Cimarron Watershed-Based Plan

Prepared by

Joanne Hilton, P.G. in cooperation with
the Cimarron Watershed Alliance
and the Quivira Coalition

December 2012

ACKNOWLEDGEMENTS

The Board and members of the Cimarron Watershed Alliance contributed valuable time and resources toward the preparation of this document.

In particular, information on probable sources, realistic management measures, and financial requirements was provided by Cimarron Watershed Alliance members. Cimarroncita Ranch, C.S. Ranch, Philmont Scout Ranch, and Vermejo Park Ranch, in addition to other local landowners, all contributed practical information. Steve Carson of Rangeland Hands and Rick Smith of Highland Solutions provided field survey reports and recommendations.

Finally, New Mexico State Parks Division, New Mexico Forestry Division, the New Mexico Environment Department Surface Water Quality Bureau, the Quivira Coalition and Trout Unlimited also contributed valuable resources toward development of this plan, and representatives from local governments provided valuable input at meetings.

TABLE OF CONTENTS

List of Figures

List of Tables

List of Acronyms

BAER	Burn Area Emergency Rehabilitation
BMP	Best Management Practice
cfu	colony forming unit
CFRP	Collaborative Forest Restoration Program
CWA	Cimarron Watershed Alliance
DWS	Domestic Water Supply
E.coli	*Esheria coli*
EMAP	EPA Environmental Monitoring Assessment Program
EPA	U.S. Environmental Protection Agency
HQCAL	High Quality Cold Water Aquatic Life
HUC	Hydrologic Unit Code
j/m2/day	Joules per meter squared per day
LA	Load Allocation
MCAL	Marginal Cold Water Aquatic Life
MOS	Margin of Safety
NMED	New Mexico Environment Department
NPS	Nonpoint Source
ONRW	Outstanding National Resource Water
SC	Secondary Contact
SSTEMP	Stream Segment Temperature Model
STEPL	Spreadsheet Tool for the Estimation of Pollutant Load
TMDL	Total Maximum Daily Load
UNM	University of New Mexico
USFS	U.S. Forest Service
USLE	Universal Soil Loss Equation
WLA	Waste Load Allocation
WBP	Watershed-Based Plan (WBP)
WRAS	Watershed Restoration Action Strategy
WWAL	Warm Water Aquatic Life

1. Introduction

The Cimarron Watershed Alliance (CWA) was formed in 2001 to provide local input on water quality issues in the Cimarron Watershed in northeastern New Mexico. The CWA developed a Watershed Restoration Action Strategy (WRAS) in 2003 to guide watershed restoration efforts (CWA, 2003). The WRAS identified water quality concerns, defined potential watershed restoration projects, and established restoration priorities including water quality monitoring, re-planting riparian areas, reducing forest biomass, and improving wastewater management throughout Colfax County.

After initial development of the WRAS, the U.S. Environmental Protection Agency (EPA) provided additional guidance to direct restoration projects and address nonpoint source pollution (EPA, 2008). The EPA now requires that a Watershed-Based Plan (WBP) be completed prior to receiving new funding for restoration activities. Accordingly, the WBP needs to address the following nine elements of watershed-based planning:

a) ***Source of Load Reductions***. Identify the causes and sources, or groups of similar sources, which must be controlled to achieve load reductions.

b) ***Estimate Load Reductions***. Estimate the expected load reductions by using the management measures described in paragraph (c) below.

c) ***Nonpoint Source Management Measures***. Describe the nonpoint source (NPS) management measures needed to achieve estimated load reductions.

d) ***Cost Estimate***. Provide an estimate of the amounts of technical and financial assistance, associated costs, and/or sources and authorities to be used to implement the Cimarron WBP.

e) ***Information/Education Component.*** Include an information/education component to enhance public understanding of the project and encourage participation.

f) ***Implementation Schedule.*** Devise a schedule for implementing the NPS management measures identified in the WBP.

g) ***Interim Milestones.*** Describe the interim, measurable milestones for determining whether NPS management measures or other control actions are being implemented.

h) ***Load Reduction Criteria.*** Compile a set of criteria to determine whether loading reductions are being achieved over time and to determine if substantial progress is being made towards attaining water quality standards.

i) ***Monitoring Component.*** Include a monitoring component to evaluate the effectiveness of the implementation efforts over time, measured against the criteria established in item (h) above.

The primary focus of the WBP is to address the root causes of impairment that affect designated uses of water within the watershed. This version of the WBP expands the original WRAS, addresses new guidance directives, and incorporates field data as well as any results from past and current projects that have become available since the original WRAS was prepared. There has been active public involvement throughout the development of this WBP, and the CWA has guided and reviewed all phases of the planning effort.

This WBP will serve as a living document, adding listed impaired stretches of the Cimarron Watershed as updated NMED/SWQB 303(d)-305(b) Integrated Lists become available.

This report is organized as follows:

- Section 2 provides background information on the CWA.
- Section 3 includes an overview of the watershed characteristics.
- Section 4 provides an overview of historic data and previous studies.
- Sections 5-11 address each of the nine elements of watershed-based planning, respectively.
- Section 12 provides the list of references.
- Appendix A provides estimates of load contributions from probable sources of impairment in the Cimarron Watershed.
- Appendix B provides results of Tier 1 Field Surveys.

Due to the complexities of the Cimarron Watershed, including variable water quality and land management issues, this WBP is intended to be a flexible document that can be updated periodically to reflect new data and/or changed conditions in the watershed.

2. Cimarron Watershed Alliance

Initial efforts to form a watershed group in the Cimarron Watershed began in 2001. The CWA was created in response to water quality investigations performed by the New Mexico Environment Department (NMED), as required by the United States Environmental Protection Agency (EPA), which identified problems in streams and rivers within the Cimarron Watershed. The group developed by-laws and was incorporated as a 501(c)(3) non-profit in 2004 (Hellman, 2010). CWA holds a monthly stakeholder meeting that is open to the general public.

The CWA is composed of volunteers from both incorporated and unincorporated areas of Colfax County. The CWA has involved stakeholders from all interest groups including public officials, state and federal agency personnel, civic group representatives, ranchers, business people, and community members with the common interest of maintaining and improving water quality and water quantity within the Cimarron Watershed. There are no Native Tribes residing within the watershed, although the Sandia and Taos Pueblos own some non-federal (private) property in the Moreno Valley. Collectively, CWA members represent more than one million acres of private property.

The CWA's mission is "to strive for and maintain a healthy watershed for all residents through collaborative community activities involving all stakeholders with an interest in water."

The objectives of the CWA are:

1. To restore, maintain and/or preserve surface and groundwater quality, aquatic resources, and water supplies.
2. To provide a resource for watershed issues and information.
3. To protect, restore, and maintain natural resources (land, water, forest, and wildlife) in the watershed.

The organizational structure of the CWA is that of a board of directors, which is composed of the CWA officers and a few volunteers from the membership. Additionally, a technical advisory panel, and temporary committees are available to address specific issues as needed.

CWA's initial and recent projects included reducing high temperatures by limiting livestock and wildlife access and re-planting riparian habitats; mitigating wildland fires through forest thinning and re-planting burned areas, sediment transport reduction through bank stabilization, in-stream, and low-water crossing remediation, restoring river channels and wetlands habitat, improving wastewater management, establishing alternative watering sources for wildlife and game, and conservation education.

The CWA collaborates with a variety of partners. The partner organizations currently involved in the Cimarron Watershed Alliance include the following (Hellman, 2010):

- New Mexico Environment Department/Surface Water Quality Department (NMED/SWQD)
- U.S. Forest Service (USFS)
- Quivira Coalition
- New Mexico State Parks
- New Mexico State Forestry
- New Mexico Game and Fish
- New Mexico Office of the State Engineer
- Vermejo Park Ranch
- Philmont Scout Ranch
- C.S. Ranch
- Cimarroncita Ranch
- Angel Fire Resort and Ski Area
- Towns of Raton, Cimarron and Angel Fire
- Many local residents

Examples of CWA collaboration projects include:

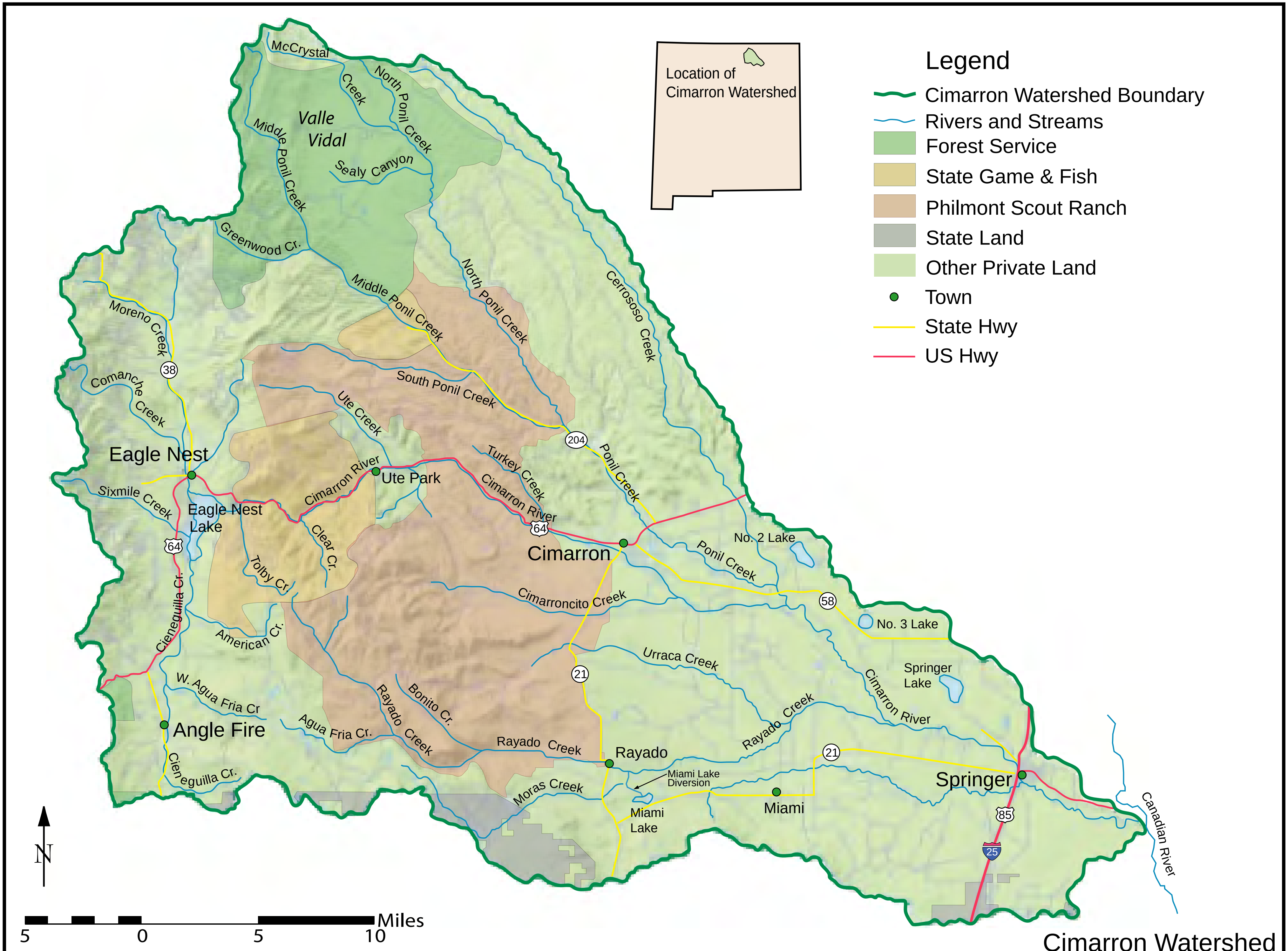
- CWA partners with the Quivira Coalition to restore riparian forests, stabilize streambanks, and control erosion on Ponil Creek. Other collaborators include Philmont Scout Ranch, Vermejo Park Ranch, Cimarroncito, Chase, and C.S. Ranches, the Village of Cimarron, NM State Forestry Department, and the NM Department of Game and Fish. The project goal is to decrease the creek temperature so that Ponil Creek can be removed from the NMED list of impaired waterways (Hellman, 2010).
- CWA collaborated with the New Mexico State Parks and Eagle Nest Elementary School to help 7th graders construct an osprey nesting platform.
- CWA collaborated with Colfax County to conduct a workshop on building and maintaining roads that prevent erosion.
- CWA collaborated with Western Wood Products to construct a transfer station in the town of Eagle Nest to reduce the distance required by landowners to haul wood materials that are accrued from forest-thinning projects.

3. Cimarron Watershed Description

The Cimarron River originates in the Sangre de Cristo Mountains of north-central New Mexico and flows generally eastward to the Canadian River (Figure 3-1). The watershed is approximately 1,032 square miles in size and lies on the eastern slopes of the Sangre de Cristo Mountains within Colfax County. The Cimarron River is part of the Canadian River Basin, which ultimately drains to the Mississippi River. Elevations in the watershed range from approximately 12,000 feet (in the headwaters located in the Valle Vidal Unit of the Carson National Forest) to slightly less than 6,000 feet (at the Cimarron/Canadian River confluence near Springer, New Mexico). The hydrologic unit code (HUC) for the Cimarron Watershed is 11080002.

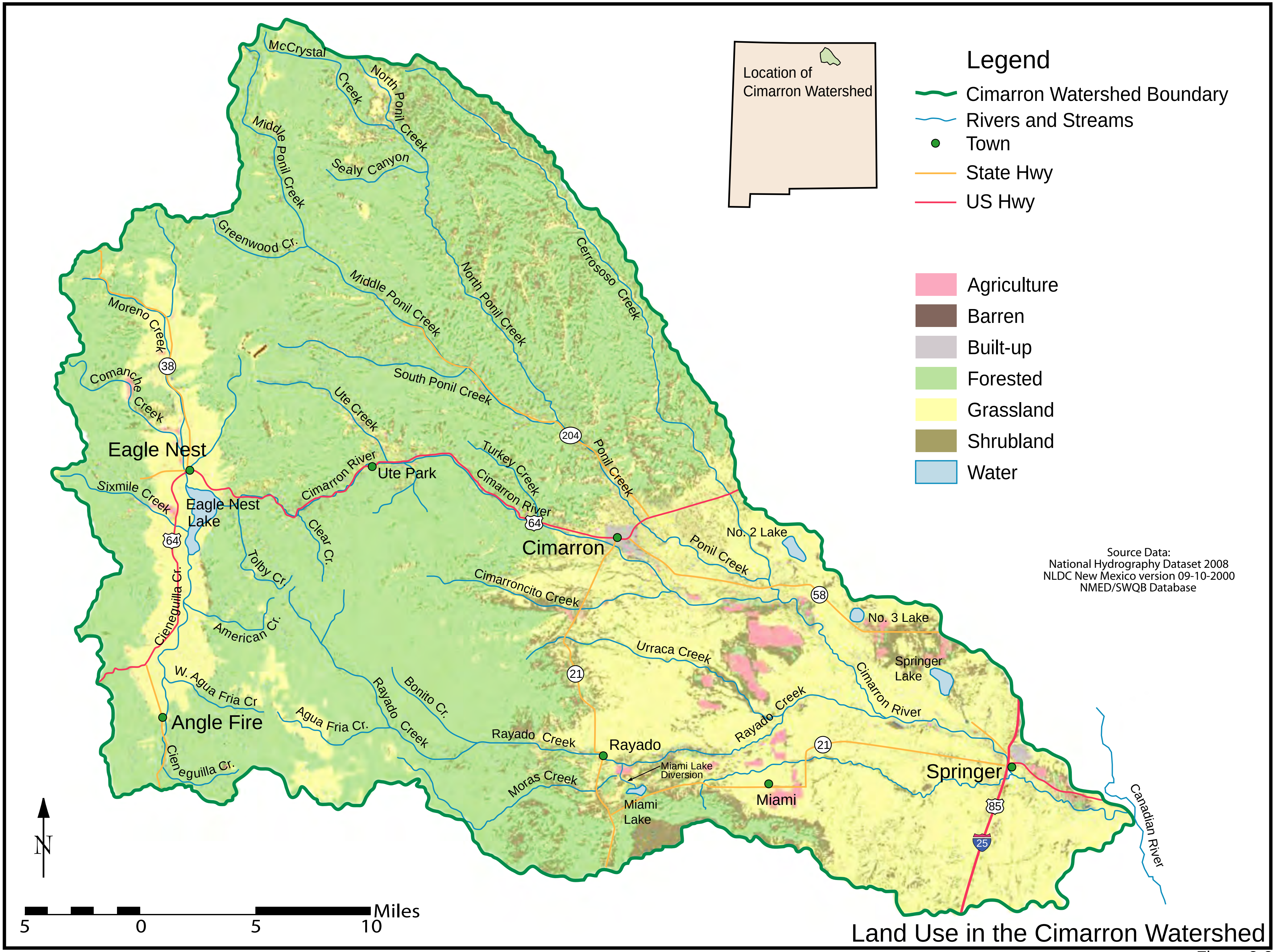
Land ownership in the Cimarron Watershed is primarily private (Figure 3-1), with ranching as the predominant land use. Both the Carson National Forest and the NM Game and Fish Department own and manage the portions of land located within the western forested areas of the watershed. A small area of state-owned lands, located in the southern part of the watershed, is managed by the State Land Office. Cimarron Canyon State Park is owned by the New Mexico Game and Fish Department and managed by the New Mexico State Parks Division, and Eagle Nest Lake State Park is located in the Moreno Valley. These state parks, along with private recreational attractions such as the Angel Fire Ski Area and the Angel Fire Golf Course, have contributed to recent growth and development in the Moreno Valley, particularly in the Angel Fire area.

The upper reaches of the watershed are dominated by forest land, except for the Moreno Valley along Cieneguilla Creek and the grassland located in the lower reaches (Figure 3-2). Vegetation distribution in the Cimarron River watershed generally varies with elevation. The western portion of the watershed is characterized by high mountain landscapes with subalpine and montane vegetation, including coniferous forests of Engelmann spruce, ponderosa pine, and Douglas fir as well as deciduous aspen stands (University of New Mexico, 2010 and U.S. Forest Service, 2009). The eastern portion of the watershed falls within the Great Plains Province and is dominated by grass and shrubs. Plains vegetation includes sagebrush, annual and perennial grasses and small trees such as piñon, juniper, and scrub oak. The watershed also includes numerous riparian corridors. Vegetation in these riparian areas varies with elevation and land use but is generally characterized by alder, willow, cottonwood, and various herbaceous species (UNM, 2010 and U.S. Forest Service, 2009).



Cimarron Watershed

Figure 3-1

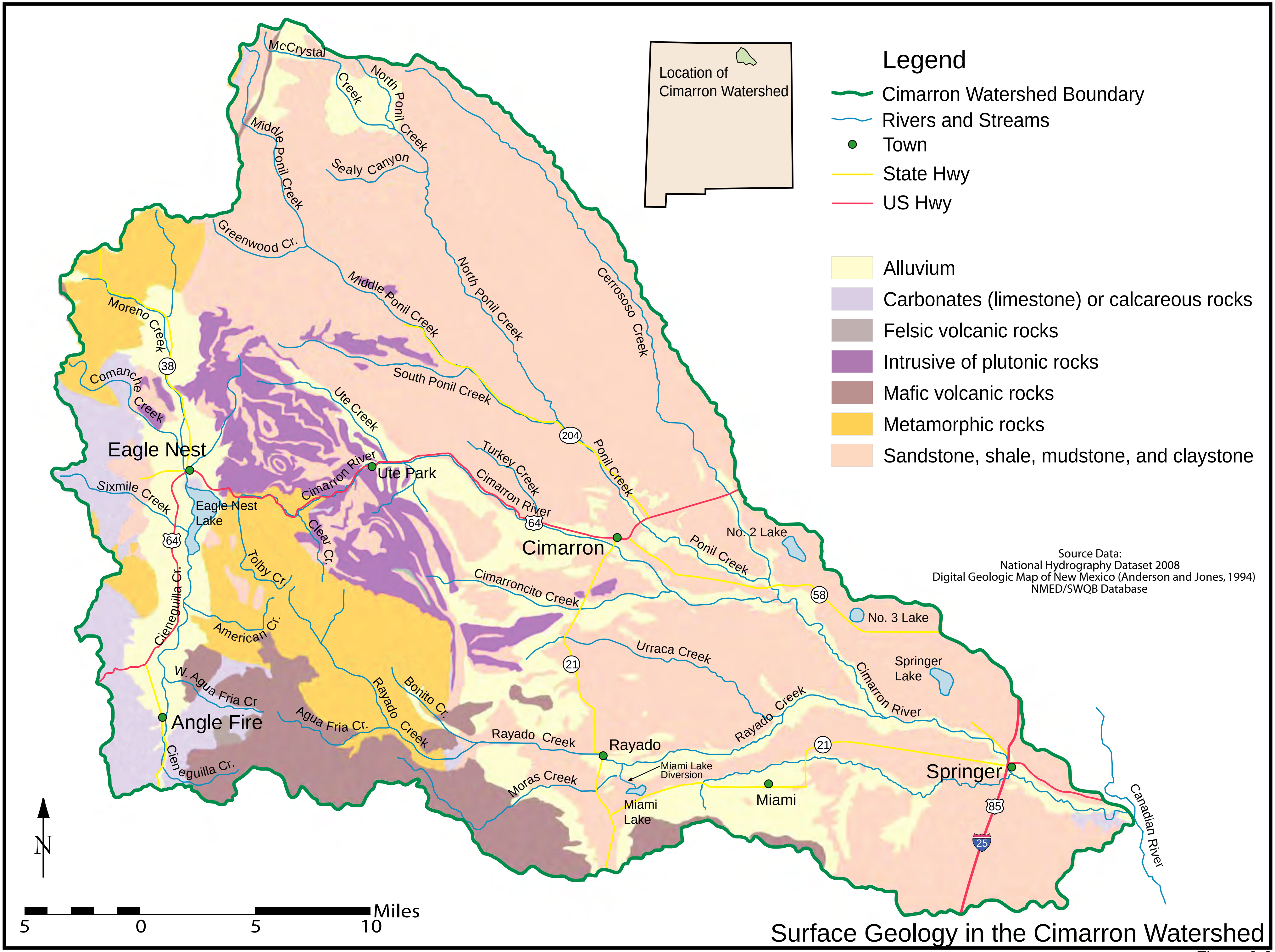


Land Use in the Cimarron Watershed

Figure 3-2

Local wildlife includes deer, elk, bear, pronghorn antelope, turkey, chipmunk, squirrel, beaver, coyote, red fox, porcupine, raccoon, bobcat, mountain lion, a few bighorn sheep, golden eagles, long-billed curlew, and other birds (NMED, 2010a). A valuable recreation population of trout species including Brown, Rainbow and Cutthroat, is also present in the Cimarron Watershed streams. Several species within this watershed are listed as either threatened or endangered by both state and federal agencies. Endangered species include the Southern redbelly dace (*Phoxinus erythrogaster*), Southwestern willow flycatcher (*Empidonax traillii extimus*), Least tern (*Sterna antillarum*), Black-footed ferret (*Mustela nigripes*), and the rare flower, Holy Ghost ipomopsis (*Ipomopsis sancti-spiritus*). Threatened species include the Arkansas River shiner (*Notropis girardi*), Suckermouth minnow (*Phenacobius mirabilis*), Arkansas River speckled chub (*Macrhybopsis tetranema*), Bald eagle (*Haliaeetus leucocephalus*), Mexican spotted owl (*Strix occidentalis lucida*), and Piping plover (*Charadrius melodus*) (NMED 2010a).

Geology in the Cimarron watershed is diverse. Along the Cimarron River, Ponil Creek and lower Rayado Creek, the predominant geologic formations are sandstone, shale, mudstone, and claystone (Figure 3-3). Additionally, a large area in the southeastern part of the Cimarron watershed consists of Pierre Shale and the Niobrara Formation (UNM, 2010). Finally, the western part of the watershed consists of limestone, alluvial and colluvium deposits, and metamorphic rocks (Figure 3-3 and UNM, 2010). A variety of soils are present in the Cimarron watershed; soil types vary according to slope, parent geology, and elevation (UNM, 2010).



Surface Geology in the Cimarron Watershed

Figure 3-3

For purposes of this Watershed-Based Plan, the drainages within the watershed have been grouped into four sub-watershed areas. Within each sub-area, the reaches with Total Maximum Daily Loads (TMDLs), which were identified as active in 2010, are listed below.

Moreno Valley

- Cieneguilla Creek (Eagle Nest Lake to headwaters)
- Sixmile Creek (Eagle Nest Lake to headwaters)
- Moreno Creek (Eagle Nest Lake to headwaters)

Ponil

- South Ponil Creek (Ponil Creek to Middle Ponil)
- Middle Ponil Creek (South Ponil to Greenwood Creek)
- North Ponil Creek (South Ponil Creek to Seally Canyon)
- Ponil Creek (Cimarron River to US 64)
- Ponil Creek (US 64 to confluence of North & South Ponil)

Mainstem of the Cimarron River and Ute Creek

- Cimarron River (Canadian River to Cimarron Village)
- Cimarron River (Cimarron Village to Turkey Creek),
- Cimarron River (Turkey Creek to Eagle Nest Lake)
- Ute Creek (Cimarron River to headwaters)

Rayado Creek

- Rayado Creek (Cimarron River to Miami Lake Diversion)
- Rayado Creek (Miami Lake Diversion to headwaters)

All of the reaches listed above are illustrated in Figure 3-1. In addition to these stream reaches, Eagle Nest and Springer Lakes are discussed in Section 4.

4. Previous Studies and Historic Water Quality Data

Planning for appropriate restoration measures can benefit by considering available data in addition to assessing the results of previous investigations. Key sources of water quality information in the Cimarron Watershed are provided in the assessments conducted by the New Mexico Environment Department (NMED) as part of their ongoing efforts to evaluate water quality conditions and the responses needed in New Mexico. NMED uses a targeted, rotational watershed-based approach to conducting ambient water-quality monitoring (NMED, 2010b). Using the targeted rotational approach to watershed assessment, the Cimarron Watershed is scheduled to be assessed again in 2016 (NMED, 2010b).

Between March and November 2006, the Surface Water Quality Bureau of the New Mexico Environment Department (NMED) conducted a water quality survey of the Canadian River and selected tributaries, including the Cimarron River (NMED, 2010a). Follow-up data were collected in 2007, 2008, and 2009 (NMED 2010a). Water quality monitoring stations were located within the Cimarron Watershed to evaluate the impact of tributary streams and ambient water quality conditions. The water quality survey included 16 sampling sites; most sites were sampled eight times, while some secondary sites were sampled from one to four times. As a result of the monitoring effort and the subsequent assessment of results, several surface water impairments were identified and added to New Mexico's Integrated Clean Water Act §303(d)/305(b) List (NMED, 2010b).

When the scope of work for this Cimarron WBP originated, it was based on the previous Clean Water Act §303(d)/305(b) List (NMED, 2008). There are some differences between these two lists:

- Some listings were revised as a result of changes in assessment protocol. For example, newer protocol identifies *E.coli* rather than the more general fecal coliform bacteria (*E.coli* is a subset of fecal *coliform*).
- Based on updates in sampling methodology, aluminum was determined to no longer be a problem in the watershed.
- Arsenic had not previously been listed but was included in the 2010 TMDL.

