The Rio Fernando de Taos Watershed-based Plan

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List of Abbreviations

AB	Amigos Bravos
BMP	Best Management Practice
BSLC	Bacteria Source Load Calculator
CFU	Colony-Forming Unit
CNF	Carson National Forest
CWA	Clean Water Act
EPA	United States Environmental Protection Agency
FLJ	La Jara Sampling Site
FRE	Riparian Exclosure Sampling Site
GI	Green Infrastructure
LID	Low Impact Development
MDWA	Mutual Domestic Water Association
MST	Microbial Source Tracking Study
NMDOT	New Mexico Department of Transportation
NMED	New Mexico Environment Department
NOAA	National Oceanic and Atmospheric Administration
NPS	Nonpoint Source
NRCS	Natural Resources Conservation Service
ONRW	Outstanding National Resource Water
RGWF	Rio Grande Water Fund
RFdT	Rio Fernando de Taos
RFdT Collaborative	Rio Fernando de Taos Revitalization Collaborative
RPdT	Rio Pueblo de Taos
SWQB	New Mexico Environment Department Surface Water Quality Bureau
TC	Taos County
TLT	Taos Land Trust
TMDL	Total Maximum Daily Load
TNC	The Nature Conservancy
ToT	Town of Taos
TSWCD	Taos Soil and Water Conservation District
TVAA	Taos Valley Acequia Association
USFS	United States Forest Service
USGS	United States Geological Survey
WBP	Watershed-Based Plan
WQCC	New Mexico Water Quality Control Commission
WRAS	Watershed Restoration Action Strategy

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1 Executive Summary

In 2006, the Meridian Institute received a 319 grant from the U.S. Environmental Protection Agency (EPA) through the New Mexico Environment Department's (NMED's) Surface Water Quality Bureau (SWQB) to develop a WRAS (Watershed Restoration Action Strategy; Atencio et al. 2006) for the Upper Rio Grande Watershed. The WRAS included sections for seven sub-watersheds including the Rio Fernando de Taos (RFdT). It was noted at the time that the WRAS for the Rio Fernando de Taos needed additional information for future restoration and funding. The 2006 WRAS identified sources of water quality impairment as follows:

- Recreation and Tourism Activities
- Range Grazing
- Natural Sources
- Land Disposal
- Land Development
- Highway Maintenance and Runoff
- Habitat Modification
- Construction
- Bank or Shoreline Modification Destabilization

In 2007 Amigos Bravos initiated a Monitoring Program with Sierra Club Water Sentinels to develop a baseline of information. In 2016 Amigos Bravos received a 319 Grant to complete a Watershed-based Plan (WBP) to collect further data and create detailed on-the-ground restoration projects for the RFdT. The primary impetus for developing the RFdT WBP derives from an abundance of *E. coli* sampling that highlighted an on-going water quality and public health concern. The most current TMDL report for the Upper Rio Grande basin, which includes the Rio Fernando de Taos, identified *E. coli* exceedances affecting the river's "primary contact" designated use. The cause of impairment in the RFdT is identified as *E. coli* in the 2012 TMDL document for Upper Rio Grande (NMED 2012). However, neither the WRAS, the 2009 study nor the interpretation methods that led to development of the TMDL were designed to identify sources of impairment other than in general terms. There was also a need to create a more focused project plan for the RFdT than was done in the Upper Rio Grande WRAS in 2006.

Amigos Bravos and other stakeholders identified the following data/ information gaps critical to characterizing the sources of impairment in the watershed and creating more detailed project to address this impairment:

- The need to augment ongoing monitoring by Sierra Club Water Sentinels and Amigos Bravos by conducting extensive *E. coli* monitoring to pin-point pollutant sources.
- The need to identify detailed solutions to water quality problems for the Taos community and the river.

Amigos Bravos utilized their already existing and successful monitoring program to conduct testing and monitoring of the Rio Fernando de Taos at different times of the year and developed a significant database of findings. The results of testing of levels of *E. coli* at approximately 50 sampling sites along the river can be found in Section 4.6 and 4.7 of this document. Microbial Source Tracking results of *E. coli* bacteria sources (human, dog, elk, etc.) at five sites can be found in Appendix A and Chapter 4 (Section 4.9). A robust project list has been developed and can be found in Chapter 6.

Confirmed sources of *E. coli* pollution in the Rio Fernando during this project (2016-2019) are: contaminated stormwater runoff, humans, cattle, birds, dogs, and beavers. There were many sample events following rain events that confirm run-off as a major source of *E. coli* pollution. Results indicate that source mitigation is most necessary in the upper and lower reaches of the river with a focus on human, dogs, and cattle sources. Seasonal sampling and the MST study confirmed that the cattle grazing allotments in the upper watershed are a prevalent source of the *E. coli* loading in the area (Cow DNA was 64% and 36% detection frequency). This sampling also indicated that dog and bird were even more frequent contributors to the area than cattle. This does not tell us which source was contributing more *E. coli* bacteria, just how frequently the source was contributing. See Appendix A for a more detailed analysis.

While birds were found to be a common source at the five sites in the MST study, this is a natural source that is often controlled through reducing private feeding of birds on the river. However, feeding birds is not a practice in the area at a level that would artificially inflate the bird populations on the Rio Fernando de Taos. However, we will inform the community of these findings, and create bird-focused projects if needed and feasible based on their feedback. It is important to note that on-the-ground projects identified in this document that increase flow in the river and/or create/repair wetlands will help most to decrease all natural *E. coli* inputs including those from birds.

A total of 24 on-the-ground projects (Figure 6-1) are proposed along with 14 Outreach projects (Figure 7-1) to address the sources found in this Watershed-based Plan. Amigos Bravos has 32 years of experience protecting watersheds through research, public involvement, and legal activities. Please visit www.amigosbravos.org for more information about our many projects across New Mexico.

2 Introduction

2.1 Nonpoint Source Pollution Control in New Mexico

According to New Mexico's Water Quality Control Commission (WQCC) Clean Water Act (CWA) 303(d)/305(b) Integrated Report, the majority of surface water quality problems identified in New Mexico are caused by nonpoint source (NPS) pollution (WQCC, 2012). In 1987, the United States Congress recognized that state and local water authorities needed technical and financial resources to develop and implement management measures to control NPS pollution. Therefore, Congress passed the *Water Quality Act of 1987*, amending the CWA to include 33 U.S.C. §1329, hereafter Section 319, which requires states to assess the nature and extent of water quality impairment resulting from NPS pollution and develop management programs to control sources identified. According to the United States Environmental Protection Agency (EPA), NPS pollution "occurs when water runs over land or through the ground, picks up pollutants, and deposits them in the surface waters or introduces them into groundwater" (EPA, 2018). Under Section 319 of the CWA, the State of New Mexico has the legal authority to implement the NPS Management Program to address NPS pollution within the state's waters. The New Mexico NPS Management Program emphasizes watershed-based planning to support implementation of established Total Maximum Daily Loads (TMDLs), coordinate restoration efforts on priority watersheds, and facilitate the achievement of surface water quality standards.

2.2 New Mexico Water Quality Standards

Under the CWA and the New Mexico Water Quality Act, New Mexico is required to adopt water quality standards. New Mexico's water quality standards (*Standards for Interstate and Intrastate Surface Waters, New Mexico Water Quality Control Commission, 20.6.4 NMAC 2019*) establish designated uses for all surface waters of the state, and determine specific biological, chemical and descriptive criteria needed to maintain designated uses. Criteria for water quality standards are broken into three categories: General, Designated Use and Segment-Specific.

General criteria standards apply to all surface waters of the state, unless a specified criterion is provided elsewhere under the Designated use or Segment-specific criteria.

Designated use criteria are developed to ensure designated uses of waterbodies can be maintained.

Segment-specific criteria determine standards that pertain to specific segments of a waterbody and apply to water bodies that are divided into different segments depending on chemical and physical characteristics as well as the designated uses for that segment.

The Water Quality Control Commission is New Mexico's designated agency tasked with overseeing water pollution control to ensure compliance with federal and state water quality standards. Because the WQCC has no technical staff, the commission utilizes the New Mexico Environment Department (NMED) to monitor and enforce state water quality standards. The New Mexico Environment Department's Surface Water Quality Bureau (SWQB) utilizes intensive watershed surveys to identify water quality problems and determine designated use attainment status. Streams that do not meet water quality standards or maintain all designated uses are considered *impaired* and placed on the State's 303(d) List of Impaired Surface Waters [303(d) List]. Waterbodies that are considered impaired must have TMDLs calculated. New Mexico's NPS Management Program requires NMED to work with cooperating organizations and local stakeholders to develop watershed-based plans (WBPs) to implement the NPS portions of TMDLs. Implementation of WBPs is a key part of the NPS Management Program to help waters attain designated uses and achieve water quality standards.

The state also adopted the antidegradation policy that assures where waterbodies meet or exceed water quality standards, measures are in place to prevent deterioration of water quality and protect outstanding national resource waters (ONRWs).

2.3 Total Maximum Daily Loads (TMDLs)

In cases where the SWQB finds water quality standards have been exceeded, the waterbody is considered impaired and placed on the State's 303(d)/305(b) list of impaired waters. The New Mexico Environment Department is then tasked with calculating TMDLs for the impaired waterbody. A Total Maximum Daily Load identifies the maximum amount of pollutant that a waterbody can receive without violating water quality standards.

TMDL is calculated as the sum of:

1. Individual waste load allocations for point sources
2. Load allocation for nonpoint sources
3. Natural background conditions

This summation determines the budget for pollutant influx to a specific waterbody. A TMDL document as a written plan and analysis is established to ensure that a waterbody will attain and maintain water quality standards. A TMDL document also takes into consideration existing and foreseeable increases in pollutant loads. Once a TMDL has been established for a waterbody, NMED encourages implementation through point source permitting and a WBP to explain the sources of impairment and what management measures will reduce pollution to attain water quality standards. Because most pollutant loading to the RFdT is from non-point sources, the WBP is critical for identifying appropriate load reduction methods.

2.4 Watershed-Based Planning Process

Due to the complex and diffuse nature of NPS pollution, the substantial costs to address it, and reliance on voluntary actions taken by individual landowners to reduce pollutant loading, the NMED encourages development of a WBP to address NPS pollution and attain water quality standards. The watershed planning process is a stakeholder driven approach that provides comprehensive analysis of the causes and sources of pollution and identifies and prioritizes the critical areas where conservation practice implementation should occur to restore or maintain water quality.

The guiding principles for creating a WBP require building partnerships with local stakeholders, characterizing the watershed to understand the causes and sources of impairment, and determining what management measures will result in necessary pollutant load reductions to attain designated uses and water quality standards. Over the years, successful Section 319 funded projects demonstrate that implementation of a WBP occurs when stakeholders participate in identifying the sources and causes of pollution and help determine what management measures will be implemented. Stakeholder involvement during the planning process ensures a local willingness to adopt and maintain the conservation practices that will restore and maintain water quality.

2.5 Nine Elements of Effective Watershed-based Plans

In order to create effective NPS management plans, the EPA developed the nine minimum elements of WBPs to guide the planning process and provide a flexible framework that systematically leads to water quality improvements and restoration efforts that attain water quality standards. Under Section 319(h) of the CWA, EPA requires that these nine elements be addressed in the WBP to receive 319(h) funding for implementation. Addressing these elements ensures a watershed plan can implement established TMDLs to attain water quality standards and restore watershed health. The nine elements of a WBP include:

1. Identify the causes of impairment and pollutant sources that will need to be controlled to achieve load reductions or other goals identified within the plan.
2. An estimation of load reductions expected from the management measures used to achieve water quality goals.
3. Information about NPS management measures that will need to be implemented to achieve load reductions, and description of the critical areas in which those measures will need to occur to implement the plan.
4. Estimate technical and funding needs to support the implementation and maintenance of restoration measures, and the sources and authorities that will be relied upon to implement the plan.
5. An information/education component used to enhance public understanding of the project and encourage early and continued participation in selecting, designing and implementing the NPS management measures that will be implemented.
6. A schedule for implementation of NPS management and restoration measures and identification of appropriate lead agencies to oversee implementation, maintenance, monitoring and evaluation.
7. A description of interim, measurable milestones for the actions to be taken and desired water quality goals and outcomes.
8. A set of criteria that can be used to determine whether loading reductions are being achieved over time and substantial progress is being made toward attaining water quality standards.
9. A monitoring component to evaluate the effectiveness of the implementation efforts over time, measured against criteria established under section 8.

2.6 Impairment of Concern in the Rio Fernando de Taos Watershed

The impetus for developing the Rio Fernando de Taos (RFdT) WBP derives from an abundance of *Escherichia coli (E. coli)* that highlighted an on-going water quality and public health concern. The most current TMDL report for the Upper Rio Grande basin, which includes the RFdT, identified *E. coli* exceedances affecting the rivers *primary contact* designated use.

> The TMDL report establishes TMDLs for *E. coli* on three assessment units (stream segments) of the Rio Fernando de Taos. The three segments are described and broken down further below. **The segments will be referred to as the "upper", "middle", and "lower" segments throughout this document.**

The New Mexico Environment Department began working on TMDL background monitoring for the RFdT in 1999 and released a final document for the Upper Rio Grande, including the RFdT in 2005. The two parameters of concern for TMDLs were temperature and specific conductance. Amigos Bravos (AB) and the Sierra Club Water Sentinels-Rios de Taos conducted water quality monitoring in the Upper Rio Grande Basin and compiled information in the *2011 Taos Water Quality Sampling Report*. This monitoring documented the *E. coli* impairment in the RFdT, which was accepted by NMED and included in its 2012–14 303(d) list of impaired waters. This list includes three segments of the RFdT for the following impairments:

Segment details:

<u>1) UPPER SEGMENT: NM-98.A_001: Tienditas Creek to Headwaters:</u> Not supporting Primary Contact (No other designated uses assessed). Segment length: 3 miles; Watershed area: 12.1 square miles.

Impaired for: E .coli

Probable sources: Cattle/livestock use, rangeland grazing, hiking trails waste from pets, waterfowl, wildlife, low water crossing, paved/dirt/gravel roads, on-site treatment systems, impervious surfaces, stormwater runoff.

On the upper segment of the RFdT, NMED has identified grazing as a source of impairment. According to the 2012–14 303(d) list (p145):

- *Study of E. coli levels associated with flow observations in the upper 3 miles of the RFdT and Apache Canyon tributary to assess potential impacts from livestock grazing in 2006. The study demonstrated instances when grazing on the Flechado Allotment increased E. coli levels in Apache Canyon and this portion of the RFdT.*
- *Further sampling work performed by AB and Water Sentinels confirmed the E. coli presence and led to impairment listing. Grazing is also implicated in the listing for the lowest segment of the RFdT. All three segments have "unknown" sources of E. coli as well, though on-site treatment (septic) systems have been attributed as the probable source of this "unknown" E. coli impairment.*

The *2006 Rio Fernando de Taos Watershed Restoration Action Strategy* (Atencio et al. 2006) identified grazing, recreational activities, removal of riparian vegetation, stream bank modification and destabilization, runoff from impervious surfaces, pollution from municipal point sources, and natural leaching as having affected water quality in the RFdT.

2) MIDDLE SEGMENT: NM-2120.A_513: USFS boundary to Tienditas Creek: Not Supporting Primary Contact; Fully Supporting High Quality Coldwater Aquatic Life (no other designated uses assessed).

Impaired for: E. coli.

Probable Sources: Cattle/livestock use, rangeland grazing, hiking trails waste from pets, waterfowl, wildlife, low water crossing, paved/dirt/gravel roads, on-site treatment systems, impervious surfaces, stormwater runoff.

3) LOWER SEGMENT: NM-2120.A_512 RPdT to USFS boundary: Not Supporting High Quality Coldwater Aquatic Life or Primary Contact (all other designated uses Fully Supporting except Public Water Supply, which was not assessed).

Impaired For: E. coli, Nutrient/Eutrophication Biological Indicators, Sedimentation/Siltation, Specific Conductance, and Temperature.

Probable Sources: A wide variety of typically urban sources: highway/road/bridge runoff, septic tanks, irrigated crop production, natural sources, other recreational sources, rangeland grazing, source unknown, and stream bank modification/destabilization.

2.7 Significance of the *E. coli* Water Quality Impairment

E. coli bacteria are commonly found in the digestive tracts of warm-blooded animals, including humans. *E. coli* enters the environment through fecal excretion and can be transported to surface waters. Most strains of *E. coli* are not harmful to humans; however, pathogenic strains of *E. coli* exist and have been implicated in several food-borne illness outbreaks in the United States. Along with *E. coli,* numerous other pathogens exist in the intestines of warm-blooded animals and may be present in their feces.

E. coli is currently the most commonly used indicator of fecal bacterial contamination of surface waters in the U.S. according to water quality standards requirements set by EPA. Therefore, water quality standards are developed by most states and tribes for *E. coli* to monitor fecal matter contamination and possible presence of pathogens in waterways.

E. coli enters the water column in numerous ways; for example, when rain or snowmelt washes fecal matter into surface waters or when septic systems fail and leach sewage into ground or surface waters. Both human and animal sources of fecal pollution present serious health risks due to likelihood of pathogens existing in fecal waste. Presence of *E. coli* is a strong indication of recent sewage or animal waste contamination in waterways. However, aquatic environments with high organic matter and nutrient content can harbor significant numbers of *E. coli* in their sediments over time, effectively forming a reservoir of *E. coli* which can be resuspended in the water-column during times of high-flow. Another consideration for *E. coli* in waterways is when growth conditions and adequate nutrients exist, *E. coli* levels could potentially be maintained or even increase within the water column. In these cases, persistence of *E. coli* in the water column may falsely indicate recent fecal contamination and may bolster elevated colony counts, indicating sizable loading of fecal contamination.

Humans are exposed to *E. coli* through two primary pathways: direct ingestion of contaminated water or ingestion of uncooked food products that have been in contact with contaminated water. In northern New Mexico, untreated surface waters are not utilized for drinking, therefore *E. coli* exposure would likely occur during primary contact activities within these contaminated water sources.

Swimming in waters with high levels of *E. coli* (indicating other fecal coliform bacteria as well) increases the chance of developing diseases and illnesses that can be contracted in water with high fecal coliform counts. *E. coli* pathogens that can enter the body through the mouth, nose, ears, or cuts in the skin may cause symptoms of fever, nausea or stomach cramps indicating infection and resulting in disease and illnesses including: typhoid fever, hepatitis, gastroenteritis, dysentery, and ear infections. Fecal coliform and *E. coli* like other bacteria, can usually be killed by boiling water or by treating it with chlorine. Washing thoroughly with soap after contact with contaminated water can also help prevent infections.

E. coli bacteria multiply quickly when conditions are favorable for growth, or die in large numbers when conditions are not. Because bacterial concentrations are dependent on specific conditions for growth, and these conditions change quickly, bacteria counts are not easy to predict. For example, although winter rains may wash more fecal matter from urban areas into a stream, cool water temperatures may cause a major die-off. Exposure to sunlight (with its ultraviolet disinfection properties) may have the same effect, even in the warmer water during summer months.

Bacteria levels do not necessarily decrease as a watershed develops from rural to urban (Oram 2014). Instead, urbanization generates new sources of bacteria, for example farm animal manure and septic systems are often replaced with new systems such as domestic pet feces and leaking sanitary sewers. In fact, stormwater runoff in urbanized areas has been found to be surprisingly high in fecal coliform bacteria concentrations (Strassler and Pritts 1999). The presence of old, disintegrating storm and sanitary sewers, misplaced sewer pipes, and good breeding conditions are common explanations for the high levels measured.

Sediment Load

High amounts of sediment are often correlated to high concentrations of pathogenic bacteria. The bacteria can attach to sediment particles. Fast-running water can carry more sediment, so higher levels of bacteria can occur during high runoff events. Bacteria are more abundant on soils than in water, **therefore retaining soils on the land can reduce *E. coli* loading to surface water**. Methods to keep soil on the land include green infrastructure (GI) and low impact development (LID) erosion control structures. These mitigation techniques help retain nutrients and soils on land, allowing more vegetation to grow that in turn provides more soil retention during large rain events. Pasture management and rangeland management that promotes increased ground cover and reduced runoff can also keep soils and nutrients on the land and reduce *E. coli* loading to surface water.

Temperature

E. coli bacteria grow faster between 30°-40° C (86°-104° F). The growth rate slows drastically at very low temperatures, making it a Mesophile (see Figure 2-1). A mesophile is any organism that grows best in moderate temperatures. All human pathogens are mesophiles (Lumenlearning online course).

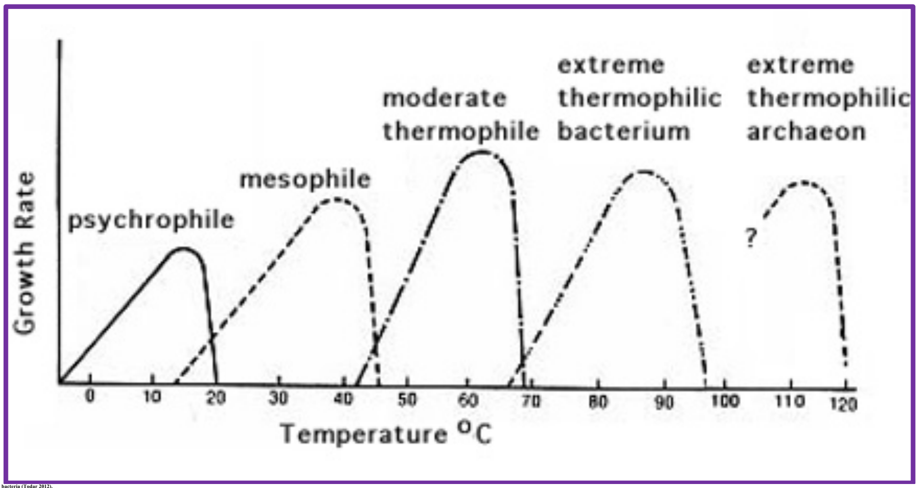


Figure 2-1: Growth rate of different bacteria types. *E. coli* is a mesophilic bacteria (Todar 2012).

