Upper Cache la Poudre Watershed and Horsetooth Reservoir

Mine Assessment and Action Plan

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INTRODUCTION

The upper Cache la Poudre (CLP) watershed and Horsetooth Reservoir are a valuable assets providing high quality drinking water supply to the City of Fort Collins. The upper CLP watershed encompasses 310,133 acres of land from the City's raw water intake structure located at Gateway Natural Area, near the Poudre River Canyon Mouth, to the headwaters of the Poudre River in Rocky Mountain National Park. Most of the land in the upper CLP watershed is forested with minimal land use impacts to water quality and watershed function. Historical mining occurred throughout the watershed, but the footprint, compared to other watersheds in Colorado, is small due to the lack/quality of mineral resources located throughout the basin; however, historical and active mines were identified as a "high priority" potential source of contamination in the City of Fort Collin's Source Water Protection Plan (Mihelich et al., 2016).

Most abandoned and inactive mines in the Upper CLP watershed were mined for metals or industrial material. There was one gold-mining town in the upper CLP watershed known as Manhattan. Manhattan Mining District, established in 1886, was located north of the Town of Rustic on the divide between the Sevenmile and Elkhorn Creek drainages. The gold rush in the upper CLP watershed did not last long as ore was not rich in valuable minerals, but the legacy of Manhattan and other abandoned mines remain (Evans and Evans, 1991). This document further investigates historical and active mining sites in the upper CLP watershed to identify areas that may pose environmental threat to the City of Fort Collins' drinking water quality.

Nearly all Horsetooth Reservoir water comes from the Colorado Big Thompson Project. The watersheds that contribute water and influence water quality in Horsetooth Reservoir included watersheds both west and east of the Continental Divide, which include the Upper Colorado River watershed and Big Thompson River watershed. This mine assessment and action plan focuses on the smaller contributing watershed surrounding Horsetooth Reservoir.

The contributing watershed draining directly into Horsetooth Reservoir encompasses approximately 10,982 acres of land. Land use around the reservoir consists of mixed forest, grassland, and residential land cover. Water from the Hansen Feeder Canal enters Horsetooth Reservoir at the south end of the reservoir. The natural, local Horsetooth Reservoir watershed area includes several small, intermittent streams that flow into the east side of the reservoir (including the named intermittent drainages Soldier Canyon, Well Gulch, Arthur's Rock Gulch, Mill Creek, and Spring Creek) during the spring snowmelt period and during significant rainfall events.

Historically, the hogbacks surrounding and within Horsetooth Reservoir were quarried for sandstone from 1870 to the 1893. Quarry mining flourished during this time, but never fully recovered following the economic panic of 1893. Many of the old quarries are now located beneath the waters of Horsetooth Reservoir (Evans and Evans, 1991).

OBJECTIVES AND GOALS

The goal of the Upper Cache la Poudre Watershed and Horsetooth Reservoir Mine Assessment and Action Plan is to inventory existing and historical mining activity within the upper CLP watershed and Horsetooth

