WATERSHED RESTORATION ACTION STRATEGY (WRAS)

for the

COMANCHE CREEK WATERSHED

View East across Comanche Creek from Fernandez Canyon

Prepared by

The Quivira Coalition

September 2005

(Original June 2003)

TABLE OF CONTENTS

INTRODUCTION

The Federal Clean Water Action Plan (CWAP) of 1998 was developed to help meet the goals of the Clean Water Act through state-led cooperative efforts. These efforts attempt to identify and prioritize watersheds with water quality concerns. A New Mexico Unified Watershed Assessment (1998) was conducted by a statewide task force in response to the actions mandated in the CWAP. New Mexico's Unified Watershed Assessment identified 21 out of New Mexico's 83 watersheds as "in need of restoration" (Category 1). Comanche Creek is within a designated Category 1 watershed - the Upper Rio Grande.

This Watershed Restoration Action Strategy (WRAS) for the Comanche Creek subwatershed focuses on restoring and protecting water quality that is currently impaired by high temperatures, heavy stream bottom deposits, and metals. The WRAS is a required product for incremental funding, under the 1999 Guidance for Clean Water Act (CWA) section 319 Program, and has been developed for a variety of planning, reporting, and funding purposes. The structure and content of this WRAS draws from previous Watershed Restoration Action Strategies (WRASs) developed for other watersheds in New Mexico, in particular the Rio Puerco Watershed Restoration Action Strategy.

The ultimate goals of this plan are to improve the condition of the Comanche Creek watershed to meet current water quality standards and to restore normal hydrologic function to Comanche Creek and its tributaries. The benefits of meeting these goals are numerous and include the primary objective of improving habitat for the Rio Grande cutthroat trout (RGCT). Secondary objectives include improving riparian habitat for other native fish and aquatic species; improved habitat for terrestrial wildlife; providing the foundations for sustainable economic use; and creating enhanced recreational opportunities for people in local communities as well as visitors to the area.

Restoration efforts on Comanche Creek have a very high likelihood of success. Many of the administrative, social, and ecological elements needed to accomplish the goals outlined in this document are already in place. Comanche Creek is entirely within the Valle Vidal Management Unit of Carson National Forest. It is under the management of a single Federal Agency (USDA Forest Service) and is protected from future development. Both the primary and secondary objectives mentioned above are consistent with current Forest Service management objectives for the Valle Vidal Management Unit. An active and collaborative stakeholder group is already working to support and create positive change on the ground. Most indicators of stream, riparian, and upland health are on upward trends due to changes in management that occurred when the Forest Service gained ownership and began restoration efforts. The upper reaches of the creek already support a population of Rio Grande cutthroat trout and habitat indicators are improving along the watercourse. For these reasons Comanche Creek has excellent potential to become a thriving high quality cold water fishery and healthy watershed.

WRAS Development

Development of this WRAS included input from the following agencies and organizations:

- USDA Forest Service
- The Quivira Coalition
- Bionomics Southwest
- Trout Unlimited – Truchas Chapter
- New Mexico Trout
- New Mexico State Highway and Transportation Department
- New Mexico Environment Department
- New Mexico Department of Game and Fish
- U.S. Environmental Protection Agency

Together, this group developed the following goal statement for the restoration of Comanche Creek.

The goal of the stakeholders in the working group is to cooperate and collaborate on restoring and securing native Rio Grande cutthroat trout populations and their associated fish and benthic assemblages within the Comanche Creek watershed. This includes:

- improving stream, riparian and upland habitat conditions, including water quality;
- managing the watershed as a whole;
- providing opportunities to educate the public about the importance of the watershed, its native trout populations and associated aquatic and wildlife assemblages; and, if successful…
- serve as a demonstration forum showcasing the type of multiple use management practices that are effective in restoring and maintaining wild trout populations on public lands.

The lessons learned through this effort will be shared so that they might be applied in adjacent or similar watersheds.

Other current cooperating stakeholders include the Valle Vidal Grazing Association, Amigos Bravos, NM Wilderness Alliance, the Albuquerque Wildlife Federation, The Valle Vidal Coalition, Rocky Mountain Youth Corp, Boy Scouts of America, the Taos Soil and Water Conservation District, Zeedyk Ecological Consulting, Rangeland Hands, and Resource Management Services. It is hoped and expected that the list of cooperating stakeholders will increase as restoration projects continue and outreach efforts inform others of activities on Comanche Creek. While this WRAS defines many of the types of activities that need to be undertaken to restore Comanche Creek to a high quality cold water fishery, we expect this plan to evolve over time based on input from the many participants and from actually implementing measures on the ground. The collaborative identification of watershed management goals and management opportunities have lead to the development of a WRAS for the larger Rio Costilla Watershed and will possibly lead to participation in a larger watershed coalition.

This WRAS contains the following:

- A description of the Comanche Creek watershed and its tributaries;
- The specific water quality problems to be addressed, and the sources of impairment;
- A discussion of previous and current restoration activities in the watershed;
- The public outreach plan and the methods that will be used to engage and maintain involvement by local residents, visitors, recreationists, and local, state, and federal governments;
- Monitoring and evaluation activities based on water quality Total Maximum Daily Load (TMDL) reductions and other goals and assessment of progress towards meeting these goals;
- A strategy for implementing impairment remediation and natural resource restoration activities;
- A schedule for implementation of these restoration activities; and
- Funding needs to support the implementation and maintenance of restoration measures.

WATERSHED SETTING

Comanche Creek is located within the Sangre de Cristo Land Grant in the Sangre de Cristo Mountains of north central New Mexico (Map A). Comanche Creek is a tributary to Rio Costilla within the Upper Rio Grande watershed (USGS Hydrologic Unit Code 13020101015). Comanche Creek contributes 27,430 acres or 43 square miles to the Costilla Watershed (Pittenger 2002). The headwaters of Comanche Creek lie at an elevation of roughly 10,400 feet. It flows north for 11.80 miles to empty into the Rio Costilla at an elevation of 8,940 feet. Spring runoff constitutes the peak flow of Comanche Creek, which usually occurs in May and June. The fall and winter months see the creek at its lowest (Pittenger 2002). Comanche Creek discharged 5.4 cubic feet per second in May 2000, 1.6 cubic feet per second in July, and 1.4 in October (NMED 2000a).

Comanche Creek has several perennial tributaries along its length (see Map B – Appendix 1). On its west side (river left) beginning at the Comanche Creek headwaters, the named tributaries are: Foreman Creek, La Belle Creek, Gold Creek, Chuckwagon Creek, and Fernandez Creek. On the east (river right) beginning at the headwaters, the named tributaries are Vidal Creek, Grassy Creek, Holman Creek, Springwagon Creek, and Little Costilla Creek. For the purposes of the following discussions Comanche Creek can be divided into a lower reach – from the confluence with Rio Costilla to Little Costilla Creek; a middle reach – from the confluence with Little Costilla Creek to Grassy Creek; the upper reach, or the box canyon – from the confluence with Grassy Creek to the headwaters above Foreman Creek. Individual projects mentioned in this WRAS may define reaches differently based on the location and nature of their work.

Land Use History

Pennzoil donated 100,000 acres of its Vermejo Park Ranch property to the USDA Forest Service in 1982 and the entire Comanche Creek watershed lies within the Valle Vidal Management Unit of Carson National Forest. The area has a long history of grazing, mining, and logging. These activities left the uplands, Comanche Creek, and its tributaries in a highly degraded state.

