WATERSHED-BASED PLAN FOR THE UPPER RIO SAN ANTONIO DRAINAGE BASIN

Professional Services Contract # 13-667-5000-0015

Prepared by:

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Chimayo, NM 87522

Submitted To:

New Mexico Environment Department
Federal Clean Water Act Section 319 (h) Nonpoint Source Grant
Surface Water Quality Bureau
Attn: Abraham Franklin
PO Box 5469
1190 St. Francis Drive, Rm. 2050
Santa Fe, NM 87502-5469

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PREPARATION DATE:

APRIL 2016

INVESTIGATOR/S:

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Signature

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Introduction

The purpose of this Watershed Based Plan (WBP) is to help guide management and restoration efforts within the Upper Rio San Antonio Watershed from the headwaters down to Montoya Canyon, Assessment Unit (AU) ID: NM-2120.A_901 (Figures 1 & 2). The management measures discussed here focus on those that directly affect stream temperatures and indirectly affect dissolved oxygen (D.O.).

This WBP has been funded by the Federal Clean Water Act Section 319 Nonpoint Source Grant, through the New Mexico Environment Department Surface Water Quality Bureau (NMED SWQB). Chimayo Conservation Corps (CCC) was awarded the funding and has worked closely with Rocky Mountain Ecology LLC (RME) throughout the process. The WBP includes the nine key elements of watershed plans as determined by the U.S. Environmental Protection Agency (USEPA) (2013). This plan examines the current condition of the Upper Rio San Antonio, identifies specific causes and sources of impairments, and recommends efforts to aid in restoration efforts. The goal of this WBP is to provide a framework for implementation of restoration work that will result in the eventual removal of the Upper Rio San Antonio from the list of impaired waters.

According to the 2012-14 303(d)/303(b) Report, the A.U. was listed as temperature impaired, D.O. impaired, and *Escherichia coli* (*E. coli*) impaired (NMED 2012). This WBP focuses primarily on temperature impairments, with limited discussion of D.O. impairments. The impaired reach is designated by the State of New Mexico as a High Quality Cold Water Fishery (HQCWF) and was listed as not supporting its designated use following the Water Quality Survey for the Upper Rio Grande Watershed (Cochiti Reservoir to the Colorado Border (NMED 2009a). Moreover, the Cañada Tio Grande, which drains into the impaired reach of the Rio San Antonio, was also recently listed as temperature impaired on the New Mexico Water Quality Control Commission (NMWQCC)-Approved 2012-2014 Integrated List. Both the impaired reaches of the Cañada Tio Grande and the Rio San Antonio were also listed in the 2012-2014 Integrated List as not supporting water quality criteria for D.O.

Project Area

The Rio San Antonio within the project area is approximately 13.9 river miles and receives drainage from 34,408 acres (Figure 2). The project area has been divided into seven reaches (1, 2, 2a, 3, 4, 5, & 6), for clarification (Figure 2). Reach 6 included several hundred meters upstream of Monitoring Station 5, though water flow was very low at that locale. Multiple canyons and/or streams drain into the Rio San Antonio within the project area, including Placita Canyon, Dry Canyon, Cañada Tio Grande, the Rio Nutritas, Tanques Canyon, Lagunitas Creek, and Cañon Largo. The area is located on the Tres Piedras Ranger District (District) of the U.S. Forest Service Carson National Forest (Forest), with some private inholdings.

This project takes place in the upper Rio San Antonio priority stream reach, with the AU Name "Rio San Antonio (Montoya Canyon to Headwaters)," ID: NM-2120.A_901. The specific twelve-digit watersheds include all of the Cañada Tio Grande – Rio San Antonio

(HUC: 130100050301), and a small portion of the adjacent Cañada de Los Ranchos-Rio San Antonio (HUC: 130100050302). This is the watershed area upstream of the primary monitoring station established by NMED for this AU. According to the 2012-14 303(d)/303(b) Report, the A.U. is listed as temperature impaired, D.O. impaired, and *E. coli* impaired (NMED 2012). The Cañada Tio Grande, a principal tributary of the Rio San Antonio, is listed on the 2012-14 303(d)/303(b) Report as temperature impaired and D.O. impaired. The parameters with established total maximum daily loads (TMDLs) are temperature and *E. coli* on the Rio San Antonio. In cases where a TMDL for D.O. has not been developed, NMED in 2014 recognized that D.O. impairment is generally more easily understood as nutrient enrichment, as reflected in the newer 2014-2016 303(d)/305(b) Integrated Report. This WBP focuses on temperature because temperature was the only parameter with a TMDL when the planning project began, but also includes some discussion of D.O. (or alternatively, nutrient enrichment) impairments.

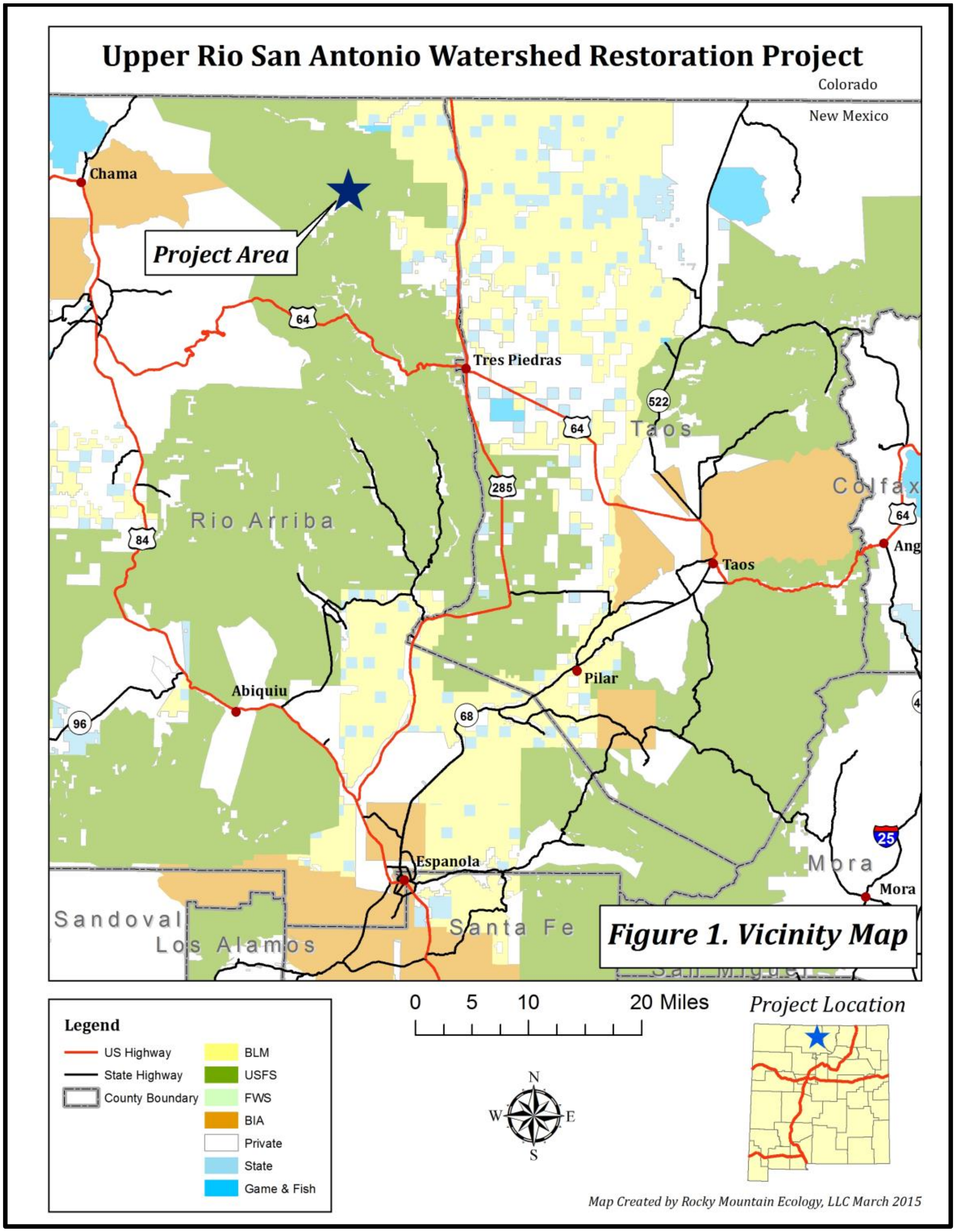
Upper Rio San Antonio Watershed Restoration Project
Colorado
New Mexico
Chama
Project Area
64
Tres Piedras
522
64
Taos
Colfax
285
64
Rio Arriba
84
Taos
Ang
Pilar
Abiquiu
96
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Figure 1. Vicinity Map
Legend
US Highway
State Highway
County Boundary
BLM
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Project Location
Map Created by Rocky Mountain Ecology, LLC March 2015

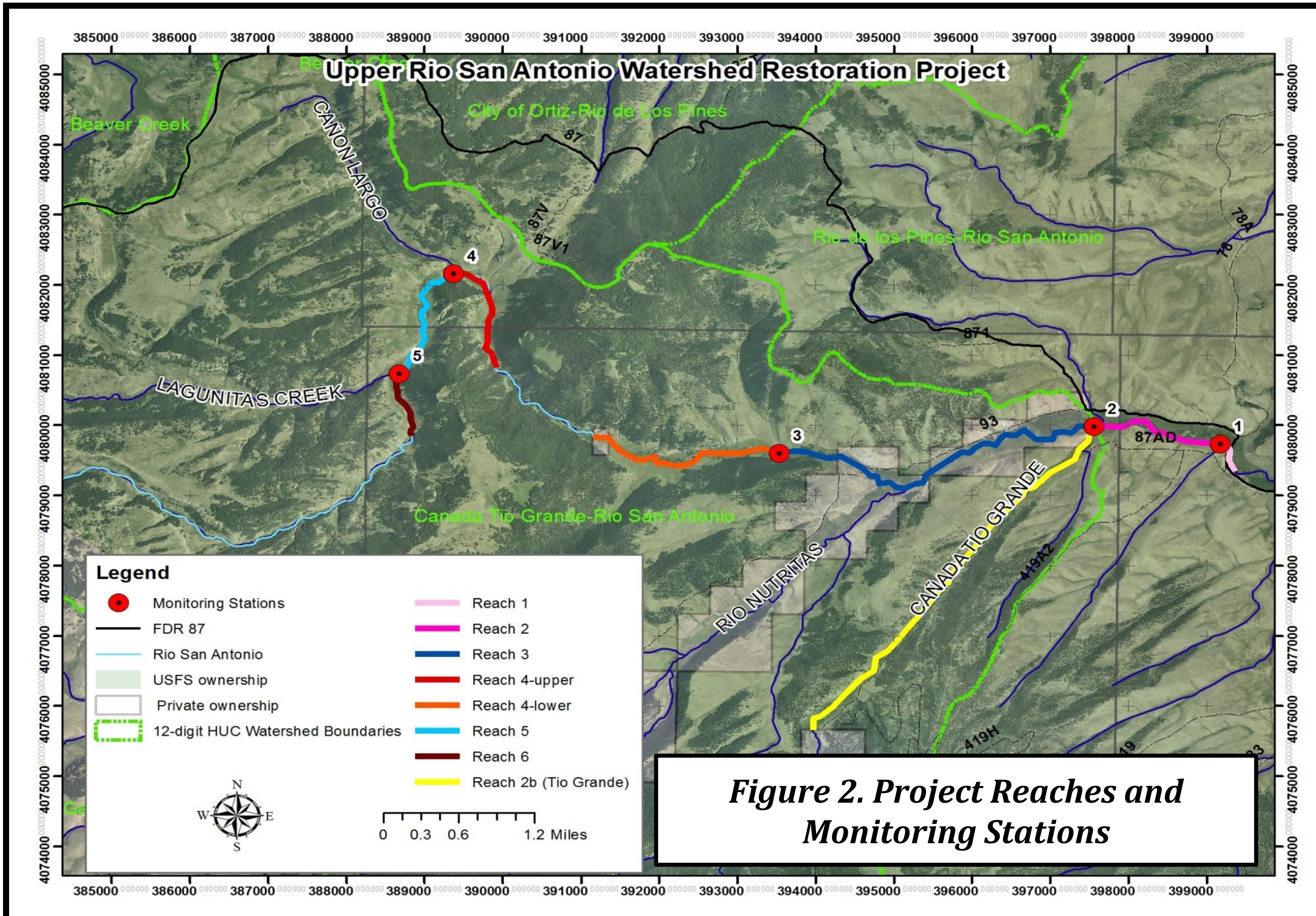


Figure 2. Project Reaches and Monitoring Stations

Project Overview

Upon a notice to proceed in 2012, CCC and RME initiated a stakeholder group that included specialists with the District, staff from NMED, and members of the Chama Peak Land Alliance (CPLA). Scoping letters were mailed to all agricultural permittees and stakeholders in the area (Appendix E).