3 Watershed Background

3.1 Location

The Rio Fernando de Taos (RFdT) watershed is a sub-watershed of the Upper Rio Grande Watershed, Hydrologic Unit Code (HUC) 13020101, located within Taos County of north-central New Mexico. The RFdT watershed area covers approximately 71.7 square miles, ranging in elevation from just below 11,000 feet at the headwaters in the Sangre de Cristo Mountains to about 7,100 feet at its confluence with the Rio Pueblo de Taos (RPdT) in the agricultural community of Ranchitos, proximate to the Town of Taos (ToT). The project area is defined as the main stem of the RFdT, which is approximately 21 miles in length and is comprised of two sub-watersheds or 12- HUC codes 130201010604 and 130201010601, which break the watershed into an Upper and Lower portion.

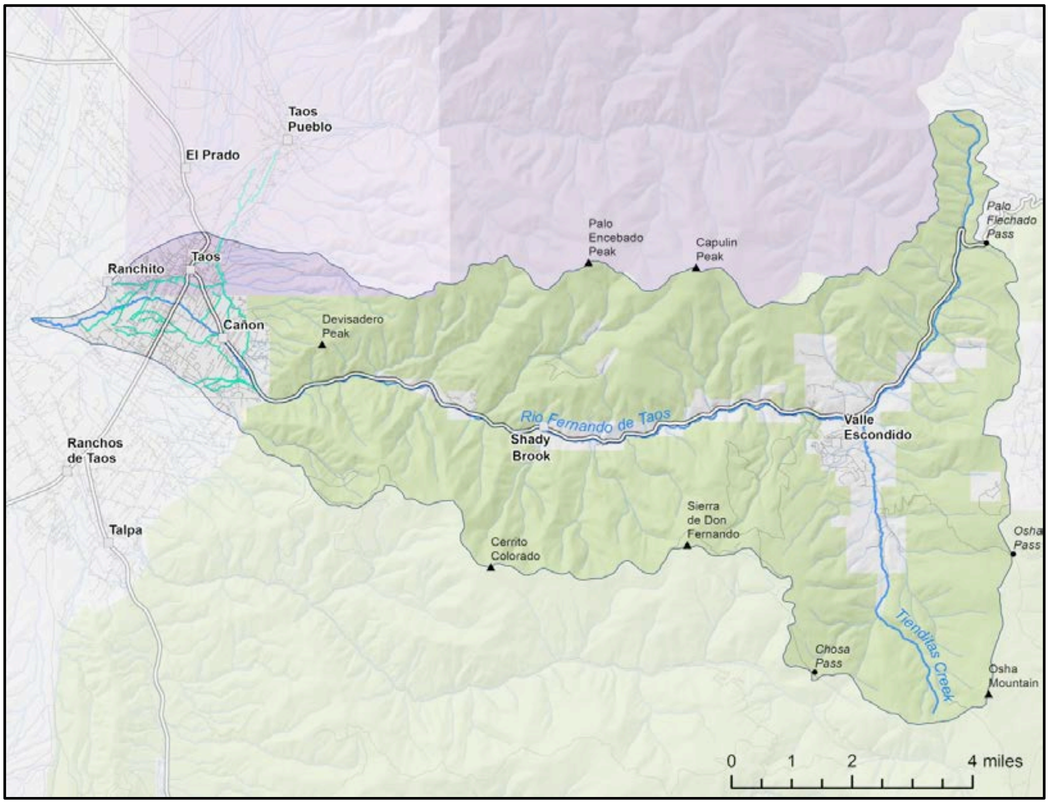


Figure 3-1: Rio Fernando de Taos Watershed Area

The headwaters of the RFdT are fed by two tributaries, La Jara Canyon Creek and Tienditas Creek, which join at the turnoff to Valle Escondido. While coursing through Taos Canyon, the RFdT main stem receives contributions from several small tributary streams emerging from their respective canyons, including Baca Canyon, Capulín Canyon, Ranchos Canyon, Shady Brook Canyon, Mondragon Canyon, and Mascareñas Canyon. To the north, the watershed boundary follows the Pueblo Ridge, which surrounds La Jara Canyon and contains Capulín, Palo Encebado, and Devisadero Peak. The eastern watershed boundary is the ridgeline that separates the Upper Rio Grande and Canadian river basins as well as Taos and Colfax Counties. The southern boundary follows the Fernando Mountains and Osha Mountain ridgeline which encompasses Valle Escondido and the Tienditas Creek Drainage.

3.2 Geology

Geology of the watershed planning area is composed primarily of Paleozoic sedimentary rock created during the Pennsylvanian period (approximately 300 million years ago). These limestones, siltstones, sandstones, shales and conglomerates are exposed over most of the southern part of the Sangre de Cristo Mountains due to tectonic activity and stream erosion, with exposure evident along the RFdT. Parallel-bedded strata of arkosic sandstone, argillaceous limestone and black shales result in stable hillsides and mountain slopes that are not prone to land failure or mass wasting unless altered by undercut erosion resulting in diminished vegetation composition and root strength. Examination of these exposed Pennsylvanian rocks reveals evidence of the original environments where deposition occurred in ancient rivers, deltas, shorelines, tidal flats and shallow seas. Alluvial flows in the corridor have created valley fill, creating alluvial fans at the mouth of tributary drainages and where the mainstem of the RFdT exits in Taos Canyon.

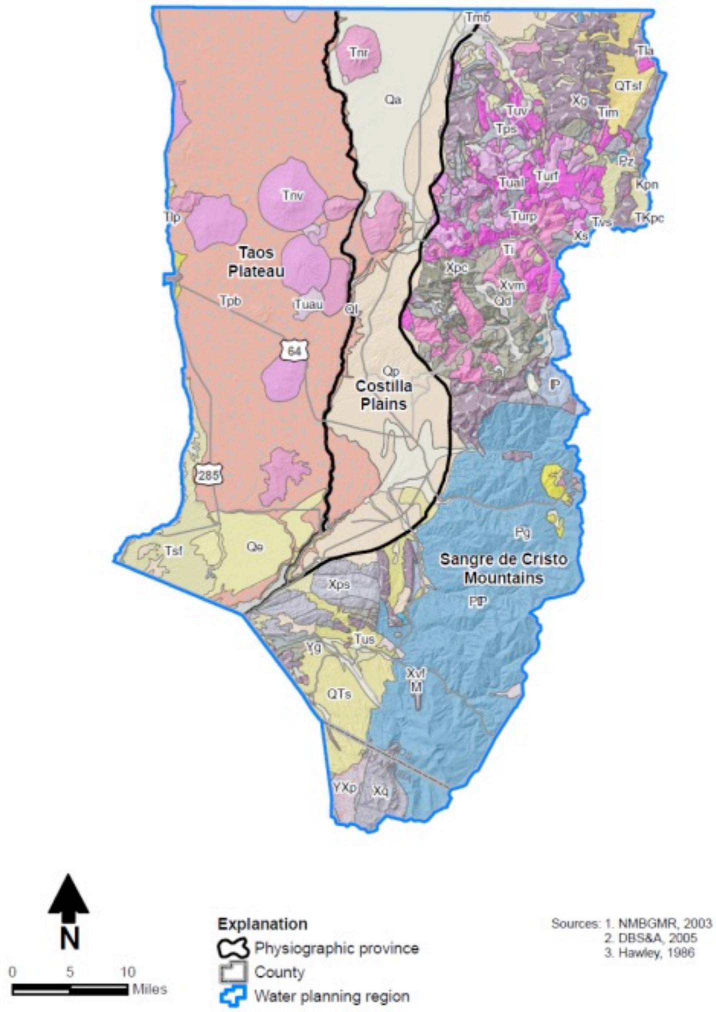


Figure 3-2: Geology of Taos County (New Mexico Natural History Museum 2019)

3.3 Soils

Mountain Slopes: The majority of soils in the upper watershed are characterized by steep mountain slopes, where parent material is typically colluvium derived from weathered or residual sandstone. Colluvial soils here were formed from material moving downslope, where it accumulates at the base of slopes and along small streams. Steepness of the grade typically determines soil profile characteristics and depth. A typical profile often features loam that ranges in clay, sand and silt content with poorly sorted, angular rock fragments at varying sizes. The potential for runoff in these areas ranges from high to very high and coincides with the degree of slope on which they exist.

Mountain Valley Floors: In mountain valleys adjacent to small streams in the upper watershed area, such as Valle Escondido and La Jara Canyon, the parent material is colluvium derived from granite and/or residuum weathered from granite. The typical soil profile here generally features gravelly loam on the surface with cobbly clay loam underneath and finally transitions to sandy loam until reaching bedrock. Due to less dramatic slope and accumulation of material, the potential for runoff in these areas are low.

Terraces: Soils found on terraces within the upper watershed are alluvium based, with the typical profile classified as very cobbly sandy loam with increasing amounts of sand in lower layers. Terraced areas can exhibit stratified extremely cobbly sand and sandy clay above bedrock.

Valley Sides: Directly adjacent to the RFdT on nearly level slopes, the parent material shifts towards alluvial sediments and features loam over sandy clay loam with low potential for runoff.

Alluvial Fans: At the mouth of tributary drainages and Taos Canyon, the landform pattern is characteristic of an alluvial fan and features sediments transported from alluvial flows. The typical soil profile in these alluvial fans is characterized by clay loam at the surface with increasing amounts of silt beneath. The alluvial fan accounts for the majority of farmland within the RFdT watershed and when irrigated is considered prime farmland.

3.4 Vegetation

Vegetation composition in the upper watershed often features densely forested ecosystems. In the highest elevations of the watershed area, vegetative composition is dominated by spruce-fir forest types, with patches of aspen throughout. On south facing slopes species such as ponderosa pine can become more prominent within mixed conifer systems. Forest areas in the lower elevations are composed primarily of Piñon/Juniper woodlands.

Acres by Vegetation Cover Type on National Forest	
Vegetation Type	**Acres**
Oak Shrub	595
Aspen	4,384
Pinon - Juniper	4,698
Ponderosa Pine	4,750
Mixed Conifer	19,461
Spruce Fir	2,388
Grasslands	1,027
Private	5,175
Total Acres	42,477

Figure 3-3. Vegetation Cover Types in the RFdT watershed (USFS 2019).

Vegetation communities in tributary drainage areas and broad meadows of the upper watershed are composed of species typically observed in wet upland meadows, herbaceous and woody wetlands and riparian ecosystems. These high water-table areas adjacent to surface waters in the upper watershed host a diverse range of perennial grasses, forbs, sedges, deciduous trees such as willow and alder as well as mixed conifers making it desirable habitat for numerous wildlife such as elk and deer and valuable pasture for grazing permitees (cattle) and private landowners.

Vegetation in the lower watershed is dominated by herbaceous perennials found in irrigated fields that are utilized either as pasture for livestock grazing or cultivation of feed crops such as alfalfa and hay. Due to flood irrigation methods and proximity to riparian areas, a large portion of these lands effectively function as emergent herbaceous wetlands. Much of the tree canopy in the lower watershed is made up of deciduous species typically found in riparian zones and exists near surface waters, either along the main stem of the RFdT or the *acequias* (irrigation ditches) that divert its waters. Shrubs are another common vegetation type found in the lower watershed and are interspersed in some of the upper watershed meadows. Dominant species such as sagebrush, rabbitbrush or snakeweed are often found interspersed in lower elevation shrub/grasslands with shrubby cinquefoil more common in higher elevation meadows.

3.5 Wildlife

Wildlife species found within the watershed corridor are typical of the Southern Rockies, with the watershed area supporting a diversity of fauna including elk (*Cervus canadensis)*, deer (*Odocoileus hemionus*), American black bear (*Ursus americanus*), mountain lion/cougar (*Puma concolor*), bighorn sheep (*Ovis canadensis)*, waterfowl (various species), raptors (various species), songbirds (various species) and many other small, animals both native and invasive. Elk and deer are considered abundant in the upper watershed area and potentially pose threats to sensitive riparian and wetland vegetation from grazing pressure and over-population. The Rio Fernando de Taos Revitalization Collaborative (RFdT Collaborative) has proposed performing an elk carrying capacity study within the watershed to better understand the impacts of the elk herd population dynamics and the study's potential to inform management objectives and actions.

Beaver (*Castor canadensis*) have been sighted within the corridor and are believed to once have once been abundant. Years of trapping, dam removal and grazing of riparian and wetland areas have diminished much of their historic range within the watershed. One of the RFdT's designated uses is High Quality Coldwater Aquatic Life, which means the river should support species associated with clean, cold streams typical of the intermountain west such as native Cutthroat Trout (*Oncorhynchus clarkii*) and aquatic macroinvertebrates. The Tienditas Creek tributary contains a conservation population of native Rio Grande Cutthroat Trout (*Oncorhynchus clarkii virginalis)*. Restoration of RFdT's riparian zones could promote aquatic life and encourage beaver to recolonize areas by enhancing and expanding habitat.

3.6 Hydrology

The upper watershed area is tightly bounded within the Sangre de Cristo Mountain range. Steep hills and canyon walls lead surface water to follow a dendritic drainage pattern that flows primarily east to west with most tributary drainages contributing water flow to the mainstem in a northerly to southerly direction. In total, the watershed contains approximately 53 miles of perennial stream. The Rio Fernando de Taos watershed is fed primarily by snowmelt. Review of available United States Geological Survey (USGS) data for the RFdT indicates that peak flow typically occurs in Spring and coincides with the height of snowmelt runoff. Approximately 50% of total precipitation in the watershed

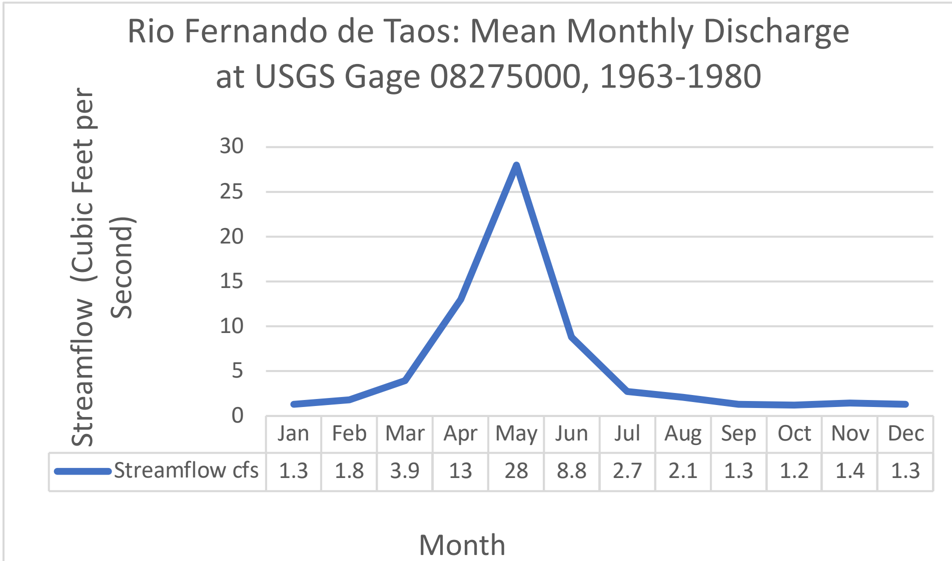


Figure 3-4: Hydrography Data of RFdT at USGS Gage Station 08275000

occurs during winter months in the form of snowfall and is stored in higher elevation portions of the drainage. High elevation snowpack contributes a majority of surface water to instream flow during spring runoff events. Peak flow occurrence during late summer is attributed to monsoonal events that contribute large amounts of precipitation at varying intensity and duration within the watershed area. Streamflow measurement and observation during this period indicate that peak flow occurrence can be determined either by the amount of snow pack and rate of snowmelt or the duration and intensity of summer monsoonal activity.

According to hydrogeological survey and modeling done of the area, groundwater recharge occurs primarily in the upper watershed's wetland areas (Benson 2004). Beaver ponds downstream of the Valle Escondido turnoff also provide groundwater recharge, as these features retain, store and slow surface water movement and sediment flow allowing for infiltration to the alluvial aquifer.

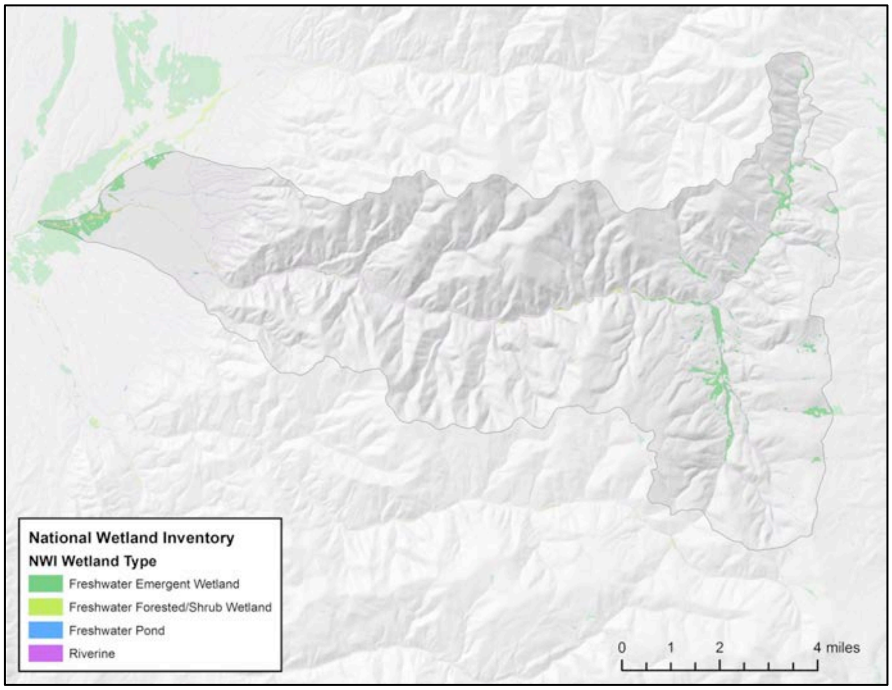


Figure 3-5: Rio Fernando de Taos Wetland Inventory; US Fish and Wildlife National Wetland Inventory.

Meadows in upland areas and along ridge tops accumulate snowmelt and rainwater that also provides a source of groundwater recharge. Hydrological reports of the Taos valley area indicate that flooding of areas adjacent to lower segments through traditional acequia use augments urban filtration and serves to recharge the community's aquifer system (Benson, 2004).

3.7 Climate

Climate of the watershed planning area varies throughout the corridor with regards to precipitation and temperature. The headwaters begin in the high elevation, alpine environs of the Sangre de Cristo Mountains where the climate is sub-humid and average annual precipitation is 21–30 inches. Most precipitation in this area falls in the form of snow from November–March and is typically stored as snowpack during winter months and released in phases of spring melt as runoff. In the lower elevation segments of the RFdT, the climate of the surrounding area shifts towards semi-arid conditions. In this segment of river, the area receives 13–14 inches of annual precipitation on average. Most of this precipitation falls in the form of rain and is received during summer monsoonal events that typically occur from July–September. Average maximum and minimum temperatures vary within the watershed dependent on elevation. The Palo Flechado SNOTEL climate station provides air temperature data representative of the upper watershed. The Town of Taos climate station takes readings at 6,985 feet, which is representative of the climate in the lower watershed. The upper watershed experiences colder temperatures for longer periods of time leading to an increase in precipitation that falls in the form of snow and potential to accumulate snowpack. The lower watershed on average experiences higher temperatures and a reduced capacity to retain snowpack. Most precipitation in this portion of the watershed is received during summer monsoonal events.

