NORTH FORK OF THE GUNNISON RIVER WATERSHED PLAN *UPDATE*

NORTH FORK RIVER IMPROVEMENT ASSOCIATION (NFRIA)

June 30, 2010

North Fork of the Gunnison downstream of Somerset. Photograph by Mike Maxwell

WWW.NFRIA.ORG

ACKNOWLEDGEMENTS

This watershed plan updates the North Fork Watershed Restoration Action Strategy completed by the North Fork River Improvement Association (NFRIA) in November, 2000. It was supported by a Severance Tax Grant used by the Colorado Water Conservation Board (CWCB) to augment the Colorado Healthy Rivers Fund. Chris Sturm acted as project coordinator for CWCB. David Stiller, Executive Director, was the project coordinator for NFRIA. Sarah Sauter, as a consultant to NFRIA, was this document's primary author.

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Executive Summary

A. The Watershed

The North Fork of the Gunnison River (North Fork) watershed is located in western Colorado's Gunnison and Delta counties (Figure 1-1). The river begins at the confluence of Anthracite Creek and Muddy Creek in the Gunnison National Forest. The North Fork flows 33 miles in a southwesterly direction through the Towns of Paonia and Hotchkiss, confined by a valley of multiple river terraces that run parallel to the river. The valley is flanked by Grand Mesa on the north and west and the West Elk Wilderness area on the east and south. The North Fork watershed drains approximately 969 square miles.

B. Problems

- Four segments of the North Fork are listed on Colorado's 2010 303(d) impaired water list as high priority for selenium impairment.
- Tributaries to the North Fork are on the Monitoring and Evaluation (M&E) list for total recoverable iron
- The North Fork is recognized as a major contributor of salt to the Colorado River System.
- *E. coli* samples occasionally exceed state water quality standards.
- There are no baseline data to evaluate potential impacts from natural gas development.
- The river channel remains structurally unstable in some reaches.
- In-stream flows, especially from Paonia to Hotchkiss, while not as severe as in the past, remain low to intermittent during the summer.
- Paonia Reservoir has lost 24% of its storage capacity
- Public access to the river is limited.

C. Goals and Objectives

Goal 1) Improve water quality

- Reduce dissolved selenium loads
- Better characterize total recoverable iron in North Fork Tributaries on the M&E list
- Reduce salt loads
- Reduce the frequency of *E. coli* exceedances
- Characterize baseline water quality conditions to determine if and how natural gas exploration may affect the watershed

Goal 2) Improve river channel stability

- Stabilize key unstable river reaches

Goal 3) Improve summer flows between Paonia and Hotchkiss

- Identify long term strategies to augment flows

Goal 4) Maintain existing reservoir storage capacity

- Manage Paonia Reservoir sediment influx

Goal 5) Improve recreation opportunities that are consistent with private landowner rights.

- Improve existing access points
- Educate the public about rights, responsibilities and safety

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EPA Nine Elements of a Watershed Plan

The United States Environmental Protection Agency (EPA) requires all implementation, demonstration, and outreach-education projects funded under Section 319 of the federal Clean Water Act to be supported by a Comprehensive Watershed Plan which includes nine listed elements. The nine EPA required elements, and the location of the plan component addressing these elements are listed below.

A. An identification of the causes and sources

Section 7, Table 7-1 (page 7-2)

B. An estimate of the load reductions expected for the management measures

Section 8, Table 8-2 (page 8-7)

C. A description of the NPS management measures that will need to be implemented to achieve the load reductions and an identification of the critical areas in which those measures will be needed to implement this plan.

Section 7 and Section 8, Table 7-1 (page 7-2), Table 7-2 (page 7-3), Figure 7-1 (page 7-4) and pages 8-2 to 8-6

D. An estimate of the amounts of technical and financial assistance needed; associated costs, and/or the sources and authorities that will be relied upon, to implement this plan.

Section 8, pages 8-2 to 8-6

E. An information/education component that will be used to enhance public understanding of the project and encourage their early and continued participation in selecting, designing, and implementing the NPS management measures that will be implemented.

Section 9 (page 9-3)

F. A schedule for implementing the NPS management measures identified in this plan that is reasonably expeditious.

Section 8, pages 8-2 to 8-6

G. A description of interim, measurable milestones for determining whether NPS management measures or other control actions are being implemented.

Section 8, pages 8-2 to 8-6

H. A set of criteria that can be used to determine whether loading reductions are being achieved over time and substantial progress is being made towards attaining water quality standards and, if not, the criteria for determining whether this watershed based plan needs to be revised or, if a NPS TMDL has been established, whether the NPS TMDL needs to be revised.

Section 8, pages 8-2 to 8-6

I. A monitoring component to evaluate the effectiveness of the implementation efforts over time, measured against the criteria established under item (h) immediately above.

Section 10 (Table 10-1)

Acronyms

AFY – Acre Foot per Year
BLM – Bureau of Land Management
BMP – Best Management Practice
CFS – Cubic Feet per Second
CDPS – Colorado Discharge Permit System
CDSS – Colorado Decision Support System
CHIA - Cumulative Hydrologic Impact Analysis
CNHP – Colorado Natural Heritage Program
CRBSCP – Colorado River Basin Salinity Control Project
CWCB – Colorado Water Conservation Board
DMR – Discharge Monthly Report
DOLA – Department of Local Affairs
DOW – Division of Wildlife
DPR – Detailed Project Report
DRMS - Division of Reclamation, Mining and Safety
FEMA – Federal Emergency Management Agency
FMCRC – Fire Mountain Canal and Reservoir Company
FERC – Federal Energy Regulation Commission
GMUG – Grand Mesa Uncompahgre Gunnison National Forest
HUC - Hydrologic Unit Code
ICIS – Integrated Compliance Information System
ISDS - Independent Sewage Disposal System
ISF – Instream Flow
M&E – Monitoring and Evaluation List
M&I – Municipal and Industrial
Mg/L - Milligram per Liter
NCNA – Non-Consumptive Needs Assessment
NFMU – North Fork Management Unit
NFRIA – North Fork River Improvement Association
NFWCD – North Fork Water Conservancy District
NPDES – National Pollution Discharge Elimination System
NPS – Non-Point Source Pollution
NRCS – Natural Resources Conservation Service
RCMAP – Reconfigured Channel Monitoring and Assessment Program
SWE – Snow Water Equivalent
SWSI - Statewide Water Supply Initiative
TDS – Total Dissolved Solids
TMDL – Total Maximum Daily Load
TSS – Total Suspended Solids
TVS – Table Value Standard
WBID – Water Body Identification
WQCC – Water Quality Control Commission
WQCD – Water Quality Control Division
WRAS – Watershed Restoration Action Strategy
WSERC - West Slope Environmental Resource Council
WWTP – Waste Water Treatment Plant
USACE – United States Army Corps of Engineers
USBOR – United States Bureau of Reclamation
USDA – United States Department of Agriculture
USEPA – United States Environmental Protection Agency
USFS – United States Forest Service
USGS – United States Geological Survey

Section 1: Background and Introduction

1.1 *North Fork River Improvement Association*

Landowners established the North Fork River Improvement Association (NFRIA) in 1996 as a means to improve the health of the North Fork of the Gunnison River. NFRIA takes a community-directed, solution-focused, grassroots approach to watershed organization and river rehabilitation. The mission of this group is to meet current and future demands for traditional uses of the river while improving stream stability, riparian habitat, and ecosystem function. Our goal is to solicit community input from all stakeholders and government agencies involved with the river, build consensus, and develop collaborative solutions to the common problems of this stream system.

NFRIA has successfully brought together riverfront landowners, farmers and ranchers, environmentalists, irrigation companies, recreationalists, in-stream gravel mining companies, and concerned members of the community. The group enthusiastically faces the social, political, and technical challenges before them and looks forward to developing collaborative efforts between all stakeholders and government agencies to ask better questions, find substantive answers, and ultimately promote positive action.

1.2 *Purpose of a watershed plan*

Ten years after the initial development of the North Fork River Watershed Action Plan (NFRIA 2000), NFRIA decided to update the watershed plan. This watershed plan update was funded by the Colorado Water Conservation Board (CWCB). The watershed plan's update addresses new water quality data, reports and community concerns, as well as the EPA required nine elements for watershed planning. The revised action plan laid out in this report will serve as NFRIA's road map and guide book as we continue our river-restoration course in the foreseeable future.

Watershed planning is an inclusive approach that supports environmental protection, economic development and quality of life issues. It provides a flexible framework for managing water resource quality and quantity within a watershed. It also includes stakeholder involvement and management actions that are supported by sound science and appropriate technology. The watershed planning process works within this framework by using a series of cooperative, iterative steps to characterize existing conditions, identify and prioritize problems, define management objectives, develop protection or remediation strategies, and implement and adapt selected actions as necessary. The outcomes of this process are documented or referenced in a watershed plan. A watershed plan is a strategy that provides assessment and management information for a geographically defined watershed, including the analyses, actions, participants, and resources related to developing and implementing the plan.

North Fork Watershed

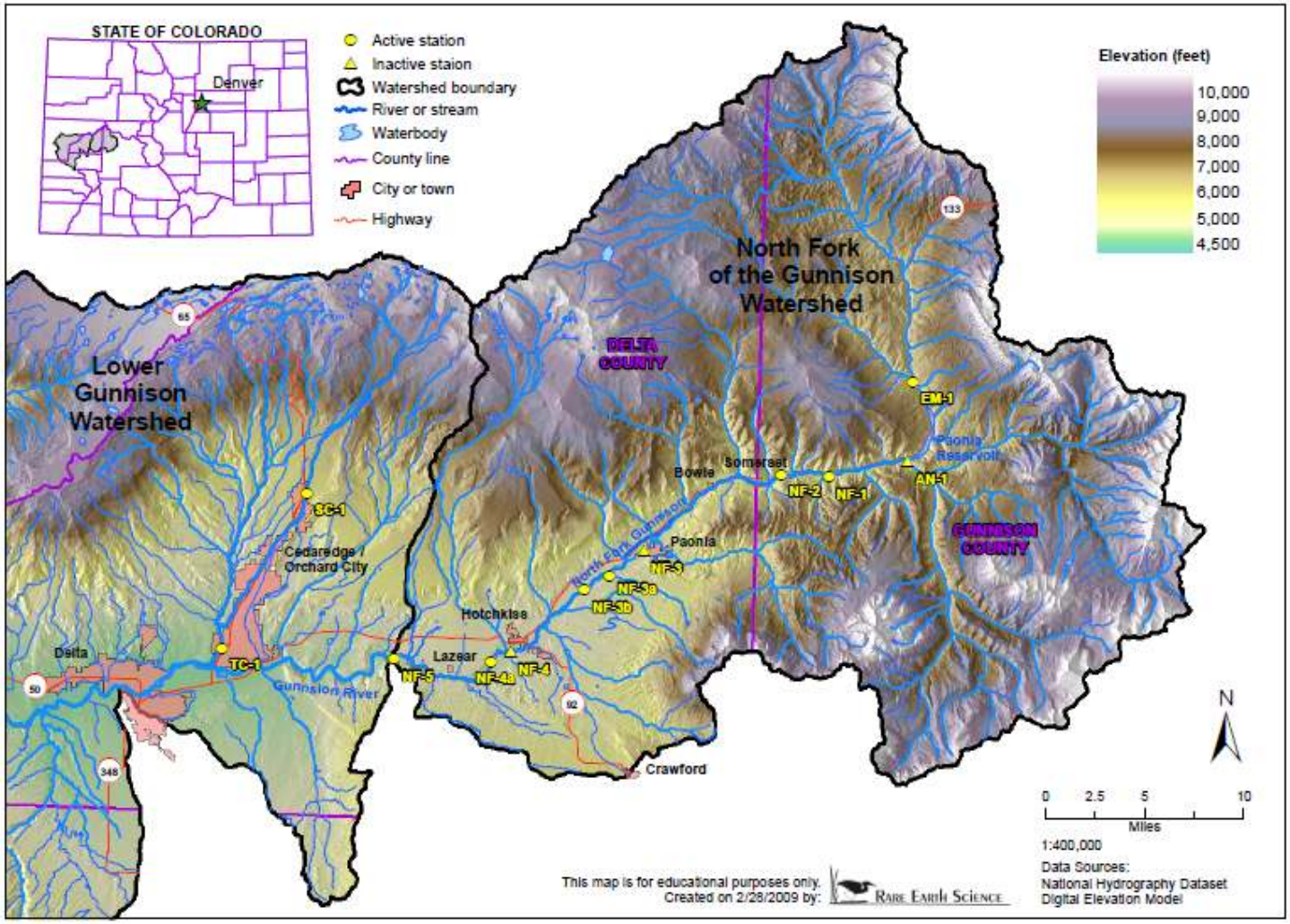

Figure 1-1: North Fork Watershed

1.3 *2009 Stakeholder Concerns*

In 2009, NFRIA hosted two public meetings designed to gage public sentiment about the North Fork. NFRIA wanted to know how community concerns about the river had changed since the last round of stakeholder meetings in 2000. The 2009 meetings were held in Hotchkiss on October 14 and in Paonia on December 9. The general stakeholder comments expressed by attendees are as follows:

- Enforcement of private property rights with allowance for public access to river
- Floodplain at Midway seems to be functioning better
- Feasibility of micro-hydro on irrigation ditches
- Natural Gas Drilling
    - Best Management Practices (BMPs) should be followed
    - Background sampling needed as soon as possible
    - Identification of indicator analytes is needed for fracking chemicals
    - Colorado 1298 rules apply only to private land
    - BLM and USFS have separate rules and BMPs
    - Potential violation of Colorado water law by drillers who pump water from streams/rivers
    - Work with Thompson Divide Coalition
- Public Education
    - Website/Blog to update public on issues of concern
    - Links to other organizations
    - What is NFRIA's role versus other groups in the community (e.g. Citizens for Healthy Community, WSERC)?
- Chronic low summer flows
    - Why not find incentives to move conditional water rights for storage around the upper watershed to encourage and support instream flows?
    - No senior rights for minimum instream flow
    - Increase water conservation
    - Encourage water efficiency
- Collaborate with other planning efforts
    - BLM Uncompahgre Field Office Resource Management Plan
    - USFS GUMG Plan
- Sedimentation/ Loss of storage in Paonia Reservoir
- Selenium

Section 2: Summary of 2000 Plan and Achievements

With funding from EPA through Section 319 of the Clean Water Act, NFRIA published an initial Watershed Restoration Action Strategy in 2000 (NFRIA, 2000). To serve as NFRIA's guidebook and roadmap, this living document compiled baseline river information with the oversight of a technical advisory group comprised of river experts and representatives from 12 state and federal agencies.

The 2000 Watershed Restoration Action Strategy (WRAS) identified eleven problems.

1) The River is structurally unstable.
2) In-stream flows, especially near the town of Paonia, are low to intermittent during the summer.
3) Paonia Reservoir is filling with sediment.
4) Flood damage in the valley has increased.
5) Riparian vegetation has declined in acreage and vigor.
6) Aquatic and terrestrial wildlife have lost habitat in the river corridor.
7) Some stream segments are on Colorado's evaluation and monitoring list for fecal coliform.
8) Some stream segments are impaired by selenium.
9) Some stream segments are being monitored for high levels of ammonia.
10) The North Fork is recognized as a major contributor of salt to the Colorado River system.
11) Public access to the river is limited.

Starting in 1996, NFRIA hosted several public meetings to capture the community's vision for the river. NFRIA then established goals that reflected public sentiments and actions proposed by other groups and agencies. The goals are as follows:

Goal 1: Improve ecosystem function and reduce the amount of valuable land lost to excessive stream bank erosion.

Goal 2: Improve water quality.

Goal 3: Increase recreational potential.

Since then, NFRIA has grown into a vigorous non-profit, non-partisan organization that has worked for more than a decade to foster the restoration of the North Fork into a healthy, usable and sustainable river while promoting sustainable agricultural practices and community enrichment. During that time, NFRIA has achieved a remarkable record of successful restoration and enhancement projects through the work of its staff and volunteers, with grants from over 60 local, state and national organizations and individual donations of its membership, which now totals more than 200. Table 2-1 summarizes NFRIA's accomplishments since the development of the 2000 Watershed Action Plan. More information about NFRIA's restoration projects can be found at www.nfria.org.

Table 2-1: NFRIA Accomplishments

2000 WRAS Plan	Projects Addressing Objective
Goal 1: Improve ecosystem function and reduce the amount of valuable land lost to excessive stream bank erosion	
Objective 1: Understand the factors that lead to instability and unpredictability of the river channel.	Hotchkiss Demonstration
Objective 2: Develop community education and outreach	Hotchkiss Demonstration, Annual River Awareness Float
Objective 3: Construct floodplain rehabilitation projects	Hotchkiss Demonstration, Midway Enhancement, Upper Curry Restoration
Objective 4: Protect environmentally sensitive and recently restored areas	Chipeta Dam Removal, Curry Conservation Easement
Objective 5: Reduce impacts of gravel mining	Paonia River Park, Curry Conservation Easement
Objective 6: Improve irrigation diversions	Smith-McKnight Ditch, Sheppard-Wilmot Ditch, Short Ditch, Monitor Ditch, Van Der Ford Ditch, Paonia and Feldman Ditches.
Objective 7 : Improve flood management within the North Fork Valley	Hotchkiss Demonstration, Midway Enhancement, Upper Curry Restoration
Goal 2: Improve Water Quality	
Objective 1: Encourage development of riparian buffers and new wetlands	Hotchkiss Demonstration, Midway Enhancement, Upper Curry Restoration, Chipeta Dam Removal
Objective 2: Reduce pollution from municipal wastewater	
Objective 3: Monitor water quality in the North Fork and create a source water protection plan	Monthly Water Quality Monitoring
Objective 4: Reduce selenium in the tributaries of the North Fork	Monthly Water Quality Monitoring
Objective 5: Reduce sediment in the North Fork	Hotchkiss Demonstration, Midway Enhancement, Upper Curry Restoration
Objective 6: Reduce salinity to the lower Colorado River from the North Fork	
Goal 3: Increase recreational potential	
Objective 1: Increase public access	Paonia River Park
Objective 2: Improve fisheries	Smith-McKnight Ditch, Sheppard-Wilmot Ditch, Short Ditch, Monitor Ditch, Van Der Ford Ditch, Paonia and Feldman Ditches.
Objective 3: Improve public safety on the river	Smith-McKnight Ditch, Sheppard-Wilmot Ditch, Short Ditch, Monitor Ditch, Van Der Ford Ditch, Paonia and Feldman Ditches.

NFRIA Restoration Projects

The majority of NFRIA's restoration efforts over the years have taken the form of mitigation/ enhancement projects focused predominantly on channel rehabilitation, irrigation diversion reconstruction and habitat restoration. These types of projects seek to replicate historical river patterns and minimize erosion with geomorphically designed enhancement efforts. In many cases, this means slowing the river down by increasing meanders throughout the full extent of the floodplain, thereby reducing the overall slope of the channel. Through these projects, NFRIA also removes foreign materials, as well as unneeded dikes and dams.

Over its fourteen years of operations, NFRIA has developed a strong record of accomplishments improving the North Fork Gunnison River. A brief synopsis of each project follows, with information on the necessary logistics and problems encountered during each. More information about NFRIA's restoration projects can be found at www.nfria.org. Figures 2-1 and 2-2 show the location and date of each project.

Figure 2-1: Location of NFRIA River Restoration Projects

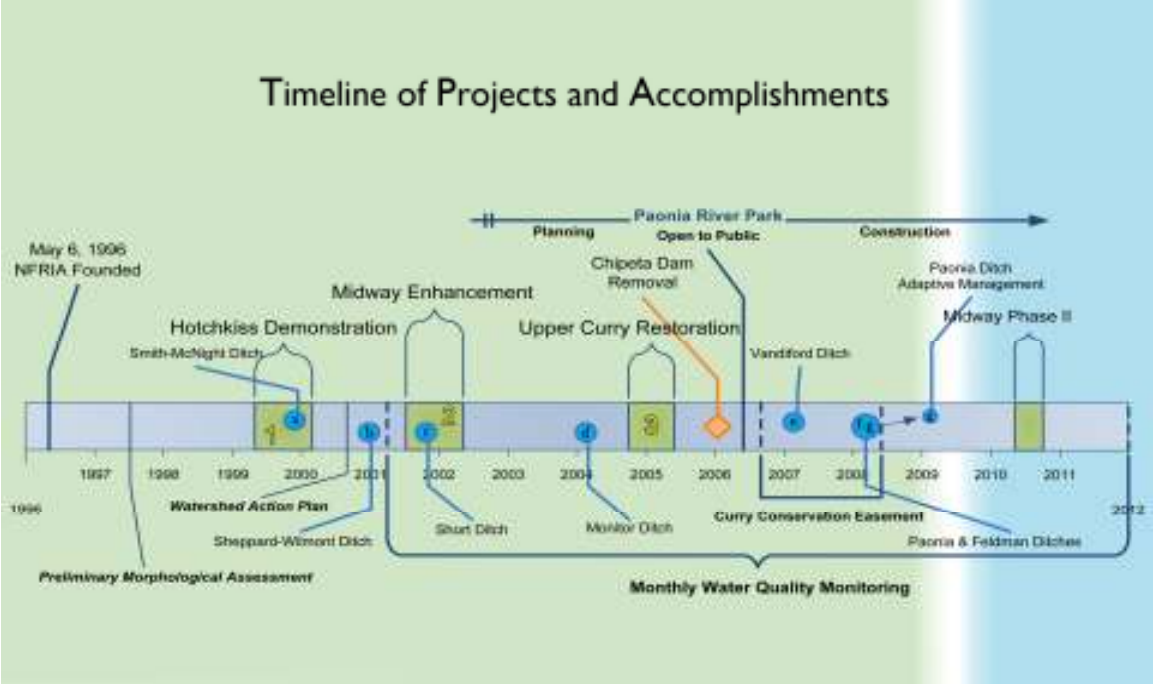

Figure 2-2: Timeline of Projects and Accomplishments

Hotchkiss Demonstration Project

After publishing assessments of the health of the North Fork Gunnison River and developing plans for rehabilitation, NFRIA began a project in 1999 aimed at providing the surrounding community with a highly visible demonstration of the importance and effectiveness of its proposed river restoration techniques.

In February 2000, NFRIA completed the rehabilitation of 1.5 miles of the river near Hotchkiss, Colorado. The improvements illustrated NFRIA's use of innovative technologies for natural floodplain rejuvenation, habitat enhancement, and channel stabilization. The project consolidated what was a wide, braided stream system into a morphologically balanced single thread channel. The restoration reconfigured natural river channel morphology to encourage natural processes to maintain the channel's stability and reduce excessive bank erosion. Riparian, wetland, and natural floodplain areas were enhanced and protected to minimize flood damage and to maximize in-stream water flow capacity. Figure 2-3 shows a picture of the Hotchkiss Demonstration Project.

Completed low-head rock weir just above Smith-McKnight Ditch site on Hwy 92 in Hotchkiss

Figure 2-3: Hotchkiss Demonstration Project

Midway Enhancement Project

Building on the success of the Hotchkiss Demonstration Project, NFRIA sought out and secured funding to restore a significantly longer stretch of the North Fork Gunnison River, beginning a few miles downstream of Paonia and extending 4.5 miles to the Mancos shale bluffs overlooking the river above the Town of Hotchkiss.

The Midway Enhancement project, completed in April 2002, had as its primary goal the reduction of impacts from human intervention in the active river channel to restore the natural behavior of the river. The project was designed to protect private property and revitalize the ecosystem by utilizing the full potential of the floodplain to reduce erosion, improve water quality, enhance fish and wildlife habitat, and recharge groundwater storage. A small portion of Phase II is expected to begin in 2011. Phase II goals include the installation of boulder structures and channel vegetation to reduce bank erosion and restore wildlife habitat. Figure 2-4 shows before and after picture of the Midway Enhancement Project.

Midway Enhancement Project – November 2001, before reconstruction

Midway Enhancement Project - July 2005, after reconstruction

Figure 2-4: Midway Enhancement Project

Upper Curry Enhancement

With the successful completion of the Midway project, a large percentage of the highly utilized stretch of river between Paonia and Hotchkiss was restored. However, significant sites still needed to be addressed. One such site was a half-mile reach below the lower extent of the Midway project.

The Curry Enhancement project treated an estimated 2,000 linear feet of channel and adjacent riparian area. The change in channel alignment increased sinuosity, reduced grade, widened the riparian zone, and reestablished a natural riffle/pool sequence for preferred fish habitat. Non-native tamarisk and Russian olive were removed, and habitat values in the riparian area were improved with additional live willow plantings. In addition, fence was installed to confine livestock to adjacent properties. These modifications also provided wetlands and backwater nesting areas for waterfowl and habitat for fish spawning. Figure 2-5 shows a picture of the Upper Curry Enhancement Project.

Upper Curry Enhancement river stretch prior to restoration

Figure 2-5: Upper Curry Enhancement

Lower Curry Conservation Easement & Restoration

In partnership with many other organizations, including the Western Slope Environmental Resource Council (WSERC), NFRIA helped to retire an in-stream gravel mine, restore the damaged area, and secure the property in a permanent conservation easement. Bank erosion, head cutting, and over-excavation in the river channel had decimated fish and wildlife habitat. The solution required reconstruction of the channel and an irrigation diversion structure, the creation of numerous rock structures for channel and bank stabilization, and re-vegetation of the banks and floodplain using several bioengineering techniques along approximately one mile of the river.

Chipeta Dam Removal

The U.S. Army Corps of Engineers (USACE) has cataloged approximately 75,000 dams along the waterways of the United States. More than a quarter of these dams have exceeded their 50-year life expectancy. One of these, the crumbling concrete Hotchkiss Diversion Structure, or Chipeta Dam, was once used to divert water to the Hotchkiss Fish Hatchery, which has long since moved several miles downstream. The obsolete structure reached more than 150 feet across the North Fork, trapped boaters, prevented fish migration and created isolated populations of fish.

Most of the concrete structure was removed, though some pieces were buried deep in the channel as an easy means of bank stabilization. A newly graded bank and river stretch with a riffle-pool-run sequence allows for native and sport fish to thrive in a stretch that was previously occupied by large, non-native carp. Four new rock structures protect banks from erosion, provide habitat for aquatic life, and create fun hydraulics for boaters. The re-graded, re-vegetated floodplain will also allow flood energy to dissipate safely during high water over smooth banks. Seven new willow “silt fences” were planted on either side of the river. These fences stabilize banks with their root structures and trap nutrient-rich sediment during high water. Volunteers from the community participated in willow planting. Figure 2-6 shows a picture of the Chipeta Dam site before and after restoration.

Chipeta dam site before and after restoration

Figure 2-6: Chipeta Dam Site

NFRIA Irrigation Diversion Projects

NFRIA has constructed seven efficient, low-maintenance permanent concrete and steel headgates and permanent low-head rock diversion structures along the river, while restoring the adjacent river segments, significantly improving the sustainable management of water rights in the river, removing fish and recreational boating barriers and simultaneously enhancing aquatic habitat and recreational potential.

Monitor Ditch

The Monitor Ditch headgate had for years made use of yearly-maintained gravel push-up dams that diverted the entire river into a side channel in order to maintain delivery of a full decree of water, before returning the remainder to the main channel. NFRIA constructed a large concrete headgate at the entry to this side channel, and created a permanent low-head diversion structure allowing for the passage of fish even in low water. In addition, this project removed a large number of old vehicle bodies that had been attached to the banks of the river as stabilization by property owners.

Paonia and Feldman Ditches

This project constructed headgates for two ditches and a low-head rock weir at the diversion point of the ditches immediately upstream of the Paonia River Park. The project, like all of NFRIA's diversion reconstruction projects, was designed to allow for delivery of a full-decree of water into the existing irrigation ditch systems while conserving in-stream flow, improving use efficiencies, reducing the annual use of bulldozers in the channel, and decreasing suspended sediment in the North Fork. In addition, significant public benefits were provided by the restoration of a channel for fish migration and the safe passage of boats, both prevented by the previous diversion structure.

Smith-McKnight Ditch

NFRIA built its first sustainable irrigation intake structure, the Smith-McKnight Ditch, as part of the Hotchkiss Demonstration Project. NFRIA's installation of a simple low-head rock weir structure and permanent concrete headgate replaced the destructive and costly practice of annually constructed bulldozer gravel "push-up" dams that redirect the entire river into the ditches before the unallocated portion of the flow is returned to the river. The Smith-McKnight structure was designed to create just enough backwater to divert a full decree of irrigation water to the ditch with greatly improved efficiency, while increasing in-stream flows, reducing diversion maintenance, allowing for undisturbed migration of fish, safe passage of boats, and the creation of year-round riparian and aquatic habitat.

Short and Sheppard-Wilmot Ditches

The Sheppard-Wilmont Ditch diversion site, located within the Midway project reach, supplies irrigation and stock water year-round to several farms and ranches along the north side of the river. It was one of the few irrigation ditches on the North Fork that did not require annual bulldozing of a gravel dam in the river in order to receive its full decree of water. The diversion point is located along the outside of a bend in the river where a natural gravel bar had formed, acting as a low diversion dam. Because the ditch is built at a lower elevation than the channel, the river's entire flow would divert down the ditch at times of low water before being returned to the river after the ditch headgate.

This worked well for the ditch company. Unfortunately, the Short Ditch has its diversion between the intake and return points of the Sheppard-Wilmot ditch. In times of low water, the Short ditch was left dry.

In order to alleviate the water crisis for the Short Ditch, NFRIA designed and constructed a concrete headwall across the entrance to the Sheppard ditch that restricted the flow to its decreed amount during low water times. A sluice structure in front of the headwall accommodates drop boards when necessary to raise the water level slightly.

This illustrates NFRIA's commitment to developing simple and effective solutions to diverse and complex problems encountered in river restoration projects.

Van Der Ford Ditch

NFRIA reconstructed the Van Der Ford Ditch as part of the Lower Curry Conservation Easement and Restoration project. NFRIA designed and built an efficient and low maintenance concrete headwall using best management practices to prevent negative impacts on water quality and downstream habitat. Construction of the diversion wall was carried out using a water-diverting dike to prevent excessive sedimentation in the river and water quality degradation. The structure is similar to NFRIA's other successful ditch diversion reconstructions.

Section 3: State of the North Fork Watershed

This section describes the current conditions in the North Fork of the Gunnison River Watershed. It includes information on the physical environment, environmental resources, hydrology, river condition, economics, demographics, water use.

3.1 *Physical Environment*

This section describes the physical characteristics of the North Fork Watershed. It includes geography, climate, topography, geology and soils. Much of the information in this section was derived from the 2010 NRCS Rapid Watershed Assessment of the North Fork Watershed. The final report can be found at: (http://www.co.nrcs.usda.gov/technical/WaterRes/WaterResources.html).

Location

The North Fork Watershed (HUC 14020004) covers 969 square miles (620,271 acres) of the Gunnison Basin in southwestern Colorado. The watershed stretches from the West Elk Mountains to the confluence of the North Fork and Gunnison River at Pleasure Park. The watershed extends to parts of Delta and Gunnison Counties. Table 3-1 shows the percent of each county in the watershed. The largest towns in the watershed are Paonia (1,564) and Hotchkiss (968) (DOLA, 2009).