Five monitoring stations were established along the 13.9-mile project corridor (Table 1; Figure 2). These stations were selected to cover the range of reaches and tributaries in the project area. Specifically, the monitoring stations were selected based on representative stream segments within upstream and downstream locations.

Table 1. Monitoring Stations

Station	Description and Rationale
1	Up and down-stream of the Placita Canyon confluence
2	Up and down-stream of the Cañada Tio Grande confluence, including Tio Grande
3	Up and down-stream of the Rio Nutritas confluence
4	Up and down-stream of the Cañon Largo confluence
5	Up and down-stream of the Lagunitas Creek confluence

Data were collected over a 2-year period (2013-2014) for the following metrics:

1. Water temperature
2. D.O.
3. Nitrogen and Phosphorus
4. Geomorphology
5. Vegetation
6. Canopy Cover
7. Photo points
8. Coarse, relative riparian vegetation cover assessment/Geographic Information System (GIS) and aerial photography analysis

Results from these data collection efforts are on file with the NMED SWQB, and have been used to guide development of this WBP.

Numerous scoping/ stakeholder meetings were held throughout the project duration, both on-site and in the field. United States Forest Service (USFS) agricultural permittees that have allotments within the project area are supportive of the proposed management measures. The Enchanted Circle Chapter of Trout Unlimited (TU) is also in support of the project and attended the riparian field sampling tour in May 2015.

Nine Elements of a Watershed Based Plan

The following nine elements of a WBP have been described by the USEPA (2013). Our team has adopted those nine elements to ensure a comprehensive WBP. They are as follows:

1. Identify the causes and sources of impairment
2. Estimate pollutant loading and expected load reductions
3. Provide management measures to support load reductions
4. Describe technical and financial assistance needed
5. Develop education and outreach programs
6. Develop an implementation schedule
7. Describe measurable milestones of implementation
8. Provide criteria for evaluating load reduction achievements
9. Develop a monitoring program

Identify the Causes and Sources of Impairment

CAUSE OF IMPAIRMENT

The NM Standards for Interstate Surface Waters designates the uses of water in the Rio San Antonio as the following (Table 2):

Table 2. Use Attainment

Designated Use	Use Attainment
Domestic water supply	Fully supporting
High quality cold water aquatic life (HQCWAL)	Not supporting (temperature; D.O.)
Irrigation	Fully supporting
Livestock watering	Fully supporting
Wildlife habitat	Fully supporting
Primary contact	Not supporting (*E. coli*)

Use attainment status in Table 2 is for the Rio San Antonio from Montoya Canyon upstream to its headwaters, as per the 2014-2016 303(d)/305(b) Integrated Report. The NMED determined that HQCWAL is not fully supported in both the Rio San Antonio (Headwaters to Montoya Canyon) and the Cañada Tio Grande, a primary tributary of the Rio San Antonio. According to the NMWQCC-Approved 2014-2016 303(d)/303(b) Integrated Report, the A.U. is listed as temperature impaired, nutrient impaired, and *E. coli* impaired. The Cañada Tio Grande is listed on the 2014-2016 303(d)/303(b) Integrated Report as impaired impaired by excessive temperature and nutrient enrichment.

According to the NMED Temperature Assessment Protocol, HQCWAL is fully supported if, "instantaneous (hourly) temperature does not exceed 23° Celsius (C) … and temperatures do not exceed 20° C … for four or more consecutive hours in a 24 hours cycle for more than 3 consecutive days (4T3)" (NMED 2011).

Temperature data were collected from 2002 and 2003 by NMED SWQB staff, and described in the Final Approved TMDL for Upper Rio Grande Watershed. (NMED SWQB 2004). This report indicates temperatures during the summer of 2002 exceeded HQCWF criterion 255 of 1,446 times with a maximum temperature of 27.1° C. 2003 summer temperatures exceeded HQCWF criterion 350 of 1,446 times with a maximum temperature of 27.6° C.

The TMDL for temperature is WLA (0) + LA (147.48) + MOS (16.39) = 163.87 joules (j)/meters squared (m^2)/second (s)/day. The TMDL establishes a goal for target load reduction of 127.82 joules/ m^2/s. There are no permitted point sources for temperature impairment on this segment of the Rio San Antonio, thus this load reduction goal can only be met by addressing nonpoint sources of pollution.

- *Data Gaps*

No D.O. or nutrient TMDL has been developed for the subject reach, and an extensive analysis of D.O. or nutrient loading is beyond the scope of this project. However, the Rio San Antonio is no longer listed for D.O. impairment. The former D.O. impairment is now considered a nutrient problem (Franklin, Abraham – pers. communication, 3/2016). However, the A.U. was surveyed during the 2009 Upper Rio Grande study (NMED 2009a). D.O. sonde data indicated impairment (combined instantaneous minimum of 5.37 milligrams (mg)/liter (L) with 70.4% saturation). Moreover, the maximum thermograph temperature was 24.7 degrees C, and the criterion (20 degrees C) was exceeded for > 4 hours for >3 consecutive days. NMED staff indicated that further evaluation is needed to determine if excessive nutrients is the cause of the D.O. impairment (Henderson, H. 8/2015, personal communication).

- *Management Strategy to Address Data Gaps*

NMED will be surveying the project with specific focus on nutrients during their next water quality survey, scheduled for 2017 – 2019. The Nutrient Assessment Protocol for Wadeable, Perennial Streams (Nutrient Protocol) (NMED 2015), which was used in the 2009 Upper Rio Grande study (NMED 2009), will be used for that effort. In summary, this approach involves two main steps - a Level I Nutrient Survey (Level I) (and in-stream measurements), and if necessary a Level II Nutrient Survey (Level II). For this project a Level II survey would be conducted. The Level II survey consists of collection of long-term (sonde) D.O. datasets and algal samples for chlorophyll analysis. The Level II survey is generally conducted during 15 August to 15 October though variations in Nutrient Protocol would be followed (NMED 2015). "For most streams indicators will be compared to thresholds values derived from water quality standards, NMED SWQB analyses or published literature. If however, the assessor feels that these thresholds are not appropriate for the class of stream being assessed, a reference reach will be surveyed and indicators from the study reach will be compared to those of the reference reach rather than the established thresholds" (NMED 2015).

E. coli bacteria will also be sampled during the 2017-2019 survey effort. The following methods could be used for this work. *E. coli* could be sampled and stream flow measured at representative sites each month for two years. This intensive sampling should indicate seasonal patterns in *E. coli* levels and enable NMED to relate these levels with changes in loading at each site. Additionally, iterative targeted sampling could be used. This approach involves a follow-up intensive sampling event two days after an original sampling event, in apparent hot spots. This approach increases the ability to detect hot spots and long-term patterns. Further, this approach would include animal source modeling to estimate pollution sources. Animal source modeling will be conducted using a Bacteria Source Load Calculator, or using geospatial modeling in ArcGIS.

SOURCES OF IMPAIRMENT

The TMDL lists nonpoint pollution sources of temperature impairment for the Rio San Antonio as: Range Grazing – Riparian or Upland; Flow Regulation/Modification; Removal of Riparian Vegetation; and Streambank Modification or Destabilization (NMWQCC 2014). The TMDL establishes a target load of 55.0% stream shade in order to meet load reduction goals based on Stream Segment Temperature Model (SSTEMP) modeling. The target load reduction therefore is the percent increase from established or current stream shade levels to the target stream shade goal of 55%.

Below, results are described for the eight metrics for which data were collected:

1. Water temperature
2. D.O.
3. Nitrogen and Phosphorus
4. Geomorphology (width-to-depth ratio)
5. Vegetation (Greenline transects)
6. Canopy Cover
7. Photo points
8. Coarse, relative riparian vegetation cover assessment/GIS and aerial photography analysis

Appendix B lists the global positioning system (GPS) coordinates and/or detailed descriptions for each locale where the above-referenced metrics were sampled.

Water Temperature

Standards for HQCWAL are described in the NMED Temperature Assessment Protocol. Under the protocol, Use Support is fully attained under two considerations: 1) instantaneous hourly temperature in a segment does not exceed 23° C or, 2) hourly temperature readings 20° C for equal or greater are not exceeded at the 4T3 threshold. A segment is not supporting if either threshold is exceeded.

Five HOBO Water Temp Pro v2 water temperature-logging devices were deployed by RME and CCC during 2013 and 2014 to confirm the temperature impairment listed in the TMDL, and to further understand stream shade and width to depth data. This device has a sensor that produces accuracy ±0.2°C. All data were collected based on metrics described in the Project Quality Assurance Protection Plan (PQAPP). The NMED Standard Operating Protocol for temperature data logger deployment and data collection periods was utilized (NMED SWQB 2011). The SSTEMP Version 2.0 was utilized to analyze the data (Bartholow 2002).

Temperature data loggers were located at five sampling stations generally downstream of significant tributaries such as the Tio Grande, the Rio Nutritas, Cañon Largo and Lagunitas Creek (Table 3; Figure 2). Data logger results indicated that five out of five sites exceed temperature standards (Table 3).

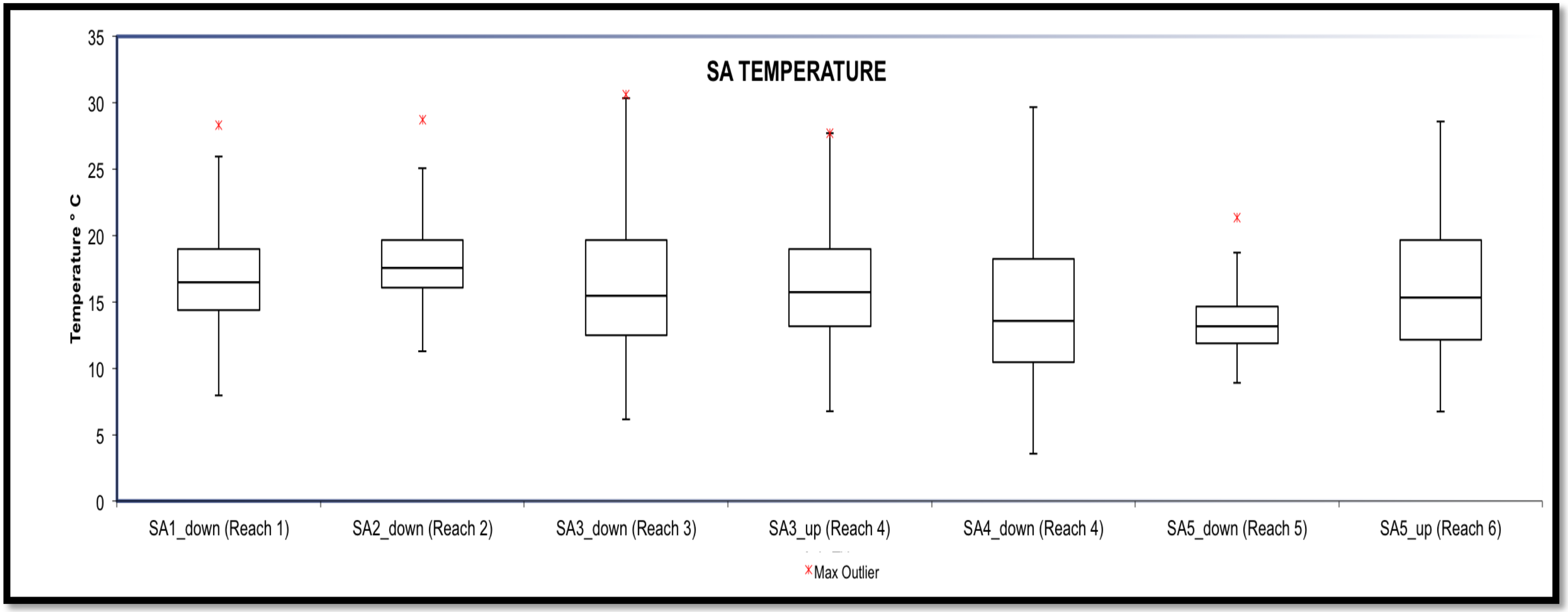
Table 3. Temperature Data Logger Results