In order to provide the most current WBP possible, this plan addresses the more recent group of TMDLs (NMED, 2010a). Since the original scope did not include arsenic, additional arsenic data collection is warranted to fully characterize that issue. However, since further characterizations of arsenic distribution were not included in the scope assigned to this project, only a cursory evaluation has been included in the WBP. Where applicable, data gaps have been identified.

In addition to the CWA §303(d)/305(b) and TMDL information, NMED provides programmatic guidance for Nonpoint Source Management. An updated plan for the Nonpoint Source Management Program was developed and approved in 2009 (NMED, 2009). This plan describes six objectives with an overall goal of meeting and maintaining water quality standards and the usage of surface water and groundwater resources in New Mexico. The Nonpoint Source Management Program is a cooperative effort among watershed stakeholders and NMED, established to educate others, implement best management practices (BMPs), and reduce the ability of nonpoint pollutants to enter surface and ground waters. These objectives are related to planning, restoring water quality, protecting water quality, education, protecting groundwater quality, and interagency cooperation (NMED 2010b.).

In addition to NMED sampling, in June of 2010 the University of New Mexico Water Resources Graduate Program conducted a survey of water quality in the Cimarron Watershed and the Maxwell National Wildlife Refuge as part of this planning effort (UNM, 2010). This study included measuring flows and water quality characteristics at 34 surface water sites in the two study areas. The EPA Environmental Monitoring Assessment Program (EMAP) protocol was used to assess six reaches of the Cimarron River and one reach of Rayado Creek. The assessment evaluated hydrology, geomorphology, riparian vegetation, human impacts, benthic macroinvertebrates, and water quality. In addition, flow measurements and water quality samples were taken at 24 other locations within the basin.

The UNM assessment found generally high quality conditions of the river and riparian environment throughout the Cimarron River. This conclusion was supported by the type and diversity of benthic macroinvertebrates, by channel geomorphic criteria, and by water quality measurements (UNM, 2010). Electrical conductivity, an indirect measure of salinity, was found to increase as the river flows onto the eastern plains; the source was not identified. The water in the river is hard and is dominated by calcium, magnesium and sulfate ions. The UNM assessment was performed near the peak of spring runoff, and the study recognized that it is likely that low-flow conditions later in the summer will present environmental stresses to the system. Low but measurable concentrations of nitrates were found throughout the watershed, with the highest concentrations occurring in Cieneguilla Creek samples collected near a residential area and golf course located downstream from the town of Angel Fire. The UNM study included recommendations for further studies to quantify stream flows and diversions in the watershed to gain a better understanding of water use and to characterize the seasonal concentrations of chemical constituents in the Cimarron River and its tributaries.

An initial Cimarron Watershed Restoration Action Strategy (WRAS) was prepared in 2003 shortly after the Cimarron Watershed Alliance was formed. The WRAS identified key restoration focus areas, including: establishing healthy riparian areas, reducing forest biomass, and improving wastewater systems. The WRAS also identified plans for monitoring and public outreach.

The Colfax Regional Water Plan (DBS&A, 2003) provided an overview of surface and groundwater conditions and water quality in Colfax County. Detailed analysis of stream flow was included in the plan to assess the probability of whether supplies would be able to fulfill adjudicated water rights. The plan also provided an overview of water quality in Colfax County, including the Cimarron Watershed, and identified watershed protection as a key regional water planning priority.

In addition to the studies that pertain to the Cimarron Watershed as a whole, a number of existing studies also pertain to specific parts of the watershed as discussed below.

4-1. Moreno Valley Area

The Moreno Valley includes Eagle Nest Lake and three tributaries: Cieneguilla, Sixmile and Moreno Creeks. These tributaries are all headwater drainages that flow into Eagle Nest Lake from the south, west, and north respectively (Figure 3-1).

The geology, soils, and stream systems of the Moreno Valley were characterized in order to understand why sedimentation is a chronic problem during precipitation run-off (Huerta, 2012). The NRCS Web Soil Survey (websoilsurvey.nrcs.usda.gov/n) was used to define soil properties, elevations, landscape characteristics, and precipitation near Cieneguilla, Six Mile and the Moreno Creeks. The study indicated that the Moreno Valley is a glacial valley with a mean annual precipitation of 15 to 20 inches. The following descriptions pertain to the soil structure of flood plain areas; however, this information does not reflect the soil structure for the entire course of the three perennial creeks (Huerta, 2012):

- The Cieneguilla Creek courses through an elevation of 8,000 to 10,500 feet. The Cieneguilla Creek bed is mainly composed of 65% gently sloping (1-5%) Frolic association with 30% Cumulic Haplaquolls and similar soils. The creek area is moderately well-drained. The capacity of the most limiting layer to transmit water (Ksat) is moderately high up to high (0.60 to 2.00 in/hr). This drainage system is subject to occasional flooding with an average adsorption ratio maximum of 1.0 and an available water capacity at the high end of about 9.6 inches. The Cumulic Haplaquolls soils profile is 0 to 15 inches of very fine sandy loam; 15 to 35 inches of loam; with 35 to 42 inches of fine sandy loam, and 42 to 60 inches of silt (NRCS/WSS 2010). Any run-off in Cieneguilla Creek is loaded with fine soil particulates.

- The Moreno Creek bed is mainly composed of Morval and similar soils at 55%; Moreno and similar soils at 35%; sloping at 1 to 5%. The capacity of the most limiting layer to transmit water (Ksat) is moderately high to high (0.60 to 2.00 in/hr). The depth to the water table is more than 80 inches. Flooding is possible but rare, and the available water capacity is high, at about 10.9 inches. The Morval/Moreno soils profile is 0 to 21 inches of Clay loam; 21 to 57 inches of Clay loam; with 57 to 60 inches of gravelly sandy clay loam; and 60 to 70 inches of stony clay loam (NRCS/WSS 2010).

- Six Mile Creek bed is similar to that of Moreno Creek at 35% Moreno and similar soils and 55% Morval soils, sloping at 1 to 5%. The capacity of the most limiting layer to transmit water (Ksat) is moderately high to high (0.60 to 2.00 in/hr). Flooding is rare and the available water capacity is high at about 10.9 inches. The Morval Moreno soil profile is: 0 to 21 inches of Clay loam; 21 to 57 inches clay loam; with 57 to 60 inches of gravelly sandy clay loam; and 60 to 70 inches of stony clay loam (RCS/WSS 2010).

The 2003 WRAS identified fecal coliform bacteria in the Moreno Valley in Cieneguilla and Moreno Creeks as a key concern. Bacteria continue to be a problem, and the 2010 TMDL included *Escherichia coli* (*E.coli*) for Cieneguilla and Moreno Creeks.

Coliforms (colon bacillus) are bacteria that live in the intestines of warm-blooded animals (humans, pets, farm animals, and wildlife). *Fecal coliform* bacteria are a species of coliform that is associated with human or animal wastes, and *Escherichia coli (E. coli)* is part of this group of fecal coliforms. Most coliforms are not dangerous to humans; however, some may cause adverse health effects such as vomiting or diarrhea (NMED, 2010a). Additionally, coliforms may indicate the presence of other disease-causing bacteria, such as those that cause typhoid, dysentery, hepatitis A, and cholera. To address this issue, the CWA undertook an additional study to better understand both the sources and the distribution of these bacteria. A draft source tracking study indicated that wildlife, specifically waterfowl, has been the dominant contributor to the bacterial presence. This tracking study was released in 2010 (NMSU, 2010).

The bacterial source tracking study reported that *E. coli* is a natural inhabitant of warm-blooded animals, and that because of the unique biochemical environment in the gastro-intestinal tract of each animal, the *E. coli* have become adapted and differ genetically from the *E. coli* in a different animal host. Genetic analyses were used to track the source of *E. coli* back to its animal host. Since there are limitations to this method of analysis, any source tracking studies, such as this one, must only be considered as reasonable estimates to identify various sources of stream *E. coli,* rather than considered to be exact attributions.

Samples were collected from Cieneguilla and Moreno Creeks near the points where they drain into Eagle Nest Lake. Volunteers were trained to collect screening samples to identify the presence of larger quantities of *E.coli*. Samples from select locations were then transmitted to a laboratory for source tracking analyses. Samples were collected over a two-year period using standard methodology.

Results of the bacterial source tracking study indicated seasonal variability, with *E.coli* concentrations highest in the summer, intermediate in the fall, and lowest in the spring. Levels of stream water turbidity followed the same seasonal trends as *E. coli* occurrence in Cieneguilla Creek, but not in Moreno Creek. These results show significant turbidity variations between the two sites, as well as significant differences of *E. coli* levels. These results indicate that differing runoff and and/or land use patterns impact these two creeks.

Overall, of the three most important wildlife sources (24% avian, 12% raccoon and 9.8% elk/deer) each one had greater contributions than the three largest anthropogenic sources (8.7% horse, 7.6% cattle and 6.5% sewage). Since meaningful statistics typically cannot be applied to source track data, these differences only indicate source trends. Nevertheless, results indicate that wildlife, particularly avian sources, are the most important contributors of *E. coli* in the streams that are located immediately upstream of the point where they flow into Eagle Nest Lake. These results are consistent with a source tracking study on the middle Rio Grande, New Mexico, in which avian sources were also identified as the most important contributors of *E. coli* (NMSU, 2010).

In addition to completing the source tracking study, the CWA has participated in a project to restore bank stability along Cieneguilla Creek. Post vanes were installed to deflect water from cut banks. Exclosures have also been established to allow for revegetation in a section of the creek that is upstream from Eagle Nest Lake. A recently completed report (CWA, 2012) documents the observed field improvements resulting from the project.

Another issue facing the Moreno Valley is poorly constructed roads. In particular, the Taos Pines subdivision, located west of the Village of Angel Fire in steep terrain, has numerous unpaved roads that are sources of sediment during storm events. In 2009, Rangeland Hands conducted a field survey of the Taos Pine Roads to assess conditions and develop cost estimates for road improvements that would mitigate erosion and sedimentation. The assessment indicated that road conditions were extremely poor, due to the clay-base soil type, poor original design, a road width that is wider than necessary, poor maintenance and management practices, plugged culverts, and system overloading from driveway runoff and steep grades (Rangeland Hands, 2009). Additionally, this road system is hydraulically connected in numerous locations via wheel tracks, ruts, and improperly maintained road ditches, culverts, and driveways as well as old roads. In these locations, water is trapped on the road surface for hundreds of consecutive feet. Rangeland Hands recommended an effective, reliable road drainage system with long-term maintenance, and prepared a design that calls for the installation of ninety-nine (99) road surface cross drains, the cleaning of thirty-two (32) culverts, the replacement of one (1) culvert, the removal of one (1) culvert, and the cleaning of hundreds of feet of uphill side road ditches (Rangeland Hands, 2009). Implementation of these practices could prove to be crucial for future water quality in the Moreno Valley.

Other projects of interest in the Moreno Valley include fuel reduction by private landowners and local governments. The purpose of these projects is to reduce the risk of catastrophic wildfires, which could cause additional impairment, particularly turbidity, sedimentation, and temperature. These projects are protective of long-term water quality in the area.

Eagle Nest Lake is a key resource in Moreno Valley and one of the oldest reservoirs in New Mexico. According to a 2005 survey completed by NMED (NMED, 2005) Eagle Nest Lake is impounded by a concrete dam which was completed in June of 1918. Charles and Frank Springer built this lake to store irrigation water derived from three perennial streams

(Cieneguilla, Six Mile and Moreno Creeks) that feed the lake. The storage capacity of Eagle Nest Lake is about 81,360 acre-feet at maximum pool. The lake elevation is about 2,500 meters (8,200 ft.) above mean sea level, making Eagle Nest Reservoir the highest large lake in New Mexico.

Both Angel Fire and Eagle Nest treat their domestic wastewater, and Angel Fire discharges their domestic wastewater near Cieneguilla Creek, which empties into Eagle Nest Lake about ten miles north of the wastewater facility.

Eagle Nest Lake was purchased by the State of New Mexico, Department of Game and Fish in 2002. The lake is now managed by New Mexico State Parks Division, who took control of the lake's recreational facilities in 2004. The New Mexico Water Quality Standards list has designated the following uses for Eagle Nest Lake:

- high-quality coldwater aquatic life
- domestic water supply
- irrigation
- livestock watering
- wildlife habitat, municipal and industrial water supply
- secondary contact

The principal fish species, as recognized and supported by the New Mexico Department of Game and Fish, are Kokanee and Coho Salmon, Rainbow Trout, and Cutthroat Trout. Perch have been reported to be of catchable size by State Park employees.

Lake chemistry sampling conducted by NMED consisted of total, dissolved, and calculated nutrients, anions and cations, total and dissolved heavy metals, synthetic organics, radionuclides, bacteria, and cyanide. This sampling covered all standards of criteria that are pertinent to the protection of all designated uses (NMED, 2005). The nitrogen and phosphorus ratio showed that nitrogen was the limiting nutrient during five of the six visits, and co-limiting for the remaining visit.

Eagle Nest Lake experienced thermal stratification during the summer sampling visit, and again in the spring at one deep station (NMED, 2005). Dissolved oxygen fell below the criteria for high-quality coldwater aquatic life at both stations in the summer. The sampling visits during the fall resulted in non-support of this use. Furthermore, a fish consumption advisory was set for Eagle Nest Lake, which also resulted in an impairment of aquatic life use. One exceedence of six measurements for pH was below the 6.6 lower criteria, but did not constitute a use impairment. The lower pH was probably due to the heavy spring snow melt. Snow is typically acidic; reports show that the lake elevation increased by 13 feet during the spring.

Four of six heavy-metals results for arsenic exceeded the 2.3 parts per billion criteria that were adopted for the protection of the domestic water supply use (NMED, 2005). The source of the arsenic is unknown, and may be naturally occurring. In 1998, a similar study conducted by NMED showed levels similar to those from 2005. However, the water quality standard applicable at the time of the 1998 study was 0.05 mg/L or 50 ppb. All other uses were fully supported during the NMED study of Eagle Nest Lake.

Eagle Nest Lake is listed as not supporting either for the domestic water supply or for the high-quality cold water aquatic life categories. However, Eagle Nest Lake is fully supporting for other categories of use (NMED, 2010b). Further assessments for arsenic and dissolved oxygen are scheduled for 2017.

The assessment comments for Eagle Nest Lake point out that there are small legacy hardrock mining operations in the upper watershed that may be contributing to the elevated arsenic levels (NMED, 2012). In addition, the level of mercury in fish has prompted a consumption advisory to be issued to anglers taking fish from the lake.

4-2. Ponil Creek

Ponil Creek is formed by three main tributaries: the North Ponil, the Middle Ponil, and the South Ponil Creeks (Figure 3-1). The CWA has been managing a Clean Water Act section 319 grant primarily to address temperature exceedences in the Ponil watershed; however, restoration treatments will also reduce sediment and lessen turbidity and nutrients within the creek. The CWA has been implementing the three-year project through a collaborative process with Philmont Scout Ranch, Vermejo Park Ranch, the Chase and C.S. Ranches, the Village of Cimarron, the New Mexico State Forestry, and the New Mexico Department of Game and Fish. This project has focused on lowering the stream temperature through the restoration of riparian forests, the stabilization of stream banks, and the implementation of erosion control treatments.

The project consists of the following four components:

- Restore 11 miles of riparian forest by planting native cottonwood trees to provide shade.
- Reduce erosion and sediment through upgrades and improvements of three low-water crossings.
- Repair two cutbanks that are threatening to undermine the road along the Ponil (NM 204) and one large headcut in the main channel that contributes to the stream's increased velocity.
- Assess the Middle Ponil Creek from the confluence with the South Ponil to the confluence at Greenwood Creek, to improve the identification of source problems as well as potential mitigation options.

The treatments identified above will lower the temperature by increasing the amount of effective shade and by reducing both the heat-trapping sediment and the width-to-depth ratio. Further discussion of recent assessment results from this project is provided in Section 7.

4-3. Valle Vidal (Ponil Drainage)

The Valle Vidal is located at the headwaters of Ponil Creek (Figure 3-1). A recent study evaluated the effectiveness of various watershed treatments in the Valle Vidal (Allred 2009). This study considered the possibility that the suppression of wildfires has created opportunities for catastrophic wildfires, which can increase stream temperature, stream flow, erosion, and sediment in nearby streams and lakes. The study also reviewed Burn Area Emergency Rehabilitation (BAER) treatments to minimize the effects that follow a wildfire, considering conditions that resulted from the 2002 92,000 acre Ponil Complex Fire.

One treatment reviewed was induced meandering, which utilizes rock structures to promote the stabilization of incised degrading channels by simulating river riffles, elevating channel bottoms, establishing channel slopes to encourage channel meandering, and forming an active floodplain (Allred, 2009).

The Allred project evaluated the effectiveness of rock baffles, one-rock dams, and aerial seeding in stabilizing an incised discontinuous gully channel post-wildfire. The methods used to evaluate the effects of treatment included photo documentation, vegetation percent cover, cross-sectional measurements, streambed geology, and a riparian habitat assessment.

The Allred (2009) study concluded:

- Results from photo documentation of the channel illustrated that meandering is occurring; however, the cross-sectional data indicated that the channel has stabilized. The findings were supported by vegetation percent cover data and streambed geology.
- Photo documentation and data of vegetation percent ground cover indicated that aerial seeding on the upland slopes was successful.
- The riparian habitat assessment confirms that gullies are not suitable riparian habitat.
- Continued monitoring, research, and understanding of induced meandering and other rehabilitation treatments are needed to provide the best possible post-wildfire treatments.
- The Allred study also included a summary of existing research on the effectiveness of various techniques for post-fire stabilization.

In January 2006, the New Mexico Water Quality Control Commission designated the surface water within the Valle Vidal Unit of the Carson National Forest as Outstanding National Resource Waters (ONRWs) in accordance with the Clean Water Act. This designation disallows any new or increased discharges to ONRWs or to their tributaries that would result in lower water quality. Any project proposals in Valle Vidal Unit will acknowledge the ONRW designation and comply with this policy.

The CWA and the USFS are interested in pursuing Collaborative Forest Restoration Program or other funding to reduce fuel loads and restore habitat in the Valle Vidal Unit.

4-4. Cimarron River and Ute Creek

Surface water for three municipal water systems (the Village of Cimarron, the City of Raton, and the Town of Springer) is supplied by releases from Eagle Nest Dam (on the main stem of the Cimarron River) and by three perennial tributaries (Clear Creek, Tolby Creek, and Cimarroncita Creek), along with seasonal flows from Ute Creek. The Village of Cimarron and the City of Raton both have diversions upstream from the Village of Cimarron. Springer obtains its water supply from a diversion through the Springer Ditch system that supplies Springer Lake, which is located west of Springer. Each of these municipalities collects water quality data as needed for the operation of their treatment plants and drinking water systems.

Both Cimarron and Raton obtain their primary water supply from other sources, and only use Cimarron diversions as supplemental supplies. Due to the 2011 Track Fire that severely damaged the primary municipal watershed for the City of Raton, the Cimarron River was temporarily used to supply all of the drinking water supply for the City of Raton. Studies have not yet been completed to identify other potential suppliers of drinking water for the City of Raton in the event of future wildfires in Cimarron Canyon.

Ute Creek contributes surface water to the Cimarron River from its headwaters on the East side of the Baldy Mountain complex. Flows along Ute Creek are diverted through a system of ditches that irrigate pastures used during the summer by a sizeable local elk herd as well as cattle. Some waters from this area are channeled into pass-through lakes and one reservoir (Huerta, 2012).

Sandia and Los Alamos National Laboratory (LANL) conducted a study of the main stem of the Cimarron River (LANL and Sandia, 2011). Data were collected by both Los Alamos National Laboratory (LANL) and Sandia National Laboratory; the final analysis was performed by LANL. The purpose of the study was to evaluate the impact of the irregular flow regime from Eagle Nest Dam on potential visitors and fishing clients that spend valuable tourism dollars within the upper watershed. The study assessed the minimum flow of the Cimarron River outflow through Eagle Nest dam to provide an appropriate depth estimate for trout habitat, which could/would be useful to guide future conservation decisions and protect a stable tourism economy.

The LANL/Sandia study relied on United States Geological Survey (USGS) stream flow gauges to provide insight into the natural flow regime of the upper Cimarron watershed. This study reported that the minimum combined average flow into Eagle Nest Reservoir from the gage tributaries (Cieneguilla, Sixmile, and Moreno Creek) is 1.9 cubic feet per second (cfs); this occurs during the month of December. This value represents a minimum pre-reservoir flow below Eagle Nest reservoirs, and does not account for the flow from ungaged tributaries and springs.

Seventeen channel profiles were measured in six areas. Manning's equation was used to estimate the required flows to maintain the agency's recommendations for particular depths. To maintain the U.S. Fish and Wildlife Service's recommended depth of 0.5 ft requires 2.9 cfs from

Eagle Nest dam. Alternatively, to maintain the New Mexico Department of Game and Fish's recommendation of 1.0 ft requires 14.9 cfs from Eagle Nest dam. The outflow of Eagle Nest reservoir provides adequate flow for trout during 9 months of the year. In order to provide a minimum depth of 0.5 ft at the Tolby campground, the study estimated that 90 days of flow would be required, for a total of 518 acre feet (LANL and Sandia, 2011).

Cimarroncita Ranch is headquartered along the Cimarron River near the perennial Cimarroncita Creek, whose headwaters lie on the Northern aspect of Cimarroncito Peak. Cimarroncita Ranch is the location of the Cimarron Conservation Camp. This camp is dedicated to conservation education; it regularly monitors temperature, flow levels, and turbidity of the Cimarron River (Huerta, 2012). The Cimarron Conservation Camp has been involved with both Sandia and Los Alamos National Labs through the NM Small Business Association to determine the impact of low flows on the local tourist economy, as discussed above.

Cimarroncita Ranch is in the process of establishing a conservation easement that encompasses the riparian area of the Cimarron River, which passes through the ranch (Huerta, 2012). Cimarroncita Ranch has a management plan that focuses on the protection and conservation of its natural assets, to provide a living laboratory for students of all ages to study and work. In addition to providing a location and opportunity for national laboratory-sponsored studies, Cimarroncita Ranch will be setting aside a riparian conservation easement to establish and monitor a wetlands improvement project which will aide biotic life and water transport. Due to potential impacts of jurisdictional wetlands near Angel Fire, (the result of an electrical sub-station expansion), a plan for wetland mitigation on the Cimarroncito Ranch was prepared (Paramatrix, 2011).

4-5. Rayado Creek

The Philmont Scout Ranch, headquartered along Rayado Creek, owns much of the land located in the headwaters of the drainage. Philmont maintains a conservation department that is actively involved in watershed restoration along Rayado and Ponil Creeks. For example, the Philmont Conservation Department recently prepared an assessment of Bonito Creek, which is a tributary to Rayado Creek, and prepared initial conceptual designs for treatments to mitigate erosion features such as incised channels, head cuts, side arroyos, and collapsed banks on Bonito Creek (Philmont Scout Ranch, 2010). This project defined conservation and education goals to address restoration.

In addition, the Miami Domestic Water Users Association monitors water quality as required by the Safe Drinking Water Act and the NMED Drinking Water Bureau. They recently completed comprehensive source water sampling for *E.coli.* This study indicated that the annual mean coliform concentration of 12.7 *E.coli*/100ml was less than the trigger level of 100 *E.coli*/100ml, indicating that the Association could conduct less extensive monitoring in the future (Vigil, 2010).

5. Causes and Sources of Water Quality Impairment

The first of nine elements of watershed-based planning requires identification of the causes and sources, or groups of similar sources that need to be controlled to achieve load reductions. The cause of a water quality problem refers to a chemical or physical condition that leads to impairment, for example, measurements of arsenic or another chemical or a physical parameter such as temperature that exceeds water quality standards. The source of the problem is the nature of land use or another activity that creates the water quality concern, such as an old mine leaching arsenic, or loss of vegetation that contributes to increased water temperatures.

5-1. Causes of Water Quality Impairment

NMED conducted field water quality measurements (Section 4) to identify the causes of water quality degradation in the Cimarron Watershed. A summary of the causes of water quality degradation by stream reach, as identified in the 2010 TMDL (NMED, 2010a), are shown in Table 5-1 and in Figure 5-1. Temperature, nutrient/eutrophication, and *E. coli* are the most common causes of impairment in the Cimarron Watershed. These impairments also comprise the top three major causes of river and stream water quality impairments in New Mexico (NMED, 2010b).