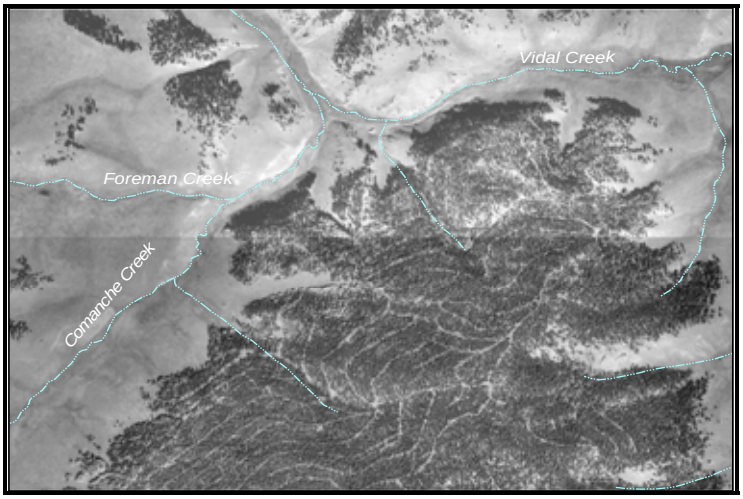
Grazing

Approximately 3,000 steers were grazing on the Valle Vidal portion of the Vermejo Park Ranch when it was donated to the Forest Service. During the early 19th century, the area was heavily grazed by sheep. The actual numbers are unknown but are speculated to have exceeded 1,500 head. The combined impact of intensive, unregulated grazing of moderate to steep slopes by sheep, and of gentle to moderate slopes and riparian bottoms by cattle, easily could have resulted in the geomorphological stream channel instabilities we see today. Past grazing use occurred from early spring to late fall for most grasses. Cattle were probably left in the watershed from first greenup in early May until October. Much of the denuding of vegetation in riparian areas and streambank destabilization can be attributed to this minimally managed livestock grazing. When the Forest Service assumed management of the area, domestic livestock grazing was suspended for two years and a new stocking rate was established to allow for recovery of the vegetation base that had historically been abused - the Forest Service purposely under stocked the allotment. The Valle Vidal Grazing Association is currently following an annual rest-rotation pasture herding operation under an allotment management plan in place since 1984. The cattle spend May through July on the East Side of the Valle Vidal and then come into the Comanche Watershed pastures in August. Cattle finish in the Valle Vidal unit and are moved to home pastures by the end of October. Under this controlled grazing plan the cattle are moved within the watershed throughout the summer. This change in management has improved upland conditions (from pre 1984 conditions) and in some drainages, and has decreased negative impacts to streambanks. Improvements in the health of the overall vegetative condition of the Comanche Creek watershed have even allowed for minor increases in the initial stocking rate of the allotment. The current herding plan needs to be "tweaked" to coordinate with current restoration efforts and to maximize wet meadow, riparian and associated trout habitat stream channel recovery.

Logging

The Vermejo Park Ranch property was also heavily logged using a method called jammer logging. This method uses a cable and winch system to drag or skid logs uphill to a collection and loading area (Stokes et al 1989:16). Jammer cables have a reach of only 100 to 300 feet, so jammer logging requires the construction of closely spaced roads or terraces. **This method put a new road every 150 feet up many hillsides.** These road networks are clearly visible in aerial photos today (Figure 1).

Figure 1. Roads from jammer logging near the confluences of Comanche Creek with Forman and Vidal Creeks. DOQQs from the late 1990s are courtesy of USFS Carson National Forest. The line across the middle of the picture is the join between two aerial photographs.



Logging in the watershed continued into the late twentieth century. Road construction associated with logging created numerous small and large cuts and fills. Many of these roads remain unstable with sparse natural vegetation recovery. The condition of these areas ranges from at-risk for severe erosion to severely eroded. In addition, culverts have been installed in numerous locations within Comanche Creek itself and in some instances contribute to erosion and sediment loading in Comanche Creek. A sawmill was located in the Chuckwagon and Fernandez catchments. These areas appear to be major contributors of sediment.

Mining

Placer gold deposits were discovered in La Belle Creek in 1870 (USFS 1983) and the mining town of La Belle grew up around the mine site (Figures 2 and 3). Mining in the area continued into the late 1800s. Placer deposits are basically gravels containing gold particles. Placer mining exploits river and stream bottom deposits using pans, rockers, and sluices, and often involved diversion of the stream from its original channel.

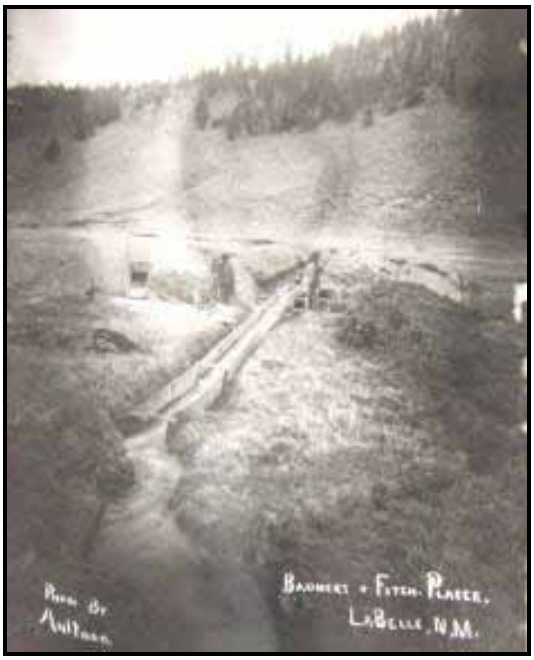


Figure 2. Mine and Sluice on La Belle Creek, circa 1890s (photo courtesy Carson National Forest).

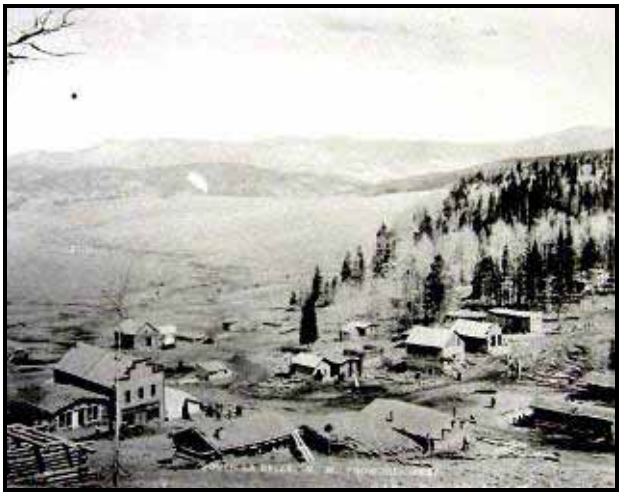


Figure 3. La Belle, NM circa 1898 (photo courtesy Carson National Forest).

Since 1982

Since acquiring the property the Forest Service has placed special management emphasis "on providing a diverse and high quality wildlife and fisheries resource…" (USFS 1982:3). Wildlife is the primary management objective on the Valle Vidal Management unit, but Forest Service multiple-use mandates also provide for the secondary land uses of grazing and recreation. Recreation use occurs in the form of camping, horseback riding, hunting, fishing, hiking, picnicking, and wildlife viewing. Over the past 20 years the Forest Service has made great strides toward returning the watershed to a functioning condition through the activities described below.

SECTION 1: DEFINING SPECIFIC WATER QUALITY PROBLEMS

The current condition of Comanche Creek and its tributaries is clearly a product of past human land use within the watershed. Since 1982, when acquired by the USFS, the health of the area has been on an upward trend.

Water Quality

Comanche Creek has been monitored as part of the TMDL process for exceedences of New Mexico water quality standards. The TMDL process can be described as "determining and planning a watershed or basin-wide budget for pollutant influx to a watercourse" New Mexico Environment Department - Surface Water Quality Bureau web site, (NMED-SWQB) http://www.nmenv.state.nm.us/swqb). The TMDL process has identified exceedences of temperature standards in Comanche Creek. Stream bottom deposits have been observed as potential future threats to water quality.

Temperature

Thermograph measuring at the same two stations between May and October of 2002 showed temperatures as high as 27.1 degrees Celsius. This exceeds the 20 degrees Celsius (68 degrees Fahrenheit) standard for the state of New Mexico. It is much higher than the 17.8 degrees C (64 degrees F) defined by the USFS as the upper threshold for properly functioning habitat for the Rio Grande cutthroat trout (2001). The most current temperature monitoring data on Comanche Creek can be found in the New Mexico Department of Game and Fish DRAFT Report: Interpreting Temperature Data for Little Costilla Creek, Comanche Creek, Vidal Creek, Chuckwagon Creek, North Ponil Creek, Costilla Creek, and McCrystal Creek of the Valle Vidal. This report can be found as part of this document in ***Appendix 2***. Data for 2005 is currently being collected.