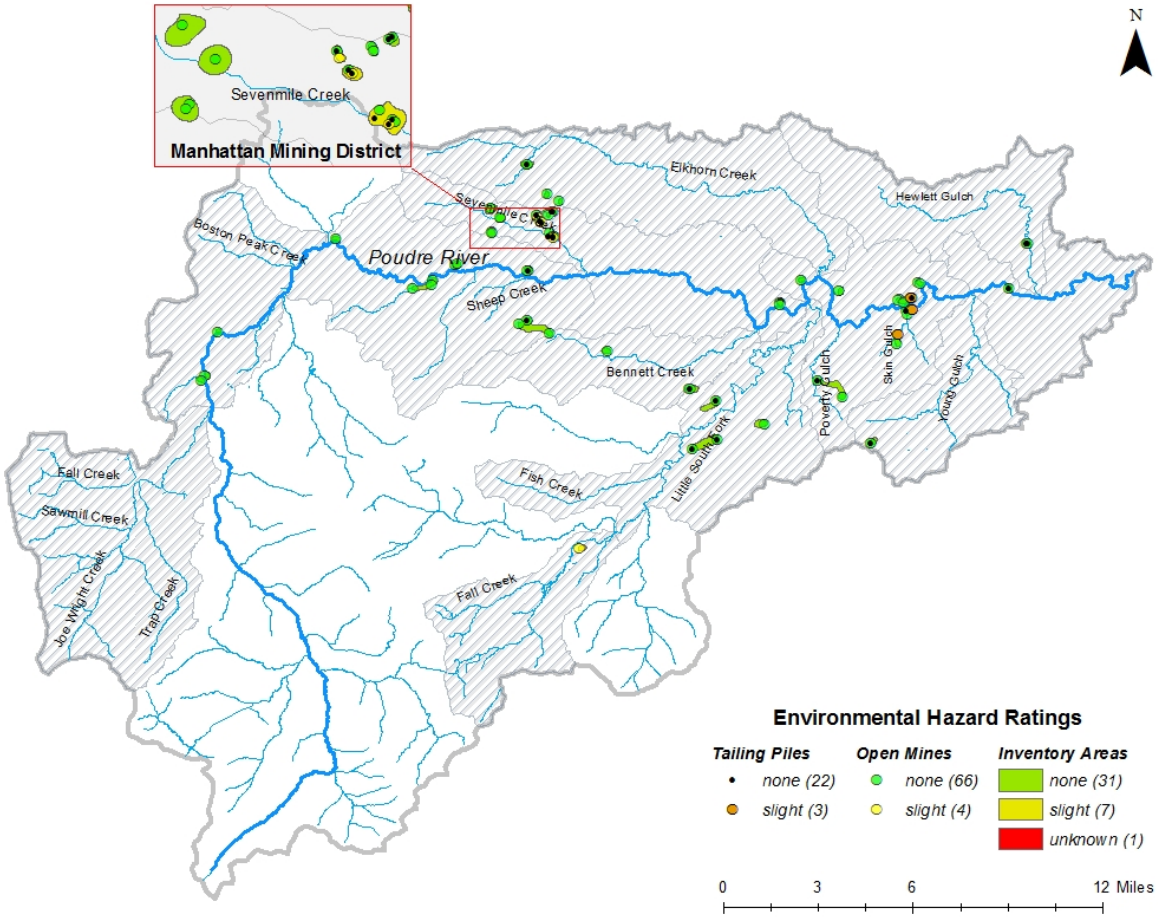
Reservoir, and evaluate potential water quality impacts of historical and active mining to the City's source drinking water supplies. The objectives to meet this goal are: 1) conduct a research review that considers all relevant historical background information, relevant data, and past abandoned mine inventories and assessments associated with mining activities and impacts within the watershed; 2) identify sites from mine inventories with potential or confirmed environmental degradation which require further investigation; 3) identify sub-basins with mining activity that drain directly to the Poudre River and Horsetooth Reservoir that may impact water quality ; 4) develop and implement a water quality monitoring plan to inventory water quality of perennial streams of these sub-basins entering the Poudre River and Horsetooth Reservoir.