Table 3-1: Counties in the North Fork Watershed

County	Acres	Acres in North Fork Watershed	% of County in North Fork Watershed	% of North Fork Watershed in County
Delta	735,674	282,656	38.4%	45.6%
Gunnison	2,085,945	337,615	16.2%	54.4%
Total		620,271		

Source: NRCS Rapid Watershed Assessment, 2009

Topography

The topography of the North Fork Watershed is highly varied, as shown in Figure 3-1. The river flows 33 miles in a southwesterly direction through a valley of multiple river terraces that run parallel to the river. These terraces make up a broad, highly dissected valley with a gentle to moderate down-valley slope. The valley is flanked by Grand Mesa on the north and west, highest elevation of 11,237 feet, and the West Elk Wilderness area on the east and south, highest elevation 13,042 feet.

Climate

The climate in the North Fork Watershed is highly influenced by topography and elevation. Table 3-2 displays the average annual minimum and maximum temperature, total annual precipitation, and snowfall in the watershed at the Paonia climate Station - which represents the climate of the lower watershed. Mean temperatures range from 26.6 degrees Fahrenheit in January to 72.6 degrees Fahrenheit in July. The growing season typically lasts 126 days. Average precipitation for the year is 15.45 inches, with an average snowfall of 46.65 inches. The climate of the North Fork Valley is semi-arid with an abundance of sunshine and frequent wind. The prevailing direction of air movement is from the west.

North Fork Watershed: Elevation

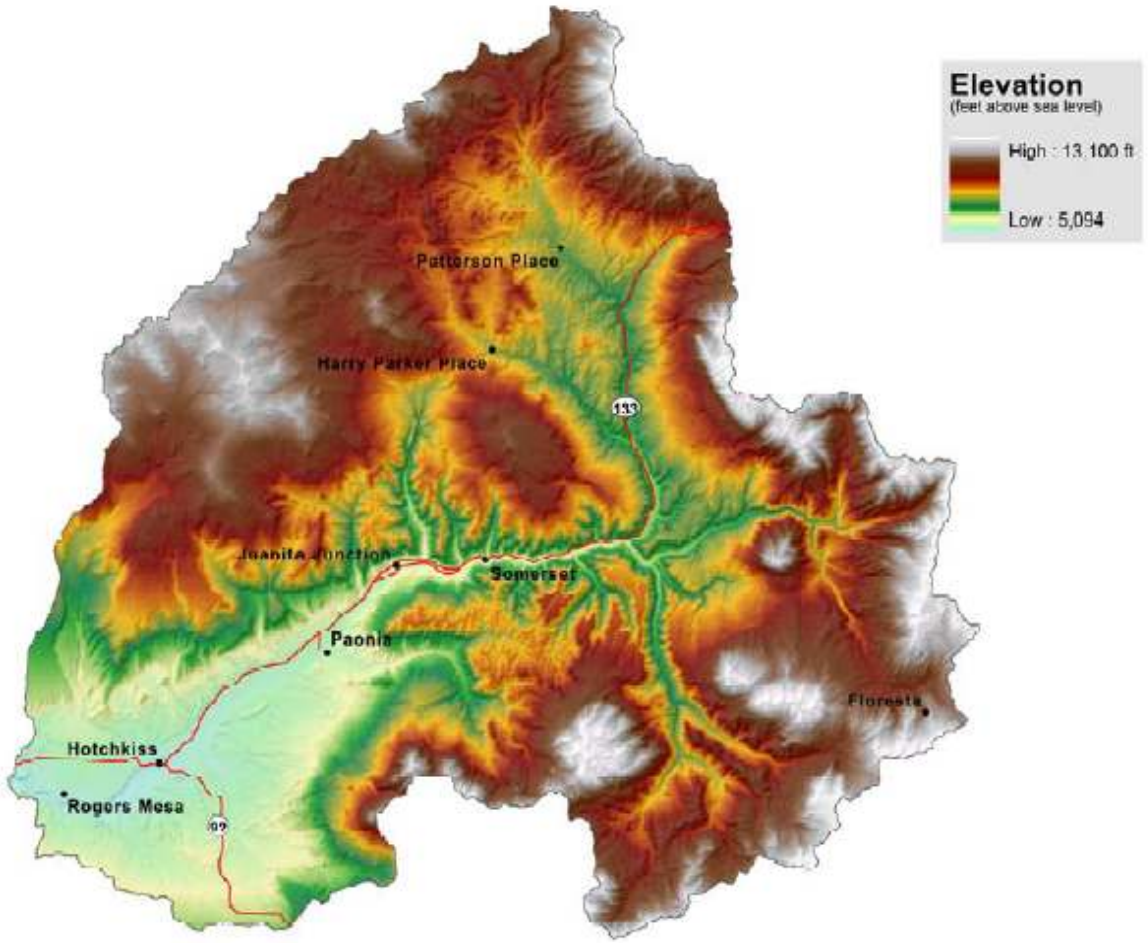

Figure 3-1: Digital Elevation Model of the North Fork

Source: Rapid watershed Assessment

Table 3-2: Summary of Climate Data at Paonia (1893 - 2009)

Paonia Station 56306	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Temperature (°F)													
Monthly Mean Temp	26.6	32.7	40.6	48.4	57.4	66.3	72.6	70.5	62.4	51.5	39.3	28.2	49.7
Monthly Mean Maximum Temp	38.6	45.0	53.8	63.0	73.1	83.5	89.2	86.4	78.0	66.5	52.4	40.2	64.1
Monthly Mean Minimum Temp	13.8	20.5	27.4	33.9	41.7	49.2	56.0	54.6	46.7	36.5	26.1	16.1	35.2
Precipitation (Inches)													
Average	1.21	1.18	1.47	1.36	1.38	0.77	1.06	1.313	1.50	1.60	1.27	1.32	15.45
Maximum	4.18	3.49	6.40	3.55	3.97	3.30	3.06	3.33	3.81	5.08	3.43	4.20	23.75
Minimum	0.10	0.08	0.14	0.03	0.00	0.00	0.02	0.14	0.03	0.00	0.00	0.00	8.48
Snowfall (Inches)													
Average	11.86	9.04	6.31	2.34	0.23	0.00	0.00	0.00	0.06	0.77	4.70	11.85	46.65
Maximum	54.40	28.00	29.00	18.00	6.50	0.00	0.00	0.00	2.00	8.00	35.00	39.50	77.90
Minimum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.50

Source: Colorado Climate Center, 2010

Geology and Soils

The geology of the North Fork watershed is complex mixture of sedimentary deposits and igneous intrusions (Figure 3-2). The watershed lies on the western edge of the Elk Mountain Range and in the southern half of the Piceance Structural Basin. The Piceance Basin has come to increasing public attention in recent years because of widespread drilling to extract natural gas. It contains significant reserves of coal, natural gas and oil shale.

The Mancos Shale, present throughout the Lower Gunnison Basin, was formed as a product of deposition in the marine environment of the Cretaceous Seaway approximately 100 million years ago. Mancos Shale is a known contributor of dissolved mineral salt loads, selenium in particular, to the Colorado River system. Mancos Shale also possesses high clay content and will shrink and swell in response to moisture.

Beginning in the late Cretaceous Period and ending 35 to 55 million years ago during the early Tertiary Period, a great mountain-building event, known as the Laramide Orogeny, occurred. This mountain-building process lifted the Cretaceous sea and created an extremely varied landscape – a mountainous region dominated by igneous cone-shaped peaks rising above mesas, ridges, basins and benches formed from sedimentary materials. Remnants of the Wasatch Formation, present in the Upper North Fork Watershed, were likely deposited in response to this tectonic uplift. The Wasatch Formation is loosely consolidated, highly erosive, and produces naturally high sediment loads in the river.

Alluvial deposits near the river valley consist of sand, silt and gravel from Quaternary age materials throughout the basin. The soils along the river valley are deep to moderately deep, nearly level to steep, well-drained gravelly loam and stony loam that formed in outwash alluvium derived from igneous rock in the upper watershed.

The Cretaceous formations are bituminous coal-bearing. Coal in the North Fork Valley is mined from the Mesa Verde Formation, located in the Uinta Coal Region. Bituminous coal produced in the Uinta Coal Region is considered high quality because it has a high energy potential, is low in sulfur and trace elements such as mercury and sulfur, and has moderately low ash content (CGS, 2005).

North Fork Watershed: Geology

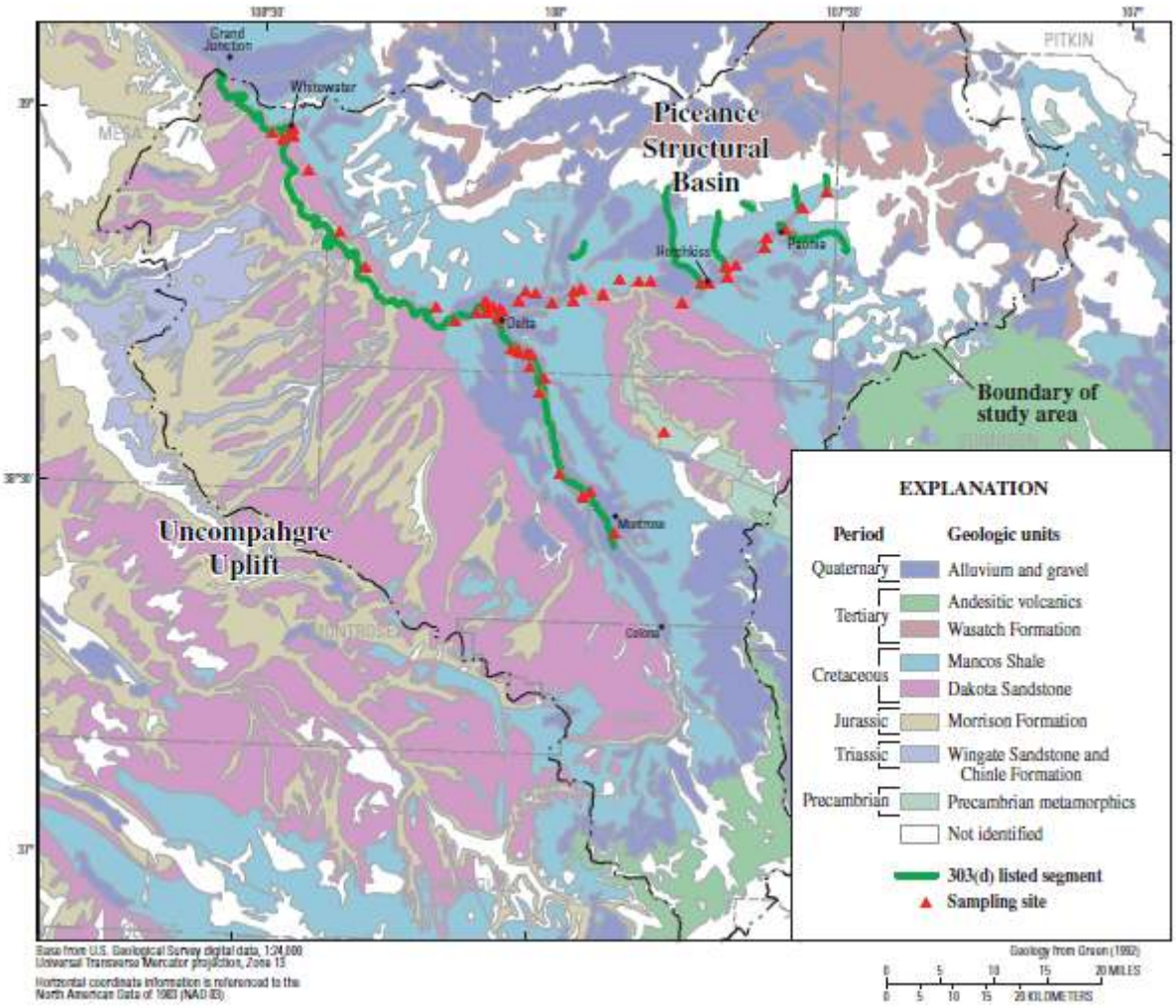

Figure 3-2: Geology of the Lower Gunnison Basin
Source: Leib and Mayo, 2008

3.2 *Environmental Resources*

This section describes the environmental resources of the North Fork Watershed, including vegetation, wetlands and riparian zones, flora and fauna, species of special concern, invasive species, wildlife corridors and forest health.

Vegetation

Vegetation in the North Fork Watershed is influenced by the semi-arid climate. Vegetation in the upper watershed is primarily mixed and coniferous forest dominated by aspen, spruce and pinyon pine with small patches of irrigated agriculture and rangeland (Figure 3-3). In the lower watershed, the dominant vegetation type is irrigated agriculture and shrub/brush rangeland consisting of juniper, sagebrush, western wheatgrass, muttongrass, fourwing saltbush and bitterbrush.

North Fork Watershed: Vegetation Cover

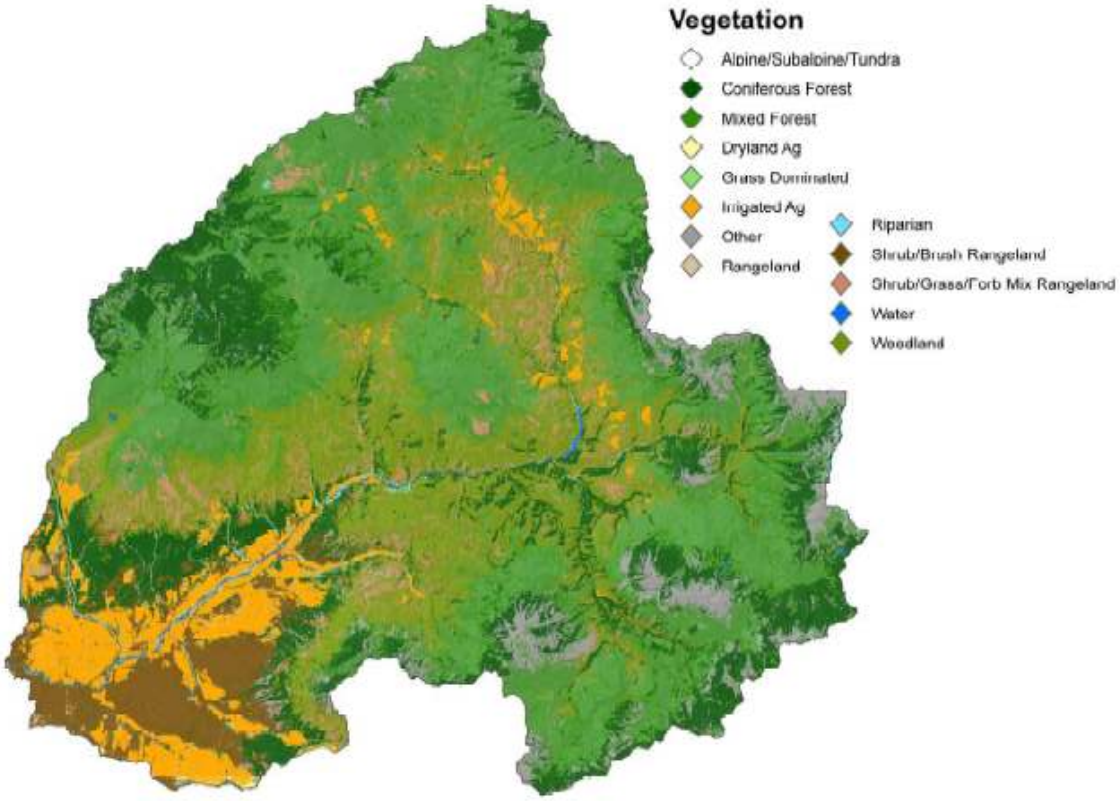

Figure 3-3: Vegetation Cover in the North Fork Watershed

Source: North Fork Rapid Watershed Assessment, 2009

Wetlands and Riparian Zones

The North Fork of the Gunnison was ranked as a highly significant proposed conservation site in the 1998 Natural Heritage Biological Survey of Delta County (CHNP, 1998). The floodplain of the North Fork contains many examples of the globally-imperiled riparian forests of cottonwoods with skunkbush or coyote willow understory. Under natural circumstances, this community would be much more abundant and in better condition than it is. Along much of the river, however, rather than occupying a broad flood plain, cottonwoods are confined to a narrow band less than fifty feet wide. There are occasional larger groves, which often have more exotic species than native vegetation in the understory.

The native plant community is dependent on periodic flooding for regeneration. Sites where this association occurs vary from point bars and other depositional features to alluvial terraces that may be many meters away from the main channel, and several meters above the high water mark. Since mature cottonwoods are able to tap deeper water tables than seedlings, mature stands primarily reproduce by suckering. Seedlings tend to be numerous along the shoreline, but often do not survive to maturity. The condition of the riparian vegetation is highly variable, with many areas invaded by tamarisk, Russian olive, Siberian elm, Russian knapweed, and other non-native plants.

Projects undertaken by NFRIA since 2000 have helped to reestablish the vigor of the riparian vegetation. At the Midway project site and the Paonia River Park, cottonwood saplings are taking hold in the once barren floodplain. For more information on the biodiversity and conservation potential of the North Fork, please refer to the 1998 Delta County Natural Heritage Survey, or 2000 CNHP Gunnison River Tributaries Study at http://www.cnhp.colostate.edu/.

Non-Native Species

Invasive species are non-native organisms whose introduction causes, or is likely to cause, economic harm, environmental harm, or harm to human health. These species grow and reproduce rapidly, causing major disturbance to the areas in which they are present. If uncontrolled, invasives can and will limit land use. Nation-wide, invasive species cause billions of dollars in economic losses per year. Approximately 14% of threatened or endangered species are at risk due to non-native invasive species (http://www.invasive.org/101/index.cfm).

The 2000 CHNP riparian survey identified invasive species in the North Fork (CHNP, 2000). Common weedy species in wet areas along the North Fork include tamarisk, Russian olive, Siberian elm, red top, rabbitfoot grass, Kentucky bluegrass, reed canary grass, and sweet clover. Common dry area weeds include cheatgrass, orchard grass, smooth brome, alfalfa, Canada thistle, and Russian thistle. The survey also identified the distribution of non-native riparian species in North Fork Tributaries:

- Hubbard Creek – Russian Olive
- Roatcap Creek – Tamarisk, Siberian Elm
- Jay Creek – Siberian Elm
- Leroux Creek – Tamarisk, Siberian Elm
- Minnesota Creek – Tamarisk, Russian Olive, non-native brome
- Cottonwood Creek – Tamarisk, Russian Olive, Siberian Elm

In 2007, the Colorado Headwaters Invasives Partnership (CHIP) developed a strategic plan for riparian areas impacted by non-native invasive trees, principally tamarisk and Russian olive. The survey determined that tamarisk and Russian olive infestations were *moderate* in the wide, braided floodplain of the North Fork (CHIP, 2007). The report suggested that biological control should be sufficient to control contiguous tamarisk infestations, but that mechanical controls should be used beginning at Hotchkiss to control Russian Olive (CHIP, 2007). In 2009, Painted Sky Resource Conservation & Development (RC&D) released tamarisk beetles at five sites in the North Fork Valley and Delta area to battle tamarisk. Painted Sky RC&D plans to release more beetles in 2010.

Fisheries

According to the Colorado Division of Wildlife (DOW) summary of the North Fork Management Unit (NFMU), the North Fork River watershed contains 40 lakes and reservoirs and 342 stream miles. The standing water resources in the North Fork are managed according to one of five classifications: catchable stocked coldwater lakes (intensive), sub catchable stocked coldwater lakes (optimum), wild trout lakes, warm water, and non-managed. Stream resources are divided into four classifications: catchable stocked streams (intensive), wild trout streams, Colorado River cutthroat trout conservation, and non-managed waters. Most of the stream resources in the North Fork are managed as wild trout streams or un-managed. Figure 3-4 shows the fish management classifications in the North Fork (DOW, 2003).

Recreational fisheries resources include 14 trout stocked lakes and ponds, one trout stocked stream, one warm water stocked lake, 39 stocked wild trout lakes, and 66 wild trout stream segments. Stream fisheries are dominated by the excellent wild trout streams throughout the North Fork watershed, including Anthracite, Hubbard, Muddy, Terror and many other tributary streams throughout the basin. The West Elk and Raggeds wilderness areas offer wild trout fishing for brook, brown, rainbow, and cutthroat. The North Fork mainstem offers fishing for both stocked and wild trout.

Flat water opportunities include Paonia and Overland reservoirs, in addition to numerous high elevation lakes on the Grand Mesa and West Elk mountains. Most high lakes are managed as wild trout water or stocked with fingerling cutthroat trout and provide diverse angling in a remote setting.

Six native fish species exist in the North Fork watershed: Colorado River cutthroat trout, flannelmouth sucker, bluehead sucker, roundtail chub, mottled sculpin, and speckled dace. There are twelve streams segments, covering 67 miles, managed for Colorado River cutthroat trout conservation. Several streams are currently managed as wild trout streams, but are under consideration for management as Colorado River cutthroat trout conservation.

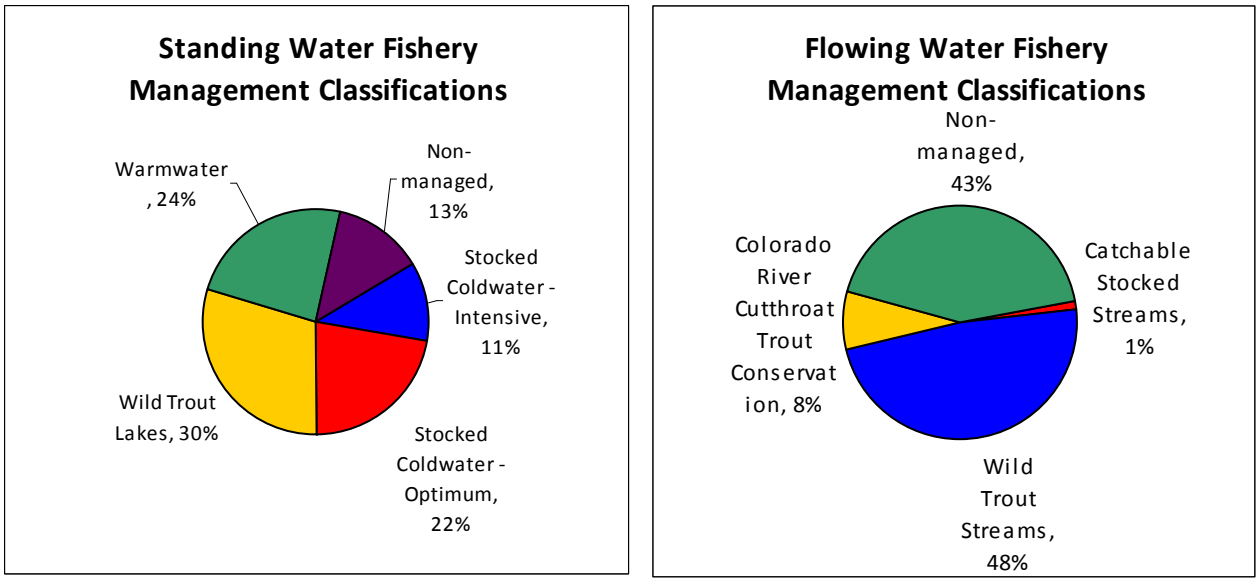

Figure 3-4: Fishery Management Classifications

Source: DOW, 2003

Wildlife

Riparian zones are the most species-diverse wildlife habitats in Colorado and provide some or all of the habitat requirements for about 75% of the state's wildlife. Wildlife habitat within riparian areas varies, depending on plant species composition, woodland and shrubland structural characteristics, climate, geologic substrate, surface water regime, adjacent upland habitat type, and level of disturbance.

Big game species in the project area include mule deer, elk, black bear, and mountain lion. The river corridor and lowland areas provide critical winter habitat for elk and mule deer. The 2000 NFRIA Watershed Action Plan includes a description of big game winter ranges. The diverse riparian and canyon habitats of the North Fork support a wide range of wildlife species. Riparian habitats are essential for many species, such as frogs and toads, beaver, muskrat, waterfowl, and wading birds.

Species of Special Concern

There are eight species that the State of Colorado considers Species of Concern (Table 3-3). Species of concern is in informal term that commonly refers to species that are declining or appear to be in need of concentrated conservation actions.

Table 3-3: Species of Concern

Common Name (*Scientific Name*)	Status
Northern leopard frog (*Rana pipiens*)	Colorado species of concern
Peregrine falcon (*Falco peregrinus anatum*)	Colorado species of concern
Whooping crane (*Grus americana tabida*)	Federally and Colorado endangered
Southwestern willow flycatcher (*Empidonax traillii extimus*)	Federally and Colorado endangered
Bald Eagle (*Haliaeetus leucocephalus*)	Colorado threatened
Greater sandhill crane (*Grus canadensis tabida*)	Colorado species of concern
Western yellow-billed cuckoo (*Coccyzus americanus*)	Colorado species of concern
River otter (*Lutra canadensis*)	Colorado threatened

Source: http://wildlife.state.co.us/WildlifeSpecies/SpeciesOfConcern/

Northern Leopard Frog: The northern leopard frog has seriously declined in some parts of Colorado. Population decline in many areas has been attributed to river diversions, wetland degradation, and predation by introduced bullfrogs and predatory fish (Hammerson 1999). Small populations of leopard frogs occur along the North Fork and along principal tributaries including Hubbard, Roatcap, Jay, Leroux, Muddy, Anthracite, Minnesota, and Cottonwood Creeks (CHNP 2000).

Peregrine Falcon: The Peregrine Falcon is known to exist in Delta and Gunnison Counties. Breeding pairs nest on cliffs and forage over adjacent coniferous and riparian forests. Migrants and winter residents occur mostly around reservoirs, rivers, and marshes, but may also be seen in grasslands, agricultural areas. The 2000 CHNP report documented a Peregrine Falcon roosting site near Crawford.

Whooping Crane: The Whooping Crane is the rarest bird in North America. Historic populations existed in Delta and Gunnison counties. Fruitgrowers Reservoir near Eckert, a few miles from the North Fork, used to be a significant stopover point for several thousand cranes each spring and fall; however Whooping Cranes have not been seen in Colorado since 2002.

Southwest Willow Flycatcher: Willow flycatchers are neo-tropical migrant songbirds that breed in dense willow clumps or similar riparian vegetation throughout much of North America. The southwestern subspecies has experienced severe declines in recent decades due to degradation of riparian habitat and increased nest parasitism by brownheaded cowbirds, which thrive in rural agricultural areas. Most of the subspecies' known breeding sites are along the Gunnison River west of Delta. In recent years, one to several pairs nested each year in the Escalante State Wildlife Area's dense thickets of willow, tamarisk, Russian olive, and cottonwood. The 2000 CNHP study found that Terror and Anthracite Creeks offered potential breeding and migratory habitat for the Southwest Willow Flycatcher, while Terror and Cottonwood Creeks offered limited habitat.

Bald Eagle: Bald eagle populations are on the rise in Colorado. Once limited to only two or three breeding pairs, the population has increased to hundreds. Bald eagle habitat includes wide valleys, reservoirs or rivers with well-developed cottonwood stands. According to the DOW NDIS, Bald eagle

winter habitat in the North Fork includes Anthracite Creek, Paonia Reservoir, and the entire North Fork corridor below Paonia Reservoir – including the floodplain between Paonia and Hotchkiss.

Greater Sandhill Crane: Greater Sandhill Cranes are migrants in Delta County, en route between their wintering grounds in New Mexico and breeding areas in Idaho and Montana. Enormous flocks of thousands of birds annually stop to rest in the irrigated pasturelands. Populations in Colorado are declining as a result of human settlement.

Western Yellow-billed Cuckoo: The Western Yellow-billed Cuckoo inhabits lowland riparian forests. The historic range in Colorado included the western valleys and south of Mesa County. Over the past ten years, the North Fork is the only place in western Colorado where Western Yellow-billed Cuckoo breeding has been documented. The Rocky Mountain Bird Observatory confirmed cuckoo breeding on the North Fork in 2008 (Jason Beason, personal communication).

River Otter: River otters were once widespread in most Colorado Rivers, but by the early 1900s otters was extirpated from the state. Unregulated trapping, water depletions, and decimation of fish populations all contributed to the decline. A reintroduction effort in the 1970s restored river otters to the Gunnison River above the confluence with the North Fork. Otters have since colonized downstream. However, otters are still relatively uncommon throughout the watershed, and they probably reach their greatest density in the Gunnison River from the North Fork confluence downstream to Escalante Creek. The most recent confirmed river otter sighting in the North Fork occurred during winter, 2007, below Paonia. It is unknown if there is a breeding population on the North Fork, but the sighting suggests that the North Fork provides wintering habitat for the species.

3.3 *Hydrology*

This section describes the hydrology of the North Fork River Watershed. The background information provides a description of the area's surface and groundwater resources as well as snowpack, instream flows and diversions.

River Flows

The North Fork of the Gunnison River is a 4th order perennial stream that drains approximately 969 square miles in the upper Colorado River basin. The North Fork is a major tributary of the Gunnison River. The headwaters of the North Fork are located in the Gunnison National Forest and are formed by the confluence of Muddy Creek and Anthracite Creek downstream of Paonia Dam at an approximate elevation of 6,200 feet. The UGSS hydrological unit code is 14020004.

Selected stream flows in the North Fork watershed are continuously measured at a number of real-time flow gaging stations. Table 3-4 lists the active real-time flow gages, period of record, and mean annual stream flow in the North Fork.

Table 3-4: Stream Gages

Gage Number	Station Name	Period of Record	Mean Annual Stream Flow (CFS)
9132500	North Fork Gunnison Near Somerset, CO.	1933 - current	456
9132960	Hubbard Creek at HWY 133 at Mouth near Bowie, CO	2001 – current*	26
9132995	Terror Creek at Mouth Near Bowie, CO.	2001 - current	13
9132940	Hubbard Creek above Iron Point Gulch Near Bowie, CO.	2001 – current*	n/a
9134000	Minnesota Creek Near Paonia, CO.	1936 – current	22
9134100	North Fork Gunnison River Below Paonia, CO.	2000 – current*	408
NORLUXCO	North Fork Gunnison River Below Leroux Creek, Near Hotchkiss, CO. N.F.	1997 – current*	354
9136100	North Fork Gunnison River Above Mouth Near Lazear, CO.	2009 – current	n/a

* Operated seasonally

River flows in the North Fork are highly variable depending on the season. Flows range from approximately 100 to 300 cfs in late summer and winter to between 2,000 and 9,000 cfs during peak runoff. The highest peak flow on record is 9,220 cfs, recorded on May 24, 1984 at the USGS gage in Somerset. The mean annual high water runoff at Somerset is approximately 3,654 cfs. Average flows are highest during the spring snowmelt runoff months of May and June (Figure 3-5). Major flooding also occurs during spring runoff when rapidly melting snow is augmented by rain.