Stream Bottom Deposits (SBD)

The lower reach of Comanche Creek, from the Rio Costilla to Little Costilla Creek (Map B – Appendix 1), was on the State of New Mexico 303d list (2000-2002) for exceedence of Aluminum and stream bottom deposits. Non-point source contributions were associated with these exceedences. Eight samples for water chemistry taken three times from May – October 2000 by NMED/SWQB at each of two stations, one at the mouth of Comanche Creek, and one in the lower reach, showed no exceedence of Aluminum. Benthic macroinvertebrate and geomorphological data taken May – October 2000 by NMED/SWQB showed no exceedence for stream bottom deposits. Impacts were observed in both these indicators, however, that warrant close attention during future surveys. This suggests that though these elements of water quality

in Comanche Creek might have recently improved, they are not stable. Continued monitoring will determine if this data is anomalous, or the beginning of an upward trend.

Contributing factors

Substrate analyses conducted on Comanche Creek by NMED/SWQB in the 1990s recorded a high frequency of small particle size classes (NMED 1996). Investigation into the origin of these fine sediments found them to come from the following sources (NMED 1996:29-30):

1 Hillslopes with unconsolidated soils showing rivulets that contact the stream channel.
2 Destabilization of stream banks in lower, middle and upper reaches.
3 Cattle and Elk graze annually throughout the Comanche Creek basin.
4 Tributaries to Comanche Creek which all transport fine sediment.
5 Road-cuts and road-banks that have unconsolidated soils.
6 Culverts and bridges that alter flow and increase erosion.
7 Roads without waterbars which allows fine sediment to be transported down the road surface
8 Headcutting in Comanche Creek and tributaries that increase erosion and sediment deposition in the creek.

Streambank stability, geomorphology, and cover problems relate to wildlife use (elk), livestock grazing, and human land use and development.

Geomorphology

Comanche Creek is classified as a Rosgen E4 type channel. This means Comanche Creek is a single-thread channel that is slightly entrenched with a width:depth ratio less than twelve and a high sinuosity (>1.5), with a slope range less than 0.02 percent and gravel channel material (from www.wildlandhydrology.com, April 2003.) Although Comanche Creek is showing clear signs of recovery since USDA Forest Service acquisition, the stream channel itself is still unstable and eroding, contributing sediment to the stream itself. Some of this instability may be due to the loss of willows, and/or streamside wetland plant species, some may be due to the natural movements (meanders) of the creek to find a new equilibrium.

Roads

Under Forest Service management approximately ~300 miles of road have been closed in the Valle Vidal since 1982. Approximately 42 miles remain open for public access and approximately 100 miles of road have had no work done to them in 15 years. Many of the closed roads have revegetated naturally (see Figure 4) and are stable, but some are still major contributors of sediment to Comanche Creek.

Figure 4. Road cut beginning to revegetate.

Vegetation Loss

Lack of streambank vegetation has been proven to dramatically increase water temperatures in streams. Vegetation removal in both upland and riparian areas can be attributed to long-term grazing pressure by both wildlife and domestic livestock.

Effects on values

Wildlife

Beaver: Abandoned beaver dams are found in the headwaters of Comanche Creek and associated tributaries. The establishment of woody plant species such as willow is possible and could contribute to the establishment of beaver in the main channel of Comanche Creek. Establishment of beaver would greatly accelerate the recovery of the Comanche Creek stream trout and riparian habitats.

Trout: The Rio Grande cutthroat trout (*Oncorhynchus clarki virginalis* – Figure 5) is the State Fish of New Mexico and once occupied nearly all mountain streams over 5,500 feet elevation in northern and central New Mexico (**www.truchas-tu.org,** March 2003). The species is now only found in isolated tributary streams, its numbers gravely reduced by habitat degradation, predation from exotic fish, and inter-breeding with other species.

Figure 5. Cutthroat trout (photo courtesy Frank Weissbarth, from www.truchas-tu.org).

These small, isolated populations are subject to genetic inbreeding, and cannot constitute a genetic "bank" able to repopulate larger watersheds following catastrophes such as wild fires or floods. Because the Rio Grande cutthroat trout evolved as part of the ecosystem of Northern New Mexico, its recovery is important to the creation and maintenance of a resilient and responsive native ecosystem in the Comanche Creek watershed. Rio Grande cutthroat trout predominate in the upper reaches of the Comanche Creek watershed, while most trout in the lower reaches appear to be a cross of Rainbow Trout (*Oncorhynchus mykiss*) with Rio Grande Cutthroat. A 2001 population survey by NMGF in Comanche Creek proper shows lower overall trout numbers in the middle reach than in either the upper or lower reaches. High stream temperatures are a major contributor to degraded habitat for the Rio Grande cutthroat trout. Recent temperature data collected by the USFS show that stream temperatures are acceptable in the box canyon of the upper reach, but worsen as the creek leaves the canyon and enters the open meadow areas of the middle reach where there is more direct sun exposure.

Elk: Hunting and observation of elk provide unique and compelling recreational opportunities for local communities and visitors alike. The upper portion of the Rio Costilla watershed is home to one of the larger elk populations in New Mexico. Last surveyed by NM Game and Fish in 2000, the herd is number close to 2,500 individuals. The population structure shows 35 bulls per hundred cows, and 47 juveniles per hundred cows. The herd has increased slightly in population over the last several surveys. These elk range across the Comanche Creek watershed throughout calving season and the summer months, but spend most winters on the eastern side of the mountains (Michael Catanach, NMG&F, personal communication, 2003). Grazing and browsing of riparian vegetation along Comanche Creek by elk, in addition to that by cattle, may contribute to TMDL exceedences of temperature and geomorphological instability, but the differences, if any, in the two species' impacts are not yet clear.

Resource Use

The Forest has made a specific allocation of resources to different resource values in the Valle Vidal. These are: 15-18% for cattle, 20% elk, and 60% watershed values. Monitoring in the early 80s showed 20-25% of resources going to elk and cattle based on visual observations.

SECTION 2: RESTORATION WORK IN THE COMANCHE CREEK WATERSHED

There have been a variety of efforts to stabilize and improve habitat along Comanche Creek and they have resulted in mixed levels of success. Revetment structures and small wood and rock in-stream habitat structures installed in the mid to late 1980s (see Figure 6) failed rapidly. Failure most likely was due to improper design, placement, and construction relative to channel characteristics, and the inability to withstand heavy stream flows during spring and summer rain events.

Figure 6. Revetment structure in Comanche Ccreek built in the late 1980s.

Cattle exclosures and separate elk/cattle exclosures constructed in the 1980s and 1990s were effective, but are now in need of repair or replacement. Three large exclosures were constructed in the mid-1980s that together enclose roughly 85 acres. Only the large exclosure (on the west side of Gold Creek in the middle reach) is in a semi-functional state. During a September 2005 visual assessment, the south-east corner was down and the gate is low enough to allow for elk use. Evidence of recent use by both elk and cattle were observed inside the exclosure (Figures 7, 8, and 9). With improvements in replacement materials and sustained maintenance these exclosures will become more effective at vegetation regeneration. The other two exclosures (close to the intersection of Little Costilla drainage) are completely non-functional and it may prove worth while to remove the old fencing materials.

Figure 7. Pipe gate on large exclosure – this gate is too low to effectively exclude elk. Figure 8. South-east corner of fence is down allowing for cattle and elk access. Photos taken September 2005.

Figure 9. Overgrazed and trampled vegetation shows evidence of use by elk and or cattle inside the large Gold Creek exclosure, September 2005.

In 1991 the New Mexico Environment Department and Carson National Forest cooperated in using a CWA section 319(h) grant from the U.S. EPA to stabilize erosion along Comanche Creek (NMED 1996). Because large exclosures may interfere with the natural migration patterns of the elk, and elk are less likely to jump into a smaller/confined space, five small, "point-bar" exclosures installed in 1994 remain in place and have been successful at propagating woody vegetation, especially willows. Efforts to plant cottonwood poles have had little success. However, small exclosures constructed to protect existing willow plants provided a safe haven for the natural regeneration and establishment of cottonwoods and willows in the lower reach of Comanche Creek (Figure 10). Numerous cottonwood and willow volunteers have sprouted and survived within these exclosures. During the May 2005 high water event, these exclosures held up well and only required minor repairs.

Figure 10. Woody riparian vegetation growing within a mini cattle/elk exclosure built in the 1990s (photo taken August 2002)

In 2001 a CWA section 319 (h) grant from the EPA was awarded by NMED-SWQB to The Quivira Coalition entitled: **Comanche and Cordova Creeks Watershed Restoration Action Strategy, Education, and Restoration (FY-01Q).** In August and September of 2002 work on mini-exclsoures in the Comanche Creek main drainage began. In 2003 & 2004 upland erosion control treatments in contributing tributaries were installed. Initially, six demonstration vanes were installed during two educational workshops. Additional vanes were constructed in 2005 after the CWA section 404 permit was approved. Additional vanes will be constructed with completion by 2006 in the lower reach of Comanche Creek. In 2004 a second CWA section 319 (h) grant was awarded to The Quivira Coalition entitled, **Comanche Creek Watershed Restoration Project—Restoring Habitat for the Rio Grande Cutthroat Trout, Part 2**, to continue restoration work in the Comanche Creek Watershed.