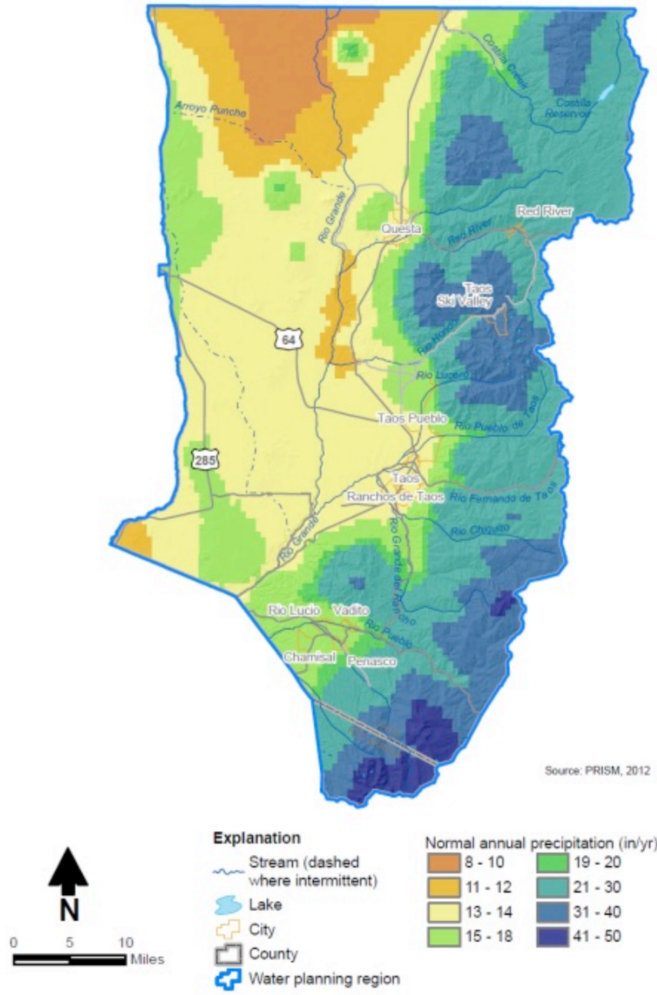


Figure 3-6: Average Annual Precipitation in Raster Data Form from PRISM Climate Data 2012, Based on 1980–2010 Climate Normals; Map taken from Taos County Regional Water Plan (2016)

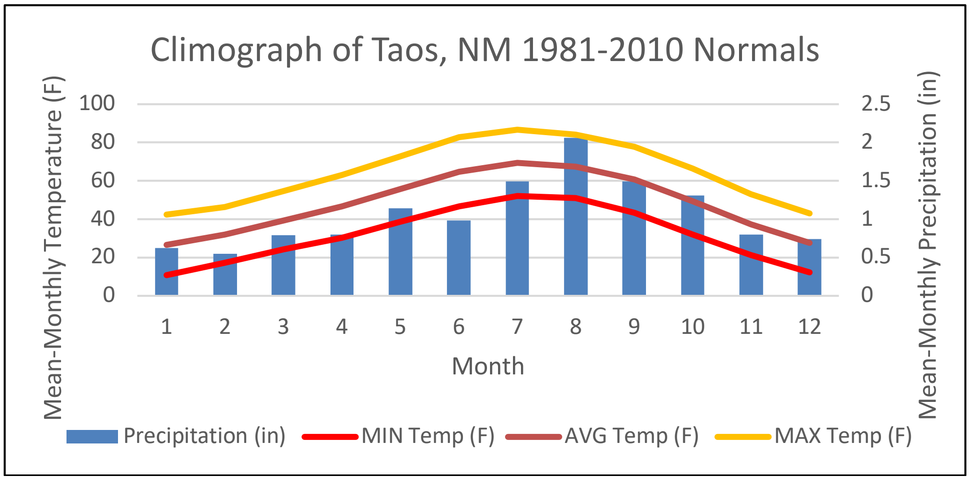


Figure 3-7: Town of Taos Climograph; Data collected at Taos Climate Station: Elevation 6,985 feet. Climate Normals generated by National Climatic Data Center of NOAA (NOAA 2010).

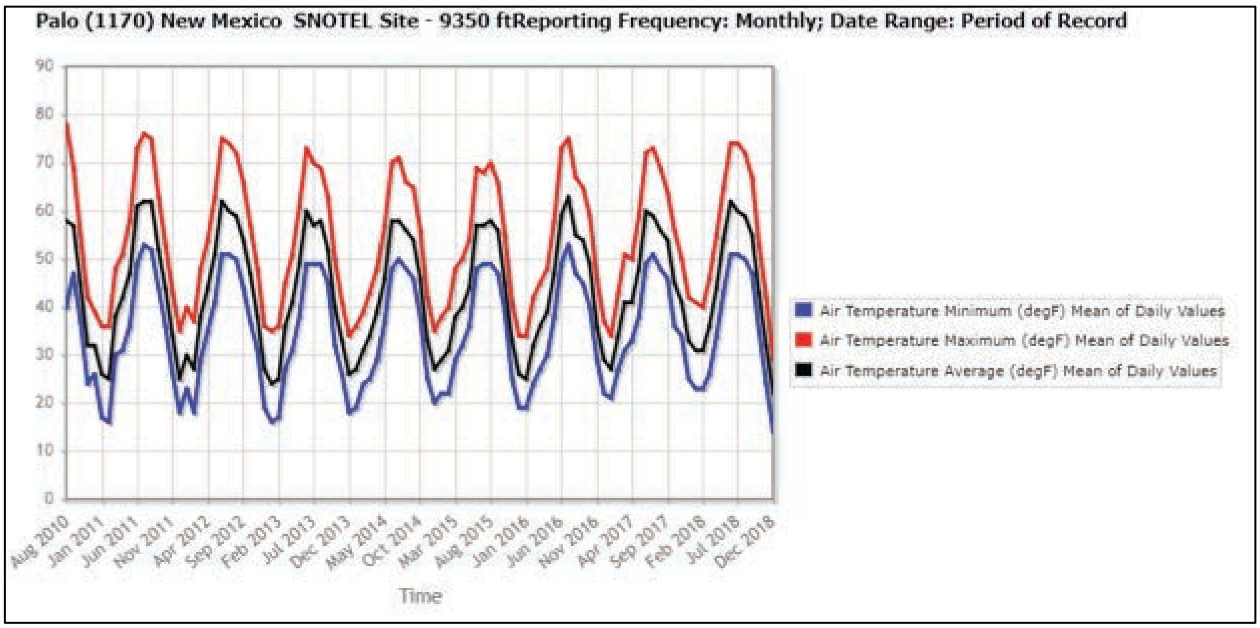


Figure 3-8: Palo SNOTEL Climate Station (Elevation 9,350 feet): Temperature Data from Natural Resources Conservation Service (NRCS) National Weather and Climate Center (USDA NRCS 2018).

3.8 Land ownership within the Rio Fernando de Taos Planning Area

United States Forest Service (USFS): Within the watershed planning area, surface land ownership is dominated by USFS who manages 88% of the total watershed area. National Forest System lands within the watershed are administered by the Camino Real Ranger District of the Carson National Forest. USFS administered lands support a variety of land uses and activities and have several on-going management projects within the watershed area.

Private: Within the watershed planning area, 12% of land is owned privately. Private lands within the upper watershed planning area are primarily located within the riparian zone of the main stem of the RFdT as well as the Tienditas Creek drainage. Highway US-64 runs parallel for most of the length of the river, connecting the ToT to the Moreno Valley. Along the highway, numerous individual dwellings are found adjacent to the river. Valle Escondido is the second largest community in the watershed, located in the upper reaches along Tienditas Creek and features a large golf-course and resort. Most of the drainage area in the lower portion of the watershed is privately owned by individuals or the ToT. In this portion of the watershed, private land owners often utilize irrigable lands as pasture for grazing of livestock or winter feed production. This segment of the watershed area features a much higher building and population density relative to the rest of the watershed. Increased amounts of impervious surface (building footprints and roadways) which creates higher potential for urban runoff contaminants to enter the river during monsoonal or snowmelt events.

Taos Pueblo: Taos Pueblo lands boarder the top of the Rio Fernando watershed at what is called Pueblo Ridge.

3.9 Land Use/ Land Cover

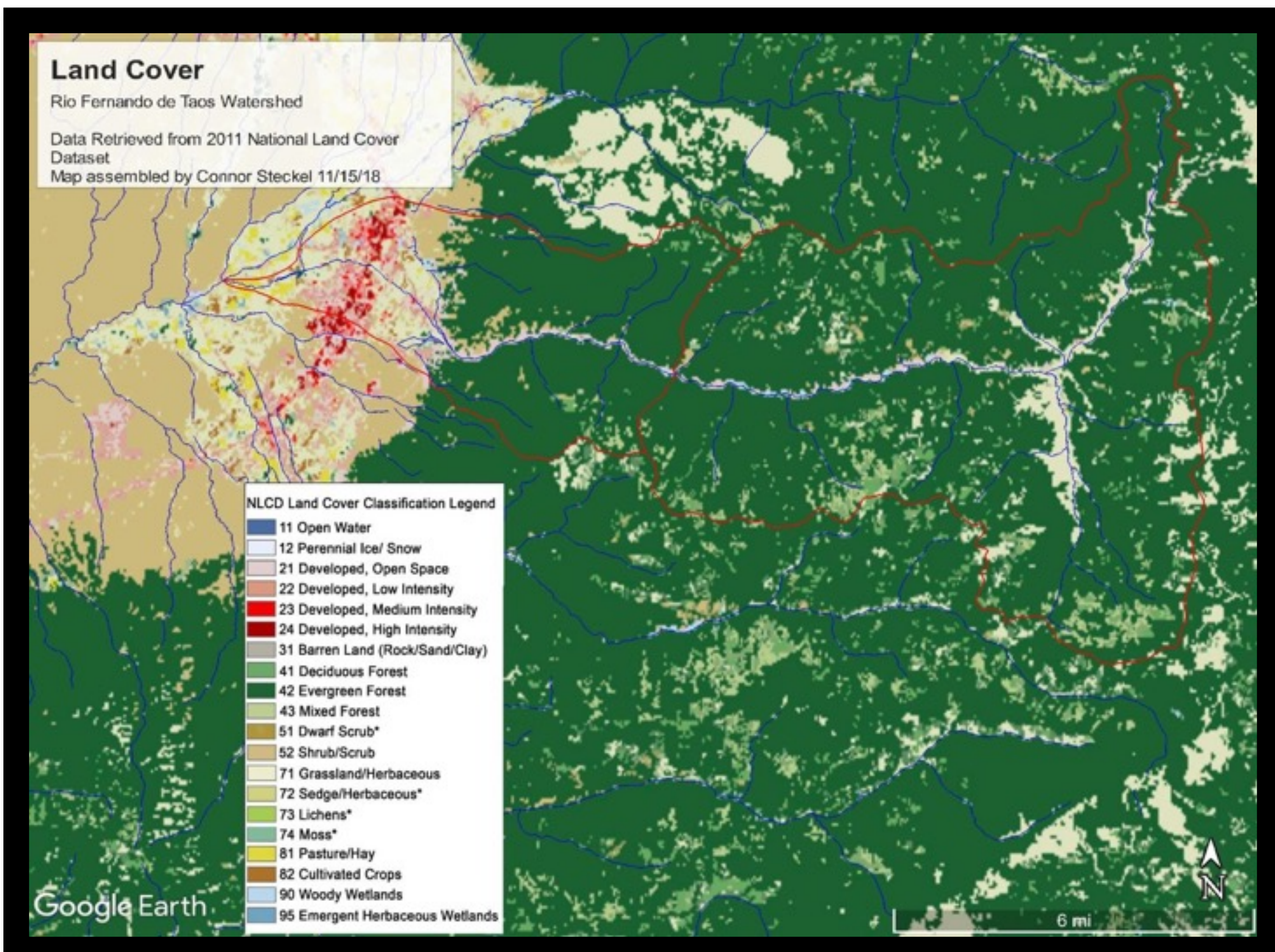


Figure 3-9: Land Cover of Rio Fernando de Taos Watershed, Data retrieved from 2011 National Land Cover Dataset (NLCD 2011).

Upper Watershed: USFS boundary at Taos Canyon to Headwaters

Analysis of the 2011 National Land Cover Dataset shows the upper watershed is dominated by forest, covering about 91.6% of watershed area. Grass/pasture covers approximately 6% and developed land accounts for less than 1% of the upper watershed area. The remaining land cover in the upper watershed is attributed to shrubland and wetland. Most of the developed land and impervious surface within the upper watershed can be attributed to US highway 64 (US-64) and the individual dwellings adjacent to the roadway. There are numerous recreational opportunities that exist on USFS lands adjacent to US-64 and proximity to town makes some of these areas highly trafficked. There is also illegal off-road vehicle use and dispersed camping that occurs in riparian areas that can pose threats to sensitive vegetation communities.

There are two USFS administered grazing allotments within the upper watershed. The Flechado Allotment #453 is permitted to graze up to 100-131 cow/calf pairs and was authorized in 2018 to run 80 cow/calf pairs with 4 bulls. Capulin Allotment is permitted to graze up to 55 cow/calf pairs and 4 bulls, and ran 44 cow/calf pairs and 4 bulls in 2018. The Capulin Allotment is approximately ¼ in the "upper" segment of the watershed and ¾ in the "middle" segment of the watershed. Grazing on these allotments typically occurs between June 1 and September 30, but a range readiness assessment determines the allotments 'on-date' and is performed by USFS specialists and the permittee. Maps below display Capulin allotment drinker/spring locations and the four pastures used. This allotment does not have direct access to the Rio Fernando but to its tributaries.

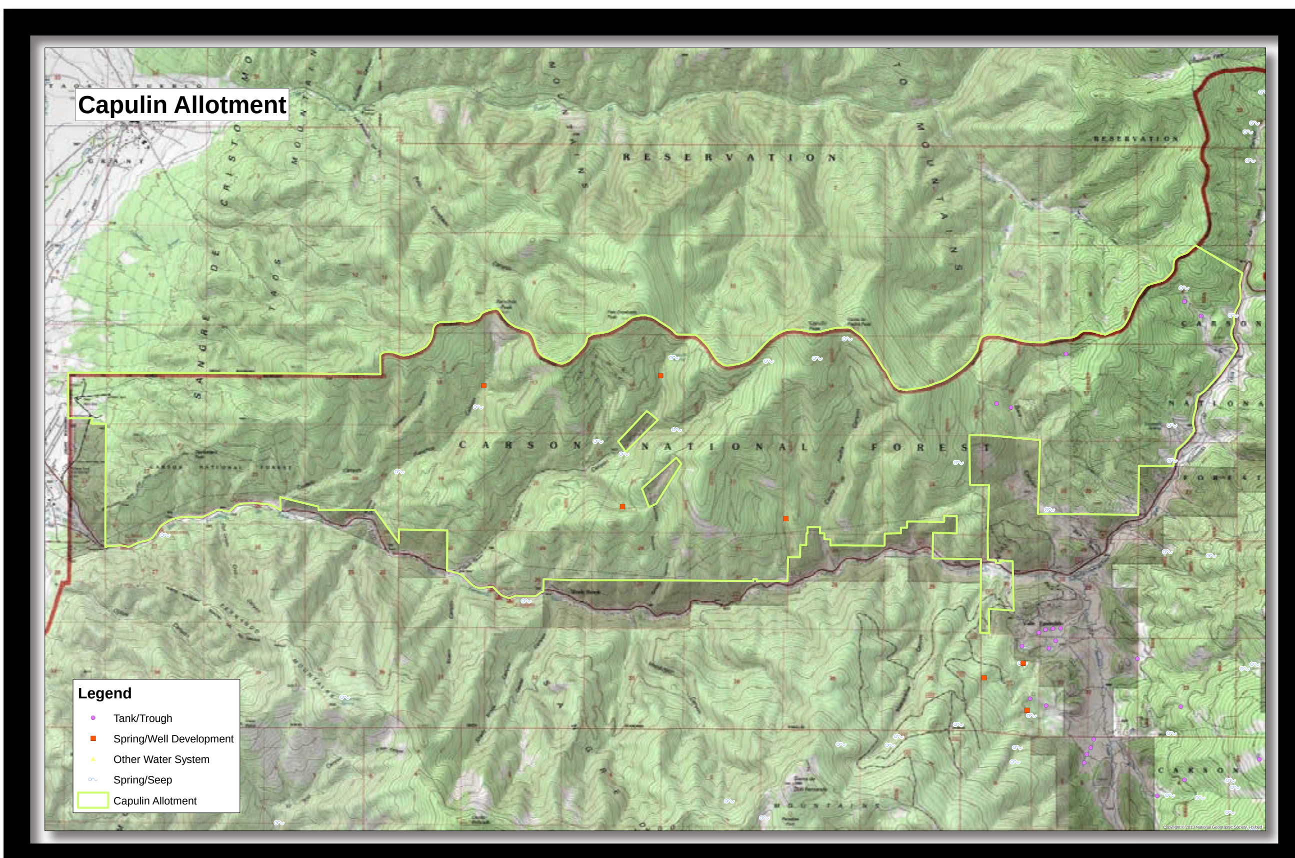


Figure 3-10 Capulin Allotment and Drinker Map

Figure 3-11. Capulin Allotment Map showing the Pastures.

The Flechado Allotment features six pastures for the permittee to rotate cattle between. Each pasture has estimated on-dates and duration of use, which range from 25-10 days. Drinkers in the La Jara Canyon area were developed in the past two years to increase grazing infrastructure in accordance with wider grazing/natural resource management planning efforts. The idea behind developing springs for livestock watering is to provide sources of water further from riparian areas, ideally incentivizing cattle to graze and congregate in areas outside of riparian zones. These cattle are permitted (Annual Operation Instructions) by the Forest Service to have access to the Rio Fernando approximately 40 days. However fencing often is broken and cattle access the river many more days than the Permit/Annual Operation Instructions allows. During this WBP process, a fencing project was complete around the Riparian Pasture, FRE to address this problem (location explained in Chapter 4).

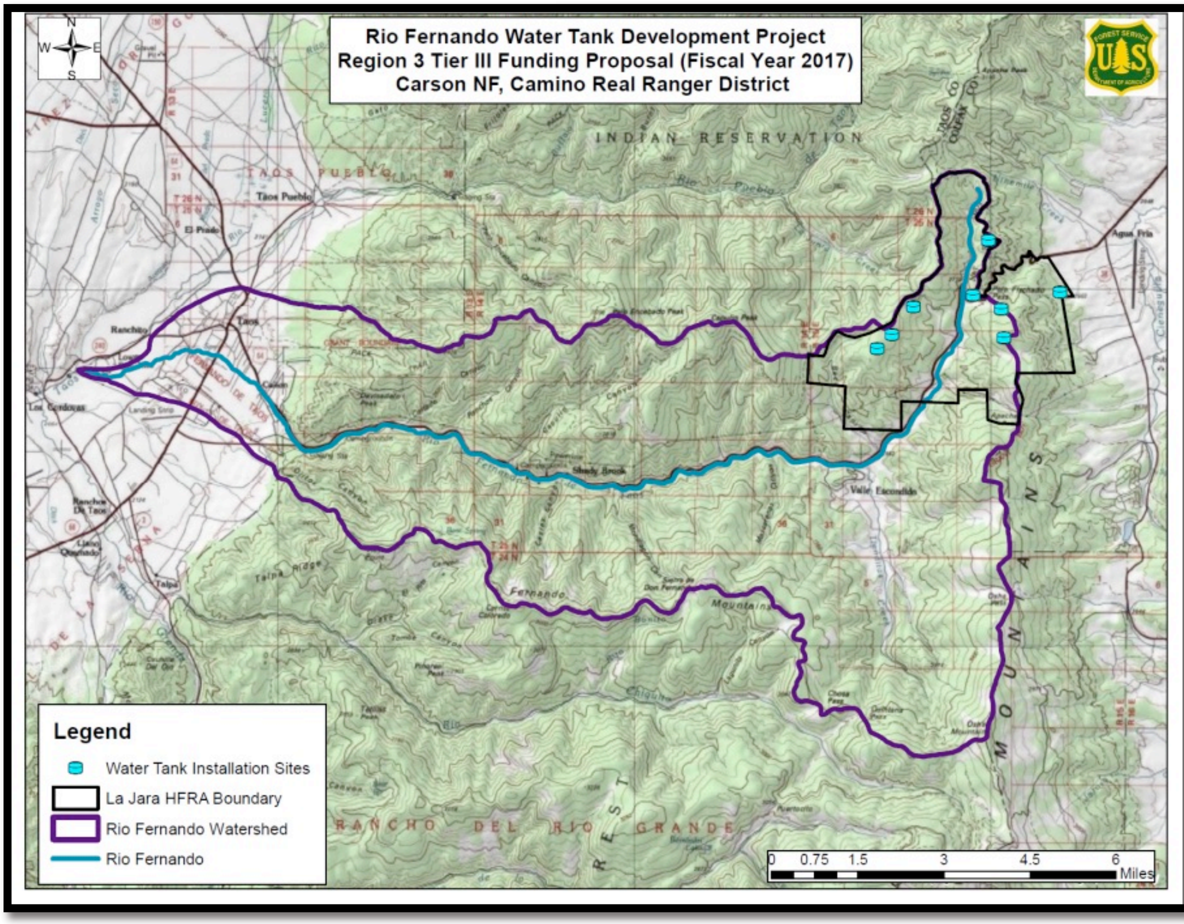


Figure 3-12: Rio Fernando Water Tank Development Project Map; Courtesy of Carson National Forest, USFS. These water tanks have been installed.

Private land owners in the upper watershed often utilize their lands for grazing livestock as well. Many of these parcels also include individual dwellings and feature buildings with on-site treatment systems (septic) located within riparian zones, which can increase their potential contribution of *E. coli* contamination in the river.