Table 5-1. Causes of Stream Water Quality Impairment

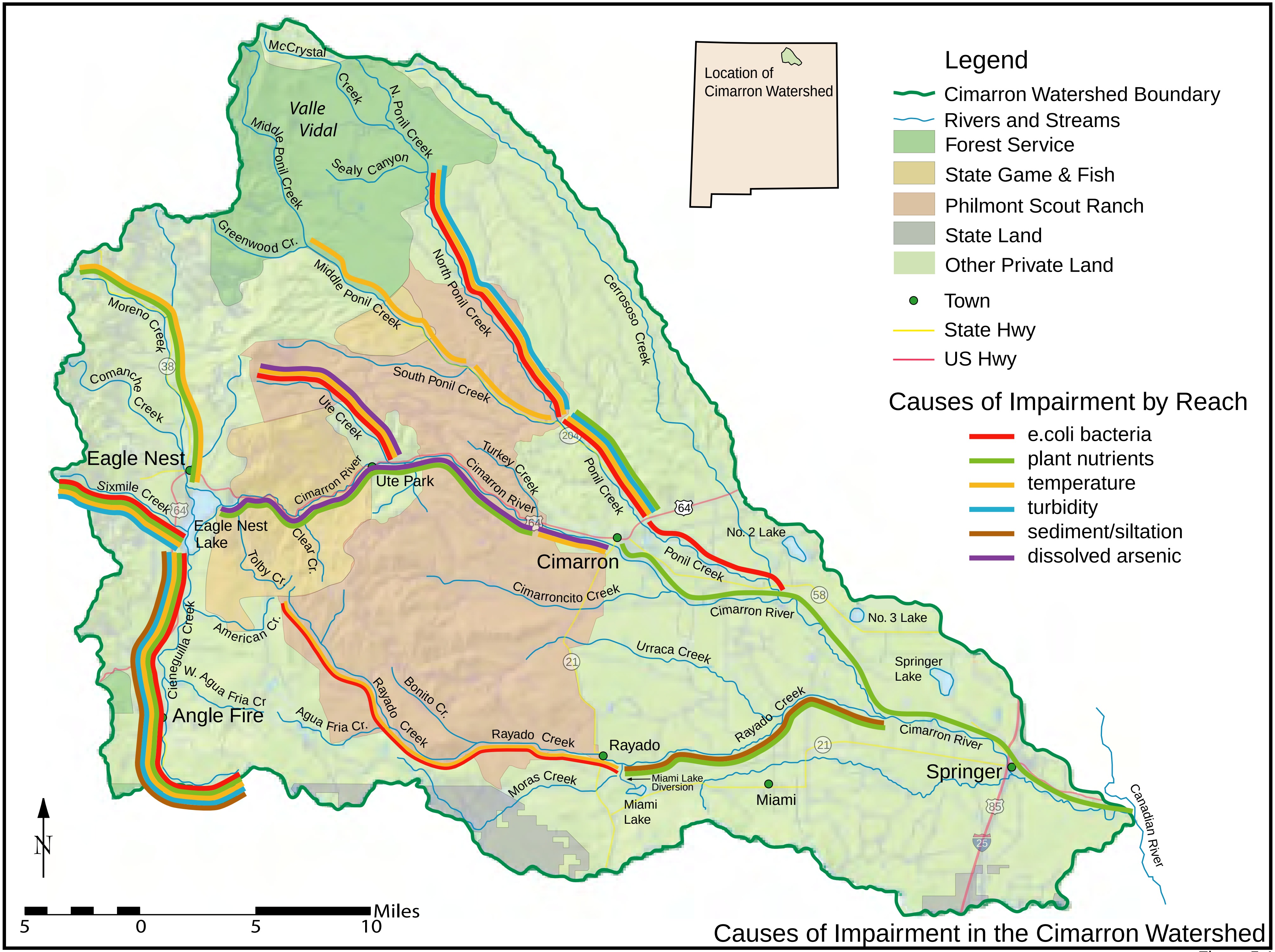
Location	2010 TMDL	Continued Impairment [a]	Not supporting[b]
Moreno Valley			
Cieneguilla Creek (Eagle Nest Lake to headwaters)	*E.coli*, plant nutrients, temperature	turbidity, sediment/siltation	HQCAL, SC
Moreno Creek (Eagle Nest Lake to headwaters)	plant nutrients, temperature		HQCAL
Sixmile Creek (Eagle Nest Lake to headwaters)	*E.coli*, plant nutrients, temperature	turbidity	HQCAL, SC
Ponil Creek and Tributaries			
North Ponil Creek (South Ponil Creek to Seally Canyon)	*E.coli*	turbidity, temperature	HQCAL, SC
North Ponil Creek (Seally Canyon to Headwaters) [c]	temperature		HQCAL
Middle Ponil Creek (South Ponil to Greenwood Creek)	none	temperature	HQCAL
South Ponil Creek (Ponil Creek to Middle Ponil)	temperature		HQCAL
Ponil Creek (US 64 to confluence of North and South Ponil)	*E.coli*, plant nutrients	turbidity, temperature	HQCAL, SC
Ponil Creek (Cimarron River to US 64)	*E.coli*		SC, WWAL
Cimarron River and Ute Creek [d]			
Cimarron River (Turkey Creek to Eagle Nest Lake)	dissolved arsenic, plant nutrients		DWS, HQCAL
Cimarron River (Cimarron Village to Turkey Creek)	dissolved arsenic, temperature		DWS, HQCAL
Cimarron River (Canadian River to Cimarron Village)	plant nutrients		WWAL
Ute Creek (Cimarron River to headwaters)	dissolved arsenic, *E.coli*, temperature		DWS, HQCAL, SC
Rayado Creek			
Rayado Creek (Miami Lake Diversion to headwaters)	*E.coli*, temperature		HQCAL, SC
Rayado Creek (Cimarron River to Miami Lake Diversion)	plant nutrients	sediment/siltation	MCAL, WWAL

a) Impaired based on earlier assessment, listed as continued impairment in 2010 Total Maximum Daily Load (TMDL) document

b) As identified in NMED 2010b. DWS=Domestic Water Supply; HQCAL= High Quality Cold Water Aquatic Life, MCAL = Marginal Cold Water Aquatic Life; WWAL = Warm water aquatic life; SC = Secondary Contact

c) Seally Canyon to Headwaters reach not included in 2010 TMDL so not included in remainder of this WBP

d) Ute Creek from headwaters to main stem of the Cimarron



Causes of Impairment in the Cimarron Watershed

Figure 5-1

5-2. Sources of Water Quality Impairment

In addition to identifying the causes of impairment, the EPA guidance (2008) requires identification of the probable sources of impairment. Sources are defined as activities that may contribute either pollutants or stressors to a water body. A list of probable sources of impairment was included in the TMDL (2010a). The probable source list provided in the TMDL is intended to include any and every activity that could be contributing to the identified impairment. However, this list is not intended to single out any particular land owner or any specific land management activity; therefore, it has been labeled as “probable” (NMED, 2010b).

The CWA reviewed the probable source lists presented in the TMDL, and stakeholders familiar with each stream reach listed the relative percentages of probable sources. The percentages estimated by each stakeholder were averaged, and the averages for each source category were further considered in workshops conducted with local land owners as well as other stakeholders who are familiar with the sub-watersheds and the reaches of concern. Additionally, field reconnaissance of select areas was conducted to observe probable source conditions. For example, if the probable source considered was low-water crossings, then field observations could verify this finding as a likely source. Although the resulting distributions of probable sources are not based on measurable data and are not completely accurate, they are considered to represent a reasonable understanding of the most significant sources in comparison to those of lesser importance.

A summary of the probable sources for each stream reach is presented in Table 5-2. The load from identified probable sources for each reach was estimated by the group of stakeholders and local land owners as described above and is included in Appendix A.

Table 5-2. Probable Sources of Impairments in the Cimarron Watershed

Location	Contaminants of Concern	Primary Probable Sources [a]	Secondary Probable Sources[b]
Moreno Valley			
Cieneguilla Creek (Eagle Nest Lake to headwaters)	*E.coli*, plant nutrients, sediment/siltation, temperature, turbidity	loss of riparian habitat (wildfire), rangeland grazing, roads, streambank modification/ destabilization, wildlife	airport, dam/impoundment, construction, municipal point source discharges, other recreational pollutant sources, septic tanks
Moreno Creek (Eagle Nest Lake to headwaters)	plant nutrients, temperature	mining, rangeland grazing, roads, septic systems, wildlife	corrals, gravel pits, roads, waste from pets
Sixmile Creek (Eagle Nest Lake to headwaters)	*E.coli*, plant nutrients, temperature, turbidity	gravel pits, habitat modification, livestock feeding, rangeland grazing, septic systems	natural sources, roads
Ponil Creek and Tributaries			
North Ponil Creek (South Ponil Creek to Seally Canyon)	*E.coli*, temperature, turbidity	loss of riparian habitat (wildfire), low-water crossings, rangeland grazing, roads	habitat modification, hydromodification, fire suppression, sediment, mining, silvaculture
Middle Ponil Creek (South Ponil to Greenwood Creek)	temperature	loss of riparian habitat (wildfire), rangeland grazing	wildlife
South Ponil Creek (Ponil Creek to Middle Ponil)	temperature	recreational uses, rangeland grazing, wildlife	low-water crossings, roads
Ponil Creek (US 64 to confluence of North and South Ponil)	*E.coli*, plant nutrients, temperature, turbidity	loss of riparian habitat (wildfire), rangeland grazing, roads, streambank modification/ destabilization, wildlife	livestock confinement areas (corral relocation), recreational uses, roads, septic systems, waste from pets
Ponil Creek (Cimarron River to US 64)	*E.coli*	avian sources, rangeland grazing, septic systems, unknown sources, wildlife	recreational uses, roads, waste from pets

a) Primary Probable Sources are those considered by the group as contributing 10% or more of the total load

b) Secondary Probable Sources are those considered by the group as contributing less than 10% of the total load

TABLE 5-2 (continued)

Location	Contaminants of Concern	Primary Probable Sources [a]	Secondary Probable Sources[b]
Cimarron River and Ute Creek			
Cimarron River (Turkey Creek to Eagle Nest Lake)	dissolved arsenic, plant nutrients	dams or impoundment, historical mining, septic systems (cesspools), wildlife	geology, livestock, other recreational sources, roads, unknown sources
Cimarron River (Cimarron Village to Turkey Creek),	dissolved arsenic, temperature	loss of riparian habitat, rangeland grazing, roads, wildlife	baseflow depletion, corrals, diversions, mining, low-water crossings, pets, unknown sources
Cimarron River (Canadian River to Cimarron Village)	plant nutrients	flow alterations from water diversions, rangeland grazing, septic systems (cesspools), wildlife	Low-water crossings, roads, impervious surface run-off
Ute Creek (Cimarron River to headwaters)	dissolved arsenic, *E.coli*, temperature	historic mining, loss of riparian habitat, low-water crossings, rangeland grazing, roads, wildlife	pets, septic systems
Rayado Creek			
Rayado Creek (Miami Lake Diversion to headwaters)	*E.coli*, temperature	baseflow depletions from groundwater withdrawals, roads, low-water crossings, rangeland grazing, wildlife	avian/waterfowl, flow alterations, highways, septic tanks
Rayado Creek (Cimarron River to Miami Lake Diversion)	plant nutrients, sediment/siltation	dam or impoundment, loss of riparian habitat, rangeland grazing, roads, low-water crossings, wildlife	flow alterations, habitat modifications, highways

a) Primary Probable Sources are those considered by the group as contributing 10% or more of the total load

b) Secondary Probable Sources are those considered by the group as contributing less than 10% of the total load

5-3. Data Gaps

The constituents that contribute to water quality problems in the watershed (Table 5-1) all vary depending on streamflow and other conditions. Critical streamflow conditions that cause water quality standards to be exceeded can occur when:

- Low-flow conditions either limit the dilution of chemical constituents or cause temperatures to rise due to slower velocities and greater surface areas, or
- Conversely, some water quality standard exceedences are more likely to occur during storm events, particularly during high-intensity monsoon events that can accelerate erosion and contribution of sediment, chemical constituents, nutrients, and/or bacteria.

The majority of the reaches included in the TMDL exceeded standards primarily at low flows. The TMDL then used the 4Q3 (the minimum average four-consecutive day flow that occurs with a frequency of once in three years) as a critical flow level for achieving standards (NMED, 2010a). This method provides a reasonably conservative estimate for calculating needed load reductions. However, since the available water quality data were limited, and do not fully reflect the large degree of temporal and spatial variability that occurs for each constituent within the characterized stream reaches, more accurate assessments could be completed with a greater range of data. Additional data would help to more fully characterize the temporal variability of the streams that are included in this report as well as both Eagle Nest and Springer Lakes. In particular, water can be released from three different gates at Eagle Nest Dam. Characterizing the stratification could help to optimize the timing and location of releases.

The estimates of relative contributions from probable sources were made by local landowners and others familiar with the watershed, based on visual observations of the watershed. For example, where low-water crossings were identified as a significant probable source, both the number and condition of those roads were considered. However, complete data to characterize water quality conditions, both upstream and downstream of the low-water crossings, or to identify other probable sources under a variety of streamflow conditions, were not available.

As watershed restoration activities are implemented, continued water quality monitoring is needed with a focus on TMDL constituents for the reaches of concern, to refine water quality goals and improvements during implementation. Data needs include the continued operation of existing U.S. Geological Survey (USGS) stream gages (Cieneguilla Creek near Eagle Nest, Sixmile Creek near Eagle Nest, Moreno Creek at Eagle Nest, Eagle Nest Lake Near Eagle Nest, Cimarron River below Eagle Nest, Cimarron River near Cimarron, Rayado Creek near Cimarron, Ponil Creek near Cimarron, and Cimarron River at Springer). In some cases the gages may need to be repaired or reinstalled to allow for continued operation.

Additional streamflow measurements and water quality sampling are also warranted to characterize a fuller range of constituent levels at varying streamflows. Recommended monitoring to address this data gap is discussed in Section 12.

Additionally, NMED has not fully characterized all of the streams within the Cimarron Watershed, including American Creek, West Agua Fria Creek, Clear Creek, Tolby Creek, Bonito Creek, Greenwood Canyon, McCrystal Creek, Seally Canyon, and North Ponil Creek from Seally Canyon to the headwaters. Also, streams that are not currently listed as impaired could be listed in the future, due to possible wildland fires or other changing conditions. As a result of these data gaps and changing conditions, the CWA views this WBP as a living document that may need to periodically include new information and/or addendums for individual reaches, as listed in the subsequent 303(d)/305(b) Integrated Lists.

Specific plans for addressing these data gaps in the Cimarron Watershed are:

- Meet with a representative of the USGS to discuss plans for repair and continued operation of key stream gages and to discuss opportunities for CWA and USGS to work collaboratively to seek funding and support for operation of streamflow gages and water quality monitoring.
- Meet with the OSE to discuss opportunities to collaborate on research and monitoring at Eagle Nest Lake that will help with optimizing release operations.
- Complete monitoring activities as identified in Section 11.
- Review and synthesize ongoing monitoring data collected by NMED, USGS, and other agencies and information collected through specific projects such as the Riparian Ecosystem Restoration Initiative (RERI) grant to provide an integrated and up-to-date water quality database.

Additionally, the CWA will continue to share new data and information through monthly meetings and annual reporting.

6. Load Reductions

The objective of the watershed-based planning process is to improve water quality so that TMDL standards are achieved. Once the causes and sources of pollutants have been identified, the next step in the planning process is to quantify load reductions that are required to meet water quality objectives. Guidance for watershed-based planning indicates that, in cases where a TMDL for affected waters has been developed and approved, or is being developed for approval, the watershed plan should be crafted to achieve the load reductions required by the TMDL (EPA, 2008). A summary of the load reductions, as reported in the TMDL (NMED, 2010a), is provided on Table 6-1, which illustrates the significant load reductions that are required to meet standards. The TMDLs, along with associated load reductions required to meet the TMDLs (NMED, 2010a) are included in Tables 6-2 through Table 6-5. Load reductions expected for select management measures are discussed in Section 7.

Table 6-1. Estimated Load Reductions

Location	Contaminants of Concern	Required Load Reduction (percent) [a]
Moreno Valley		
Cieneguilla Creek (Eagle Nest Lake to headwaters)	E.coli	88
	plant nutrients [b]	40, 28
	sediment/siltation	NE*
	Temperature	37
	Turbidity	NE*
Moreno Creek (Eagle Nest Lake to headwaters)	plant nutrients	55,45
	Temperature	43
Sixmile Creek (Eagle Nest Lake to headwaters)	E.coli	59
	plant nutrients	51,29
	Temperature	35
	Turbidity	NE*
Ponil Creek and Tributaries		
North Ponil Creek (South Ponil Creek to Seally Canyon)	E.coli	47
	Temperature	NE*
	Turbidity	NE*

a) Per 2010 TMDL (NMED, 2010a)

b) Phosphorus and nitrogen, respectively

* NE –For constituents listed as continued impairment from previous assessments, (see Table 5-1), the TMDL (NMED, 2010a) did not estimate a required load reduction. In most cases, the management measures which were implemented to address other constituents will also address this constituent.

TABLE 6-1 (continued)

Location	Contaminants of Concern	Required Load Reduction (percent) [(a)]
South Ponil Creek (Ponil Creek to Middle Ponil)	Temperature	14
Ponil Creek (US 64 to confluence of North and South Ponil)	E.coli	53
	plant nutrients	59,50
	Temperature	NE*
	turbidity	NE*
Ponil Creek (Cimarron River to US 64)	E.coli	75
Cimarron River and Ute Creek		
Cimarron River (Turkey Creek to Eagle Nest Lake)	dissolved arsenic	64
	plant nutrients	77,65
Cimarron River (Cimarron Village to Turkey Creek)	dissolved arsenic	44
	Temperature	33
Cimarron River (Canadian River to Cimarron Village)	plant nutrients	31,42
Ute Creek (Cimarron River to headwaters)	dissolved arsenic	50
	E.coli	49
	Temperature	24
Rayado Creek		
Rayado Creek (Miami Lake Diversion to headwaters)	E.coli	36
	Temperature	37
Rayado Creek (Cimarron River to Miami Lake Diversion)	plant nutrients, sediment/siltation	53,32

a) Per 2010 TMDL (NMED, 2010a)

b) Phosphorus and nitrogen, respectively

* NE –For constituents listed as continued impairment from previous assessments (see Table 5-1) the TMDL (NMED, 2010a) did not estimate a required load reduction. In most cases, management measures implemented to address other constituents will also address this constituent.

Table 6-2. Calculation of Load Reduction for Dissolved Arsenic

Location	Target Load (lbs/day) [a]	Measured Load (lbs/day)	Reduction (lbs/day)	Percent Reduction [b]
Cimarron River (Cimarron Village to Turkey Creek)	0.236	0.424	0.188	44%
Cimarron River (Turkey Creek to Eagle Nest Lake)	0.150	0.413	0.263	64%
Ute Creek (Cimarron River to headwaters)	0.004	0.008	0.004	50%

Notes: The Margin of Safety (MOS) is not included in the load reduction calculations because it is a set-aside value, which accounts for any uncertainty or variability in TMDL calculations. Therefore, the MOS should not be subtracted from the measured load.

(a) Target Load = TMDL - MOS

(b) Percent reduction is the percentage amount of the existing measured load that must be reduced to achieve the TMDL, and is calculated as follows: (Measured Load – Target Load) / Measured Load x 100

Table 6-3. Calculation of Load Reduction for *E. Coli*

Location	Target Load (cfu/day) [(a)]	Measured Load (cfu/day)	Reduction (cfu/day)	Percent Reduction [(b)]
Cieneguilla Creek (Eagle Nest Lake to headwaters)	3.01×10^{9}	2.42×10^{10}	2.12×10^{10}	88%
North Ponil Creek (South Ponil Creek to Seally Canyon)	6.45×10^{8}	1.21×10^{9}	5.61×10^{8}	47%
Ponil Creek (US 64 to confl of North and South Ponil)	9.03×10^{8}	1.91×10^{9}	1.01×10^{9}	53%
Ponil Creek (Cimarron River to US 64)	1.97×10^{9}	7.75×10^{9}	5.78×10^{9}	75%
Rayado Creek (Miami Lake Diversion to headwaters)	5.24×10^{9}	8.23×10^{9}	2.99×10^{9}	36%
Sixmile Creek (Eagle Nest Lake to headwaters)	4.73×10^{8}	1.15×10^{9}	6.82×10^{8}	59%
Ute Creek (Cimarron River to headwaters)	2.02×10^{9}	3.94×10^{9}	1.92×10^{9}	49%

Note: The Margin of Safety (MOS) is not included in the load reduction calculations because it is a set-aside value, which accounts for any uncertainty or variability in TMDL calculations. Therefore, the MOS should not be subtracted from the measured load.

(a) Target Load = TMDL - MOS

(b) Percent reduction is the percentage amount of the existing measured load that must be reduced to achieve the Target Load, and is calculated as follows: (Measured Load – Target Load) / Measured Load x 10

Note: cfu = colony forming unit

Table 6-4. Calculation of Load Reduction for Nutrients (Total Phosphorus and Total Nitrogen)

Location	Nutrient	Target Load (lbs/day) [a]	Measured Load (lbs/day)	Reduction (lbs/day)	Percent Reduction[b]
Cieneguilla Creek (Eagle Nest Lake to headwaters)	P	0.315	0.525	0.210	40%
Cieneguilla Creek (Eagle Nest Lake to headwaters)	N	2.97	4.14	1.18	28%
Cimarron River (Canadian River to Cimarron Village)	P	0.126	0.183	0.057	31%
Cimarron River (Canadian River to Cimarron Village)	N	1.89	3.26	1.37	42%
Cimarron River (Turkey Creek to Eagle Nest Lake)	P	0.324	1.42	1.10	77%
Cimarron River (Turkey Creek to Eagle Nest Lake)	N	3.96	11.4	7.41	65%
Moreno Creek (Eagle Nest Lake to Headwaters)	P	0.018	0.040	0.022	55%
Moreno Creek (Eagle Nest Lake to Headwaters)	N	0.225	0.410	0.185	45%
Ponil Creek (US 64 to confl of North and South Ponil)	P	0.036	0.088	0.052	59%
Ponil Creek (US 64 to confluence of North and South Ponil)	N	0.396	0.788	0.392	50%
Rayado Creek (Cimarron R. to Miami Lake Diversion)	P	0.063	0.135	0.072	53%

Note: The Margin of Safety (MOS) is not included in the load reduction calculations because it is a set-aside value, which accounts for any uncertainty or variability in TMDL calculations. Therefore, the MOS should not be subtracted from the measured load.

(a) Target Load = TMDL – MOS

(b) Percent reduction is the percentage amount of the existing measured load that must be reduced to achieve the target load, and is calculated as follows: (Measured Load – Target Load) / Measured Load x 100.

TABLE 6-4 (continued)

Location	Nutrient	Target Load (lbs/day) [(a)]	Measured Load (lbs/day)	Reduction (lbs/day)	Percent Reduction[(b)]
Rayado Creek (Cimarron R. to Miami Lake Diversion)	N	0.918	1.35	0.433	32%
Sixmile Creek (Eagle Nest Lake to headwaters)	P	0.018	0.037	0.019	51%
Sixmile Creek (Eagle Nest Lake to headwaters)	N	0.207	0.294	0.087	29%

Note: The MOS is not included in the load reduction calculations because it is a set-aside value, which accounts for any uncertainty or variability in TMDL calculations. Therefore, the MOS should not be subtracted from the measured load.

(a) Target Load = TMDL – MOS (refer to Table 5-10)

(b) Percent reduction is the percentage amount of the existing measured load that must be reduced to achieve the target load, and is calculated as follows: (Measured Load – Target Load) / Measured Load x 100.

Table 6-5. Calculation of Load Reduction for Temperature

Location	Target Load (j/m2/sec) [a]	Measured Load (j/m2/sec)	Reduction (j/m2/sec)	Percent Reduction [b]
Cieneguilla Creek (Eagle Nest to headwaters)	131.79	207.83	76.04	37%
Cimarron River (Cimarron Village to Turkey Creek)	104.70	157.05	52.35	33%
Moreno Creek (Eagle Nest Lake to headwaters)	97.35	170.48	73.13	43%
Rayado Creek (Miami Lake Diversion to headwaters)	143.96	226.85	82.89	37%
Sixmile Creek (Eagle Nest Lake to headwaters)	171.46	265.36	93.90	35%
South Ponil Creek (Ponil Creek to Middle Ponil)	143.09	165.98	22.89	14%
Ute Creek (Cimarron River to headwaters)	177.99	232.67	54.68	24%

Notes: The MOS is not included in the load reduction calculations because it is a set-aside value, which accounts for any uncertainty, or variability, in TMDL calculations. Therefore, the MOS should not be subtracted from the measured load.

(a) Target Load = LA + WLA

(b) Percent reduction is the percentage amount of the existing measured load that must be reduced to achieve the target load, and is calculated as follows: (Measured Load – Target Load) / Measured Load x 100.

Note: j/m2/sec = joules per meter squared per second

7. NPS Management Measures

Management measures that will help to achieve needed load reductions were evaluated by cause of impairment as well as by geographic area. When considering nonpoint source management measures or best management practices to achieve load reductions, there are two primary types of actions:

- ***Overall management measures that address the root cause or source of contamination***. These may include changing land use practices, such as grazing management, relocating roads, installing a wastewater treatment plant to replace aging septic tanks, or any other activity that directly addresses the source of contamination.
- ***Mitigation measures that focus on reducing the impacts of degradation***. For example, high levels of erosion from upland land use management practices may cause stream bank instability. Mitigation measures to restore bank stability can be beneficial, but will only have limited long term impact without addressing the root cause of the degradation. Mitigation measures can be important in helping to restore streams and reducing loads to meet water quality standards. However, they must be coupled with appropriate management measures to have long-term success.

As discussed in section 5, the causes of impairment in the Cimarron watershed, as identified in the TMDL process, include *E.coli*, plant nutrients, turbidity, sediment/siltation, temperature, and dissolved arsenic. Although numerous probable sources were also identified in Section 6, plant nutrients, turbidity, sediment/siltation, and to some degree, *E.coli* are largely related to the processes of erosion and resulting contributions of sediment into the stream system. Therefore, a key focus of management measures is to control erosion.

Due to the large size of the Cimarron Watershed, the CWA is approaching this WBP project in two Tiers:

- Tier 1 projects have been evaluated in greater detail; therefore, more specific information has been developed related to management measures, anticipated load reductions and costs. These projects have a high implementation priority, and are ready to move forward. As Tier 1 projects are completed and the CWA proceeds with implementation of the WBP, additional Tier 1 sub-watersheds will be identified for more detailed assessment and to establish on-the-ground project funding.
- Tier 2 management measures have been identified for the entire watershed. These measures are linked both to the causes and the sources of impairment (Section 5) and to the estimated load reductions that are needed to improve water quality (Section 6). However, the scope of this WBP did not allow for detailed field assessment of the entire watershed. Consequently the Tier 2 portion of the watershed is not evaluated in as much detail as the Tier 1 portion.

An overview of management measures for the entire watershed is included in Section 7.1. More detailed discussion of Tier 1 projects is included in Section 7.2.

7-1. Cimarron Watershed Management Measures

While a significant number and variety of management measures will be needed to address impairment throughout the watershed, there are some key categories of management practices that will be essential to achieve load reductions and improve water quality. These categories include:

- ***Livestock Grazing Management Practices:*** Active livestock grazing management practices can limit access to prevent over-grazing. Prescribed grazing is the controlled harvest of vegetation by using grazing or browsing animals, managed with the intent to maintain or improve water quality and quantity. For example, on grazed forest, native pasture, or rangeland, grazing is limited so that the grazing animals will consume no more than 50% of the annual growth of preferred types of vegetation (EPA, 2008). In many situations, the utilization rate should be in the range of 25% to 30%, in order to optimize livestock grazing, wildlife utilization, range biodiversity, and health. These more limited utilization rates can assist all the animals, grasses and forbs through future droughts. Also, de-stocking can be expected to be less severe; the range will recover much more quickly and will be in better condition. Individual ranches, and the managers who are responsible for wildlife management, can develop site-specific grazing management plans that are appropriate for the number of livestock as well as for current vegetation. Some grazing management practices which can be beneficial for water quality include:
    - ***Herding and Rotation.*** By rotating livestock through herding, vegetation can be preserved by allowing only a certain amount of the vegetation to be consumed before livestock is rotated to a new pasture. Herd rotation prevents erosion by leaving sufficient surface litter and root structure in place. ***Rest Rotational*** grazing plans can also be used to protect vegetation and prevent erosion.
    - ***Paddocks or corrals*** can be used to manage herds. There are some locations in the Cimarron watershed where it would be beneficial to relocate corrals a greater distance from water sources to minimize the flux of nutrients, bacteria, and sediment in to the streams.
    - ***Grazing*** should be keyed to range monitoring, where no more than 25- 50% of the forage is used in any one rotation
    - ***A drought management plan*** must be written and adhered to, with triggers that are based on precipitation and range condition.

- *Riparian Grazing Management*, one type of livestock grazing, can be utilized to reinvigorate vegetation and keep it from becoming decadent. Key species for riparian monitoring are sedges and woody vegetation. Once riparian vegetation has been established, riparian zones can be grazed during 3 out of 4 years, alternating between spring, mid-season, and late-season (this method should be used for upland paddocks when possible). Alternatively, dormant season grazing on the riparian paddocks can normally be done during two out of every three years. In some cases, during initial restoration, livestock may need to be kept completely out of the riparian areas for several years to avoid the destruction of re-growth.

- In some cases, fencing may be more appropriate than rotational herding to control livestock access to key areas.

- ***Managing access to streams and riparian areas.*** Managing access by pets, livestock and wildlife can help to reduce the influx of sediment, nutrients, and turbidity into streams and can protect the vegetation that contributes to lower stream temperatures. Some of the best management practices in this category include:

  - Elk or other wildlife exclosures, which consist of fencing around sensitive areas to exclude access. This feature can be particularly important when trying to establish new vegetation.