A total of fifty-two mini-exclosures have been or will be constructed along the lower reach of Comanche**.** Due to a high water event (spring snow melt) in May of 2005, most of the mini-exclosures built from 2001-2004, were damaged or down. New specifications for building these exclosures were developed and various volunteer groups came out in record numbers to help repair or build new structures. There are currently forty-seven functional mini-exclosures along the lower reach of Comanche with five more to be built or repaired in 2006 and one mini-exclosure to be removed.

Figure 11. A Rock Baffle on Comanche Point Gully, installed September 2003.

Sedimentation within the Comanche Creek channel is controlled using instream treatments like vanes and rock plugs, and upland erosion control treatments in contributing tributaries.

Upland erosion control treatments installed along side drainages of Comanche creek are designed to slow the movement of water, collect soil, nourish vegetation and prevent sediment from entering the creek. Examples include One Rock Dams, Rock Baffles, Rock Bowls, Worm Ditches and a Log and Fabric Headcut Control Structures (Figures 11-12). In 2002-2003 171 erosion control structures were installed during on-the-ground educational workshops using volunteer labor.

Figure 12. A log and fabric structure installed in the Holman Creek wet meadow, September 2003.

Figure 13. Three Vanes installed along an eroding bank during a 2004 work shop (Photo taken September 2005)

Instream treatments consist primarily of vanes and rock plugs. Vanes are wooden posts or rock structures installed at strategic locations in Comanche Creek to direct stream flow left or right, away from eroding banks to reduce sediment production and promote streambank vegetative growth. (Figure 13). Fifty-six vanes will be installed along the lower reach. There are currently seventeen vanes along eroding banks of the lower reach and thirty-nine are

scheduled to be installed in 2006. One rock plug was installed in 2005 to move an eroding bank away from FS Road 1950.

Road surveys and treatments. In 2003, fifty miles of old logging roads and administrative roadways in the watersheds of Fernandez, Chuckwagon, Gold, Labelle, Little Costilla, Springwagon, Holman, Grassy and several intermingled, unnamed watersheds was inventoried. A Road Inventory Report by Bill Zeedyk (***Appendix 12***) determined that about 9 miles of roadways need erosion control treatment using heavy equipment and about 2 miles can be maintained using hand tools. The remaining forty miles need no follow-up treatment for erosion control purposes, or indicated sites are so scattered or marginal that cost of further treatment is not warranted. The most severely eroding roadways are in the Little Costilla, Chuckwagon, Holman and Gold Creek watersheds, although not all roadways in these drainages require treatment. Roadways in the Grassy Creek, Fernandez and Springwagon watersheds need no follow-up work at this time. Eight stream crossings (culverts) at inventoried sites were identified to be removed and replaced by low-water crossings to correct or avoid serious damage to the channel or floodplain. Treatment will require removing culvert pipes, excavating embankment material from channel and floodplain, stabilizing and vegetating dredged materials, installing rock low-water crossings and in some cases other incidental treatments. Failure to do so will result in downcutting and erosion of the stream channel and streambanks, and headcutting all contributing to chronic sources of sedimentation and turbidity. Needed culvert extractions include four sites on Chuckwagon, two on Little Costilla, one on Gold and perhaps one on Fernandez. As a result of the road inventory report, during July – September 2004, 11.7 miles of road were rehabilitated to reduce sediment sources in the watershed with the following treatments implemented.

Figure 15. Rolling waterbars installed on an old road to the east of Gold Creek, September 2004.

- *0.2 mi. road completely restored to natural contours;*
- *1 stream crossing rehabilitated to restore natural floodplain banks and decrease sediment from FS Administrative use road;*
- *5.2 miles (approx.) stabilized with rolling grade dips & waterbars;*
- *2 culverts removed that were affecting the stream channel;*
- *1 culvert plugged - not needed for road drainage and better handled; surface flows with a grade dip;*
- *2 culverts functionality improved with install of associated grade dips;*
- *Holman Creek (old timber sale access road) 1.3 miles (approx.) stabilized with rolling grade dips & waterbars;*
- *Gold Creek 1.8 miles (approx.) stabilized with rolling grade dips & waterbars. (Figure 15); Chuckwagon Canyon 3.4 miles (approx.) stabilized with rolling grade dips & waterbars; and 1.0 miles road completely restored to natural contours.*

In 2005, Bill Zeedyk completed a second road survey for the upper reaches of the Comanche Creek watershed (***Appendix 12***). Those treatments are scheduled for implementation in 2006-2007.

SECTION 3: PUBLIC OUTREACH AND INVOLVEMENT PLAN

The goal of the public involvement process is to ensure a multifaceted, proactive and responsive interaction among the working group, the public, and resource agencies. Restoration of Comanche Creek continues the efforts of a number of organizations including the Carson National Forest, New Mexico Trout, Trout Unlimited, and the State Department of Game and Fish, for restoration of habitat for the Rio Grande cutthroat trout and other native fish species, and the New Mexico Environment Department (NMED) for riparian restoration.

There are three segments of this public outreach plan. The first is outreach, and entails strategies for informing those not already directly involved with the Comanche Creek watershed about the restoration activities taking place. The second is involvement and includes strategies for getting groups and individuals out on the ground or in the meeting room to assist with restoration activities and planning. The third is the transfer of technology, guaranteeing that the lessons learned in the Comanche Creek watershed - the concepts, technology, and methods that worked, and those that didn't work - are transferred to other agencies including non-governmental watershed and stream restoration groups. Efforts will also be included to see that technology, including knowledge, is passed along through time, so that the restoration on Comanche Creek can be maintained and continued past the foreseeable future.

Outreach

The target audiences for outreach are people in surrounding communities, recreationists, and interested parties throughout the region who could easily be considered "stakeholders" with vested interests in the continued health and viability of the Comanche Creek watershed. Outreach efforts will focus on informing individuals and groups, including school children, about stream and watershed restoration in general, with activities in the Comanche Creek watershed as an example. Most of this audience is not expected to become directly involved in restoration activities on Comanche Creek, but can learn about the ecological processes involved with restoration through these materials. However, these outreach tools can also serve as a 'gateway' for those who would like to become directly involved with projects on Comanche Creek or in other watersheds.

Outreach Tools

- Printed Material – flyers, restoration field guides, books, brochures, news releases, articles in media, working group member organization newsletters, to be passed out during volunteer workshops and workweekends
- Posters and other presentations at related professional conferences and other educational events
- Talks by project personnel to interested groups, organizations, Universities and other school groups, and Tribal organizations in Taos and other communities in New Mexico or other regions with similar issues
- Interpretive signs on site for those recreationists who might visit the watershed but not be involved in restoration activities
- Website: www.comanchecreek.org

Involvement

The target audiences for public involvement strategies are those groups and individuals who are interested in and committed to being actively engaged in planning and on-the-ground restoration

activities on Comanche Creek. This includes neighboring landowners, permittees, and all the stakeholders listed as already being active in the restoration of this watershed.

Involvement Tools

- Field Trips – tours of the watershed to present the problems, what has been done in the past and what is currently being done (Figure 16).
- Workshops – learning opportunities related to the techniques and concepts being used in the watershed. These might be classroom based or outdoors and might be combined with field trips or work days.
- Workdays – with or without a specific educational component, workdays provide structured and supported (i.e. lunch and water) opportunities for groups to participate in implementing techniques – building structures, collecting data, etc.

Figure 16. Tour of the Comanche Creek Project, September 2005

- Volunteer Monitoring Program – conducted by project staffs (agency or N.G.O.), will provide training and field experience for those interested in learning how to plan, develop, and implement short and long term monitoring programs.

Technology Transfer

Technology transfer can be achieved through many of the outreach and involvement tools already discussed. It also may require specific, focused workshops, field trips or work days to address specific issues of concern to specialists or other agency personnel, or even employment.