Lower Watershed: Confluence with Rio Pueblo de Taos to USFS boundary at Taos Canyon

Land use in the lower portion of the watershed sees an increase in development intensity and agricultural use. Along this segment of river, a significant amount of surface water is diverted to six acequias for irrigating adjacent agricultural fields and residential gardens in the Taos Valley. There is a total of 1,268.5 acres of **allowable** surface water irrigation in the Lower Rio Fernando Watershed. The Cañon Sur and Cañon Norte acequias (total 521.8 acres) are withdrawing water only from the Rio Fernando. Also, thirty-two (32) "private ditches" are permitted to divert water from the Rio Fernando to irrigate about 282 acres in the watershed; all but 11.8 acres are in the upper watershed (Graham Ditches #1 & #2). Rio Pueblo Water irrigates 484.9 acres of the Acequia Madre del Rio Pueblo system. Acequias downstream from the Acequia Madre del Rio Pueblo de Taos are most likely benefitting from Rio Pueblo surface water conveyance and application (irrigation); however, it is not clear yet to what degree. Though the water is withdrawn (diverted) for irrigation, the depletion of water (water that is lost to crops and evaporation) is far less than that diverted (RFdT Revitalization Collaborative Plan, 2018).

Data reviewed from Cropscape or the National Cropland Data Layer, shows the amount of acreage covered by each crop within the watershed area. Of the approximate 1,200 acres of irrigated farmland in the lower watershed, grass/pasture was the predominant crop fed by acequias, covering 694.5 acres, alfalfa covered 293.1 acres and hay/non-alfalfa covered 228.8 acres. The data shows that irrigated land in the lower watershed is primarily utilized as pasture for grazing or feed production for livestock.

According to the 2011 National Land Cover Dataset, development/impervious surfaces cover an estimated 11.8% of the lower watershed area. Impervious surfaces such as roads, parking surfaces and other elements of the built environment can pose threats to water quality. Runoff from impervious surfaces, septic systems, construction sites and infrastructure development are considered nonpoint pollutant sources. Another potential impact from developed areas is increased water temperature that occurs when runoff on impervious surfaces is warmed before entering waterways during summer. Highway US-64 bisects almost the entire watershed and runs parallel along much of the mainstem of the RFdT. Effectively constraining the river channel has the potential to cause water quality issues by increasing susceptibility to channelization, stormwater discharge and urban runoff within the watershed. Paseo del Pueblo Sur and other roadways in town, intersect the river in the lower portion of the watershed. Much of the drainage area in the lower watershed has little or no stormwater controls, which means during rain and snowmelt events, there is increased potential for contaminated runoff from urban sources to enter the river. **There are few if any GI mechanisms implemented to mitigate and alleviate negative impacts of roadways and other impervious surfaces.**

Lower RFdT Watershed Land Coverage: CropScape Data Analysis

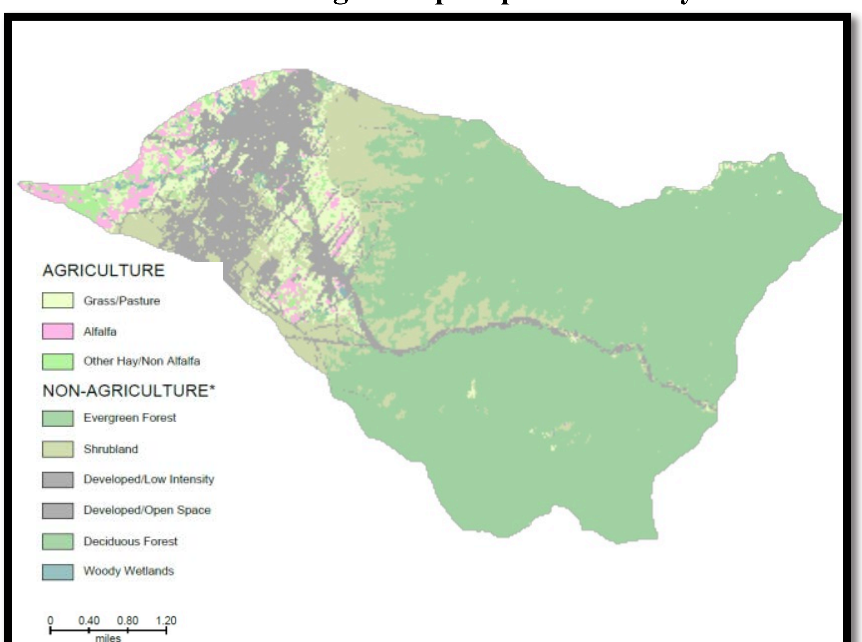


Figure 3-13: Lower Rio Fernando Watershed; Data retrieved from National Agriculture Statistics Service CropScape- Cropland Data Layer.

Category	Acreage	Percent of Lower Watershed
Alfalfa	293.1	2%
Other Hay/ Non-Alfalfa	228.8	2%
Grass/Pasture	694.5	5%
Forest	8601.7	67%
Shrubland	1468.9	11%
Wetland	68.5	1%
Developed	1520.8	12%
Total	12877.2	100%

Figure 3-14: Lower Rio Fernando Watershed National Agriculture Statistics .

Historical Description of the Rio Fernando de Taos Watershed Area

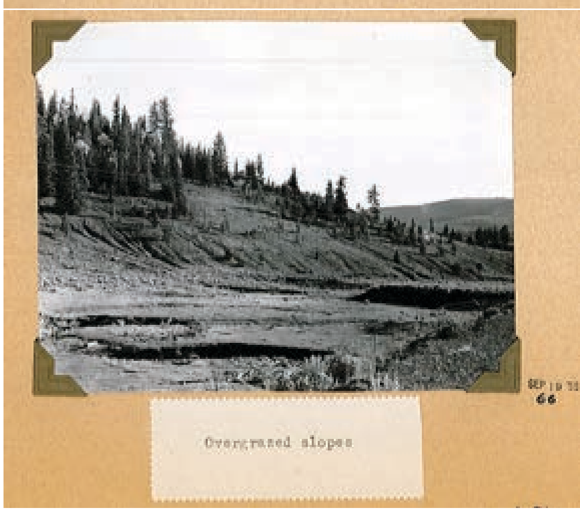
Historically, Taos Canyon and the RFdT watershed have served various groups as a resource use area. Taos Canyon has consistently been utilized as a corridor for trade and travel, connecting Taos Valley with the eastern plains. As with other tributaries that drain into the Upper Rio Grande Watershed, the RFdT played a significant role in the development of irrigated agriculture in the Taos Valley. The practice of irrigation was practiced by Puebloan farmers. After arrival to the area now known as Taos County, Spanish settlers worked to expand existing irrigation systems, increasing the number of acequias and the amount of acreage that could be brought under cultivation. Most modern acequias utilized today were developed by the Spanish and came into existence during a period of expansion in the 18th and 19th century (Johnson, 2005).

Following the Pueblo Revolt of 1680, Spanish resettlement of the area brought renewed requests to settle prime agricultural and rangelands situated along the valley's major streams. The Rio Fernando de Taos, despite being the smallest principal tributary of those feeding the RPdT, became a major water source for settlers and continues to irrigate pasture and cultivated land in Taos Valley today. Authorized Spanish resettlement of the area began in 1795 with the Don Fernando de Taos Land Grant when 60 families took residence in Taos Valley that first year. With additional settlers arriving the following year, the Don Fernando de Taos Land Grant quickly became the largest Hispano community settlement in the valley. Having secured possession of agricultural lands, these settlers began construction of the two major acequias that originate in the RFdT and still exist today: Acequia del Sur and Acequia del Norte. By 1797 or the second planting season, land grantees recognized that the RFdT's water supply was inadequate in meeting settler demands for irrigation. Subsequently, landholders began to request rights to use surplus waters or *sobrantes* from the neighboring RPdT and Rio Lucero (Baxter, 1990). Since then, water allocation and shortage issues on the RFdT have persisted to the present day.

Over the next century, Taos Canyon, like much of the Sangre de Cristo Mountains, would provide settlers with natural resources from a commonly shared landscape. In the watershed area, settlers harvested wood from forested areas for building materials and fuel wood, drove livestock to alpine meadows for summer range, and diverted waters to irrigate fertile soils in Taos Valley. Despite the mountain's ability to provide a seemingly abundant pool of natural resources, overgrazing, unchecked logging and resource extraction would eventually lead to a decline in the productivity of these lands. In the early 1900's, as New Mexico moved closer to statehood, the US government acquired most of these lands that previously had been administered as common land by valley residents. With an abundance of land now in possession of the public, the newly created USFS was consequently tasked with managing the degraded forest and rangeland within the Sangre de Cristo Mountains. Initially, USFS was concerned with reforming natural resource management and usage within the Sangre de Cristo Mountains, which meant controlling logging and restricting livestock numbers, in order to allow these areas to regenerate and deter further degradation of the Nation's natural resources. A consequence of this strategy was the displacement and alienation of numerous valley farmers, ranchers and loggers who previously utilized these natural resource areas unconstrained. Taos Valley ranchers and loggers who no longer had claim to summer range for livestock or trees to harvest on USFS lands turned to lands within Taos Canyon which at the time were owned by the State of New Mexico and administered as the Tienditas State Exchange lands. Increased pressure from grazers without claim to other summer range, and poor logging practices would prove ecologically devastating for the Taos Canyon and RFdT watershed. A quote from a USFS range analysis of the area performed in the early 1950's described the Tienditas State lands as,

> *"veritable no-man lands while they were administered as New Mexico State leases…Anyone in the Taos Valley who did not have summer range brought cattle, horses, sheep, goats and burros to the Tienditas State lands. Since competition was so great for forage produced, the livestock was brought to these units as soon as snow started melting. Much soil loss and compaction resulted. By the fall of the year, most of the livestock had been removed because of a lack of forage, even steeper slopes were devoid of all palatable forage" (USFS, 1950).*

Figure 3-15: US Forest Service photos showing example of resource overuse in the area. Photos are from 1931-1955 (USFS Photobook 1962).

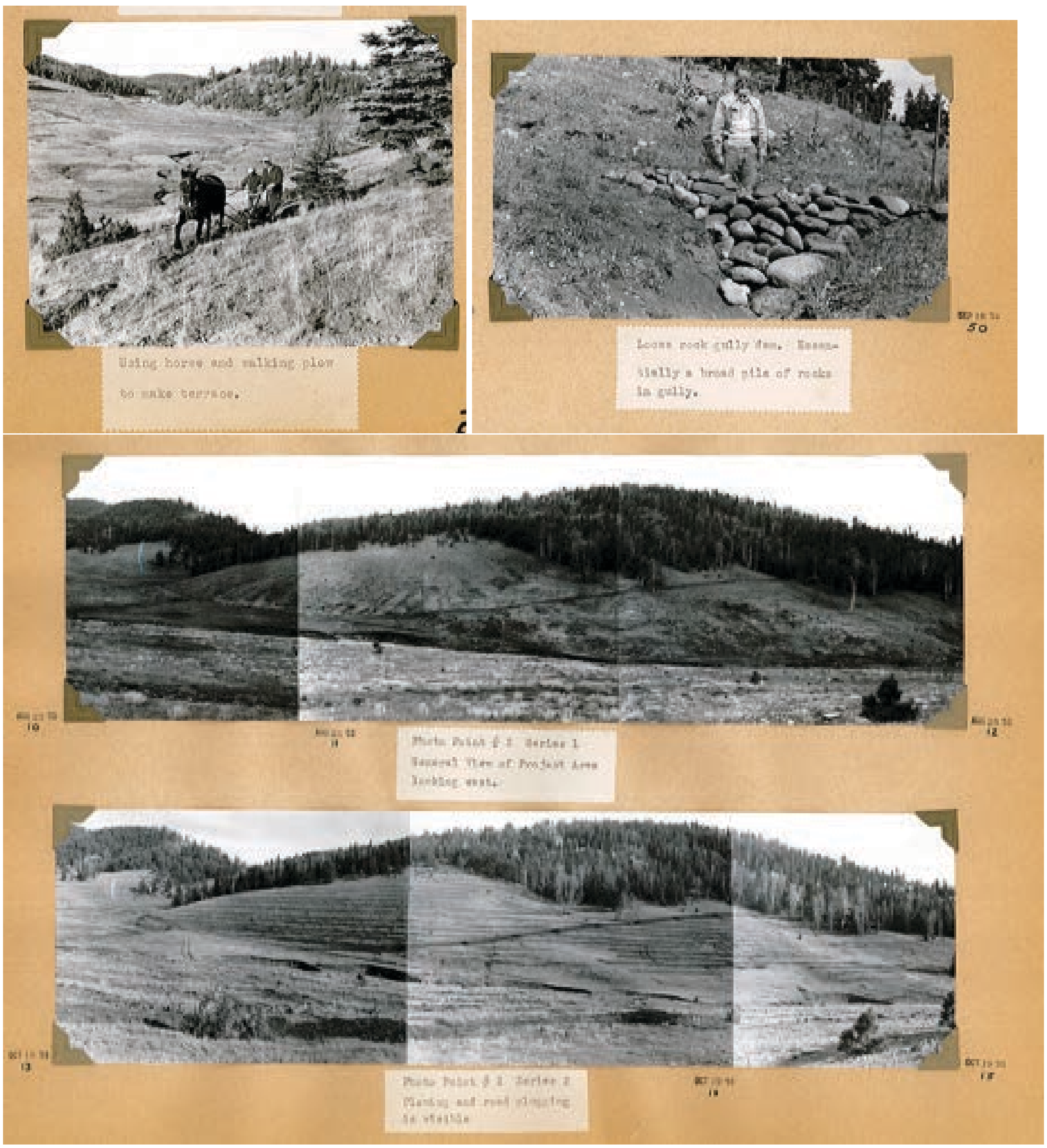


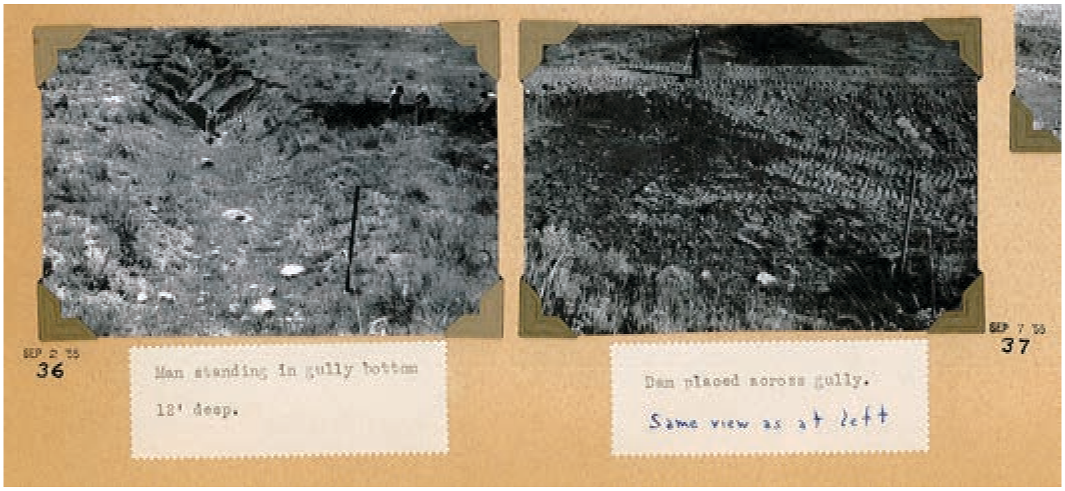
Rio Fernando de Taos Watershed Restoration and Planning Efforts
USFS Taos Canyon Restoration Project 1955–1962

In 1950, the United States acquired the Tienditas State lands, and administration of the land was placed under the USFS. Over time, rampant over-grazing and poorly administered timber harvest had severely degraded the area and were major sources of NPS pollution in the upper portions of the RFdT. As described above, prior land use had left much of the upper watershed devoid of vegetation and susceptible to erosion which in turn led the USFS to initiate grazing reforms and watershed improvements which can be credited as the primary turning point in watershed restoration.

Starting in 1950, control efforts to eliminate stray and trespass livestock were initiated. However, effective management and control of trespass livestock was not fully achieved until about 1955. Around this time, the Taos Canyon Watershed Improvement project was initiated. From 1955–1962, USFS would intensively implement numerous conservation projects throughout the watershed and effectively revegetate much of the barren acreage. During the Taos Canyon project, much of the area was contour plowed, numerous gullies were plugged, water spreaders were formed, and natural slopes were created by reshaping, cutting back, filling and reseeding actively eroding arroyos. Photos from the project show the extent of restoration and improvement projects carried out from 1955–1962. Much of the RFdT's main channel was avoided until 1988, when a riparian zone protection fence was constructed to help accelerate the recovery of the main channel. Grazing management in the watershed aided in recovery of channel stability and woody vegetation in a manner similar to the riparian exclosure (Figure 3-16).

Figure 3-16: US Forest Service Rio Fernando de Taos (Taos Canyon) Restoration Project 1955-1962 (USFS Photobook 1962).





Background monitoring of water quality within the Upper Rio Grande watershed began in 1999 and ended with NMED preparing TMDLs for the watershed in 2005. This period of monitoring provided a comprehensive assessment of water quality impairments and limiting pollutants that prompted restoration planning for the RFdT as a sub-watershed. This initial planning effort was the product of the Rio Don Fernando Watershed Group (RDFWG) who coalesced a broad base of watershed stakeholders and utilized a collaborative, consensus-based approach to address water quality issues throughout the entire drainage. The two parameters of concern for which TMDLs were approved at that time were temperature and conductivity. At that time, water quality monitoring indicated stream temperature as the lone parameter known to exceed New Mexico water quality standards. The *2006 Watershed Restoration Action Strategy* (Atencio et al. 2006) acknowledges that the RFdT is designated as a High-Quality Coldwater Aquatic Life by NMED and that water quality impairments have resulted in higher temperatures affecting cold-water fishery habitat.

The 2006 Rio Fernando de Taos Watershed Restoration Action Survey (WRAS; Atencio et al. 2006) identified grazing, recreational activities, removal of riparian vegetation, stream bank modification/destabilization, runoff from roads and/or parking lots, pollution from municipal point sources, as well as unknown sources as having affected water quality in the RFdT. They noted that a combination of these sources had resulted in increases in the levels of nutrients, conductivity, pH, temperature, and stream bottom deposits that caused exceedances of established water quality standards.

Specific issues identified in the RFdT WRAS include grazing, dense forest cover, and infrastructural changes. To address these issues, the RFdT WRAS suggests several areas for action and key stakeholders to partner with:

- Grazing practices and impacts to stream banks
- Willow and cottonwood planting with a focus on the segment from the RPdT to Ranchos Canyon
- Streambed meandering restoration projects
- Forest thinning projects
- Educational Outreach on erosion and sedimentation prevention
- Updated delineation of the floodplain of the RFdT in the urban/wildland interface from Ranchos Canyon to the confluence with the RPdT

- Characterization of the riparian corridor including the hydrologic and biologic factors to help prioritize areas that require reclamation, treatment, and preservation
- Monitoring stormwater runoff and acequia return-flows to prevent water quality impacts to the riparian ecosystem and the quality of the groundwater it recharges
- Monitoring for nutrient loading to determine levels of septic waste contribution and grey water contribution degrading the surface water quality and the groundwater quality

Key Stakeholders Identified in WRAS: USFS, NMED, State Forestry, RDFWG, Taos Soil and Water Conservation District (TSWCD), Taos County (TC), Quivira Coalition, Taos Land Trust (TLT), Private Property Owners, New Mexico Department of Transportation (NMDOT), Valle Escondido Golf Course, Rio Fernando Fire Department, Local Mutual Domestic Water Associations (MDWA's), Taos Valley Acequia Association (TVAA).

4 Identification of Causes and Sources of Impairment

4.1 Introduction:

This section of the plan identifies the RFdT's cause of impairment and sources of pollution that need to be controlled. This plan addresses the *E. coli* impairment identified for three assessment units of the RFdT's mainstem. **The sources of impairment are identified as the activities or land uses within the RFdT watershed that contribute to observed *E. coli* exceedances.** To determine the sources of *E. coli* within the watershed, a review and analysis of past water quality and *E. coli* related data was performed, followed by 21 months of intensive *E. coli* sampling and water quality monitoring to identify patterns and trends with *E. coli* levels and their relationship with other water quality parameters. A Microbial Source Tracking (MST) study was also conducted to help characterize the species-level sources of *E. coli* impairment on the mainstem (e.g. human, cattle, dog, etc.). This study is summarized within this plan and included as a full report in Appendix A.

4.2 Cause of Impairment:

The cause of impairment was identified as *E. coli* in the document Total Maximum Daily Load (TMDL) for Upper Rio Grande Watershed (NMED, 2012). NMED established TMDLs for three assessment units of the RFdT's mainstem. The Total Maximum Daily Load document also provides measured loads that are approximate loading values observed during the year when sampling occurred. For each assessment unit, a load reduction goal to achieve water quality standards associated with the waterbody's Primary Contact Use can be calculated by subtracting the TMDL from the measured load.[1]

[1] [1]Primary Contact designated use: the monthly geometric mean cannon exceed 126 colony forming units per 100 milliliters (CFU/100ml) and a single sample cannot exceed 235 CFU/100ml (criterion used to evaluate site samples and calculate TMDLs).

4.3 Initial Data Analysis from Prior Studies and Monitoring Efforts:

Review of existing data concerned with *E. coli* pollution in the RFdT was analyzed to identify potential trends and determine where data gaps existed. *E. coli* monitoring efforts within the RFdT watershed were performed by USFS, NMED's SWQB, AB and Sierra Club Water Sentinels – Rios de Taos from 2006–2013. Sampling during this period found that levels of *E. coli* were often above the applicable water quality standard in both the upper and lower reaches of the RFdT. High *E. coli* results throughout the watershed, as reported by Sierra Club Water Sentinels/AB, NMED's SWQB and the USFS, indicated serious problems with *E. coli* loading and the need to better characterize the sources of *E. coli* present.