  - Alternative water sources, sometimes in combination with animal trails, exclosures, or improved grazing practices, can be used to keep livestock or wildlife away from direct stream access.

- ***Restoring riparian vegetation***. Healthy riparian areas stabilize soil and can help reduce erosion and sedimentation, as well as the influx of nutrients or other contaminants, by providing a buffer zone between roads or other sources and streams. Restoration of riparian vegetation by planting and limiting livestock and wildlife access and in some cases vehicle access can also aid in reducing water temperatures by increasing shade cover, and can help to restore cold-water fisheries.

- ***Restoring channel stability and natural geomorphologic conditions.*** Stabilizing channels will connect streams to floodplains and reduce erosion and sedimentation. Re-establishing appropriate geomorphologic conditions can help to stabilize stream banks and potentially reduce turbidity, sedimentation, nutrients, and bacteria that enter the stream through erosion processes. Additionally, geomorphologic restoration can assist in establishing riparian vegetation to reduce stream temperatures.

- ***Improving road conditions***. Implementing BMPs for roads can help to reduce the influx of sediment, nutrients, bacteria and other contaminants that may run off of road surfaces into streams, as well as help to reduce road maintenance costs. Typical BMPs include:
  - ***Stabilizing low-water crossings.*** Numerous unpaved roads in the Cimarron watershed cross directly through streams. During high flows, these roads may be impassable. At other times, driving through the water leads to ruts and, in some cases, severe erosion. The road crossings can be stabilized by installing boulders and gravel to provide a more secure driving surface.

- o ***Relocating Roads.*** In some cases, relocating roads, rather than stabilizing stream crossings, may be feasible. Relocating roads out of the riparian area to either eliminate or reduce the number of stream crossings allows for better opportunities to improve drainage as well as adding natural buffer zones to mitigate potential contamination between the road and the riparian area.

- o ***Improving drainage.*** Poor road drainage that can accelerate erosion and runoff can be mitigated through both proper placement of culverts and bridges, and low maintenance water harvesting techniques, to minimize erosion from unpaved road surfaces. Additionally, implementing standards and oversight to ensure that any new roads are properly designed and installed can protect against further water quality degradation.

- o ***Water Bars.*** Water Bars are commonly constructed on roads or skid trails when they are no longer used. The purpose of Water Bars is to slow the speed of water flow as well as to divert water away from the road or trail.

- ***Implementing best management practices for construction projects.*** Similar to roads, other construction projects can potentially contribute sediment, nutrients, bacteria, and other contaminants to streams through erosion processes. For example, construction of recreation and commercial facilities (ball parks, ski areas, parking lots, etc.) in the watershed are sources of potential concerns. Best management practices related to construction include:

  - o ***Pre-construction planning*** to consider how runoff will be addressed can minimize any future impacts of the project under consideration. Stormwater BMPs described below may be identified during the planning and permitting process.

  - o ***Temporary sediment fences or wattles*** may be used to ensure that runoff from construction sites does not reach waterways.

- o ***Hydraulic mulching (hydromulch)*** is a process by which wood fiber mulch, processed grass, hay, or straw mulch is applied with a tacking agent; this process is performed using a slurry. This mulching method provides for temporary stabilization of bare slopes or other bare areas, as well as uniform, economical slope protection. Hydromulch may be combined with hydroseeding as a revegetation method (EPA, 2006). However, where hydromulching is used, care must be taken to ensure that invasive species are not introduced.

- ***Preventing catastrophic wildfires and conducting post-fire restoration.*** Catastrophic or crown fires have the potential to cause severe erosion and sedimentation, as well as the influx of other contaminants into waterways. Fuel reduction projects can help some fires to have fewer impacts by reducing ladder fuels, allowing for a more natural fire regime (as opposed to a catastrophic crown fire), and helping to minimize post-fire erosion and sedimentation, flooding, and temperature increases due to loss of hillslope and/or streamside vegetation. Also, the installation of swales, sediment ponds, log contouring, mulching, and reseeding after fires can potentially help to mitigate fire impacts.

- ***Management of streamflow releases and diversions.*** As discussed in Section 5, water quality is partially dependent on streamflow. In many cases, streamflow impairment occurs during low-flow conditions. Management of releases from Eagle Nest Dam, and diversions throughout the watershed to optimize water quality conditions, could be beneficial. However, this WBP does not affect water rights, and any changes in diversions would be voluntary, as is the case with all management practices suggested in this WBP. Therefore, this management practice needs further exploration to determine if there is a willingness to pursue voluntary involvement of water rights holders. If there is sufficient interest and funding to cover the considerable expense, water rights could be purchased for watershed restoration purposes. These could be similar to other current projects that have been implemented to protect endangered species through the strategic water reserve on the Rio Grande (OSE, 2008).

  Land managers and water right users along the Cimarron River can help manage flows by:

  - o Planning water consumption for irrigation during early morning and late evening hours to reduce evaporation,
  - o Grass banking and managing riparian zones to retain soil moisture and minimize soil erosion, and

    Providing buffer zones with shade plants along the river to reduce water temperatures.

- If releases from Eagle Nest Dam are not managed properly, and/or if there are failures in the mechanical operation of the release gates, these releases could become a source of impairment. Releases of eutrophied water and water containing high levels of sediment could contribute to the exceedence of water quality standards for dissolved oxygen, turbidity, and heavy metals such as arsenic, mercury or other constituents. A concerted effort by the managers of Eagle Nest Dam is needed, not only to monitor water quality being released, but also to use the release gates in such a manner as to mix eutrophied waters with oxygenated waters. This management effort would mitigate any point source contamination.
- ***Agriculture Best Management Practices.*** Though the land area involved in agriculture (other than livestock) is relatively small in the overall watershed, there can still be benefits from implementing agricultural BMPs. These benefits are most likely to affect water quality on Rayado Creek and the mainstem of the Cimarron River. Agricultural BMPs include:
    - ***Conservation crop rotation*** is the practice of growing different crops on the same piece of land in a planned sequence. This sequence might involve growing high-residue-producing crops, such as corn or wheat, in rotation with low-residue-producing crops, such as vegetables or soybeans. The rotation might also involve growing forage crops in rotation with various field crops. Crop rotation can help reduce soil erosion and break insect, disease, and weed cycles (EPA, 2006).
    - ***Contour farming*** includes tillage, planting, and other farming operations performed with the rows on or along the contour of the field slope. It helps to reduce sheet and rill erosion and the resulting transport of sediment and other waterborne contaminants (EPA, 2006).
    - ***Critical area planting*** is the planting of grasses, legumes, or other vegetation to stabilize slopes in small, severely eroding areas. This permanent vegetation stabilizes areas such as gullies, over-grazed hillsides, and terraced backslopes. Although the primary goal is erosion control, the vegetation can also provide nesting cover for birds and small animals (EPA, 2006).
- ***Managing Storm Water.*** Though urban and developed areas represent only a small part of the watershed, managing storm water runoff in these areas can help prevent the influx of sediments, nutrients, bacteria, and other contaminants into streams. Additionally, the BMPs in this category can be used to address impacts from construction projects, mines, or other local sources.

- ***Diversion*** is the redirection of a storm drain line or outfall channel so that it can temporarily discharge into a sediment-trapping device. Its purpose is to prevent sediment-laden water from entering a watercourse, public property, or private property through a storm drain system. A diversion may also provide temporary underground conveyance of sediment-laden water to a sediment-trapping device (EPA, 2006).

- ***A dry detention basin*** is a storm water retention basin that remains dry except for short periods of time following large rainstorms or snowmelt events. Its main benefit is the moderating influence it provides on peak flows, which help to control streambank erosion (EPA, 2006).

- ***A filter strip*** is a strip or area of vegetation for removing sediment, organic matter, and other pollutants from runoff and wastewater before they reach water bodies or water sources, including wells (EPA, 2006).

- ***Grass swales*** are elongated depressions in the surface of the land that have been vegetated with erosion-resistant and flood-tolerant grasses. Swales are formed to direct storm water flows into primary drainage channels to allow some storm water to infiltrate into the ground. These depressions are, at a minimum, seasonally wet. Usually, they are also heavily vegetated and they normally lack flowing water. Sometimes check dams are strategically placed in swales to moderate the flow (EPA, 2006).

- ***Implementing Mine BMPs.*** Additional monitoring and assessment of potential impacts from old mine sites is needed. Potential BMPs at these sites include:

  - Diverting drainage away from exposed soils by applying storm water BMPs described above.

  - Working with New Mexico Abandoned Mine Lands Program to implement site specific remediation projects, such as covering tailings or closing shafts.

- ***Addressing Failing Septic Systems.*** Providing education resources to homeowners regarding the proper maintenance and potential replacement of older septic systems, such as those present in Ute Park, can help to reduce loads of nutrients and bacteria to stream systems.

The management measures to be implemented for each geographic area/impaired stream reach that will contribute to needed load reductions are listed on Table 7-1, and priorities impairments to address by sub-watersheds are shown on Table 7-2. The locations of these sub-watersheds are shown on Figure 7-1. Implementation of the management measures will lead to improved water quality and greater resilience in the watershed.

.

Table 7-1. Management Measures

Location	Causes of Impairment	Primary Probable Sources	Secondary Probable Sources	NPS Management Measures Needed to Achieve Load Reductions	
				Projects Completed	Additional Projects
Moreno Valley					
Cieneguilla Creek (Eagle Nest Lake to headwaters)	*E.coli*, plant nutrients, sediment/siltation, temperature, turbidity	loss of riparian habitat, rangeland grazing, roads, streambank modification/ destabilization, wildlife	airport, dam/impoundment, construction, municipal point source discharges, other recreational pollutant sources, septic tanks	- bacterial source tracking - geomorphology/bank stabilization - wildlife exclosures - C.S. Ranch Corral Relocation	- Angel Fire effluent re-use - channel stability BMPs - construction BMPs - conservation easements - fuel reduction/fire BMPs - grazing BMPs - open space purchase - riparian vegetation - remediation of older septic systems - sediment traps or filter strips below gravel pits - wildlife management - protection of riparian areas

Location	Causes of Impairment	Primary Probable Sources	Secondary Probable Sources	NPS Management Measures Needed to Achieve Load Reductions	
				Projects Completed	Additional Projects
Moreno Creek (Eagle Nest Lake to headwaters)	plant nutrients, temperature	mining, rangeland grazing, roads, septic systems, wildlife	corrals, gravel pit, roads, waste from pets	bacterial source tracking	- abandoned mine assessment - fuel reduction/fire BMPs - remediation of older septic systems - sediment traps or filter strips below gravel pits - septic tank BMPs - wildlife management - livestock corral relocation - road improvements
Sixmile Creek (Eagle Nest Lake to headwaters)	*E.coli*, plant nutrients, temperature, turbidity	gravel pit, habitat modification, livestock feeding, rangeland grazing, septic systems	natural sources, roads		- fuel reduction/fire BMPs - remediation of older septic systems - sediment traps below gravel pits - Taos Pines road improvements - wildlife management

Location	Causes of Impairment	Primary Probable Sources	Secondary Probable Sources	NPS Management Measures Needed to Achieve Load Reductions	
				Projects Completed	**Additional Projects**
Ponil Creek and Tributaries					
North Ponil Creek (South Ponil Creek to Seally Canyon)	*E.coli*, temperature, turbidity	loss of riparian habitat, low-water crossings, rangeland grazing, roads	habitat modification, hydromodification, fire suppression sediment, mining, silvaculture	initial review of channel conditions	- channel stability BMPs - fuel reduction/fire BMPs - low-water crossings - riparian vegetation - road improvements - livestock corral relocation
Middle Ponil Creek (South Ponil to Greenwood Creek)	Temperature	loss of riparian habitat, rangeland grazing	wildlife	- low-water crossings - channel stability - post fire rehabilitation	- channel stability BMPs - fuel reduction/fire BMPs - low-water crossings - riparian vegetation - road improvements - livestock corral relocation
South Ponil Creek (Ponil Creek to Middle Ponil)	Temperature	recreational uses, rangeland grazing, wildlife	low-water crossings, roads	initial review of channel conditions	- channel stability BMPs - fuel reduction/fire BMPs - low-water crossings - riparian vegetation - road improvements - livestock corral relocation

Location	Causes of Impairment	Primary Probable Sources	Secondary Probable Sources	NPS Management Measures Needed to Achieve Load Reductions	
				Projects Completed	**Additional Projects**
Ponil Creek (US 64 to confluence of North and South Ponil)	*E.coli*, plant nutrients, temperature, turbidity	loss of riparian habitat, rangeland grazing, roads, streambank modification/destabilization, wildlife	livestock confinement areas, recreational uses, roads, septic systems, wastes from pets	initial review of channel conditions	- channel stability BMPs - fuel reduction/fire BMPs - riparian vegetation - road improvements - livestock corral relocation
Ponil Creek (Cimarron to US 64)	*E.Coli*				
Cimarron River and Ute Creek					
Cimarron River (Turkey Creek to Eagle Nest Lake)	dissolved arsenic, plant nutrients	dam or impoundment, historical mining, septic systems, wildlife	geology, livestock, other recreational sources, roads, unknown sources		- channel stability BMPs - evaluate alternative releases from Eagle Nest* - fuel reduction/fire BMPs - road BMPs, including turnouts and filter strips to address runoff - groundwater monitoring and remediation of septic tanks
Cimarron River (Cimarron Village to Turkey Creek),	dissolved arsenic, temperature	loss of riparian habitat, rangeland grazing, roads, wildlife	baseflow depletion, corrals, diversions, mining, low-water crossings, pets, unknown sources		- channel stability BMPs - evaluate alternative releases from Eagle Nest Dam* - fuel reduction/fire BMPs - riparian vegetation

Location	Causes of Impairment	Primary Probable Sources	Secondary Probable Sources	NPS Management Measures Needed to Achieve Load Reductions	
				Projects Completed	Additional Projects
Cimarron River (Canadian River to Cimarron Village)	plant nutrients	flow alterations from water diversions, rangeland grazing, septic systems, wildlife	Low-water crossings, roads, impervious surface run-off		- channel stability BMPs - evaluate alternative releases from Eagle Nest* (no flow periods) - evaluate ditches and storm water runoff in Cimarron - fuel reduction/fire BMPs - Springer Ditch leakage reduction
Ute Creek (Cimarron River to headwaters)	dissolved arsenic, *E.coli*, temperature	historic mining, loss of riparian habitat, low-water crossings, rangeland grazing, roads, wildlife	pets, septic systems		- channel stability BMPs - assess abandoned mines - fuel reduction/fire BMPs - riparian vegetation on lower part of Ute Creek
Rayado Creek					
Rayado Creek (Miami Lake Diversion to headwaters)	*E.coli*, temperature	baseflow depletions from groundwater withdrawals, roads/low-water crossings, rangeland grazing, wildlife	avian/waterfowl, flow alterations, highways, septic tanks		- agriculture BMPs - channel stability BMPs - fuel reduction/fire BMPs - livestock grazing BMPs - manage diversions/water bank - riparian vegetation - wildlife management
Rayado Creek (Cimarron River to Miami Lake Diversion)	plant nutrients, sediment/siltation	dam or impoundment, loss of riparian habitat, rangeland grazing, roads/ low-water crossings, wildlife	flow alterations, habitat modifications, highways	Philmont Conservation Department Project Philmont education projects	- agriculture BMPs - channel stability BMPs - evaluate irrigation diversions and effects on water temperature - fuel reduction/fire BMPs - livestock grazing BMPs - manage diversions/water bank - riparian vegetation - wildlife management

Location	Causes of Impairment	Primary Probable Sources	Secondary Probable Sources	NPS Management Measures Needed to Achieve Load Reductions	
				Projects Completed	Additional Projects
Entire Watershed					
entire watershed	see above	see above	see above		- hire an outreach and implementation coordinator - follow construction BMPs - provide educational resources, particularly to new rural residents - work with County to evaluate road, septic, and other land-use regulations - evaluate use of commercial fertilizers - promote protection and conservation of riparian areas via conservation easements, creation of open space agencies and/or purchase of riparian buffer zones - evaluate use and presence of pesticides in the watershed - conduct ecosystem services evaluation

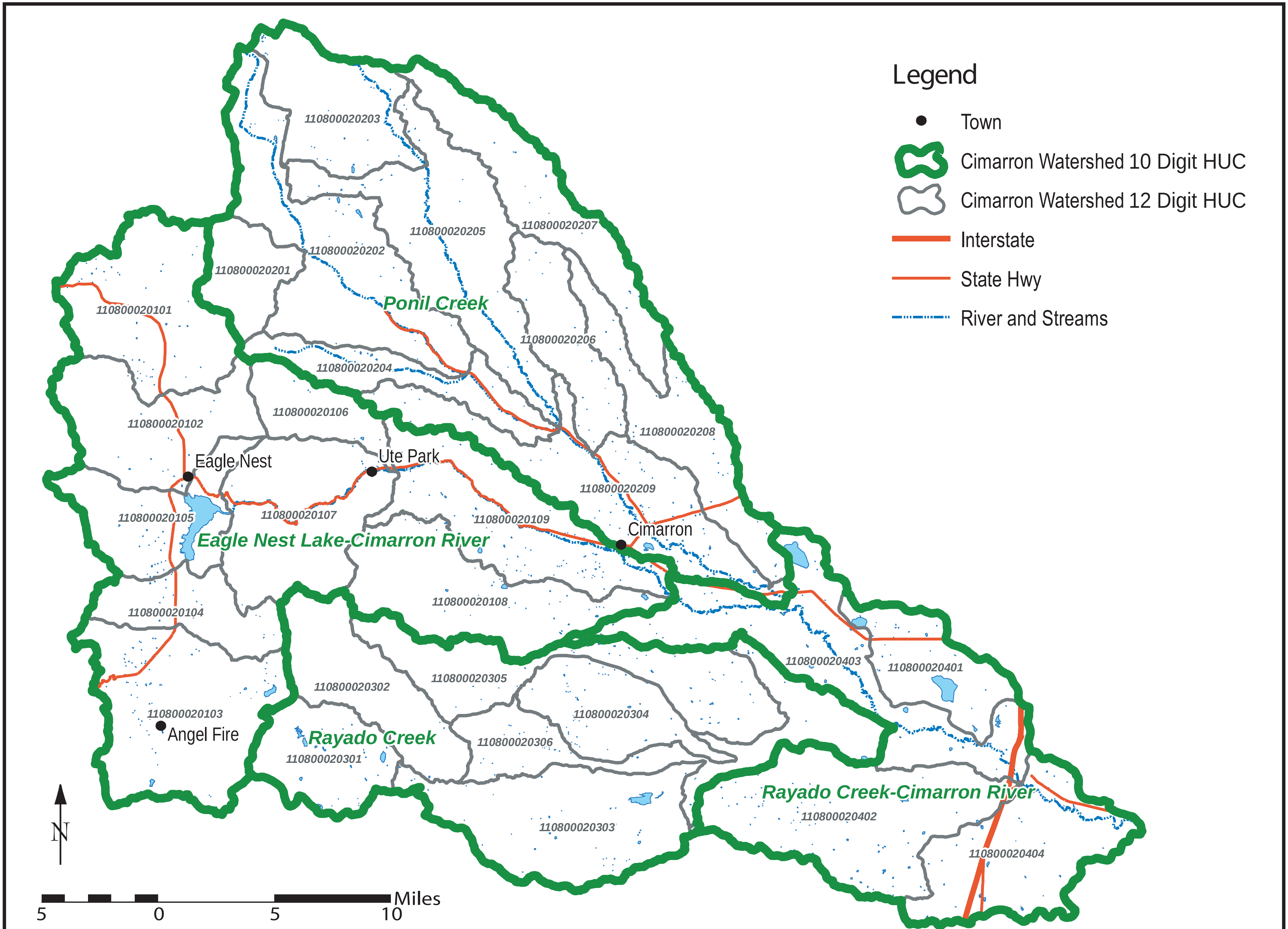
Table 7-2. Priority Best Management Practices by Sub-Watershed

Watershed ID	Watershed Name	Water Quality Impairments	Priority Best Management Practices
110800020103	Headwaters Cieneguilla Creek	*E. coli,* plant nutrients, temperature, turbidity, sediment/siltation (all in Cieneguilla Creek)	Livestock Grazing Management , Riparian BMPs
110800020104	Outlet Cieneguilla Creek	*E. coli,* plant nutrients, temperature, turbidity, sediment/siltation (all in Cieneguilla Creek)	Livestock Grazing Management , Riparian BMPs
110800020109	Cimarroncito Creek-Cimarron River	Plant nutrients, in Cimarron River (Canadian River to Cimarron Village); temperature and dissolved arsenic in Cimarron River (Cimarron Village to Turkey Creek); dissolved arsenic and plant nutrients in Cimarron River (Turkey Creek to Eagle Nest Lake)	Channel stability BMPs, alternative releases from Eagle Nest, fuel reduction/fire BMPs, riparian vegetation, Springer Ditch leakage reduction
110800020108	Cimarroncito Creek	Plant nutrients, in Cimarron River (Canadian River to Cimarron Village)	Channel stability BMPs, alternative releases from Eagle Nest, fuel reduction/fire BMPs, riparian vegetation, Springer Ditch leakage reduction
110800020403	Rayado Creek-Cimarron River	Plant nutrients, in Cimarron River (Canadian River to Cimarron Village)"	Channel stability BMPs, alternative releases from Eagle Nest, fuel reduction/fire BMPs, Springer Ditch leakage reduction
110800020401	Springer Lake	Plant nutrients, in Cimarron River (Canadian River to Cimarron Village)	Channel stability BMPs, alternative releases from Eagle Nest, fuel reduction/fire BMPs, Springer Ditch leakage reduction
110800020402	Salado Creek	Plant nutrients, in Cimarron River (Canadian River to Cimarron Village)	Channel stability BMPs, alternative releases from Eagle Nest, fuel reduction/fire BMPs, Springer Ditch leakage reduction
110800020404	110800020404-Cimarron River	Plant nutrients, in Cimarron River (Canadian River to Cimarron Village)	Channel stability BMPs, alternative releases from Eagle Nest, fuel reduction/fire BMPs, Springer Ditch leakage reduction

Watershed ID	Watershed Name	Water Quality Impairments	Priority Best Management Practices
110800020107	Ute Creek-Cimarron River	Dissolved arsenic and plant nutrients in Cimarron River (Turkey Creek to Eagle Nest Lake)	Channel stability BMPs, alternative releases from Eagle Nest, fuel reduction/fire BMPs, Springer Ditch leakage reduction
110800020202	Middle Ponil Creek	Temperature in Middle Ponil Creek (South Ponil to Greenwood Creek) Temperature in South Ponil Creek (Ponil Creek to Middle Ponil Creek)	Channel stability BMPs, fuel reduction/fire BMPs, riparian vegetation, livestock corral relocation
110800020201	Greenwood Canyon	Temperature in Middle Ponil Creek (South Ponil to Greenwood Creek)	Channel stability BMPs, fuel reduction/fire BMPs, riparian vegetation, livestock corral relocation
110800020101	Headwaters Moreno Creek	Plant nutrients and temperature in Moreno Creek.	Fuel reduction/fire BMPs, livestock corral relocation
110800020102	Outlet Moreno Creek	Plant nutrients and temperature in Moreno Creek.	Fuel reduction/fire BMPs, livestock corral relocation
110800020205	Outlet North Ponil Creek	*E. coli,*temperature, and turbidity in North Ponil Creek (South Ponil Creek to Seally Canyon); *E. coli*, plant nutrients, temperature, and turbidity in Ponil Creek (US 64 to confl of North & South Ponil)	Channel stability BMPs, fuel reduction/fire BMPs, riparian vegetation, livestock corral relocation
110800020209	Ponil Creek	Plant nutrients in Cimarron River (Canadian River to Cimarron Village); *E. coli*, plant nutrients, temperature, and turbidity in Ponil Creek (US 64 to confl of North & South Ponil)	Channel stability BMPs, alternative releases from Eagle Nest, fuel reduction/fire BMPs, riparian vegetation, Springer Ditch leakage reduction for the lower Cimarron River. Riparian vegetation and livestock corral relocation for Ponil Creek (US 64 to confl of North & South Ponil)

Watershed ID	Watershed Name	Water Quality Impairments	Priority Best Management Practices
110800020208	Outlet Cerrososo Creek	Plant nutrients in Cimarron River (Canadian River to Cimarron Village)	Channel stability BMPs, alternative releases from Eagle Nest, fuel reduction/fire BMPs, riparian vegetation, Springer Ditch leakage reduction
110800020204	South Ponil Creek	*E. coli,* plant nutrients, temperature, and turbidity in Ponil Creek (US 64 to confl of North & South Ponil)	Channel stability BMPs, fuel reduction/fire BMPs, riparian vegetation, livestock corral relocation
110800020206	Chase Canyon	*E. coli,* nutrients, temperature, and turbidity in Ponil Creek (US 64 to confl of North & South Ponil)	Channel stability BMPs, fuel reduction/fire BMPs, riparian vegetation, livestock corral relocation
110800020306	Outlet Rayado Creek	Plant nutrients and sediment in Rayado Creek (Cimarron River to Miami Lake Diversion); *E. coli* and temperature in Rayado Creek (Miami Lake Diversion to headwaters); plant nutrients, in Cimarron River (Canadian River to Cimarron Village)	Agriculture BMPs, channel stability BMPs, fuel reduction/fire BMPs, riparian vegetation, livestock grazing BMPs
110800020305	Urraca Creek	Plant nutrients and sediment in Rayado Creek (Cimarron River to Miami Lake Diversion)	Agriculture BMPs, channel stability BMPs, evaluate irrigation diversions and effects on water temperature, fuel reduction/fire BMPs, livestock grazing BMPs, manage diversions/water bank, riparian vegetation
110800020304	Chicoso Creek	Plant nutrients and sediment in Rayado Creek (Cimarron River to Miami Lake Diversion)	Agriculture BMPs, channel stability BMPs, evaluate irrigation diversions and effects on water temperature, fuel reduction/fire BMPs, livestock grazing BMPs, manage diversions/water bank, riparian vegetation

Watershed ID	Watershed Name	Water Quality Impairments	Priority Best Management Practices
110800020303	Moras Creek	Nutrients and sediment in Rayado Creek (Cimarron River to Miami Lake Diversion)	Agriculture BMPs, channel stability BMPs, evaluate irrigation diversions and effects on water temperature, fuel reduction/fire BMPs, livestock grazing BMPs, manage diversions/water bank, riparian vegetation
110800020302	Headwaters Rayado Creek	*E. coli* and temperature in Rayado Creek (Miami Lake Diversion to headwaters)	Agriculture BMPs, channel stability BMPs, evaluate irrigation diversions and effects on water temperature, fuel reduction/fire BMPs, livestock grazing BMPs, manage diversions/water bank, riparian vegetation
110800020301	Agua Fria Creek	E. coli and temperature in Rayado Creek (Miami Lake Diversion to headwaters)	Agriculture BMPs, channel stability BMPs, evaluate irrigation diversions and effects on water temperature, fuel reduction/fire BMPs, livestock grazing BMPs, manage diversions/water bank, riparian vegetation
110800020105	Eagle Nest Lake	*E. coli*, nutrients, temperature, and turbidity in Sixmile Creek (Eagle Nest Lake to headwaters)	Livestock Grazing and Fuel reduction/fire BMPs
110800020204	South Ponil Creek	Temperature in "South Ponil Creek (Ponil Creek to Middle Ponil Creek)".	Channel stability BMPs, fuel reduction/fire BMPs, riparian vegetation and livestock corral relocation
110800020106	Ute Creek	Arsenic, E. coli, and temperature in Ute Creek. Also, arsenic and nutrients in "Cimarron River (Turkey Creek to Eagle Nest Lake)".	Table 7.1 identifies management measures recommended for each impaired stream reach. "Channel stability BMPs" and "riparian vegetation on lower part of Ute Creek" are listed among management measures for Ute Creek. More detail is provided starting on p 32.