Transfer Tools

- Within-organization employee/volunteer work details – temporary transfers of personnel within the member organizations to a Comanche Creek project or from a Comanche Creek project to other units of their organization, with the hope that physical proximity, face-to-face interaction, and common vocabularies and experiences (organizational culture) will facilitate learning and creativity.
- Between-organization employee/volunteer details – exchange of personnel across agencies within the working group, or from working group member organizations to other organizations involved in watershed restoration.
- Training – focused training of personnel within member organizations of the working group, so they can continue, improve, and disseminate the ideas and methods used on Comanche Creek.

Figure 17. Horseback Field Trip, Valle Vidal

Public Outreach and Involvement Activities to Date

To a great extent, the progress currently being made on Comanche Creek is the result of outreach and collaborative efforts by involved stakeholders and those groups currently active in the working group. In 2001, New Mexico Trout asked The Quivira Coalition

to facilitate a discussion of the impacts of grazing on the fish habitat with the Valle Vidal Grazing Association. As a result, Quivira organized a field trip in late summer 2001 to the area with NM Trout, Amigos Bravos, the Valle Vidal Grazing Association, and the Forest Service to determine the best way to proceed (Figure 17).

The Quivira Coalition (see www.quiviracoalition.org) has organized and hosted three workshops/tours on riparian restoration and erosion control within the Comanche Creek Watershed (August 3-4, 2002, September 12-13, 2003, July 30-31, 2004, July 16, 2005 and September 16, 2005) and New Mexico Trout and Trout Unlimited – Truchas Chapter has organized and implemented twelve on-the-ground restoration work days since 2002. [The Quivira Coalition has also organized and hosted since 2002, three Riparian Restoration Workshops, eight Rangeland Health workshops and one Conference around NM as part of their 319 Comanche Creek Grant]. Quivira will continue to organize and coordinate a series of educational activities and on-the-ground restoration workshops as part of Comanche Creek outreach efforts that pertain to issues related to Comanche Creek.

Quivira has produced several newsletters on related subjects:

- *Is Long-term Rest the Answer to the Grazing Debate?* May 2002
- *Balancing Weeds and Ranch*, June 2002
- *A Sense of Place: Fishing for Solutions*, September 2002
- *Restoring Natural Systems Through Natural Processes*, October 2003
- *Watershed Management in Nature's Image: About Commitment to and Kinship with a Place*, June 2004
- *Collaboration in Our Backyard: Lessons from Community-Based Collaboration in the West*, April 2005 *(Restoring Comanche Creek article)*
- *Collaborative Science: Making Research a Participatory Endeavor for Solving Environmental Challenges*, August 2005

In addition, The Quivira Coalition in collaboration with the Rio Puerco Management Committee, Earth Works Institute, Zeedyk Ecological Consulting and Resource Management Services have written and published three field guides and one book to be published in October 2005 entitled: ***An Introduction to Induced Meandering: A Method for Restoring Stability to Incised Stream Channels,*** July 2004; ***An Introduction to Erosion Control***, May 2004; and, Rangeland Health and Planned Grazing Field Guide, July, 2004; ***A Good Road Lies Easy on the Land: Water Harvesting from Low Standard Rural Roads,*** October, 2005. These guides are distributed at all workshops, conferences and workdays.

The Quivira Coalition is also in the process of implementing a website, www.comanchecreek.org that will be up on the web by November 15, 2005. This will be an interactive site with information on ***Education and Outreach*** activities, a list off ***Cooperators*** and links to their websites, ***Reports*** related to the Comanche Creek Project, treatment implementation protocols for ***Restoration Practices,*** and reports for upland and riparian ***Monitoring & Maps.***

NMED has presented posters on Comanche Creek activities at related professional meetings throughout the region.

The Truchas Chapter of Trout Unlimited (see www.truchas-tu.org) organized a stream geomorphology workshop in 2002. The Truchas Chapter provides periodic updates on the Comanche Creek restoration work on its web site and in its newsletters. The Truchas Chapter has also included posters on Comanche Creek activities at its general meetings and at sportsmen's conclaves. TU will continue to support the Comanche Creek work and Rio Grande cutthroat trout reintroduction efforts through public outreach activities.

SECTION 4: MONITORING AND EVALUATION

Monitoring and evaluation of the projects undertaken by this WRAS are important elements in adjusting and improving on management strategies based on the performance of implemented Best Management Practices (BMPs). The goal of the assessment and monitoring plan is to develop a long-range monitoring program that achieves two objectives:

- Targeting the implementation of Best Management Practices in areas that have the greatest potential for contributing sediment and other pollutants into Comanche Creek; and

- Tracking trends in reducing sediment loads, decreasing stream temperature, and improving the overall health of the watershed.

Baseline data has been collected on the conditions that contribute to the water quality problems reported in the Total Maximum Daily Load (TMDL) Report. Water quality data have been collected by the New Mexico Environment Department's Surface Water Quality Bureau through the TMDL process. TMDLs are currently being developed for temperature and stream bottom deposits. Biological, geomorphological, and fisheries data are also being collected for Comanche Creek and reference reaches (Midnight Creek and others) by the New Mexico Environment Department.

A Project Quality Assurance Plan (PQAP) was developed and approved in 2003. This PQAP has since been updated to reflect the monitoring and assessment needs for the **Comanche Creek Watershed Restoration Project—Restoring Habitat for the Rio Grande Cutthroat Trout, Part 2 319 grant.** This report is included in the document in ***Appendix 3***.

Monitoring Activities to Date

Early Monitoring Efforts
Two years of data collection were done by the USFS in 1983-84 on the effects of grazing on the Comanche Creek watershed, **Monitoring Effects of Grazing by Cattle and Elk on Wet Meadows and Aspen at Valle Vidal,** (Moir and Williams 1985). A copy of this report is included in this document as ***Appendix 4.***

Upland Conditions
An initial assessment of upland conditions was conducted by The Quivira Coalition with support from the USDA Forest Service in conjunction with CWA 319(h) Project (FY-01Q). The assessment consisted of a one-day horseback trip through the upper Valle Vidal and Comanche Creek watershed followed by a three-day assessment on foot. This assessment followed the

procedures outlined in *Interpreting Indicators of Rangeland Health, Version 3* (Pellant et al. 2000). The **Comanche Creek Preliminary Assessment Report** is included in this document as ***Appendix 5***. This preliminary assessment determined that the majority of uplands are in good condition with clear signs of improvement; however, there are upland areas in need of additional management.

An upland monitoring protocol was implemented by The Quivira Coalition in October 2001 based on the USDA Jornada Experimental Range's Rangeland Monitoring Protocol ("Jornada Protocol"; Herrick et al. 2000). The objectives of the upland monitoring efforts are**:**

- Determining the stability of the watershed associated with Comanche Creek and its tributaries;
- Assessing contributing factors to accelerated erosion with emphasis on closed and open roads and grazing impacts;
- Determining if proposed treatments are effective in slowing erosion to acceptable levels.

Baseline data using the Jornada Protocol have been collected from eleven upland monitoring points. Digital Orthophotographic Quarter Quadrangle (DOQQ) maps were used in conducting the initial assessment and the monitoring. These and Digital Elevation Models (DEMs) serve as the base maps for GIS layers of the monitoring locations (see Map C – Appendix 1) and other information.

Upland monitoring points were chosen according to a monitoring design defined to fit the priorities of the project. The following detailed site data were collected at each of the monitoring sites:

1. Photo points – permanent photo points allow qualitative monitoring of vegetation and landscape changes through time.
2. Line-point intercept for vegetative cover and composition – this is a rapid, objective way of assessing ground cover consisting of vegetation, litter, rocks, and biotic crusts, and involves recording the types of cover encountered at regular points along each monitoring transect.
3. Gap intercept or substitution of measurement to nearest perennial plant – gap intercept measures the proportion of a monitoring transect covered by plant canopy. Spaces greater than 20 centimeters are considered gaps.