Historical and Active Mine Review

Colorado Geologic Survey

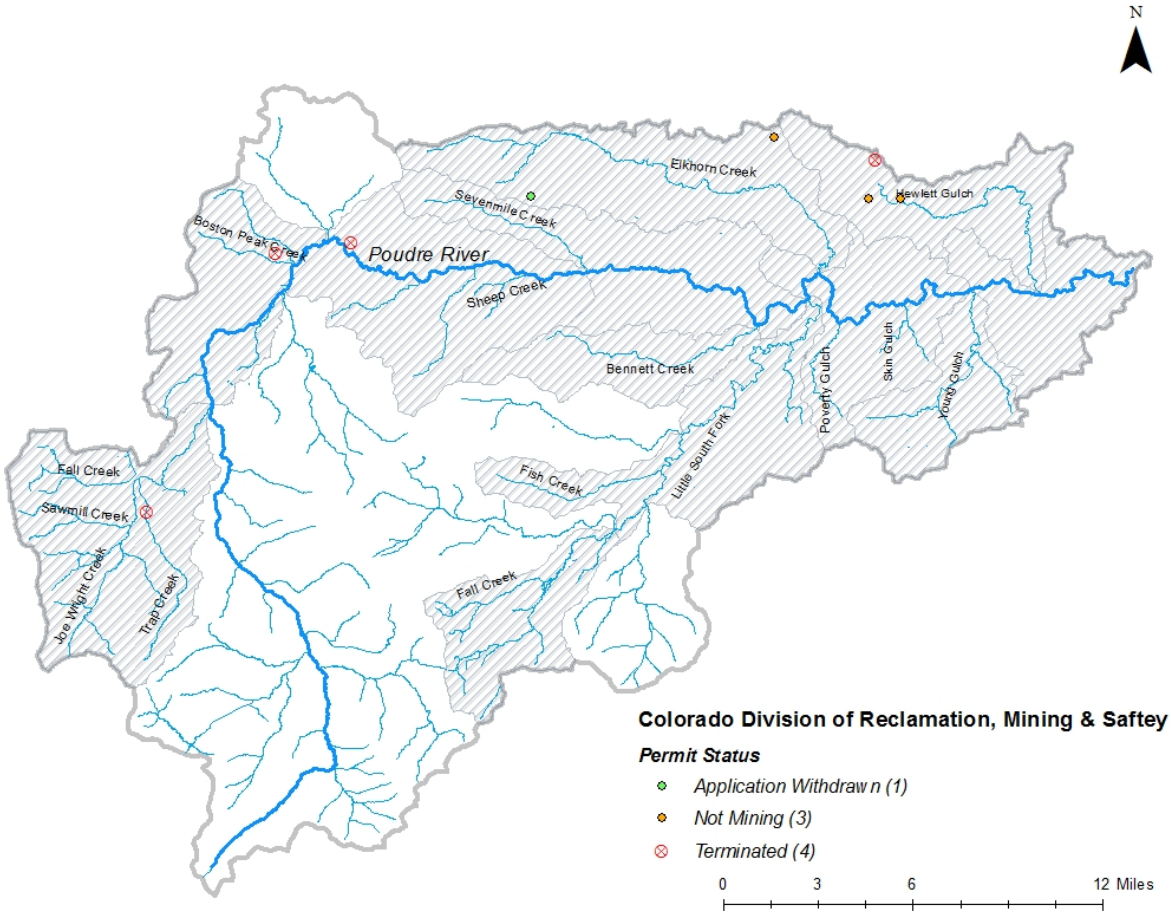
The Colorado Geologic Survey conducted an inventory of abandoned and inactive mines within the Estes-Poudre Ranger District in 1993 to assess environmental degradation (www.coloradogeologicalsurvey.org). The mine inventory area assessment included mapping of features, environmental information, environmental safety ratings, and water and waste water samples from selected sites. The Colorado Geologic Survey found that the district is "remarkably free of environmental problems" (Sares, 1993). The highest environmental degradation rating given within this ranger district was 4 ("slight") based on a 1 through 5 scale with 1 being "extreme" and 5 being "none." Seven out of 40 inventoried areas within the Upper CLP were identified as having a "slight" impact to the environment. These seven locations were situated within three sub-basins Skin Gulch, Sevenmile Creek (Manhattan Mining District), and Headwaters South Fork Cache la Poudre River.

The Colorado Geological Survey also examined mine openings and tailing piles to determine the conditions, access, deterrents, water drainages, dimensions and other features of mine dumps or tailing piles. A total of 26 tailings piles and 71 openings were identified and inventoried on USFS land within the Upper CLP watershed. Field visits verified that no draining water was exiting any of the 26 tailing piles, however, three locations exhibited signs of erosion (sheet wash, rills, and gullies) indicative of flowing water. Tailing piles within the Upper CLP watershed do not have perennial flowing water, but likely experience intermittent flowing water during snowmelt runoff and storm events. Standing water was identified at mine openings located in the historic Manhattan Mine District in the Sevenmile Creek sub-basin, which was given a "slight" environmental hazard rating.


N
Sevenmile Creek
Manhattan Mining District
Elkhorn Creek
Hewlett Gulch
Boston Peak Creek
Poudre River
Sheep Creek
Bennett Creek
Poverty Gulch
Skin Gulch
Young Gulch
Little South Fork
Fish Creek
Fall Creek
Sawmill Creek
Joe Wright Creek
Trap Creek
Fall Creek
Environmental Hazard Ratings
Tailing Piles
none (22)
slight (3)
Open Mines
none (66)
slight (4)
Inventory Areas
none (31)
slight (7)
unknown (1)
0
3
6
12 Miles