Cimarron Sub-Watersheds and Hydrologic Unit Codes

Figure 7-1

7-2. Tier 1 Projects

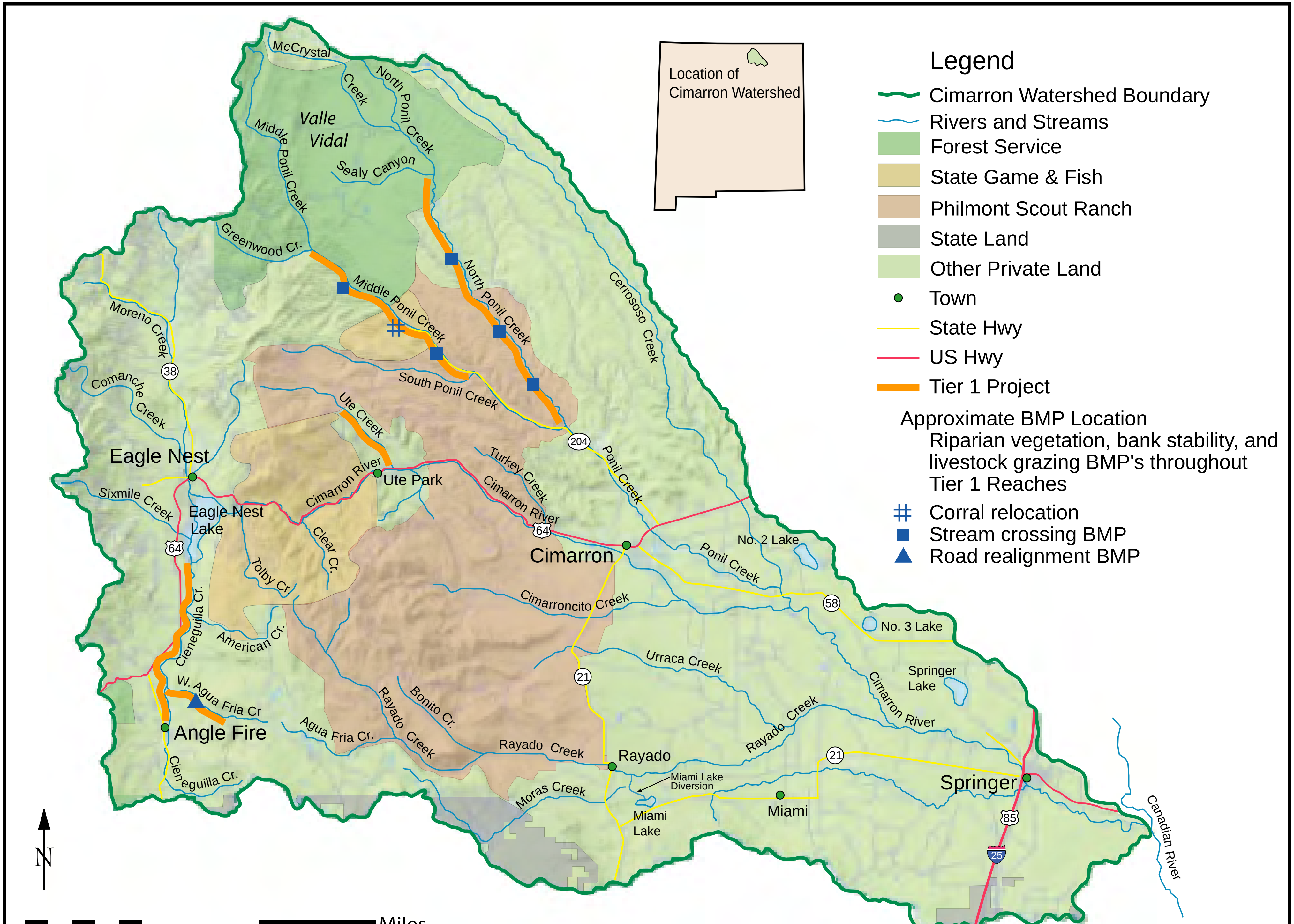
Due to the large size of the Cimarron Watershed, the CWA identified priority areas for additional assessment and implementation of high priority (Tier 1) projects. These priority areas are included in Table 7.1, and additional detail on the areas is included in this sub-section. The locations of the Tier 1 projects are shown on Figure 7-2.

The Tier 1 projects will help to reduce pollutant loads, have active interest and support from land owners, and are ready to proceed toward implementation when funding is secured. Field assessments to provide information for the project design and the costs of Tier 1 projects were completed in May-July, 2012 and additional analyses were conducted to estimate load reductions resulting from management measures included in these projects.

The Tier 1 project areas are:

- Cieneguilla Creek
- West Agua Fria Creek (tributary to Cieneguilla Creek)
- Middle Ponil Creek
- North Ponil Creek
- Ute Creek

The discussion outlined below includes the reasons that these specific reaches were chosen as priority project areas, summarizes the results of the field surveys, and discusses estimated load reductions from management measures. More detailed Tier 1 Field Survey Reports are also included in Appendix B.



Location of Tier 1 Projects in the Cimarron Watershed

Figure 7-2

Cieneguilla Creek. As shown on Table 5-1, Cieneguilla Creek is impaired for temperature, *E.coli*, plant nutrients, sediment/siltation, and turbidity. Due to the multiple causes and sources of impairment on this reach, it has been identified as a high priority area for restoration. The CWA has been involved in restoration and monitoring on Cieneguilla Creek near the Angel Fire airport as discussed in Section 4; there is interest and potential benefit in expanding these activities. A field survey completed in June of 2012 (Appendix B) indicated that most of the creek is devoid of shade and that numerous exposed banks are contributing considerable sediment loads to the creek. This erosion also contributes nutrients and bacteria to the stream system. Bacterial source tracking (NMSU, 2010) indicated that avian species were the largest contributor to the *E.coli* impairment, but there are also contributions from wildlife and livestock. Additionally, the field survey indicated that grazing is contributing to bank instability. Based on the field survey, the following restoration practices are indicated:

- Plant shade species (willow, red alder and cottonwood) in Angel Fire and north of Angel Fire, between the airport and Eagle Nest Dam. Tree planting will need to be coupled with wildlife and livestock exposures to successfully establish shading.
- Maintain existing wildlife exclosures as well as adding new wildlife exclosures in other areas.
- Restore exposed banks, focusing on those that rated as high to very high on the BEHI ranking system. A cut and paste system is recommended to reconfigure the channel morphology at each problem location. The material and vegetation on the enlarged point bars or overlong meanders are removed and placed at the toe of the opposite eroding bank. Additional discussion of this method is included in the North Ponil Assessment report in Appendix B.
- Remove and restore an old road alignment that is affecting channel function.
- Meet with gravel pit operators to discuss best management practices.
- Work with land owners to provide education and resources regarding grazing management and to assist with off channel stock watering options.
- Meet with managers of Angel Fire Golf course to discuss management practices and determine if there are any opportunities for collaboration.
- Work with Colfax County to conduct a valley wide road assessment to identify which roads may be repaired for improved drainage and culvert placement
- Work with Colfax County and the New Mexico Department of Transportation to implement BMPs during road construction projects.
- Work with local schools and community volunteers to clean up trash and debris in the creek.

Load reductions on Cieneguilla Creek that could occur from the identified management measures were estimated, using the Spreadsheet Tool for Estimating Pollutant Loads (STEPL). STEPL is a customized, spreadsheet-based model in Microsoft Excel. It uses simple algorithms to calculate both the nutrient and the sediment loads from different land uses, and the load reductions that would result from implementing various best management practices. STEPL computes surface runoff; nutrient loads (including nitrogen and phosphorus), and sediment delivery, based on various land uses and management practices. The annual nutrient loading is calculated based on the runoff volume and the pollutant concentrations in the runoff water, as influenced by factors such as land-use distribution and management practices. The annual sediment load (from sheet and rill erosion only) is calculated based on the Universal Soil Loss Equation (USLE) and the sediment delivery ratio. The sediment and pollutant load reductions that result from the implementation of BMPs are computed using the known BMP efficiencies.

The STEPL gully and streambank calculation tool, along with inputs from the field survey, were used to estimate erosion that could contribute to the sediment and nutrient load (and indirectly turbidity and *E.Coli* impairment also). On Cieneguilla Creek, where considerable bank instability was observed using the BANCS method (Appendix B), STEPL was used to calculate load reductions from bank stabilization projects. These calculations indicated that much of the load entering the stream could be reduced for the treated reaches focusing on the high to very high exposed banks. Therefore addressing this erosion should lead to achievement of the 28-40% load reduction required to meet the TMDL (Table 5-1). However, to have long term success in meeting the TMDL goals, upland and riparian land management practices will also need to be addressed.

The Stream Segment Temperature Model (SSTEMP) developed by the U.S. Geological Survey (USGS) was used to evaluate potential temperature changes due to the addition of shading in Cieneguilla Creek. SSTEMP estimates the combined topographic and vegetative shade as well as solar radiation penetrating the water (Bartholomew, 2002). SSTEMP calculates the heat gained or lost as it passed through a stream segment by simulating the various heat flux processes that determine that temperature change. Setting parameters for late summer when flows are lowest and temperatures are highest, SSTEMP was used to evaluate changes in temperature due to increased shading; the results indicated that water temperatures could be lowered approximately 3 degrees Fahrenheit by establishing a 40 percent density of shade species along the 5 mile stretch of the Creek between the Angel Fire Airport and Monte Verde Lake. SSTEMP was also used by NMED in the development of the Cieneguilla Creek TMDL. The NMED modeling indicated that the water quality standard would be met when the shading on Cieneguilla Creek was increased to 38% (NMED, 2010a).

Aqua Fria Creek. West Agua Fria Creek is a perennial headwater stream that flows west from the Garcia Park area, off the north side of Agua Fria Peak and east of Angel Fire. The creek then enters Cieneguilla Creek on the east side of the Angel Fire Airport, contributing sediment and nutrients to the impaired reach of Cieneguilla Creek. A field survey conducted by Rangeland Hands indicated significant erosion and sediment contributions from a 1,600 foot section of West Agua Creek. To stop the direct sediment contribution into West Agua Fria Creek, it is recommended that this section of road be closed and drained, and an existing road that is on the north side of the creek be reopened. The old road would be abandoned and drained. The proposed work would include a significant number of cross-drains, so that no one drain has enough discharge to flow into the creek. Drainage would be directed into the limited buffer areas on the south side of the creek. Two culverts would be removed, and the stream channel would be reshaped to its original cross-sectional shape. The road also cuts through a small, spring-fed sloped wetlands. Local soil materials would be used to fill in the truncated end of the sloped wetlands. All berms and ditches would be removed and contoured into the old road prism. The road surface would be ripped and reseeded with native grasses. The new road alignment would be on an abandoned road on the north side of the creek. This new alignment is not as steep as the old road, and provides better buffer areas to sequester road drainage sediment.

North Ponil Creek. The North Ponil Creek is impaired for *E.coli*, temperature, and turbidity. A field survey conducted by Rangeland Hands and Highland Solutions indicated that the watershed has been significantly negatively impacted by historical and current land management practices. Based on data collected by the assessment team and quantified by Rick Smith, the 3.6 miles of the North Ponil has a sediment contribution load of 5,394 tons per year from unstable stream banks (Appendix B).

The field team recommended the following restoration projects:

- Revise the existing grazing management plan to include a two-year rest and recovery period so that the ground cover and species diversification can be reestablished. Then a well-managed dormant season, i.e., November to March, grazing plan should be put into place. These practices will result in a reduction of soil loss and sediment and will provide a nutrient contribution to the stream system, as well as supporting a better and more reliable source of forage, which would reduce the need and cost for supplemental hay feeding that is now the practice.

- Install a properly designed and constructed Rolling Dip Road Surface Cross Drain System along the North Ponil Creek stream corridor. The return on this investment is a reduction of erosion and sediment contribution to the stream system with increased forage due to road water harvesting. Proper drainage will create significantly reduce road surface erosion, which, in turn, reduces the need for road maintenance and reduces the cost of vehicle maintenance. The road stream crossing locations are also noted in the road stabilization work. These areas should be stabilized using a boulder sill on the downstream side, and a cobble infill on the roadway that crosses the stream.

- A cut and paste system is recommended to reconfigure the channel morphology at each problem location. The material and vegetation on the enlarged point bars, or overlong meanders, are removed and placed at the toe of the opposite eroding bank. While doing the cut and paste of these materials, a vegetated bankfull bench is created at the toe of the eroding bank. The pool depth is reduced and the radius of curvature is reduced as the material is removed from the point bar or overlong meander. These geomorphologic modifications change the ratios of the near-bank maximum depth to the bankfull mean depth, the ratio of radius of curvature bankfull width, as well as changing the width-to-depth ratio, thus reducing the near bank stress and the power of the streams to erode the opposite bank. To stop this downward trend, the source of sediment must be controlled, i.e. grazing and roads first, then bank erosion. If the work does not proceed in this order, the in-stream work will be at risk, because the additional sediment coming off poorly managed rangelands and roads will still be in the system.

- The assessment team notes numerous locations along the North Ponil where hand-work could be conducted by Scout Crews. This hand-work would include planting willows to stabilize banks and to provide shade for lower water temperatures; the construction of rock or log bankfull benches, the installation of one rock dams, and the removal of mid-channel and transverse bars. Other hand-work would be the treatments of terrace headcuts, and the installation of media lunas, to re-spread water over the existing alluvial fans.

The team used the BANCS Model-Bank Assessment for Non-Point Source Consequences of Sediment (WARSSS 5-55). Field data was collected using the Bank Erosion Hazard Index (BEHI) and the Near Bank Stress Estimating System (NBS) #5 calculation method, ratio of near bank maximum depth to bankfull mean depth. Using this method, it was determined that 94 percent of the erosion in the reach surveyed was due to banks categorized as a high to very high bank erosion hazard. Therefore, addressing these high instability banks, in conjunction with the upland management measures, can help to achievement the load reductions discussed in Section 6.

Middle Ponil. The Middle Ponil watershed is currently listed for temperature impairment and has previously been listed for sediment/siltation and turbidity. The Ponil below the confluence of the Middle is currently impaired by plant nutrients, *E.coli* and temperature. Consequently, reducing erosion, as well as the influx of nutrients and bacteria from this reach, remains a concern for the larger stream system. The Middle Ponil was surveyed by Steve Carson of Rangeland Hands and Rick Smith of Highland Solutions. Based on data collected by the assessment team and quantified by Rick Smith, the 5.5 mile assessment reach of the Middle Ponil has a sediment contribution load of 7,068 tons per year from unstable stream banks. Restoration priorities that were identified include grazing management, relocating the equine corral, improving road drainage, bank stabilization, willow planting, and/or other hand-work to be completed by Scout crews. Details of the restoration recommendations are provided in Appendix B.

The team used the BANCS Model-Bank Assessment for Non-Point Source Consequences of Sediment (WARSSS 5-55). Field data was collected using the Bank Erosion Hazard Index (BEHI) and the Near Bank Stress Estimating System (NBS) #5 calculation method, ratio of near bank maximum depth to bankfull mean depth. Using this method, it was determined that 87 percent of the erosion in the reach surveyed was due to banks categorized as high to very high bank erosion hazard. Addressing these high instability banks, in conjunction with upland management measures, can help to achievement the load reductions discussed in Section 6.

Ute Creek was also identified by CWA as a high priority area, due to its listing for dissolved arsenic, *E.coli* and temperature. However, a field survey has not yet been completed, due to resource limitations.

8. Estimates of Technical and Financial Assistance Needed

The section describes the amounts of technical and financial assistance that will be relied upon to implement the Cimarron WBP. The CWA is an active volunteer group which has been able to contribute to the successful implementation of some important best management practices in the watershed. However, additional assistance will be required to continue the programs and activities that will be needed to move toward compliance with all TMDLs, as well as to prevent future water quality degradation. The resources described below include overall administrative requirements needed to keep the group coordinated and active, to complete funding applications, and to conduct education and watershed-scale monitoring, as detailed in Section 8.1.

Project-specific resources needed to implement BMPs to address impairment in various watershed sub-areas are described in Section 8.2.

8-1. Administrative and Outreach Assistance Requirements

Since much of the watershed is privately owned, ongoing education and outreach will be required to involve numerous landowners in plan implementation. The CWA was formed as a volunteer group and currently anticipates the continued involvement of members and landowners with considerable in-kind contributions toward restoration efforts. The CWA has also consistently encouraged capacity-building among members who have acquired monitoring skills worthy of remuneration. Due to the large size of the watershed, with a total of 14 reaches which have various impairment issues, the effective implementation of this WBP will best proceed with a full-time coordinator. This coordinator would be responsible for preparing, obtaining, and managing grants to implement best management practices, providing education and resource materials, communicating with landowners and other project stakeholders, directing monitoring and adaptive management, and coordinating in-kind and volunteer resources.

Additional costs for office rental and expenses are required to support an ongoing, active watershed group. The cost for the coordinator position is estimated at $45,000 per year plus $20,000 per year for insurance, travel and other expenses. The costs for the office expenses are estimated at $1,000 per month for rent, utilities, and miscellaneous expenses, resulting in a total of approximately $77,000 per year.

In addition to the coordinator position, further monitoring is needed to better understand water quality conditions in a larger range of streamflows (Section 11). CWA can best proceed with monitoring by contracting with skilled members who have expertise in the field, and by partnering with educational institutions where possible, facilitating graduate research to address ongoing water quality questions. The estimated budget for these monitoring tasks is approximately $25,000 to $45,000 per year for at least a five-year period, including costs for instrumentation, sampling, and analysis. Monitoring costs will be lower if local volunteer help can assist and/or if monitoring is coupled with the education component.

8-2. Project-Specific Technical and Financial Assistance Requirements

The BMPs discussed in section 7 are numerous, and will require implementation over a large area to address all the causes and sources of impairment that were identified in Section 5. The costs for watershed-wide BMP implementation are summarized on Table 8-1. These costs were estimated primarily by considering unit costs of recently completed projects in the Cimarron Watershed. Additionally, specific costs have been developed for the Tier 1 projects discussed in Section 7; and the project-specific costs are included in Appendix B, the Tier 1 Field Survey Reports. These project costs range from less than $1,000 (with largely volunteer labor) to more than $40,000 for more extensive rehabilitation projects (Appendix B).

Table 8-1. Summary Financial Assistance Requirements

Project Type	Cost/Unit	Number of Units	Subtotal
Cut bank stabilization with boulder vanes	$5,000 to $6,000 per bank	40-60	$200,000 to $360,000
Head cut restoration with boulder vanes	$7,000 to $9,000 per head cut	20-30	$140,000 to $270,000
Low-water crossings with Rosgen cross vanes	$20,000 to $25,000 per crossing	20-30	$400,000 to $750,000
Riparian vegetation improvements	$4,000 to $6,000 per mile	50-100	$200,000 to $600,000
Taos Pines road improvements	$165,000 for subdivision [a]	1	$165,000
Road upgrades [b]	$4,500 to $6,000 per mile	50-100 miles	$225,000 to $600,000
Septic tank upgrades	$1,500 to 2,000 per tank [c]	50-100 tanks	$75,000 to $200,000
Wildlife exclosures	$2,600 to $3,000 per acre	20-50 acres	$50,000 to $150,000
Water banking [d]	$25,000 to $75,000 plus $5,000 to $10,000 per acre-foot	10-50 acre-feet	$75,000 to $575,000
Coordinator/ education and administration	$75,000 to $100,000 per year	5-15 years	$375,000 to $1,500,000
Monitoring	$25,000 to $45,000 per year	5-15 years	$125,000 to $675,000
Total			$1,900,000 to $5,900,000

a) Based on estimate by Rangeland Hands, 2010

b) Using Bill Zeedykes low maintenance/water harvesting techniques for dirt roads

c) Full replacement with new tanks would be more expensive, however, typically the costs would be paid by homeowners

d) Study, evaluate, and purchase water rights

The level of funding available through NMED nonpoint source management programs is unlikely to be sufficient for completing most or all of the activities listed above. It is more likely that select priority projects, as listed in the Tier 1 assessment, will be partially funded over time. To obtain a better success rate for implementation, other potential funding sources should be considered. Some of the potential sources include:

- *The Collaborative Forest Restoration Program (CFRP)* is managed by the U.S Forest Service. The purpose of this program is to promote collaborative efforts that sustain additional forestry projects. The CWA has been working with the Carson National forest to pursue a CFRP grant for a landscape-scale restoration project. The CFRP funding is most likely to fund fuel reduction projects and/or habitat restoration projects that can help to protect the watershed from post-fire erosion and sedimentation.

- *The New Mexico State Forestry Division* supports a cost-share program to improve the health of New Mexico Community Forests. The program focuses on developing sustainable urban fuels reduction projects to reduce fire risks that can help to protect the watershed from post-fire erosion and sedimentation. Grant proposals are staggered throughout the year. Projects that involve storm water management/water quality improvement are supported by the program, and non-profit agencies such as the CWA are eligible for funding. Projects that couple fuel reduction with economic use of the harvested forest products would also be possible projects in the Cimarron watershed. The New Mexico State Forestry Division can also provide technical expertise regarding implementation of fuel reduction BMPs in the Cimarron Watershed.

- *The New Mexico Water Trust Board* funds a variety of projects which are related to the water supply for New Mexico communities. The Water Trust Board funding process includes a separate category for watershed restoration projects. Projects that protect the water quality of drinking water supplies, as listed in Section 7, would be eligible for this funding, particularly those related to the water supply from the Eagle Nest Reservoir or Springer Lake, which both provide drinking water supplies. Funding applications can be completed and submitted only by an eligible public entity, so the CWA could not apply directly for this funding.

- The US Department of Agriculture Natural Resource Conservation Service (NRCS) *Environmental Quality Incentives Program (EQIP)* provides funding for conservation projects to private landowners (with a cost share). As part of a new national directive starting in 2012, NRCS is setting aside 5% of the EQIP budget for work on priority watersheds to address waters on the Integrated 305(b)/303 (d) Report (NMED, 2010b). The primary focus is nutrients and sediment, however, funding can address other listed constituents. The EQIP program could be used to help private landowners fund improved stream-crossing and other farming and ranching BMPs identified in Section 7.

- Potential partners for completing research and monitoring tasks are the *New Mexico Universities,* in particular the University of New Mexico Water Resources Program, New Mexico State University, and New Mexico Forest and Watershed Restoration Institute at Highlands University in Las Vegas, New Mexico. While these institutes are not likely to provide direct funding, they could provide in-kind services such as the monitoring that was conducted in support of this WBP.

- *New Mexico Soil and Water Conservation Districts (SWCDs)* can help to provide technical assistance, particularly to private landowners needing help with implementing agricultural best management practices. The Cimarron Watershed is located within the jurisdiction of the Colfax SWCD.

- *USEPA Clean Water State Revolving Funds (CWSRF)* provide low interest loans to fund water quality protection for wastewater treatment, nonpoint source pollution control, and watershed management. Local governments, farmers and nonprofit groups such as the CWA are eligible recipients. The ability to repay the loan will be central to applicability in the Cimarron Watershed. The most likely projects to be funded through this program would be projects that could be addressed through local government participation, such as septic issues in Ute Park or stormwater management in Angel Fire.

- The *AmeriCorps Volunteers in Service to America (VISTA)* program places volunteers in positions that will provide them with training and experience to improve their prospects for future employment. The CWA could provide training, oversight, and a work place for a VISTA volunteer to help with project coordination and implementation of key projects.

- The *U.S. Fish and Wildlife Service (USFWS)* may provide technical assistance for water quality improvements that will support fish and wildlife. Additionally, funding for small projects may be available through the *Partners for Fish and Wildlife* Small Grant Program.

For the successful implementation of this WBP, a variety of funding and volunteer resources will be required.

9. Education and Outreach Component

The nine elements of watershed-based planning (EPA, 2008) require an information/education component to enhance public understanding of the project and encourage participation. The CWA has emphasized active public education since its inception in 2003. Since the watershed is primarily located on private land, both communication and voluntary cooperation are critical to successful implementation of the plan.

As discussed in Section 3, the stakeholders currently participating in the CWA include public officials, state and federal agency personnel, representatives of civic groups, ranchers, business people, and other community members. Partner organizations currently or recently involved in the Cimarron Watershed Alliance include:

- New Mexico Environment Department/Surface Water Quality Department (NMED)
- U.S. Forest Service (USFS)
- Quivira Coalition
- New Mexico State Parks
- New Mexico State Forestry
- New Mexico Game and Fish
- Vermejo Park Ranch
- Philmont Scout Ranch
- C.S. Ranch
- Cimarroncita Ranch Resort
- Angel Fire Resort and Ski Area
- Towns of Raton, Cimarron and Angel Fire
- Local Area High Schools and Middle Schools (Cimarron High School, Eagle Nest Middle School and Angel Fire High School)
- Sandia National Laboratory
- Los Alamos National Laboratory
- University of New Mexico
- New Mexico State University
- New Mexico Small Business Association
- Trout Unlimited
- New Mexico Wildlife Federation

The CWA intends to continue to work with these participants and conduct outreach to involve more private landowners, ranchers, and other stakeholders in the watershed. As discussed in Section 8, the CWA would like to hire a coordinator that would be responsible for overseeing educational activities, in addition to other duties. The CWA had a coordinator when it was initially formed. The coordinator was extremely helpful in providing educational resources, as well as involving local ranchers and other stakeholders. The coordinator will work with the CWA Board and other members to conduct education and outreach activities.

Education and outreach activities that will be implemented in conjunction with management measures identified in this plan include:

- Maintaining a CWA website where education information on the watershed can be posted, and also contribute any CWA materials that are appropriate for posting on the New Mexico Watershed Association website.
- Attending local events and providing information on CWA.
- Collecting email addresses from watershed stakeholders who are interested in receiving periodic updates about CWA activities.
- Contacting homeowners in areas with septic tank issues to provide information on septic tank maintenance and upgrades.
- Partnering with Quivira Coalition or other conservation organizations to provide training to ranchers on livestock practices that can help protect water quality while maintaining the economic interests of ranches.
- Working with the National Resource Conservation Service, the Colfax County Soil and Water Conservation District, the New Mexico Water Trust Board, and the Office of the State Engineer to provide information about water and soil conservation issues and agricultural best management practices.
- Contacting neighborhood associations such as Taos Pines to evaluate partnerships for addressing road maintenance and upgrades.
- Presenting information on the importance of achieving water quality standards and CWA activities at local meetings such as Chamber of Commerce meetings, agricultural associations, civic groups, or other local groups.
- Conducting tours of completed projects. For example, viewing the benefits of improved low-water crossings on the Ponil could potentially interest other landowners to improve ranch roads and low-water crossings. Project tours can emphasize maintenance issues so that the benefits of BMPs are not lost over time.