Site ID	Data Logger Deployment Location	Max temperature	Determination
SA1_down (Reach 1)	Downstream of culvert at FR 87	28.3° C	Exceeds- 4T3
SA2_down (Reach 2)	Downstream of Tio Grande confluence	28.7° C	Exceeds-4T3
SA3_down (Reach 3)	Between monitoring stations 2 and 3. Public parcel between private land	30.6° C	Exceeds-4T3
SA3_up (Reach 4)	Just upstream of monitoring station 3, with influence approximately 1.6 miles upstream	27.7° C	Exceeds- 4T3
SA4_down (Reach 4)	Just downstream of confluence of Canyon Largo, with influence approximately 1 mile downstream	29.6° C	Exceeds- 4T3
SA5_down (Reach 5)	Downstream of confluence of Lagunitas Creek	26.5°C	Exceeds instant
SA5_up (Reach 6)	Upstream of monitoring station 5	28.7° C	Exceeds- 4T3
Tio Grande (Reach 2b)	No data collected	NA	NA

In general, data revealed downstream reaches experienced prolonged periods of elevated temperatures. Notably, upstream monitoring stations also showed protracted high temperature conditions during critical low flow conditions. Elevation differences between downstream and upstream monitoring locations seemed to exert less influence on temperature, whereas the virtual absence of shade (e.g., woody riparian vegetation) at the two headwater monitoring locations (Reaches 4 and 5) is likely contributing to elevated temperatures.

The box and whisker plots shown in Figure 3 depict the interquartile range, median values, and maximum and minimum ranges. Upstream sites experienced lower median temperature values and significant variability with maximum values exceeding the water quality standard.

Figure 3. Temperature Results



Dissolved Oxygen

From a biological perspective, D.O. is essential for aquatic life and can have pronounced effects on aquatic organisms. Oxygen is introduced into water bodies through plant photosynthetic activity and diffusion from the atmosphere. Concentrations of D.O. are related to the solubility of oxygen and water temperature. The solubility of oxygen and temperature share an inverse relationship. For example, as water temperature increases the capacity to hold oxygen decreases. This mechanism is a key principle for understanding undesirable water quality conditions and relates directly to water quality impairments and management strategies.

Organics and nutrients have several interactions that can, in the process of decomposition, depress D.O. levels. Oxygen-demanding wastes include all types of organic matter such as decomposing aquatic plant detritus, woody debris, and dead aquatic life. Oxygen-demanding interactions include respiration of aquatic life, such as decomposing microbes, and other chemical processes. The relative strength of oxygen-consuming processes of biodegradable material in a parcel of water in a given time period is known as biological oxygen demand (BOD). Low D.O. is an indicator of biochemical activity, possibly resulting from elevated specific nutrients such as phosphorus as well as organic nitrogen, which may exist as ammonia, nitrite, or nitrate. Excessive nutrients can lead to increased growth of algae and aquatic plants. When those plants or algae die the result is an increased BOD. Plant regeneration processes can result in eutrophication in which accumulated nutrients lead to increased algae and other nuisance aquatic plant growth. That result is subsequent decreased D.O. levels as bacteria decompose organic matter and consume oxygen in the process. Furthermore, D.O. concentrations are subject to cyclical, diurnal fluctuations related to the photosynthetic processes of algae in which plants consume carbon dioxide and produce an overabundance of oxygen. Such plants and algae respire at night which depletes D.O. leading to undesirable variations in water quality which may harm other aquatic life.

Two methods were performed to measure D.O. levels: meter and probe sampling using a Hanna Instruments HI9146-10 - Dissolved Oxygen Meter; and long-term measurement using a HOBO U26 Dissolved Oxygen Data Logger. Two HOBO U26 DO Data Loggers were deployed in the project area: 1) Reach 2 - in a low-gradient downstream section distinguished by numerous beaver ponds and interspersed channels, and; 2) Reach 6 - in a high-elevation, upstream location above the confluence of Lagunitas Creek (Figure 2; Appendix B). Instruments were placed in pool sections at the bottom of the water column. Grab D.O. samples were conducted using a Hanna Instruments HI9146-10 Dissolved Oxygen Meter.

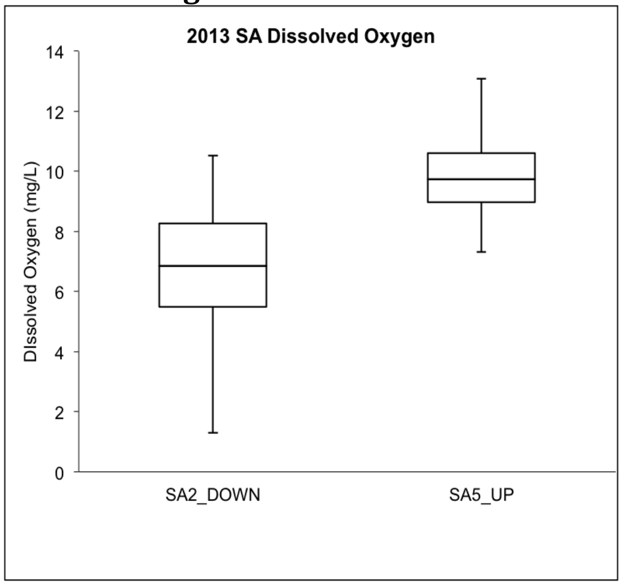
These data were collected in accordance with procedures described in the 2012 NMED SWQB Standard Operating Procedures For Data Collection (NMED SWQB 2012); Hanna Instruments HI9146-10 Dissolved Oxygen Meter and temperature meter (Hannah Instruments 2010), and; Surface Water Sampling Methods and Analysis — Technical Appendices – (Government of Western Australia: Department of Water 2009).

The standard D.O. benchmark of 6.0 mg/L or less, has been identified in the Procedures for Assessing Water Quality Standards Attainment for the State of New Mexico Clean Water Act (CWA) §303(d) /§305(b) Integrated Report Assessment Protocol (NMED 2009b). Data logger results for this sampling effort indicated that the lower site was below acceptable standards.
Results for D.O. composite sampling (i.e. data loggers) are presented in Figure 4. Mean values from both logged data sets are above the chosen standard; however protracted declines in D.O. are evident at SA_2 (Reach 2). The upstream instrument location (Reach 6-SA5_up) exhibited higher values and less variability. Impounded water from an extensive beaver dam complex (in Reach 2) likely contributed to high variability and depleted D.O. values. Additionally, the location of the device in the water column (~1.0 meter below the surface) may have influenced logged values. Conversely, Reach 6 experiences greater aeration and oxygenation due to vigorous upstream turbulence as a result of a steeper grade and abundant riffles.

D.O. mean values at SA5_UP (Reach 6) were 10.66 mg/L with a standard deviation of 1.6 over the 2013 monitoring season. Minimum D.O. was logged at 7.32 mg/L. The downstream monitoring site displayed highly variable D.O. readings. Measured values produced a mean of 6.43 mg/L and standard deviation of 2.4, with a eutrophication event likely occurring as data showed D.O. levels dropped below 1.0 mg/L at that monitoring site. The low D.O. experienced in this stream segment is perhaps a result of rapid decomposition in conjunction with the management of dams in which ponds are partially drained leaving low water levels, thus altering water levels and flow conditions. Based on D.O. readings, it is hypothesized that water within the beaver dam complex is prone to reaching levels of moderate to severe eutrophic states. However, it is important to note the network of impoundments, pools, and abbreviated channels sustain a vigorous riparian habitat. Moreover, grab samples indicated D.O. levels recover in sampled downstream locations.

D.O. grab samples were consistent with composite sampling methods performed by data loggers. Grab samples at Tio Grande (Reach 2b) were taken during critical low flow conditions characterized by elevated stream temperatures (i.e. >20 °C), which showed D.O. levels slightly below desired conditions.

Figure 4. D.O. Results



See *Causes of Impairment* section above for data gaps and a management strategy to address them.

Nitrogen and Phosphorus

Water is an excellent solvent and as it contacts various chemical constituents found in watershed soils, it acquires elements of them. Moreover, the effects of land use can be seen in the chemistry of water bodies. Phosphorus and nitrogen are among several nutrients capable of creating undesirable impacts on streams. An overabundance of phosphorus and nitrogen can cause excessive growth of algae and aquatic plants, leading to impacts regarding D.O., temperature, and other water quality indicators. When combined with nitrogen, the presence of phosphorus may accelerate algal blooms. Elevated nutrient levels may lead to eutrophication, as well as hypoxic (i.e. areas of low D.O. concentrations) and anoxic (i.e. areas in which D.O. is completely depleted) conditions that are harmful to aquatic life.

Grab samples for total nitrogen and phosphorous were collected at five locales throughout the project corridor, associated with the five monitoring stations (Figure 2; Appendix B). These data were collected in accordance with procedures described in the 2012 NMED SWQB Standard Operating Procedures For Data Collection (NMED SWQB 2012); methods outlined by Hall Labs, Albuquerque, NM and; Surface Water Sampling Methods and Analysis — Technical Appendices – (Government of Western Australia: Department of Water 2009).

Hall Labs analyzed samples according to EPA procedures or the equivalent. NMED has water quality targets for nutrients that include levels of total nitrogen (0.42 mg/L) and total phosphorus (0.07mg/L). Total nitrogen is described as below detectable limits (BDL) if samples contained <1.0 mg/L total nitrogen, and for total phosphorus the detection limit is <0.1 mg/L. Four of five samples were BDL for total nitrogen and phosphorous. The grab sample collected from SA_1 (Reach 1) was found to have 0.17 mg/L total phosphorus. .

No grab samples indicated increased nutrient loading. Nutrient levels at SA_1 (Reach 1) are consistent with qualitative remarks in which communities of algae were observed. The lack of detectable nutrients is likely attributed to low flow conditions during the sampling period.

Geomorphology
Width-to-depth ratio and longitudinal profile data were collected in accordance with *Stream Channel Reference Sites: An Illustrated Guide to Field Technique* (Harrelson, et al 1994). A complete Rosgen Level II analysis was beyond the scope of this project.

Monitoring efforts detected numerous long sub-reaches where high width-to-depth ratios are resulting in increased water surface areas exposed to solar radiation within the project area, both on the Rio San Antonio and Tio Grande. These data are provided in Appendix D, and will be used as pre-treatment baseline benchmarks that can be re-measured after in-stream structures have been installed, as part of the implementation process.

Unnaturally high width-to-depth ratios are partially responsible for elevated water temperatures. Moreover, the lack of adequate pool formations has resulted in decreased habitat value.

Vegetation (Streambank Stability)
Structural factors contribute to the ecological health of stream and riparian systems. Stream bank stability is essential for reducing sediment input, providing refuge for aquatic life, particularly trout, and for promoting stream channel stability. For example, roots of streamside vegetation greatly enhance stream bank stability, however variability in rooting characteristics among riparian plant species result in varying ability to reduce erosion and promote bank stability. Furthermore, livestock and other grazing ungulates may trample stream bank vegetation and reduce vegetation massing thereby promoting undesirable channel alterations and water quality problems.

Baseline vegetation composition features were sampled at each of the five sampling stations. Stream bank integrity was considered and streamside vegetation was evaluated using the "greenline" sampling method (Winward 2000). The greenline is the "first perennial vegetation that forms a lineal grouping of community types on or near the water's edge." Winward considers the riparian complex to evaluate relative bank stability. A riparian complex is defined as "a unit of land with a unique set of biotic and abiotic factors." Complexes are defined on the basis of their overall geomorphology, substrate characteristics; stream gradient and associated flow features, and general vegetation patterns (Winward 2000). The greenline method also considers woody vegetation regeneration by age class; this is particularly important when considering potential temperature load reductions.