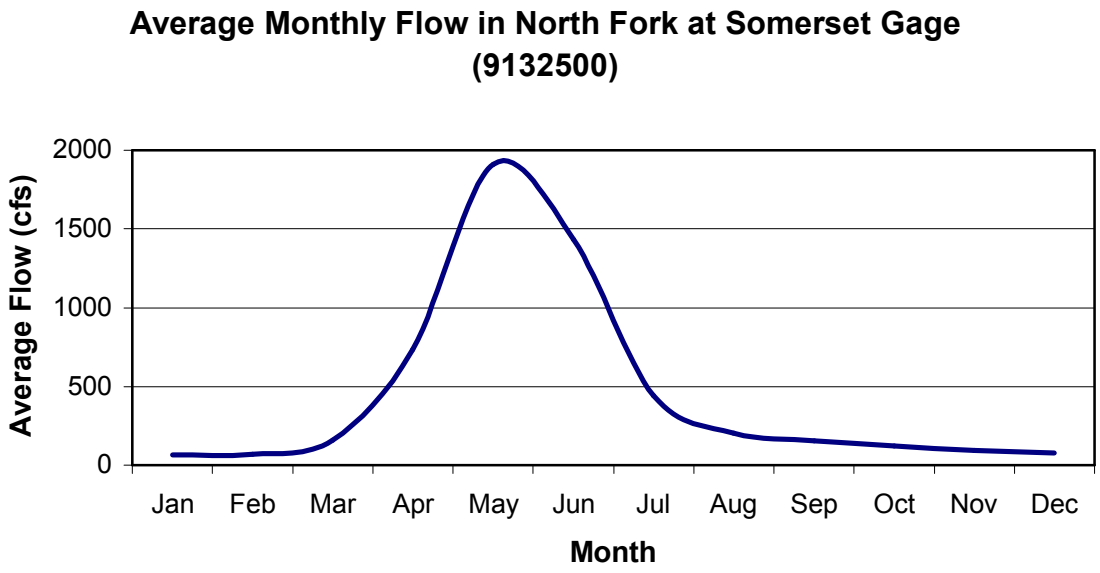

Figure 3-5: Average Monthly Flows at Somerset

Source: USGS Real Time Flow Data Water Years 1934-2009

There are twelve (12) major irrigation diversions along the North Fork River between Somerset and Hotchkiss that deliver water to thousands of acres of agricultural land in the valley. Most of the un-used irrigation water is returned to the river, either through direct tributaries and wastewater channels or indirectly through groundwater recharge. In late summer, some reaches of the river are left with almost no water. At certain points, such as through the Town of Paonia, the river is almost completely diverted into irrigation ditches and metered at headgates. Excess water is returned to the river channel downstream, but the temporary short-circuiting of the river channel can be detrimental to fish and wildlife.

Paonia Reservoir

The U.S. Bureau of Reclamation (BOR) completed construction of Paonia Dam and Reservoir, located on Muddy Creek just above the confluence with Anthracite Creek, in January 1962. The reservoir's primary purpose is to store irrigation water for the Fire Mountain Canal and Reservoir Company and the Ragged Mountain Water Users Association. The reservoir also provides recreational and wildlife benefits as well as supplemental flood control by reserving storage space through forecasts of snowmelt runoff and regulation of flood flows. The Paonia Reservoir has 2,280 acre feet of capacity assigned to flood control. The Paonia Project provided $253,000 in flood control benefits from 1950 to 1999 (BOR, 2009). Average annual discharge from the reservoir is approximately 90,000 acre feet.

When originally constructed, Paonia Reservoir had a capacity of 20,950 acre-feet. Subsequent sediment deposition has consumed substantial storage capacity, resulting in a total present capacity of approximately 15,000 acre feet. The projected rate of capacity loss from sedimentation is approximately 124 acre feet per year.

The active storage pool – water that is available for delivery – is about 15,000 acre feet, of which 14,650 is currently allocated for irrigation. Fire Mountain Canal and Reservoir Company has the rights to 12,650 acre feet, and 2,000 acre feet are allocated to the Ragged Mountain exchange. Five hundred acre feet are reserved for wildlife flows. Much of the dead storage pool[1] has been filled with sediment.

[1] The reservoir capacity from which stored water cannot be evacuated by gravity.

Groundwater

Aquifers of the North Fork Gunnison River basin are found in the alluvium and bedrock. Most wells in the North Fork are at altitudes below 7,500 feet and yield from 2 to 40 gallons per minute. The wells are often located in alluvial sand and gravel, sandstone, or fractured bedrock. Springs generally are at altitudes above 7,000 feet, discharge from perched water tables at geologic contacts, have calcium magnesium bicarbonate water types, and are much less saline than water from wells.

A USGS investigation of groundwater resources in the North Fork watershed found that alluvial aquifers yield water with dissolved-solids concentrations ranging from 43 to 2,300 mg/L. Dissolved solids concentrations of water samples from the Mesa Verde Formation and the Dakota Sandstone and Burro Canyon Formations ranged from 56 to 3,200 mg/L. Dissolved solids concentrations of water samples from the Mancos Shale ranged from 1,800 to 8,200 mg/L (Ackerman and Brooks, 1986).

Groundwater from bedrock aquifers in the upper watershed are generally comprised of sodium-bicarbonate that is neutral to alkaline (pH 7-9), with low metals content and high methane content. Dissolved solids in the bedrock units are in the general range of 1,000 to 2,500 mg/L, with the exception of the Rollins sandstone, which is between 3,000 and 9,000 mg/L (DRMS, 2009).

Snowpack

Approximately 80% of Colorado's water supply comes from melting snow. The SNOTEL program collects data on snow depth, snow water equivalent, and year-to-date precipitation. Snow water equivalent (SWE) is the amount of water contained within the snowpack and is a valuable tool for stream flow forecasting. Since 1979, Colorado Basin River Forecast Center has collected SWE data on McClure Pass (MCPC2) (http://www.wcc.nrcs.usda.gov/snotel/Colorado/colorado.html). Figure 3-6 shows average monthly snow water equivalent (SWE) at McClure Pass. SWE can be thought of as the depth of water that would theoretically result if you melted the entire snowpack instantaneously. Average monthly snowpack is greatest in March and April.

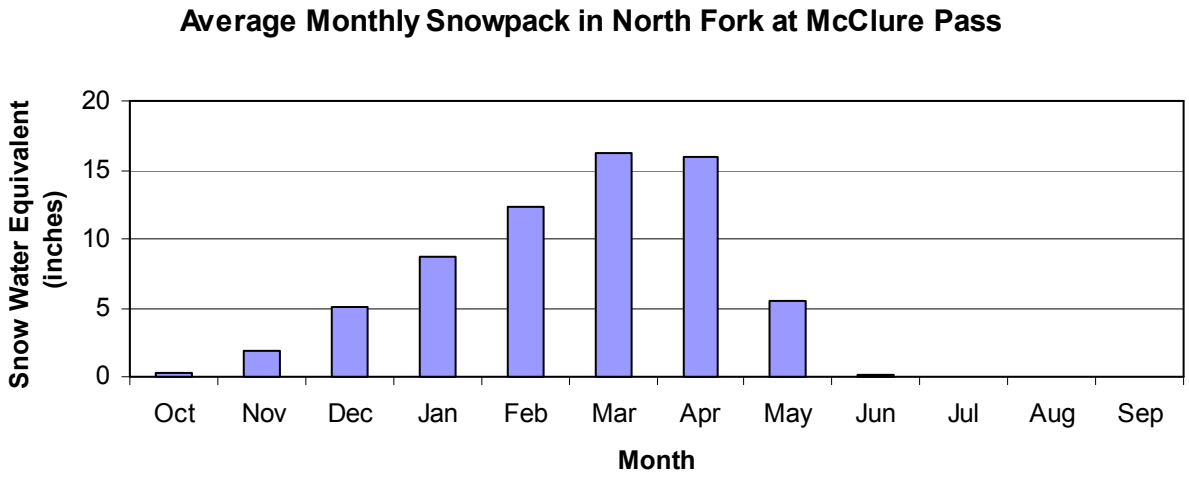

Figure 3-6: Average Monthly Snowpack at McClure Pass

Source: http://www.wcc.nrcs.usda.gov/snotel/Colorado/colorado.html

Annual snowpack varies from year to year. Figure 3-7 shows SWE and precipitation summaries for water year 2010, as well as the 30-year average at the McClure Pass SNOTEL Station. The profile shows that 2010 spring snowmelt occurred much earlier and faster than the thirty year average. Earlier spring snowmelt can cause reservoirs to fill ahead of schedule and require water to be released for flood control, deprive soils from retaining moisture, and cause vegetation to dry out earlier - increasing the risk of forest fire. Accelerated spring snowmelt can result from dust on snow events and increased temperatures.

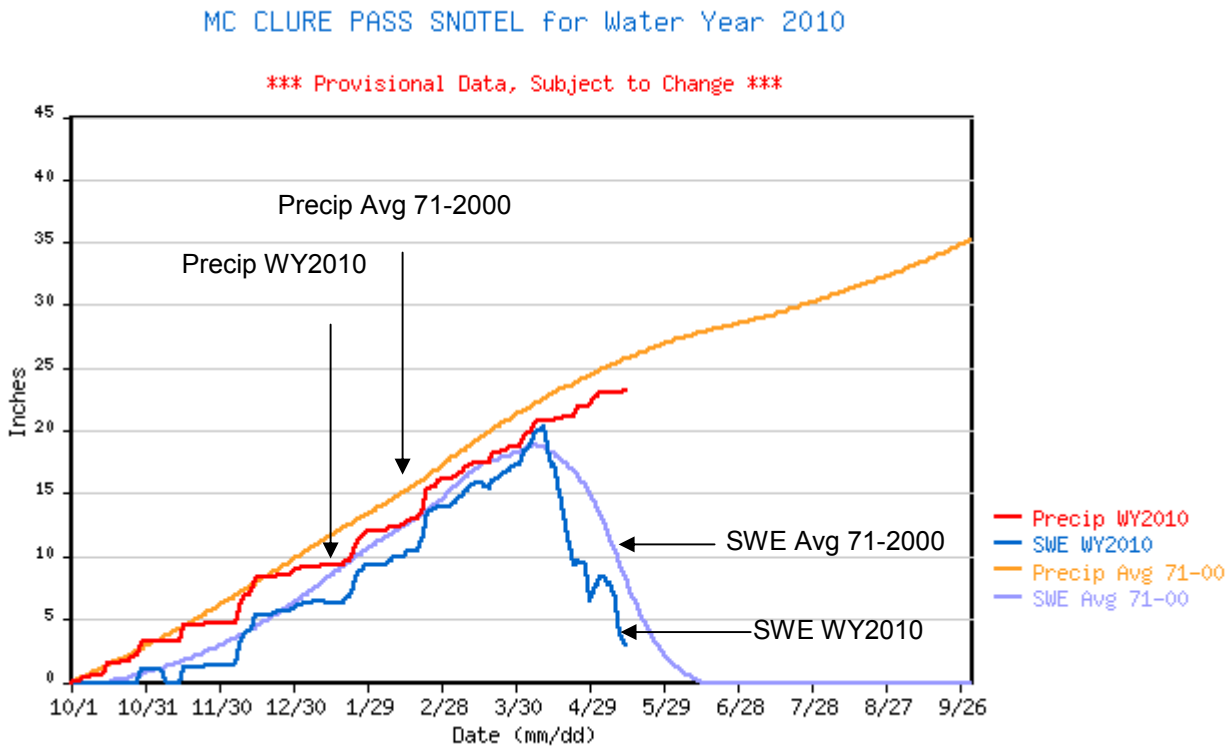

Figure 3-7: McClure Pass SNOTEL Snowpack Summary

Source: SNOTEL Water Year Graph for McClure Pass Station
http://www.wcc.nrcs.usda.gov/cgibin/site-wygraph-multi.pl?state=CO

Flooding and Drainage

Major flood events in the North Fork watershed are often the result of snowmelt, sometimes augmented by localized cloudburst storms, in the spring and summer months. Historical flood records along the North Fork River date back to the late 1800s. Figure 3-8 shows annual peak flows at the Somerset Gage. The highest recorded peak flow on the North Fork River at the Somerset Gage is 9,220[2] cfs on May 24, 1984. This flood event corresponds to the largest known flood event on the Gunnison River, which resulted from rapid snowmelt, intensified by heavy rain. At Delta, the Gunnison River was reported to be 10 feet above bank full stage and approximately three-quarters of a mile wide.

[2] 9,220 cfs at Somerset corresponds to a 100-year flood recurrence interval (FEMA, 1983).

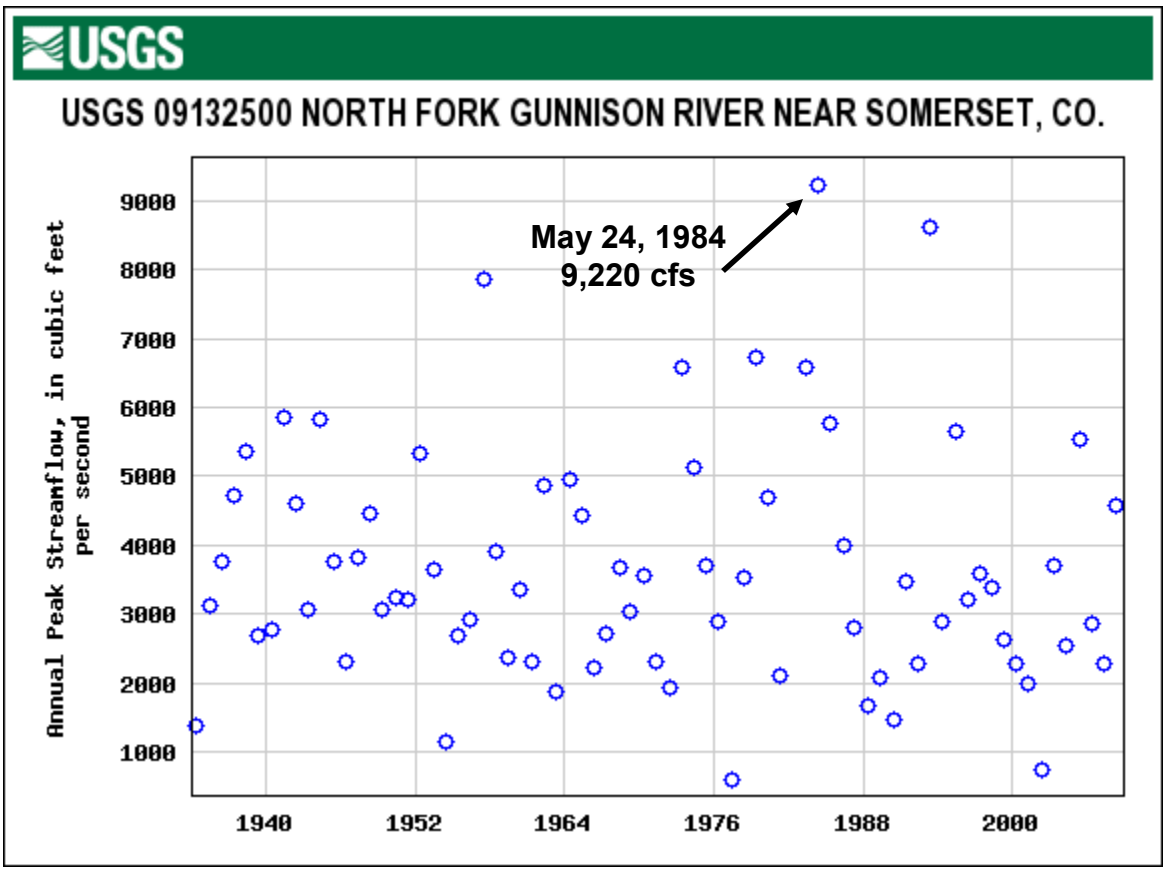

Figure 3-8: Annual Peak Flow at Somerset

Source: http://waterdata.usgs.gov/co/nwis/rt

According to the *Flood Hazard Information, North Fork Gunnison River, Hotchkiss to Somerset, Delta and Gunnison Counties, Colorado* (USACE, 1980), high flows along the North Fork are generally contained in-channel. Extensive overbank flooding is infrequent. However, newspaper accounts indicated flood damage to orchards, roads and bridges, railroad facilities, homes, and business establishments in 1906, 1907, 1912, 1916, 1917, 1920, and 1927. These events occurred during May and resulted in serious erosion of farmland, pastureland, and orchards. Since the installation of the first flow gage in the North Fork in 1933 at Somerset, the highest recorded flows occurred in 1957, 1973, 1979, 1983, 1984, and 1993.

In general terms, flooding occurs when a water body exceeds its “bank-full” capacity. Riverine flooding generally occurs as a result of prolonged rainfall, or rainfall that is combined with soils already saturated from previous rain events. The area adjacent to a river channel is its floodplain. The Federal Emergency Management Agency (FEMA) refers to the “floodplain” as the area that is inundated by the 100-year flood. 100-year flood events have a one percent chance of happening in any given year.

In Colorado, each county must address flood hazard potential in a hazard mitigation plan. The 2008 Delta County Multi-Hazard Mitigation Plan (AMEC, 2008) warns that, with the exception of Crawford, every town in Delta County is at risk to riverine flooding. Major flooding concerns in the North Fork Valley near developed areas exist at the confluence of Muddy and Anthracite Creek below Paonia Reservoir and the confluence with Minnesota Creek and the North Fork at Paonia.

3.4 *River Condition*

This section describes the geomorphology of the North Fork River Watershed. The background information reviews three reports on North Fork morphology, as well as a review of NFRIA river restoration projects.

Three major geomorphic assessments have been conducted for the North Fork of the Gunnison River. The first, conducted by Crane (1997), is entitled "Preliminary Assessment of the Morphological Characteristics of the North Fork of the Gunnison River." The assessment supported the design and implementation of restoration and river management activities. The second assessment was performed by Jaquette (2003) and is entitled "Historic Analysis and Sediment Budget Development of the North Fork of the Gunnison River, Colorado." This effort was "designed to provide a framework for current rehabilitation efforts by examining controls on channel form and sediment on the watershed scale." The third assessment, performed by the US Army Corps of Engineers (2006) is entitled "North Fork Gunnison River Aquatic Ecosystem Restoration Project." This detailed project report documented the plan formulation process and potential environmental effects associated with implementation of restoration alternatives. The following paragraphs summarize the current morphology, as outlined in the three documents.

At the beginning of the North Fork (at the confluence of Muddy and Anthracite Creeks), the river channel is a stable, slightly entrenched, meandering, riffle/pool, cobble dominated stream with a healthy riparian buffer. At Farmer's Ditch diversion, just downstream of Terror Creek, the channel evolves into an entrenched and channelized stream where agricultural land development and road construction have pinched the river into a constricted channel.

The river from Black Bridge to below the Town of Paonia cascades from an entrenched, channelized stream into a more unstable, meandering, riffle/pool system. A series of channelization operations and several encroachments into the floodplain probably caused the change of stream type and reduced riparian function. Between Paonia and Hotchkiss, the valley opens up into a series of terraces and mesas with reduced slope. Here, the river begins a cycle of alternating channel degradation to aggradation. A series of previous in-stream gravel mines located between Paonia and Hotchkiss, active at different times over the last 50 years, have created upstream head-cutting and downstream degradation of the channel due to bedload-starved conditions below the pits. Alternatively, between the gravel mines, the channel was regularly bulldozed. The resulting dikes would commonly collapse during spring runoff and force the river in many unintended directions. This would substantially reduce the channel bedload carrying capacity by increasing the width/depth ratio and result in an aggrading situation. The channel transitions from a meandering riffle/pool stream above Paonia to an alternating braided/entrenched stream type. A channel rehabilitation project in the winter of 2001-2002 between Paonia and Hotchkiss at Midway consolidated much of the braided system into a single-thread meandering stream. Just above Hotchkiss, channelization near an existing in-stream gravel mine constricts the river back into an entrenched meandering system. From the Town of Hotchkiss to approximately 3 miles west of town, it alternates between a braided channel and a single-thread meandering stream type with numerous indications of previous channel alterations. Just below the former Chipeta Fish Hatchery, the river enters another canyon and the channel returns to a stable, slightly entrenched, meandering, riffle/pool, cobble-dominated stream with improved riparian and aquatic habitat.

The Crane and Jaquette studies share many conclusions. Both indicate that anthropogenic activities over the past 130 years have increased the instability of lower segments. Such activities include:

- Development of the valley floor and removal of riparian vegetation
- Channel alteration in attempts to control flooding and channel instabilities
- Bulldozing the channel from the late 1940s to early 1980s
- Construction of irrigation diversions
- Urbanization
- Bridge construction

The US Army Corps report concludes that the North Fork was, and still is, a relatively high energy system with a gradient on the order of 0.006 to 0.008. Under these conditions, the channel has experienced

temporal and spatial changes in stability and channel form. In response to local or system-wide events, highly dynamic behaviors leading to the evolution of a highly eroded and braided system are to be expected. In contrast, other areas could have a less dynamic, single-thread system. This interpretation is supported by relict footprints in the floodplain indicating that meandering, single-thread channels were also a part of the historic form.

As part of his geomorphic assessment of the North Fork, Crane used the Rosgen stream classification system to characterize the North Fork at twelve cross sections. The Rosgen classification system uses geomorphic portraits to establish empirical morphological relationships and predict stream responses. Crane found that historical knowledge of the river, combined with an understanding of the river's present characteristics, suggests that the most probable stable form of the North Fork (Paonia to Hotchkiss) is a C3. As a stable C3 river, the North Fork would have increased sinuosity, an expanded floodplain, and improved composition, density and vigor of riparian vegetation.

3.5 *Demographics and Economic Activities*

This section describes the economic activities that influence water management in North Fork watershed. It includes demographics, land use, agriculture and irrigation, coal mining, natural gas development, and recreation. Much of the information in this section is from the Colorado Department of Local Affairs (DOLA). Economic and demographic information from DOLA can be found at: http://www.dola.state.co.us/

Demographics

Population statistics indicate that the North Fork watershed is experiencing only slight increases in population. Growing populations can have significant impacts on water quality, water supply and water management strategies, so it is important to consider population trends when developing management decisions that must meet growing demands.

The majority of the population in the North Fork occurs in Delta County. The major municipalities for which population data exist in the North Fork are the Towns of Paonia and Hotchkiss. Figure 3-9 illustrates population distribution in Delta County. In 2008, nearly half of the population lived in unincorporated areas and eight percent (2,532 people) lived in Hotchkiss and Paonia.

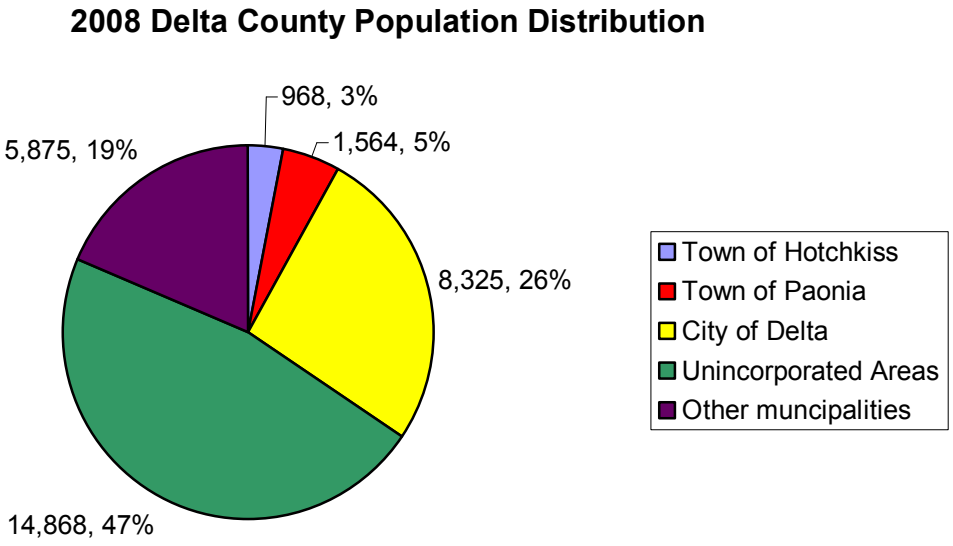

Figure 3-9: 2008 Delta County Population Distribution

Source: DOLA 2008 Delta County Population Forecasts

The population of Delta County grew by 14% from 2000 to 2008. During this period, the population of Hotchkiss did not change (968 people), and the population of Paonia increased by 4%, or 67 people. The population of unincorporated areas grew by 15%, or 775 people. The population in Delta County is expected to more than double between 2000 and 2035, increasing by 111%. However, much of this growth is likely to occur near the City of Delta, which is not in the North Fork watershed.

Land Ownership

Federally managed public lands make up 71% of the North Fork watershed (Figure 3-10). The US Forest Service (USFS) manages 379,326 acres (61%) of the land in the upper watershed as part of the Grand Mesa Uncompahgre Gunnison National Forest (GMUG). A small section of USFS land has been designated as the West Elk Wilderness and Raggeds Wilderness. The BLM manages 59,337 acres (7%) of the lower watershed as part of the Uncompahgre Field Unit. The remaining 181,685 acres (29%) of the North Fork watershed is privately owned. The majority of the North Fork River corridor is privately owned.

Figure 3-11 shows a land cover map of the North Fork Watershed. The dominant land cover is forest (deciduous, evergreen, mixed forest), particularly in the headwaters. In the lower watershed, below Paonia, the landscape transitions to shrub/scrub and pasture land. There are also sections of shrub/scrub and pasture land in the East Muddy Creek drainage above Paonia Reservoir.

North Fork Watershed: Land Ownership

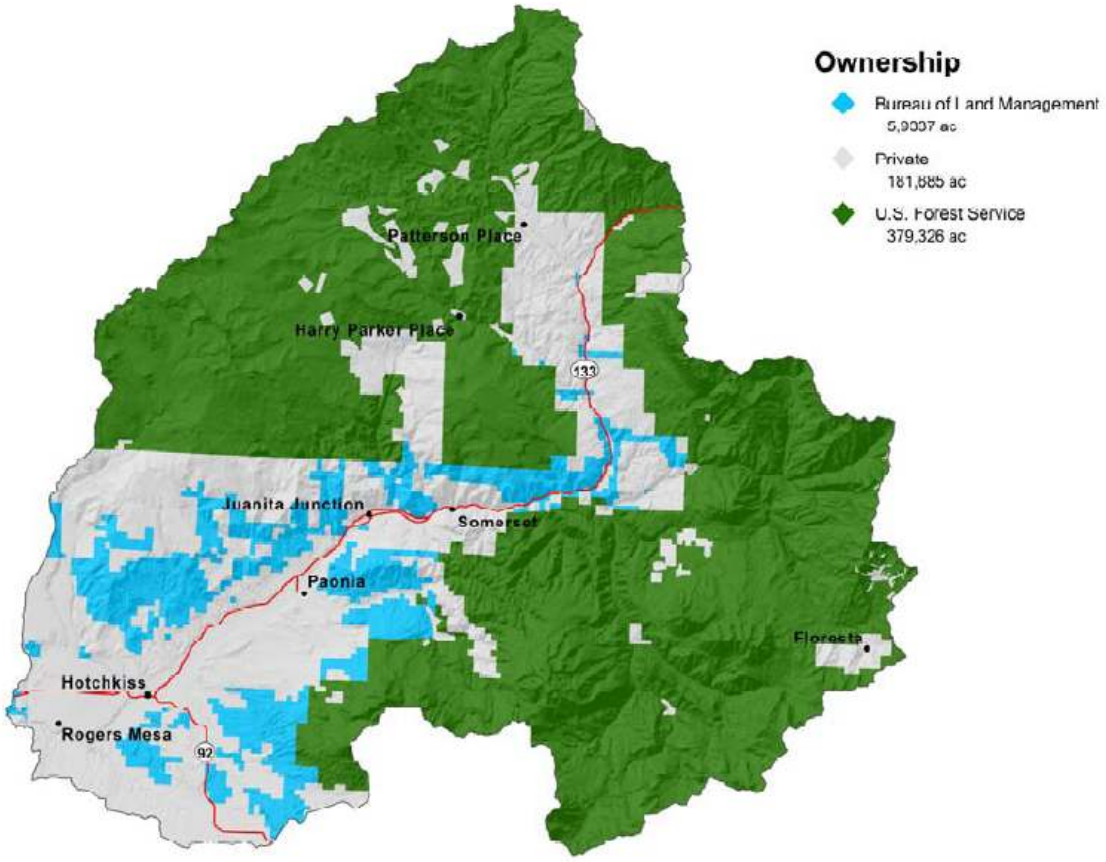

Figure 3-10: Land Ownership

Source: NRCS Rapid Watershed Assessment, 2009

North Fork Watershed: Land Cover

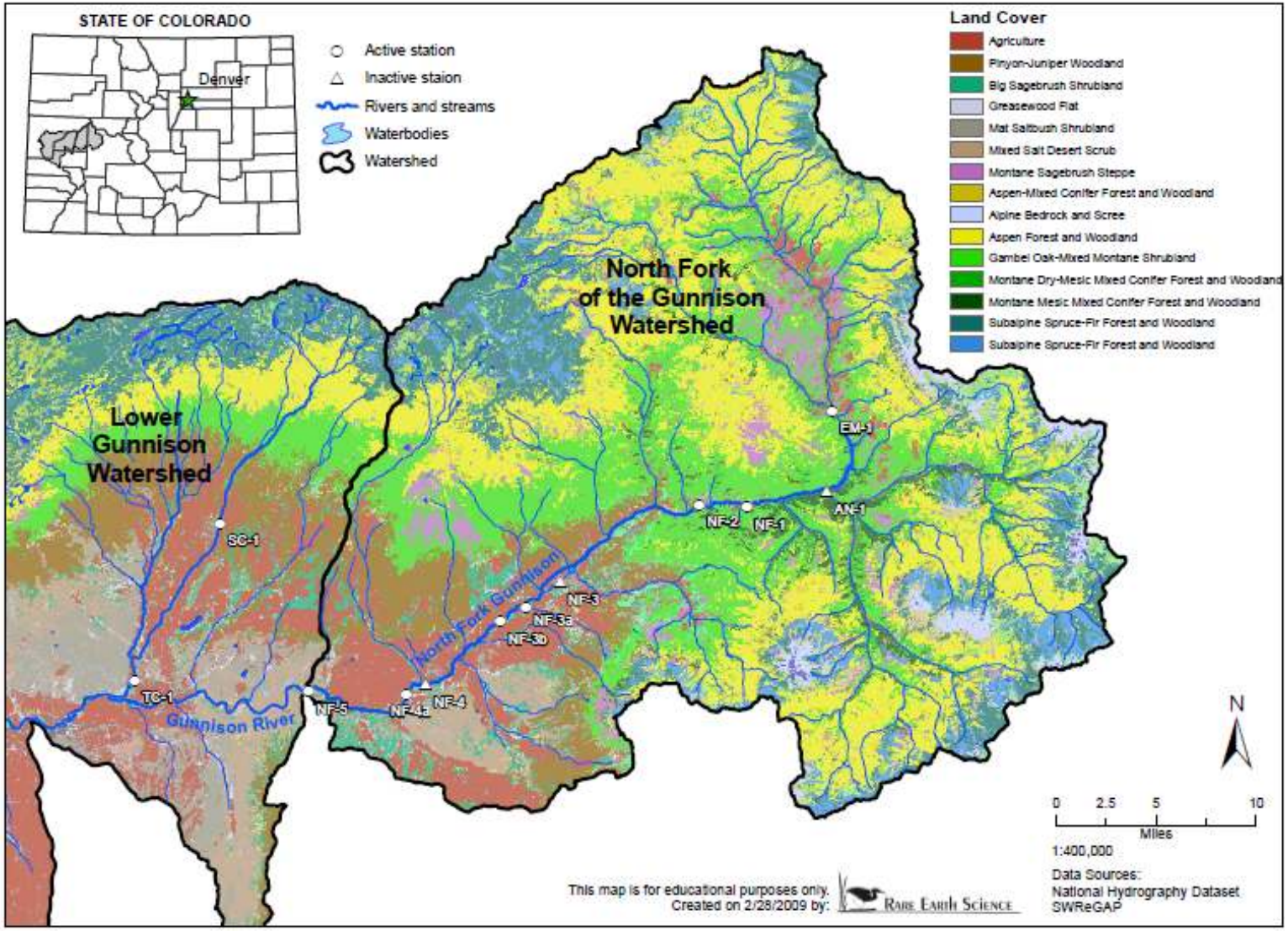

Figure 3-11: Landcover

Agriculture and Irrigation

The U.S. Department of Agricultural Statistics Service 2007 Agricultural Census reports that the total market value of agricultural products in Delta County did not change from 2002 to 2007. Table 3-5 shows the market value of agricultural products in Delta County. The market value of crops increased 17%, while the value of livestock declined by 10%. The average market value per farm decreased 18%, which is likely due to an increase in the number of small acreage farms with lower market production values.