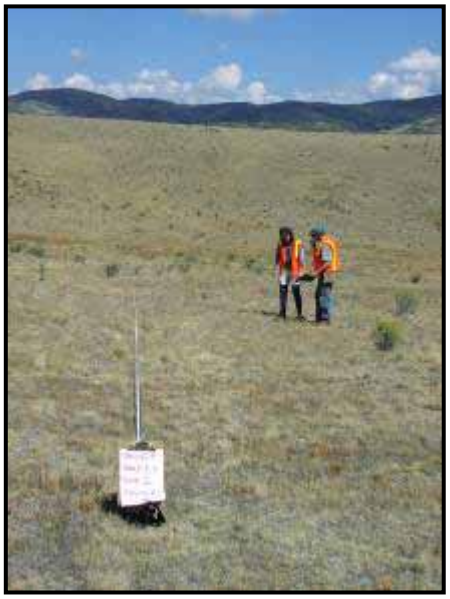


Figure 18. Upland Monitoring Photo Point in Upper Comanche Creek Watershed

The results of this monitoring are included in the Baseline Monitoring Report, **Comanche Creek Baseline Quantitative Uplands Monitoring Report.** These monitoring sites were re-read in September 2005 and the report, **Quantitative Monitoring Report of Upland Range Conditions within the Comanche Creek Watershed.** Both reports are included as part of this document in ***Appendix 6***. This is a comprehensive report comparing data and photos collected in 2001 to that

collected in 2004 and watershed visual observations. Reference photos will continue to be taken annually at each monitoring site (Figure 18).

Geomorphologic and Vegetation Conditions along Comanche Creek

In 2001 Trout Unlimited completed a design for monitoring trout habitat and collected baseline monitoring data (Pittenger 2001, 2002). These studies, **Trout Habitat Monitoring Plan for Comanche Creek,** 2001 ***and*** **Comanche Creek Trout Habitat Monitoring Results*, 2002,*** identified excessive fine sediment, high water temperatures, and lack of adequate pool depth and cover as the major factors limiting Rio Grande cutthroat trout populations in Comanche Creek. Based on these findings the monitoring for trout habitat (separate from trout populations) will focus on measuring three habitat variables: (1) channel cross section; (2) stream bottom deposits; and (3) bank erosion. Three sites in the middle reach of Comanche Creek were recorded in the baseline monitoring for this project. Two sites (Treatment A and Treatment B) are within the cattle/elk exclosure and the cattle exclosure, respectively. The control site, subject to grazing by both cattle and elk, is located between the two treatment sites. These reports are included in ***Appendix 7***. These transects were re-read by Art Vollmer of Truchas Chapter – Trout Unlimited in 2004 and data from 2001 and 2004 are compared in the report, **Comanche Creek Trout Habitat Monitoring Summary Report 2001-2004** and is included as part of this document in ***Appendix 8.***

In June and August, 2005 Cuchilla Blanca Ecology performed baseline monitoring at two sites on Comanche Creek in the Valle Vidal. Both sites were located in areas where Elk exclosures had been built. Rosgen Level II monitoring (cross sections, longitudinal survey) was implemented at both sites. Several "hubs" were set up to accurately monitor the changes in bank location and shape due to the installation of Vanes for bank protection. A hub is several cross-sections arising from the same central point (the hub), unlike typical monitoring cross-sections, they may or may not be located at the "riffle" of the stream.

"Vegetation monitoring was performed at both sites using "Monitoring the Vegetation Resources in Riparian Areas" by Alma H. Woodward, also known as "Greenline Monitoring". Vegetation Cross-Section Composition, Greenline Composition, and Woody Species Regeneration monitoring was implemented at both sites.

Site 1 (Large Exclosure Site) was placed in the large Elk Exclosure on Comanche Creek off of where Forest Road 1950 leaves the Comanche Creek valley. This site is upstream of a tributary called Springwagon Creek, which enters from the right. Site 2 is about 1.2 miles upstream from the confluence of Comanche Creek with the Rio Costilla, and runs through three small Elk exclosures, numbers 43-45 (exclosure numbers may be different after completion of installation of exclosures in 2006)."

Rosgen Level II and Vegetation Monitoring in the Middle and Lower Reaches of Comanche Creek Monitoring, June 2005, report is included in this document in ***Appendix 9.***

Mapping and Photo Documentation

In May 2002 The Quivira Coalition, in association with Resource Management Services, Bionomics Southwest, and Bill Zeedyk, recorded the streambanks along both sides of the lower reach of Comanche Creek with a Trimble XRS GPS unit (submeter accuracy). This work also located willow colonies to be protected with exclosures constructed later that season, and places where future in-stream structures will be constructed. In June 2005, after a high water event,

sites instream structures and willow colonies were identified and mapped and high priorities noted. The location and area of all lower reach exclosures will be re-mapped and numbered in 2006 when the final 5 exclsoures are completed and one removed. A final map of lower reach structures and streambank will be produced once all structures are in place. During the 2005 middle reach assessment, sites for installation of instream structures was mapped and are included in this document in ***Appendix 10.*** All upland drainage erosion control treatments have been mapped and photo documented. These maps are included as part of this document in ***Appendix 11.*** As an adjunct to this effort historical aerial photographs (from the 1970s and 1981 – before transfer of the land to the USFS) were scanned and geo-referenced into a GIS layer. Road Survey Reports and Maps are included as part of this document in ***Appendix 12.***

Water Quality

Water quality will be monitored following the guidelines described in the Quality Assurance Project Plan for Water Quality Management Programs 2002 (NMED 2002). Specific water quality factors to be measured include stream bottom deposits, turbidity, temperature, and stream flow. 2003 and 2004 Thermograph data for 3 sites along Comanche Creek are included in this document in ***Appendix 2***.

Riparian and Fisheries

Fishery and riparian monitoring will be conducted by the New Mexico Environment Department, New Mexico Department of Game and Fish, and the USFS. A monitoring schedule for these elements is being developed based on the type of data collected and the implementation of individual projects.

In a population survey of trout in Comanche Creek performed in 2001, the New Mexico Department of Game and Fish found that the lower reaches of Comanche Creek were dominated by a rainbow/cutthroat trout cross (*Oncorhynchus mykiss/Oncorhynchus clarki*) while Rio Grande cutthroat dominated the upper reaches. This same survey found that the middle reach of Comanche Creek, from Holman Creek downstream to Little Costilla Creek (refer to Map in Appendix 1), had noticeably reduced fish numbers when compared with the lower reach, between Little Costilla Creek and the Rio Costilla (NM Game and Fish 2001). In general, low fish numbers in this middle reach are an indicator of reduced habitat condition there. The report noted that the gradient in the middle reach decreases from upstream, causing water to slow and increase in temperature, and increased sediment (aggradation) was noted along the stream channel in this reach.

It is desirable that all monitoring data be compiled in a GIS system, and that all monitoring information will be stored in a single location. The Quivira Coalition currently maintains a GIS compilation but it does not yet contain data from all members of the Working Group. All reports will eventually be available on the Comanche Creek website: www.comanchecreek.org

SECTION 5: DESIRED WATER QUALITY GOALS AND ACTIONS TO BE TAKEN

The Best Management Practices (BMPs) proposed for the watershed will address non-point sources to significantly reduce pollutant loadings along Comanche Creek and its tributaries, and to reduce water temperature within Comanche Creek itself. These BMPs include revegetating disturbed areas, constructing water bars on slopes and closed roads to direct water to areas where

water will be most beneficial, and restoring the geomorphological character of the creek to improve its stability and provide a high quality cold-water fishery habitat

Current Goals

Four goals apply to efforts to improve water quality in Comanche Creek. The projects implemented under this WRAS will address:

- Sediment reduction through sediment retention;
- Vegetation and habitat improvement, both in uplands and in riparian/wetland areas;
- Restoration of geomorphologic stability; and
- Support and promotion of other watershed factors through public awareness, promoting economic development, and improved resource management.

These goals will be achieved through a variety of specific activities listed below:

- Improved water distribution through the proper grading and drainage of active and abandoned roadways;
- Improved management of cattle currently grazing on the Valle Vidal property;
- Riparian restoration with selective fencing and continued use of a herding grazing management strategy;
- Repair, relocation, removal, or supplementation of culverts to obtain proper water distribution;
- Public workshops on grazing management and erosion control;
- A watershed archive/reference library housed in a single location that contains all reports, plans, photos one copy at least, and other information relevant to management of the Comanche Creek watershed since 1982.

Project Management and Coordination

The Forest Service is the land management agency in Comanche Creek and has final authority on all projects implemented. Actual project implementation has in the past been coordinated by Forest Service personnel. Recently The Quivira Coalition has coordinated efforts funded by their 319 grant, and many projects initiated by member organizations of the Working Group, while the Forest Service coordinates all other activities. Forest Service involvement has been positive, fully participatory and all indications are that the Forest Service will remain a key partner in the full success of restoration of the Comanche Creek watershed. The Forest Service continues to endorse efforts of The Quivira Coalition to coordinate and involve all key Stakeholders in the Comanche Creek watershed and it is expected that the existing relationship with Quivira Coalition and the Working Group will continue.