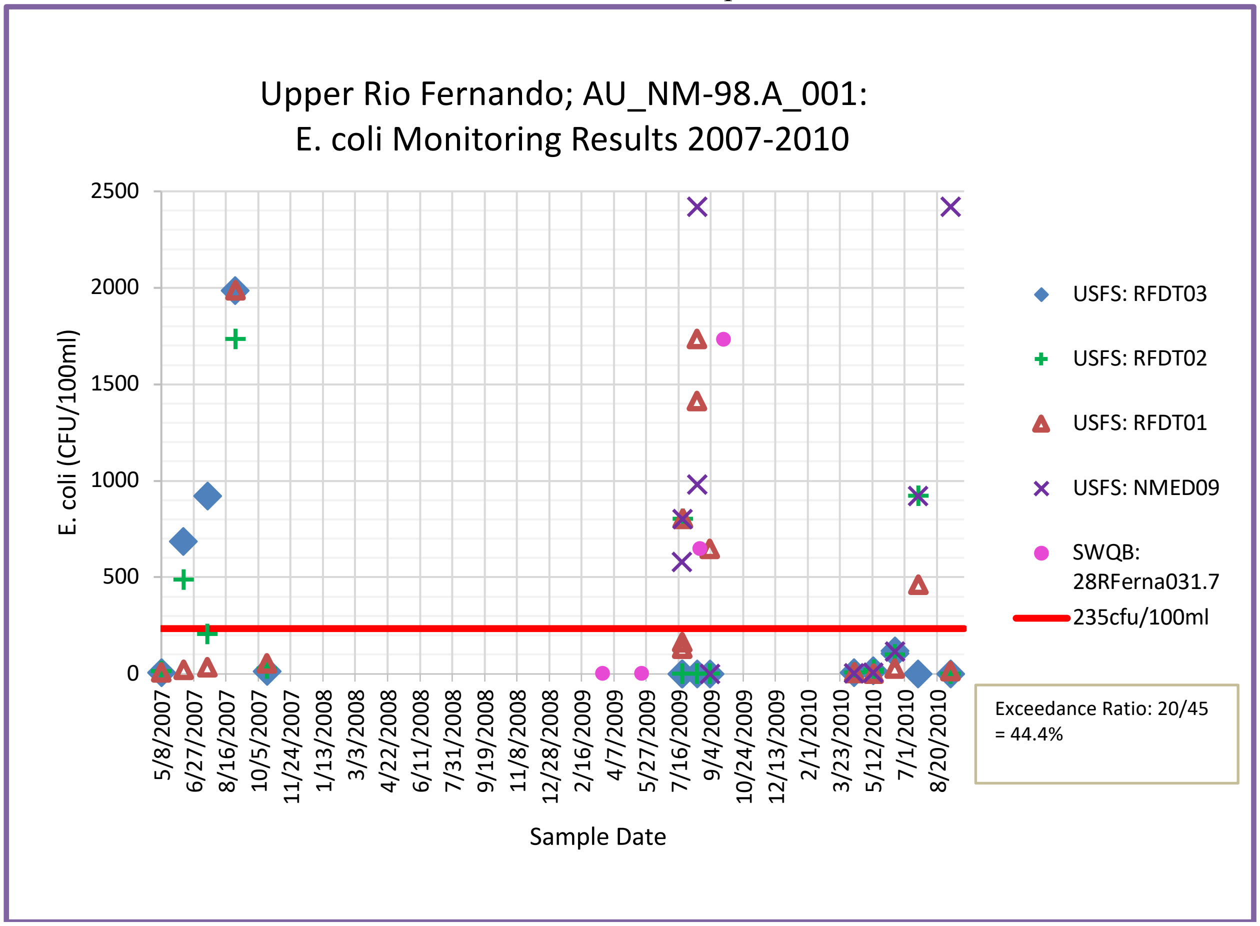


Figure 4-1: E. coli results from USFS Carson National Forest in cooperation with SWQB on the upper segment in 2007 and 2009–2010.

In the upper segment of the RFdT, AU_NM-98.A_001, NMED's SWQB Watershed Protection Section completed a special study of *E. coli* levels associated with flow observation to assess potential impacts from livestock grazing in 2006. The study demonstrated instances when livestock grazing on the Flechado Allotment probably increased *E. coli* levels in this segment of the RFdT (NMED 2012). The USFS Carson National Forest in cooperation with SWQB sampled for *E. coli* on this segment in 2007 and 2009–2010 which is displayed in the graph above. In total there are four sample sites within this assessment unit, with the USFS sample site RFDT01 being the same location for SWQB's 28RFerna031.7.

Sample Locations – Upper Segment 2007-2010

RFDT01 – Hwy 64 bridge at top of turn to Angel Fire
RFDT02 – Upstream from elk exclosure (upper)
RFDT 03 – Downstream from elk exclosure (upper)

Of the 45 samples collected within this segment, 20 samples exceeded the 235 CFU/100ml criterion for a single sample. Sampling from this segment shows most exceedances occurred during mid to late summer, often in the months of July, August and September.

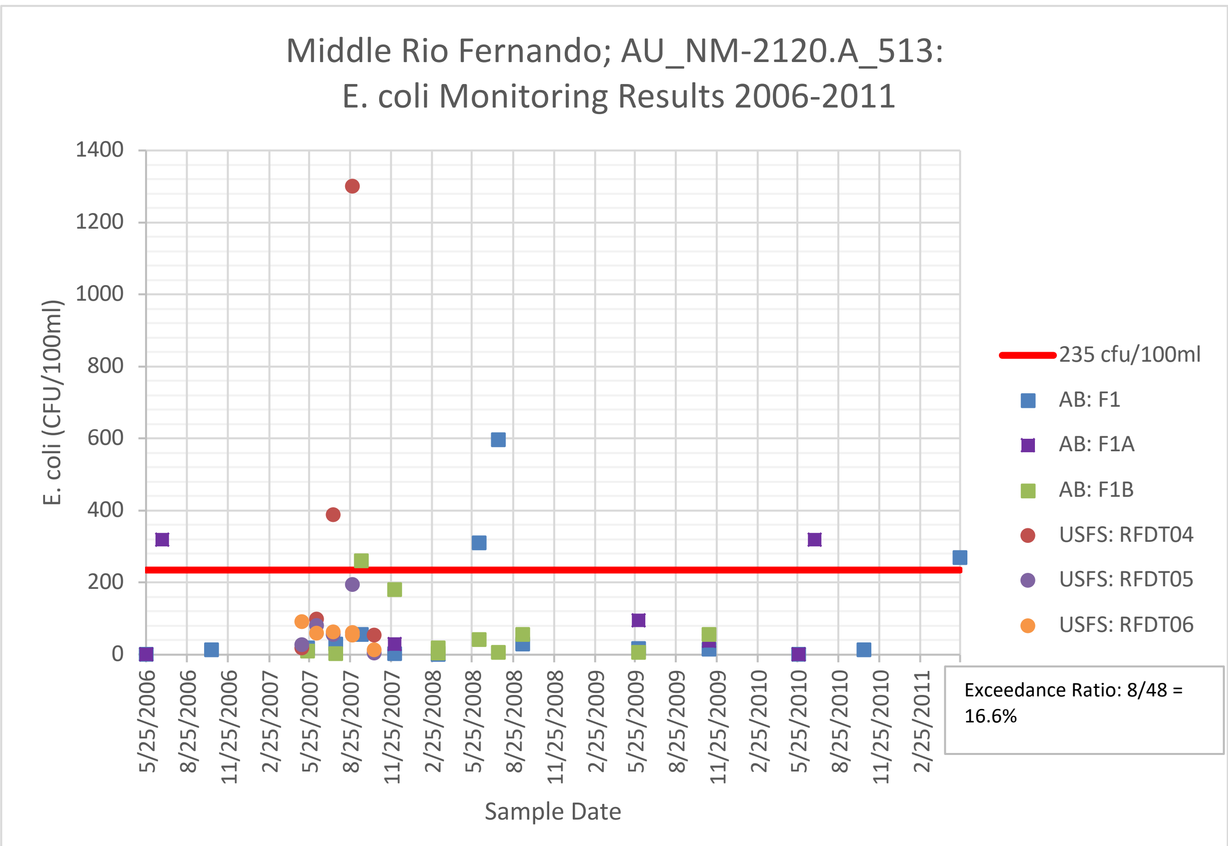


Figure 4-2: E. coli results from USFS and AB at three sites over the course of a five-year period.

Sample Locations – Middle Segment 2006 – 2011

F1 = RFDT06 – El Nogal/Divisidero
F1B = RFDT05 – La Sombra Campground
F1A = RFDT04 – Downstream of RF437 road crossing

The Middle Segment of the RFdT, AU_NM-2120.A_513, was sampled by USFS and AB at three sites over the course of a five-year period. Of the 20 samples collected at site F1=RFDT06, located at El Nogal/Devisadero Recreation Site, 3 exceeded the 235 CFU/100ml water quality standard. Of the 16 samples collected from site F1B=RFDT05, located at La Sombra Campground, 1 sample exceeded the water quality standard. Of the 12 samples collected at F1A=RFDT04, located downstream of Forest Service 437 Road Crossing, 4 samples exceeded water quality standards. Of the three assessment units on the RFdT's mainstem, *E. coli* samples from the middle segment exceeded water quality standards the fewest times. Most exceedances in this assessment unit occurred during June, July and August.

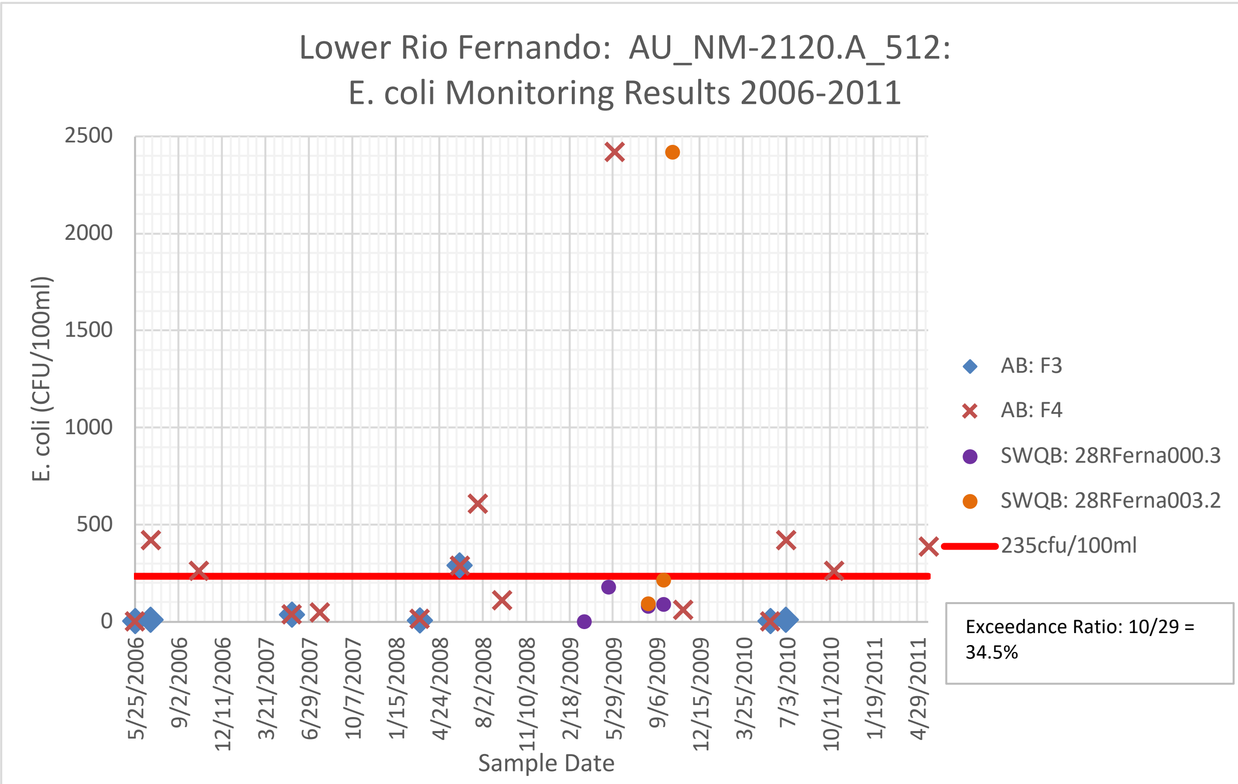


Figure 4-3: E. coli results from AB and SWQB at three sites over the course of a five-year period.

Sample Locations – Lower Segment 2006 - 2011
F3 – Downstream from Paseo del Pueblo Sur
28RFerna000.3 – Above Rio Pueblo de Taos
28RFerna003.2 = F4 – Fred Baca Park

The Lower Segment of the RFdT, AU_NM-2120.A_512, was sampled for *E. coli* over the course of a five-year period by AB from 2006–2011 and by SWQB in 2009. Sampling occurred at three different sites in the lower assessment unit. Of the 17 samples collected at site F4=28RFerna003.2, located at Fred Baca Park, 9 exceeded water quality standards. The other sample site where an exceedance occurred is F3, located downstream from Paseo del Pueblo Sur, on 6/10/2008.

<u>2012 TMDL Creation Summary:</u>

The document *Total Maximum Daily Load (TMDL) for the Upper Rio Grande Watershed* (NMED 2012) identified probable sources of impairment based on general watershed characteristics, hydrology and natural and anthropogenic activities within the watershed (NMED, 2012). The following table lists probable sources by assessment unit (in order of lower, middle, upper segments):

AU ID #	Probable Sources from NMED Upper Rio Grande TMDL (2012)
NM-98.A_001	Cattle/ livestock use, rangeland grazing, hiking trails, pet waste, waterfowl, wildlife other than waterfowl, low water crossings, paved/gravel/dirt roads, on-site treatment systems, impervious surfaces, stormwater runoff
NM-2120.A_513	Cattle/ livestock grazing, on-site treatment systems (septic), ORV use, roads/bridges/culverts, habitat modifications, logging/forestry operations, recreational uses, mining operations, wildlife other than waterfowl, impervious surfaces, campgrounds, stormwater runoff
NM-2120.A_512	Cattle/ livestock grazing, stormwater runoff from construction, on-site treatment systems, campgrounds, pet waste, illegal dumping, highway/road/bridge runoff, low water crossing, paved/gravel/dirt roads

Figure 4-4: TMDL for Upper Rio Grande Watershed; RFdT Probable Sources by Assessment Unit. Order is from source of the river to the confluence with the Rio Pueblo.

The probable source list above describes sources in general terms and is intended to include both natural and anthropogenic activities that could be contributing to the identified impairment.

4.4 Identifying Data Gaps and Information Needs:

As stated above, the cause of impairment in the RFdT is identified as *E. coli* in the Total Maximum Daily Load (TMDL) for the Upper Rio Grande Watershed document (NMED 2012). However, neither the 2009 study nor the interpretation methods that led to development of the TMDL was designed to identify **sources** of impairment other than in general terms. Therefore, Amigos Bravos and other stakeholders identified the following data/ information gaps critical to characterizing the sources of impairment in the watershed:

- The need to augment ongoing monitoring by Sierra Club Water Sentinels and AB by conducting extensive *E. coli* monitoring to pin-point sources.
- The need for iterative-targeted sampling to occur where a sample event identifies an *E. coli* hot spot.
- The need for a load duration curve of *E. coli.*
- The need to interpret water quality data to pin point-loading events in the watershed.
- The need for microbial source tracking to estimate *E. coli* enumeration from different animal and human sources.

Due to these data gaps, there was insufficient information to identify sources of *E. coli,* so further monitoring and study was recommended to better characterize the *E. coli* impairment in the RFdT.

4.5 319(h) Water Quality Sampling and Monitoring 2017–2018:

4.5.1 Sampling Methods for Watershed-based Plan from February 2017–October 2018:

The full Quality Assurance Project Plan with detailed methods used is available in Appendix B. Sampling was conducted by volunteers and Project Manager Romeling. Over 50 people signed up to be volunteers and about half of those participated in the project.

Samples were collected using the containers, preservatives, volumes and holding times identified in Figure 4-5. *E. coli* levels were determined using the IDEXX method (Standard Methods, Part 9000; APHA 2005). Field sampling procedures followed the SWQB Standard Operation Procedure 9.1 for Bacteriological Sampling and Analysis. This SOP is available in Appendix C.

Parameter	Optimum Volume	Container Type	Preservation Method	Holding Time
E. coli And Fecal Coliform	100 ml	Sterile Bottle	Cold (on ice)	**8 Hours**
Dissolved Oxygen	Determined On-Site			**None**
Temperature	Determined On-Site			**None**
Conductivity	Determined On-Site			**None**
pH	Determined On-Site			**None**
Stream Flow	Determined On-Site			**None**

Figure 4-5: Parameter information of water quality data.

Quality assurance of laboratory methods were the responsibility of the sample analysis contacts previously identified by Romeling and Patterson. Samples were tagged appropriately with identifying number/information and delivered to appropriate laboratory personnel accompanied by appropriately completed and signed Chain of Custody (COC) forms (Part of the Field Sampling Form - Appendix D). Amigos Bravos used the IDEXX Laboratories, Inc. Colilert® procedures for enumeration of total coliform and *E. coli* by the most probable number (MPN) method. The procedure is explained in Standard Methods, Part 9000 (APHA 2005). Background on the MPN method can be found in Oblinger and Koburger (1975).

4.5.2 **Site Locations**

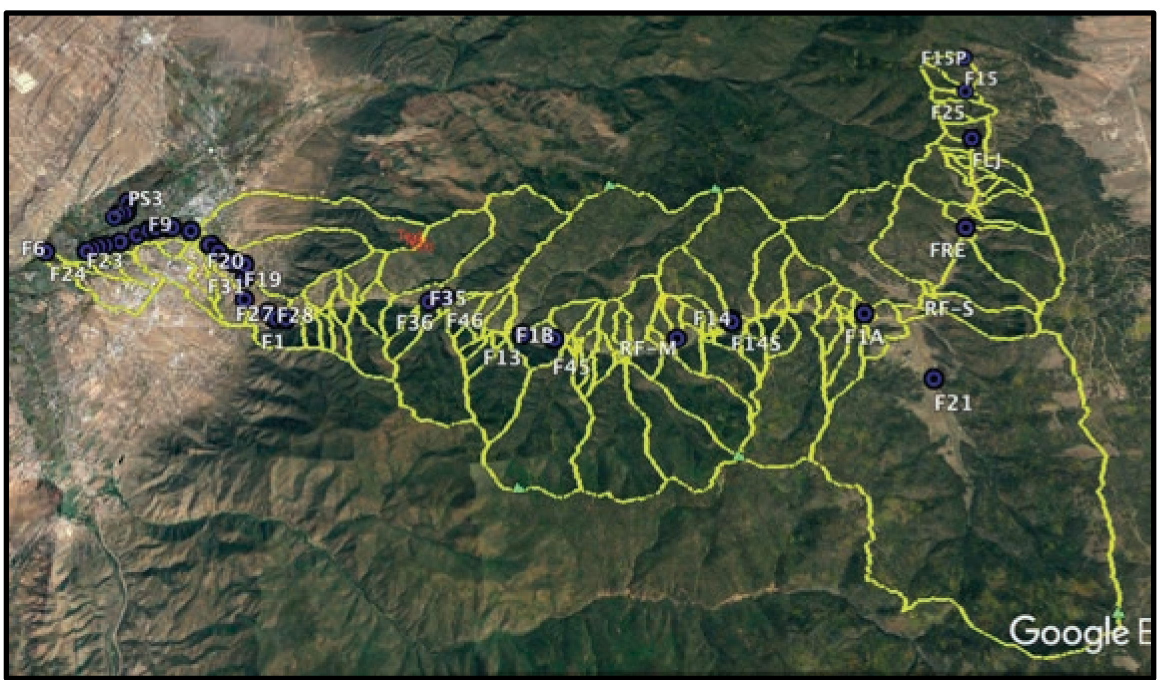


Figure 4-6: Map detailing sample site locations and sub-watersheds within the watershed. Data Provided by James Karo Associates.