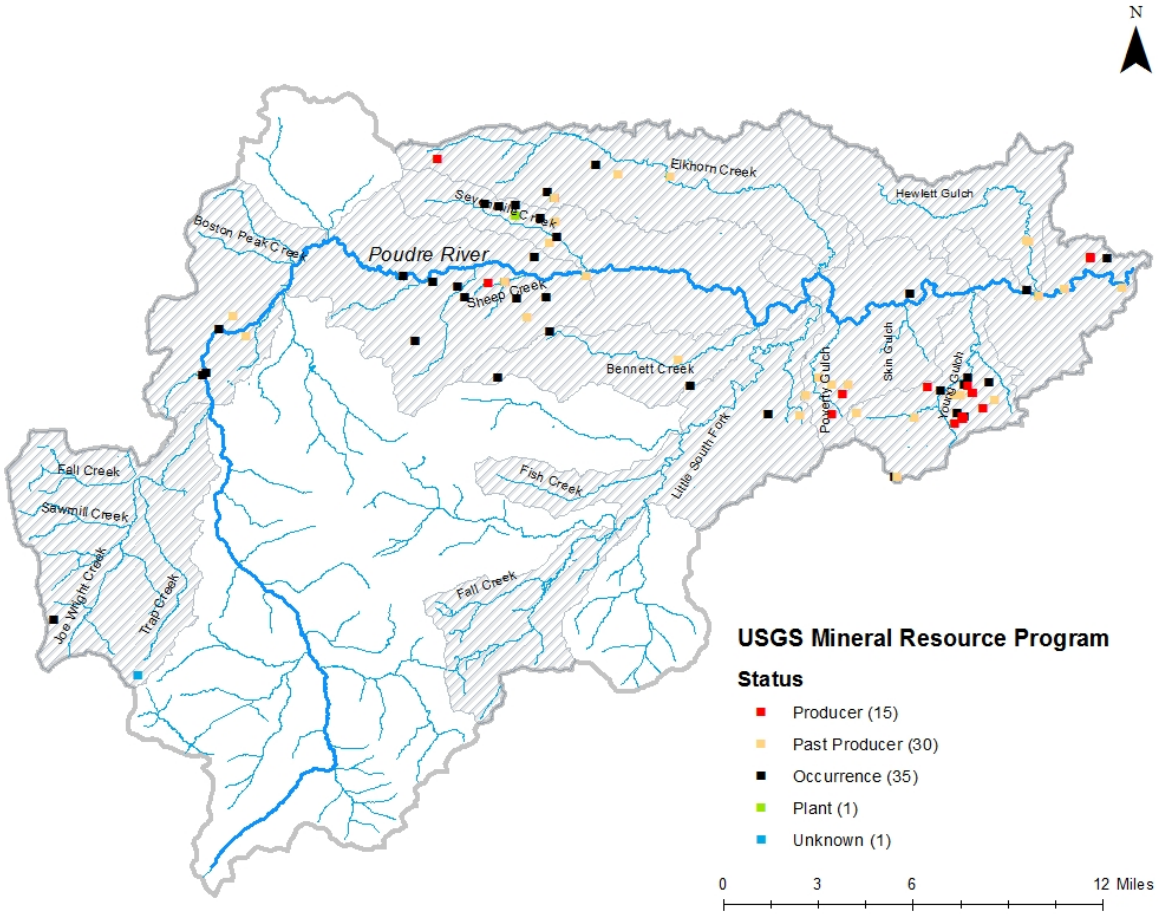
COLORADO DIVISION OF RECLAMATION, MINING & SAFETY

Colorado's Reclamation, Mining, and Safety (DRMS) Division is a program administer by the Colorado Department of Natural Resources (www.mining.state.co.us/). The DRMS is responsible for mineral and energy development, policy, regulation and planning. The division is responsible for granting mining permits and maintains a database of all permitted mine sites throughout Colorado. The Upper CLP watershed contains eight permitted mines, but applications have either been terminated, withdrawn, or no mining has occurred. Currently, no active construction, hardrock or coal mine permits exist for the Upper CLP waters, but historically there were two inactive hardrock mine permits and six inactive construction mine permits. The Horsetooth Reservoir watershed did not have any identified DRMS permitted mines.