Table 3-5: Market Values of Agricultural Products in Delta County: 2002-2007

Parameter	2002*	2007	% Change
Market value of production	$46,892,400	$46,800,000	*0%*
Average per farm	$44,113	$36,167	*-18%*
Crops	$17,295,600	$20,158,000	*17%*
Livestock	*$29,596,800*	*$26,642,000*	*-10%*

**Adjusted for inflation to 2007 dollars*

Source: U.S. National/Agricultural Statistics Service, 2007 Agricultural Census

Extractive Resources

Coal mining is a significant part of the Colorado and North Fork Valley economy. Colorado ranks eighth in the United States for coal production. In 2008, Colorado coal producers mined 32 million tons of coal, valued at $887 million (http://www.coloradomining.org/mc_miningfacts.php). Over 40% of the state's coal is produced in the North Fork. According to the Union Pacific Rail Road, approximately 19 million tons of coal are produced in the North Fork Valley each year (http://www.uprr.com/customers/energy/coal/colorado.html). Coal mining in the North Fork has generated over $300 million in sales and $85 million in salaries.

There is a long history of gravel mining in the North Fork. Gravel mining often occurs in streams and along riparian areas. Two active gravel mines exist in the North Fork; however, there are no publically available statistics on the economic value of gravel mining in Delta County.

According to the Colorado Petroleum Association, Colorado oil and gas extraction employment in 2000 averaged 7,200 jobs. Oil production was valued at $400 million, and gas production was valued at $2,830 million. Until recently, most natural gas development in Delta County was centered near the Town of Cedaredge. Drilling eventually ceased because the wells did not develop sufficient pressure for good production. Drilling activities are now occurring in the Muddy Creek region, particularly in the Bull Mountain Unit and on Oak Mesa.

The Western Slope Environmental Resource Council (WSERC) has been actively tracking the progress of natural gas exploration in Delta County. WSERC's Gas Committee's mission is: *To protect Delta County area's public and private lands and watersheds, local economy and quality of life from the negative impacts of natural gas development.* The following paragraphs summarize information about gas development in the North Fork Valley, based on WSERC's conversations with BLM officials, representatives from Gunnison Energy Corporation (GEC) and SG Interests (http://www.wserc.org/).

- The Bull Mountain Unit is an area of gas production, mostly on private land near Somerset, which is being developed by SG Interests. SG Interests plans submitted to the BLM indicate that it will use 11 existing well pads and construct 49 new pads for a total of 60. SG Interests proposes as many as 150 wells using directional drilling to create multiple wells from a single pad.
- Currently proposed gas exploration on Oak Mesa is less extensive. Gunnison Energy Corporation (GEC) holds leases on thousands of acres on Oak Mesa; however, many of the leases are about to expire. In order to extend the life of leases, GEC must demonstrate to the BLM that it is actively doing gas development on these leases. Rather than developing each lease separately, however, GEC can prove "gas development" by drilling a single well, provided

the leases have been unitized – grouped into a single unit. GEC's current plans are to drill a single well on private land. If the well proves productive, GEC will work with the landowner to develop a more comprehensive plan.

- The future of gas development in the North Fork Valley is uncertain. As was the case with gas exploration near Cedaredge, the Oak Mesa area's geology may not be conducive to gas production. Oak Mesa is located near the outer edge of the Piceance Basin whereas the best producing wells are near the center of the basin. On the other hand, the Bull Mountain Unit near Somerset seems to be producing satisfactorily. However, even if the Bull Mountain Unit proves to be highly productive, development would be slow.

Recreation and Tourism

Recreation and tourism are economically important in Colorado and the North Fork Valley. Statewide, tourism spending injects $8.5 billion into Colorado's economy each year (BCC Research & Consulting, 2004). Water-related activities in the North Fork include fishing, boating, and x-county skiing. Hunting occurs throughout the watershed – from public lands near McClure Pass to the riparian zones below Hotchkiss. Water needs for recreation are generally non-consumptive and can be complementary to environmental water needs.

In 2002, the DOW commissioned a study on the Economic Impacts of Hunting and Fishing in Colorado (BCC Research & Consulting, 2004). Table 3-6 below summarizes the economic impact of hunting and fishing in Delta County. The report indicates that hunting and fishing contributed 1.7%, or $25,900,000, to the Delta County economy in 2002. The majority of the direct expenditures were attributed to elk hunting ($5,390,000) and fishing ($6,690,000).

Table 3-6: Economic Impacts of Hunting and Fishing in Delta County, 2002

Activity	Resident	Non-Resident
Hunting	$3,910,000	$9,730,000
Fishing	$8,400,000	$3,520,000
CDOW	$340,000	
Indirect Expenditures	$14,600,000	
Total Impact	$25,900,000	
Jobs	340	

Source: BBC Research & Consulting, 2004

Boating is increasing in popularity in Colorado. Flat-water boating in the North Fork watershed is centered on Paonia State Park. The park offers hiking, camping, and boating on Paonia Reservoir. There were 25,521 visitors to Paonia State Park in FY07-08. River boating is also a popular activity in the North Fork, but it is heavily dependent on water availability. The following Water Use section describes the reaches and flow recommendations of the river used by rafters and kayakers.

Section 4: Water Use

In response to the 2002 drought, the Colorado State Legislature authorized the Colorado Water Conservation Board (CWCB) to commission a comprehensive study to evaluate Colorado's long-term water needs. This study became known as the State Wide Water Supply Initiative (SWSI). The overall objective of SWSI is to help Colorado maintain an adequate water supply for its citizens and the environment. This study was expanded in 2005 when the legislature passed the Colorado Water for the 21st Century Act, which sets of a framework that provides a forum for discussions and negotiations between river basins in the state through basin roundtables. Many of the statistics in this report on water use, water demands, and projected gaps in water supplies were derived from reports created by SWSI or the Gunnison Basin Roundtable. This section includes an evaluation of consumptive and non-consumptive water use in the North Fork watershed.

4.1 *Consumptive Uses*

The term "consumptive use" applies to water that is lost to the environment by evaporation, transpiration, incorporation into products or crops, or human and livestock consumption. Municipal and Industrial (M&I) and agricultural water projections represent "traditional" uses in water planning, and are generally associated with off-stream uses that have a consumptive component. Table 4-1 shows water use estimates for Delta County in 2005 (Kenny et. al, 2009). In 2005, over 98% of the water withdrawals in Delta County were used for irrigation. The following sections examine consumptive uses in the Delta County and the North Fork River watershed.

Table 4-1: 2005 Delta County Water Use (AFY)

County	Public Supply	Domestic	Irrigation	Power	Total
Delta	6,597	2,162	505,254	0	514,013

Source: USGS Estimated Water Use in 2005 (Kenny et.al, 2009)

Municipal and Industrial

Municipal and Industrial (M&I) water demand refers to all of the water use of a typical municipal system, including residential, commercial, industrial, irrigation, and firefighting (CDM 2004a). Figure 4-1 shows a forecast of baseline M&I water demands in Delta County through 2030. The anticipated increase in demand from 2000 to 2030 is approximately 40%. Only some of the water diverted for M&I use is considered consumptive, since a portion of the water is returned to the stream through wastewater treatment plants and lawn watering.

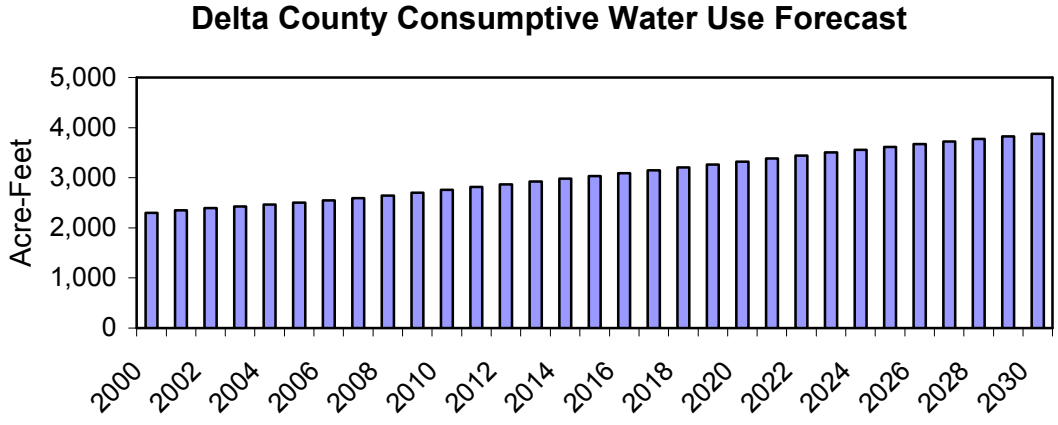

Figure 4-1: Forecasted Delta County M&I Water Demands

Source: CDM 2004b: Appendix E: Statewide M&I and SSI Water Demand Projections

Domestic water is typically provided by municipal water suppliers or community groundwater systems. Rural areas often depend on self-supplied water from wells or surface water sources, such as springs. Municipal supplies must conform to state drinking water standards and are thus more tightly controlled. There are six public water supply entities in the North Fork: Town of Hotchkiss, Town of Paonia, Sunshine Mesa Domestic Water, Bone Mesa Domestic Water, Rogers Mesa, and Lazear.

The Colorado Statewide Water Supply Initiative consulted with local water providers to identify future water supply gaps. The Town of Hotchkiss reported adequate direct flow rights from Overland Reservoir and therefore identified no gap in future Municipal and Industrial supplies. The Town of Paonia reported a gap of 300 acre-feet in M&I needs and has identified the expansion of Lone Cabin Reservoir as a possible supply to accommodate growing M& I needs. Jim Hokit of the North Fork Water Conservancy District projected a 5% increase in M&I demands from unincorporated areas of Delta County (CDM, 2006).

Agriculture

The estimated agricultural water demand in 2000 for the Gunnison Basin was 1,705,000 acre feet (AFY). Agricultural demands in the basin are projected to decrease to 1,640,000-1,689,000 AFY by 2030 (CDM. 2004c). According to the USGS, nearly 98% of all water withdrawals in Delta County were for irrigation (Kenny et.al, 2009). Figure 4-2 shows county water withdrawals used for irrigation from 1985 to 2005. Total irrigation withdrawals decreased by approximately 221 AFY between 2000 and 2005. The decline in irrigation withdrawals may be due to prolonged drought conditions or the declining amount of irrigated land per farm (see Table 4-2). Groundwater accounted for less than 1% of irrigation withdrawals in Delta County.

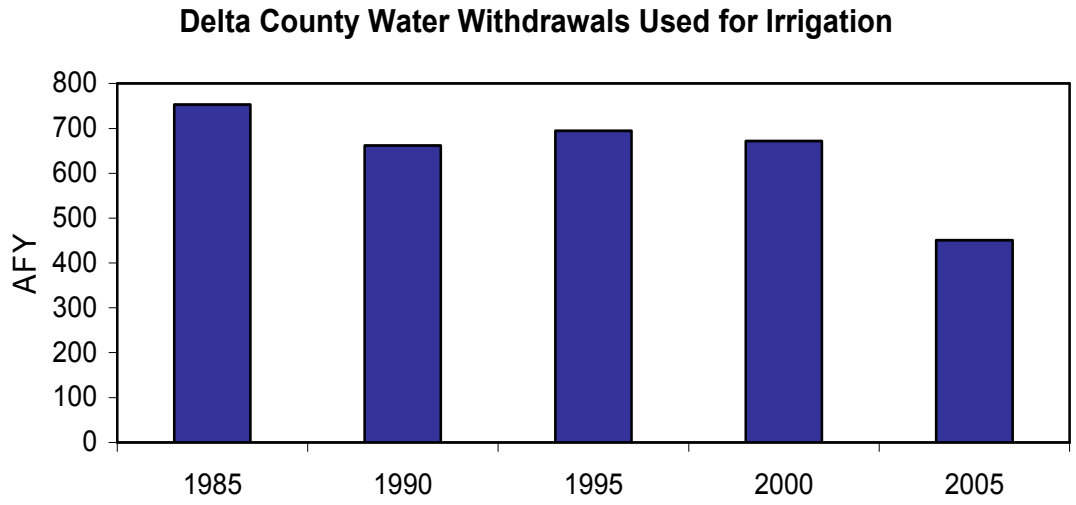

Figure 4-2: Trends in Delta County Irrigation Withdrawals (1985-2005)

Source: USGS Estimated Use of Water in the United States: 1985 - 2005

Table 4-2 provices a summary of irrigated farmland trends in Delta County from 2002 to 2007. The USDA's National Agricultural Statistics Service (2007) reports that total irrigated farmland in Delta Counties rose eight percent 8% from 211,472 acres in 2002 to 228,356 acres in 2007. The total number of farms with irrigation increased 21%, while the average irrigated land per farm decreased 11% over the same period. This may be due to the growing number of farms with less than 50 acres of irrigated land. These statistics follow a national trend of large ranches and farms being split into smaller parcels and used as “hobby farms,” resulting in an increase in number of farms but smaller acres per farm (Personal Communication, NRCS).

Table 4-2: Trends in Irrigated Farmland, Delta County, 2002-2007

Parameter	2002	2007	*% Change*
Total Farms with Irrigated Land (# Farms)	913	1,108	*21%*
Farms with less than 50 irrigated acres	497	617	*24%*
Farms with 50 to 500 irrigated acres	350	408	*17%*
Farms with more than 500 irrigated acres	66	83	*26%*
Average Irrigated Land/farm (acres/farm)	*232*	*206*	*-11%*

Source: U.S. National/Agricultural Statistics Service, 2007 Agricultural Census

Colorado Decision Support System (CDSS) data were used to evaluate trends in irrigated acreage and irrigation type in the North Fork watershed between 1993 and 2005 (Figure 4-3). During this period, the total irrigated acres decreased by 20% (41,563 acres to 33,217 acres). The SWSI report predicts that this trend will continue and that that entire Gunnison Basin will lose 2,500 to 10,000 irrigated acres by 2030. The predicted loss of irrigated land is expected to come from urbanization and agricultural transfers (CDM, 2006).

Trends in irrigation techniques were also identified using CDSS data (Figure 4-3). Furrow irrigation is the dominant type of irrigation in the North Fork watershed, accounting for over half of irrigated acres since 2000. Just over one-quarter of irrigated lands are flood irrigated, while sprinkler irrigation accounts for only 2%. Figure 4-5 shows the location of irrigated lands in the North Fork.

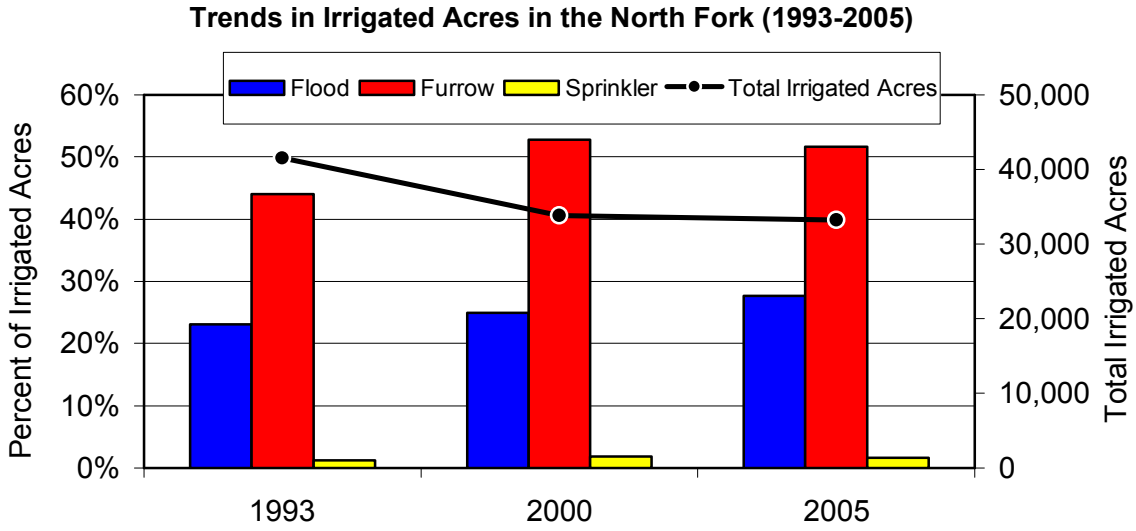

Figure 4-3: Irrigated Acres and Methods

Source: Source: CDSS Irrigated Acreage, 1993-2005

North Fork Watershed: Residential and Irrigated Lands

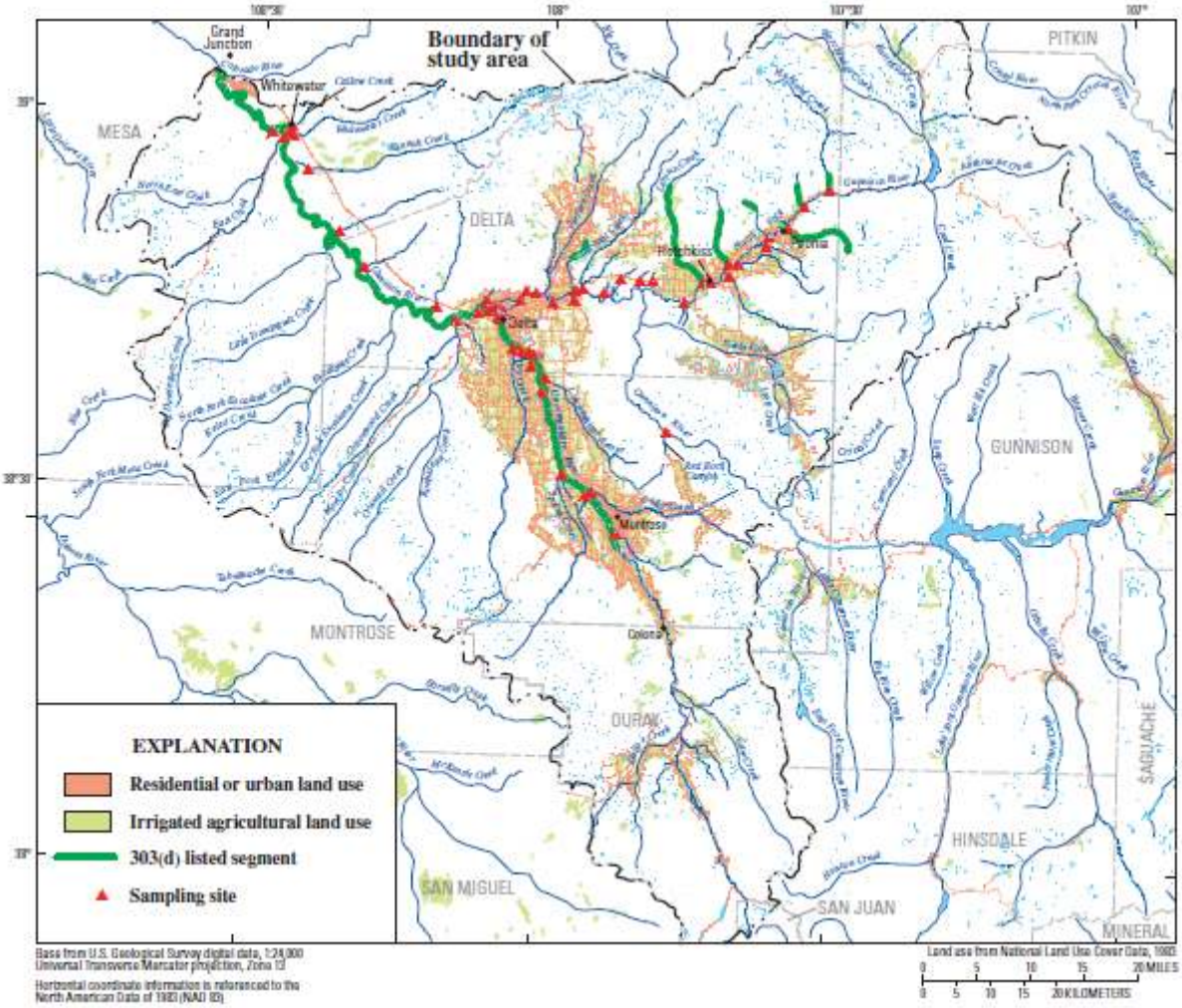

Figure 4-4: Residential and Irrigation Lands

Source: Butler and Leib, 2002

According to the CDSS, there are over 800 irrigation diversions in the North Fork watershed. Over 280 ditches depend on the North Fork River as a water source (CDSS 2008). These ditches provide water to thousands of acres of agricultural land throughout the valley. Much of the irrigation water is returned to the river, either through direct tributaries and wastewater channels or indirectly through groundwater recharge.

Table 4-3 lists the largest water users with the North Fork. The biggest diversion is the Fire Mountain Canal. The Fire Mountain Canal and Reservoir Company has a decree to divert 238 cfs from the North Fork River. The basin's remaining major diversions are maintained by local ditch and reservoir companies.

Table 4-3: Major Water Users

ID	Name	Use	Decreed Rate Total (cfs)
3416	Paonia Reservoir	Irrigation/ stock	21,000 AF
2347	North Fork River	Min. stream flow	60
1133	Fire Mountain Canal	Irrigation	238
1206	Stewart Ditch	Irrigation	77.9
2681	Stewart Ditch	Stock	5.0
1196	Short Ditch	Irrigation/ stock	43.5
1189	Paonia Ditch	Irrigation	32.29
1185	Farmers Ditch	Irrigation	32.13
1195	Sheppard-Wilmont Ditch	Irrigation Stock	12.6 3.5
1213	Van Der Ford Ditch	Irrigation	14.5
1197	Smith-McKnight Ditch	Irrigation	10.303
1183	Monitor Ditch	Irrigation Stock	8.25 2.0

Source: http://cdss.state.co.us/DNN/ViewData/StructuresDiversions/tabid/75/Default.aspx

4.2 *Non-Consumptive Uses*

Water used consumptively diminishes the source and is not available for other uses, whereas non-consumptive water use does not deplete the source or impair future water use. Non-consumptive water uses include environmental, recreational and hydropower generation. Environmental and recreational water needs are generally in-channel and flow-based. Non-consumptive water uses have not traditionally been a major part of water planning. The 2004 SWSI Report identified the importance of environmental and recreational needs in the study's key findings (CDM 2004d). The following sections discuss non-consumptive water use, including environment, recreation and hydropower generation.

Hydropower

Hydroelectricity is electricity obtained from hydropower. Hydroelectric power comes from water driving a turbine that is connected to a generator. Hydroelectricity is a low-cost, non-polluting, renewable energy source. Considered by some to be a non-consumptive use of water, hydropower can alter natural flow regimes. There are no major hydroelectric facilities in the North Fork watershed, but there is a growing interest in the use of micro-hydro in irrigation canals. Micro-hydro is a term used for hydroelectric power installations that typically produce up to 100 kW of power. These installations can provide power to an isolated home or small community, or are sometimes connected to electric power networks.

The Federal Power Act requires Federal Energy Regulatory Commission (FERC) licenses for most hydropower projects, with some minor exemptions for small micro-hydro facilities. Delta County does not regulate micro-hydro projects. To construct a project in a stream channel or irrigation ditch, a landowner must contact FERC and the US Army Corps of Engineers for permit compliance, depending on whether the project will impact a jurisdictional waterway or wetland. Depending on the size and location of the project, mitigation issues may need to be addressed if the facility will have a negative impact on the surrounding area. This is typically dealt with in the Special Use Permit process.

Environment

In 1973, the Colorado State Legislature granted the Colorado Water Conservation Board (CWCB) authority to appropriate and acquire water for instream flows to preserve or improve the natural environment to a reasonable degree. An “instream flow” or “natural lake level” water right is for "minimum flows" between specific points on a stream or "levels" in natural lakes. Instream flow rights can only be

held by the CWCB and are administered within the state's water rights priority system. There are 26 instream flow rights and ten natural lake level filings in the North Fork watershed. Table 4-4 and Table 4-5 show the watershed's instream flow and natural lake level water rights (http://cwcb.state.co.us/StreamAndLake/).

The Colorado Instream Flow Program (ISF) is a step toward protecting environmental flows. However, the ISF program has several limitations. ISF rights are not always met because they are administered within the state's prior appropriation system. Furthermore, ISF rights are difficult to administer because they are often located in places where stream gages are not present and accurate real-time flow measurements are not available.

Table 4-4: Natural Lake Level Rights

Case #	Name of Lake	Volume (AF)	Appropriated Date
4-W-3345-77	Buck Creek Lake, North	1.5	3/9/1977
4-W-3343-77	Buck Creek Lake, West	4.2	3/9/1977
4-W-3316-77	Chair Mountain Lake	112	1/19/1977
4-W-3323-77	Deep Creek Lake #1, South	25	1/19/1977
4-W-3322-77	Deep Creek Lake #2, North	118	1/19/1977
4-W-3373-77	Dollar Lake	95	5/12/1976
4-W-3350-77	Green Lake	77	3/9/1977
4-W-3327-77	Mt. Gunnison Lake #1, North	45	3/9/1977
4-W-3328-77	Mt. Gunnison Lake #2, South	200	3/9/1977
4-W-3376-77	Sheep Lake	125	5/12/1976

Source: CWCB Natural Lake Level District 4 Tabulations

There are no active real-time flow gages on segments with instream flow rights. Many of the ISF rights in the North Fork watershed are located within the Grand Mesa, Uncompahgre and Gunnison (GMUG) National Forest. The Pathfinder Project is a pilot program initiated by GMUG National Forests whose purpose is to provide external ideas, perspectives, and options related to strategic planning for instream flow protection on National Forest lands (http://www.gmugpathfinder.org/). Work completed by the Pathfinder steering committee was incorporated into the 2007 GMUG Forest Plan Revision.

Table 4-5: Instream Flow Rights

Case #	Name of Stream	Upper Terminus	Lower Terminus	Amount (CFS)	Approp. Date
4-06CW230	Anthracite Creek	Confl Ruby Anthracite Cr	Confl Coal Creek	54 (04/01-07/14) 39 (07/15-08/14) 17 (08/15-03/31)	01/25/2005
4-09CW077	Clear Fork East Muddy Creek	headwaters	Forest Service boundary	13 (04/01-08/15) 5 (08/16-03/31)	01/27/2009
4-84CW409	Cliff Creek	Headwaters	Confl Coal Creek	6 (01/01-12/31)	05/04/1984
4-06CW231	Coal Creek	Confl Little Gunnison	Confl Anthracite Creek	18 (11/15-02/14) 21 (02/15-03/31)	1/25/2005
4-84CW405	Coal Creek	Headwaters	Confl Robinson Creek	5.5 (01/01-12/31)	05/04/1984
4-84CW406	Coal Creek	Confl Robinson Cr	Confl Cliff Creek	9 (01/01-12/31)	05/04/1984
4-84CW415	Cunningham Creek	headwaters	Confl WF Terror Creek	1.5 (01/01-12/31)	05/04/1984
4-84CW415	Curecanti Creek	Headwaters	Confl Commissary Gulch	3 (01/01-12/31)	05/04/1984
4-04CW157	Dyke Creek	outlet unnamed lake	hdgt Bell Ranch Div #1	3.2 (05/1-08/15) 1.5 (08/16-10/31) 1 (11/01-04/30)	01/28/2004
4-84CW416	East Leroux Creek	Confl unnamed tributary	Confl West Leroux Creek	1 (01/01-12/31)	05/04/1984
4-84CW404	Grouse Spring Creek	headwaters	Confl Snowshoe Creek	3 (01/01-12/31)	05/04/1984
4-84CW413	Hubbard Creek	Forest Service boundary	Forest Service boundary	3 (01/01-12/31)	05/04/1984
4-84CW414	Little Dyke Creek	headwaters	Confl Hubbard Creek	2 (01/01-12/31)	05/04/1984
4-84CW410	Little Gunnison Creek	headwaters	Confl Coal Creek	2 (01/01-12/31)	05/04/1985
4-09CW072	Little Spring Creek	outlet of Ragged Res #1	Crystal Ditch hdgt	1.25 (01/01-12/31)	01/27/2009
4-09CW073	Little Spring Creek	Crystal Springs	inlet of Ragged Res. #1	1.25 (01/01-12/31)	01/27/2009
4-84CW412	Main Hubbard Creek	Confl Little Dyke Cr	Forest Service boundary	3 (01/01-12/31)	05/04/1984
4-84CW403	Middle Creek	headwaters	Confl Ruby Anthracite Creek	1.5 (01/01-12/31)	05/04/1984
4-84CW400	Middle Leroux Creek	headwaters	Confl East Leroux Creek	2(01/01-12/31	05/04/1984
4-84CW400	North Fork Gunnison R	Confl Coal Creek	Confl Elk Creek	60 (03/01-11/30) 30 (12/01-02/29)	05/04/1984
4-84CW407	Robinson Creek	headwaters	Confl Coal Creek	0.6 (01/01-12/31)	05/04/1984
4-84CW401	Ruby Anthracite Creek	outlet Lake Irwin	Confl Middle Creek	2.5 (01/01-12/31)	05/04/1984
4-84CW408	Snowshoe Creek	Confl Grouse Spg & Shafer Cks	Confl Anthracite Creek	3 (01/01-12/31)	05/04/1984
4-84CW402	Trout Creek	headwaters	Confl Ruby Anthracite Creek	1 (01/01-12/31)	05/04/1984
4-84CW418	West Leroux Creek	Confl unnamed tributary	Confl East Leroux Creek	1 (01/01-12/31)	05/04/1984
4-84CW411	West Muddy Creek	headwaters	Confl Cow Creek	2 (01/01-12/31)	05/04/1984

Source: CWCB Instream Flow Rights Database

The State Water Supply Planning process established basin roundtables which were charged with developing a basin-wide water needs assessments. The Gunnison Basin Roundtable's non-consumptive needs assessment (NCNA) includes a list of major stream and lake segments with flow-dependent environmental values (CDM 2009). Table 4-6 and Figure 4-5 shows the major environmental attributes assigned to stream and lake segments in the North Fork watershed.