Site Name	Segment Name	Segment Description	Lat	Long
F2	Lower	Bridge over the Paseo just west of the County courthouse	36.399054	-105.57701
F4	Lower	Fred Baca Park just upstream of the foot bridge	36.399578	-105.58931
F5	Lower	Taos Land Trust Property just upstream of Fred Baca Park	36.400083	-105.5874
F6	Lower	Vigil property near confluence with RPdT	36.394683	-105.61805
F7	Lower	Hall property near the Martinez Hacienda	36.396683	-105.59702
F9	Lower	Under the bridge that crosses Salazar Road, by Habitat for Humanity building	36.400217	-105.58263
F11	Lower	Angladas building and Los Pandos intersection, down from bridge.	36.39035	-105.56345
F12	Lower	Los Pandos Rd. between Witt Rd. and Dolan St. bridge intersections	36.39325	-105.56832
F16	Lower	Santistevan Lane just downstream of F9	36.400167	-105.58355
F17	Lower	Dolan Street Bridge	36.3952	-105.57078
F18	Lower	Frazer Land	36.395667	-105.60305
F19	Lower	North Acequia at Baca Lane	36.3884	-105.56048
F20	Lower	Rosen land	36.389713	-105.56279
F22	Lower	Monson house	36.395017	-105.60473
F23	Lower	Monson downstream by road	36.394533	-105.60638
F24	Lower	Monson acequia going into F23	36.394517	-105.6062
F26	Lower	Downstream of Angladas building where acequia comes in	36.391217	-105.56445
F31	Lower	Octaviano Road bridge crossing	36.386583	-105.55982
F32	Lower	Acequia on Witt Road	36.377427	-105.55241
F33	Lower	Farther down acequia on Witt Road	36.380753	-105.55936
F34	Lower	Los Pandos Bridge here it goes over the RF by Dolan Street. By large homeless camp and dump site	36.395146	-105.57115
F37	Lower	Homeless camp just west of TC Courthouse on other side of the Paseo—tons of trash	36.399167	-105.57903

F39	Lower	Merris spring at Sandoval family driveway—just before it reaches the RPdT.	36.404972	-105.59861
F40	Lower	Rio Pueblo de Taos at confluence of Merris Spring on Sandoval Property	36.404908	-105.59853
F41	Lower	Kanthack property, Spring next to river, can see pools.	36.395883	-105.60115
F42	Lower	End of Fred Baca Park past /acequia pipes right before it flows under Camino de Medio (Found big crayfish-alive in river)	36.398433	-105.59257
MS2	Lower	Merris Spring Pool by Lavadie Road	36.404165	-105.59881
MS3	Lower	Merris Spring Pool (Spring) in wetland just south of Sandoval House.	36.404767	-105.59856
PA1	Lower	Near driveway to the house next to the church (Pacheco Acequia)	36.405943	-105.59691
PA2	Lower	Just downstream of PA1 by corner of house that is closest to the Good News Church	36.405685	-105.5972
PS3	Lower	Merris spring as it crossed Upper Ranchitos Road by the Good News Church	36.4048	-105.59808
PS3-2	Lower	Acequia at culvert where it goes under the church driveway. Partially frozen, slow flow.	36.40507	-105.59739
PS3-A	Lower	Farthest up before fence—eastern side of the Good News church	36.40519	-105.59612
PS3-B	Lower	Where pipe comes out see picture of pipe and house	36.40505	-105.59637
PS3-C	Lower	Spot closest to the Good News church—going into culvert and then into wetland	36.40475	-105.5967
PS3D	lower	Merris Spring intersection with Pacheco acequia	36.40459	-105.59719
PS3-E	Lower	Above confluence of spring and Pacheco acequia above the culvert.	36.40446	-105.59722
PS3-F	Lower	Where acequia crosses lower Ranchitos Road	36.403875	-105.59755
PS3-H	Lower	Puddle behind empty building on the corner.	36.404393	-105.59791
PS7	Lower	Rio Pueblo de Taos Diversion as it goes into the San Francisco Ditch	36.403477	-105.59998
F1A	Middle	Valle Escondido at intersection of the road and the RFdT	36.372217	-105.38542
F1B	Middle	La Sombra Campground	36.36855	-105.4725

F1	Middle	Devisadero/South Boundary trailhead	36.3756	-105.54723
F13	Middle	Capulín Campground	36.36985	-105.4813
F14	Middle	Allen Property	36.371233	-105.42285
F14-Spring	Middle	Allen's spring	36.371667	-105.423
F27	Middle	Headgate by drum building	36.376008	-105.5506
F28	Middle	Giant headgate farther up from drum building	36.375735	-105.5499
F35	Middle	Vaughn property 1st sample, also got house sample. Just downstream of Sierra Village RV	36.378717	-105.5072
F36	Middle	Just upstream of F35—closer to Sierra Village RV Park	36.379268	-105.50582
F46	Middle	Grey's house, mile marker 259. A lot of algae on the bottom and growing near the surface.	36.379617	-105.5025
F45	Middle	Puddles with barely any flow. Sampled at bridge. Just upstream of Shady Brook	36.36705	-105.46218
RF-M	Middle	Mondragon trail head.	36.367607	-105.43845
F25	Upper	Between top and bottom of La Jara	36.432562	-105.34169
FLJ	Upper	La Jara, at base of Forest Road 5	36.418273	-105.34331
FRE	Upper	Riparian Exclosure	36.403791	-105.34512
F15	Upper	Top of La Jara	36.443014	-105.33944
F21	Upper	Tienditas Creek in Valle Escondido	36.355867	-105.36963
F15P	Upper	Berm drinker pond at F15	36.44195	-105.33907
RF-S	Upper	New Spot b/c water was gone at FRE, across from Pottery House	36.378733	-105.36705

Figure 4-7: List of Site Locations.

4.6 Results of Watershed-based Plan sampling from 2017–2018

Data was collected from February 1, 2017 through October 2018 (21 months). A total of 20 initial locations were identified to sample once a quarter. In addition, further sites were sampled upon landowner permission and public interest. Total number of samples collected over 21 months was 315, averaging 15 per month. When exceedances were found, further sampling adjacent to the site occurred to narrow the source.

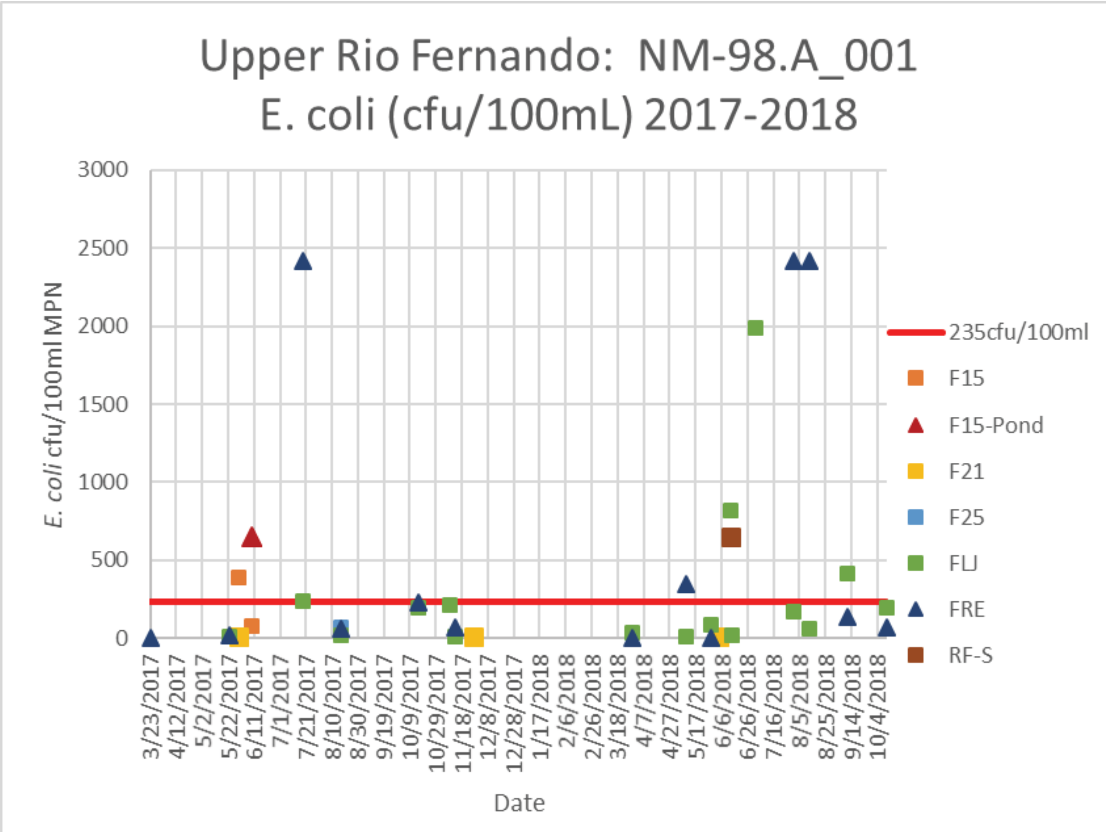


Figure 4-8: Upper Rio Fernando de Taos watershed *E. coli* results from March 2017 – October 2018.

Samples were collected every four to five weeks at six sites from March 2017 – October 2018 in the upper segment of the RFdT. In total, 40 *E. coli* samples were collected during this monitoring period. Of the 40 samples, 11 (27.5%) exceeded the single sample 235 CFU/100ml water quality standard. Review of data show a strong seasonal pattern of *E. coli* exceedances in this reach. All exceedances occurred during summer months with two in May, three in June, three in July, two in August, and one in September. Federal grazing in this reach of the watershed typically occurs from mid-June through September for a period of 107–120 days. Exceedances that occur prior to livestock presence in this area may be attributed to other potential sources such as wildlife, waterfowl, pet waste or older livestock fecal deposits. To better characterize the sources of *E. coli* in this segment, two sites FRE and FLJ, were selected as sample sites for the MST Study to estimate contributions from different source animal species or groups.

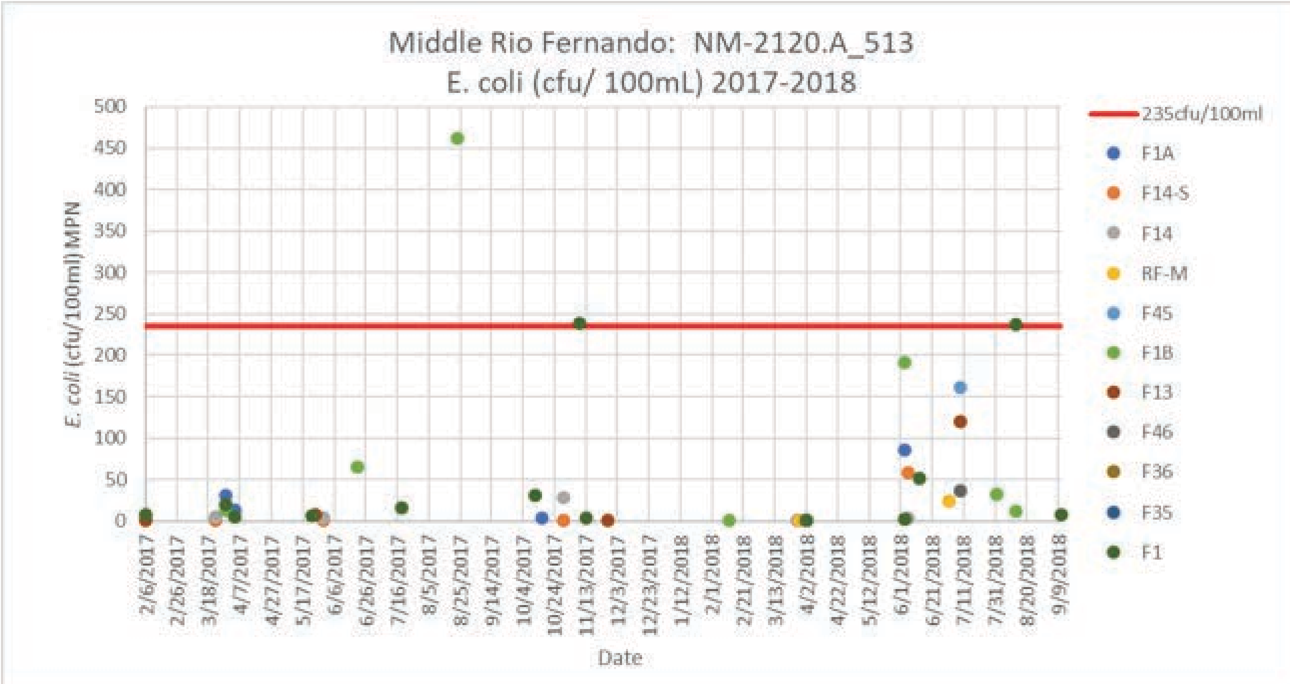


Figure 4-8: Middle Rio Fernando de Taos *E. coli* results.

In the middle segment of the RFdT, samples were collected every four to six weeks at eleven river sample sites. Sampling of this segment occurred from Feburary 2017–September 2018. In total 46 samples were collected at eleven sites. Of the 46 samples, 3 (6.5%) exceeded water quality standards. These exceedances occurred at the F1 and F1-B sites. The two exceedances at the F1 site occurred at 11/9/17 and 8/13/18. The observed exceedance at F1-B occurred on 8/23/17. Due to the low number and infreqeuncy of exceedances in this segment of the stream, no sites were chosen for the MST Study.

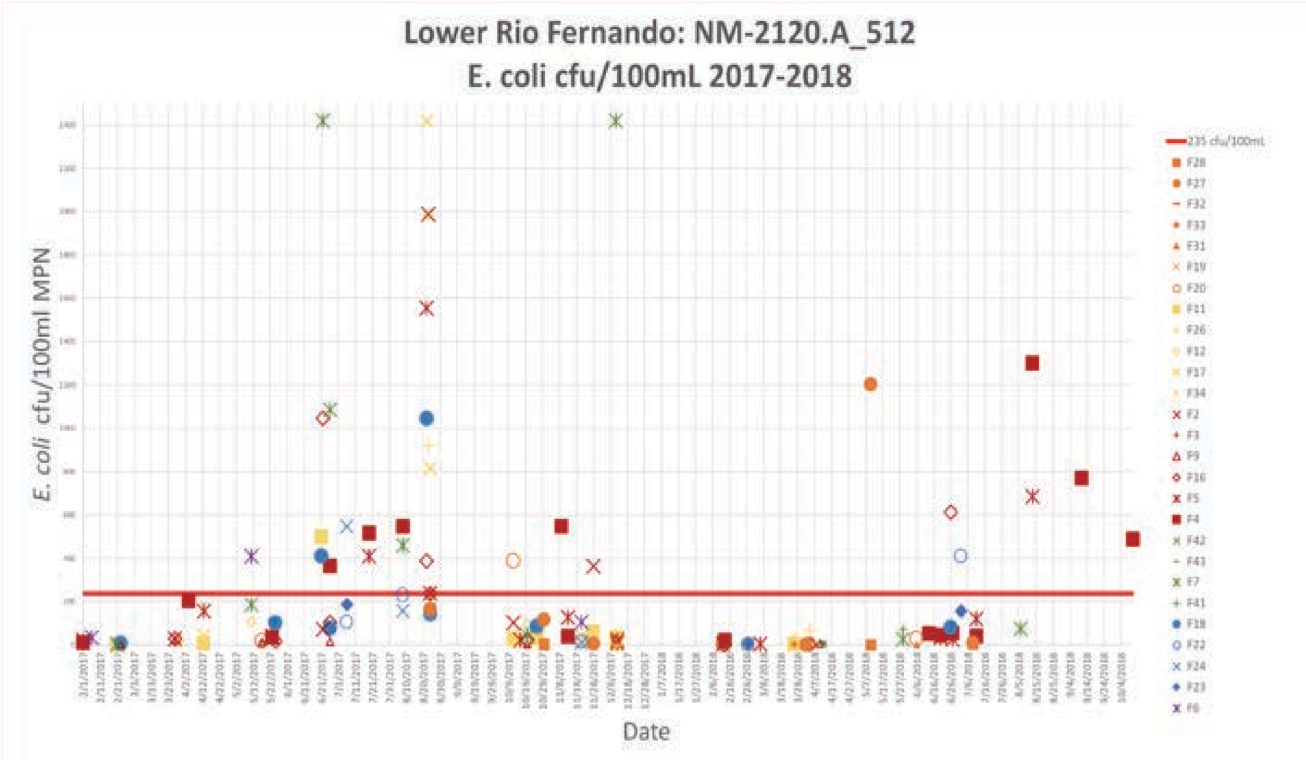


Figure 4-9: Lower Rio Fernando de Taos *E. coli* results from February 2017 – October 2018. Sample sites are grouped by color according to catchment area and listed in order from the top of the lower watershed at the mouth of Taos Canyon (F28) to the confluence with the RPdT (F6).

Of the Rio Fernando de Taos' three segments, the lower segment was sampled the most intensely. Sample collection on this segment occurred from February 2017 to October 2018. Samples were collected at 27 sample sites. During the 2017–2018 monitoring effort, 159 samples were collected within this segment. Of the 159 samples, 32 (20.1%) exceeded water quality standards. 26 exceedances occurred during summer months with 2 in May, 7 in June, 4 in July and 13 in August. Other exceedances occurred during the fall with 1 in September, 2 in October, 2 in November and 1 in December. Review of data show exceedances occurred most frequently at the F4 (7), F7 (4), F5 (4) and F16 (4) sites. Three sites from this segment, F4, F16, and PS3 were selected for the MST study due to the number of exceedances observed during this and prior monitoring efforts.

4.7 Discussion and Interpretation of 2017–2018 Data

Interpretation of the 2017–2018 monitoring effort was conducted by comparing *E. coli* sample results from different sites that were sampled on the same date in order to pinpoint *E. coli* loading within the watershed. This process helped to determine when and where loading was occurring. For example, interpreting the data can show if observed exceedances occurred throughout the watershed on the same date, or if an exceedance was an isolated loading event. Precipitation data was also reviewed by sampling date to help determine potential transport mechanism of *E. coli* at the time of sampling. James Karo and Associates were hired to use GIS to map the data. Please see Figures 3-12 to 3-15 for trends in the different segments of the river

Sampling Date	Precipitation Prior to Sampling	*E. coli* Sample Results by Site: Sites are listed in order, from top of the watershed to the confluence. Exceedances are highlighted in yellow.		
		Upper: NM-98.A_001	Middle: NM-2120.A_513	Lower: NM-2120.A_512
5/11/17	Rainstorms	None	None	F12: 105.4 F7:186.0 F6: 410.6
5/30/17	None	F15: 387.3	F1A: 4.1 F14: 4.1	None
6/9/17	Rain two days Prior	F15: 74.0 F15-Pond: 648.8	None	None
6/21/17	Spotty Showers	None	F1B: 65.8	F11: 501.2 F18: 218.7
6/22/17	Spotty Showers	None	None	F2: 71.2 F16: 1046.2 F7: 2419.8
6/26/17	Light Showers	None	None	F9: 14.6 F16: 101.4 F4: 365.5 F7: 1086.3
7/6/17	None	None	None	F22: 105.0 F24: 549.1 F23:185.6
7/19/17	Monsoonal Rain Events	FLJ: 238.2 FRE: 2419.7	F1: 16.1	F5: 410.0 F4: 517.2
8/8/17	Monsoonal Rain Events	None	None	F4: 547.5 F7: 461.1 F22: 228.2 F24: 156.5
8/22/17	Monsoonal Rain Events	None	None	F17: 2419. F5: 1553.1 F18: 1046.2
8/23/17	Monsoonal Rain Events	None	F1B: 461.1 F26: 920.8	F12: 1986.3 F2: 1986.3
8/24/17	Monsoonal Rain Events	None	None	F28: 166.4 F27: 161.6 F17: 816.4 F16 235.9 F5: 238.2 F18: 142.1
10/12/17	None	None	F1: 31.1	F20: 387.3 F11: 26.2 F2: 101.7
11/28/17	None	None	None	F27: 4.1 F11: 58.1 F2: 365.4
5/10/18	None	FLJ: 1203.3 FRE: 1.0	None	F28: 1.0 F27: 1.0

6/13/18	None	FLJ: 648.8 RF-S: 648.8	F1: 52.1	F4: 20.1
6/26/18	None	None	None	F9: 1.0 F16: 547.5 F18: 78.9
7/2/18	None	FLJ: 1732.9	RF-M: 24.6	F22: 410.6 F23: 156.5
8/1/18	None	FLJ: 172.2 FRE: 2419.7	None	F18: 33.1
8/13/18	Light Showers	FLJ: 56.3 FRE: 2419.7	F1B: 12.1 F1: 238.2	F5: 686.7 F4: 1299.7
9/11/18	None	FLJ: 410.6 FRE: 133.3	F1: 7.4	F4: 770.1
10/11/18	None	FLJ 191.8 FRE: 68.3	None	F4: 488.4

Figure 4-11: *E. coli* exceedances by sampling date with rainfall information.