- Partnering with the Cimarroncita Ranch and Philmont Scout Ranch to provide education and hands-on experiences for water quality protection, stream bank stabilization, and wetlands restoration to students of all ages. Participation of Philmont Scout Ranch will allow the CWA a unique opportunity to provide education on water quality protection and stream restoration to youth located throughout the Country.
- Continuing to coordinate educational efforts with other collaborators, such as State Parks and Carson National Forest.
- Coordinating education efforts and service-learning projects with other collaborators, including local schools (elementary through High School), State Parks, and other interested partners.
- Educating land owners about practices that affect water quality such as appropriate household cleaning agents, pet management, or other household issues.
- Training CWA members and local citizens in water-monitoring techniques and data collection methods to meet standards set forth by the NMED Surface Water Quality Bureau.

Education efforts will continue to be a high priority throughout the implementation of the Cimarron Watershed-Based Plan. For long-term success, the continued involvement of land owners and other stakeholders in maintaining BMPs is needed. Coordination of BMP maintenance will be accomplished in a collaborative fashion between the CWA coordinator and the project partners. The CWA monthly meetings currently dedicate a portion of the agenda to standard project reporting, and a portion of the agenda is dedicated to guest speakers or revolving topics. As BMPs are implemented, the standard agenda will be revised to include a place for reporting on ongoing project maintenance, needs for volunteer or group assistance, and reporting of any new monitoring data or relevant project information. Even if the project reporting is short, by focusing on the topic at the monthly meetings, the group will be assured that completed projects and BMPs are not forgotten. Additionally, maintenance issues and status can also be included in the CWA annual report.

10. Implementation Schedule, Interim Measurable Milestones, and Achievement Criteria

The schedule for implementing the NPS management measures identified in the WBP is dependent on funding for project implementation. Due to the large number of impaired reaches, impaired sub-watersheds, and numerous small projects to be implemented, the CWA estimates a time frame of 10 to 15 years to fully implement the management measures identified in this plan. Most projects will require a 3-5 year cycle for final design, implementation, and post-restoration monitoring. If full funding had been initially available, it would be possible to shorten this time frame. However, a longer time frame is more realistic, given the scarcity of funding resources for watershed restoration. If base-level funding for group coordination, outreach, project design, and submittal of funding applications is available, the CWA is more likely to quickly move forward toward meeting water quality objectives. The project implementation schedule is shown on Table 10-1.

Table 10-1. Implementation Schedule and Interim Measurable Milestones

Location	Causes of Impairment	NPS Management Measures Needed to Achieve Load Reductions Projects	Schedule	Interim Measurable Milestone and Date		Milestone Achievement Criteria
Entire watershed	See below for impairment by geographic area	Hire an outreach and implementation coordinator	2014	Apply for Grant Funding	2013	Coordinator Hired
		Implement Public Education Plan	2028	5 Educational Events	2014	Event or Written Material Distributed
				2 Events per year	2016-2028	Event or Written Material Distributed
Cieneguilla Creek (Eagle Nest Lake to headwaters)	*E.coli*, plant nutrients, sediment/siltation, temperature, turbidity	Cieneguilla Tier 1 Project	2017	Apply for Grant Funding	2013	Grant Application Submitted
				Project Initiated	2014	Project Funded and Initiated
				Project Completed	2017	Final Project Report
		Agua Fria Tier 1 Project	2016	Apply for Grant Funding	2014	Grant Application Submitted
				Project Completed	2016	Visual Survey of Road Relocation, Final Project Report

Location	Causes of Impairment	NPS Management Measures Needed to Achieve Load Reductions Projects	Schedule	Interim Measurable Milestone and Date		Milestone Achievement Criteria
Cieneguilla Creek (Eagle Nest Lake to headwaters)	*E.coli*, plant nutrients, sediment/siltation, temperature, turbidity	Implement Additional BMPS (Angel Fire effluent re-use, channel stability, construction, conservation easements, fuel reduction/fire, grazing, open space purchase, riparian vegetation, remediation of older septic systems, sediment traps or filter strips below gravel pits, wildlife management	2028	5 stream miles completed	2020	Number of BMPs completed
				Complete additional BMPs and BMP maintenance	2018	20% load reduction sediment (contributor of nutrients to downstream impairment
				Entire reach completed	2028	Number of BMPs completed
Moreno Creek (Eagle Nest Lake to headwaters)	Plant nutrients, temperature	Increase shading, bank stability BMPs, fuel reduction BMPs	2028	2 stream miles completed	2022	Measured shade increase, Number of BMPs completed
				4 additional stream miles completed	2028	Measured shade increase, Number of BMPs completed

Location	Causes of Impairment	NPS Management Measures Needed to Achieve Load Reductions Projects	Schedule	Interim Measurable Milestone and Date		Milestone Achievement Criteria
Sixmile Creek (Eagle Nest Lake to headwaters)	*E.coli*, plant nutrients, temperature, turbidity	Fuel reduction/fire BMPs, remediation of older septic systems, sediment traps below gravel pits, Taos Pines road improvements, wildlife management	2028	2 stream miles completed	2020	Measured shade increase, Number of BMPs completed
				3 additional stream miles completed	2028	Measured shade increase, Number of BMPs completed
North Ponil Creek (South Ponil Creek to Seally Canyon)	*E.coli*, temperature, turbidity	North Ponil Tier 1 Project	2017	Apply for Grant Funding	2013	Grant Application Submitted
				Project Initiated	2014	Project Funded and Initiated
				Project Completed	2017	Final Project Report
		Additional channel stability BMPs, fuel reduction/fire BMPs, low-water crossings, riparian vegetation and road improvement BMPs	2020	Complete additional BMPs and BMP maintenance	2018	20% load reduction sediment (contributor of nutrients to downstream impairment
				Complete additional BMPs and BMP maintenance	2020	Measured shade increase, Number of BMPs completed

Location	Causes of Impairment	NPS Management Measures Needed to Achieve Load Reductions Projects	Schedule	Interim Measurable Milestone and Date		Milestone Achievement Criteria
Middle Ponil Creek (South Ponil to Greenwood Creek)	Temperature	Middle Ponil Tier 1 Project	2017	Apply for Grant Funding	2013	Grant Application Submitted
				Project Initiated	2014	Project Funded and Initiated
				Project Completed	2017	Final Project Report
		Additional BMPs (low-water crossings, channel stability, post fire rehabilitation)	2020	Complete additional BMPs and BMP maintenance	2020	Measured shade increase, Number of BMPs completed
South Ponil Creek (Ponil Creek to Middle Ponil)	Temperature	Channel stability BMPs, fuel reduction/fire BMPs, low-water crossings, riparian vegetation and road improvement BMPs	2028	4 stream miles completed	2020	Measured shade increase, Number of BMPs completed
				4 additional stream miles completed	2028	Measured shade increase, Number of BMPs completed
Ponil Creek (US 64 to confluence of North and South Ponil)	*E.coli*, plant nutrients, temperature, turbidity	Channel stability BMPs, fuel reduction/fire BMPs, low-water crossings, riparian vegetation BMPS	2028	Reach completed	2028	Measured shade increase, Number of BMPs completed
Ponil Creek (Cimarron River to US 64)	*E.coli*	Channel stability BMPs, fuel reduction/fire BMPs, low-water crossings, riparian vegetation BMPS	2028	Reach completed	2028	Measured shade increase, Number of BMPs completed

Location	Causes of Impairment	NPS Management Measures Needed to Achieve Load Reductions Projects	Schedule	Interim Measurable Milestone and Date		Milestone Achievement Criteria
Cimarron River (Turkey Creek to Eagle Nest Lake)	Dissolved arsenic, plant nutrients	Channel stability BMPs, evaluate alternative releases from Eagle Nest*, fuel reduction/fire BMPs, road BMPs, including turnouts and filter strips to address runoff groundwater monitoring and remediation of septic tanks	2025	2 stream miles completed	2020	Number of BMPs completed
				3 additional stream miles completed	2025	Number of BMPs completed
Cimarron River (Cimarron Village to Turkey Creek),	Dissolved arsenic, temperature	Channel stability BMPs, evaluate alternative releases from Eagle Nest Dam*, fuel reduction/fire BMPs, riparian vegetation	2028	2 stream miles completed	2024	Number of BMPs completed
				3 additional stream miles completed	2028	Number of BMPs completed

Location	Causes of Impairment	NPS Management Measures Needed to Achieve Load Reductions Projects	Schedule	Interim Measurable Milestone and Date		Milestone Achievement Criteria
Cimarron River (Canadian River to Cimarron Village)	Plant nutrients	Channel stability BMPs, evaluate alternative releases from Eagle Nest* (no flow periods) evaluate ditches and storm water runoff in Cimarron, fuel reduction/fire BMPs, Springer Ditch leakage reduction	2028	4 stream miles completed	2022	Number of BMPs completed
				3 additional stream miles completed	2028	Number of BMPs completed
Ute Creek (Cimarron River to headwaters)	Dissolved arsenic, *E.coli*, temperature	Tier 1 BMPs: channel stability BMPs; assess abandoned mines, fuel reduction/fire BMPs, riparian vegetation on lower part of Ute Creek	2020	Apply for Grant Funding	2015	Grant Application Submitted
				Project Initiated	2016	Project Funded and Initiated
				Project Completed	2020	Final Project Report
Rayado Creek (Miami Lake Diversion to headwaters)	*E.coli*, temperature	Agriculture and grazing BMPs, channel stability BMPs, evaluate irrigation diversions and effects on water temperature, fuel reduction/fire BMPs	2028	2 stream miles completed	2024	Number of BMPs completed
				2 additional stream miles completed	2028	Number of BMPs completed
Rayado Creek (Cimarron River to Miami Lake Diversion)	Plant nutrients, sediment/siltation	Agriculture and grazing BMPs, channel stability BMPs, evaluate irrigation diversions and effects on water temperature, fuel reduction/fire BMPs	2024	2 stream miles completed	2018	Number of BMPs completed
				2 additional stream miles completed	2024	Number of BMPs completed

The implementation schedule shown on Table 10-1 identifies key projects and milestones for a 15-year cycle for BMP implementation. Additionally, the CWA has identified a more detailed set of priorities and interim measurable milestones for completion in the next three years:

- Hire a CWA coordinator.
- Conduct education/outreach activities including contacting land owners, maintaining a website, conduct tours of completed projects, and continue education projects with local schools.
- Continue channel stabilization and riparian vegetation projects on Cieneguilla Creek as discussed in Section 7.2.
- Seek additional funding to continue channel stability and riparian vegetation improvements on the Ponil and tributaries as discussed in Section 7.2.
- Review the status of abandoned mines in the Moreno Valley.
- Conduct a feasibility study and riparian survey to design and implement riparian buffers using conservation easements or land purchases.
- Meet with State Parks and the Interstate Stream Commission to explore opportunities for considering water quality in water management operations and to outline a plan for improved characterization of water quality in Eagle Nest Lake.
- Conduct a detailed inventory and characterization of septic systems and cesspools in Ute Park, and seek funding to assist homeowners with remediation.
- Conduct an assessment of channel stability on the mainstem of the Cimarron River.
- Meet with landowners on the Rayado to explore opportunities for improved low-water crossings.
- Work with potential project partners such as Universities and local citizen's to develop a more detailed monitoring plan and quality assurance plan.
- Seek funding and continue water quality monitoring efforts to better characterize water quality and to evaluate interim management measures.

The remainder of the management measures identified in Section 7 will be implemented within the 4 to 15-year timeframe, depending on the availability of funding resources, as indicated on Table 10-1. Further definition of second-tier priorities will be established as the project progresses.

Successful implementation of the WBP also requires identification of criteria that can be used to determine whether loading reductions are being achieved over time, and to determine whether substantial progress is being made towards attaining water quality standards. The achievement criteria most applicable to the Cimarron Watershed are those which are in compliance with published TMDLs, including the reduction of loads to levels below water quality standards. Interim monitoring as described in Section 11 will be used to assess compliance with water quality standards. Where standards have changed since completion of the TMDL, the most recent standard will be considered. For example, the arsenic standard has been changed since preparation of the TMDL, and changes to the temperature standards are being considered.

Based on current conditions, the achievement criteria that will be used for each cause of impairment are as follows:

- *Dissolved Arsenic:* laboratory measurements of arsenic concentrations from filtered samples.
- *E.Coli:* laboratory measurements of bacteria concentrations, stream bank stability surveys.
- *Plant Nutrients:* field or laboratory measurements of nitrate and phosphorus, steam bank stability surveys, visual surveys for algae or other aquatic plants.
- *Sediment/siltation and turbidity:* field measurement of turbidity concentrations, laboratory measurements of sediment concentrations, and stream bank stability surveys.
- *Temperature:* field measurements of stream temperatures and field surveys for percent shade.

The quantitative water quality data can be directly compared to the water quality standards and the TMDLs. Additionally, the quantitative data can be supplemented by surveys of stream bank stability, aquatic vegetation, and shading, to provide indications of the conditions that are reflective of the root causes of impairment.

Finally, as discussed in Section 7, for long-term success in achieving water quality standards, upland land management practices that support the stability of the watershed need to be implemented. Therefore implementation of farming, grazing, road construction and other BMPs as identified in Section 7 are also important achievement criteria.

- Progress toward meeting the achievement criteria described above will be dependent on the availability of the funding provided for project implementation.

In addition to the interim milestones listed above, field restoration projects will include interim assessments and resultant adaptive management to optimize field techniques, as directed by the WBP guidance (EPA, 2008). The CWA will also complete an annual report that reviews accomplishments and any adaptive management needed to direct future actives toward compliance with applicable water quality standards.

11. Monitoring Component

Two primary types of monitoring are required for successful implementation of the WBP:

1. Long-term monitoring to better understand the variability of constituents of concern, the degree of impairment, and the condition of overall watershed health under a greater range of streamflow conditions, and

2. Project-specific monitoring to evaluate the effectiveness of specific management measures and to guide adaptive management and help optimize future restoration efforts toward the achievement of water quality standards.

11-1. Watershed Monitoring and Assessment

As discussed in Section 5, there is a high level of variability in water quality and streamflow in the Cimarron watershed. Additional data will help to better characterize both the sources of impairment and the variability of impairment with a greater range of streamflow, and a higher number of sampling points. Watershed monitoring would focus primarily on the existing causes of impairment (arsenic, *E.coli*, nutrients, sediment, temperature, turbidity) with more samples collected to assess the temporal and spatial variability of these components. Some specific additional monitoring that is needed includes:

- ***Sample for Additional Metals.*** To better determine the source and extent of arsenic on the Cimarron River and Ute Creek, sampling for other metals in addition to arsenic could assist in determining if the source is related to historic mining or to natural causes.
- ***Optimize Water Release through Stratification***. Releases from Eagle Nest Lake contribute water to impaired reaches on the mainstem of the Cimarron River. It is possible that releases of water could be optimized by considering water quality stratification in the reservoir and by varying releases according to depth; however, further assessment is needed to address this question. Monitoring that will characterize the temporal and depth variations of water quality over a period of time, along with an evaluation differences in water quality resulting from the usage of different release gates, would help to guide the development of a better operations plan.
- ***Track Bacterial Sources***. Additional bacterial source tracking, such as the study conducted on Cieneguilla and Moreno Creeks, would be useful for all reaches that have E. coli impairment.
- ***Additional Temperature Monitoring.*** Additional water temperature monitoring would help to correlate water temperatures with changes in shade density, or for other restoration efforts. This monitoring can also be used to guide adaptive management.

The Cimarron Watershed Coordinator, once hired, will be the responsible person for monitoring activities. In many cases, watershed monitoring can benefit by cooperating with State and Federal agencies, New Mexico universities, and trained citizens within the Cimarron Watershed. Projects such as the one completed by UNM in 2010 were made possible in cooperation with Wildlife Conservancies, the Cimarron Conservation Camp, and other private land owners within the watershed. The watershed monitoring will include:

- Sampling for each of the listed constituents (arsenic, sediment, turbidity, nitrate, phosphorus (plant nutrients) *E.coli* and temperature).

- Collection of water quality samples at locations upstream and downstream of the impaired reaches shown on Figure 5-1. The CWA estimates collection of samples from approximately 20 locations to characterize the continuing impairment of the reaches illustrated on Figure 5-1.

- Collection of sufficient samples to characterize the temporal variability in streamflow. In particular temperature measurements should be made during low-flow conditions, and other samples should also be collected during low flows periods. Additionally, turbidity and sediment concentrations should be monitored during monsoon when there is higher likelihood for bank erosion and sedimentation. A collection period of 4 samples per year for a three year period, for the 20 locations, results in 240 samples total.

- A detailed sampling plan and quality assurance project plan (QAPP) will be prepared during the first year that a coordinator is hired.

11-2. Project-Specific Monitoring

As each project is implemented, site-specific monitoring protocol will be defined. Monitoring will focus on:

- Using current quality assurance procedures to ensure that reliable data is collected.
- Identifying pre-project baseline conditions for the constituents of interest, focusing on the causes of impairment and considering related indicators of water quality conditions.
- Conducting post-project monitoring under a variety of streamflow conditions to evaluate project success.

As funding applications are prepared, specific monitoring plans for restoration projects will be developed, along with complete project designs.

11-3. Reporting of Monitoring Results

Reporting of project specific monitoring results will be included in project plans at that time that funding is sought for implementation of specific projects. Additionally, the CWA annual report will include a section that summarizes what monitoring has occurred for each project. The annual reporting process will be used to evaluate what the combined monitoring data are indicating about watershed conditions and compliance with water quality standards, and if the data indicates that adaptive management is warranted, that will also be discussed in the annual report.

12. References

Allred, Jennifer Montano, December 2005. Evaluating the Effectiveness of Induced Meandering within an Incised, Discontinuous Gully System Post Wildfire Within the Valle Vidal, Carson National Forest, New Mexico. A professional paper submitted to partially fulfill degree requirements of the University of New Mexico Water Resources Program.

Bartholomew J., 2002. Steam Segment Temperature Model (SSTEMP) version 2.0. Revised August, 2002. Ft. Collins, Colorado. U.S. Geological Survey

Cimarron Watershed Alliance, 2003. Watershed Restoration Action Strategy/Watershed Implementation Plan. August 2003 Draft.

Cimarron Watershed Alliance, 2012. *Cieneguilla Creek Riparian Ecosystem Restoration Project 2012 Final Report.* Prepared by Implementation Task Manager: William “Hoot” Gibson and Monitoring Coordinator: Alan Huerta.

Daniel B. Stephens & Associates, Inc. March 2003. *Colfax Regional Water Plan*. Prepared for the Colfax Soil and Water Conservation District and the Interstate Stream Commission. Available at http://www.ose.state.nm.us/water-info/NMWaterPlanning/regions/colfax/colfax_vol1.pdf

Hellman, Bethany, 2010. *Cimarron Watershed Alliance, a case study*. Provided by Cimarron Watershed Alliance.

Huerta, 2012. Personal Communication between Alan Huerta, Cimaroncito Ranch and Joanne Hilton, February, 2012.

Los Alamos National Laboratory and Sandia National Laboratory, 2011. Final Report Cimarron Watershed Study to Support Outdoor Tourism Businesses. December 13, 2011; in Cooperation with Alán Huerta Owner, Cimarroncita Ranch, by Principal Investigator and Project Lead, Robert C. Roback; Funded by New Mexico Small Business Administration *LA-UR -11-12252*

New Mexico Environment Department Surface Water Quality Bureau, 2005. *Water Quality Assessment for Selected New Mexico Lakes.* http://www.nmenv.state.nm.us/swqb/Surveys/LakeWaterQualityAssessments2005.pdf

New Mexico Environment Department Surface Water Quality Bureau, 2006. Water Quality Assessment for Selected New Mexico Lakes. ftp://ftp.nmenv.state.nm.us/www/swqb/MAS/Surveys/Lakes-2006.pdf

New Mexico Environment Department. *The 2007 NMED/SWQB Standard Operating Procedures For Data Collection*, Sections (NMEB Surface Water Quality Bureau July 26, 2007); Quality Assurance Project Plan for Water Quality Management Programs, *Appendix C., Field Sampling Plan Tables* (NMED/SWQB March 2007); Water Quality Management Plan, Appendix C., Assessment Protocol, Attachment A., *New Mexico Environment Department Surface Water Quality*

NMED, August 8, 2008. Final 2008-2010 *State of New Mexico Clean Water Act §303(d)/§305(b) Integrated Report*.

NMED, 2009. New Mexico Environment Department Surface Water Quality Bureau. *New Mexico Nonpoint Source Management Program 2009.*

NMED, 2010a. New Mexico Environment Department Surface Water Quality Bureau. Total Maximum Daily Load (TMDL) Cimarron River (Canadian River to Headwaters). Final Draft. July 23, 2010.

NMED, 2010b. New Mexico Environment Department Surface Water Quality Bureau July 29, 2010b. *2010-2012 State of New Mexico Clean Water Act* §303(d)/§305(b) *Integrated Report.*

NMED, 2012. New Mexico Environment Department Surface Water Quality Bureau March 13,2012. 2010-2012 State of New Mexico Clean Water Act §303(d)/§305(b) Integrated Report; Water Quality Control Commission Approved.

NMSU, 2010. New Mexico State University, 2010. Smith, Dr. Geoff; GBS Environmental, LLC and NMSU Biology Department. *Bacterial Source Tracking Study in the Cimarron New Mexico Watershed*; in cooperation with CWA board members and local Angel Fire High School students.

OSE, 2008. *Strategic Water Reserve Fact Sheet*. Available at: http://www.ose.state.nm.us/PDF/HotTopics/StrategicWaterReserve/SWR-FactSheet-LayDescription_7_8_08_final.pdf

Paramatrix, August 2011. Cimarroncito Wetland Mitigation Plan. Paramatrix, Albuquerque, NM.

Philmont Scout Ranch, November 2010. *Bonito Creek Watershed Restoration Project*. Prepared by Seth Mangini and Michael Sudmeier, Conservation Department, Philmont Scout Ranch.

Rangeland Hands, 2009. Taos Pine Roads Field Survey (2009).

Sandia and Los Alamos National Labs, 2009. *Cimarron Final Report*: December, 17, 2009; Sandia National Labs: Rich Jepsen, Jesse Roberts, Michael Chapin, Luis Abeyta, Los Alamos National Labs: Lisa Henne, Naomi Becker. Funded by New Mexico Small Business Administration.

U.S. Department of Agriculture Natural Resources Conservation Service, 2010. NRCS/WSS 2010. Available at http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm)

U.S Environmental Protection Agency, November, 2006, *User's Guide, Spreadsheet Tool for the Estimation of Pollutant Load (STEPL) version 4.0*. Developed for the U.S. Environmental Protection Agency by TetraTech, Inc. Fairfax, VA.

U.S. Environmental Protection Agency, March, 2008. Handbook for Developing Watershed Plans to Restore and Protect Our Waters.

U.S. Forest Service 2009 U.S. Forest Service (Content source); Mark McGinley (Topic Editor); (2009). *"Southern Rocky Mountain Steppe - OpenWoodland - Coniferous Forest - Alpine Meadow Province (Bailey)."* In: Encyclopedia of Earth. Retrieved from http://www.eoearth.org/article/Southern_Rocky_Mountain_Steppe_-_OpenWoodland_-_Coniferous_Forest_-_Alpine_Meadow_Province_(Bailey)

University of New Mexico Water Resources Program, July 2010. Water Resources Assessment of the Cimarron River and Evaluation of Water Quality Characteristics at the Maxwell National Wildlife Refuge, Dr. Bruce Thomson and Dr. Abdul-Mehdi Ali, editors.

Vigil, March 2010. Correspondence from NMED Water and Wastewater Infrastructure Development Division to Mike Vigil, Miami Domestic Water Users Association.

Appendix A. Estimated Load Contributions from Probable Sources of Impairment in the Cimarron Watershed

Moreno Valley

Cieneguilla Creek (Eagle Nest Lake to headwaters)
Causes of Impairment: E.coli, plant nutrients, sediment/siltation, temperature, turbidity

Probable Source	Estimated Contribution to Load (Percent)
Loss of riparian habitat	11
Municipal point source discharges	6
Other recreational pollution sources	6
Rangeland grazing	13
Streambank Modification/destablization	10
Wildlife	24
Dam/impoundment	6
Construction	9
Airport	3
Roads	10
Septic tanks/systems	2

Moreno Creek (Eagle Nest Lake to headwaters)
Causes of Impairment: plant nutrients, temperature

Probable Source	Estimated Contribution to Load (Percent)
On-site treatment systems (septic systems and similar decentralized systems)	20
Rangeland grazing	16
Waste from pets	6
Roads	13
Mining	17
Wildlife	18
Gravel pit	8

Sixmile Creek (Eagle Nest Lake to headwaters)
Causes of Impairment: E.coli, plant nutrients, temperature, turbidity

Probable Source	Estimated Contribution to Load (Percent)
Habitat modification - other than hydromodification	14
Livestock (grazing or feeding operations)	18
Natural sources	7
On-site treatment systems (septic systems and similar decentralized systems)	10
Rangeland grazing	18
Wildlife (other than waterfowl)	13
Gravel pit	10
Roads	10

Ponil Creek and Tributaries

North Ponil Creek (South Ponil Creek to Seally Canyon)
Causes of Impairment: E.coli, temperature, turbidity

Probable Source	Estimated Contribution to Load (Percent)
Forest roads (road construction and use)	18
Habitat modification - other than hydromodification	6
Loss of riparian habitat	20
Low-water crossings	21
Rangeland grazing	20
Silviculture harvesting	2
Natural/drought	3
Fire suppression sediment	4
Mining	2
Hydromodification	4

Middle Ponil Creek (South Ponil to Greenwood Creek)
Causes of Impairment: temperature

Probable Source	Estimated Contribution to Load (Percent)
Rangeland grazing	26
Roads	15
Fires	12
Wildlife	15
Loss of riparian habitat	15
Low-water crossings	10
Other recreational uses	7

South Ponil Creek (Ponil Creek to Middle Ponil)
Causes of Impairment: temperature

Probable Source	Estimated Contribution to Load (Percent)
Rangeland grazing	29
Roads	15
Fires	9
Wildlife	15
Loss of riparian habitat	20
Low-water crossings	5
Other recreational uses	7

Ponil Creek (US 64 to confluence of North and South Ponil)
Causes of Impairment: E.coli, plant nutrients, temperature, turbidity

Probable Source	Estimated Contribution to Load (Percent)
Livestock (grazing or feeding operations)	5
Loss of riparian habitat	24
On-site treatment systems (septic systems and similar decentralized systems)	4
Rangeland grazing	18
Waste from pets	4
Streambank modification/destabilization	15
Road use	12
Recreation use	4
Low-water crossings	4
Wildlife	10

Ponil Creek (Cimarron River to US 64)
Causes of Impairment: E.coli

Probable Source	Estimated Contribution to Load (Percent)
Avian sources (waterfowl and/or other)	20
On-site treatment systems (septic systems and similar decentralized systems)	11
Source unknown	19
Waste from pets	8
Recreational uses	4
Road	7
Rangeland grazing	16
Wildlife	15

Cimarron River and Ute Creek

Cimarron River (Turkey Creek to Eagle Nest Lake)
Causes of Impairment: dissolved arsenic, plant nutrients

Probable Source	Estimated Contribution to Load (Percent)
Dam or impoundment	24
On-site treatment systems (septic systems and similar decentralized systems)	20
Other recreational pollution sources	8
Source unknown	5
Wildlife (other than waterfowl)	15
Historical/ mining	15
Geology	3
Roads	8
Livestock	2

Cimarron River (Cimarron Village to Turkey Creek)
Causes of Impairment: dissolved arsenic, temperature

Probable Source	Estimated Contribution to Load (Percent)
Baseflow depletion from groundwater withdrawals	8
Loss of riparian habitat	20
Rangeland grazing	10
Source unknown	8
Mining	8
Roads	13
Raton water diversion	4
Low-water crossings	4
Railway sediments	3
Seasonal pollution; diesel from sludge, pets	6
Corrals, etc.	4
Wildlife	12

Cimarron River (Canadian River to Cimarron Village)
Causes of Impairment: plant nutrients

Probable Source **Estimated Contribution to Load (Percent)**

Flow alterations from water diversions	25
Impervious surface/ parking lot runoff	5
On-site treatment systems (septic systems and similar decentralized systems)	20
Rangeland grazing	30
Roads	4
Low-water crossings	1
Wildlife	15

Ute Creek (Cimarron River to headwaters)
Causes of Impairment: dissolved arsenic, E.coli, temperature

Probable Source **Estimated Contribution to Load (Percent)**

Loss of riparian habitat	12
On-site treatment systems (septic systems and similar decentralized systems)	2
Rangeland grazing	12
Historic mining	25
Wildlife	20
Roads	15
Pets	2
Low-water crossings	12

Rayado Creek

Rayado Creek (Miami Lake Diversion to headwaters)
Causes of Impairment: E.coli, temperature

Probable Source	Estimated Contribution to Load (Percent)
Baseflow depletions from groundwater withdrawals	15
On-site treatment systems (septic systems and similar decentralized systems)	6
Rangeland grazing	25
Wildlife (other than waterfowl)	25
Flow alterations	6
Avian/waterfowl	8
Roads/low-water crossings	15

Rayado Creek (Cimarron River to Miami Lake Diversion)
Causes of Impairment: plant nutrients, sediment/siltation

Probable Source	Estimated Contribution to Load (Percent)
Dam or impoundment	20
Habitat modification - other than hydromodification	4
Highway/road/bridge runoff (non-construction related)	2
Loss of riparian habitat	10
Rangeland grazing	20
Wildlife	20
Flow alterations	9
Roads/ low-water crossings	15

Appendix B. Tier 1 Field Survey Reports

Stream Survey of Cieneguilla Creek

May 29-31, 2012

Survey Area: **Cieneguilla Creek from headwaters southeast of Angel Fire to Eagle Nest Lake**

Primary Assessment Team and report by: Cieneguilla Creek was surveyed by Joanne Hilton and Ben Christensen with assistance from CWA volunteers Jim Morgan and Alan Huerta. The survey was conducted from May 29-31, 2012.