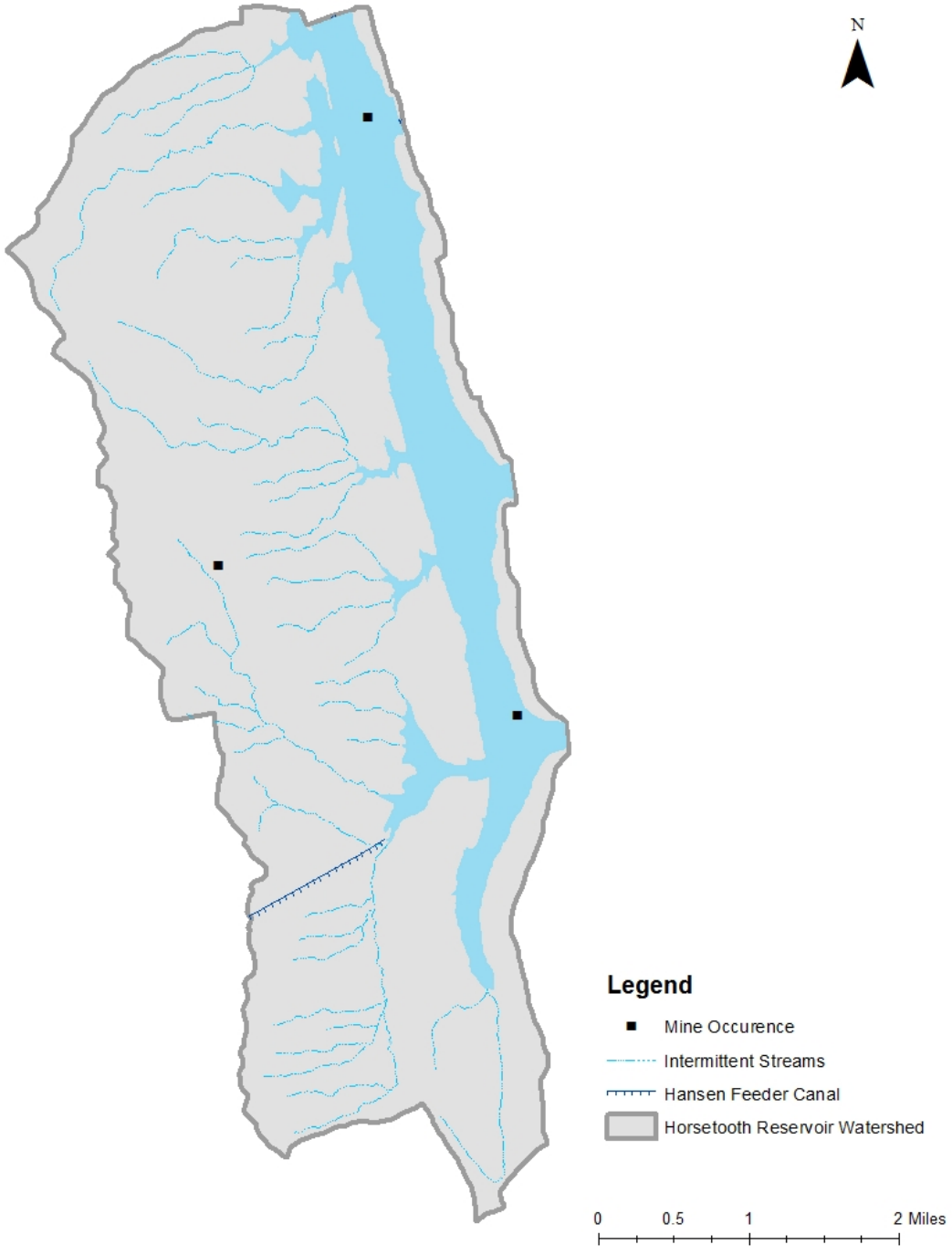


United States Geologic Survey Mineral Resources Program

The United States Geologic Survey Mineral Resources Program provides science and information to understand mineral resources potential, production, consumption and how minerals react with the environment (www.minerals.usgs.gov). The Mineral Resources Data System hosted by the USGS Mineral Resources Program provides spatial information on metallic and nonmetallic mineral resources throughout the world. The database contains past or present mines, mine prospects or mine occurrences, and processing plants. The Upper CLP watershed contains 15 producing mines, 30 past producing mines, 35 occurrences, one processing plant, and one unknown. More than half of the producing and past producing mines are located within the Skin Gulch, Young's Gulch, and Hill Gulch basin. Beryllium was documented as the primary commodity mined in the 15 producing mines throughout the basin. The sole processing plant in Upper CLP water is located near the Manhattan Mining District in the Sevenmile Creek basin. Mining occurrences are spread throughout the basin, some of which overlap with mines documented during the Colorado Geologic Survey's 1993 inventory.