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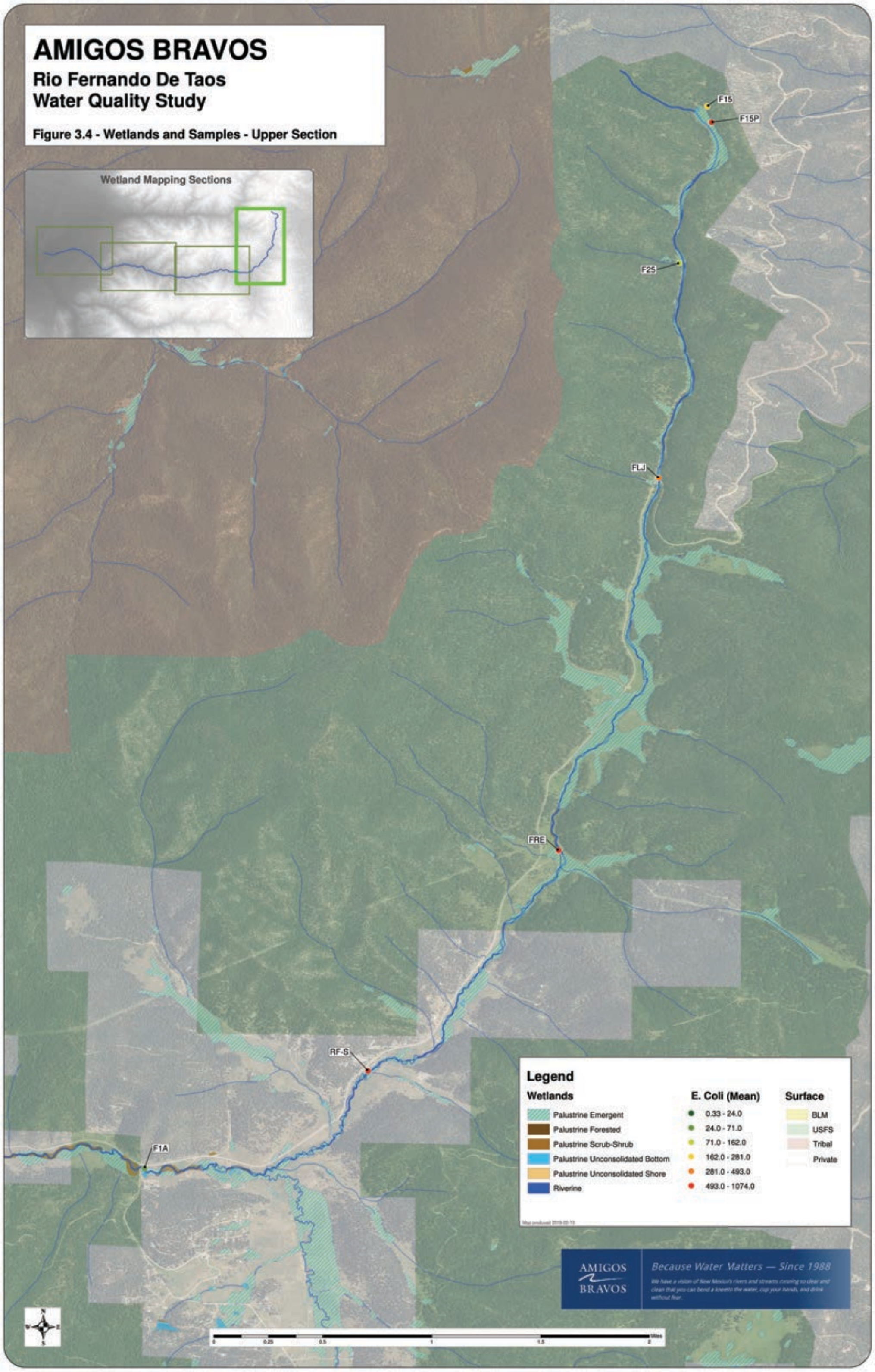

Figure 4-12: ***E. coli*** **exceedances on the upper segment of the Rio Fernando. Dot colors show MEAN level of** ***E. coli*** **bacteria found at that site.**

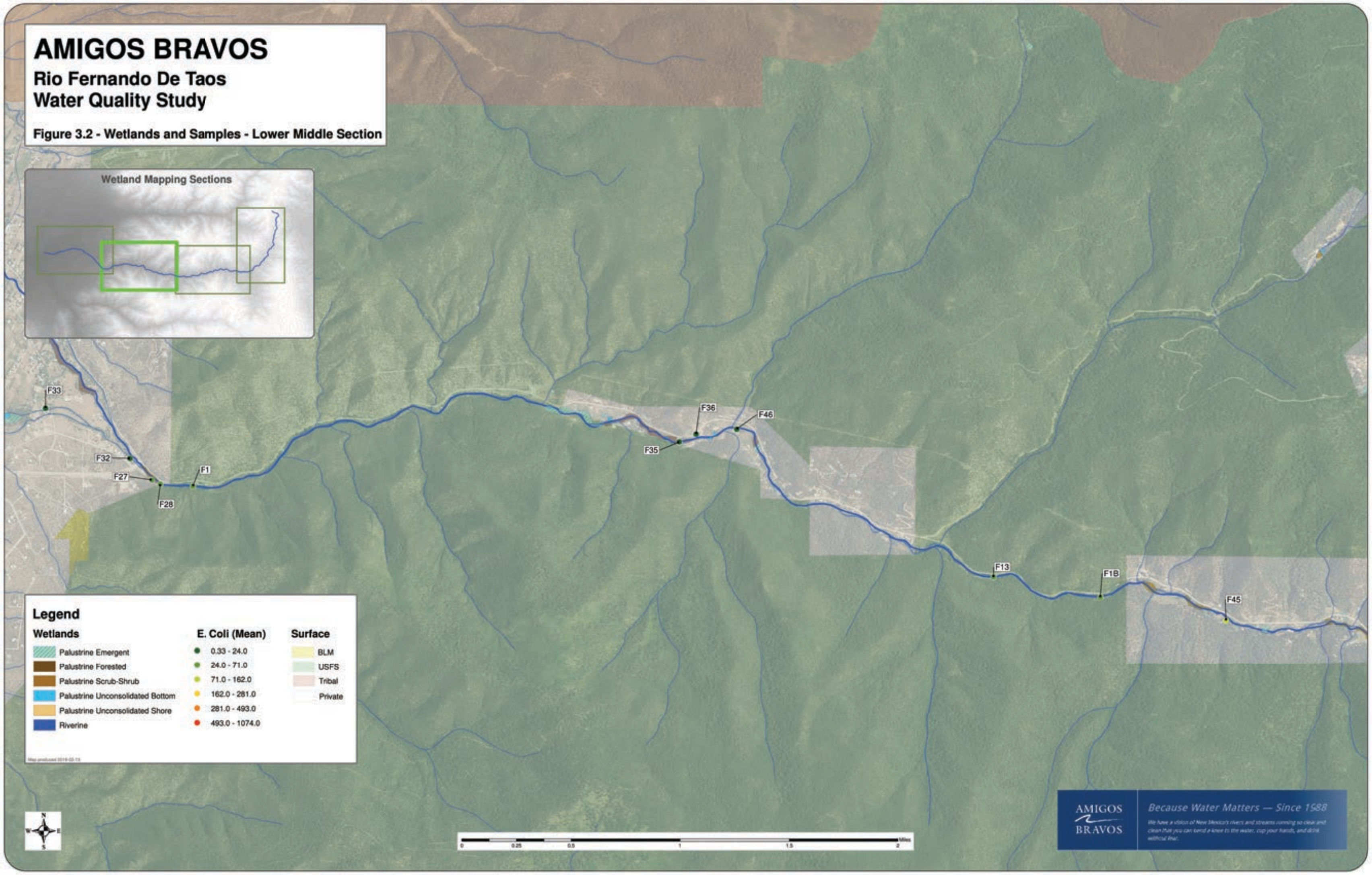

Figure 4-13 (two maps): Two maps showing the E. coli exceedances on the middle segment of the Rio Fernando. Dot colors show the Mean E. coli levels found at each site.

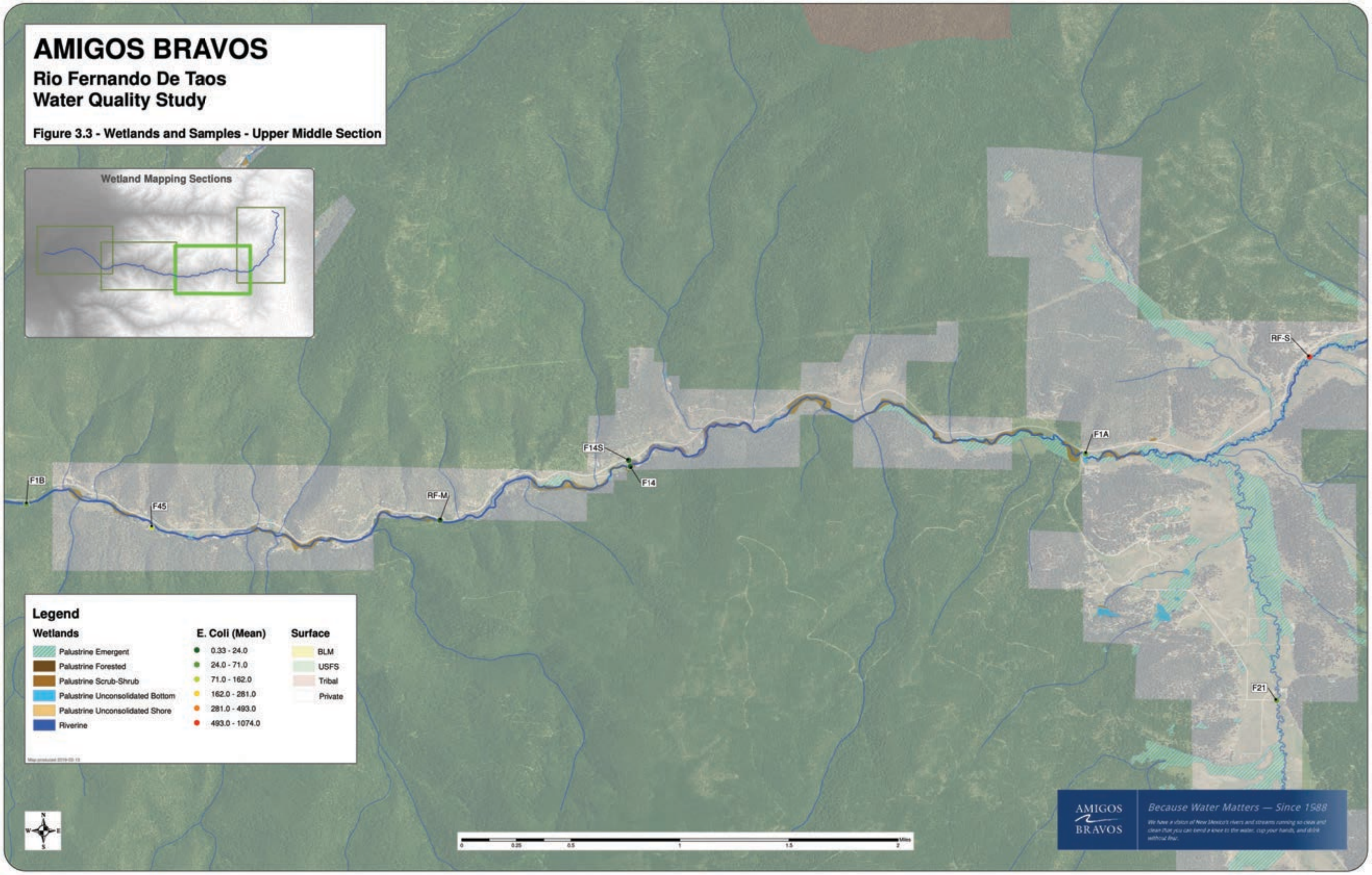

Figure 4-13 (two maps): Two maps showing the E. coli exceedances on the middle segment of the Rio Fernando. Dot colors show the Mean E. coli levels found at each site.

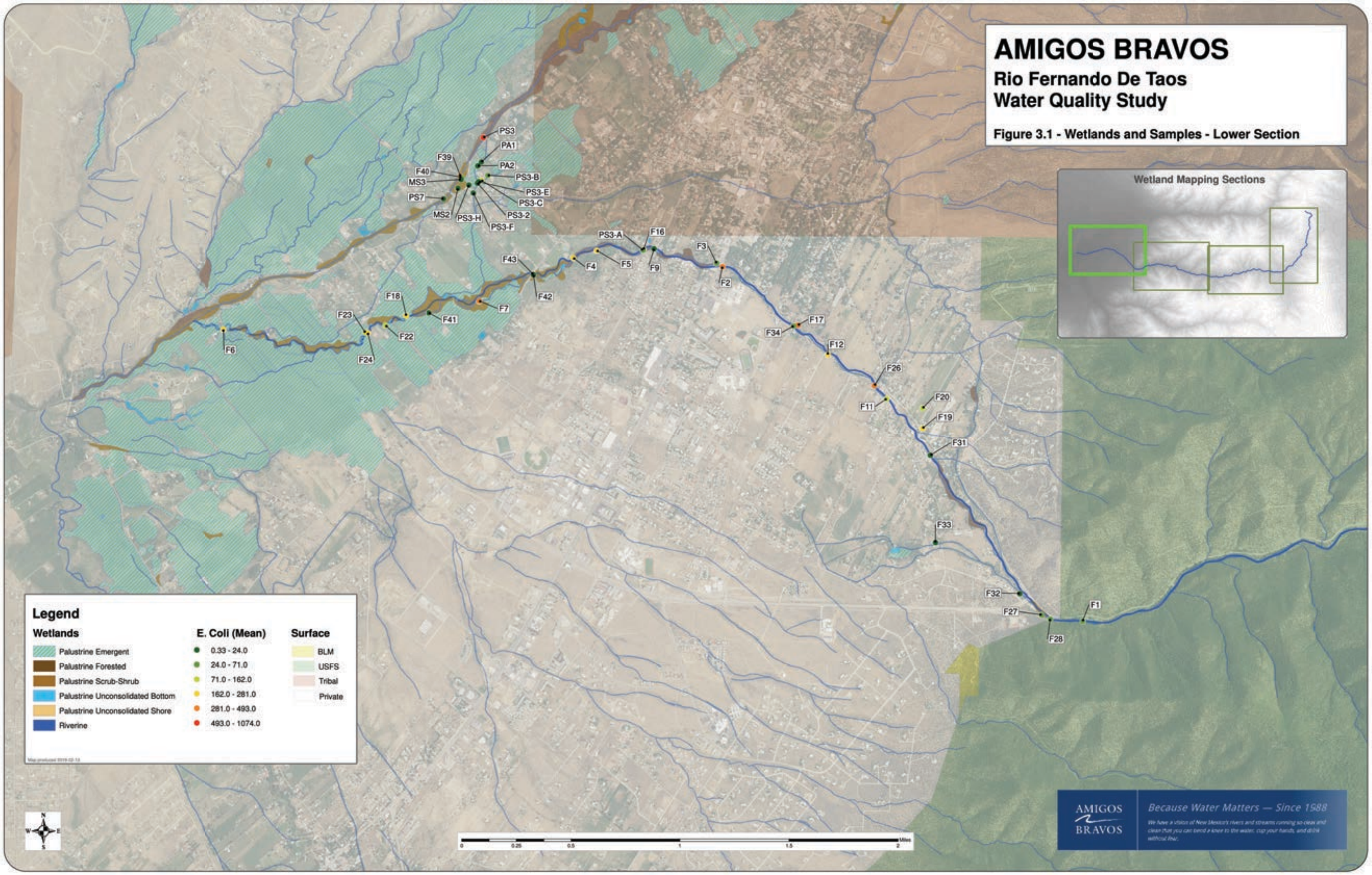

Figure 4-14. Map showing the *E. coli* exceedances on the lower segment of the Rio Fernando. Dot colors show the Mean *E. coli* levels found at each site. **PS3 is located closer to F39 than is shown in the map*

4.7.1 **Review of *E. coli* Sampling Data by Date:**

Conclusions are in bold for convenience.

5/13/2017: Three samples were collected in the lower watershed on 5/13/2017. The data show there is a slight increase in *E. coli* between the F12 and F7 site from 105.4 CFU/100ml to 186.0 CFU/100ml, but a significant contribution of *E. coli* loading occurred above the F6 site where the *E. coli* count was 410.6 CFU/100ml. Review of probable sources and remote sensing of aerial imagery between the F7 and F6 site, coupled with precipitation data that show rainstorms occurred within the watershed prior to sampling, **indicate that runoff from adjacent livestock pastures, cattle with direct access to the stream and/or on-site treatment systems may have contributed the increased loading of *E. coli* at this site.**

5/30/2017: Three sites were sampled on 5/30/2017 with one site in the upper segment, and two in the middle segment. The only site with an observed exceedance on this date was at the F15 (very top of watershed) site which had an *E. coli* count of 387.3 CFU/100ml. Both sites that were sampled below had *E. coli* counts of 4.1 CFU/100ml. Results from this sampling date indicate that loading occurred at or above the F15 site and that *E. coli* did not persist in the water column or gain any additional loading prior to sampling of the sites below. Probable sources in this portion of the watershed are cattle and/or wildlife that have direct access to the stream. Precipitation data show there was no rain event prior to sampling and **therefore the likely mechanism of *E. coli* loading during this sampling event was direct deposit of fecal matter into the stream or in the adjacent riparian area.**

6/9/2017: Two sites at the top of the upper watershed were sampled on 6/9/2017. The F15 and F15-Pond site are located very closely together where F15 is located on the stream and the F15-Pond site is located on a man-made impoundment on the main stem that captures surface water runoff from the catchment area and serves as a water source for cattle and wildlife in the area. This sampling event showed the F15-Pond site had a very high *E. coli* count measured at 648.8 CFU/100ml, whereas the F15 stream site MPN was measured at 74.0 CFU/100ml. **This indicates *E. coli* loading during this sampling event most likely occurred from livestock or wildlife's direct deposition of fecal matter into the pond. This also indicates that *E. coli* is not coming out of the spring source for the Rio Fernando because site F15 was clean whereas the pond was dirty.**

6/21/2017: Three sites were sampled on 6/21/2017. F1B is located in the middle segment of the watershed and F11 and F18 are located in the lower watershed. F1B's *E. coli* count was measured at 65.8 CFU/100ml, whereas the F11 site was measured at 501.2 CFU/100ml and F18 was measured at 218.7 CFU/100ml. The data show an increase in loading occurred between the F1B and F11 site. Probable sources between the two sites are cattle/livestock, wildlife, campgrounds, on-site treatment systems, roads, bridges, culverts, impervious surfaces, pet waste, and illegal dumping. There is approximately six miles of stream length between the two sites, with several campgrounds, RV campgrounds, recreational trails, residential areas and livestock pastures. In order to pinpoint the likely source of *E. coli* loading, the MST study is needed to characterize the contributions of potential sources.

6/22/2017: Three sites in the lower watershed were sampled on 6/22/2017. The *E. coli* count at the F2 site was 71.2 CFU/100ml**. The *E. coli* count at the F16 site was 1,046.2 CFU/100ml indicating a significant loading of *E. coli* had occurred above the F16 site.** The *E. coli* count at F7 was measured at >2,419.8 CFU/100ml indicating there was a significant contribution of *E. coli* to the stream between the F16 and F7 sites but there it is also probable that *E. coli* persisted in the water column between the sample sites.

7/6/2017: Sampling conducted on 7/6/2017 was carried out at three properties in the lower watershed. Sampling occurred on two sites within the stream and one on an acequia return flow to the stream. Both stream sites were in compliance with water quality standards with F22 at 105 CFU/100ml and F23 at 186 CFU/100ml, whereas the acequia return flow sample site featured a much higher *E. coli* count at 549.1 CFU/100ml, exceeding the 235/CFU/100ml threshold. **This sampling event is an example of when irrigated pasture's return flow is carrying *E. coli* from adjacent pastures and contributing the pollutant to the stream.**

7/19/2017: The sampling event conducted on 7/19/2017 measured *E. coli* at five different sites within the watershed. Two are in the upper segment, one in the middle segment and three in the lower segment. **Data from this sampling event show pollutant loading occurred above several sites.** FLJ's *E. coli* count was measured at 238.2 CFU/100ml, which is already above the water quality standard showing there was a significant contribution of *E. coli* above this site. However, FRE's *E. coli* count was >2,419.7 CFU/100ml, indicating *E. coli* loading had occurred above the FRE site. Precipitation data show monsoonal rain events had occurred throughout the watershed prior to the sampling event. **This indicates the probable sources contributing *E. coli* in this reach are livestock and/or wildlife grazing in adjacent pastures, where fecal matter was carried to the stream from pasture runoff.** F1 was the next sample site during this sampling event located in the middle segment of the stream. The *E. coli* count was 16.1 CFU/100ml, **indicating that *E. coli* did not persist in the water column from the FRE site to the F1 site.** In the lower watershed, F5 had an *E. coli* count of 410.0 CFU/100ml indicating an increase in loading had occurred between the F1 and F5 sites. Another source of *E. coli* was contributed to the stream between F5 and F4 as indicated by the 517.2 CFU/100ml *E. coli* count measured at F4. Probable sources above F5 and F4 are on-site treatment systems, pet waste, stormwater runoff, livestock, and wildlife within the catchment area. **As noted above, monsoonal rain events prior to the sampling event indicate pollutant loading occurred as a result of runoff carrying fecal matter from various sources to the stream.**

8/8/2017: The sampling event conducted on 8/8/2017 sampled four sites in the lower segment of the watershed. **The *E. coli* count at F4 was 547.5 CFU/100ml which was the highest reading of the day, indicating the majority of pollutant loading occurred above that site.** The data show a decreasing count in *E. coli* between from F4 to F7 where F7's count was measured at 461.1 CFU/100ml. F22's *E. coli* count was 228.2 CFU/100ml indicating a further decrease in pollutant loading between sites as well as the F24 irrigation return flow site which had an *E. coli* count of 156.5 CFU/100ml. Precipitation data show there were several rain events prior to the sampling event, indicating that fecal matter from livestock, wildlife, on-site treatment systems, pet waste, and illegal dumping may have been carried by runoff within the catchment area, but that the largest loading contribution occurred above the F4 site.

8/22/2017: Sampling was conducted on 8/22/2017 at three sites in the lower segment of the watershed. Precipitation data show monsoonal rain events occurred prior to the sampling event. Sampling data show all three sites exhibited high counts of *E. coli* with F17 >2,419.6 CFU/100ml, F5 at 1,553.1 CFU/100ml and F18 1,046.2 CFU/100ml. **The data show a decreasing pattern in *E. coli* counts throughout the reach, with the largest pollutant loading occurring above the F17 site.** It is likely that *E. coli* persisted in the water column indicated by the high counts seen at the lower sampling sites. The probable source of pollutant loading above the F17 site are on-site treatment systems, livestock, wildlife, pet waste, and storm water runoff. Due to prior monsoonal events in the watershed, it is likely runoff carried fecal matter from probable sources to the stream.