Assessment Goals: Evaluate the watershed condition and options for mitigating temperature, sediment, nutrients, *E.Coli,* and turbidity impairment.

General Watershed Information:

Geologic Formation: Alluvium, High Glacial Valley

Channel Type: Primarily E6 below Monte Verde Lake in upper part of watershed.

Flow Regime: Snow Melt Dominated, Perennial

Assessment Method:

The team used the BANCS Model-Bank Assessment for Non-Point Source Consequences of Sediment (WARSSS 5-55). Field data was collected using Bank Erosion Hazard Index (BEHI) and the Near Bank Stress Estimating System (NBS) #5 calculation method, ratio of near bank maximum depth to bankfull mean depth. The team also used their general observation skills along the stream channel as well as viewing the watershed area as a whole and its general condition, current use and historical use.

Watershed History:

Farming and ranching have been present in the Moreno Valley since the 1800's. Historic mining occurred south of Eagle Nest Lake also in the 1800s, but not directly in the Cieneguilla Creek watershed. Currently there two gravel pits located near Cieneguilla Creek between Angel Fire and Eagle Nest Lake.

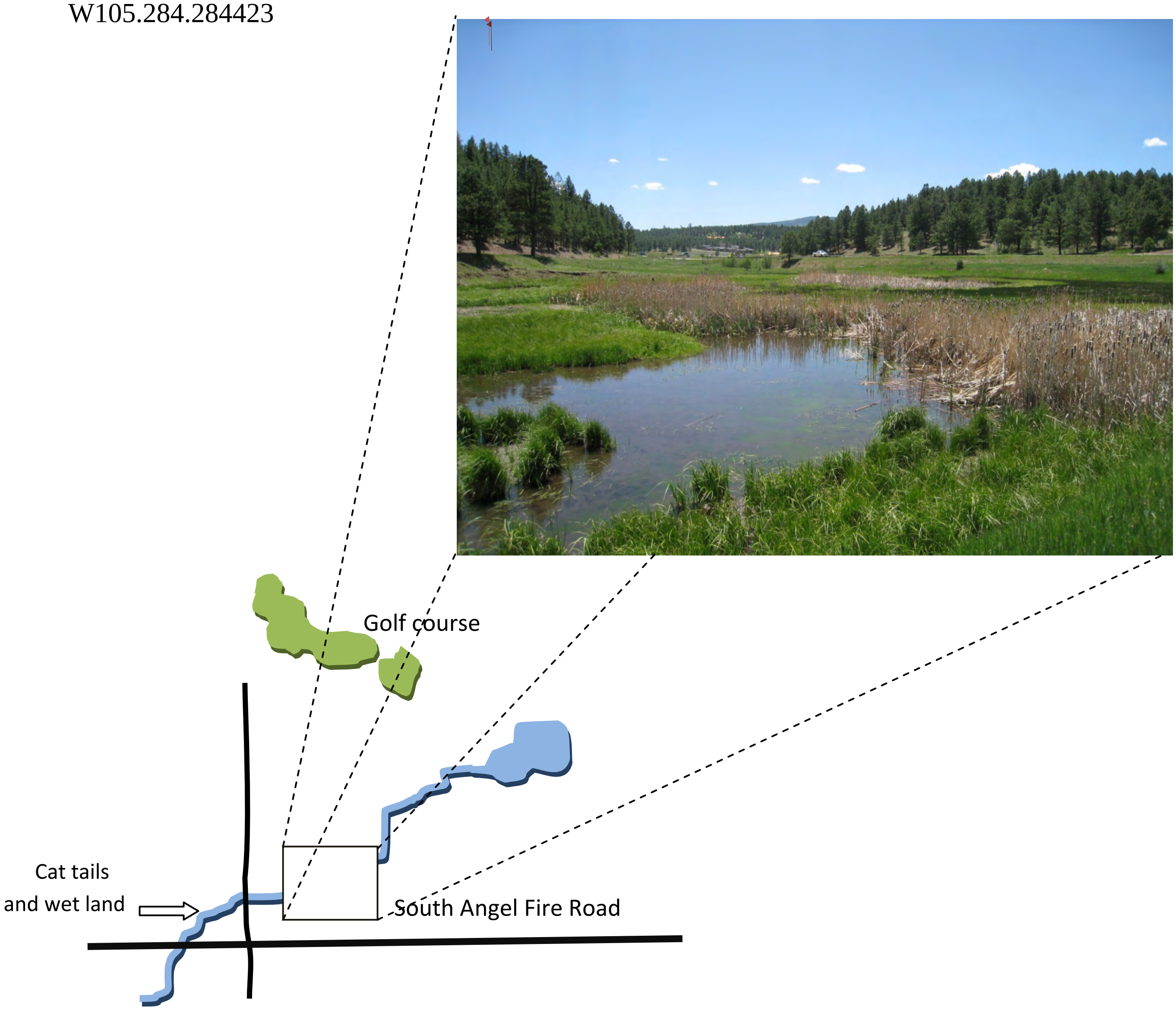
Cieneguilla Creek flows through the Town of Angel Fire. Construction began on the resort community of Angel Fire in 1966. Angel Fire has developed as recreation/resort area with Angel Fire Ski area, Angel Fire Golf Course, and Eagle Nest Lake State Park as key attractions.

Watershed Survey

The following notes document conditions in the watershed, beginning at the headwaters and continuing to Eagle Nest Lake. Forms with BEHI ratings were completed separately and are summarized below.

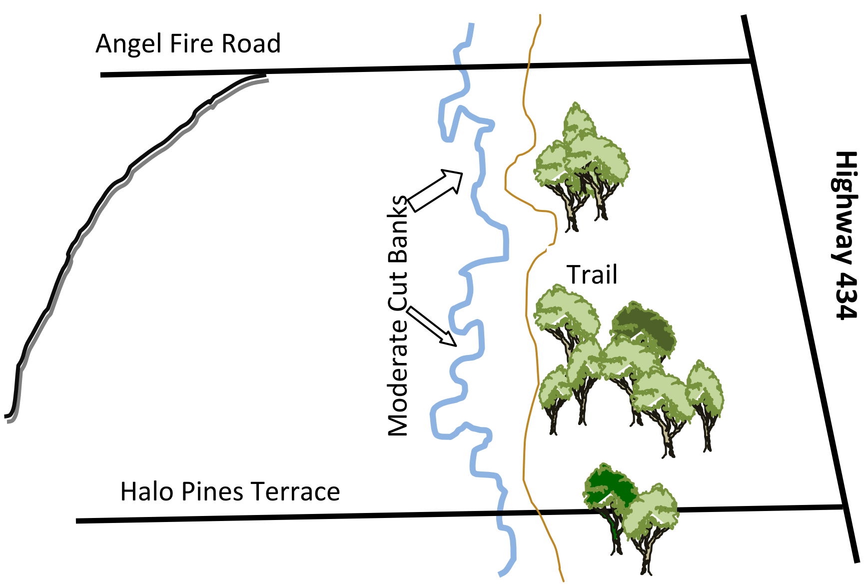
There were ponds and development on the upper Cieneguilla's left fork just downstream of where it leaves the road. Monte Verde lake impounds the water coming from the other tributary.

Relatively healthy wetlands are located below Angel Fire Road downstream of the golf course.
Waypoint 62 N36.38428
W105.284.284423



There are three culverts that discharge downstream of the road

These culverts appear to contribute to stream velocity and should be evaluated for improved placement.



There are 1-2ft cut banks along meanders immediately below the road.

These photos are looking at the stream from Halo Pines terrace looking east

Waypoint 63 is located downstream of El Camino Grande, taking the first left heading toward ranch properties, N36.41708 W105.28721.

At waypoint 64, N36.42305 W10528458 there is an old road crossing that needs to be removed. The stream is cleaner and less silty with a more stable bottom. This photo shows old meander.

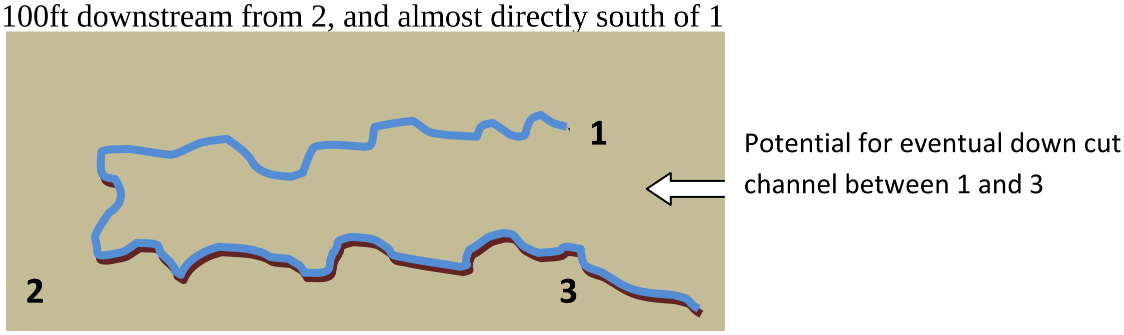
5-30 Waypoint 65, N36.44013 W105.27456, is located downstream of the airport going toward eagle nest on the main road; then on the 1st road to the right just past security building. There is a 3ft culvert at the road crossing.

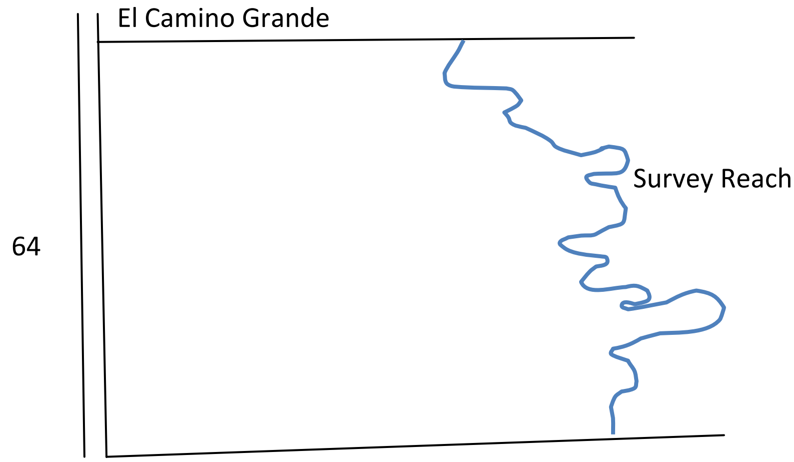
There are extreme-moderate banks downstream and moderate banks upstream and an electric fence on both sides of the road.

5-30 Off of the first road south of the Airport, El Camino Grande, and the survey started at the crossing of the Cieneguilla. It then proceeded downstream to the airport.

Primary areas of stress

1. 100ft downstream of the road there were culverts. It scored a 24 on BEHI and a moderate on the NBS. Some moderate BEHI banks between points 1 and 2
2. 200ft downstream. Some moderates between 2 and 3
3. 100ft downstream from 2, and almost directly south of 1





4. There is a large pond with a very silty stream bottom located 50ft downstream of Halo Pines Terrace road crossing/culvert. There is a lot of trash in the stream, and another moderate bank 340ft downstream of the road. All along the stream there is tall grass sometimes growing in the stream slowing down the current. 130ft farther downstream there is a fence going across the stream. 34ft downstream of the fence there is a moderate bank and grass in the stream. 3 inch and smaller fish were observed 30ft farther downstream there is another moderate bank with a grass bench below.

5. 380ft downstream of the last point there is a bank slump. Waypoint 58. 60ft downstream of waypoint 58 there is a short undercut bank with grassy bench below. Cieneguilla Creek continues to be very silty and slow with some grass in the stream. Another 340ft beyond Waypoint 58 there is a high exposed bank about 70ft long. Another 140ft downstream there is a board bridge across the stream. Another 90ft there is an exposed cut bank with high BEHI indicators.

6. Waypoint 59 is 320ft farther downstream. Vegetation is protecting the bank when the flow is moderate, however, at high flows it is completely exposed. The BEHI index is 35, giving it a high rating. 150ft beyond Waypoint 59 there is a 10ft long undercut bank that is between high and very high on the BEHI. 60ft farther there is an almost identical bank. Another 130ft downstream there is an outside meander, and very high on the BEHI. The flow is better and less obstructed by trash and vegetation in the stream there. 170ft farther downstream there is a log in the stream with scum built up behind it.

7. Another 230ft downstream there is a small silt fence below an industrial site, located about 500ft away from the stream. There was a small gray rat observed. There are moderate BEHI banks throughout this reach. 230 feet beyond the fence there is a moderate bank with a bench below. 90 feet past that there is a silt fence coming in to the stream.

90ft farther downstream there is a blue drum and garbage in the stream.

An additional 150ft downstream there is a fence across the stream. There is a significant amount of trash all throughout the stream. This reach is more stable and grassy. 260ft downstream of the fence there is a side drainage coming in. There is a well about 100ft east of the stream. 120 farther there is a lot of grass and a small wetland area. There is an old pipe in the stream as well as moderate exposed banks.

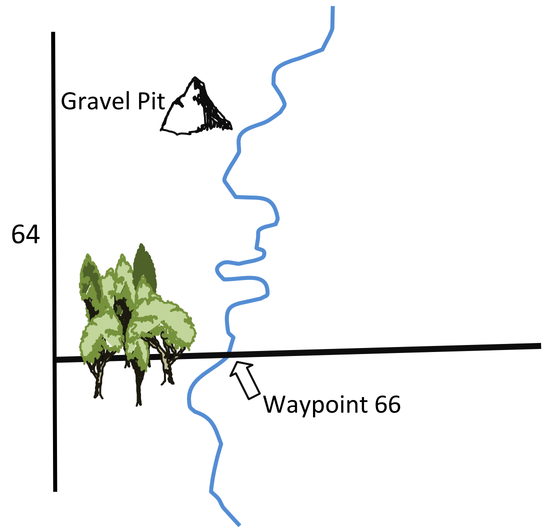
8. Located at N36.40395 and W105.28350 there is 80ft of exposed bank with a BEHI of high to very high. There is a drainage coming in close to the road.

600ft farther down there is a high BEHI bank.

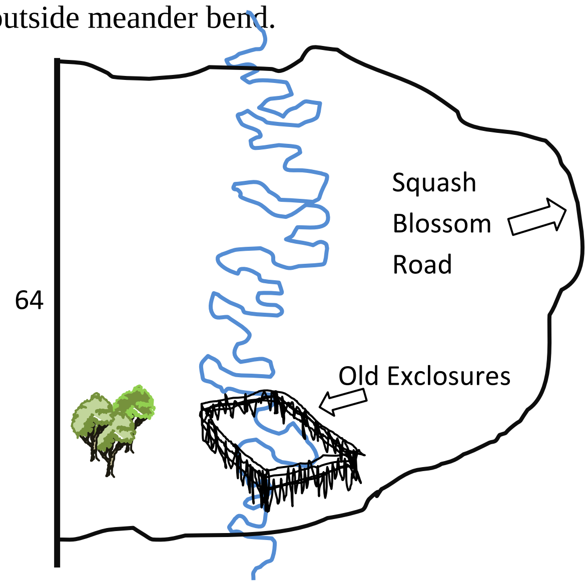
50ft farther downstream many 1inch fish and one 10inch black fish observed. The stream is deeper and slower here. 260ft farther a soccer field is located directly to the west and Moreno Valley High School is to the east. There are banks here that are high- very high BEHI. In the reach there are more moderate banks. 130ft farther the stream is flowing better and the bottom has cobble instead of silt. Downstream an additional 330ft there is a 10ft long and 4ft high bank with a high BEHI.

9. 390ft farther downstream is Waypoint 60, N 36.40815 W105.28467. There is an 80ft long by 3.5ft high exposed bank with less than 10% vegetation, and a high BEHI. 200ft downstream of Waypoint 60 there is a 30ft long 2.5ft high exposed bank (high BEHI). Downstream another 100ft there are more exposed banks with lots of undercut and slumping between there and the road (El Camino Grande). 400ft farther there is a small drainage coming in, at less than 0.2 cubic feet per second (estimated). 150ft downstream of the incoming drainage there is an exposed bank and there are bigger fish in this reach, also the banks are more stable. Another 300ft downstream there is spring discharge into the creek. The spring is located about 250ft upstream of the road. There are moderate banks from here to the road.

5-30 The next road south is where Waypoint 66 is located, N36.45467 W105.27107. There are many cattle trails and moderate banks in this reach.



5-30 Waypoint 67. N36.47556 W105.26476, is located on the crossing at Squash Blossom Road. There are three culverts crossing Squash Blossom Road. There is a 50ft long 4.5ft high bank outside meander bend.



5-31 Waypoint 68, N36.47555 W105.26464, is located off of the first road south of Eagle Nest Lake. Along the Cieneguilla there are a series of exclosures. Upstream there is a fence that has a no trespassing sign. It is south 300ft downstream of the gauging station. The stream is very silty with extreme meanders. Most of the banks are very high to moderate BEHI in both the upstream and downstream direction.

5-31 At Waypoint 69, N36.48659 W105.28814, there is a 100ft long 6ft high bank just North East of the parking lot at the end of the road. That bank has a BEHI of 41: very high erosion potential. 150ft downstream on the Cieneguilla there is a bank with high BEHI, about 100ft long, directly east of the restroom and it borders the exclusion fence.

Looking downstream into the exclosure, there are moderate cut banks with some smaller fencing inside as well as small recently planted vegetation.

It is possible to walk into the exclosure from the north end. Downstream toward Eagle Nest Lake there are moderate to high banks.

Summary Recommendations

Based on the watershed conditions observed above, the following treatments are recommended for Cieneguilla Creek:

- Plant shade species (willow, red alder and cottonwood) in Angel Fire and north of Angel Fire, between the airport and Eagle Nest Dam. Tree planting will need to be coupled with wildlife and livestock exposures to successfully establish shading.

- Maintain existing wildlife exclosures as well as adding new wildlife exclosures in other areas.

- Restore exposed banks, focusing on those that rated as high to very high on the BEHI ranking system. A cut and paste system is recommended to reconfigure the channel morphology at each problem location. The material and vegetation on the enlarged point bars or overlong meanders are removed and placed at the toe of the opposite eroding bank. Additional discussion of this method is included in the North Ponil Assessment report in Appendix C. Simpler methods such as post vanes are appropriate along much of the creek.

- Remove and restore an old road alignment that is affecting channel function.

- Meet with gravel pit operators to discuss best management practices.

- Work with land owners to provide education and resources regarding grazing management and to assist with off channel stock watering options.

- Meet with managers of Angel Fire Golf course to discuss management practices and determine if there are any opportunities for collaboration.

- Work with Colfax County to conduct a valley wide road assessment to identify which roads may be repaired for improved drainage and culvert placement

- Work with Colfax County and the New Mexico Department of Transportation to implement BMP's during road construction projects.

- Work with local schools and community volunteers to clean up trash and debris in the creek.

Costs

The cost for the education and coordination components of this project would be covered by the Watershed Coordinator and only additional expenses are reflected here. Approximate project costs for the recommendation above are:

Exclosures 3 acres at $3,000 per acre =$9,000

Cut bank stabilization: 10 banks at $6,000 per bank = $60,000.

Establishing riparian vegetation 5 miles at $ 5,000 per mile =$25,000

Address old road =$20,000

Monitoring and reporting $20,000

Misc. expenses (mileage, etc.) $5,000

Total project cost: Approximately $140,000

Report Submitted by: Steve Carson,

Rangeland Hands, Inc.
46 County Road 84A
Santa Fe, New Mexico 87506
Email: rangehands@gmail.com
505-455-0012 / Cell 470-3542 / Fax 455-7060

8/6/2012

Proposed West Agua Fria Creek Powerline Road Reroute Assessment Report:

Project Goal: Reduce the direct sediment contribution of 1,600 feet of unimproved dirt road into West Agua Fria Creek.

West Agua Fria Creek is a perennial stream that flows west from the Garcia Park area and off the north side of Agua Fria Peak, east of Angel Fire New Mexico. West Agua Fria Creek is a head water drainage that flows west form elevations of 9,000 to 10,975 feet above sea level and enters Cieneguilla Creek on the east side of the Angel Fire Airport. The drainage area is approximately 25 square miles. The stream system is a snow melt dominated flow regime with contributions from summer monsoon rain events. Average annual precipitation is approximately 25 inches. The dominate geology in this area is volcanic lava flows that have created an abundance of basalt outcroppings and boulder fields along with a dominate high clay content soil type.

The land owner in the proposed project area is the CS Ranch / American Creek Properties.

The existing road system crosses West Agua Fria Creek from the north side of the creek over to the south side along the 245 KV powerline right of way and runs east crossing over the creek again and then turns north. Both creek crossings currently have culverts in them. This section of road is approximately 1,600 feet in length.

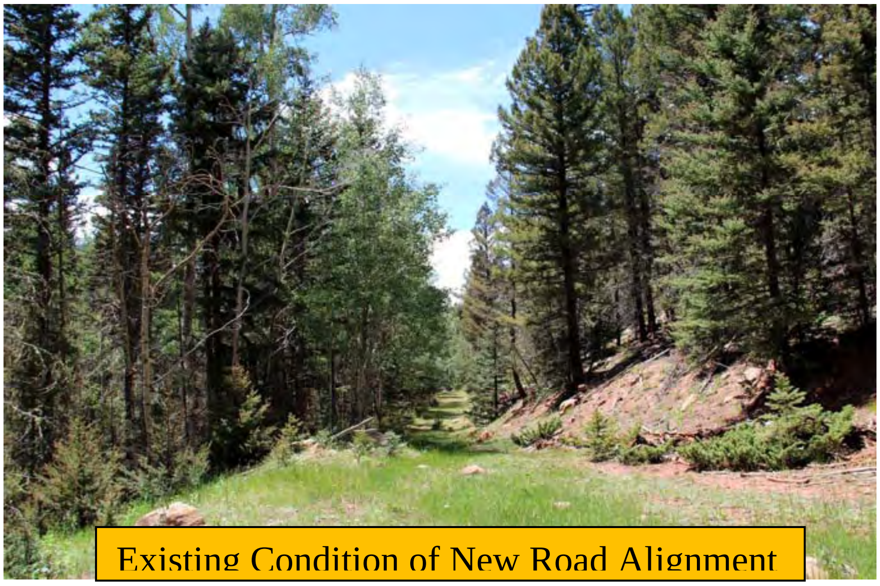
The west section of this road, +/- 750 feet is at a slope of +/- 12% currently drains directly into the creek. The east end of the road, +/- 750 feet also drains directly into the creek at the location of the upper culvert. The soils in this area are fine red clay. This road could be cross drained, however; it is very close to the creek and there are limited buffer areas to filter the runoff water before it enters the stream system.

The proposal to stop the direct sediment contribution into West Agua Fria Creek is to close and drain this section of road and reopen an existing road that is on the north side of the creek.

The old road would be abandoned and drained. The proposed work would include a significant number of cross drains so that no one drain has enough discharge to flow into the creek. Drainage would be directed into the limited buffer areas on the south side of the creek. The two culverts would be removed and the stream channel reshaped to its original cross sectional shape. The road also cuts through a small spring fed sloped wetlands. Local soil materials would be used to fill in the truncated end of the sloped wetlands. All berms and ditches would be removed and contoured into the old road prism. The road surface would be ripped and reseeded with native grasses.

The new road alignment, approximately 1,450 feet long, would be on an abandoned road on the north side of the creek. This new alignment is not as steep as the old road and provides better buffer areas to sequester road drainage sediment. The road would require +/- ten Rolling Dip Road Surface Cross drains as well as +/- 5 drains on an abandoned road that enters the new alignment from the north. The new alignment crosses over a spring fed sloped wetlands. To cross these wetlands a permeable fill crossing would be installed at this location. The preamble fill area is approximately 100 feet long x 15 feet wide x 2 feet deep.

Proposed Re-utilization of New Road Alignment



The project estimated cost is $32,600.00

Project Design References:

A Good Road Lies Easy on the Land….Water Harvesting from Low Standard Rural Roads: Bill Zeedyk 2006

Managing Roads for Wet Meadow Ecosystem Recovery: USDA Forest Service, FHWA-FLP-96 016: Bill Zeedyk 1995

7/1/2012 Revised 7/9/2012 SC

North Ponil Creek / North Ponil Watershed Assessment Report:

Assessment Dates: Spring 2012

Primary Assessment Team and Report by: Steve Carson, Rangelands, Inc. and Rick Smith, Highland Solutions, LLC.

Assessment Goals: Determine the source of sediment contribution to the mainstem stream channel, North Ponil Creek within the North Ponil watershed area and develop remedies to reduce this sediment contribution within the system.

