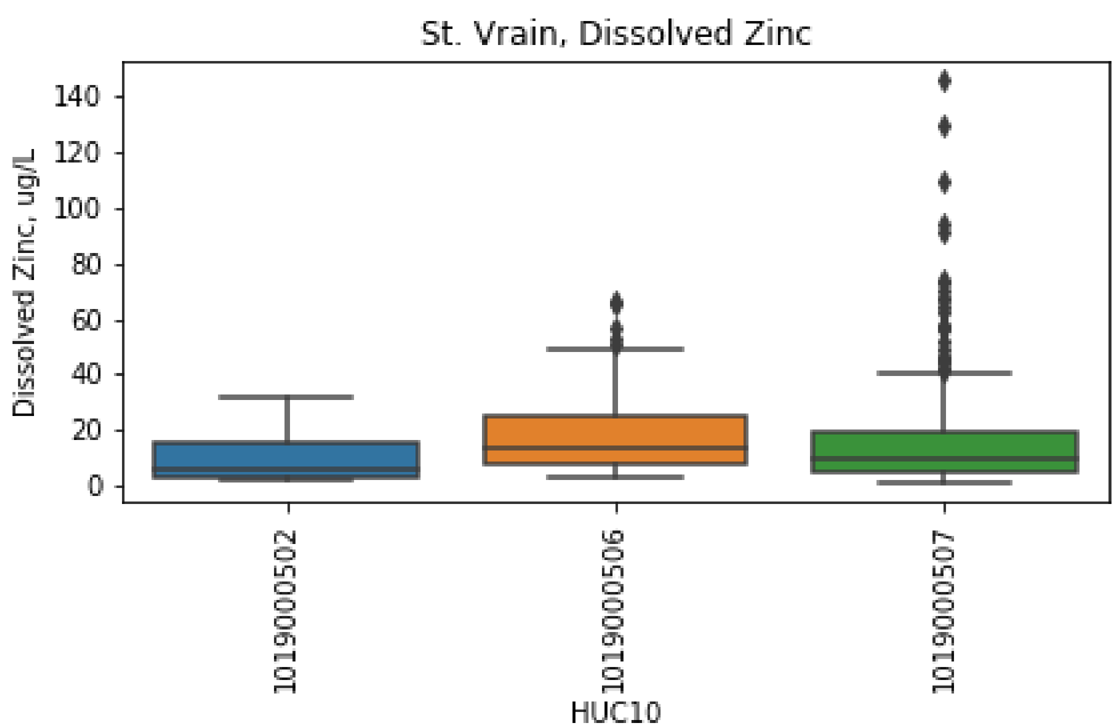

St. Vrain, Total Iron
Total Iron, ug/L
15000
10000
5000
0
1019000502
1019000506
1019000507
HUC10


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
0
5
10
15
20
25
30
1019000502
1019000506
1019000507
HUC10


St. Vrain, Dissolved Zinc
Dissolved Zinc, ug/L
0
20
40
60
80
100
120
140
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