Table 4-6: Environmental Attributes

Stream or Lake Segment	Attribute
Stream Segments on Headwaters Wilderness*	• Aquatic-Dependent State Endangered, Threatened, and Species of Concern [b,c,d,f,g] • Rare Aquatic-Dependent Plants and Significant Riparian/Wetland Plant Communities [a,b] • Special Value Waters [b]
North Fork of the Gunnison River - Paonia Dam to Confluence with Gunnison River	• Aquatic-Dependent State Endangered, Threatened, and Species of Concern [b,c,d,f,g] • Rare Aquatic-Dependent Plants and Significant Riparian/Wetland Plant Communities [a,b] • Special Value Waters [b]
Muddy Creek Headwaters above North Fork of Gunnison River	• Aquatic-Dependent State Endangered, Threatened, and Species of Concern [a,d,f] • Rare Aquatic-Dependent Plants and Significant Riparian/Wetland Plant Communities [b] • Special Value Waters [b]
Coal & Anthracite Creeks	• Aquatic-Dependent State Endangered, Threatened, and Species of Concern [a,f] • Rare Aquatic-Dependent Plants and Significant Riparian/Wetland Plant Communities [b] • Special Value Waters [b]
Surface and Leroux Creeks	• Aquatic-Dependent State Endangered, Threatened, and Species of Concern [f,g] • Special Value Waters [b]
Terror Creek Headwaters	• Aquatic-Dependent State Endangered, Threatened, and Species of Concern [a] • Rare Aquatic-Dependent Plants and Significant Riparian/Wetland Plant Communities [b] • Special Value Waters [b]
Bell Creek (SW of Paonia)	• Aquatic-Dependent State Endangered, Threatened, and Species of Concern [f]
* Major Environmental Segment **Federally Listed Fish Species**: a – Colorado River Cutthroat Trout , b – Roundtail Chub, c – Flannelmouth Sucker, d – Boreal Sucker, e – Boreal Toad, f – Northern Leopard Frog, g – river otter sightings, h – bald eagle sites **Special Value Waters:** a – CWCB Natural Lake Levels, b – CWCB Instream Flows, d – WQCD Outstanding Waters, e – GMUG Wilderness Area waters	

Source: Gunnison Basin NCNA Mapping Report (CDM 2009)

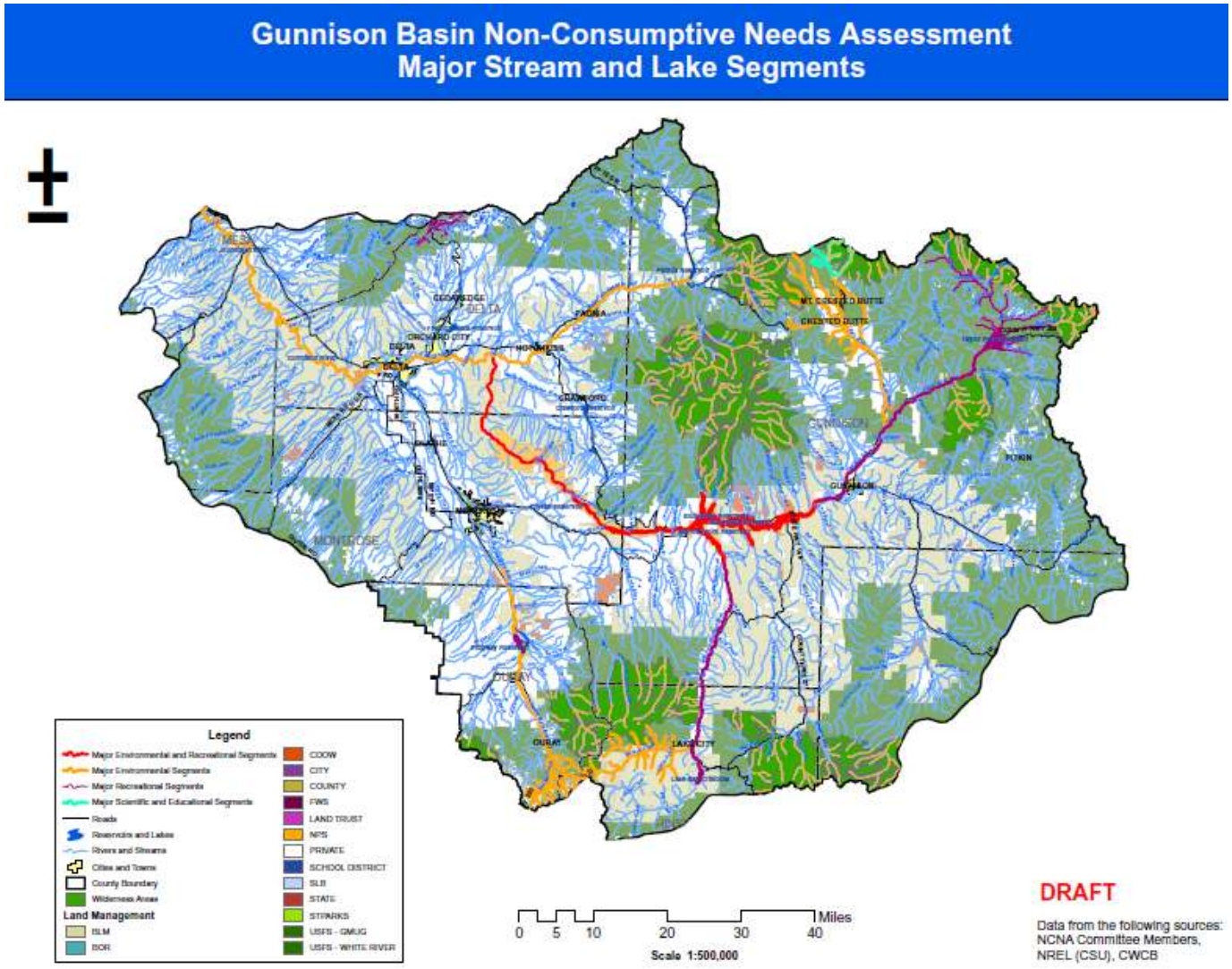

Figure 4-5: Environmental and Recreation Attributes

Source: Source: Gunnison Basin NCNA Mapping Report (CDM, 2009)

Recreation

The Gunnison Basin NCNA also includes a list of major stream and lake segments with flow-dependent recreational values. Table 4-7 shows the recreational attributes assigned to stream and lake segments in the North Fork watershed. Recreational attributes in the watershed include fishing, wildlife viewing and waterfowl hunting, boating, and high recreation areas.

Table 4-7: Recreation Attributes

Stream or Lake Segment	Attribute
Stream Segments on Headwaters Wilderness*	• Whitewater and Flat-water Boating [b] • Riparian/Wetland Wildlife Viewing and Waterfowl Hunting [a] • Significant Cold and Warm-Water Fishing [b]
North Fork of the Gunnison River - Paonia Dam to Confluence with Gunnison River	• Whitewater and Flat-water Boating [b] • Riparian/Wetland Wildlife Viewing and Waterfowl Hunting [a] • Significant Cold and Warm-Water Fishing [b]
Paonia Reservoir	• Whitewater and Flat-water Boating [d] • Significant Cold and Warm-Water Fishing [c]
* Major Recreation Segment **Whitewater and Flat-water Boating:** b - Rafting (and Kayaking), d – flat-water boating **Riparian/Wetland Wildlife Viewing and Waterfowl Hunting:** a – wildlife viewing and waterfowl hunting **Significant Cold and Warm Water Fishing:** b -River and Stream Fishing, c- Reservoir and Lake fishing	

Source: Gunnison Basin NCNA Mapping Report (CDM 2009)

Whitewater and kayaking stretches identified in the NCNA Report were based on information from the NCNA Committee. A review of popular whitewater rafting websites indicates that there are additional reaches used for boating not included in the NCNA report. These segments are listed in Table 4-8. The whitewater inventory suggests that the North Fork can be floated with flows as low as 500 cfs, although the general consensus is that optimum flow rates should exceed 1000 cfs at the Somerset Gage. During runoff, the entire North Fork is raftable.

Table 4-8: Whitewater Inventory

Location	Class	Optimum Flow (CFS)
Anthracite: Lower Anthracite	II+	>300 cfs
Anthracite: Middle Fork	V	n/a
Anthracite: Ruby Fork	V+	300-600 cfs
Anthracite: Middle North Fork	II+	> 500 cfs
North Fork: Paonia Reservoir to below Somerset	III+	300- 6000 cfs
Lower North Fork	II+	> 500 cfs

Source: American Whitewater National Whitewater Inventory and Mountain Buzz (http://www.americanwhitewater.org/content/River/state-summary/state/CO/, http://www.mountainbuzz.com/?page=flows)

4.3 *Historic and Potential Role of Drought and Conservation*

Drought is a natural and unpredictable occurrence in Colorado and a constant topic of discussion by water planners in the arid climate of the North Fork Watershed and the Gunnison Basin. The Colorado Drought Mitigation and Response Plan was developed to "provide an effective and systematic means for the State of Colorado to deal with emergency drought problems which may occur over the short or long term." The plan provides a mechanism to reduce the impacts of water shortages by coordinating drought monitoring, impact assessment, response to emergency drought problems, and mitigation of long term drought impacts (DOLA, 2001). Through the CWCB's Office of Water Conservation and Drought Planning, the state provides technical and financial assistance for drought mitigation planning http://cwcb.state.co.us/Conservation/.

In 2004, the CWCB published the Colorado Drought & Water Supply Assessment (CWCB, 2004). This document was the first statewide assessment of how prepared Colorado is for drought and identified measures to better prepare the state for the next drought. This document includes summaries of survey responses provided by water users within each river basin. The Gunnison Basin summary is based on responses from 70 participants, including municipal, agricultural, federal, state, conservancy districts and industry interests. The report was updated in 2007, but focused only on municipal and urban water providers.
http://cwcb.state.co.us/Conservation/DroughtPlanning/DroughtWaterSupplyAssessment/

As in other parts of the state, Gunnison Basin water users identified structural projects as effective means to mitigate the effects of drought in the basin. Creating new surface water storage facilities was selected as the most important method to mitigate drought, but unlike the rest of the state, other projects, such as large scale multi-basin projects and lining of ditches, were ranked at nearly the same priority level. New or upgraded pipelines and water distribution systems were also identified as important. Structural and non-structural drought mitigation projects identified in the Gunnison Basin are shown in Tables 4-9 and 4-10.

Table 4-9: Need for Structural Drought Mitigation Projects

Type of Project	Statewide Need*	Gunnison Basin*
New storage for surface water	40%	38%
Large-scale/multi-basin projects	24%	36%
New storage for groundwater	19%	16%
New or Upgraded Pipelines	33%	37%
New or Upgraded Water Distribution Systems	33%	35%
Lining of Ditches	19%	32%
**Percentage of Respondents Who Rated Issue as high importance*		

Source: Gunnison Basin Drought Water Supply Assessment Basin Summary. (http://cwcb.state.co.us/Conservation/DroughtPlanning/DroughtWaterSupplyAssessment/)

Table 4-10: Need for Non-Structural Drought Mitigation Projects

Non-Structural Project	Statewide Need*	Gunnison Basin*
Public Education & Awareness	46%	46%
Improved Water Conservation Methods	46%	55%
Technical Support in Water Supply Planning	43%	55%
Technical Support in Drought and Conservation Planning	42%	48%
Improved Water Conservation Measurement Methods	29%	33%
**Percentage of Respondents Who Rated Issue as high importance*		

Source: Gunnison Basin Drought Water Supply Assessment Basin Summary. (http://cwcb.state.co.us/Conservation/DroughtPlanning/DroughtWaterSupplyAssessment/)

The Gunnison River Basin Assessment (CWCB, no date) summary found that the Gunnison River basin represents “some of the most pristine areas of Colorado’s high country.” However, as a group, Gunnison Basin waters users are involved with less planning that most of the state. This is particularly worrisome because Gunnison Basin water users “appear to have been more severely impacted by the recent drought than most of the other basins, with the agricultural community particularly hard hit.” The report goes on to say that agricultural entities “in the Gunnison Basin do not have the range of measures and programs available to them for managing and responding to drought.” The report concluded that while other major river basins are facing more pressing issues, the pristine nature of the Gunnison Basin carries additional responsibilities that must be considered when “striking the balance between traditional and future water use.”

Section 5: Current Conditions

This section discusses current river conditions in the North Fork watershed. It includes a review of state water quality standards, designated uses, impaired waters, use-impaired waters, and a review of water quality reports and river stability reports.

5.1 *State Water Quality Standards*

Water quality standards and designated uses are determined by the Colorado Water Quality Control Commission (WQCC). For the purpose of water quality standards, streams and water bodies are split into segments and assigned water body IDs (WBID). WBIDs are delineated according to points where use, physical characteristics or water quality characteristics are determined to change significantly enough to require a change in use classification or water quality standard. Eight WBID segments exist in the North Fork watershed (Table 5-1).

Regulation 35 establishes use classifications and standards for the Gunnison River/Lower Dolores River Basins. Use classifications are based on actual beneficial uses of the water. Numeric standards determine the allowable concentrations of various parameters. In certain instances, a table value standard (TVS) has been adopted based on numerical criteria set forth in the Basic Standards and Methodologies for Surface Water (Regulation 31). Please refer to WQCC Regulation 35 for Table Value Standards. Use classifications are determined by how a water segment is being used and what beneficial uses are desired in the future. By law, use classifications are adopted for the highest water quality attainable. Use classifications and water quality standards are not uniformly applied to the state or a watershed. Rather, they are set on a segment by segment basis. Table 5-1 also shows the Use Classifications, Numeric Standards and Temporary Modifications for segments in the North Fork River watershed. Beneficial uses identified in the North Fork include:

1) Agriculture: These surface waters are suitable or intended to become suitable for irrigation of crops usually grown in Colorado and which are not hazardous as drinking water for livestock.

2) Domestic Water Supply: These surface waters are suitable or intended to become suitable for potable water supplies. After receiving standard treatment (defined as coagulation, flocculation, sedimentation, filtration, and disinfection with chlorine or its equivalent) these waters will meet Colorado drinking water regulations and any revisions, amendments, or supplements thereto.

3) Recreation

> *Class E - Existing Primary Contact Use:* These surface waters are used for primary contact recreation or have been used for such activities since November 28, 1975.
>
> *Class N - Not Primary Contact Use:* These surface waters are not suitable or intended to become suitable for primary contact recreation uses. This classification shall be applied only where a use attainability analysis demonstrates that there is not a reasonable likelihood that primary contact uses will occur in the water segment(s) in question within the next 20-year period.
>
> *Class P - Potential Primary Contact Use:* These surface waters have the potential to be used for primary contact recreation. This classification shall be assigned to water segments for which no use attainability analysis has been performed demonstrating that a recreation class N classification is appropriate, if a reasonable level of inquiry has failed to identify any existing primary contact uses of the water segment, or where the conclusion of a UAA is that primary contact uses may potentially occur in the segment, but there are no existing primary contact uses.

4) Aquatic Life: These surface waters presently support aquatic life uses as described below, or such uses may reasonably be expected in the future due to the suitability of present conditions, or the waters are intended to become suitable for such uses as a goal:

Class I - Cold Water Aquatic Life : These are waters that (1) currently are capable of sustaining a wide variety of cold water biota, including sensitive species, or (2) could sustain such biota but for correctable water quality conditions. Waters shall be considered capable of sustaining such biota where physical habitat, water flows or levels, and water quality conditions result in no substantial impairment of the abundance and diversity of species.

Class 2- Cold and Warm Water Aquatic Life: These are waters that are not capable of sustaining a wide variety of cold or warm water biota, including sensitive species, due to physical habitat, water flows or levels, or uncorrectable water quality conditions that result in substantial impairment of the abundance and diversity of species.

Outstanding Waters

In Colorado, the highest level of water quality protection is applied to waters that constitute an outstanding state or national resource. No degradation of outstanding waters is allowed. The regulation creating the *antidegradation* framework is called the *Basic Standards and Methodologies for Surface Water*, often referred to as the *Basic Standards* (WQCC Regulation 31). The Colorado Water Quality Control Commission has only applied this designation to headwaters streams in public lands. One segment in the North Fork watershed is designated as *Outstanding Waters*: COGUNF01 (All tributaries to North Fork of the Gunnison River, including all lakes, reservoirs, and wetlands within the West Elk and Raggeds Wilderness Areas).

303(d) Listed Waters

The Federal Clean Water Act (CWA) requires Colorado to prepare a biennial report summarizing the status of water quality as a means of conveying recent monitoring data to the United States Environmental Protection Agency (USEPA). Waters determined to be “impaired” (i.e., either “partially supporting” or “not supporting” their designated uses), are placed on the state’s list of impaired waters, as required by Section 303(d) of the Clean Water Act. The state is then required to establish Total Maximum Daily Loads (TMDLs) to meet and maintain water quality standards for water bodies on the 303(d) List.

The Colorado Water Quality Control Commission is required to update the 303(d) list every two years. The major pollutant causing water quality impairment in the North Fork is selenium. In 2010, there were four segments on the 303(d) list for selenium (Se) impairment (Table 5-2). Figure 5-1 shows the location of the impaired segments; the four listed segments include the North Fork mainstem and all tributaries below Paonia. The North Fork water quality impairments have been designated as high priority for TMDL determination. In 2009, the WQCC published a draft TMDL assessment for the Lower Gunnison Basin, including the North Fork. The findings of the TMDL are discussed later in this section.

Table 5-1: Use Classifications and Standards

Stream Segment	Designation	Classification	Numeric Standards						Temporary Modifications
			Physical and Biological	Inorganic (mg/L)		Metals (ug/L)			
COGUNF01: All tributaries to North Fork of the Gunnison River including all lakes, reservoirs, and wetlands within the West Elk and Raggeds Wilderness Areas.	OW	Aq Life Cold 1 Recreation E Water Supply Agriculture	D.O.=6.0 mg/l D.O.(sp)=7.0 mg/l pH=6.5-9.0 E.Coli=126/100ml	NH_3(ac/ch)=TVS Cl_2(ac)=0.019 Cl_2(ch)=0.011 CN=.005	S=0.002 B=0.75 NO_2=0.05 NO_3=10 Cl=250 SO_4=WS	As(ac)=340 As(ch)=0.02(Trec) Cd(ac)=TVS(tr) Cd(ch)=TVS CrIII(ac)=50(Trec) CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=WS(dis) Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ac/ch)=TVS Mn(ch)=WS(dis) Hg(ch)=0.01(tot)	Ni(ac/ch)=TVS Se(ac/ch)=TVS Ag(ac)=TVS Ag(ch)=TVS(tr) Zn(ac)=TVS Zn(ch)=TVS(sc)	
COGUNF02: Mainstem of North Fork of the Gunnison River from the confluence of Muddy Creek and Coal Creek to the Black Bridge (41.75 Drive) above Paonia.		Aq Life Cold 1 Recreation E Water Supply Agriculture	D.O.=6.0 mg/l D.O.(sp)=7.0 mg/l pH=6.5-9.0 E.Coli=126/100ml	NH_3(ac/ch)=TVS Cl_2(ac)=0.019 Cl_2(ch)=0.011 CN=0.005	S=0.002 B=0.75 NO_2=0.05 NO_3=10 Cl=250 SO_4=WS	As(ac)=340 As(ch)=0.02(Trec) Cd(ac)=TVS(tr) Cd(ch)=TVS CrIII(ac)=50(Trec) CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=WS(dis) Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ac/ch)=TVS Mn(ch)=WS(dis) Hg(ch)=0.01(tot)	Ni(ac/ch)=TVS Se(ac/ch)=TVS Ag(ac)=TVS Ag(ch)=TVS(tr) Zn(ac)=TVS Zn(ch)=TVS(sc)	
COGUNF03: Mainstem of North Fork of the Gunnison River from the Black Bridge (41.75 Drive) above Paonia to the confluence with the Gunnison River.		Aq Life Cold 1 Agriculture Oct-March Recreation N April – Sept Recreation E	D.O.=6.0 mg/l D.O.(sp)=7.0 mg/l pH=6.5-9.0 Oct. 1 to March 31 E.Coli=630/100ml April 1 to Sept. 30 E.Coli=126/100ml	NH_3(ac/ch)=TVS Cl_2(ac)=0.019 Cl_2(ch)=0.011 CN=0.005	S=0.002 B=0.75 NO_2=0.05 NO_3=100	As(ac)=340 As(ch)=7.6(Trec) Cd(ac)=TVS(tr) Cd(ch)=TVS CrIII(ac/ch)=TVS CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ac/ch)=TVS Hg(ch)=0.01(tot) Ni(ac/ch)=TVS Se(ac/ch)=TVS	Ag(ac)=TVS Ag(ch)=TVS(tr) Zn(ac/ch)=TVS	Temporary Modification: Se(ch)=5.7 Expiration date 12/31/2011.
COGUNF04: All tributaries to the North Fork of the Gunnison River including all lakes, reservoirs, and wetlands from the source of Muddy Creek to a point immediately below the confluence with Coal Creek; all tributaries to the North Fork of the Gunnison including all lakes, reservoirs, and wetlands, including the Grand Mesa Lakes which are on national forest lands, except for the specific listing in Segments 1 and 7.		Aq Life Cold 1 Recreation E Water Supply Agriculture	D.O.=6.0 mg/l D.O.(sp)=7.0 mg/l pH=6.5-9.0 E.Coli=126/100ml	NH_3(ac/ch)=TVS Cl_2(ac)=0.019 Cl_2(ch)=0.011 CN=0.005	S=0.002 B=0.75 NO_2=0.05 NO_3=10 Cl=250 SO_4=WS	As(ac)=340 As(ch)=0.02(Trec) Cd(ac)=TVS(tr) Cd(ch)=TVS CrIII(ac)=50(Trec) CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=WS(dis) Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ac/ch)=TVS Mn(ch)=WS(dis) Hg(ch)=0.01(tot) Ni(ac/ch)=TVS	Se(ac/ch)=TVS Ag(ac)=TVS Ag(ch)=TVS(tr) Zn(ac)=TVS Zn(ch)=TVS(sc)	
COGUNF05: Mainstems of Hubbard Creek, Terror Creek, Minnesota Creek, and Leroux Creek from their boundary with national forest land to their confluences with the North Fork of the Gunnison River; mainstem of Jay Creek from its source to its confluence with the North Fork of the Gunnison River; mainstem of Roatcap Creek including all tributaries, wetlands, lakes and reservoirs, from its source to its confluence with the North Fork of the Gunnison.		Aq Life Cold 1 Recreation P Water Supply Agriculture	D.O.=6.0 mg/l D.O.(sp)=7.0 mg/l pH=6.5-9.0 E.Coli=205/100ml	NH3(ac/ch)=TVS Cl_2(ac)=0.019 Cl_2(ch)=0.011 CN=.005	S=0.002 B=0.75 NO2=0.05 NO3=10 Cl=250 SO_4=WS	As(ac)=340 As(ch)=0.02(Trec) Cd(ac)=TVS(tr) Cd(ch)=TVS CrIII(ac)=50(Trec) CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=WS(dis) Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ac/ch)=TVS Mn(ch)=WS(dis) Hg(ch)=0.01(tot) Ni(ac/ch)=TVS	Se(ac/ch)=TVS Ag(ac)=TVS Ag(ch)=TVS(tr) Zn(ac/ch)=TVS	Temporary Modification: Se(ch)=existing ambient quality Expiration date of 12/31/2011.
COGUNF06a: All tributaries to the North Fork of the Gunnison River including all lakes, reservoirs, and wetlands which are not on national forest lands, except for the specific listings in Segments 4, 5, 6b and 7.	UP	Aq Life Warm 2 Recreation P Agriculture	D.O.=5.0 mg/l pH=6.5-9.0 E.Coli=205/100ml	NH_3(ac/ch)=TVS Cl_2(ac)=0.019 Cl_2(ch)=0.011 CN=0.005	S=0.002 B=0.75 NO_2=0.05 NO_3(ac)=10 Cl(ch)=250	As(ac)=340 As(ch)=100(Trec) Cd(ac/ch)=TVS CrIII(ac)=50(Trec) CrVI(ac/ch)=TVS	Cu(ac/ch)=TVS Fe(ch)=1000(Trec) Mn(ac/ch)=TVS Hg(ch)=0.01(tot) Ni(ac/ch)=TVS`	Se(ac/ch)=TVS Ag(ac)=TVS Ag(ch)=TVS Zn(ac/ch)=TVS	
COGUNF06b: Mainstem and all tributaries to Bear Creek, Reynolds Creek, Bell Creek, McDonald Creek, Cottonwood Creek, Love Gulch, Cow Creek, Dever Creek, German Creek, Miller Creek, Stevens Gulch, Big Gulch, Stingley Gulch and Alum Gulch including lakes, reservoirs, and wetlands which are not on national forest lands from their source to the North Fork of the Gunnison River.	UP	Aq Life Warm 2 Recreation P Water Supply Agriculture	D.O.=5.0 mg/l pH=6.5-9.0 E.Coli=205/100ml	NH_3(ac/ch)=TVS Cl_2 (ac)=0.019 Cl_2 (ch)=0.011 CN=.005	S=0.002 B=0.75 NO_2=0.05 NO_3(ac)=10 Cl(ch)=250 SO_4=WS	As(ac)=340 As(ch)=0.02(Trec) Cd(ac/ch)=TVSCrIII(ac)=50(Trec) CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=WS(dis) Fe(ch)=1000(Trec) Mn(ac/ch)=TVS Mn(ch)=WS(dis) Hg(ch)=0.01(tot) Ni(ac/ch)=TVS`	Se(ac/ch)=TVS Ag(ac)=TVS Ag(ch)=TVS Zn(ac/ch)=TVS	Temporary Modifications: Fe(ch)(Trec)=existing ambient quality, Se(ch)=existing ambient quality Expiration date of 12/31/2011. Water + Fish Standards
COGUNF07: Paonia Reservoir.		Aq Life Cold 1 Recreation E Water Supply Agriculture	D.O.=6.0 mg/l D.O.(sp)=7.0 mg/l pH=6.5-9.0 E.Coli=126/100ml	NH_3(ac/ch)=TVS Cl_2 (ac)=0.019 Cl_2 (ch)=0.011 CN=.005	S=0.002 B=0.75 NO_2=0.05 NO_3=10 Cl=250 SO_4=WS	As(ac)=340 As(ch)=0.02(Trec) Cd(ac)=TVS(tr) Cd(ch)=TVS CrIII(ac)=50(Trec) CrVI(ac/ch)=TVS	Cu(ac/ch)=TVS Fe(ch)=WS(dis) Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ac/ch)=TVS Mn(ch)=WS(dis)	Hg(ch)=0.01(tot) Ni(ac/ch)=TVS Se(ac/ch)=TVS Ag(ac)=TVS Ag(ch)=TVS(tr) Zn(ac/ch)=TVS	

TVS =Table Value Standard, ac = acute, ch = chronic, dis = dissolved, tot = total

Table 5-2: WBID Segments on the 2010 Impaired Waters List

WBID	Segment Name	Portion	Impairment	Priority
COGUNF03	North Fork of the Gunnison from Black Bridge above Paonia to the confluence within the Gunnison	all	Se	H
COGUNF05	Hubbard, Terror, Minnesota and Leroux Creeks from USFS boundary to N. Fork. Mainstem of Jay Creek and mainstem and tribs of Roatcap Creek to the N. Fork	Leroux Creek, Jay Creek	Se	H
COGUNF06a	Tributaries to N. Fork of Gunnison River not on USFS property	Short Draw	Se	H
COGUNF06b	Bear, Reynolds, Bell, McDonald, Cottonwood, Love, Cow, Dever, German and Miller Creeks, Stevens, Big, Stingley and Alum gulch not on USFS property	Cottonwood Creek	Se	H

Source: 2010 303(d) List of Impaired Waters

Use-Impaired Waters

Colorado also maintains a Monitoring and Evaluation (M&E) List. The M&E List identifies water bodies with suspected water quality problems but where there is insufficient information about whether it meets standards. The 2010 M&E List identified two segments of the North Fork that may be impaired by total recoverable iron (Fe). Table 5-3 summarizes water bodies that are on the M&E list, and Figure 5-2 shows their location.