Assessment Conclusions as to the sources of sediment, in order of contribution:

1. Unstable streambanks.
2. Poor grazing management practices.
3. Roads
4. 2002 fire.
5. Geology, a constant that is affected by all of the above.

General Watershed Information:

Geologic Formation; Raton is a sandstone high relief, rocky, flashy, rapidly eroding geologic system. This system has a natural high geological sediment contribution.
Valley Type III, alluvial fan dominated with steep rocky slopes.
Channel Type: C, F and G / Variable
Flow Regime: Snow Melt Dominated, Intermittent Perennial.

North Ponil Watershed Assessment Area:

The assessment to determine the contribution of sediment into the North Ponil Creek from bank erosion and other factors, was started at the fence line of XA Ranch and the Philmont Scout Ranch and proceeded downstream from this point for approximately 3.6 miles.

Assessment Method:

The team used the BANCS Model-Bank Assessment for Non-Point Source Consequences of Sediment (WARSSS 5-55). Field data was collected using the Bank Erosion Hazard Index (BEHI) and the Near Bank Stress Estimating System (NBS) #5 calculation method, ratio of near bank maximum depth to bankfull mean depth. The team also used their general observation skills along the stream channel as well as viewing the watershed area as a whole and its general condition, current use and historical use.

Watershed History:

It is very important to understand the historical use of a watershed. The effects of historical use in any given watershed generally are associated with the present problems and conditions we see today. If we do not understand the cause of the problems we now see, we cannot understand the remedies to reverse the present trends.

North Ponil Watershed Historical Use:

The North Ponil has a long history of human influence. There is evidence of Native American cultures using this area year round. However, historical indicators generally point to summer seasonal use of this area by native cultures. European influence dates back to the early 1800's and the influence of the fur trappers and the impact that this activity had on the stream system due to a heavy reduction in the beaver population, which at one time was a dominating influence in this watershed.

Post Civil War 1866 and beyond, brought an influx of pioneers to the western United States. This area was not exempt from this influx and demographic change, especially with its proximity to the Santa Fe Trail. Homesteads, farming and ranching as well as timber and mineral extraction began in this time period. Large numbers of all types of livestock were introduced into the area and by 1890 the numbers surpassed the limits of the forage carrying capacity and the ability of soils to stay in place due to the reduction in grass cover. Major soil erosion started in this time period due to accelerated surface discharge caused by the lack of ground cover. The accelerated surface discharge not only caused the loss of topsoil, but cut deep gullies in the landform and overloaded the mainstem channels with sediment as well as causing down cutting in the mainstreams and tributary channels. Couple these effects with the loss of beavers and the stability of the overall watershed and stream channel system losses its natural equilibrium and goes into an unstable downward erosional trend.

In approximately 1885 a logging railroad was constructed up the middle of the North Ponil Valley. Logging railroads of this type were a temporary system to be used to extract the timber resource and then be dismantled and moved to the next timber area to be harvested. The construction of these rail systems summarily disregarded any effects that it might have on the natural resources that it was built upon. This is truly the case on the North Ponil. The rail bed was built in the center of the valley with no regard for the presences of the existing stream channel and associated wetlands. Materials needed to build the elevated rail bed were dug out of the valley bottom on each side of the bed alignment. The stream channel was straightened and moved to one side of the valley as much as possible to minimize the need for stream crossing trestles and the cost associate with them. The original meander pattern was eliminated, stream channel slope was increased and major stream channel down cutting occurred at this point. As the mainstem dropped, all the tributary channels head cut and incised proportionately to the down cutting of the mainstem. Channel down cutting and incision drained the water table in these locations. The loss of alluvial water table storage has had a significant effect on this system. The most obvious effects are the loss of wetlands, mature cottonwoods and base flows in the stream channel.

The rail system and timber operation brought with it an influx of people, farming and livestock to support the timber operation. The heavy loss of timber cover and the associated impact of skid and logging roads further destabilized the headwaters of the North Ponil watershed. By 1900 the entire North Ponil watershed was in a state of total instability. The channel system incised and down cut, upland top soils eroded to the point that the A horizon was eliminated and mineral soils exposed.

The stream channel has attempted to stabilize itself through the natural channel succession process over the last 100 +/- years. There are some reaches of C channel type that have reached a stable equilibrium. However, the majority of the North Ponil is still in a very frustrated state, continuing to incise, headcut, carving out its banks in an attempt to create more width. It is overloaded with sediment that builds over wide and over high point bars that further create more bank erosion as well as overlong meanders caused by too much sediment which again creates more bank erosion. This insidious process repeats itself through the entire channel system.

The anthropogenic effects on the North Ponil have converted a once beaver dominated perennial stream system with associated wetlands to a down cut, incised and eroded intermittent stream system with very little associated, if any, wetlands.

We are now dealing with these legacy effects and associated problems as well as current effects and management practices.

Recent and Current Effects on the North Ponil Watershed:

Weather: The flows in this stream system are dominated by snow melt run off. It appears that the last bankfull runoff event was in the spring of 2010. Since that time there has been decline in moisture in this area due to the current drought.

Fire: The watershed has seen continually used since 1900 for ranching, farming, grazing and the associated use of the Philmont Scout operation. As recently as 2002 the Ponil Complex Fire burned a significant amount of this watershed. The loss of ground cover caused by the fire coupled with steep rock sandstone topography has caused a significant increase in sediment contribution to the stream system. This sediment contribution is now decreasing due to the re-vegetation occurring on the burn area. The fire and associate ground cover loss also created accelerated and higher than normal watershed discharges. The increased discharge caused further down cutting and bank erosion on an already fragile, legacy affected stream channel and watershed system.

The team observed that pre fire, many areas on North Ponil Creek were well vegetated with riparian woody vegetation along the stream channel, i.e., willows and cottonwoods. During the post fire flood a large amount of organic debris was caught in the willows along the stream. This debris elevated the stream bank and in many places blocked access to the flood plain creating a willow/debris hardened G channel type. This change in the width to depth ratio has caused the channel bottom to further down cut and incise as well as creating an increase in Near Bank Stress (NBS) in many cases.

Grazing: Current grazing in this area for a herd of horses starts in October and extends into the spring cool weather growing season until June. The team observed what would be described as 100% hoof shear from valley hill slope to hill slope as well as along the stream channel. The hoof shear along the stream channel is so heavy that it has obliterated the bankfull indicators as well as destabilized the bankfull benches where they occur (C, B and in some F channel types). The grass forage utilization was 100% on the terraced areas as well as along the stream channel. There is a considerable amount of bare ground; some areas have some native grass cover and other areas are dominated by annual weeds. The herd of horses has also grazed significantly on the willows and cottonwoods. The cottonwoods are more affected by this grazing due to the grazing impact on the smaller saplings. If continued, this could cause a reduction in cottonwood regeneration. The team observed numerous and closely spaced horse dung piles throughout the North Ponil canyon. This observation denotes that the horses are in this area for an extended time period and along with the 100% hoof shear it can be concluded they repeatedly heavily graze over this area a number of times between October and June. This area has the appearance of a confined horse corral rather than a grazed pastured.

The current grazing practices in this area have a significant effect on the stability of watershed function. The loss of ground cover and a decrease in species type has increased the surface area discharge and velocity causing top soil erosion, increasing gully erosion and increasing the amount of sediment that is being discharged into the stream system.

Roads: The current access road in the North Ponil valley generally follows the alignment of the old rail bed. The road is poorly drained, if at all. Long segments are hydraulically connected causing road surface erosion and generally causing gully/head cut erosion at the point where the water finally exits the roadway. There are some road drainage locations as well as stream crossing locations that the road runoff and sediment is discharged directly into the stream channel. The team members also took two evening road observation trips. One such trip was up Cottonwood Canyon and looping around and coming out on Metcalf Canyon. The other observation route was Cook Canyon road and looping south back over the mesa/burn area and coming back into the North Ponil at +/- Old Camp. These roads have been recently, i.e., Fall 2011, bladed with a bull dozer. The road up Cottonwood Canyon is in the creek channel and has created a channel destabilization which adds to the overall sediment contribution to the watershed system. The remainder of both road systems, although recently bladed, are not well drained, if at all. The blading operation has created a continuous berm on the downhill side of the road that keeps the water trapped on the roadway causing road surface erosion, high sediment discharge and the continued need for costly, repeat road maintance.

Scouting: The main effect of the Scouting operation is the concentrated Scouting activities at locations along the stream channel. These areas have been impacted to the point that the ground is bare and the streambanks destabilized due to trailing. These areas have a direct contribution of sediment into the stream channel.

Conclusion of the Historical and Current Effects on the North Ponil:

The North Ponil watershed has been significantly negatively impacted by historical and current land management practices. Based on the BEHI, NBS and BER data collected by the assessment team and quantified by Rick Smith, the 3.6 miles of the North Ponil has a sediment contribution load of 5,394 tons per year from unstable stream banks. (Note: The unstable streambank sediment contribution could be extrapolated to include the remainder of the North Ponil Creek down to the confluence with the Middle Ponil +/- 3.5 miles) This calculation does not add in the other sediment contributions created by the effects of fire, roads, grazing and other human activities. Given the results of the stream bank erosion data, coupled with the historic and present land management practices, the overall system would be rated at unstable with a downward trend.

Stabilization and Restoration Opportunities:

References:

Watershed Assessment Practices can be reviewed in:

Evaluating the Bank Erodibility Hazard Index In New Mexico, Wilbert Odem, Ph.D., P.E., 1999

Regional Relationships for Bankfull Stage in Natural Channels of the Arid Southwest, Tom Moody, PE, 2003

Watershed Assessment of River Stability and Sediment Supply (WARSSS), Second Addition, Dave Rosgen 2009

A Good Road Lies Easy on the Land…. Water Harvesting From Low-Standard Rural Roads Second Addition, Bill Zeedyk 2010

7/1/2012 Revised 7/9/2012 SC

Middle Ponil / Barker WMA to Ponil Scout Camp Watershed Assessment Report:

Assessment Dates: Spring 2012

Primary Assessment Team and report by: Steve Carson, Rangelands, Inc. and Rick Smith, Highland Solutions, LLC.

Assessment Goals: Determine the source of sediment in the Middle Ponil watershed area and develop remedies to reduce the sediment contribution within the system.

Assessment Conclusions as to the sources of sediment, in order of contribution:
1. Unstable streambanks.
2. 2002 fire.
3. Roads
4. Geology, a constant that is affected by all of the above.

General Watershed Information:
Geologic Formation; Raton, a sandstone high relief, rocky, flashy, rapidly eroding geologic system. This system has a naturally high geological sediment contribution.
Valley Type III, alluvial fan dominated with steep rocky slopes.
Channel Type: Variable, B, Bc, C, F, G
Flow Regime: Snow Melt Dominated, Perennial

Middle Ponil / Barker Watershed Area:
The assessment to determine the contribution of sediment into the Middle Ponil from bank erosion was started at the fence line on the west end of the Barker WMA and proceeded downstream from this point for approximately 5.5 miles to the horse /burro corral at the Ponil Scout camp just below the confluence of the South Ponil.

Assessment Method:
The team used the BANCS Model-Bank Assessment for Non-Point Source Consequences of Sediment (WARSSS 5-55). Field data was collected using Bank Erosion Hazard Index (BEHI) and the Near Bank Stress Estimating System (NBS) #5 calculation method, ratio of near bank maximum depth to bankfull mean depth. The team also used their general observation skills along the stream channel as well as viewing the watershed area as a whole and its general condition, current use and historical use.

Watershed History:
It is very important to understand the historical use of a watershed. The effects of historical use in any given watershed generally are associated with the present problems and conditions we see today. If we do not understand the cause of the problems we now see, we cannot understand the remedies to reverse the present trends.

Middle Ponil WS Historical Use:
The Middle Ponil has a long history of human influence. There is evidence of Native American cultures using this area year round. However, historical indicators generally point to summer seasonal use of this area by native cultures. European influence dates back to the early 1800's and the influence of the fur trappers and the impact that this activity had on the stream system due to a heavy reduction in the beaver population, which at one time was a dominating influence in this watershed.

Post Civil War 1866 and beyond, brought an influx of pioneers to the western United States. This area was not exempt from this influx and demographic change especially with its proximity to the Santa Fe Trail. Homesteads, farming and ranching as well as timber and mineral extraction began in this time period. Large numbers of all types of livestock were introduced into the area and by 1890 the numbers surpassed the limits of the forage carrying capacity and the ability of soils to stay in place due to the reduction in grass cover. Major soil erosion started in this time period due to accelerated surface discharge caused by the lack of ground cover. The accelerated surface discharge not only caused the loss of topsoil, but cut deep gullies in the landform and overloaded the mainstem channels with sediment as well as causing down cutting in the mainstreams and tributary channels. Couple these effects with the loss of beavers and the stability of the overall watershed and stream channel system losses its natural equilibrium and goes into an unstable downward erosional trend.

In approximately 1885 a logging railroad was constructed up the Middle Ponil Valley as far as the Ponil Scout Camp. At this point, the rail line turned south and went up the South Ponil drainage. Logging railroads of this type were a temporary system to be used to extract the timber resource and then be dismantled and moved to the next timber area to be harvested. The construction of these rail systems summarily disregarded any effect that it might have on the natural resources that it was built upon. This is truly the case on the Middle Ponil downstream from the Ponil Scout Camp. The rail bed was built in the center of the valley with no regard to the presence of the existing stream channel. Materials needed to build the elevated rail bed were dug out of the valley bottom on each side of the bed alignment. The stream channel was straightened and moved to one side of the valley as much as possible to minimize the need for stream crossing trestles and the cost associated with them. The existing meander pattern was eliminated, stream channel slope was increased and major stream channel down cutting occurred at this point. As the mainstem dropped, all the tributary channels head cut and incised proportionately to the down cutting of the mainstem. The effects of this channel down cutting and incising can be seen in the assessment area upstream from the Ponil Scout Camp.

The rail system and timber operation brought with it an influx of people, farming and livestock to support the timber operation. The heavy loss of timber cover and the associated impact of skid and logging roads further destabilized the headwaters of the Middle Ponil watershed.

Farming operations dominated the Middle Ponil at the Barker and Rich Ranches. To create more easily managed farm fields the farmers rerouted the stream channel to one side of the valley. The existing meander pattern was eliminated, stream channel slope was increased and major stream channel down cutting occurred at this time. As the mainstem dropped, all the tributary channels head cut and incised proportionately to the down cutting of the mainstem.

By 1900 the watershed stability of the Middle Ponil drainage was significantly compromised. Channel systems incised and down cut and uplands top soils were eroded.

The stream channel has attempted to stabilize itself through the natural channel succession process over the last 100 +/- years. There are some reaches of C and B, Bc channel types that have reached a stable equilibrium. However, there are many locations on the Middle Ponil which are still in a very frustrated, continuing to incise, headcut, carving out its banks in an attempt to create more width. It is overloaded with sediment that builds over wide and over high point bars that further created more bank erosion as well as overlong meanders caused by too much sediment which again creates more bank erosion and this process insidiously repeats itself through the entire channel system. Even in this frustrated state the channel, especially on the Barker Reach, is well vegetated with willows, alders and cottonwoods and has stable reaches of C, Bc and B channels with numerous beaver ponds interspersed along the stream and associated wetlands.

The anthropogenic effect on the Middle Ponil has converted a once beaver dominated meandering C or E stream system with associated wetlands to a down cut and incised B stream system with loss of association wetlands.

We are now dealing with these legacy influences and associated problems as well as current affects and management practices.

Recent and Current Affects on the Middle Ponil Watershed:

Weather: The flows in this stream system are dominated by snow melt run off. It appears that the last bankfull runoff event was in the spring of 2010. Since that time there has been decline in moisture in this area due to the current drought. This reach of the Middle Ponil dried up in May of 2011. The effects of drought can be especially seen in the decline of the beaver and fish populations. There are still a few active beaver dams in this area, but most dams show no sign of activity for this year.

Fire: The watershed has seen continually used since 1900 for ranching, farming, grazing and the associated use of Philmont Scout operations. As recently as 2002 the Ponil Complex Fire burned a significant amount of this watershed. The loss of ground cover caused by the fire, coupled with the steep rocky sandstone topography, has caused a significant increase in sediment contribution to the stream system. This sediment contribution is now decreasing due to the re-vegetation occurring on the burn area. The fire and associated ground cover loss created an accelerated, higher than normal, watershed discharge. The increased discharge caused further down cutting and bank erosion on an already fragile, legacy affected stream channel and watershed system.

Grazing: The Barker Reach is not grazed by livestock. The effect of long term livestock exclosure from this area can be seen in the robust riparian vegetation and well vegetated uplands with little bare ground and a diverse species of native grasses. Down stream of the Barker Reach on the Philmont Scout Ranch there has been some livestock grazing. This area is in fair condition, but does not have the amount of stream side vegetation as does the Barker Reach.

Roads: The current access road in the Middle Ponil valley follows the stream on one side or the other. The road is poorly drained, if at all. Long segments are hydraulically connected causing road surface erosion and generally causing gully erosion at the point where the water finally exits the roadway. There are some road drainage locations that the road runoff and sediment is discharged directly into the stream channel with no buffer area. The blading operation has created a continuous berm on the down slope side of the road that keeps the water trapped on the roadway causing road surface erosion, high sediment discharge and the continued need for costly, repeated road maintance.

Scouting: The main effect of the Scouting operation observed by the team was certain areas at the streams edge where there is heavy concentration of Scout usage, predominantly in the area of the Ponil Camp. These areas have been impacted to the point that the ground is bare and the streambanks destabilized due to trailing. These areas have a direct contribution of sediment into the stream channel.

Ponil Scout Camp Horse and Burro Corral: The equine corral at the Ponil Scout Camp encompasses +/- five acres. The corral straddles the Middle Ponil at this location. As in any livestock confinement area, there is no or very little vegetation. The corral area is bare ground and the riparian vegetation along the stream channel has been eliminated due to the heavy concentration of livestock. The stream banks are bare and void of vegetation. This area is +/- five acres of bare ground within the stream channel corridor and is a significant contributor of sediment and livestock waste directly into the Middle Ponil stream system.

Conclusion of the Historical and Current Effects on the Middle Ponil:
The Middle Ponil watershed has been significantly negatively impacted by historical and current land management practices. Based on the BEHI, NBS and BER data collected by the assessment team and quantified by Rick Smith, the 5.5 mile assessment reach of the Middle Ponil has a sediment contribution load of 7,068 tons per year from unstable stream banks. This calculation does not add in the other sediment contributions created by the effects of fire, roads, grazing, livestock corrals, and other human activities. Given the results of the stream bank erosion data, coupled with the historic and present land management practices, the overall system would be rated on the average <u>in moderately stable condition with a moderate upward trend line in some areas and a downward trend in other areas.</u>

Stabilization and Restoration Opportunities:

Restoration Goal:

Reverse the current downward ecosystem trend to an upward trend. Once the trend is reversed, natural recovery processes can and will take hold and propel the trend further upward toward watershed system stability. It is our collective responsibility to set in place the mechanisms and management practices that will trigger this trend reversal.

Restoration Practitioner's Guiding Principal: **Do the easiest first!!!**
At first glance, this may sound too simplistic. However, when we look at watershed function and trend analysis, generally there are a couple of actions that can be taken that are easy and cost effective and will create immediate results that will help start the reversal of downward trends.

So using the "do the easiest first" rule, we will lay out the priorities for restoration on the Middle Ponil.

Restoration Priority #1, Equine Corral:
The proximity of this facility to the stream channel and its obvious effects on sediment contribution and riparian vegetation make it an easy fix. The restoration plan would include a new corral fence to keep livestock out of the riparian/stream channel area as well as constructing an earthen berm along stream left to contain the corral run off. This area has a sand and gravel substraight with a high infiltration factor, so ponding of water in the corral should not be an issue. The stream channel riparian area would be replanted with willows, alders, cottonwoods and native grasses by a Scout Crew. There are also opportunities to stabilize this reach of stream channel by installing One Rock Dams and possibly an opportunity to do some Induced Meandering work.

Cost: Earthen Berm, $1,500.00. Fencing: $3,000.00. Re-vegetation, $00.00: Scout Crew. Return on Investment: Clean water, reduction of sediment and livestock waste, a restored reach of riparian vegetation, a learning opportunity for Scouts and a good land management practices demonstrated by the land owner as well as a good restoration demonstration site in the midst of the Ponil Scout Camp.

Restoration Priority #2, Road Drainage:
Install a road drainage system first along the Middle Ponil stream corridor. Install a properly designed and properly constructed Rolling Dip Road Surface Cross Drain System. Cost: Design and Implementation, $20,000.00 (from Ponil Camp to the western boundary of the Barker WMA). Return on this investment is a reduction of erosion and sediment contribution to the stream system and increased forage due to road water harvesting. Stitch the micro watershed back together for proper surface hydrological function which has been interrupted by the road. Place the road drainage in the appropriate locations to achieve this goal. Proper drainage will create significant reduction of road surface erosion which in turn reduces the need for costly repeated road maintance and reduces vehicle maintance cost due to better road conditions. This is the same for the uplands/mountain road system at a cost of +/- $4,100.00 per mile for design and implementation. The greatest return on investment is the reduction in the need for annual road maintenance. By properly draining a low standard dirt road the need and cost of maintenance can be reduced by 90%, which is a significant cost savings.

Some road drainage work as been installed in this area; however, it is somewhat anemic and will need to be better designed and re-worked. The stream channel crossings have been stabilized except for one crossing in the Ponil Scout Camp on the South Ponil Road. This crossing will need a boulder sill on the downstream end and a cobble fill crossing installed.

Cost of South Ponil Road crossing: $5,000.00

Restoration Priority #3, Middle Ponil Stream Channel Stabilization:
The assessment team along with others in this field have developed a restoration system know as "Cut and Paste". The system has been tested at numerous locations in a variety of channel types and situations. As previously stated in this report, this system suffers from sediment overload which is created by a compilation of the previously stated history and situations. The sediment overload creates over wide and high, steeply sloped point bars, overlong meander bends with tight radiuses, which increase the NBS and causes erosion of the opposite bank. This system sets up an insidious chain reaction by the acceleration of the stream bank erosion. As more sediment enters the system it is then deposited on the next point bar and the process is repeated over and over again along the entire stream system. The other consequence of this type of bank erosion process is the creation of downstream meander scrolling caused by the overlong meander bends and sharp radiuses. This meander down scrolling can lead to a meander cutoff which straighten the channel, steepen the slope and create a head cut that migrates upstream. There are numerous locations on the Middle Ponil that have a high potential for a meander cutoff to occur. The assessment team noted these locations and gave them the highest priority for the restoration work.

To stop this downward trend, the source of sediment must be controlled, i.e., grazing and roads first, then stream bank erosion. If the work does not proceed in this order, then the in-stream work is at risk because of the additional sediment coming off poorly managed rangelands and roads still in the system.

The Cut and Paste system reconfigures the channel morphology at each problem location. The material and vegetation on the enlarged point bars or overlong meanders are removed and placed at the toe of the opposite eroding bank. While doing the cut and paste of these materials, a vegetated bankfull bench is created at the toe of the eroding bank. The pool depth is reduced and the radius of curvature is reduced as the material is removed from the point bar or overlong meander. These geomorphologic modifications change the ratios of the near-bank max depth to the bankfull mean depth, the ratio of radius of curvature to bankfull width as well as changing the width to depth ratio thus reducing the NBS and the stream's power to erode the opposite bank.

The Cut and Paste system uses a small excavator, +/- 20,000 pound, 100hp, and a skilled fluvial geomorphicly trained operator to conduct this work. This is a very cost effective system. Most locations can be worked in 30 to 45 minutes and there is no need for inhauled material such as rocks or logs and the associated cost of the installation of vane structures. If trees that can be harvested are readily available on site, a “Toe Wood” system can be added to the cut a paste system. Toe Wood is especially useful to fill in deep pools and can create very beneficial fish habitat. The application of Toe Wood in the Barker Reach is very feasible and cost effective due to the number of dead fire trees and other live trees that could be used for this application.

The value of the investment in bank erosion control is first seen in the reduction of sediment for improved water quality. Other benefits are; arresting the potential of meander cutoffs, improved fisheries habit, especially when the work includes a Toe Wood system as well as the increase in wetland due to ox pond being created when an overlong meander is reconfigured. The skill and art of this work is to maximize the ecological benefits in the process of achieving the main goal, i.e., bank stabilization and sediment contribution control.

Cost: +/- $175.00 per location Cut and Paste only.
+/-$550.00 per location for Cut and Paste with a Toe Wood system.
Average cost for budgeting proposes: +/- $375.00 per location each.

There is need for Cross Vane type grade control structures throughout the Middle Ponil assessment area. The assessment team recommends the use of logs for theses structures due to the abundant availability of timber and fire trees next to the stream channel. There are also opportunities to use logs to create bank full benches. Rocks and boulders would be used for these types of structures and /or in conjunction with logs if they are really available on site. The proposed use of local on site materials greatly reduces the cost of these structures compared to using inhauled materials. <u>The value of locally harvested materials hopefully could be used for a project match.</u>

Cost Log and Rock Bankfull benches; $250.00 each

Cost for grade control structures; $4,500.00 each

On the Middle Ponil just upstream from the confluence with Bonita Creek there is a 600 foot +/- reach of degraded stream channel that while require a Rosgen priority #1 channel relocation and grade control structures.

The cost for this channel relocation project would be +/- $40,000.00

<u>Other Stream Channel Restoration Practices:</u>
The assessment team notes numerous locations along the Middle Ponil that hand work could be conducted by Scout Crews. This hand work would include planting willows to stabilize banks, construction of rock or log bankfull benches, installing One Rock Dams, removing mid-channel and transverse bars. Other hand work would be the treatments on terrace headcuts and installation of Media Lunas to re-spread water over the existing alluvial fans.

Cost: $00.00, a good source of in-kind work.

<u>Other Restoration Opportunities: Alluvial Fans:</u>

The general valley type is a valley Type III, alluvial fans and debris cones with a high relief. Many of the alluvial fans have been truncated by the down cutting of the main channel as well as the main channel being pushed to one side of the valley to make room for farm fields. The fans now have very steep and high slopes at the edge of the stream channel with numerous headcuts. On top of many of the fans the distributory flow patterns have been concentrated into one channel and or bisected by a road. The distributory flow patterns should be reestablished on these fans so that the fan system can sequester as much sediment as possible before the water enters the stream channel. This can be done by re-routing the road to the head of the fan, draining and abandoning the old road and installing hand built rock or log Media Lunas constructed using Scout labor. There are also locations that could quickly be reconfigured using a dozer to re-route the flow path in conjunction with the road re-route.

Cost: Scouts Labor $00.00. Dozer cost low if done when dozer is in the area doing road work. +/- 800.00 per fan.

References:

Watershed Assessment Practices can be reviewed in:

Evaluating the Bank Erodibility Hazard Index In New Mexico, Wilbert Odem, Ph.D., P.E., 1999

Regional Relationships for Bankfull Stage in Natural Channels of the Arid Southwest, Tom Moody, PE, 2003

Watershed Assessment of River Stability and Sediment Supply (WARSSS), Second Addition, Dave Rosgen 2009

A Good Road Lies Easy on the Land…. Water Harvesting From Low-Standard Rural Roads Second Addition, Bill Zeedyk 2010