Two representative riparian complexes were selected in each of the five surveyed stream segments. Two sections of Tio Grande were also surveyed. Scoring for Winward Stability Ratings is provided in Table 4.

Table 4. Winward Stability Ratings

Winward Stability Rating
1-2=very low
3-4=low
5-6=mid
7-8=high
9-10=excellent

Calculated rankings are presented in Table 5. Overall, Winward stability ratings indicate moderate to high levels of stream bank stability. Results indicate heavy to extreme use of woody species is inhibiting woody plant growth and regeneration. Ample complexes of *Salix* spp. exist but are being over-utilized by grazers, and largely exist as stubble in sampled locations. Visual assessments of all reaches confirmed significant utilization and browsing of woody species, particularly in upstream segments 4 and 5. Winward stability ratings from Tio Grande indicated the area contains the highest values from all surveyed reaches.

Table 5. Winward Stability Values

SA_1 down (Reach 1)	SA2 (Reach 2)	SA3_down (Reach 3)	SA3_up (Reach 4)	SA4_down (Reach 4)	SA5_down (Reach 5)	SA5_up (Reach 6)	Tio Grande (Reach 2a)
7.54	No data collected	No data collected	7.36	7.24	6.89	No data collected	8.01

Canopy Cover

Canopy cover data were collected in accordance with the 2012 NMED SWQB Standard Operating Procedures for Data Collection (NMED SWQB 2012). Transects were established at each of the five sampling stations (Figure 2; Appendix B).

Canopy cover data in riparian locations were collected to determine sources of elevated temperatures and calculate load reduction goals for each stream segment. See Table 6 for canopy cover under "% Stream Shade." Canopy cover transects were established at three points in areas considered representative of each stream segment. Percent-shade was measured in the field using a densiometer and methods established by NMED (2012).

All reaches lacked the desired quantity of canopy cover. Upper reaches (e.g., 4 & 5) were notably devoid of woody riparian vegetation, whereas downstream sites generally contained more woody vegetation. Reaches 4 and 5 had evidence of woody streamside vegetation (e.g., coyote willows (*Salix exigua*) along long portions, though it was browsed down to ~ 3-inch stubble heights. Evidence of historic (i.e., dead) alder (*Alnus* spp.) clusters was evident at many of the bends and pools in the Rio San Antonio, especially in Reaches 4 and 5. These presently dead alders used to function as refugia for aquatic life, via providing shade and protection from aerial predators. However, at present no such ecological functions are provided. Tio Grande generally contained sparse canopy cover throughout, which is reflected in the data (Table 6). However, Tio Grande does harbor significant undercut bank areas which likely enable fish and other aquatic life forms to thrive.

Solar radiation contributes significantly to heat flux in stream systems. Heavily browsed or dead woody vegetation is evident in many places examined. Therefore the lack of ample woody riparian vegetation is likely contributing to elevated water temperatures and attendant water quality impairments.

Photographic Points
Permanent photograph points are useful to record riparian conditions and document changes in channel morphology. Photographic documentation can be used to record management efforts regarding the improvement of stream and watershed conditions. Photographic points were established at each of the five sampling stations in accordance with methods described in Harrelson et al. (1994) at geomorphic cross sections, and Winward (2000) at vegetation cross sections.

Images from upstream locations provide visual documentation of the absence of riparian vegetation in most reaches of the study area. Images from downstream locations show significant impacts to stream bank integrity from intensive grazing. Permanent photographic points are located in Appendix C. These can serve as a baseline for comparison of post-treatment photographs to assess change over time.

Coarse Relative Riparian Vegetation Cover Assessment
A GIS assessment of coarse riparian vegetation cover was conducted prior to initiating other data collection activities, using aerial photography and methods described in *GIS For Environmental Management* (ESRI 2006). This analysis was conducted to help direct field data collection efforts toward areas within the project area that are lacking shrub or tree cover in the vicinity of the streams.

Estimate Load Reductions

SOURCE IDENTIFICATION
The following table (Table 6) identifies, prioritizes and lists the calculated thermal load reduction for various reaches within the Project Area. Load calculation methods are described in Appendix A.

Table 6. Required Increase in Stream Shade to Achieve Load Reduction Targets and Priority Reaches

Site ID	Priority	Length (meters)	% Stream Shade	% Stream Shade Goal	Required Increase %	Total Load Reduction (J/M²/S)
SA1_down (Reach 1)	4	559	36.61	55.0	18.39	60.32
SA2 (Reach 2)						
SA3_down (Reach 3)	3	136	18.48	55.0	36.52	119.78
SA3_up (Reach 4 - *extends approx. 1.6 mi upstream of monitoring station 3*)	5	505	38.59	55.0	16.41	53.82
SA4_down (Reach 4- *extends approx. 1 mi downstream of Cañon Largo)*	1	216	0.0	55.0	55.0	180.40
SA5_down (Reach 5)	1	160	0.0	55.0	55.0	180.40
Tio Grande (Reach 2b)	2	595	5.0	55.0	50.0	164.0

Load reductions were not calculated for Reach 2 because canopy cover data were not collected. The reason is that this reach is a massive beaver complex (without a defined channel) that confounds one's ability to ascertain exactly where canopy cover should be measured.

Calculations indicate that SA4 and SA5 (Reaches 4 and 5) require the highest increases in shade to reach target load reductions. Priority reaches are identified here based primarily on those which require the largest amount of shade increase to achieve load reductions. However, it is critical to note that other constraints such as funding types, amounts, landowner willingness, road access, etc. will ultimately exert an influence on how and when proposed projects get implemented.

It should be noted that these estimates are derived from data at discrete locales along the stream reaches. However, these estimated load reductions represent the average percent shade increase and load reductions necessary for each reach.

RELATIVE CONTRIBUTIONS OF THE PROPOSED MANAGEMENT MEASURES TO LOAD REDUCTIONS

Proposed management measures are described below under the section *Management Measures to Support Load Reductions*. Overall, management measures fall into two general categories: 1) stakeholder engagement | adaptive management | technical capacity building; and 2) physical interventions that affect stream and riparian areas (i.e., physical management measures). Management measures and resulting load reductions are presented in Table 7.

Note, load reduction calculations are developed for *physical* management measures only (i.e., MMs #1, #2, #3, #4, #5, & #7). However, the execution of stakeholder engagement | adaptive management | technical capacity building management measures (MMs #6, #8, & #9) described in the following section will support or increase load reductions beyond calculated values, as they provide the foundation for physical interventions. Concurrent execution of all management measures described in this document is critical to reaching load reduction goals.

Management measures to support load reductions were estimated based on procedures in the EPA approved *Updated Watershed Based Plan for the Upper Gallinas River* (2012). Management scenarios to address thermal loading result from two primary physical actions - thus we combined some management measures for the purpose of load reduction calculations:

- Riparian plantings (MM #1) | Fence exclosures (MM #3)
- Structures (MMs #2, #4, #5, & #7)

Riparian plantings and fence exclosures (management measures #1 and #3) would occur in tandem; therefore these were combined for the purpose of calculating load reductions in Table 7. This step was taken because the ability of plantings to provide shade is related to protection from fence exclosures. Management measures #2, #4, #5 and #7 were combined for calculations, in Table 7. This step was taken because those four measures all involve placement of structures that could affect sedimentation, width-to-depth ratios, and thus the potential thermal loading within the stream.

Table 7. Calculated Management Measures to Achieve Load Reductions

Reach	Management Measures (MM)	MM Efficiency	Total Required Stream Shade Increase (%)	Total Load Reduction ($J/M^2/S$)	Relative Stream Shade Increase (%)	Relative Load Reduction ($J/M^2/S$)
SA1_down	Exclosures/ plantings	65	18.39	60.32	11.95	39.21
	Structures	35			6.44	21.11
			Management Measures Total		**18.39**	**60.32**
SA3_down	Exclosures/ plantings	65	36.52	119.78	23.74	77.86
	Structures	35			12.78	41.92
			Management Measures Total		**36.52**	**119.78**
SA3_up	Exclosures/ plantings	65	16.41	53.82	10.67	34.98
	Structures	35			5.74	18.84
			Management Measures Total		**16.41**	**53.82**
SA4_down	Exclosures/ plantings	65	USFS55	180.40	35.75	117.26
	Structures	35			19.25	63.14
			Management Measures Total		**55**	**180.40**
SA5_down	Exclosures/ plantings	65	55	180.40	35.75	117.26
	Structures	35			19.25	63.14
			Management Measures Total		**55**	**180.40**
Tio Grande	Exclosures/ plantings	65	50	164	32.5	106.60
	Structures	35			17.5	59.04
			Management Measures Total		**50**	**165.64**

Management Measures to Support Load Reductions

A series of management measures to improve water quality within the Upper Rio San Antonio watershed is presented below. These measures are inclusive of the entire watershed, including both private and USFS lands. Management measures were selected based on both stakeholder input and through demonstrated effectiveness in existing published literature.

The following are recommended management measures:

**See Table 8, below for locations of specific management measures*

1. Riparian vegetation improvements
    - Revegetation of streambanks and adjacent riparian meadows with woody and herbaceous vegetation.
        - Revegetation of streambanks and adjacent riparian meadows with woody and herbaceous vegetation. These techniques have been suggested to increase stream shade cover, to increase D.O. through increasing filtering potential, and stabilize eroded banks, thereby reducing sedimentation into the river (Zeedyk and Clothier 2009).
2. In-stream structure placement (large woody debris (LWD), boulders)
    - Placement of in-channel structures to create a series of deep pools, to decrease the width/depth ratio in strategic locations, and ultimately reduce solar radiation.
        - Placement of in-channel structures (e.g., post-vanes, weirs, baffles, zuni bowls, etc.) and LWD. These techniques have been suggested to protect eroding banks, promote bank formation, decrease the width to depth ratio of the channel and facilitate deep pool formation, which would lower stream temperatures (Zeedyk and Clothier 2009).
3. Small, fence exclosures around critical planted areas
    - Small, fence exclosures would be constructed around critical planted areas to deter livestock, beaver (and elk if necessary), and give shrub and herbaceous species the opportunity to establish.
        - Fencing of critical planted areas to prevent undesirable grazing and browsing from cattle. This technique has been suggested to protect surface vegetative cover in riparian areas (USDI-BLM 1992).
4. Fish barrier construction and deep pool formation
    - A barrier to fish migration may be constructed on the main stem of the Rio San Antonio to reduce non-native fish expansion and help conserve populations of native fishes (i.e., Rio Grande cutthroat trout (*Oncorhynchus clarkii virginalis*) and Rio Grande chub (*Gila pandora*). Native fishes within the Rio San Antonio are outcompeted by non-native species (e.g., German brown trout (*Salmo trutta*)) for food, space, and other resources. Reducing the ability of non-native fishes to migrate and compete will help ensure the long-term persistence of the native fishes within the Rio San Antonio. This management measure will also create a deep pool just upstream of the barrier, which could also reduce thermal loading.
5. Streambank/riparian erosion control
    - Post-vanes and other bankline stabilization techniques would be utilized in areas where banklines show significant evidence of on-going erosion.
        - Placement of in-channel structures (e.g., post-vanes, weirs, baffles,

zuni bowls, etc.) and LWD. These techniques have been suggested to protect eroding banks, promote bank formation, decrease the width to depth ratio of the channel and facilitate deep pool formation, which would lower stream temperatures (Zeedyk and Clothier 2009).

6. Construction of numerous water catchments
    - Water catchments would be constructed in the uplands within the watershed to provide water for ungulates and deter them from traveling down to the Rio San Antonio.
        - District range staff and permittees have repeatedly communicated the need for additional upland watering areas for livestock.
7. Construction of numerous sediment control features
    - Sediment control structures (generally utilizing native, local materials such as rocks or log structures) would be constructed in ephemeral upland drainages to arrest upstream sediment and contribute to re-vegetation as tanks fill.
        - These methods are described in An Introduction to Erosion Control (Zeedyk and Jan Willem-Jansens 2009).
8. Robust stakeholder engagement and partnerships
    - Continue strengthening stakeholder relationships with private landowners and other interested parties (agencies, conservation groups, etc.) that have been established through this planning effort. Provide special consideration of inholdings along riparian areas within planning area.
    - Maintain email list bi-annually with updates to the stakeholder group about key events, meetings, etc. that involve them.
    - Hold general riparian management workshop/s in which technical details for achieving increased success of in-stream structures, sediment control structures, etc., are demonstrated for stakeholders.
9. Adaptive Rangeland management (See *Education, Outreach & Adaptive Management* section below for details on existing livestock Allotment Management Plans (AMP).
    - Move ecological conditions of rangelands to desired conditions through use of rotational grazing systems. The USFS could work with permittees to rest pastures along riparian corridors for the entire year or for the main woody vegetation growth period (July-August). Such flexibility does exist within the allotments contained within the project area, as verified by the District. This would enable newly planted and existing, stressed riparian vegetation to become established and thrive.
    - Maintenance of construction fence exclosures over time.
    - Modification of existing management practices to achieve desired objectives.