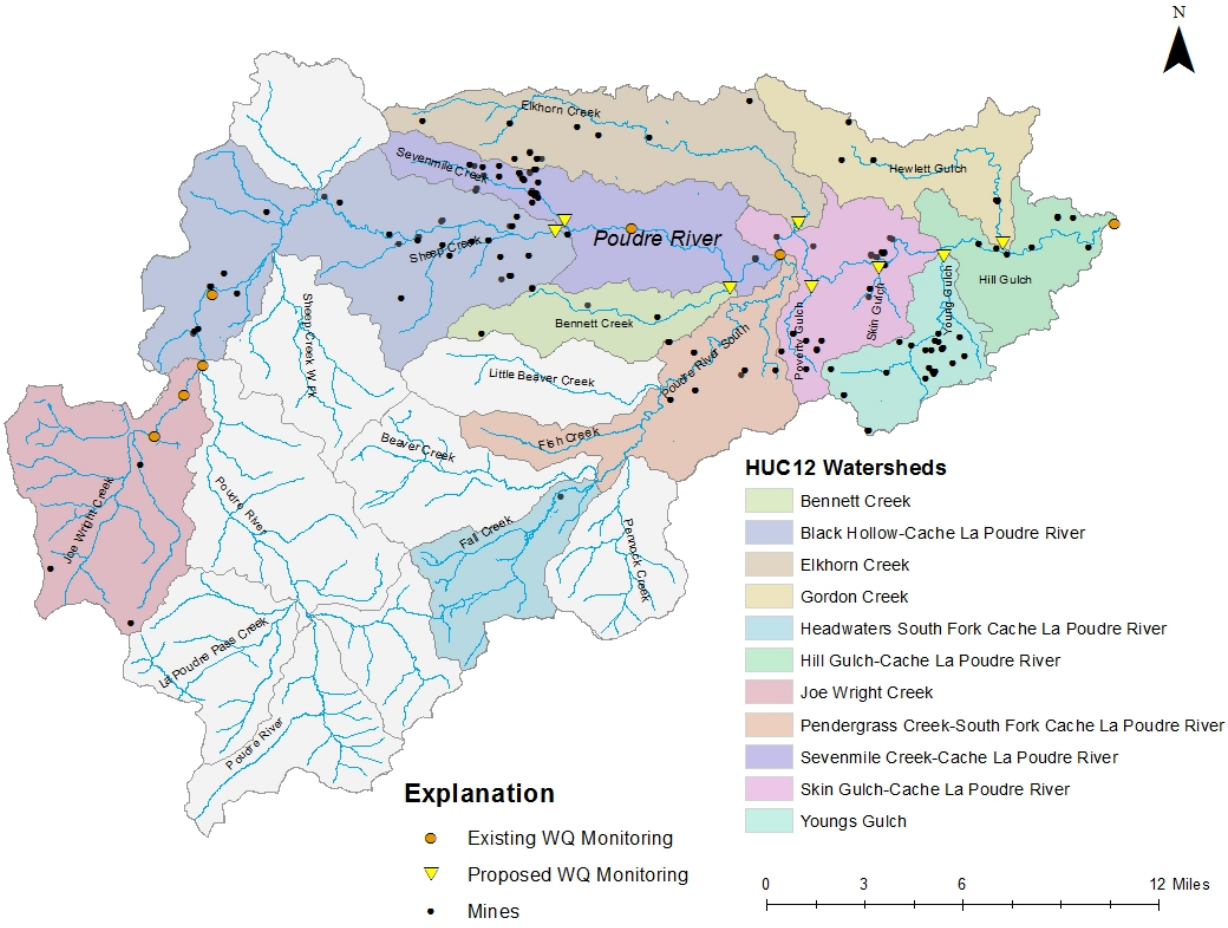
The Horsetooth Reservoir watershed contains three mine occurrences as documented by the United States Geologic Survey Mineral Resources Program. Two of the mine occurrences are currently located under the reservoir near Solider Canyon and Spring Canyon Dams. These mines were previous fire clay refractories. The third mine is located near the headwaters of an intermittent drainage that flows into Inlet Bay and was also a stone mining operation. No asbestos mines, prospects, or occurrences were documented in the Upper CLP and Horsetooth Reservoir watersheds.