Completed and Future Actions

Implementation of the restoration plan will continue to focus on the following categories of actions that are necessary to restore water quality and healthy watershed function in the Comanche Creek sub-watershed:

Public Outreach

- Continue to provide technical support for collection and monitoring of riparian and upland habitats.
- Provide coordination support to assist in the planning and implementation of BMPs.

- Provide coordination support to assist in the development and implementation of the Watershed Restoration Action Strategy.
- Support volunteer days.
- Provide professional engineering support for the development and implementation of BMPs.
- Develop education materials.

Implementation of Best Management Practices

- Implement upland erosion control, wet meadow and riparian restoration treatments.
- Perform earthwork, including road maintenance or re-contouring, construction of appropriate erosion control structures to stabilize cut and fill slopes where appropriate, and reconstruction, removal or supplementation of culverts where they have failed or are causing additional erosion problems.
- Construct sedimentation traps and apply slope stabilization methods on cutbanks
- Implement stream restoration/stabilization projects.
- Construct exclosures within Comanche Creek and other grazed areas to improve the vegetation condition in riparian habitats.
- Work with the Valle Vidal Grazing Association to modify a grazing management plan that minimizes impacts to riparian, wetland, and wet meadow vegetation.
- Design and construct an in-channel fish barrier along Comanche Creek.
- Construct erosion control structures in cut and fill areas along roadways.
- Implement additional fisheries management to maximize habitat opportunities for Rio Grande cutthroat trout.
- Implement additional road closures with water bars, sediment traps and rolling dips.

Permitting and Compliance

- Undertake appropriate cultural resource field surveys and undertake consultations with the State Historic Preservation Officer to satisfy National Historic Preservation Act, Section 106 requirements.
- Complete National Environmental Policy Act (NEPA) requirements for all proposed BMPs.
- Complete all necessary permitting such as US Army Corps of Engineers Section 404/401 Permits.

Data Gathering and Monitoring

- Conduct a fisheries assessment.
- Measure flow and monitor water quality in various segments of Comanche Creek.
- Conduct macroinvertebrate monitoring.
- Conduct a basin wide analysis of physical characteristics using remote sensing infrared technology.
- Re-take photo points for key locations.
- Collect historical data of the condition of Comanche Creek watershed.
- Compare grazer/browser exclosures and non-excluded areas to assess wildlife and cattle grazing impacts on stream conditions and revegetation success.