- Hold riparian planting workshop/s where the most effective types of ungulate fence exclosures are constructed

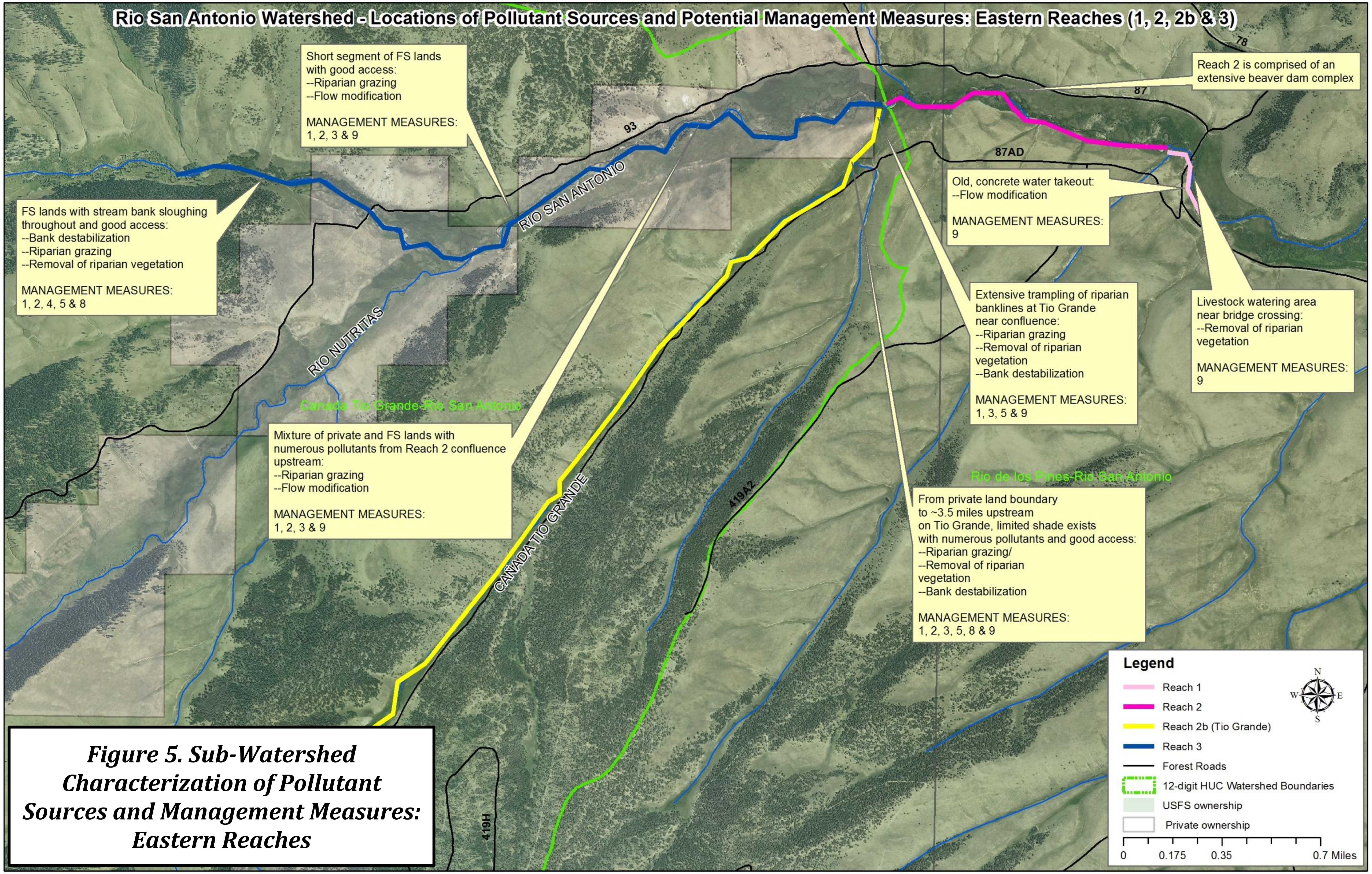
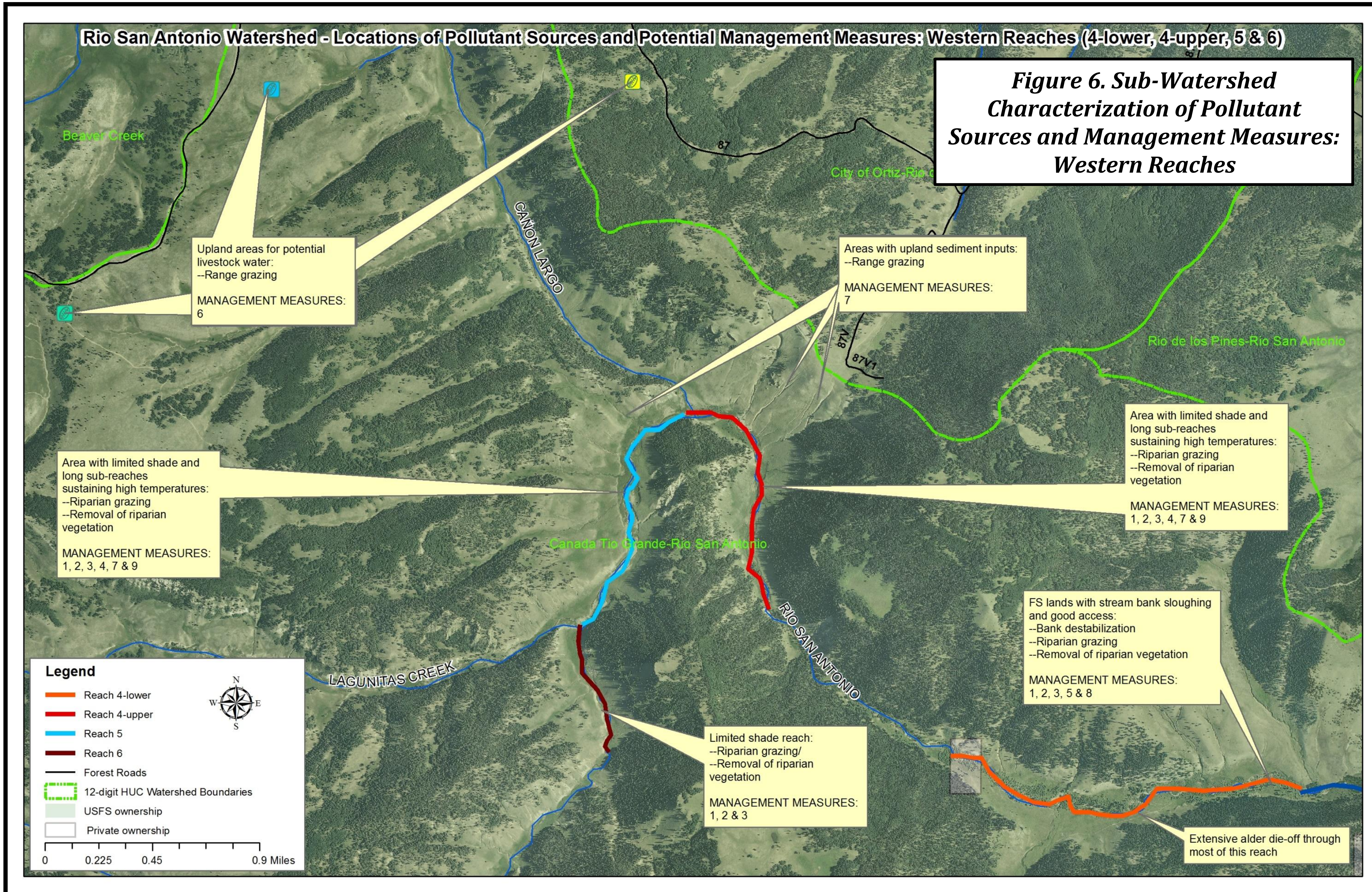


Figure 5. Sub-Watershed Characterization of Pollutant Sources and Management Measures: Eastern Reaches


Rio San Antonio Watershed - Locations of Pollutant Sources and Potential Management Measures: Western Reaches (4-lower, 4-upper, 5 & 6)
Figure 6. Sub-Watershed Characterization of Pollutant Sources and Management Measures: Western Reaches
Beaver Creek
CAÑON LARGO
87
City of Ortiz-Rio
Upland areas for potential livestock water: --Range grazing MANAGEMENT MEASURES: 6
Areas with upland sediment inputs: --Range grazing MANAGEMENT MEASURES: 7
87V
87V1
Rio de los Pinos-Rio San Antonio
Area with limited shade and long sub-reaches sustaining high temperatures: --Riparian grazing --Removal of riparian vegetation MANAGEMENT MEASURES: 1, 2, 3, 4, 7 & 9
Area with limited shade and long sub-reaches sustaining high temperatures: --Riparian grazing --Removal of riparian vegetation MANAGEMENT MEASURES: 1, 2, 3, 4, 7 & 9
Canada Tio Grande-Rio San Antonio
RIO SAN ANTONIO
FS lands with stream bank sloughing and good access: --Bank destabilization --Riparian grazing --Removal of riparian vegetation MANAGEMENT MEASURES: 1, 2, 3, 5 & 8
LAGUNITAS CREEK
Limited shade reach: --Riparian grazing/ --Removal of riparian vegetation MANAGEMENT MEASURES: 1, 2 & 3
Extensive alder die-off through most of this reach
Legend
Reach 4-lower
Reach 4-upper
Reach 5
Reach 6
Forest Roads
12-digit HUC Watershed Boundaries
USFS ownership
Private ownership
0 0.225 0.45 0.9 Miles
N S E W

Technical and Financial Assistance Needed

Technical and financial sources and amounts needed to fund implementation in priority reaches are listed in Table 8, in the *Implementation Schedule and Costs* section below. Priority reaches have been identified here based primarily on those which require the largest amount of shade increase to achieve load reductions. However, a critical consideration is that constraints such as funding types, amounts, landowner willingness, road access, etc. will ultimately exert a strong influence on how and when proposed measures get implemented.

Portions of the project area including several of the management measures listed (specifically some of those on USFS lands) already have approved regulatory clearances for them, as depicted in Figure 5. Specifically, these areas already have had cultural resource surveys conducted and Endangered Species Act Section 7 consultation concluded, with approval under a Categorical Exclusion (CE). However, any management measures implemented on private lands with federal funding would need cultural and biological surveys prior to implementation to adhere to the National Historic Preservation Act and the Endangered Species Act. Moreover, any in-stream projects implemented (regardless of jurisdiction) would need to adhere to regulations under Clean Water Action Section 401/404, which may necessitate cultural and biological clearances, as well.