Table 5-3: WBID Segments on the 2010 M&E List

WBID	Segment Name	Portion	Impairment
COGUNF06a	Tributaries to the North Fork of the Gunnison not on USFS lands	Coal Gulch, Hawksnest Creek, Gribble Gulch	Fe(Trec)
COGUNF06b	Bear Creek, Reynolds Creek, Bell Creek, McDonald Creek, Cottonwood Creek, Love Gulch, Cow Creek, Dever Creek, German Creek, Miller Creek, Stevens Gulch, Big Gulch, Stingley Gulch and Alum Gulch not on national forest lands from the source to the North Fork of the Gunnison River	Cottonwood Creek Big Gulch	Fe(Trec) Se

Source: 2010 Monitoring and Evaluation List

Impaired Stream Segments

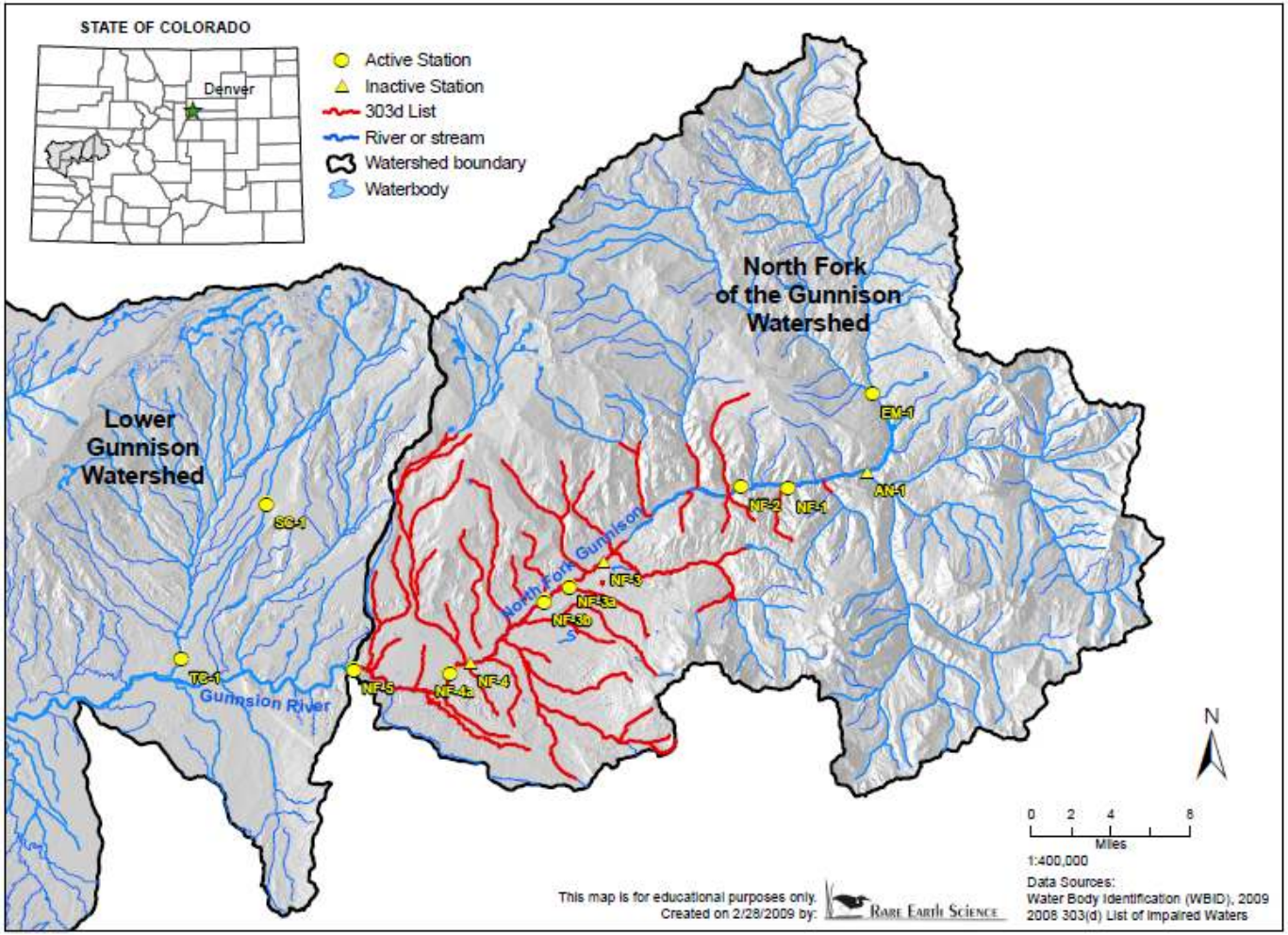

Figure 5-1: Map of Impaired Stream Segments

Monitoring and Evaluation List Map

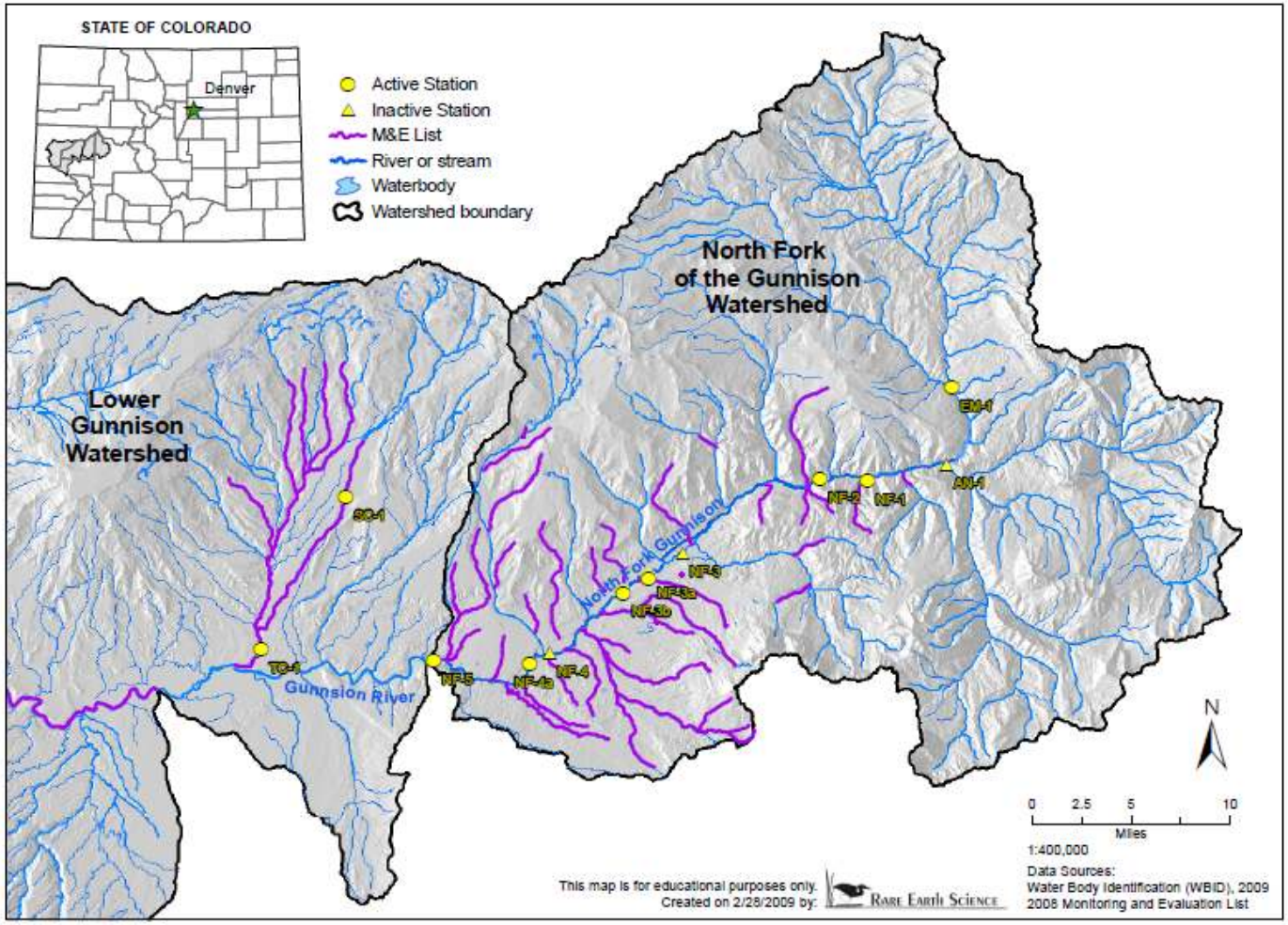

Figure 5-2: Map of M&E Segments

5.2 *Reports and Scientific Studies*

NFRIA Volunteer Monitoring Water Quality Report

In 2009, NFRIA commissioned a review of water quality data collected by the North Fork Volunteer Water Quality Monitoring Network (the Network). The Network collects and analyzes monthly surface water data in partnership with the Colorado River Watch program and EPA Region 8. The 2009 report evaluated water quality data (field parameters, metals, nutrients, bacteria and macroinvertebrates) collected in the North Fork between October 2004 and October 2007. Water quality data collected by the Network provide a baseline understanding of water quality conditions in the North Fork, help water users understand seasonal and natural variations within the watershed, and provide a basic understanding of how the North Fork compares to state stream standards.

Water quality samples collected by the Network indicate that, overall, the North Fork has moderate to good water quality, given natural dissolved solids (salts) and metals inputs that are derived from the watershed's geology. Sample analyses found elevated concentrations of dissolved arsenic and selenium that often exceeded chronic aquatic life standards. Dissolved fractions of copper, iron and lead also had isolated spikes that exceeded table value standards, but natural sources of salts in the watershed provide the North Fork with ample capacity to buffer against changes in pH and the toxic effects of the metals.

Storm events tend to move large amounts of sediment and organic material through the North Fork. Particulate matter transported through the system is often laden with adsorbed metals and nutrients, such as total iron and phosphorus. Overall, however, nutrient concentrations in the North Fork were relatively low. Nitrate concentrations were well below the 10 mg/L for drinking water standards, and ammonia concentrations were generally an order of magnitude below state the standard. Biological data indicate that the North Fork routinely exceeded the *E. coli* standard during summer months

Cumulative Hydrologic Impact Assessment

The Colorado Division of Reclamation, Mining and Safety (DRMS) is required to prepare a Cumulative Hydrologic Impact Analysis (CHIA) for each coal producing area. The objectives of the CHIA are to assess the probable cumulative impacts of all anticipated coal mining in a study area, and to verify that the cumulative impacts will not result in material damage to the hydrologic balance in areas outside of mine permit areas.

One aspect of the CHIA report is an evaluation of the impacts of mines in the North Fork watershed to groundwater. The report found that the mines do not pump significant quantities of groundwater (DRMS, 2009) Dewatering of water-bearing units does occur by removal of coal and subsidence cracks; however, dewatering appears to be localized and is not significant enough to damage groundwater supplies. Gob leachate is the mineralized water that accumulates in an underground mine. The CHIA report found that gob leachate into groundwater will be prevented by the low permeability of the un-mined rock in the walls, roof and floor of the underground workings. The potential for leachate seepage into groundwater by surface disturbances, coal piles, is also limited.

The CHIA also evaluated impacts to surface water supplies. Most of the watershed's coal mines use water from the North Fork and diversion ditches for coal spraying, dust control, fire control, and potable water supplies. The mines own water rights for over 1,858 AFY. Recent annual withdrawals have been approximately 662 acre-feet and account for less than 1% of the North Fork's average annual water use. Mine facilities also are required to comply with stormwater controls, including sediment control ponds, to limit runoff of leachate and sediment from surface facilities into a stream. Gob leachate is a potential source of surface water pollution, especially if an inactive mine working floods with groundwater and discharges to the surface. Gob leachate is commonly high in iron and TDS, and if spilled into the North Fork in high concentrations, could cause significant damage to aquatic life and irrigation supplies (DRMS, 2009).

USGS Selenium Report

In 2008, the U.S. Geological Survey (USGS), in cooperation with the Colorado Water Quality Control Division, completed an Analysis of Dissolved Selenium Loading for Selected Sites in the Lower Gunnison River Basin, Colorado, 1978-2005 (Thomas et al., 2008). The report assessed historical stream data from 12 sites within the North Fork watershed. All 12 sites lacked sufficient data to calculate mean annual selenium loads, but six sites had 85th percentile selenium concentrations that exceeded the chronic water-quality standard (4.6 ug/L). These latter sites included Leroux Creek, Jay Creek, Big Gulch, Short Draw, and Bell Creek.

The cumulative mean selenium load from all 12 sites assessed by the report was 2.3 lbs/day, which translates to approximately 840 lbs/year. The load contributed by Leroux Creek, Jay Creek, Big Gulch, Short Draw, and Bell Creek was 562 lbs/year. Attainment of the 4.6 ug/L Aquatic Life-based chronic standard at the mouth would require removal of 340 lbs/year.

In a previous report, the USGS calculated the annual selenium load at the mouth of the North Fork to be 1,300 and 1,400 lbs/year for 1999 and 2000, respectively (Butler and Leib, 2002). The cumulative mean annual selenium load calculated for the 12 previously discussed selected sites (840 lbs/year) represents more than one-half of the mean annual selenium load of the North Fork. The sources of the remaining mean annual selenium load are unknown but likely include naturally occurring selenium from groundwater, surface water runoff, deep percolation of irrigation water, or septic systems.

WQCD Draft Selenium TMDL

Under section 303(d) of the Federal Clean Water Act, states are required to develop lists of impaired waters. These are waters that are too polluted or degraded to meet the water quality standards. The law requires that states establish priority rankings for waters on the lists and develop TMDLs for these waters. A Total Maximum Daily Load, or TMDL, is a calculation of the maximum amount of a pollutant that a water body can receive and still safely meet water quality standards. The TMDL process ensures that all sources of pollutant loading are accounted for when devising strategies to meet water quality standards. There is one draft TMDL for the North Fork watershed: *Total Maximum Daily Load Assessment Gunnison River and Tributaries* (WQCD, 2009).

The Draft Gunnison River TMDL addresses water quality impairments as identified in the 2008 303(d) list for selenium contamination in the Gunnison River and its tributaries, including the North Fork (WQCD, 2009). The impaired WBID segments, listed water body, and impaired designated uses are listed in Table 5-4. The TMDL goal is “fully supporting” all assigned Use Classifications.

The TMDL assessment found that annual loads from the North Fork total 3,124 pounds. Currently, the North Fork contributes approximately 26 percent of the annual selenium load to the lower Gunnison River. In order to meet state stream standards for selenium (4.6 ug/L), the mean annual selenium load in the North Fork must be reduced by 18 percent, or 568 lbs (WQCD, 2009).

A TMDL is the sum of the Waste Load Allocation (WLA), which is the load from point source discharge, Load Allocation (LA), which is the load attributed to natural background and/or nonpoint sources, and a Margin of Safety (MOS). Data used to calculate the North Fork TMDL suggests that selenium loads associated with permitted discharges, including sand and gravel operations, as well as municipal wastewater treatment plants, may represent a significant percentage of the selenium load. The cumulative annual selenium load for permitted dischargers in the North Fork could potentially contribute as much as 32 percent of the allowable load if all facilities are discharging at design capacity during chronic low flows. However, the WQCD estimates that current point source contributions may be between 10 and 20 percent. The remainder of the load is attributable from nonpoint source contributions associated with irrigation projects (WQCD, 2009).

Table 5-4: Ambient Water Quality Criteria and Status for 303(d) Listed Segments

WBID	Waterbody	Impaired Use	Annual Load Reduction
COGUNF03	North Fork	Aquatic Life (chronic)	568 lbs
COGUNF05	Leroux Creek	Aquatic Life (chronic)	159 lbs
COGUNF05	Jay Creek	Aquatic Life (chronic)	13.9 lbs
COGUNF06a	Short Draw	Aquatic Life (chronic)	165 lbs
COGUNF06b	Big Gulch	Aquatic Life (chronic)	29 lbs
COGUNF06b	Bell Creek*		58 lbs
COGUNF06b	Cottonwood Creek	Aquatic Life (chronic)	66 lbs
* Bell Creek is not on the 303d List, but was included in the TMDL analysis			

Source: Draft Gunnison River TMDL Assessment (WQCD, 2009)

Selenium and Salt Planning Grant

The "Employing Innovative Data and Technology for Water Conservation Targeting and Planning in the Salinity and Selenium Affected Areas of the Lower Gunnison River Basin" project was developed to create a comprehensive Geographic Information System (GIS) of water- quality, water-quantity and soil survey information that could be used by NRCS and by water- and land-use planners to target specific locations for cost-effective water conservation improvements to minimize deep percolation and contaminant loading. The project compiled, digitized, mapped and analyzed available information on the location and extent of salinity control projects, soil-quality information with respect to selenium and salinity mobilization, water supply and water use information.

The results from the mapping project were used to characterize irrigation practices as well as selenium and salinity mobilization potential for water districts in Delta County and sub-watersheds in the entire Lower Gunnison Basin. The report found that 1,744 acres of irrigated land in the North Fork have high to very high selenium loading potential and 260 acres of high salt loading potential Reynolds Creek, Cottonwood Creek, and Short Draw drainages exhibited the highest selenium loading potential in the North Fork. Reynolds and Cottonwood Creek also had the highest salt loading potential (CRWCD, 2010).

Salinity

Salinity is one of the most significant water-quality issues in the entire Colorado River basin. Salinity is a measure of the mass of dissolved salts and is often expressed in terms of total dissolved solids (TDS). To date, there are no comprehensive salinity evaluations of the North Fork watershed or Gunnison basin. However, a USGS report characterizing salinity of the Gunnison River and major tributaries is expected by summer, 2010. Recent evaluations of salinity levels in the Colorado Basin indicate that average salinity concentrations in the Gunnison River, depending on the season, are 300-700 mg/L (Leib and Bauch, 2008; CRBSCF, 2008).

The 1974 Colorado River Basin Salinity Control Act authorizes the U.S. Department of Interior (Interior) and U.S. Department of Agriculture (USDA) to enhance and protect the quality of water in the Colorado River for use in the United States and the Republic of Mexico. In response to the Act, the US Bureau of Reclamation (BOR) established the Colorado River Basin Salinity Control Project (CRBSCP). Since then, the BOR and federal Natural Resources Conservation Service (NRCS) have spent millions of dollars on salinity reduction projects in the Lower Gunnison Basin. Prior to salinity improvement efforts, salinity loads from the North Fork were estimated to be 270,000 tons/year (Personal communication, Mike Baker, 2009). Water quality improvements as a result of salinity control measures are expected to be documented in the 2010 USGS study.

Preliminary Morphological Assessment

In 1997, NFRIA conducted a preliminary assessment of the morphological characteristics along the North Fork (Crane, 1997). The purpose of this study was to identify the causes of river degradation by examining historical uses and investigating morphological characteristics of the river channel. The dimensions, pattern, and profile of the North Fork were measured at 12 cross sections from Terror Creek downstream to the Chipeta Fish Hatchery. The data were analyzed to determine causes, rates, magnitudes, and directions of river adjustments, as well as to develop recommendations to decrease excessive channel erosion.

The cross sections within the study reach on the North Fork vary considerably and contain different stream types at different locations. In general, however, the entrenchment ratio and the pebble counts fall within the average range of stable C3 streams, while the width/depth ratio, sinuosity, and the slope have been substantially altered. Sinuosity, width/depth ratio and river slope were therefore determined to be the primary morphological variables in need of adjustment.

Historical knowledge of the river, combined with knowledge of the river's present channel characteristics (described above), suggests that the most probable stable form of the North Fork in the study area is a C3. As a stable C3 river, the North Fork would have increased sinuosity, an expanded floodplain, and improved composition, density and vigor of riparian vegetation.

Historical Analysis and Sediment Budget

Sediment and channel dynamics of the North Fork River were subsequently evaluated in 2000-2002 to provide context for channel rehabilitation efforts. The research demonstrated that, although broadly controlled by geology and climate, sediment and channel dynamics along the North Fork may be negatively affected by human impacts (Jaquette, 2003).

Jaquette found that the North Fork, from upstream of Paonia downstream to Hotchkiss, has been predominantly braided throughout recent history. Aerial photographs dating back to 1939 and historical records back to the late 1800s suggest that the channel was historically broad and shallow with multiple, shifting flow paths. Evidence of cottonwood tree germination in gravel, rather than fine sediment, suggests that the floodplain was fairly flat and had a high water table. These conditions are characteristic of braided river systems. Channel characteristics such as discharge, gradient, and sediment supply in the North Fork also support this conclusion.

Aerial photographs indicated, however, that the channel pattern of the North Fork has fluctuated through time, apparently and primarily in response to precipitation and discharge. During wet periods with high flows, such as the 1980s-1990s, the North Fork exhibited a broad, rapidly shifting, and highly braided pattern. During drier periods with lower flows, such as the 1930s, the river had a narrower, single-thread channel.

Human actions, including irrigation withdrawals and returns, clearing of riverside vegetation, and in-channel gravel mining, may exacerbate or counteract naturally-driven channel changes associated with wetter and drier periods. The net effect of these three human activities is to decrease bank stability and increase the degree of braiding and bank erosion along the river. Where human activities, such as gravel mining, trigger channel downcutting, the direction and rate of channel change may be substantially altered. For example, the water table along downcut, incised reaches of the channel may be too low, relative to the height of the channel banks, for riparian vegetation to persist. In the absence of such vegetation, unstable banks may require a much longer time to regain stability.

Reconfigured Channel Monitoring and Assessment Program

The U.S. Geological Survey (USGS) created a the Reconfigured Channel Monitoring and Assessment Program (RCMAP) to develop a uniform and versatile monitoring methodology for reconfigured channel reaches and to apply the methodology to selected reaches that have undergone reconfiguration. As part of the RCMAP, the USGS evaluated the North Fork River at

Hotchkiss. The findings of the program were reported in a Special Report of the Geological Society of America (Elliott and Capesius, 2009).

The report (Elliott and Capesius, 2009) attributed some of the observed streambed scour, deposition, and bank erosion during the study period to the sediment-entrainment ratio and the excess of flood boundary shear stress relative to the resisting force, or critical shear stress, of the sediment. Bed-load transport in the North Fork during a 6-year flood in 2005 resulted in streambed scour at some locations, deposition or alluvial-bar accretion in other locations, and channel migration by bank erosion. Elliot and Capsius hypothesize that constructed boulder or log structures were rendered nonfunctional at some locations because of high rates of bank erosion, bed-material deposition, or movement of individual boulders and logs.

Elliot and Capsius (2009) also compared channel slope and bank full discharge channel-pattern threshold during a 2-year flood. Their data indicated that the North Fork at Hotchkiss has a sufficiently steep channel slope and experiences frequent high discharge such that channel braiding, rather than a classical, single-thread meandering channel, is the natural tendency.

Section 206 Aquatic Ecosystem Restoration Project

The U.S. Army Corps of Engineers (USACE) and NFRIA conducted a planning study in 2007 entitled the *Section 206 Aquatic Ecosystem Restoration Project* to assess the feasibility of implementing an ecosystem restoration of the North Fork (USACE, 2007). The 206 report evaluated the historic riverine conditions, as well as impacts of anthropogenic activities, including gravel mining, irrigation, river channelization, and agriculture, on the natural function of the ecosystem, particularly fish and wildlife habitat. The study spanned 15 river miles along the North Fork including the Towns of Paonia and Hotchkiss. Over the 15-mile project reach, nine locations exhibited significant impacts in need of restoration (Figure 5-3). The Detailed Project Report (DPR) has not been finalized, but renewed funding to the USACE may revive the project. Many of the sites have been competed with other sources of funding, but there is renewed interest in projects at Paonia River Park and Midway.

Disturbances causes by the anthropomorphic activities listed above have led to channel deterioration and incision, reduced sinuosity, unstable banks, increased erosive power, increased sediment generation, and swallowing of the low-flow channels. Channel incision has also resulted in loss of floodplain connectivity. Physical changes in the river have altered aquatic habitats in many ways. Width-to-depth ratios have increased, pools have decreased in depth and frequency, and shallow runs now dominate the river. Overhanging banks, shading by riparian vegetation and in-stream cover are mostly absent, replaced in many areas by invasive non-native vegetation. These conditions promote elevated summer water temperatures, which are exacerbated by areas of reduced or negligible flow due to diversions. Some diversions inhibit or prevent fish passage. Backwater and oxbow habitats are also greatly reduced. Greater width-to-depth ratios also have allowed shallow runs and pools to freeze solid during severe winters, leading to fish kills.

Vegetation Inventory

In 1997, the Natural Resources Conservation Service conducted an inventory of riparian vegetation along the North Fork (NRCS,1997). Sixteen river miles between Terror Creek and the Chipeta Fish Hatchery were inventoried to obtain baseline information on the North Fork's vegetative composition. The study also identified reference reaches and assessed the ability of current vegetation to stabilize stream banks.

Overall, the inventoried areas display adequate seed and root sources for colonization. However, colonization is only successful when favorable sediment and hydrologic conditions are present. In most cases, entrenchment of the stream channel prevents fine sediment from depositing in the floodplain, inhibiting the establishment of vegetation.

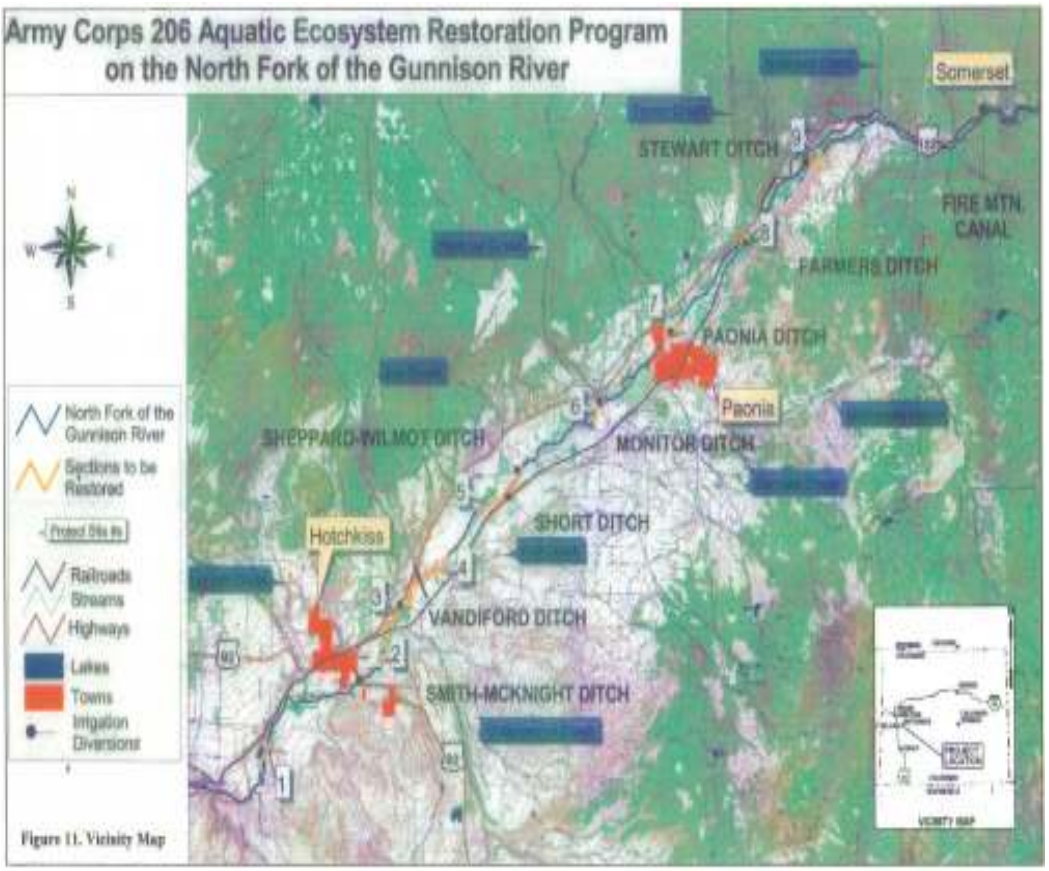

Figure 5-3: USACE 06 Restoration Sites

Source: USACE, 2007

Colorado Natural Heritage Program Report

The Colorado Natural Heritage Program reviewed riparian sites along the North Fork corridor in 2000 to identify areas with unique or significant riparian vegetation and to prioritize the sites' relative values for conservation (CNHP, 2000). The report found that heavy competition for resources has resulted in the deterioration of riparian corridor function in the Upper Gunnison basin. Much of this dysfunction is the result of non-native species introduction, regulation and diversion of river flows, and land use conversion.

In the North Fork, historical land use conversions and water diversions have been the primary factors affecting riparian vegetation. However, despite the overall decline in riparian vegetation, several locations have retained important components of a natural riparian community. These sites would require restoration in order to be returned to their natural state. Any conservation or restoration effort should include a site management plan that defines objectives and management practices. The plan should include a weed management plan and a site-specific evaluation of hydrologic conditions to ensure establishment and maintenance of native riparian vegetation.

Section 6: Issues of Concern

There are many uses of water in the North Fork watershed, all of which require adequate water quantity. Many uses similarly require good water quality. Water uses that depend on good quality include drinking and domestic water supplies, irrigation water, recreation and aquatic life. This section discusses influences on water quality in the watershed, including consumptive water use, point source and nonpoint source pollution, as well as impacts from hydro-modification of stream condition.

6.1 *Water Quantity*

Low Flow Conditions

Natural flows in the North Fork are limited by a variety of consumptive water uses, including irrigation diversions and water storage. Low flows can aggravate the effects of water pollution. Dilution is the primary mechanism by which the concentrations of contaminants (e.g. copper, lead) discharged from facilities and non-point sources are reduced. In periods of low flows, there is less water available to dilute effluent loadings, which can result in higher in-stream concentrations of pollutants. Furthermore, wind, bank storage, spring seepage, tributary streams, and the warming effect of the sun have greater impacts on stream water temperatures during low-flow periods. The exaggerated effects of these factors can be additional stressors on aquatic life. The reach of the North Fork perhaps most affected by altered flow regimes lies between Paonia and Hotchkiss. Irrigation diversions typically reduce late summer flow rates below Paonia (USGS Gage 9134100) to less than 30 cfs (Figure 6-1). What little water remains in the river is mostly derived from irrigation return flows.

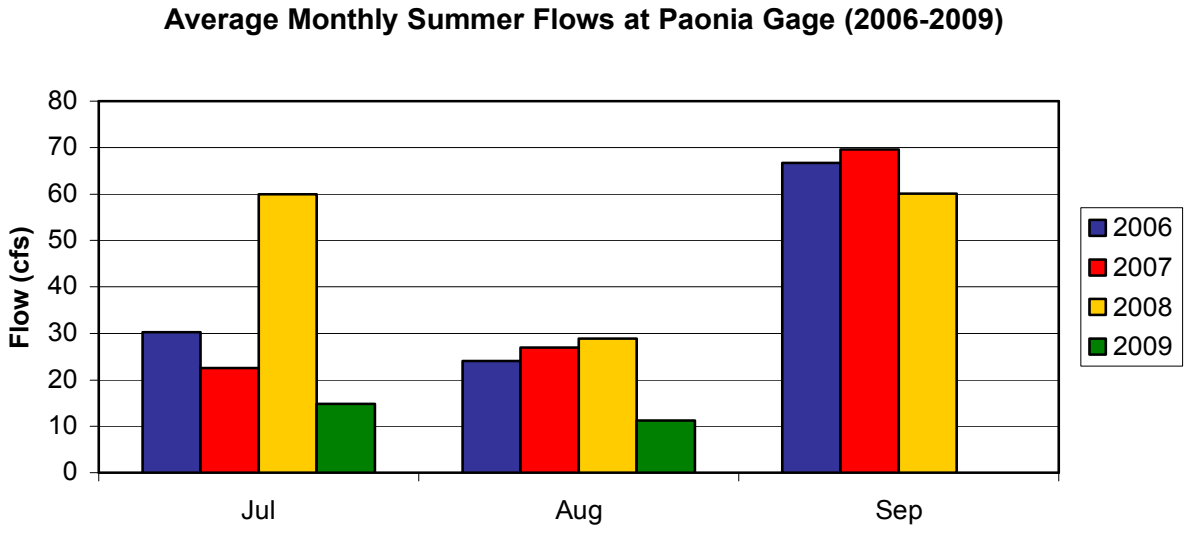

Figure 6-1: Monthly Summer Flows at Paonia

Source: NWIS Real Time Water Data

There are twelve major diversions on the North Fork (Figure 6-2). In addition, flow in most of the major tributaries (Hubbard Creek, Terror Creek, Minnesota Creek, Roatcap Creek, German Creek, Bell Creek, Jay Creek, Cottonwood Creek, and Leroux Creek) is altered to some extent by diversions for agricultural use. Inefficient diversion structures can lead to significant dewatering. Often times, the diversion structure will divert more than the appropriated water right from the river and return the excess water at a downstream location. Measuring the diversion at the point of in-take is one mechanism of increasing efficiency.

Of the twelve major irrigation diversions on the North Fork, NFRIA has reconstructed seven and was instrumental in the design and reconstruction of an eighth. NFRIA's headgate reconstruction designs are typically low head, rock diversion structures with concrete headgates at the point of diversion. Rebuilding irrigation diversions provides reliable and efficient irrigation water while conserving in-stream flows. Refer to Section 2 for a review of NFRIA's irrigation diversion projects.

Water not lost to evapotranspiration returns to the river by means of return drains, tributary streams, and groundwater. Dewatering from irrigation can also result in increased sedimentation. This occurs because reduced flow rates downstream of the diversion diminish the stream's ability to transport sediment loads, especially the stream's bedload.

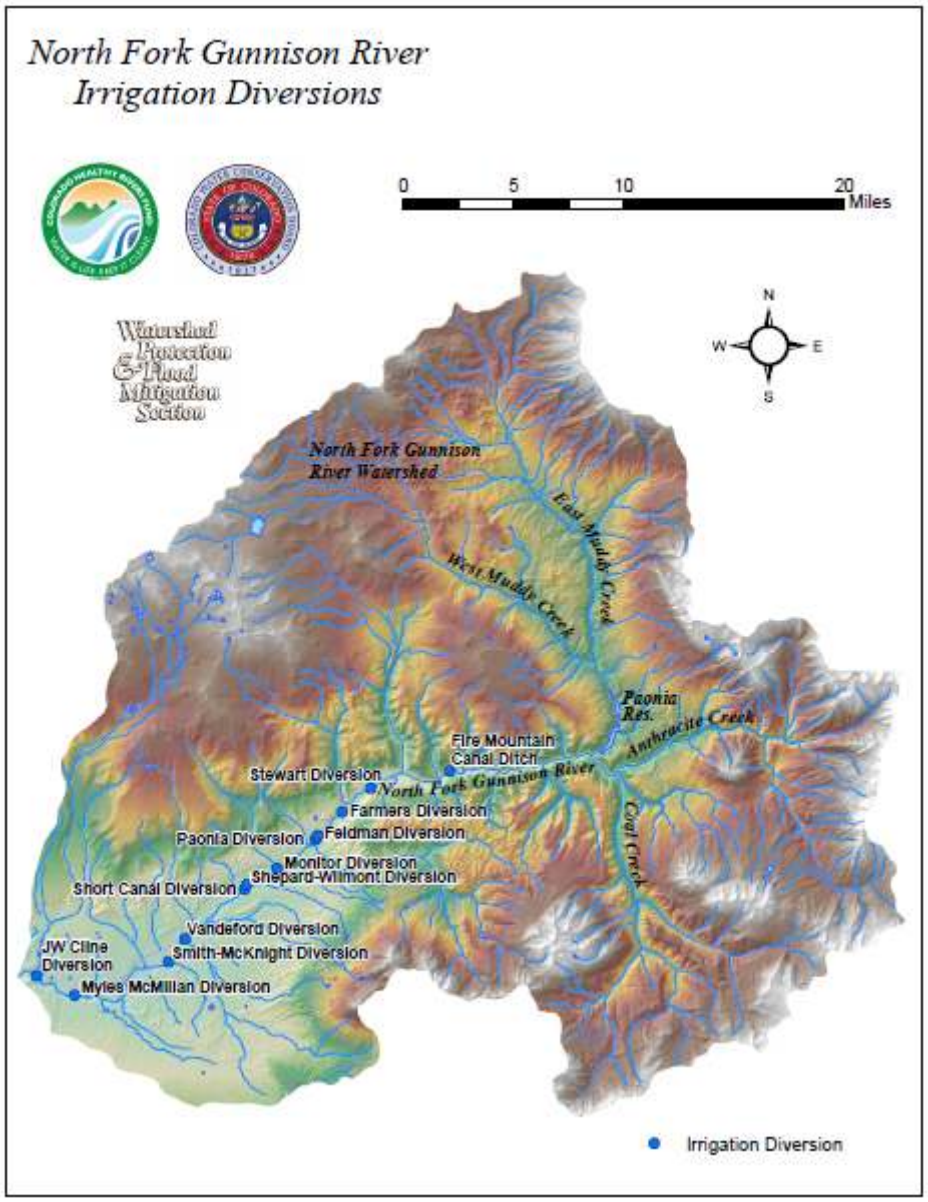

Figure 6-2: Major Diversion Structures on the North Fork River

Loss of Storage in Paonia Reservoir

Paonia Reservoir was commissioned in 1962, with an original capacity of 21,000 acre-feet. As of the last sediment survey in 2002, the reservoir has lost approximately 24% of its total capacity, and annual storage losses due to on-going sediment accumulation are approximately 124 acre-feet. Assuming this historic sedimentation rate continues, the reservoir's storage volume will be completely displaced by sediment within the next 125 years. Nearly all of the dead and inactive pools (storage reserved by federal agencies) have already been depleted due to sedimentation losses, and active storage is currently being reduced (NFWCD and FMCRC, 2007).