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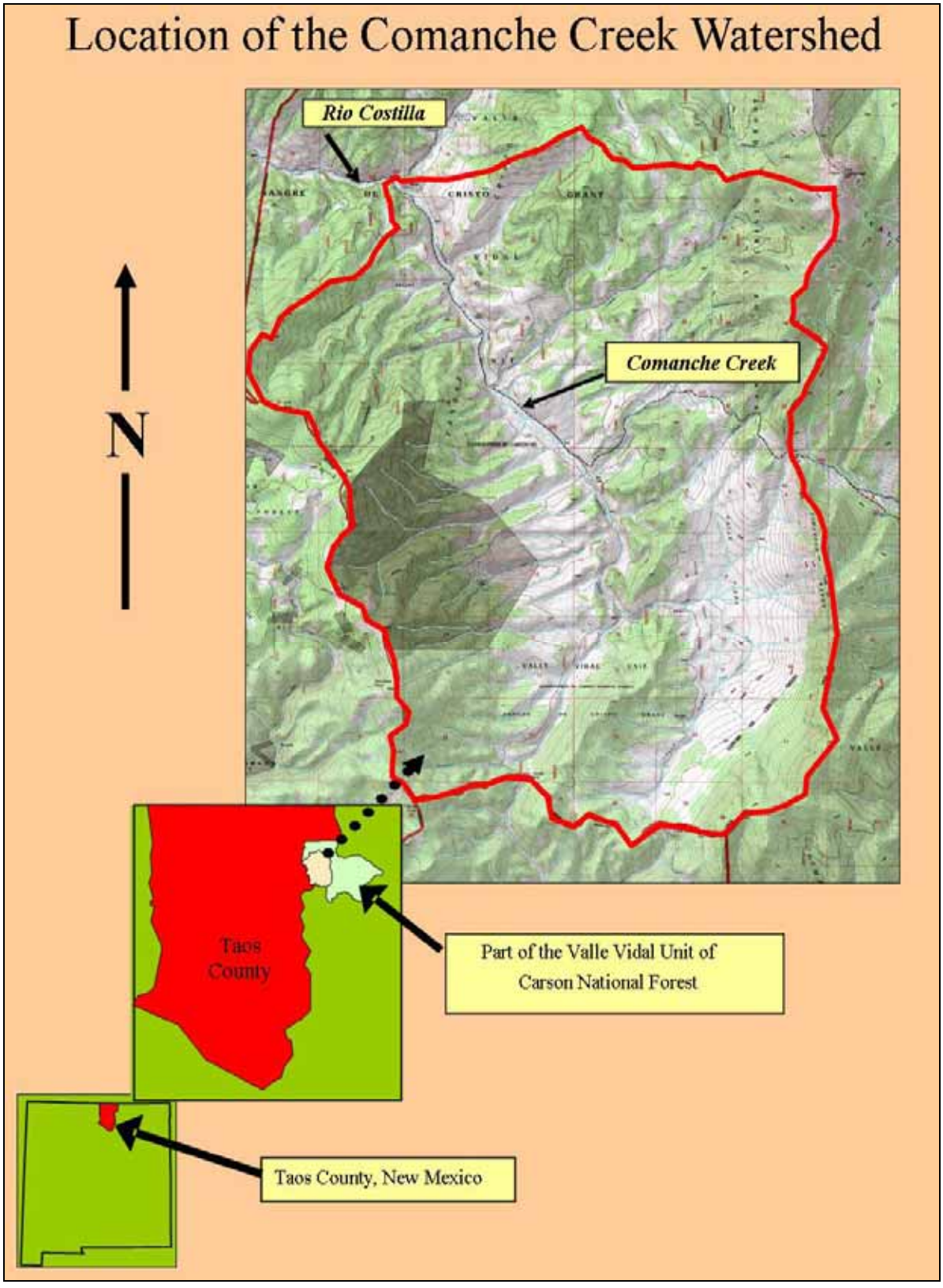
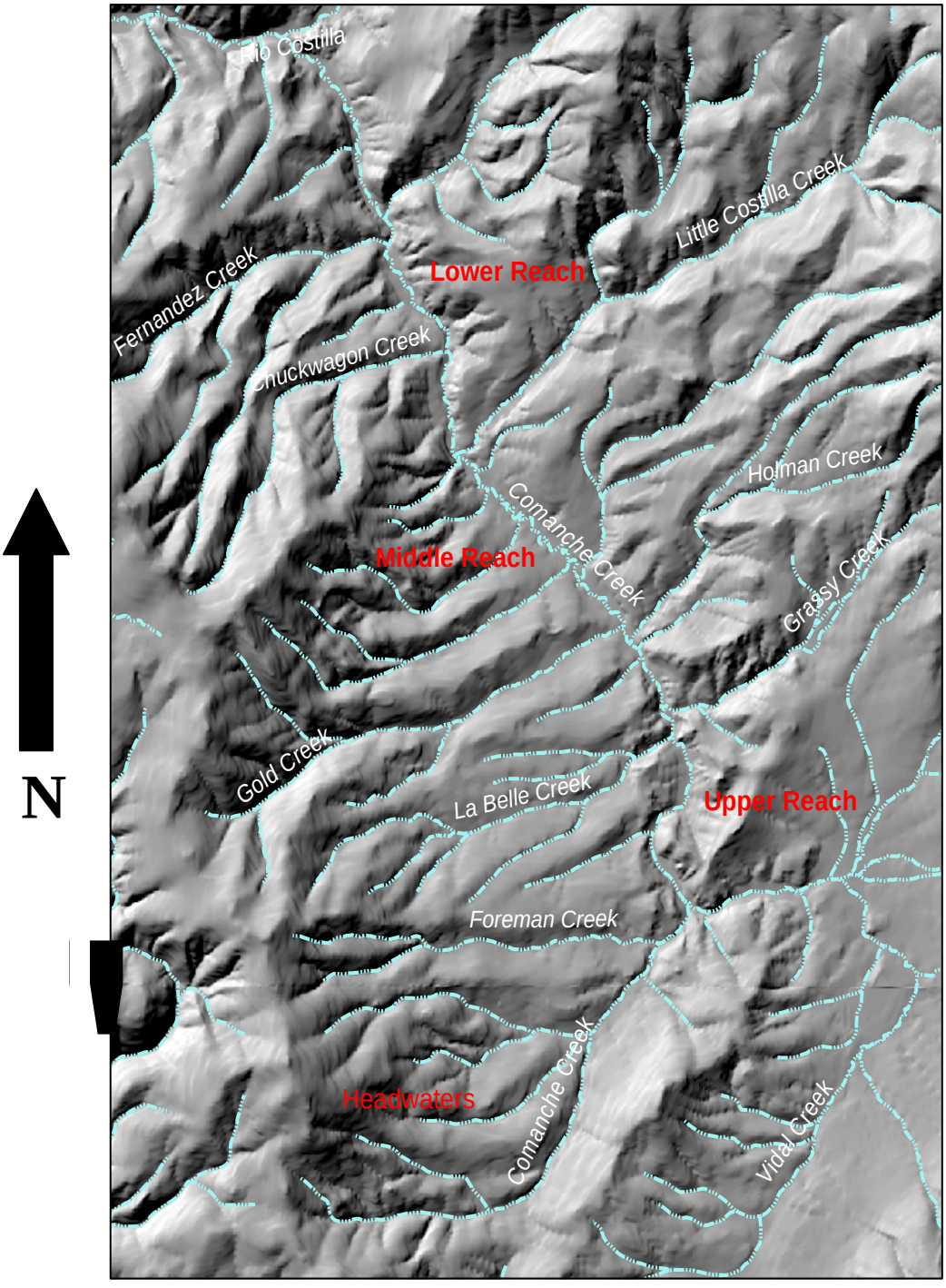
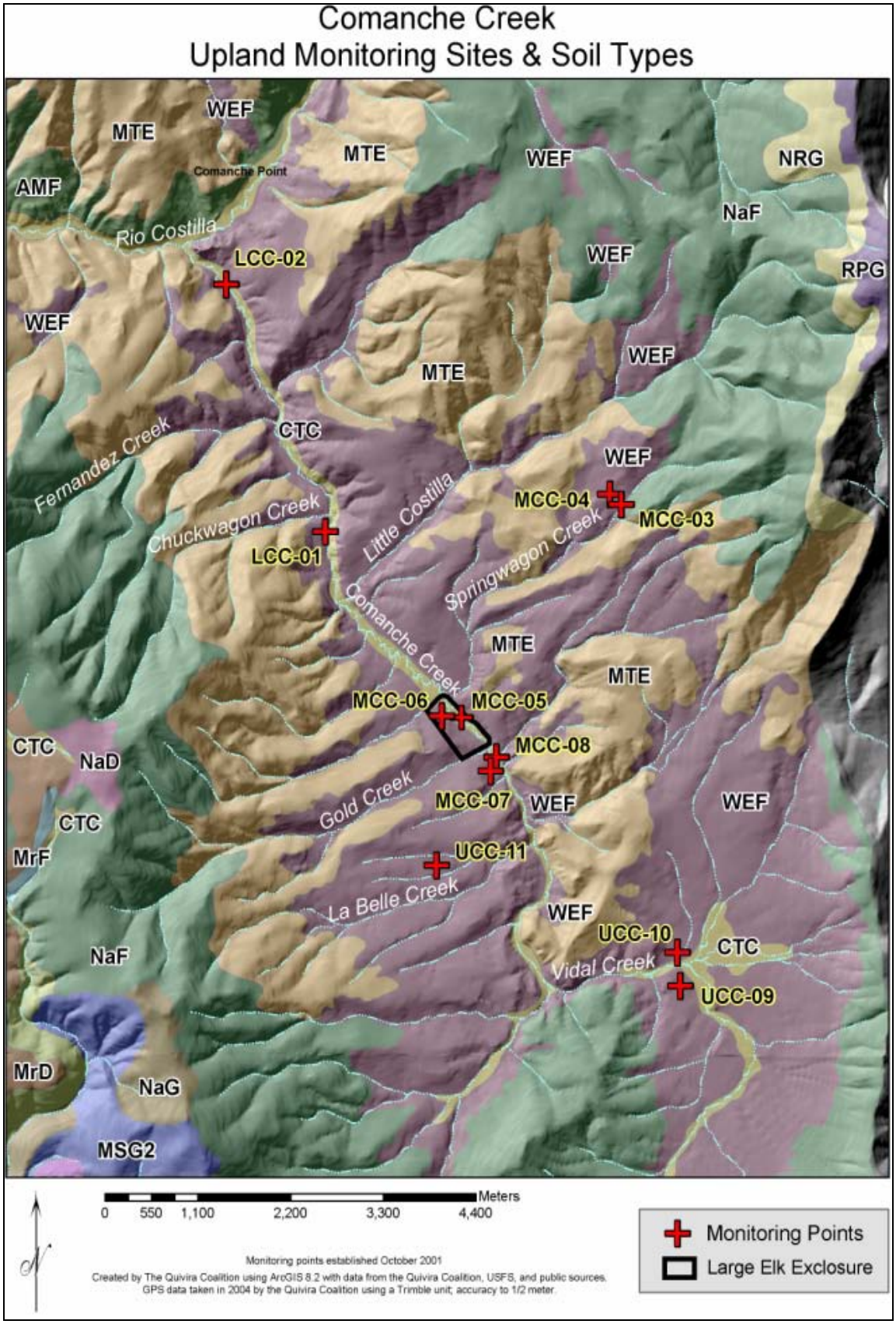
Appendix 1:
MAP A



Map B: Comanche Creek & Tributaries



MAP C


Comanche Creek
Upland Monitoring Sites & Soil Types
WEF
MTE
Comanche Point
AMF
Rio Costilla
LCC-02
NRG
NaF
RPG
CTC
Fernandez Creek
Chuckwagon Creek
LCC-01
Little Costilla
Springwagon Creek
MCC-04
MCC-03
Comanche Creek
MCC-06
MCC-05
MCC-08
NaD
MCC-07
Gold Creek
MrF
UCC-11
La Belle Creek
UCC-10
Vidal Creek
UCC-09
MrD
NaG
MSG2
0 550 1,100 2,200 3,300 4,400
Meters
Monitoring points established October 2001
Created by The Quivira Coalition using ArcGIS 8.2 with data from the Quivira Coalition, USFS, and public sources.
GPS data taken in 2004 by the Quivira Coalition using a Trimble unit; accuracy to 1/2 meter.
Monitoring Points
Large Elk Exclosure

All the following Appendices are on file at The Quivira Coalition Office or on the Comanche Creek Website: **www.comanchecreek.org.**

Appendix 2:
Interpreting Temperature Data for Little Costilla Creek, Comanche Creek, Vidal Creek, Chuckwagon Creek, North Ponil Creek, Costilla Creek, and McCrystal Creek of the Valle Vidal, 2005

Appendix 3:
Comanche Creek Watershed Restoration Project—Restoring Habitat for the Rio Grande Cutthroat Trout, Part 2 319 grant, 2004

Appendix 4:
Monitoring Effects of Grazing by Cattle and Elk on Wet Meadows and Aspen at Valle Vidal, (Moir and Williams 1985)

Appendix 5:
The Comanche Creek Preliminary Assessment Report, 2002

Appendix 6:
Comanche Creek Baseline Quantitative Uplands Monitoring Report, 2002

Quantitative Monitoring Report of Upland Range Conditions within the Comanche Creek Watershed, 2004

Appendix 7:
Trout Habitat Monitoring Plan for Comanche Creek, 2001 ***and*** **Comanche Creek Trout Habitat Monitoring Results,** 2002

Appendix 8:
Comanche Creek Trout Habitat Monitoring Summary Report 2001-2004

Appendix 9:
Rosgen Level II and Vegetation Monitoring in the Middle and Lower Reaches of Comanche Creek Monitoring, 2005

Appendix 10:
Map: Middle Reach Assessment

Appendix 11:
Map: Upland Drainage Erosion Control Treatments

Appendix 12:
Map and Road Survey Reports: 2003 and 2005