Sources of funding could include: CWA Section 319 funding, United States Fish and Wildlife Service (USFWS) Partners for Wildlife, Natural Resources Conservation Service (NRCS) Environmental Quality Incentives Program (EQIP), NMED River Stewardship Program and TU. See *Implementation Schedule and Costs* section below, for detailed

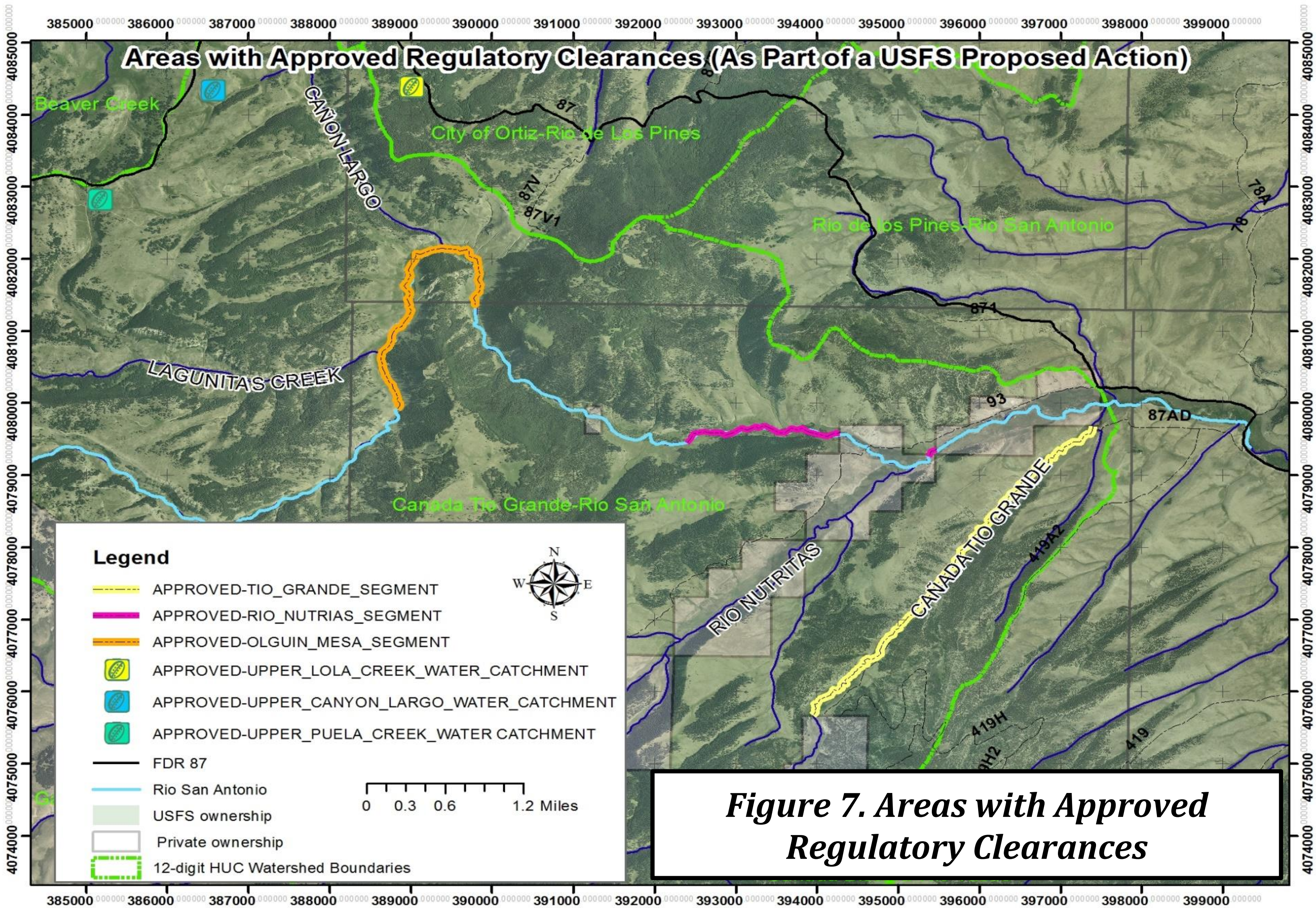


Figure 7. Areas with Approved Regulatory Clearances

Education, Outreach & Adaptive Management

WBP DEVELOPMENT:
Outreach to potential stakeholders regarding the need to achieve water quality standards, was a critical part of this WBP development (Appendix E. Consultation List). Letters were mailed using an extensive mailing list of landowners within the District jurisdiction, which included land surrounding the project area boundary. Numerous scoping/ stakeholder meetings were held throughout the project duration, at the District office and in the field. The following entities were involved in meetings associated with this WBP development:

- NMED/SWQB
- NM Department of Game and fish (NMDGF)
- USFS District staff
- TU (Enchanted Circle Chapter)
- CPLA
- RME staff
- Local grazing association members
- CCC

Additionally, a field sampling tour was held in May 2015, where participants assisted in sampling of macroinvertebrates and provided input about their water quality concerns and/or ideas for treatments. Moreover, technical specialists from the USFS were heavily involved in scoping and development of proposed management measures here in.

USFS agricultural permittees that have allotments within the project area are supportive of the proposed management measures. TU is also in support of the project and members attended the riparian field sampling tour in May 2015.

However, development of strong relationships built on trust is a prerequisite to collaborative implementation. Therefore, one of our fundamental approaches for sustainability is to continue the open dialogue, and to strengthen relationships created during the scoping process for this WBP. As trust continues to develop, the motivation to engage collaboratively in restoration projects will increase.

FUTURE WBP IMPLEMENTATION:
Future success of the implementation phase of this WBP is reliant on support from the USFS agricultural permittees, private agriculturalists, conservation groups and others consulted as part of this document development. The measures promoted herein focus on drawing upon local knowledge from agriculturalists and others, and further developing technical capabilities and capacity of land managers.

Regarding WBP implementation, below are the primary strategies proposed for stakeholder engagement | adaptive management | technical capacity building:

Robust stakeholder engagement and partnerships

- Continue strengthening stakeholder relationships with private landowners and other interested parties (agencies, conservation groups, etc.) that have been established through this planning effort. Provide special consideration of inholdings along riparian areas within planning area.

    - Entities that could be involved, and their roles include:
        - NMED/SWQB-data collection to fill data gaps for D.O., nutrients, *E.coli*, etc.
        - NMDGF-technical expertise
        - USFS-technical expertise/ land base
        - USFS agricultural permittees
        - TU-local support, knowledge of the fishery
        - CPLA-community outreach and organizing
        - RME-construction/ technical expertise
        - Natural Resource Conservation Service (NRCS)-technical expertise
        - Local grazing association private landowners-local knowledge/ technical expertise
        - CCC-local connections/ technical expertise

- Maintain and expand the existing watershed group email list, hold field meetings updating stakeholders of key, relevant events.
    - Stakeholder field meetings could be held to describe project goals of achieving water quality standards, technical information, funding opportunities, and to solicit input. These would be open to the public, advertised through direct mailings utilizing the USFS permittee mailing list and in local newspapers (if deemed necessary).
    - The email forum is essential to keep people connected, generate dialogue, create awareness of funding and technical training opportunities, and to build trust for the watershed group.
- Hold riparian management workshop/s.
    - These workshops are of course a way to promote technical knowledge, but they also expose stakeholders to each other and create another forum to build trust. Additionally, these workshops can underscore the need for stakeholder participation in the maintenance of management measures.

Adaptive rangeland management

- Adaptive management is dependent upon stakeholder input. Stakeholders (specifically local landowners, permittees, etc.) are often the first to realize when existing management measures are not effective or not achieving water quality goals. Thus, stakeholder input as described above, is critical to understanding when course correction and adaptive management needs to take place.

- Coordination with permittees for adapting grazing rotation systems.
  Since grazing is the primary land use in the project area, a detailed description of the grazing systems currently utilized is provided below.
  - Three grazing allotments occur within the project area: the San Antone Allotment (USDA-USFS 2008), the Tio Grande Allotment (USDA-USFS 2008b), and the Lagunitas Allotment (USDA-USFS 1996) (Figure 8). Their respective management strategies are summarized below. Detailed specifications for each AMP can be found in their Environmental Assessment documents cited above.

➢ *San Antone Allotment: 41,281 FS acres*

"The San Antone Livestock Association has a term permit for 861 cow/calf, 29 bulls, 5/17 to 10/16 (153 days); and 7 pasture deferred rotation or rest rotation grazing system that provides varying cool and warm growing season rest for each of the 7 pastures" (USDA-USFS 2008).

"There are riparian areas within the allotment that includes the Rio San Antonio, Lola Creek and Canada del Oso. The Rio San Antonio watertrap site is within the Wheatgrass pasture. A Rio Nutritas watertrap site is within the Nutritas pasture. An approximate 2.3-mile segment of the Rio San Antonio (located in the Ursulo pasture) is accessible to the livestock from the San Antone allotment, San Antonio Mt. allotment and Driveway Trail. Also, there are intermittent surface flow creeks and drainages within the Chino, Tanques and Hondo pastures" (USDA-USFS 2008).

"Pasture Management Actions:

- Range in livestock numbers, entry dates, exit dates and AUMs
- 107 to 153 days (5/17 – 6/1 to 9/15 – 10/16)
- Deferred/Rest Rotation Grazing System – 7 pasture deferred rotation; 3 pasture (Ursulo, Chino, Wheatgrass) entry rotation (Range Readiness entry dates for Chino and Wheatgrass are usually later than Ursulo. For example, if Wheatgrass entry date is May 24 (7 days later than May 17) - reduction of 5% of days/AUMs.
- Oso – rest 1 year in 7 years
- Oso – limit 20 to 28 days
- Tanques – limit 12 to 15 days
- Nutritas – limit 20 to 23 days
- Ursulo – herd away from Rio San Antonio riparian
- Oso – herd away from Lola Creek/Canada del Oso riparian (once each day)
- Hondo, Tanques, Nutritas – herd away from riparian areas
- All pastures - Salt areas in uplands (0.5 to 1.0 mile from water sources)
- 20% to 40% utilization monitoring guidelines" (USDA-USFS 2008).

"Periodic scheduled annual rest for each pasture within the proposed 7 pasture deferred/rest -rotation system may be equivalent to 12 months to 16.5 months of rest and the opportunity-to- grow, depending on the watershed, vegetation and climate conditions.

The pasture rotation system schedule may provide for resting partial to complete cool or warm season growth periods, as well as, providing substantial potential to increase the desirable herbaceous ground cover" (USDA-USFS 2008).

- *Tio Grande Allotment: 31,774 FS acres*

"The Tio Grande Livestock Association term permit is 988 cow/calf, 33 bulls, 5/15 to 10/14 (153 days); and is a 5 pasture deferred rotation system that provides varying cool and warm growing season rest for each of the 5 pastures. However, one of the 5 pastures, (Corral) is usually grazed during the entry and exit dates for several days during the authorized grazing period, and in some years is in nonuse due to a dry earthen dam stock tank. There are riparian areas within the allotment that includes the Rio Nutritas and Canada Tio Grande. The Rio San Antonio watertrap sites (2) are within the allotment but otherwise the Rio San Antonio is not accessible to the livestock. Also, there are intermittent surface flow creeks and drainages such as the Arroyo Aguaje de la Petaca" (USDA-USFS 2008b).

"Pasture Management Actions:

- Range in livestock numbers, entry dates, exit dates and AUMs
- 107 to 153 days (5/17 – 6/1 to 9/15 – 10/16)
- Deferred/Rest Rotation Grazing System – 5 pasture deferred/rest rotation; 2 pasture (Placitas, Lucero Lakes) entry rotation (Range Readiness entry date for Lucero Lakes is usually later than Placitas. For example, if Lucero Lakes entry date is May 22 (7 days later than May 15), then there is a reduction of 5% of days/AUMs).
- 20% to 40% utilization monitoring guidelines
- Corral – limit days to 7 to 10 days; limit number to < 150 c/c.
- Tio Grande – Authorize for only trailing of cattle through pasture
- Brokeoff – herd away from Cisneros Park
- Tecolote – not graze before 6/22; rest 1 of 4 years; manage crossing permit (1500 – 1600 cattle) to reduce Rio Nutritas riparian impacts.
- Entry pastures – Placitas/Lucero Lakes
- Placitas – alternate as entry pasture with Lucero Lakes.
- Lucero Lakes – herd away from riparian exclosures; alternate as entry pasture with Placitas.
- Brokeoff, Tecolote, Lucero Lakes Riparian Areas – herd daily away from riparian.
- All pastures – Salt areas in uplands (0.5 to 1.0 mile from water sources)" (USDA-USFS 2008b).

"Periodic scheduled annual rest for each pasture within the proposed 5 pasture deferred/rest –rotation system may be equivalent to 12 months to 15.5 months of rest and the opportunity-to- grow, depending on the watershed, vegetation and climate conditions. The pasture rotation system schedule may provide for resting partial to complete cool or warm season growth periods, as well as, providing substantial potential to increase the desirable herbaceous ground cover" (USDA-USFS 2008b).