A second and more immediate impact of sediment accumulation in Paonia Reservoir is the formation of a large delta, which has extended downstream to over 80% of the length of the reservoir and to within 3,000 feet of the dam (Figure 6-3). The delta is expected to reach the dam within the next ten to 20 years. Sediment accumulation around the reservoir's outlet intake structure is expected to adversely affect the reservoir in ways that may impede the ability to control the reservoir consistent with historic operations, in accordance with downstream demands for storage releases and in a way which avoids detrimental downstream environmental impacts.

Figure 6-3: Sediment accumulation in Paonia Reservoir

The consequences of lost storage capacity will impact all aspects of water management in the North Fork watershed. In addition to irrigation water, Paonia Reservoir provides flat-water recreation, fishing, flood control for downstream towns and developments, water for downstream calls (specifically calls placed by Redlands Water and Power Company), water to supplement normal late summer low stream flows, and existing as well as potential future augmentation water. These uses may be curtailed if a solution is not found.

In September, 2007 the North Fork Water Conservancy District and the Fire Mountain Canal and Reservoir Company received funds from the Gunnison Basin Roundtable and Statewide Water Supply Reserve Accounts for the *Sediment Management Study for Paonia Reservoir*. The results of a Paonia Reservoir sediment management study are expected the latter half of 2010. However, at this writing there appears to be no foreseeable way to remove sediment already stored in the reservoir because dredging is cost prohibitive and stabilizing upstream reaches is considered not economically feasible.

6.2 *Water Quality*

Point Sources

The National Pollutant Discharge Elimination System (NPDES) permit program controls water pollution by regulating point source discharge pollutants into waters of the United States. Industrial, municipal, and other facilities must obtain permits if their dischargers go directly to surface waters. The State of Colorado has been designated primacy to authorize and implement NPDES requirements for waters of the state on non-tribal lands. Colorado Discharge Permit System (CDPS) process water permits include construction dewatering, groundwater remediation, mining, minimal industrial discharges, water and wastewater treatment, and other permits not falling into the above categories. There are currently 17 NPDES discharge permits issued in the North Fork watershed (Figure 6-4).

North Fork NPDES Permits

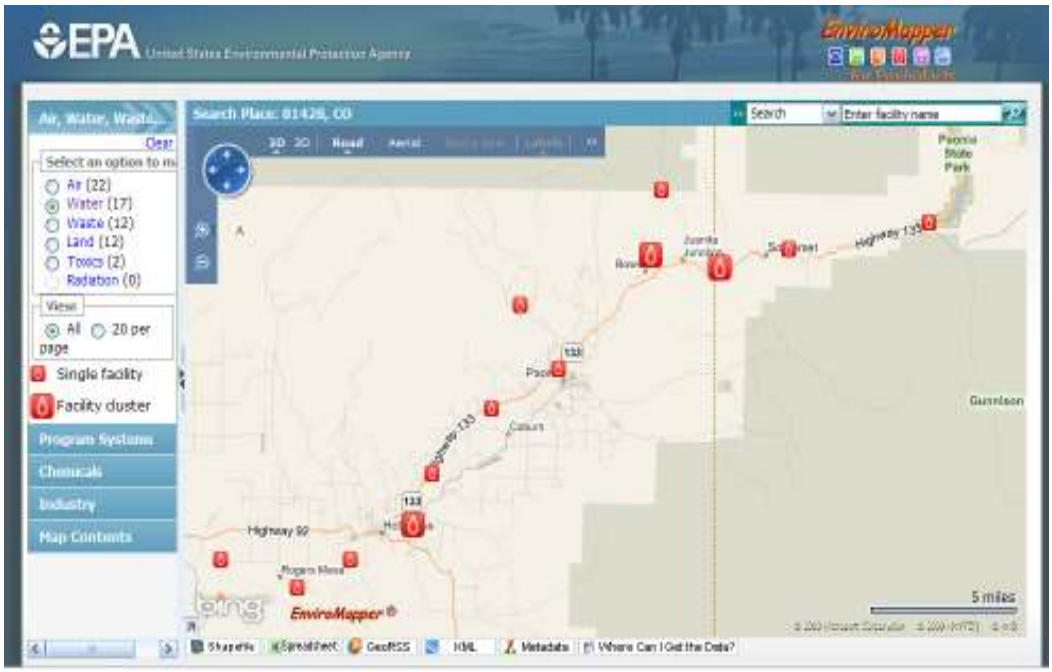

Figure 6-4: Location of NPDES Permits

Source: EPA Enviromapper, 2/19/10

Permit compliance data, required by the Federal Clean Water Act, is stored in the EPA ICIS-NPDES (Integrated Compliance Information System - National Pollutant Discharge Elimination System). This system stores permit information, inspection and enforcement history, and compliance information. Table 6-1 identifies the NPDES permits, and effluent exceedances at each facility in the past three years. As a part of an NPDES permit, facilities may be required to monitor effluent concentrations on a specific basis. The monitoring results must then be submitted to the state by means of a Discharge Monitoring Report (DMR). Table 6-1 shows that permit compliance from seven of the permitees cannot be evaluated due to *incomplete DMR entries*. This means that exceedances of effluent limits are unknown because monitored effluent values were unavailable for at least one DMR in the past three years. Of the permitees with complete DMR entries, Bowie Mine No. 2 and the West Elk Mine had the highest number of effluent exceedances in the last three years, 10 and 14, respectively. The West Elk Mine effluent violations included the following parameters: *total suspended solids; BOD, 5-day, percent removal; BOD, 5-day, 20 deg C; Suspended solids percent removal; potentially dissolved Iron;*

and total recoverable Iron. Bowie No. 2 Mine effluent violations included: *total suspended solids; BOD, 5-day, 20 deg. C; Flow, % Effect State 7 Day Chronic Ceriopaphnia and % Effect State 7 Day Chronic Pimephales.*

Whole Effluent Toxicity (WET) refers to the aggregate toxic effect on aquatic organisms from all pollutants contained in a facility's wastewater (effluent). WET tests measure wastewater's effects on specific test organisms' ability to survive, grow and reproduce. Two common measures of WET are: % Effect State 7 Day Chronic Ceriopaphnia and % Effect State 7 Day Chronic Pimephales.

Table 6-1: NPDES Permits and Effluent Exceedances

Facility Type	Permittee	Permit No.	# of Effluent Exceedances (past 3 yrs)	Notes
Sewerage Systems	Town of Paonia	CO0021709	0	
	Town of Hotchkiss	CO0044903	2	
	Crystal Meadows Ranch	COX621017	incomplete dmr entry	
Fish Hatcheries and Preserves	Hotchkiss National Fish Hatchery	CO0000086	n/a	Federal Permit, DMRs may not be required
Water Supply	Town of Hotchkiss WTF	COG641091	incomplete dmr entry	
Construction: Sand and Gravel	Tri-County Gravel Pit	COG500255	n/a	Has not discharged since 2006
	Campbell Gravel Pit	COG500397	1	
	4D Gravel Pit	COG500400	n/a	Monitoring not required as part of permit
	Tri County Pit	COG500498	0	
	Janet Pit	COG500458	0	
Bituminous Coal and Lignite Surface Mining	Blue Ribbon Mine	COG850009	incomplete dmr entry	
	Terror Creek Loadout	COG850028	0	
Bituminous Coal Underground Mining	Bowie No. 2 Mine	CO0044776	10	
	Bowie No. 1 Mine	COG850043	n/a	Not currently discharging
	West Elk Mine	CO0038776	14	
	Bear Coal Company Inc. No. 3 Mine	CO0044377	1	
	Sandborn Crk & Elk Crk Mines (Oxbow Inc.)	CO0000132	1	

SOURCE: http://www.epa-echo.gov/echo/compliance_report_water.html

Nonpoint Sources

Non-Sewered Areas

On-site septic (sewage) systems are the most common method of sewage treatment and disposal for homes not served by a public sewer line. A septic system consists of a tank and a drain field where the wastewater slowly seeps into the soil. Proper septic systems treat the sewage before it reaches ground and surface waters, whereas poorly designed or malfunctioning systems cause odor and water quality problems, including nutrients (nitrogen and phosphorus) and pathogens (fecal coliform and E. coli). Deep percolation from septic systems can also contribute to selenium mobilization. The only sewered areas in the North Fork watershed are the Town of Paonia, Town of Hotchkiss, and the Town of Somerset's centralized Independent Sewage Disposal System (ISDS).

The 2009 NFRIA Volunteer Water Quality Monitoring Report identified E. *coli* as a significant water quality problem in the North Fork. The report documented regular summer exceedances of state water quality standards at six water quality stations – ranging from East Muddy Creek (EM-1) to the mouth of the North Fork at Pleasure Park (NF-5). Sources of E. *coli* in the North Fork may include faulty septic systems, cattle, and wildlife.

Geology

The headwaters of the North Fork watershed were sculpted by great mountain-building events over 50 million years ago. The resulting geology is a complex mixture of sedimentary formations interrupted by various igneous intrusions. The West Elk Mountains, comprising the headwaters of the North Fork watershed, are on the edge of the Colorado Mineral Belt, a zone naturally rich in elements like gold, aluminum, copper, iron, and lead. The 2009 NFRIA Volunteer Water Quality Monitoring Report identified isolated spikes of dissolved aluminum, copper, arsenic, iron and lead in the North Fork River that exceeded state standards. There are no active hardrock mines in the watershed; therefore, natural weathering and erosion are the most likely source of metals in the river.

Sediment is also a well documented watershed problem in the North Fork. The impacts of high sediment loads are best exemplified in the loss of storage capacity in Paonia Reservoir, as discussed above. High Total Suspended Solids (TSS) concentrations (50 – 400 mg/L) at the East Muddy Creek Station were also identified in the 2009 NFRIA Volunteer Water Quality Monitoring Report. The Wasatch Formation, prevalent in the Muddy Creek drainage, is loosely consolidated, highly erosive, and produces naturally high sediment loads in the river. Land cover in the Muddy Creek drainage is primarily forest, with pasture along East Muddy Creek.

Bedrock aquifers in the watershed are high in dissolved solids and contribute to the North Fork by means of groundwater discharge. Concentrations of dissolved salts in most bedrock units range from 1,000 to 2,500 mg/L and in some cases approach 9,000 mg/L.

Coal Mining

There are three coal mines along the North Fork River: the West Elk mine above Somerset; the Oxbow mine below Somerset; and the Bowie Resources mine east of Paonia. All three utilize underground longwall mining techniques. Surface infrastructure includes mine roads, equipment and coal storage yards, loading areas, and coal refuse piles. Surface runoff from rain and snowmelt can leach minerals and chemicals from the mine surface facilities areas, and runoff can also erode sediment from disturbed areas associated with the mines. If uncontrolled, this leachate and sediment can flow into streams and contaminate water. Uncontrolled gob leachate could also contribute significant amounts of iron and total dissolved solids, especially during low flow.

The 2009 NFRIA Volunteer Water Quality Monitoring Report evaluated water quality at a station below Somerset, which incorporated effluent from many of the coal mines. The report did not identify any significant water quality problems attributable to runoff from the mines. Separate NPDES effluent violations, as discussed above, were common at two of the mines: West Elk Mine and Bowie No. 2 Mine, where violations included BOD, suspended solids, dissolved and total recoverable iron, and whole effluent toxicity.

Gravel Mining

In-stream gravel mining has historically directly affected the morphology of the North Fork by altering the channel geometry, lowering bed elevation, and changing the composition of bed material. In-stream gravel mining reduced the supply of bed load material to downstream segments and triggered upstream channel degradation. The cumulative effects of in-stream gravel mining have contributed to channel incision and reduced floodplain connectivity.

There are five gravel mine NPDES permits on the North Fork River, but no mining in the active channel. Along the North Fork, discharges from gravel mines may potentially contribute a significant percentage of the total selenium load carried by the river. The cumulative annual selenium load for the permitted discharges could account for up to 460 pounds, or about 32% of

the total load if all facilities are discharging at design capacity during chronic low flows (WQCD, 2009).

Agriculture

Agriculture is the mainstay of the North Fork economy, and the supply of irrigation water is crucial to its development and success. Inefficient irrigation can cause water quality problems. Excessive irrigation can transport pesticides, nutrients, disease-carrying microorganisms, and salts, all of which impact water quality in the river.

The most significant nonpoint source pollution problem associated with irrigated agriculture is selenium. Selenium is found in Mancos Shale which commonly underlies irrigated farmlands of the lower North Fork watershed. Selenium becomes highly mobile when in contact with water, often as a direct result of irrigation. Soil studies have proven that deep percolation and seepage from agricultural and residential irrigation, unlined ponds, and unlined (and un-piped) irrigation-water delivery systems can liberate selenium from the Mancos Shale. Irrigation can also release other salts in to water ways.

Selenium is perhaps the most significant water quality impairment in the North Fork watershed. There are four segments of the North Fork that are listed as high priority for selenium impairment. Section 5 discusses water quality data and calculated selenium loads in the North Fork watershed. For more information about selenium, visit www.seleniumtaskforce.org.

Channelization, Floodplain Encroachment and Loss of Riparian Vegetation

The North Fork has been historically channelized for flood and erosion control, in-stream gravel mining, and protection of railroads, highways, and bridges. Channelization efforts first began on the 1880s with manual labor and teams of horses. In 1947, Delta County began an annual campaign to straighten and deepen the river channel in an attempt to reduce flood damage to agricultural lands, bridges and towns. Though intensive dredging halted in the 1980s with the passage of the Clean Water Act, the channelization started a cycle of flood erosion and bank instability that still continues.

Channelization in the North Fork has resulted in increased bed slope and shear, which leads to channel degradation. When not accompanied by bank protection, channelization can increase shear stress and result in bank destabilization, increased erosion and large sediment supplies to downstream reaches. Increased sediment loads can accelerate erosion and contribute to the development of point bars and even braided channels (USACE, 2007). Refer to Figure 5-3 for a map of USACE study sites.

All along the North Fork, riparian and floodplain vegetation has been cleared, often in concert with channelization efforts, to increase crop and grazing land. Removal of the riparian vegetation that once served to protect and strengthen stream banks is now contributing to bank erosion and lateral channel instability. The loss of vegetation has also diminished aquatic habitat, decreased autochthonous and nutrient inputs to the aquatic system, and altered aquatic food webs. Alteration of riparian zones has also decreased the habitat available for beavers. Appendix A shows photo documentation of the most critical river restoration areas in the North Fork.

The majority of NFRIA's restoration efforts over the years have taken the form of mitigation and enhancement projects focused predominantly on channel reconstruction and habitat restoration. These types of projects seek to replicate historical river patterns and minimize erosion with geomorphically designed enhancement efforts. In many cases, that meant slowing the river down by increasing meanders throughout the full extent of the floodplain, thereby reducing the overall slope of the channel. The Midway Project, in particular, transformed the river channel from a braided system to a single channel. The stream reconstruction was fortified with boulders and riparian vegetation. Refer to Section 2 for a review of NFRIA restoration projects.

Paonia Reservoir may also be contributing to channel instability. Constructed in 1962, Paonia Reservoir is used primarily for irrigation storage to supply water to the Fire Mountain Canal during the summer. The reservoir is operated based partially on flood control criteria, but comparisons of

hydrographs before and after dam construction indicate that reservoir operations have little effect on downstream flow volumes or seasonal flow patterns (Crane Associates, 1997). Limited flood control capacity may be due to the heavy siltation in the reservoir, which deprives the North Fork of fine sediments critical to maintaining bank stability. However, a sediment budget of the North Fork suggests that there are abundant sources of fine sediment downstream of the reservoir (Jaquette, 2003). A separate report concluded that the influence of Paonia Reservoir on stream morphology is secondary to those of gravel mining, channelization and floodplain encroachment (USACE, 2007).

Oil and Gas

Recently, exploration for natural gas in the Piceance Basin has expanded into the upper North Fork watershed, where it is occurring on both public and private land. Drilling activities are now occurring in the Muddy Creek region, particularly in the Bull Mountain Unit, and on Oak Mesa. Environmental and health issues may arise from poorly-executed natural gas well drilling, development, production and infrastructure. Hydraulic fracking, a technique used to stimulate production from oil and gas wells, involves injecting large quantities of fluids underground under high pressure. Not only is this process extremely water intensive, but the fracking fluids frequently contain toxic chemicals. An estimated 30% to 70% of the fracking fluids may resurface; the balance is lost to the subsurface (http://www.endocrinedisruption.com/home.php). The exact risks from the chemicals are unknown, because fracking fluids are shielded from disclosure by federal statute. Furthermore, gas drilling can release naturally-occurring, toxic volatile compounds which can mix with the exhaust of diesel-driven equipment to produce ground-level ozone. In addition, extensive networks of road are often required for site access. These roads, frequently dirt or gravel, are heavily utilized by large trucks that haul away re-surfaced fracking fluids. Currently, there are no comprehensive base-line data collection efforts designed to evaluate the impacts of natural gas development on the water resources in the North Fork watershed.

6.3 *Recreation*

NFRIA's 2000 North Fork Watershed Action Plan identified the lack of public access to the North Fork as a community concern. Nearly 95% of the land bordering the North Fork is privately owned, offering virtually no public access to the river and considerably reducing public contact with the river. Lack of public access, in addition to river degradation, lack of summer flows, and hazardous in-stream diversions, have not only limited recreation but also impeded community members from forging a meaningful relationship with the river that runs through their towns.

Current trespass law in Colorado discourages boaters from stopping on private land. This discourages boaters from portaging around barriers such as irrigation diversions, resting, or even breaking for an emergency. If boaters choose to float the North Fork, they legally may only leave their boat at public access points. There are currently only four public access points below Paonia Reservoir: 1) BLM access point above Somerset; 2) Paonia River Park; 3) Delta County Fairgrounds in Hotchkiss (still in development); and 4) Pleasure Park (Figure 6-5).

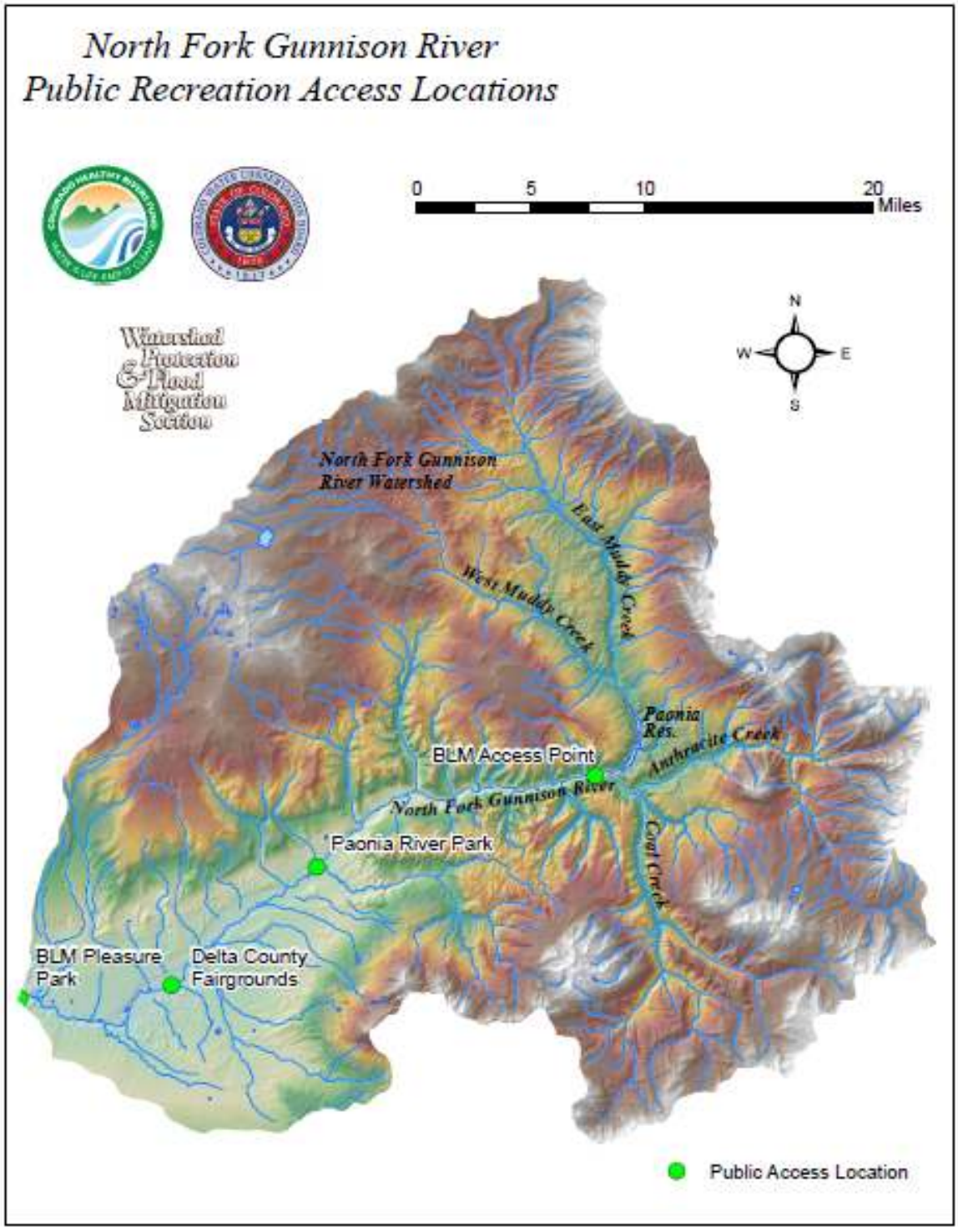

Figure 6-5: North Fork River Public Access Locations

6.4 *Summary*

This chapter identified and described the major issues of concern in the North Fork watershed. The following is a summary of these issues, how they affect specific aspects of the watershed, and their potential causes.

Problem: Four segments of the North Fork are listed as high priority for selenium impairment.

Causes:

- *Deep percolation of groundwater into Mancos Shale*
- *Inefficient irrigation practices*
- *Unlined irrigation ditches and ponds*
- *Discharge from gravel mines*

Critical Areas:

- *North Fork mainstem and tributaries from Black Bridge to river mouth*
- *Irrigated lands on seleniferous soils*

Impacts to the watershed:

- *Selenium is toxic to fish and waterfowl and can bioaccumulate*

Problem: Tributaries to the North Fork are on the M&E lists for total recoverable iron

Causes:

- *Natural sediment loads*
- *Coal Mining*
- *Land disturbing activities*

Critical Areas:

- *Coal Gulch, Hawksnest Creek, Gribble Gulch, Cottonwood Creek*
- *Coal mine discharges*
- *Irrigated lands on salt-laden soils*

Impacts to the watershed:

- *Threatens aquatic life*

Problem: The North Fork is recognized as a major contributor of salt to the Colorado River System.

Causes:

- *Irrigation runoff*
- *Inefficient irrigation practices*
- *Unlined irrigation ditches and ponds*

Critical Areas:

- *Irrigated lands on seleniferous and salt-laden soils*

Impacts to the watershed:

- *Threatens endangered Colorado River basin fish*

Problem: E. coli samples occasionally exceed state water quality standards.

Causes:

- *Poor waste management*
- *Leaking septic systems*
- *Livestock grazing in or near the river*
- *Runoff from storm events*
- *WWTP discharges that exceed effluent limits*

Critical Areas:

- *Entire North Fork River*

Impacts to the watershed:

- *Reduced recreation potential*
- *Public health hazards*

Problem: There are no background data to evaluate potential impacts from natural gas development.

Causes:

- *Chemicals used in fracking fluids are proprietary and their identify is not available to the public*
- *No baseline monitoring program*

Critical Areas:

- *Muddy Creek region*
- *Bull Mountain Unit and Oak Mesa*

Impacts to the watershed:

- *Potential impacts could include sediment from roads and construction areas, toxic effects from fracking fluids, impaired air quality from ozone and diesel emissions, and oil and grease and metals from equipment spills*

Problem: The river channel remains structurally unstable in some reaches.

Causes:

- *Historic channelization*
- *Irrigation diversions*
- *Impacts from past in-stream gravel mining*

Critical Areas:

- *Stewart Ditch Diversion (USACE Site 9)*
- *Paonia River Park (USACE Site 7)*
- *Midway (USACE Site 4)*
- *USACE Site 3*
- *USACE Site 2*
- *USACE Site 1*

Impacts to the watershed:

- *Increased erosion of agricultural lands and riverside property*
- *Increased sediment loads*
- *Loss of riparian vegetation and wildlife habitat*
- *Entrenchment of the river channel*
- *Loss of connectivity to floodplain*
- *Lowered groundwater table near the river*

Problem: In-stream flows, especially between Paonia and Hotchkiss, while not as severe as in the past, remain low to intermittent during the summer.

Causes:

- *River is fully appropriated*
- *Inefficient irrigation practices*
- *Inefficient irrigation diversions*

Critical Areas:

- *Paonia to Hotchkiss*

Impacts to the watershed:

- *Loss of aquatic habitat*
- *Increased water temperature*
- *Disruption of natural sediment dynamics*
- *Limited dilution of other pollutants*

Problem: Paonia Reservoir has lost 24% of its storage capacity

Causes:

- *Natural sediment influx from the upper basin*

Critical Areas:

- *Muddy Creek Drainage*
- *Paonia Reservoir Outlet Structure*

Impacts to the watershed:

- *Loss of irrigation water storage*
- *Reduced ability to operate outlet structure*
- *Limited recreation potential*
- *Loss of supplemental environmental flows*

Problem: Public access to the river is limited.

Causes:

- *Only four public access points*
- *95% of the land bordering the river is privately owned*
- *Non-navigable/ unsafe diversions*

Critical Areas:

- *Private land*
- *Existing public access points*
- *Diversion Structures*

Impacts to the watershed:

- *Trespass issues on private lands*
- *Decreased river awareness*
- *Limited recreation potential*
- *Decreased public concern about the river*

Section 7: Goals and Objectives

The goals for the North Fork watershed were developed after the sources and causes of the impairments were identified through the watershed assessment and review of past studies and reports. The goals are based on improving or restoring conditions in the North Fork in a manner that are compatible with the local economy, private property rights, and regulatory water quality standard compliance. Specific objectives or strategies are organized under their respective goal and address the source of the problem, typically by affecting the root cause.

7.1 *Goals*

NFRIA has identified the following goals for the North Fork Watershed:

1) Improve water quality

2) Improve river channel stability

3) Improve summer flows between Paonia and Hotchkiss

4) Maintain existing reservoir storage capacity

5) Improve recreation opportunities consistent with private landowner rights.

7.2 *Objectives*

The strategies required to meet the goals are based on addressing the identified causes of the sources of nonpoint source (NPS) pollution and resource impairments in the North Fork. NFRIA evaluated existing river conditions and prioritized the pollutants/influences based on the degree of impairment and the feasibility of reducing the pollutant/threat to desirable levels. NFRIA's pollutant/influence prioritization is outlined in Table 7-1. The sources of pollutants/influences and prioritization were evaluated in accordance with the findings of the watershed assessment. The goals and objectives are further defined in Table 7-1.

Table 7-1: Goals and Objectives

Goal	Priority	Pollutant/ Influence	Sources	Extent Present	Cause	Objective
Improve water quality	**High**	Selenium	Mancos Shale	Throughout lower basin (33,217 irrigated acres)	Deep percolation	Reduce dissolved selenium loads
			Discharge from gravel mines	5 NPDES permits		
	Low	Total Recoverable Iron	Natural Geology	Throughout the basin	Natural erosion	Better characterize total recoverable iron in North Fork Tributaries on the M&E list
			Industrial runoff	7 NPDES Permits	Coal Mining	
			Construction runoff	Unknown	Land disturbing activities	
	Medium	Salts	Mancos Shale	Throughout lower basin (33,217 irrigated acres)	Deep percolation	Reduce salt loads
	Low	Pathogens (*E. coli*)	Failing septic systems	non-sewered areas	Leaking, poorly maintained, and over capacity septic systems	Reduce the frequency of E. coli exceedances
			Agricultural runoff	Unknown	Unlimited livestock access	
	High	Chemicals in fracking fluids	Natural gas exploration	Bull Mountain Unit Oak Mesa	Unknown	Characterize baseline water quality conditions to determine if and how natural gas exploration may affect the watershed
		Sediment	Access Roads	Unknown		
Improve river channel stability	**High**	Sediment	Streambank erosion	6 critical sites	Fluctuating hydrology	Stabilize key unstable river reaches
				6 critical sites	Impaired riparian zones	
Improve summer flows	**Medium**	Low instream flow	Priority System	Entire basin	Fully appropriated river	Identify long term strategies to augment flows
			Crop irrigation	33,217 irrigated acres	Inefficient irrigation practices	
			In-channel diversion structures	Stewart Diversion	Inefficient irrigation diversions	
Maintain existing reservoir storage capacity	**Medium**	Sediment	Wasatch Formation soils in the upper watershed	Muddy Creek drainage	Natural erosion	Manage Paonia Reservoir sediment influx
Improve recreation opportunities that are consistent with private landowner rights	**High**	Public access	Public access points	4 legal public access points	Unimproved access points	Improve existing access points
	Medium	Trespass	Private Property	95% of river channel is privately owned	Limited places for boaters to portage, picnic or pull over for safety reasons	Educate the public about rights, responsibilities and safety
	Medium	Navigation barriers	In-channel diversion structures	Fire Mountain, Stewart, Farmers and Paonia diversions	Un-marked, non-navigable diversion structures that are dangerous for boaters	

7.3 *Critical Areas*

Critical areas of the North Fork are those areas having specific resource limitations that need to be addressed with appropriate management measures. The findings of the watershed assessment as well as input from local experts were used to determine the critical areas of the watershed. The critical areas are based on the goals and objectives for the North Fork and delineated by where the pollutants/impairments are impacting or threatening the desired uses. The critical areas of the North Fork are defined in order to locate areas of high priority for remediation. Table 7-2 identifies critical areas related to the North Fork goals and objectives. Figure 7-1 illustrates the location of critical areas in the North Fork.