WATER QUALITY MONITORING PLAN

PROPOSED MONITORING LOCATIONS AND MONITORING FREQUENCY

The map below outlines the proposed monitoring locations. Monitoring locations are located on primary tributaries above the confluence with Poudre River. Eight monitoring sites are situated at throughout the watershed to better understand water quality contributions from primary tributaries to the Poudre River that have experienced previous mining Collecting samples at the basin outlets will capture basin contributions and potential impacts to the Poudre River. Monitoring will be conducted in the late summer or fall during baseflow conditions following an extended dry period to avoid chemical dilution due to snowmelt runoff and storm events. The eight monitoring locations are listed below:



Drainage Name	Basin Area (acres)	Monitoring location	Approx. # of Mines	Environmental Hazard Rating
Hill Gulch – Cache la Poudre River	11,161	PNF (existing)	7	None
Gordon/Hewlett Gulch	13,908	Hewlett Gulch	5	None
Youngs Gulch	9,823	Young Gulch	20	None
Skin Gulch – Cache la Poudre River	14,920	Poverty Gulch & Skin Gulch	20	Slight
Elkhorn Creek	22,259	Elkhorn Creek	10	None
Pendergrass Creek - South Fork Cache la Poudre River	18,639	SFC (existing)	7	None
Headwaters South Fork Cache la Poudre River	11,094	SFC (existing)	1	Slight
Bennett Creek	9,210	Bennet Creek	3	None
Seven Mile Creek – Cache la Poudre River	18,640	Seven Mile Creek	27	Slight
Black Hollow – Cache la Poudre River	37,738	Cache la Poudre (below confluence with Sheep Crk./above confluence with Sevenmile Crk.	28	None
Joe Wright Creek	24,468	JWC (existing)	3	None

Data Collection, Processing, and Analysis

General water quality parameters temperature, pH, specific conductance, and dissolved oxygen will be measured at each monitoring location using a multiparameter water quality sonde. Additional water quality constituents will be monitored by obtaining grab samples from each site. Grab samples will be processed by the City's water quality laboratory and analyzed for alkalinity, hardness, major ions, and dissolved and total metals. Streamflow measurements will be taken from each site in order to appropriately compare basin chemistry and to calculate constituent loading to the Poudre River.

Quality Assurance and Quality Control Plan

Quality assurance and control (QAQC) measures will be implemented during monitoring. A minimum of 10% of the total samples collected will be a field duplicate and/or field blank sample to assure precision and accuracy of data.

Precision

Precision is a measure of the deviation from the true value. Field duplicates will be obtained and analyzed to determine precision of data. Duplicate determinations should agree within 5%. Duplicate samples that differ greater than ±5% will be flagged for further quality assurance and control measures.

Accuracy

Accuracy is a measure of the degree of closeness a measurement is to the true measurement. Calibration of equipment will be maintained to assure accuracy between measurements.

Representativeness

Representativeness is the extent to which measurements represent the true condition at the time the sample was collected. Monitoring sites for this project are representative of the goals and objectives outline previously and demonstrate the true character of the each basin at the time of sampling.

Comparability

Comparability is the comparison between the quantities of valid, or usable, data that were originally planned to be collected. The monitoring program will ensure comparability of data by complying with monitoring methods and will include obtaining field blank and lab blank samples to determine potential error in data due to contamination of water samples.

ABANDONED MINE SITE VISITS

The mining inventories documented mines located within three basins – Skin Gulch, Headwaters South Fork Cache la Poudre, and Sevenmile Creek - of the upper CLP watershed as having “slight” environmental hazard ratings. These sites will be visited and photo documented. Water quality samples will be collected from the site if mine water is present during the visit.

References

Evans, H.E. and M.A. Evans, 1991. Cahce la Poudre: The Natural History of a Rocky Mountain River.

Sares, M.A., 1993. USFS-Abandoned Mined Land Inventory Project – Summary Report Estes – Poudre Ranger Districts, May 6, 1993, Colorado Geologic Survey Report, pp. 8

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