'Best management practices that include supplemental feeding and herding away from intermittent drainages, water sources and riparian areas would continue. Limiting the number of days grazed each year under a deferred rotation to the allowable use level, would provide for conservative utilization or intensity, lower frequency of use and more opportunity to grow for cool season grass species" (USDA-USFS 2008b).

- *Lagunitas Allotment: 26,007 FS acres*

"The term permit for the Lagunitas Livestock Association is for 925 c/c, 6/16 to 10/5, 112 days; and is a 5 pasture rest/deferred rotation grazing system that provides varying cool and warm growing season rest for each of the 5 pastures" (USDA-USFS 1996).

The Lagunitas pastures listed below have portions within the following riparian areas:

Olguin Pasture:	Rio San Antonio; Rio Nutrias; Tanques Canyon
Southfork Pasture:	Rio San Antonio headwaters;Lagunitas Creek
Diablo Pasture:	Diablo Creek headwaters/Escondido Creek headwaters; Lagunitas Creek headwaters
Canon Largo Pasture:	Canon Largo headwaters; Rio San Antonio
Beaver Pasture:	Beaver Creek; Osha Creek headwaters; Lobo Creek headwaters

"Pasture Management Actions:

- The Outstanding National Resource Waters (ONRW) in New Mexico designation for Cruces Basin Wilderness area streamflows includes Lobo Creek, Escondido Creek, Osha Creek, Diablo Creek, Beaver Creek and Cruces Creek. ONRW's (perennial waters) receive the highest protection under the state Water Quality Act.
- Continue to minimize grazing use in the riparian areas of the allotment with special emphasis on the wilderness riparian in order to meet the riparian standards each grazing season. Continue to herd livestock away from the riparian areas and use salt placement to improve livestock distribution. Monitor, maintain or improve the riparian green zone forage. Improve livestock distribution when initially entering the pasture by moving small groups throughout the pasture, to various salt locations with rider representation from all the members. Also, herd/move livestock within the authorized pasture every few days to distribute cattle.
- One herd within each authorized pasture should be maintained throughout the grazing season and good cleanouts of the pastures should occur.
- Provide rest for herbage in the Canon Largo prescribed burn area when periodic burn maintenance is prescribed, possibly in 2015. Therefore, Canon Largo will be grazed early in the rotation to allow for the opportunity for growth to occur prior to burning later in the season. A prescribed burn for the grassland area (1200 acres) was conducted in the fall, 2008. The prescribed burn was conducted under favorable

prescription parameters and with adequate dormant ground fuels where the annual production was average to above-average. However, green herbage areas (high moisture) were present and were intermixed with the dormant ground fuels.

- Prevent excess use by Lagunitas cattle within the adjoining allotments, Apache, San Antone and Tio Grande. Prevent excess use by Apache or Tio Grande cattle into the Lagunitas.
- Rotate pastures to vary the cool and warm growing season rest and allow the opportunity for cool and warm season growth. Periodically follow rest rotation grazing system.
- FS monitoring of the Olguin pasture trailing route to prevent heavy use/intermingling by Grant cattle in the fall" (USDA-USFS 1996).

  - USFS personnel are committed to enhancing water quality of the area through exploring unique pasture rotation practices with their grazing permittees.
  - The terms and conditions of the term permits and the annual operating instructions (AOIs) provide flexibility in livestock numbers, entry/exit date and period of use, and would provide the potential to improve the rangeland condition/trend over the 10 year term permit. Also, the AOI flexibility and the deferred/rest-rotation system would provide cyclical cool and warm growing season rest and adjustments to the annual stocking rates. However, in advance of these changes, outreach must be made, and trust between USFS staff and permittees needs to be further developed.

- Hold riparian planting workshop/s where the most effective types of fence ungulate exclosures are constructed.
  - Land managers (i.e., USFS staff, private landowners and/or USFS permittees) must first see the value in fence exclosures prior to their interest in maintaining them. Planting workshops enable relationships to develop, which can drive motivation to maintain fence exclosures, over time.

A schedule, estimated costs and milestones for success regarding education, outreach and adaptive management is provided below in Tables 7 and 8.

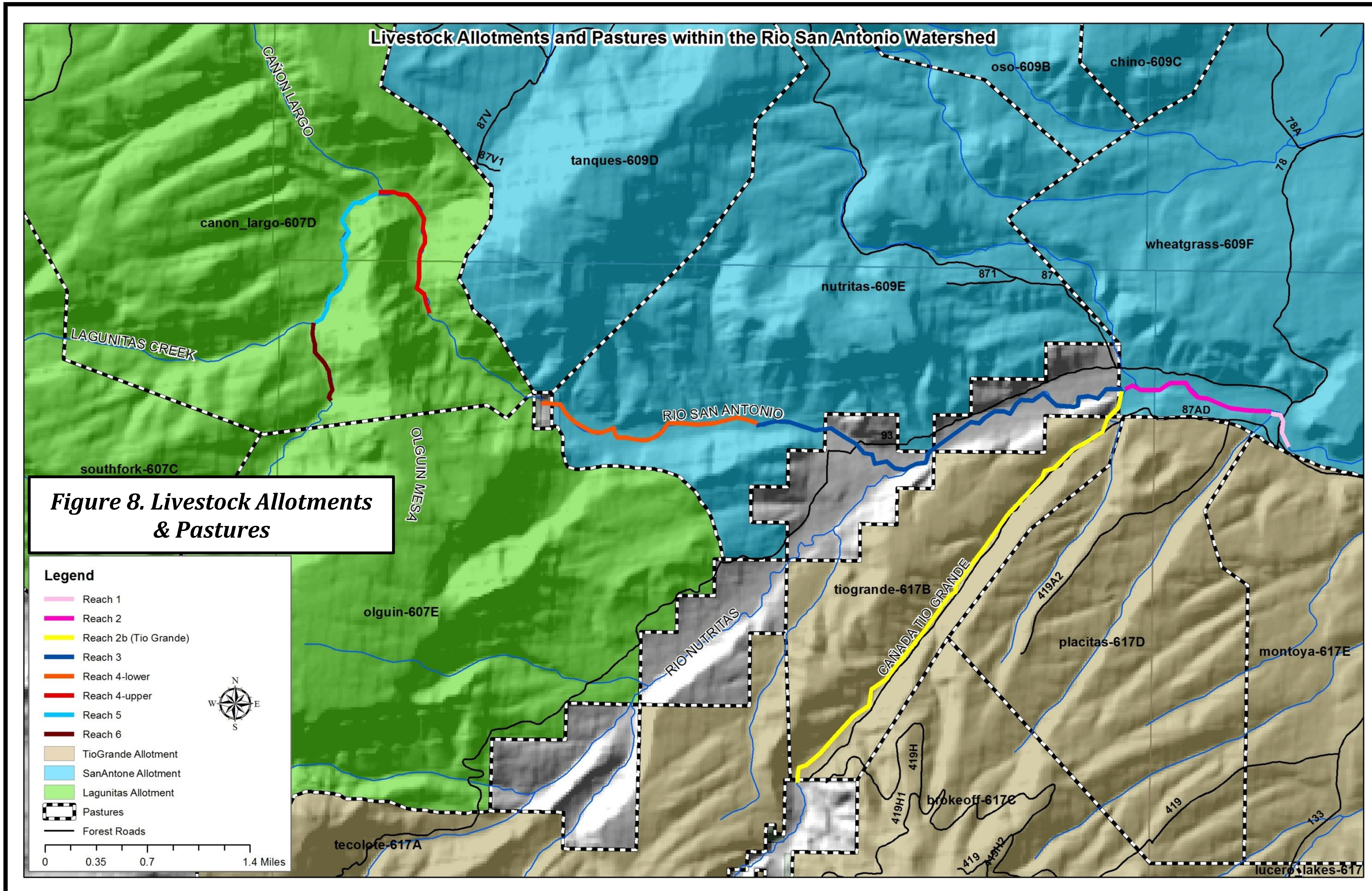


Figure 8. Livestock Allotments & Pastures

Implementation Schedule and Estimated Costs

This section of the WBP presents a proposed schedule for implementing management measures described in prior sections. Implementation of management measures on private property is conducted under the discretion of the landowner. An implementation schedule is described in Table 8. The implementation schedule describes management measures and their respective impacts on design reaches within the project area. The following table depicts the timeline of when each management measure will take place, the reaches where it should occur, potential funding sources, costs, as well as the agency or organization responsible for each management measure. The implementation schedule includes management milestones, which will address the progress of management actions. The proposed implementation schedule occurs over a 3-year period.

The achievement of milestones presented within the implementation schedule is largely dependent upon first acquiring the appropriate funding and regulatory clearances previously described.

The following funding sources (and overall estimated contributions) could be sought out:

- CWA Section 319 funding - $350,000 over multiple years
- USFWS Partners for Wildlife - $25,000 per private landowner
- NRCS EQIP - $200,000 over multiple years
- NMED River Stewardship Program - $250,000 over multiple years
- TU - $10,000 - $50,000 over multiple years

Table 8. Implementation Schedule

Management Measure	Reach (See Figure 2 for reach numbers)	Responsible Entity with Necessary Expertise	Financial Assistance	Estimated Per Unit Cost	Estimated Units to be Completed	Estimated Total Cost	Percent of Practices Implemented (Milestones) Year 1	Year 2	Year 3
MANAGEMENT MEASURES									
Land Management and Restoration Projects									
Riparian vegetation improvements	Primary 4-upper, 5, 2b Secondary 3, 1, 4-lower	USFS, Private landowners, RME, CCC	CWA Section 319 funding; USFWS Partners for Wildlife; NRCS EQIP; NMED River Stewardship Program	$2/willow whip; $15/ cottonwood pole; $20/ containerized shrub; Average $65-hr labor;	Primary 10,000 whips; 300 cottonwoods;300 containerized shrubs; 600 man-hrs; 2 weeks food/lodging Secondary 10,000 whips; 300 cottonwoods;300 containerized shrubs; 600 man-hrs; 2 weeks food/lodging	Primary Supplies-$30,500; Labor-$36,000; Secondary Supplies-$30,500; Labor-$36,000;	25%	25%	50%

Management Measure	Reach (See Figure 2 for reach	Responsible Entity with Necessary	Financial Assistance	Estimated Per Unit Cost	Estimated Units to be Completed	Estimated Total Cost	Percent of Practices Implemented (Milestones)		
In-stream structure placement (large woody debris, boulders)	Primary 4-upper, 5, 2b Secondary3, 1, 4-lower	USFS, Private landowners, RME, CCC	CWA Section 319 funding; USFWS Partners for Wildlife; NRCS EQIP; NMED River Stewardship Program	$2,500-$4,500/per structure (includes mobilization, design & harvesting material from local sources on-site and use of machine)	Primary 15 structures Secondary 15 structures	Primary $37,500-$67,500 Secondary $37,500-$67,500	25%	25%	50%
Small, fence exclosures around critical planted areas	Primary 4-upper, 5, 2b Secondary3, 1, 4-lower	USFS, Private landowners, TU, RME, CCC	CWA Section 319 funding; USFWS Partners for Wildlife; NRCS EQIP; NMED River Stewardship Program	$800/ < 0.20-ac fence exclosure (includes labor and using range fence and t-posts)	Primary Up to 30 exclosures Secondary Up to 30 exclosures	Primary $24,000 Secondary $24,000	25%	25%	50%
Weir/ Fish barrier construction	4 and/or 5 (USFS land)	USFS, NMDGF, TU	TU, USFWS Partners for Wildlife; NRCS EQIP;	$5,000-$10,000 per barrier	2 exclosures	$10,000-$20,000	25%	25%	50%

Management Measure	Reach (See Figure 2 for reach	Responsible Entity with Necessary	Financial Assistance	Estimated Per Unit Cost	Estimated Units to be Completed	Estimated Total Cost	Percent of Practices Implemented (Milestones)		
Streambank/ riparian erosion control	Primary 4-upper, 5, 2b Secondary 3, 1, 4-lower	USFS, Private landowners, TU, RME, CCC	CWA Section 319 funding; USFWS Partners for Wildlife; NRCS EQIP; NMED River Stewardship Program	$1,800-$3,000/per structure (includes mobilization, design, harvesting material from local sources on-site, and use of machine)	Primary 15 structures Secondary 15 structures	Primary $27,000-$45,000 Secondary $27,000-$45,000	25%	25%	50%
Construction of numerous water catchments in uplands	Uplands only	USFS, Urban Construction, RME, CCC	CWA Section 319 funding; USFWS Partners for Wildlife; NRCS EQIP; NMED River Stewardship Program	$3,000-$5,000 per water catchment (includes mobilization, and construction with heavy equipment)	Up to 8 water catchments	$24,000-$40,000	25%	25%	50%