Table 7-2: Critical Management Areas

Goal	Objective	Critical Areas
Improve water quality	Reduce dissolved selenium loads	• Irrigated lands on seliniferous soils • North Fork mainstem and tributaries from Black Bridge to mouth
	Better characterize total recoverable iron in North Fork tributaries on the M&E list	• Coal Gluch, Hawksnest Creek, Bribble Gluch, Cottonwood Creek
	Reduce salt loads	• Irrigated lands on seliniferous and salt-laden soils
	Better characterize E. coli sources in order to reduce the frequency of E. coli exceedances	• Unknown
	Characterize baseline water quality conditions to determine if and how natural gas exploration may affect the watershed	• Muddy Creek region • Bull Mountain Unit and Oak Mesa
Improve river channel stability	Stabilize key unstable river reaches	• Stewart Ditch (USACE Site 9) • Paonia River Park (USACE Site 7) • Midway (USACE Site 4) • USACE Site 3 • USACE Site 2 • USACE Site 1
Improve summer flows	Identify long term strategies to augment flows	• Paonia to Hotchkiss
Maintain existing reservoir storage capacity	Manage Paonia Reservoir sediment influx	• Muddy Creek Drainage • Paonia Reservoir Outlet Structure
Improve recreation opportunities that are consistent with private landowner rights	Improve existing access points	• Paonia River Park
	Educate the public about rights, responsibilities and safety	• 95% of the river corridor in private ownership • Fire Mountain Diversion, Stewart Diversion, Farmer's Diversion, Paonia Diversion • Existing Public Access Points

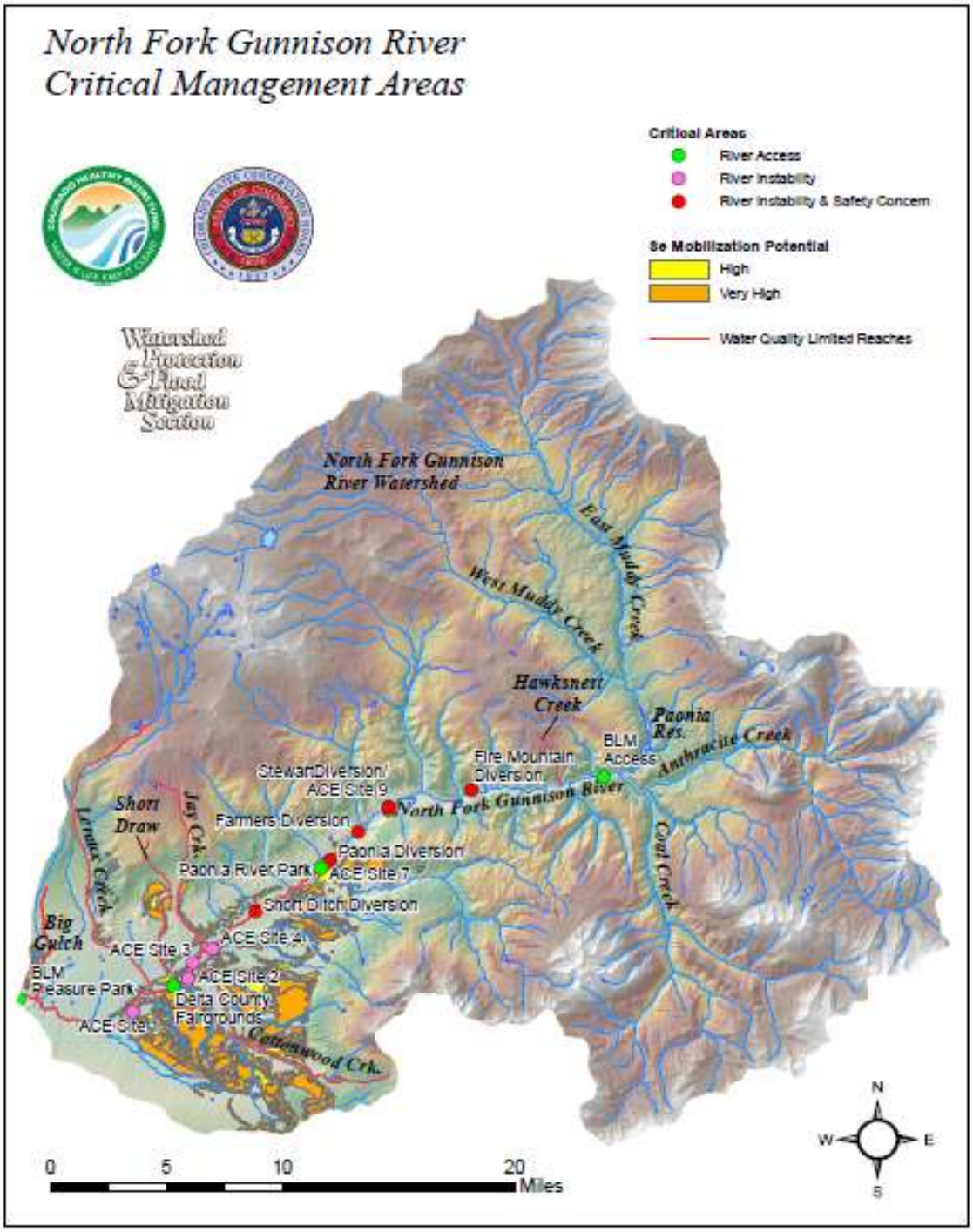

Figure 7-1: Map of Critical Management Areas

Notes: Selenium Mobilization Potential based findings from the Employing Innovative Data and Technology for Water Conservation Targeting and Planning in the Salinity and Selenium Affected Areas of the Lower Gunnison River Basin Project (CRWCD, 2010). Water Quality Limited Reaches are a combination of the 2010 303(d) and M&E list.

Section 8: Management measures to be implemented

In an effort to successfully accomplish the goals and objectives listed in Section 7, NFRIA developed a list of implementation activities based on the prioritization of watershed pollutants, sources, and causes while considering the priority areas in the watershed (Tables 7-1 and 7-2). These implementation tasks represent an integrated and collaborative approach to reduce existing sources of pollution/impairments and prevent future resource degradation while considering the local economy, private landowner rights, regulatory compliance, and conservation initiatives spear-headed by partner groups.

8.1 *Action Plans*

The recommendations for actions to accomplish the goals and objectives for the North Fork watershed are listed in the tables below. Each table contains a description of the following categories:

- Action Item: Strategy for achieving goals
- Lead organization(s) for ensuring this project is implemented: Group(s) responsible for each strategy
- Watershed Benefits: Load reduction figures where applicable, other water quality or habitat benefits that can not be quantified
- Milestones needed to execute this strategy: Sub-tasks to ensure the overall strategy is being implemented (signs of success)
- Costs: Estimated funding needed to implement each strategy
- Funding Sources: The partners, programs, foundations, and grants where funding might be sought
- Schedule
- Evaluation Methods: Methods to determine if the tasks are being implemented and whether they are effective at reducing nonpoint pollution

Projects will be implemented based on local capacity and availability of resources. The highest priority projects include:

1) **Work with STF to identify monitoring and education needs**
2) **Work with STF to promote use of BMPs**
3) **Identify additional sources of data to characterize baseline water quality conditions to determine if and how natural gas exploration may affect the watershed**
4) **Plan and execute a monitoring plan to characterize baseline water quality conditions to determine if and how natural gas exploration may affect the watershed**
5) **Implement river restoration projects as possible to improve channel stability**
6) **Support 319 Midway Project to improve channel stability**
7) **Complete Phase I of Paonia River Park to improve river access**

Goal #1: Improve Water Quality

Objective: Reduce dissolved selenium loads

Action Item	Lead Organization	Watershed Benefits	Milestones	Cost	Funding Partner(s)	Schedule	Evaluation Method
** Work with STF to identify monitoring and education needs	Selenium Task Force (STF)	Better understanding of watershed conditions, Increased public awareness	Identify data gaps Identify key stakeholders	$5,000/year	Selenium Task Force, Delta Conservation District, BOR, CO River District, NRCS, NF Conservancy District, NFRIA	on-going	Refer to Selenium Management Program and Lower Gunnison Basin Watershed Plan
** Work with STF to promote use of BMPs	Selenium Task Force (STF)	TMDL achieved (568 lbs/year)	Prioritize locations Obtain funding Implement BMPs	$5,000/year		on-going	# BMPs installed # presentations given Refer to Selenium Management Program and Lower Gunnison Basin Watershed Plan

Objective: Better characterize total recoverable iron in North Fork Tributaries on the M&E list

Action Item	Lead Organization	Watershed Benefits	Milestones	Cost	Funding Partner(s)	Schedule	Evaluation Method
Consult with WQCD regarding M&E listing	NFRIA, WQCD	Better understanding of watershed conditions	phone conference with WQCD	$1,000	WQCD, EPA, USGS, Mining Companies	2011	Data set/memo describing M&E listing
Identify additional data sources	NFRIA	Better understanding of watershed conditions	list of datasets	$2,000		2012	Database and status report describing Trec Iron data and possible sources
Plan and execute additional monitoring as needed	NFRIA	Improved water quality (1-97% load reduction)	Sample Plan Execute monitoring plan	$5,000		2012	Establish monitoring program, Evaluate sampling procedures to ensure QAPP is being implemented appropriately

**** High Priority Project**

Objective: Reduce salt loads

Action Item	Lead Organization	Watershed Benefits	Milestones	Cost	Funding Partner(s)	Schedule	Evaluation Method
Work with BOR Identify monitoring and education needs	BOR, NFRIA	Better understanding of watershed conditions, Increased public awareness	Identify data gaps Identify key stakeholders	$5,000/year	BOR, Selenium Task Force, Delta Conservation District, CO River District, NRCS, NFRIA , NF Conservancy District	On-going	Refer to Selenium Management Program and Lower Gunnison Basin Watershed Plan
Work with BOR to promote use of BMPs	BOR, NFRIA	Improved water quality	Prioritize locations Obtain funding Implement BMPs	$5,000/year		On-going	# BMPs installed # presentations given Refer to Selenium Management Program and Lower Gunnison Basin Watershed Plan

Objective: Better characterize *E. coli* sources in order to reduce the frequency of *E. coli* exceedances

Action Item	Lead Organization	Watershed Benefits	Milestones	Cost	Funding Partner(s)	Schedule	Evaluation Method
Identify additional data sources	NFRIA	Better understanding of watershed conditions	Identify datasets	$1,000	WQCD, EPA, USGS, Gunnison County, Delta County, Municipal Water Providers	2011	Database and status report describing *E. coli* data and possible sources
Plan and execute additional monitoring as needed	NFRIA	Identification of sources Improved water quality (25-52% load reduction)	Sample Plan Execute monitoring plan	$5,000		2012	Establish monitoring program Evaluate sampling procedures to ensure QAPP is being implemented appropriately

Objective: Characterize baseline water quality conditions to determine if and how natural gas exploration may affect the watershed

Action Item	Lead Organization	Watershed Benefits	Milestones	Cost	Funding Partner(s)	Schedule	Evaluation Method
** Identify additional data sources	NFRIA	Knowledge of baseline conditions	Database	$14,000	WQCD, EPA, Private donors, Gas companies	2010	Evaluate sampling procedures to ensure QAPP is being implemented appropriately
** Plan and execute monitoring plan	NFRIA	Safeguard high-quality resources by tracking changes in water chemistry and stream habitat	Sample Plan Execute monitoring plan	$5,000-25,000/year		2010	

Goal #2: Improve river channel stability

Objective: Stabilize key unstable river reaches

Action Item	Lead Organization	Watershed Benefits	Milestones	Cost	Funding Partner(s)	Schedule	Evaluation Method
Update cross section data and gather other survey data	NFRIA	Better data for decision making	Funding secured Contractor hired	$5,000	NFRIA, USACE, DOW, CWCB, NF Conservancy District, NRCS, Delta Conservation District, CO River District	2012	Use of the data in decision making for restoration projects
Review USAEC 206 plans	NFRIA	Stakeholder awareness, input and support	Technical review committee to respond to 206 plans and advise NFRIA board	$5,000 - $10,000		2011	# meetings held # landowners contacted
** Implement river restoration projects as possible *(USAC sites 1,2,3,4,7 and 9)*	USACE	Channel stability Decreased erosion Increase floodplain and riverbank vegetation by 10 acres/year	Board decision to participate with implementation	$2,000,000 (35% non-federal match) *estimate*		On-going	fundraising # projects completed aerial photos cross-sections floodplain revegetation
** Support 319 Midway Project	NFRIA	Channel stability Decreased erosion Increase floodplain and riverbank vegetation by 10 acres/year	Execute engineering plans	$100,000	CWCB, WQCD, private foundations	2010-2011	# projects completed aerial photos cross-sections floodplain revegetation

**** High Priority Project**

Goal #3: Improve summer flows between Paonia and Hotchkiss

Objective: Identify long term strategies to augment flows

Action Item	Lead Organization	Watershed Benefits	Milestones	Cost	Funding Partner(s)	Schedule	Evaluation Method
Coordinate with water users and water managers on conservation strategies	NFRIA	Increased instream flows, Increased recreation potential, Cooler water temperature, Improved summer fish habitat	Stakeholders identified	$5,000/ year	NFRIA, NRCS, BOR, CWCB, STF, CO River District, Delta Conservation District NF Conservancy District, Division of Water Resources	On-going	Summer flows at Paonia gage, # water use meetings attended

Goal #4: Maintain existing reservoir storage capacity

Objective: Manage Paonia Reservoir sediment influx

Action Item	Lead Organization	Watershed Benefits	Milestones	Cost	Funding Partner(s)	Schedule	Evaluation Method
Support entities implementing the Paonia Reservoir Sediment Management Plan	Fire Mountain Canal and Reservoir Company, NF Conservancy District	Secure Storage Capacity, Flood Protection, Environmental Flows	Refer to Paonia Reservoir Sediment Management Plan	$1,000 - $2,000/year	Fire Mountain Ditch Company, Ragged Mountain Ditch Company, BOR, CO River District, NF Conservancy District, Division of Water Resources	On-going	Sediment Load in Reservoir, See Sediment Management Study for Paonia Reservoir

Goal #5: Improve recreation opportunities that are consistent with private landowner rights.

Objective: Improve existing access points

Action Item	Lead Organization	Watershed Benefits	Milestones	Cost	Funding Partner(s)	Schedule	Evaluation Method
** Complete Phase I of Paonia River Park	NFRIA	Increased public awareness, safe access	Final Report	$90,000	GOCO, private donors, Town of Paonia, Gates Family Foundation	2011	survey park users, # visitors, See Project Plan
Participate with Delta County Fairgrounds/ Hotchkiss park design	Delta County	Increased public awareness, safe access	Join planning committee, Review plans	$100,000	Private donors, Delta County	2011	# meetings attended, See Project Plan

**** High Priority Project**

Objective: Educate the public about rights, responsibilities and safety

Action Item	Lead Organization	Watershed Benefits	Milestones	Cost	Funding Partner(s)	Schedule	Evaluation Method
Facilitate workshop to identify local solutions	NFRIA	Minimize trespass conflicts	Workshop agenda	$2,000-$10,000/year	CWCB, private donors	2011 On-going	# attendees # feasible ideas
Create and distribute educational materials	NFRIA	Increased public safety	Post signs	$2,000	Private donors		# signs posted

8.2 *Partner Watershed Efforts and Load Reductions*

To achieve many of the goals identified in Section 7, NFRIA will need to work in close collaboration with partner agencies, districts and coalitions. In most instances, NFRIA will serve in a support role while other partners take the lead role coordinating restoration activities. Many of the goals, objectives, action items, indicators, cost estimates and schedules listed in the action plans (Section 8.1) are dependent on recommendations of reports scheduled for completion in the near future (Table 8-1).

Table 8-1: List of Reports with Watershed Recommendations

Pollutant	Title of Report	Scheduled Completion	Lead Cooperator
Selenium	Lower Gunnison Basin Watershed Plan	2012 (winter)	Selenium Task Force
	Selenium Management Program	2012 (summer)	Bureau of Reclamation
Salt	Unknown (2010 Salinity Trends)	2010 (summer)	US Geological Survey
Sediment	Sediment Management Study for Paonia Reservoir	2010 (late)	North Fork Water Conservancy District and Fire Mountain Canal and Reservoir Company
	NF Section 206 Plan Review	2010 (late)	Army Corps of Engineers
Low Flows	Gunnison Basin water needs assessments	Unknown	Gunnison Basin Roundtable
Recreation	Delta County Fairground Park Master Plan	Unknown	Delta County

The EPA requires watershed plans to estimate the load reductions expected from management measures. Load reductions are based on the cause-and-effect relationship between pollutant loads and the waterbody response. Establishing this link allows evaluation of how much load reduction from watershed sources is needed to meet waterbody targets. Many of the objectives identified in Section 7 entail additional data collection efforts in order to better characterize and understand the source and scale of watershed impairments. As a result, load calculations may not accurately represent baseline watershed conditions. In some instances, NFRIA was unable to calculate pollutant loads (i.e. salt, sediment). Table 8-2 summarizes the known current and target load reductions for pollutants in the watershed.

Table 8-2: Target Load Reductions

Pollutant	Current Load	Target Load Reduction	Notes	Reference
Selenium	3,124 lbs/year	568 lbs/year	North Fork at Mouth	WQCD, 2009
Salt	Unknown	Unknown	No data available	n/a
Iron	Isolated events > 20,000 tons/ year total Iron	1 – 97% (total Iron)	Need Total Recoverable Iron data	Colorado M&E List
E. coli	Isolated events > 330 billion MFU/100 ml/year	25-52%	Late summer spikes – more data needed to identify sources	2009 North Fork Volunteer Water Quality Report
Sediment	124 AFY	124 AFY	Target of no net loss of storage	Sediment Management Study for Paonia Reservoir
	Unknown	10 acres/year gained in floodplain/ riverbank vegetation	Evaluated by aerial surveys	2010 NFRIA Reconnaissance Aerial Photo Vegetation Interpretation Study

Section 9 Education and Outreach

The long-term ecological health of the North Fork Watershed depends on the values and actions of current and future generations. Informing the residents, recreational users, local officials and resource managers of the North Fork Watershed about how their actions affect water quality is a high priority of NFRIA. Increasing awareness and, ultimately, changes in behavior is a long-term strategy for restoring and protecting water quality

NFRIA has developed a working strategy for connecting with the North Fork Valley. Its objective is twofold: to foster a sense of appreciation and understanding of natural resource stewardship, and to educate the community on the competing yet interdependent socioeconomic interests that exist within the North Fork Valley.

9.1 *Information and Education Goals*

Fostering the restoration of the North Fork River into a healthy, usable, sustainable resource while promoting community enrichment and sustainable agricultural practices has been the overarching goal of NFRIA for over a decade. Within a community, appreciation and sound stewardship stems from a sense of ownership that can only be achieved through exposure to the river and its varying characteristics. On the North Fork, this is a particularly difficult task because of limited public accessibility.

Everyone has something to lose through watershed degradation, and understanding this is the key to balancing different interests within a watershed community. The question NFRIA must answer through its education and outreach strategy is, “How can every person, whether farmer, river rafter, landowner, fisherman, or tourist, understand his or her relationship to the river and accompanying societal role in a river community?”

9.2 *Outreach Activities*

Some of the information and education activities that have already been implemented as part of NFRIA’s historic watershed planning and education efforts include:

- Public Comment meetings (October 2009, December 2009)
- Annual Community River Float Trip
- Monthly newsletter and e-letter to membership
- Annual membership meeting
- Attendance of partner meetings (e.g. Gunnison Basin Roundtable, Selenium Task Force, WSERC)
- Revised website (www.nfria.org) with an education section, river fact sheets and a book list
- Powerpoint Presentation about NFRIA and River Awareness
- Conservation Awareness Day (Spring 2009)
- Newspaper Articles
- Brochures
- 2009 NFRIA Accomplishments Pamphlet
- Youth River Awareness Initiative
- Participate in Make a Splash Teen Library Program (summer 2010)

9.3 *Key Target Audience Characteristics*

The identification of groups or individuals whose support or action will be needed to achieve the Watershed Project goals is integral to successfully implementing the Information & Education strategy. The Watershed Target Audiences were prioritized based upon the impact of the pollution/influence source and the relative acceptance of the message by the proposed target audience. Past successes suggests that riverfront property owners are willing to be pro-active in protecting the river but need specific guidance to make informed "watershed friendly" decisions. A description of the key communities NFRIA needs to reach out to include:

Riverfront landowners

This group is most affected by increased recreational use of the river, and often most adamant about restricting river boating activities. Their argument is that increased recreational use of the river is a form of development that lowers their property value and increases their liability, and leads to garbage on their property and noise pollution. These people are also most susceptible to unhealthy changes in the watershed, such as bank erosion, riparian zone degradation, or pollution.

Farmers/ranchers

These are the irrigators. About 86% of consumptive use water in Colorado is for agriculture. While their importance is unquestionable as both a provider of food and a cornerstone of the local economy, farms and irrigation ditches lead to significant deep percolation and nearly drain the river dry in the late summer, with potential adverse affects for riparian and aquatic wildlife. Also, some irrigation diversions on the river are often hazards for recreational users of the river, while others make for exciting rapids.

Industry

In the North Fork Valley, the coal, gravel and natural gas industries are a vital part of the economy, providing most of the high-paying jobs in the area. Watershed contamination and degradation is a concern for many citizens, and it is important that effective monitoring and other protective procedures take place to identify and understand any possible adverse effects of industry activities. NFRIA encourages effective but practical environmental considerations in industry practices.

Recreational users

Boaters are mostly interested in river access, a "right to float," and having adequate in-stream water flows. Other users, such as those that visit the Paonia River Park, are interested in additional and/or improved access points, as well as riparian and aquatic habitat preservation. This normally comes with a belief of a right to green, natural space.

Locally elected officials and municipal employees

As decision makers, it is important for these people to have a comprehensive understanding of community watershed management, including issues at stake and the competing viewpoints involved. Also, many grants to improve watersheds must be attained through the town government, as opposed to a watershed organization. Informed leaders allows for better decisions that have a long-lasting positive effect on the watershed.

Community at large

Even people who don't live on the river, irrigate, or use the river for recreational purposes depend on the health of the river and watershed to some degree. Much of the food they eat is grown with river water, and many of the businesses that provide area jobs, such as coal mines, restaurants, and farms, depend on the river.

9.4 *Outreach Strategies*

Table 9-1 identifies target audiences by specific watershed problems along with specific messages and delivery mechanisms for each target audience.

Table 9-1: Outreach Strategies

Pollutant source or watershed problem	Specific Target Audience	Key Message	Method of reaching Audience
Deep percolation of seliferous and salt-laden soils	Irrigators Ditch companies Water Providers	Minimize deep percolation by implementing BMPs	Educational forums Direct Mailing Resource Specialists
Septic systems	Riparian homeowners	Septic systems should be inspected/ maintained on a regular schedule	Direct mail to all watershed landowners
Industrial Discharge	NPDES permit holders (Coal Mines, Gravel Pits)	Safeguard high-quality resources by tracking changes in water chemistry and stream habitat	Review results of water monitoring program with industry representatives
Natural Gas	Natural Gas Drilling Industry General Public	Safeguard high-quality resources by tracking changes in water chemistry and stream habitat	Review results of water monitoring program with industry representatives
Eroding streambanks	Riverfront homeowners	Implementation of BMPs can minimize excessive erosion Participate in USACOE 206 Plan review	Meet on site with riverfront landowners Direct mail to riverfront landowners
Low flows	Water Users Ditch Companies	Smart Water Use	Educational forums
Loss of storage capacity in Paonia Reservoir	North Fork Water Conservancy District, Fire Mountain Canal and Ditch Company	NFRIA supports their activities	Letters of support
Trespass	Boaters and Riverfront homeowners	Respect private property Use public access points	Public Education Forum
Public Education and Safety	Boaters	The North Fork is a great place to be! Serious safety hazards exist	Signage Flyers at access points

Section 10 Evaluation of Implementation Strategies

While the North Fork Watershed Project is intended to restore and protect, it is important to periodically evaluate the implementation efforts to determine: 1) whether the project is on track and the tasks are implemented in a timely manner, and 2) whether the projects are successful in restoring and protecting water resources and that funds are spent wisely.

The purpose of the North Fork Watershed Plan is to improve or restore conditions in the North Fork River Watershed (North Fork) in a manner that is compatible with the local economy, private property rights, and regulatory water quality compliance. In order to evaluate the effectiveness of implementation measures over time, we will compare the results of watershed monitoring efforts as they are repeated.

The NFRIA Volunteer Monitoring Network collects monthly samples field, metals, nutrients, flow and bacteria data at stations throughout the watershed as part of the Colorado River Watch Program. They also collect annual macroinvertebrate samples. NFRIA is about to expand upon its existing volunteer monitoring program to establish baseline data for anticipated natural gas development and investigate selenium levels in irrigation ditches. This monitoring may be expanded upon to investigate sources of iron and *E. coli* in the watershed. Table 10-1 lists methods for NFRIA to evaluate successful implementation of the watershed plan and ultimately the health of the North Fork Watershed.

Table 10-1: Methods for Evaluating Success

Strategy	Methods for evaluating success
Reduce dissolved selenium loads	# BMPs installed, # presentations given, refer to Selenium Management Program and Lower Gunnison Basin Watershed Plan
Better characterize total recoverable iron in North Fork Tributaries on the M&E list	Data set/memo describing M&E listing, database and status report describing Trec Iron data and possible sources, establish monitoring program, evaluate sampling procedures to ensure QAPP is being implemented appropriately
Reduce salt loads	# BMPs installed, # presentations given, refer to Selenium Management Program and Lower Gunnison Basin Watershed Plan
Reduce the frequency of E. coli exceedances	Database and status report describing *E. coli* data and possible sources, establish monitoring program, evaluate sampling procedures to ensure QAPP is being implemented appropriately
Characterize baseline water quality conditions to determine if and how natural gas exploration may affect the watershed	Evaluate sampling procedures to ensure QAPP is being implemented appropriately
Stabilize key unstable river reaches	Use of the data in decision making for restoration projects, # meetings held, # landowners contacted, fundraising, # projects completed, aerial photos, cross-sections, # acres revegetated
Identify long term strategies to augment flows	Summer flows at Paonia gage, # water use meetings attended
Manage Paonia Reservoir sediment influx	Sediment Load in Reservoir, see Sediment Management Study for Paonia Reservoir
Improve existing access points	Survey park users, # visitors, see Project Plans, # meetings attended,
Educate the public about rights, responsibilities and safety	# attendees, # feasible ideas, # signs posted

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Appendix: Photo Documentation of Priority Stream Restoration Sites

1. USACE Site 1

USACE Site 1: Bank erosion, loss of vegetation, downstream deposition of eroded bank material/channel braiding

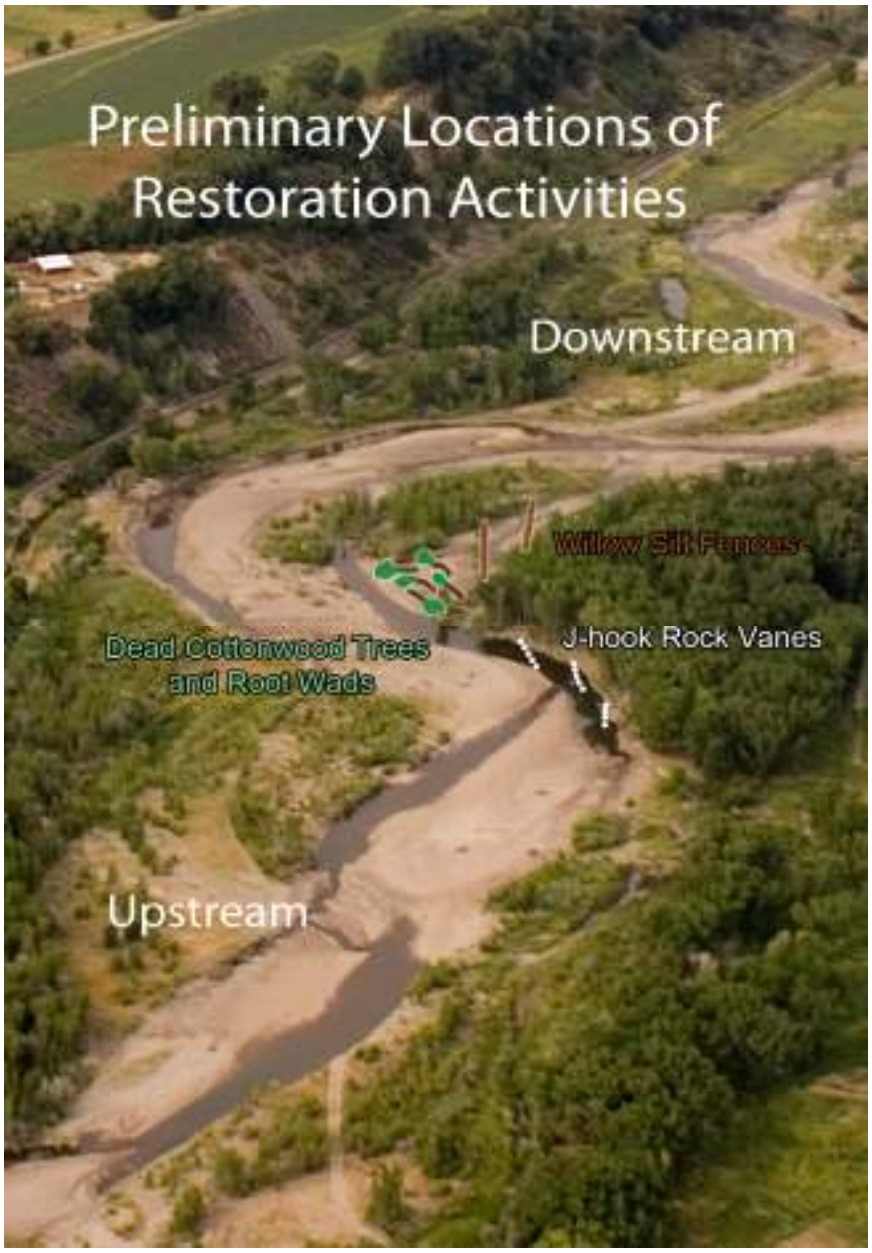
2. USAC Site 2

USACE Site 2: Bank erosion and sloughing adjacent to bank (channel widening, loss of bank vegetation)

3. USACE Site 3

USACE Site 3: Channel alteration, reduced sinuosity, reduced vegetative cover, bank instability

4. Midway (USACE Site 4)



Midway: Disturbed floodplain from past activities, over steepened gradient from past channelization, unvegetated banks

5. Paonia River Park (USACE Site 7)

Paonia River Park: Historic in-stream gravel mining, channel incision, bank erosion, braided stream channel, annual flooding

6. Stewart Diversion (USACE Site 9)

Stewart Diversion: Irrigation diversion dam, localized channel erosion, annual maintenance - bed and bank disruption.