Management Measure	Reach (See Figure 2 for reach	Responsible Entity with Necessary	Financial Assistance	Estimated Per Unit Cost	Estimated Units to be Completed	Estimated Total Cost	Percent of Practices Implemented (Milestones)		
Construction of numerous sediment reduction structures in uplands	Uplands only	USFS, Private landowners, RME, CCC	CWA Section 319 funding; USFWS Partners for Wildlife; NRCS EQIP; NMED River Stewardship Program	$2,000-$4,000 each depending on design	Up to 10 sediment reduction structures	$20,000 - $40,000	25%	25%	50%
Adaptive Management, Education and Outreach									
Robust stakeholder engagement and partnerships • Maintain email list updating stakeholders of key, relevant events • *Hold general riparian management workshop/s*		USFS, RME, CCC	CWA Section 319 funding; USFWS Partners for Wildlife; NRCS EQIP; NMED River Stewardship Program	Email list management could be covered with minimal expense. ------------------ Riparian workshop costs could range from $2,000-$3,000, depending on the scope, # of days, etc.	Up to three workshops over three years	$4,000-$6,000	33%	33%	33%

Management Measure	Reach (See Figure 2 for reach	Responsible Entity with Necessary	Financial Assistance	Estimated Per Unit Cost	Estimated Units to be Completed	Estimated Total Cost	Percent of Practices Implemented (Milestones)		
Adaptive Rangeland management • *Coordination with permittees for adapting grazing rotation systems* • *Hold riparian planting workshop/s where the most effective types of ungulate fence exclosures are constructed* • *Maintenance of fence exclosures over time*		Coordination-USFS ----------------- Exclosure maintenance-USFS, RME, CCC	CWA Section 319 funding; USFWS Partners for Wildlife; NRCS EQIP; NMED River Stewardship Program	Riparian workshop costs could range from $2,000-$3,000, depending on the scope, # of days, etc. ----------------- <$2,000 over three years	Up to three workshops over three years ---------------- One maintenance outing	$4,000-$6,000 --------------- < $2,000 over three years (not including material costs)	33%	33%	33%

Implementation Milestones

Measuring success and making adjustments are key to successful watershed management. The following measurable milestones relate to the specific criteria developed to track the implementation of management measures. Moreover, developing criteria to measure progress ensures progress will be made. Strategies for improving watershed function will be pursued under the standards of Adaptive Management, in which "careful monitoring of these outcomes both advances scientific understanding and helps adjust policies or operations as part of an iterative learning process." Notably, "adaptive management is not a 'trial and error' process, but rather emphasizes learning while doing" (USDI 2009).

QUANTITATIVE MILESTONES

- **Assessment of Standards Attainment**
  Continued stream temperature and D.O. monitoring will be performed at established instrument locations and compared to baseline data. Stream shade measurements will be compared to targets.
- **Units Completed**
  The numerical total of stream miles treated or the number of on-the-ground projects will be compared with target values.
- **Number of Education/ Outreach Efforts**
  At the end of year 1, 2, and 3 the number of education efforts will be tallied. Such efforts include consultation with landowners, workshops, trainings, and public presentations.

QUALITATIVE MILESTONES

- **General Effectiveness**
  Restoring watershed conditions are dependent on community and stakeholder engagement. The general effectiveness of community and stakeholder outreach efforts will be considered in the pursuit of watershed restoration goals. General effectiveness milestones include, but are not limited to: 1) ability of landowners to maintain management measures; 2) ensuring projects are technically and financially feasible; and 3) developing landowner interest in management measures and restoration projects.

COURSE CORRECTION & ADAPTIVE MANAGEMENT PROCESS/STRATEGY

If monitoring efforts focusing on criteria to determine the need for course corrections (as shown in Table 9) indicate that implementation milestones are not being achieved, the following course correction and adaptive management process/ strategy would be utilized:

- Data from annual or biennial monitoring efforts (detailed in Table 9) would be reviewed by technical specialists.
- Next, a field meeting involving technical specialists would first be held to evaluate particular sites/areas where management measures are not meeting targets.
- A collective agreement among stakeholders on the exact treatment measure to be implemented would occur.
- Specific funding source/s would be targeted to address the specific problem/s (if necessary).

- The appropriate contractor would be utilized to remedy the situation, with oversight by the project manager.

Criteria for Evaluating Load Reductions

Attaining water quality standards requires monitoring criteria designed to determine whether pollutant load reductions are being achieved. The following monitoring criteria provide a framework for evaluation of watershed management measures. Direct measurements of stream temperature, D.O. concentration and canopy cover will be used to evaluate load reductions. Detailed indicators, target values, and interim targets are presented in Table 9. The NMED temperature standards represent the basis for evaluating load reductions. Specifically, temperature should not exceed 20° C under 4T3 standards, instantaneous temperature should not exceed 23° C, or D.O. concentrations should not fall below 6.0 mg/L. Furthermore, increase in canopy cover will also be measured and compared to desired values (i.e. 55%). See *Causes of Impairment* section above for data gaps and a future management strategy to sample for and identify D.O., nutrients and *E. coli* at key locales throughout the project area.

Table 9. Criteria for Evaluating Load Reductions

Management Objective: Reduce Stream Temperature					
Management Measure	**Indicator to Measure Progress**	**Target Value/Condition**	**% Load Reduction**		
			Short-term	**Medium-term**	**Long-term**
Riparian vegetation improvements	Temperature/ D.O. values (May-Sept.)	Fully attaining HQCWF	20% of stations meeting standards	30% of stations meeting standards	40% of stations meeting standards
In-stream structure placement (large woody debris, boulders)	Rosgen Level II channel assessment	Width/depth ratios < 20	---	25% of surveyed reaches achieving	30% of surveyed reaches achieving
Small, fence exclosures around critical planted areas	Canopy cover measurements	Achieve 55% canopy cover in all treatment areas	10% increase over baseline	15% increase over baseline	20% increase over baseline
Streambank/ riparian erosion control	Greenline sampling method	High channel stability values (i.e. Greenline values > 7)	All values >7	All values >8	All values >8
Management Objective: Improve General Watershed Quality, Health & Stakeholder Involvement					
Management Measure	**Indicator to Measure Progress**	**Target Value/Condition**	**Measure of Success**		
			Short-term	**Medium-term**	**Long-term**
Construction of		Evidence of water	Presence of	Presence of	Presence of

numerous water catchments	Photographs	and ungulate utilization at all sites	water in all structures	water in all structures	water in all structures
Construction of numerous sediment control features	Photographs	Reduction of sediment inputs	Presence of sediment in all structures	Presence of sediment in all structures	Presence of sediment in all structures
Fish barrier construction	Genetic purity of Rio Grande cutthroat trout	Proper-Functioning; design and installation	Deep pool formation; Isolation of cutthroat trout based on genetic tests	Deep pool formation; Isolation of cutthroat trout based on genetic tests	Deep pool formation; Isolation of cutthroat trout based on genetic tests
Robust stakeholder engagement and partnerships • Maintain email list updating stakeholders of key, relevant events • *Hold general riparian management workshop/s*	Email list -------------------- -Sign-in sheets; photographs	Interaction and involvement of stakeholder -------------------- Robust private landowner and stakeholder participation in workshops	Targets achieved - for #s of people that participate in workshops	Targets achieved - for #s of people that participate in workshops	Targets achieved - for #s of people that participate in workshops
Adaptive Rangeland management • *Coordination with permittees for adapting grazing rotation systems* • *Hold riparian planting workshop/s where the most effective types of ungulate fence exclosures are constructed* • *Maintenance of fence exclosures over time*	Landowner willingness to commit to rotation systems; field measurements of range condition -------------------- Landowner willingness to maintain exclosures	Stubble-heights of riparian herbaceous vegetation meet USFS standards (≥ 4-inches at end of growing season) ------------------- High attendance of planting workshops	All riparian pastures in the adapted rotation system achieve 4–inch stubble heights at end of growing season	All riparian pastures in the adapted rotation system achieve 4–inch stubble heights at end of growing season	All riparian pastures in the adapted rotation system achieve 4–inch stubble heights at end of growing season

Monitoring Program

A monitoring program is necessary to evaluate the effectiveness of management measures over time compared to baseline conditions. Measured improvements will be documented by specific parameters and measurable criteria. Baseline data is unavailable for private land within the planning area. The monitoring efforts described in this section are designed to track the progress of load reductions and the attainment of water quality standards. As such, the monitoring program includes baseline data (i.e. those data presented in this report), project-specific monitoring (i.e. measures taken during implementation), and post-project monitoring. Monitoring actions are presented in Table 10. Effective monitoring programs will help attribute changes in water quality to the execution of management measures. When feasible, monitoring will be conducted in conjunction with education efforts.

Any implementation project supported with Clean Water Act Section 319 funds will include development of a project-specific Quality Assurance Project Plan (QAPP) to outline monitoring objectives, methods, and quality control methods in greater detail. A goal of the QAPP is to focus on monitoring methods and protocols that link the load reduction from implementation to improvements in the waterbody. A likely method to be used will be the upstream/downstream, before/after analysis of covariance (ANCOVA) used to detect changes in temperature or D.O. swing as a result of land management changes (Grabow, et al. 1998), similar as employed in the report, "Nonpoint Source Program Effectiveness Assessment, 2008-2011" (NMED/SWQB 2011b). Details for data curation and reporting will be detailed in the QAPP. Seasonal or flow-related factors that could affect the quality of the data will also be outlined in the QAPP. In such projects, the QAPP will be completed as an early task before monitoring commences. The proponent of the project (the identity of which has not been determined) or the District will lead this monitoring effort, though NMED would be involved. At present, monitoring is set to occur in association with the five monitoring stations depicted in Figure 2, though explicit details concerning sampling locations will be detailed in the QAPP.

As detailed above in the *Causes of Impairment* section, NMED will be surveying the project with specific focus on nutrients during their next water quality survey, scheduled for 2017 – 2019. The Nutrient Assessment Protocol for Wadeable, Perennial Streams (Nutrient Protocol) (NMED 2015), which was used in the 2009 Upper Rio Grande study (NMED 2009), will be used for that effort. *Escherichia coli* (*E. coli*) bacteria will also be sampled during the 2017-2019 survey effort (See *Causes of Impairment* section above for details). The water quality survey will also provide data that NMED SWQB will use to assess these streams against the temperature and D.O. standards. Additional measures included in the monitoring program of a CWA-funded project are Rosgen Level II channel assessments (i.e. entrenchment ratio, width/depth ratio, sinuosity, channel slope, channel materials (Rosgen 1996), stream shade measurements, and continued temperature and D.O. monitoring.

All personnel conducting monitoring activities will be trained in appropriate protocols and methodologies prior to commencement.

Reporting of monitoring results will occur routinely, and generally be submitted during the winter following the field season of sampling efforts.

Table 10. Monitoring Program

Station	Frequency	Parameters Monitored	Entity Conducting Monitoring
1	Annual or biennial	D.O., temperature, canopy cover, Greenline, repeat photo points, nutrients, *E. coli*, Rosgen Level II channel assessment	Proponent, District & NMED
2b	Annual or biennial	D.O., temperature, canopy cover, Greenline, repeat photo points, nutrients, *E. coli*, Rosgen Level II channel assessment	Proponent, District & NMED
3	Annual or biennial	D.O., temperature, canopy cover, Greenline, repeat photo points, nutrients, *E. coli*, Rosgen Level II channel assessment	Proponent, District & NMED
4	Annual or biennial	D.O., temperature, canopy cover, Greenline, repeat photo points, nutrients, *E. coli*, Rosgen Level II channel assessment	Proponent, District & NMED
5	Annual or biennial	D.O., temperature, canopy cover, Greenline, repeat photo points, nutrients, *E. coli*, Rosgen Level II channel assessment	Proponent, District & NMED

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