8/23/2017: Sampling conducted on 8/23/2017 occurred at four sites. Two are in the middle segment and two are in the lower segment. All samples collected during the sampling event exceeded water quality standards. F1B's *E. coli* count was 461.1 CFU/100ml. The next site in the middle segment F26's *E. coli* count was 920.8 CFU/100ml indicating pollutant loading occurred between F1B and F26. In the lower segment, both the F12 and F2 site's *E. coli* count was 1,986.3 CFU/100ml. This indicates pollutant loading occurred between F26 and F12. The pattern of increasing in *E. coli* count show there were areas contributing *E. coli* above the F1B, F26 and F12 sites. **Accumulation of *E. coli* in the water column is a likely factor in the increasing *E. coli* count seen at lower reaches; however, increases can be attributed to additional loading from runoff of catchment areas above the sample sites.** Probable sources in these portions of the watershed are stormwater runoff, livestock, wildlife, campgrounds, on-site treatment sites, and pet waste. Monsoon events prior to sampling indicate runoff from catchment areas carried fecal matter from probable sources to the stream.

8/24/2017: Sampling conducted on 8/24/2017 occurred at six sites in the lower segment of the watershed. Precipitation data show monsoonal rain events had continued to occur prior to the sampling event. F28's *E. coli* count was 166.4 CFU/100ml and F27 was 161.6 CFU/100ml. Both sites are located at the top of the lower watershed. F17's *E. coli* count was 816.4 CFU/100ml, indicating there was a significant contribution of *E. coli* above the F17 site. F16's *E. coli* count was 235.9 CFU/100ml and F5's was 238.2 CFU/100ml, indicating a decrease in loading from the F17 site. F18's *E. coli* count was 142.1 CFU/100ml indicating another decrease in loading between the F5 and F18 sites. **Pollutant loading that occurred above the F17 site indicates the catchment area above contributed *E. coli* acutely in this situation.** Probable sources in this catchment area are on-site treatment systems, pet waste, livestock, and wildlife.

10/12/2017: Sampling conducted on 10/12/2017 occurred at four sites. One is in the middle segment and three in the lower segment. Precipitation data show there was no rain events prior to sampling. F1's *E. coli* count was 31.1 CFU/100ml. F20's *E. coli* count was 387.3 CFU/100ml. **The F20 site is an irrigation return flow sampling location, indicating that runoff carried livestock and/or wildlife fecal matter from adjacent pastures to the irrigation return ditch.** F16's *E. coli* count was 26.2 CFU/100ml and F2's was 101.7 CFU/100ml, indicating an increase in pollutant loading between the sites. The major concern on this sampling date is the increased count of *E. coli* observed at the acequia return ditch, which show there are instances when flood irrigation of livestock pastures can contribute *E. coli* to the water column.

11/28/2017: Sampling conducted on 11/28/2017 occurred at three sites in the lower watershed. Precipitation data show there was no rain event prior to the sampling. F27's *E. coli* count was 4.1 CFU/100ml. F11's *E. coli* count was 58.1 CFU/100ml indicating a slight increase in loading between the sites. **F2's *E. coli* count was 365.4 CFU/100ml indicating there was a large increase in pollutant loading between the F11 and F2 sites.** Probable sources in this catchment area are on-site treatment systems, livestock, wildlife, and pet waste.

5/10/2018: Sampling conducted on 5/10/2018 occurred at five sample sites. Two are in the upper segment, one in the middle segment and two in the lower segment. FLJ's (top) *E. coli* count was 1,203.3 CFU/100ml indicating a significant amount of pollutant loading occurred above the FLJ site. Precipitation data show there was no rain event prior to sampling. **Because the sample date is prior to the scheduled on-date for federal grazing in the watershed, the likely source of *E. coli* can be attributed to humans, dogs, or wildlife with direct stream access within the catchment area.** The gate to go up this section of the river is opened on May 1 each year so humans and pets would have access above the sample site. FRE's *E. coli* count was 1.0 CFU/100ml. At the top of the lower watershed, both F28 and F27's *E. coli* counts were 1.0 CFU/100ml. Data from this sampling date indicate the observed exceedance at FLJ was an isolated loading event.

6/13/2018: Sampling conducted on 6/13/2018 occurred at four sites. Two are in the upper watershed, one in the middle segment and one in the lower segment. Both FLJ and RF-S's *E. coli* counts were 648.8 CFU/100ml. The data indicates pollutant loading occurred above the FLJ site and may have persisted in the water column, contributing or being the primary cause of the observed exceedance at the RF-S site. The *E. coli* count at the F1 site was 52.1 CFU/100ml and the F28 site was 1.0 CFU/100ml. The data indicates that pollutant loading in the upper watershed was an isolated event and may have been persistent in the water column or more pollutant loading may have occurred above RF-S. Precipitation data show there was no rain event prior to sampling. **The probable sources in the upper watershed are campers, pets, livestock, and wildlife and given the lack of recent precipitation, the likely mechanism of loading would be direct deposition of fecal matter into the stream.**

6/26/2018: Sampling conducted on 6/26/2018 occurred at three sites in the lower watershed. Precipitation data show there was no rain event prior to sampling. F9's *E. coli* count was <1.0CFU/100ml. **At F16 the *E. coli* count was 547.5 CFU/100ml, indicating pollutant loading occurred above the F16 site.** F18's *E. coli* count was 78.9 CFU/100ml. Due to lack of precipitation and the lack of pollutant loading above and below the F16, the data indicates loading at this site was an isolated event. The probable sources within this catchment area is on-site treatment systems. **Worth noting is the close proximity between F9 and F16 where if livestock or wildlife sources were present, we would expect to see a much higher *E. coli* count at F9.** With a lack of *E. coli* present at F9 and no adjacent livestock pastures between the sites, **we can isolate on-site treatment systems as the most probable source of *E. coli* loading at this site.**

7/2/2018: Sampling conducted on 7/2/2018 occurred at four sites. One is in the upper watershed, one in the middle segment and two in the lower watershed. FLJ's *E. coli* count was 1,732.9

CFU/100ml. RF-M's *E. coli* count was 24.6 CFU/100ml. F22's *E. coli* count was 410.6 CFU/100ml and F23's was 156.5 CFU/100ml. Precipitation data show there was no recent rain event prior to sampling. **The data indicates that pollutant loading occurred above the FLJ and F22 sites.** We can assume these exceedances occurred independently of one another because the RF-M site in the middle segment had a low *E. coli* count. Probable sources in the upper watershed at the FLJ site are humans, pets, livestock, and wildlife where direct deposition into the stream is the likely transport mechanism given the lack of precipitation. Above F22, probable sources are livestock, wildlife and pet waste. There are no house sites adjacent to the stream above F22 and the area is surrounded by livestock pasture. There is no fencing excluding livestock or wildlife from accessing the stream directly, therefore it is likely that direct deposition of fecal matter from livestock or wildlife is the likely source pollutant loading observed at this site.

8/1/2018: Sampling conducted on 8/1/2018 occurred at three sites. Two are in the upper watershed and one in the lower watershed. FLJ's *E. coli* count was 172 CFU/100ml. FRE's *E. coli* count was >2,419.7 CFU/100ml. F18's *E. coli* count was 33.1 CFU/100ml. Precipitation data shows there was no rain event prior to sampling. **The data indicates that pollutant loading occurred above both FLJ and FRE with a more significant contribution of *E. coli* load occurring above FRE.** The probable sources above this site are livestock, wildlife, and pets. Given the lack of precipitation, the likely mechanism of pollutant loading is direct deposition of fecal matter into the stream.

8/13/2018: Sampling on 8/13/2018 occurred at six sites. Two are located in the upper watershed, two in the middle segment and two in the lower segment. In the upper watershed, FLJ's *E. coli* count was 56.3 CFU/100ml and FRE's was >2,419.7 CFU/100ml. In the middle segment, F1B's *E. coli* count was 12.1 CFU/100ml and F1's was 238.2 CFU/100ml. In the lower watershed, F5's *E. coli* count was 686.7 CFU/100ml and F4's was 1,299.7 CFU/100ml. Precipitation data show there was no rain event prior to sampling. **The data indicates that pollutant loading occurred at several points in the watershed.** First in the upper watershed, the data indicates pollutant loading occurred between FLJ and FRE, where livestock and wildlife are the probable sources. Given the lack of precipitation it is likely that direct deposition of fecal matter from livestock and/or wildlife into the stream is the likely source of *E. coli*. In the middle segment, the data indicates pollutant loading occurred above F1, where probable sources are campgrounds, recreational areas, pet waste, and wildlife. In the lower watershed, the data indicates that pollutant loading occurred above both the F5 and F4 sites given the increase in *E. coli* between F1 and F5 as well as F5 and F4. Probable sources in this catchment area are on-site treatment systems, livestock, wildlife, pet waste, and illegal dumping.

9/11/2018: Sampling conducted on 9/11/2018 occurred at four sites. Two sites are located in the upper watershed, one in the middle segment and one in the lower watershed. In the upper watershed, FLJ's *E. coli* count was 410.6 CFU/100ml and FRE's 133.3 CFU/100ml. In the middle segment, F1's *E. coli* count was 7.4 CFU/100ml. In the lower segment, F4's *E. coli* count was 770.1 CFU/100ml. Precipitation data show there was no rain event prior to sampling. **The data indicates that pollutant loading occurred above FLJ in the upper watershed and above F4 in the lower watershed.** Probable sources in the upper watershed are livestock, wildlife, humans and pets. Lack of precipitation prior to sampling indicates that direct deposition of fecal matter into the stream from livestock or wildlife may have occurred above FLJ. Probable sources above F4 are on-site treatment systems, pet waste, livestock, wildlife and illegal dumping. **The data indicates that pollutant loading occurred above F4 on the sampling date and may be attributed to direct deposition or seepage into the stream from any of the probable sources.**

10/11/2018: Sampling conducted on 10/11/2018 occurred at three sites. Two sites are located in the upper watershed and one in the lower watershed. In the upper watershed, FLJ's *E. coli* count was 191.8 CFU/100ml and FRE's was 68.3 CFU/100ml. In the lower watershed, F4's *E. coli* count was 488.4 CFU/100ml. Precipitation data show there was no rain event prior to sampling. **The data indicates pollutant loading occurred above F4 prior to sampling.** Probable sources above F4 are on-site treatment systems, pet waste, livestock, wildlife, and illegal dumping. The data indicates that pollutant loading occurred above F4 on the sampling date and may be attributed to direct deposition or seepage into the stream from any of the probable sources.

4.7.2 Load Duration Curve Analysis by Assessment Unit:

The load duration curve analysis facilitates characterizing loads for different flow regimes and provides a visual display of relation between flow, loading capacity and observed loading by site. With this method of analysis, flow conditions where impairment occurs can be observed and accounts for how pollutant load is affected by stream flow magnitude, providing a link between water quality concerns and key watershed processes. However, this method is limited in the sense that it does not by itself account for fate and transport mechanisms but works on the assumption that flow is a primary driver of water quality variation.

The load duration curve provides information that determines under what flow conditions the observed *E. coli* exceedances occur.

From the load duration curve analysis, the pattern of impairment can be examined by plotting observed load by site against the target loading capacity which allows us to determine at what flow conditions *E. coli* exceedances occurred at any given sample site. This allows us to better understand the source of pollution at the sample site by helping to characterize the potential delivery mechanism of *E. coli* in the RFdT.

A load duration curve was developed for each assessment unit by multiplying stream flow with the applicable *E. coli* monthly geometric mean of 126 CFU/100ml water quality criteria. Points plotted above the target loading capacity show an exceedance has occurred where as those plotted below the line are considered in compliance with the water quality standard.

Each load duration curve was constructed with flow and water quality data from the 2017–2018 monitoring effort. Flow was measured on-site with direct instream measurements utilizing standard procedures. All flow measurements were converted from cubic-feet per second to millions of gallons per day for easier comparison with NMED's TMDL calculations. Each graph is discussed by flow and location.

Upper Rio Fernando de Taos, Assessment Unit: NM-98.A_001:

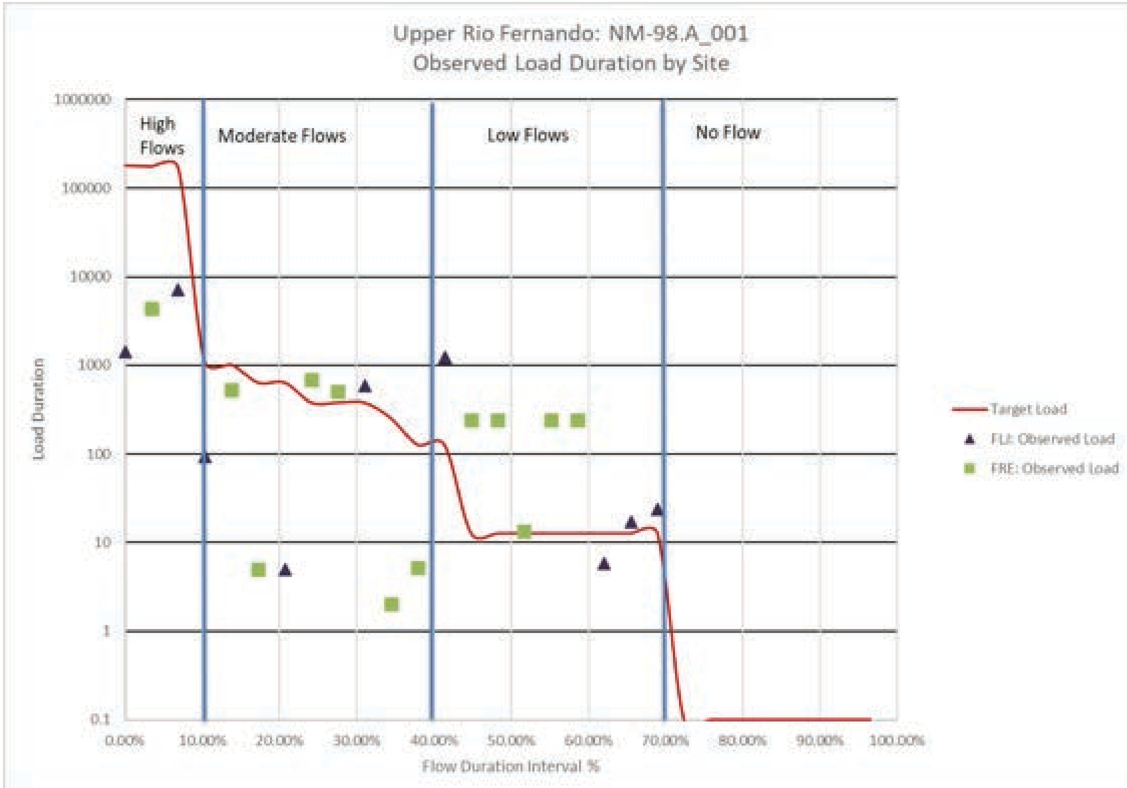

Figure 4-15: **Upper Rio Fernando de Taos, Assessment Unit: NM-98.A_001 observed load duration by site.**

Exceedances observed at the FRE sample site occurred on 10/16/2017 and 5/10/2018 during moderate flow conditions. Precipitation data show there was no recent precipitation prior to either the 10/16/2017 or 5/10/2018 sampling events. This indicates the source of *E. coli* may be attributed to direct deposition of fecal matter into the stream within the riparian zone. Grazing of cattle in the FRE site occurred from September 21, 2017–September 30, 2017 and August 31, 2018–October 6, 2018. In 2017, the sample was taken 16 days after cattle were present. **This and the fact that there was no precipitation before the sampling lead us to think that deposits of cattle fecal matter decomposing and wildlife are contributing sources.**

Grazing of Cattle at the FRE Site:

September 21 2017–September 30 2017
August 31 2018–October 6, 2018

Cattle also frequently entered this area throughout the 2017 and 2018 grazing season due to fencing maintenance problems.

Exceedances observed at the FLJ sample site during low flows occurred on 7/19/2017, 5/10/2018 and 8/1/2018. Precipitation data show there were rainstorms that occurred prior to the 7/19/2017 and 8/1/2018 sampling events, indicating that runoff from the catchment area may have carried fecal matter from livestock, human (campers), pets, and wildlife to the stream. Livestock is included in this conclusion because the datasheets indicate "fresh cow pies" and "odor of manure" on 7/19/17. This is an example of the several documented times when cattle were accessing the river during period that they were not meant to. Precipitation data show there was no recent precipitation prior to the 5/10/2018 sampling event. This indicates that direct deposition of fecal matter from wildlife into the stream may have occurred because the sampling date is prior to when the livestock were brought in on June 1, 2018. The datasheet from that day also documents high prairie dog activity in the area at that time.

Grazing of Cattle at the FLJ Site:

This allotment was rested in 2017—no cattle grazing occurred.
June 1, 2018–June 23, 2018

Cattle also frequently entered this area throughout the 2017 and 2018 grazing season due to fencing maintenance issues.

Exceedances observed at the FRE sample site occurred on 10/16/2017 during moderate flow conditions. As with the exceedance observed at the FLJ site on the same date, there was no recent precipitation within the catchment area. While livestock were removed from the area on September 30th, the datasheet documents cow pies seen in the exclosure.

Exceedances observed at the FRE sample site during low flows occurred on 7/19/2017, 8/1/2018, 8/13/2018 and 9/11/2018. As stated above, rain events occurred prior to the 7/19/2017 as well as the 8/1/2018, 8/13/2018 and 9/11/2018 sampling events. Permitted grazing of livestock does occur in the catchment area during these dates and therefore livestock as well as wildlife are likely sources of *E. coli* observed in the stream during these sampling events. **Fresh evidence of cattle activity was documented in the data sheets on 7/19/17, 8/1/18, and 9/11/18. Cattle were meant to be in this area from August 31–October 6.** The timeframe was longer than 10 days this year due to a fencing project that was in process. The fence will be back up following the 2019 grazing season. Because of precipitation prior to the sample events, it is likely runoff carried fecal matter from both livestock and wildlife within the catchment area to the stream.

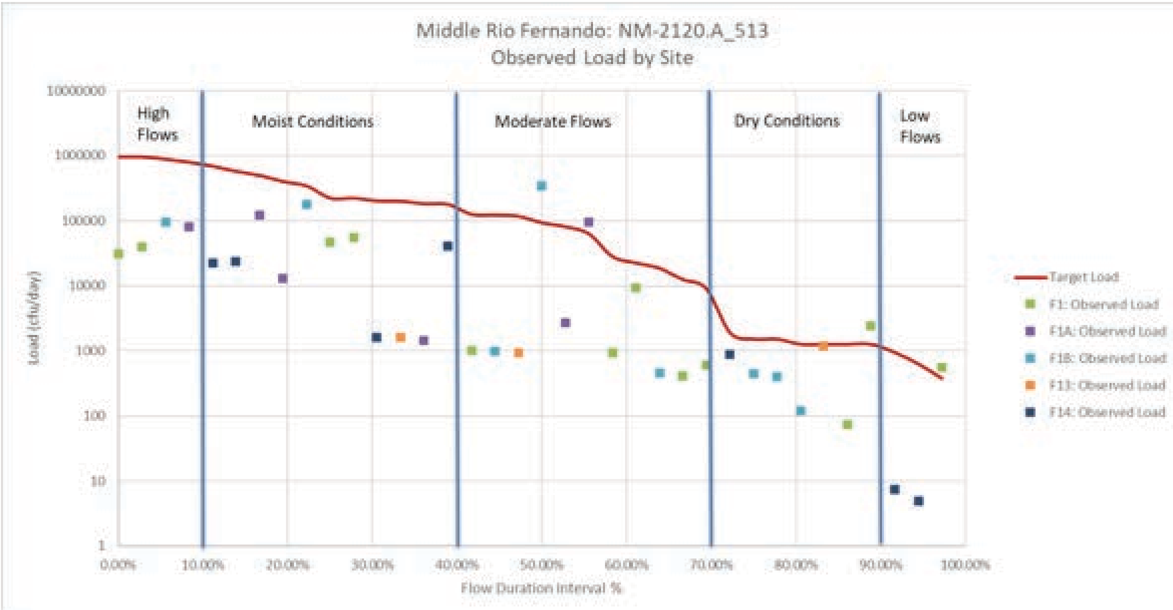

Figure 4-12: Middle Rio Fernando de Taos: Assessment Unit: NM-2120.A_513 observed load duration by site.

Analysis of the Middle RFdT load duration curve shows that most of the time *E. coli* levels are within compliance of water quality standards. Two exceedances were observed at the F1 site during times of dry conditions and a lower flow magnitude on 8/13/2018. Precipitation data show rainstorms occurred in the area prior to the sampling date that may indicate that runoff carried fecal matter from campgrounds, livestock, wildlife or on-site treatment systems.

Exceedances observed at the F1A and F1B site occurred on 6/4/2018 and 8/23/2017 respectively during moderate flow conditions. Precipitation data show there were rain events prior to both sampling dates at the F1A and F1B sites, indicating that natural sources of fecal matter from livestock and wildlife and or anthropogenic sources from campgrounds, roads/bridges/culverts, impervious surface, and other stormwater runoff may have been picked up and carried by runoff within the catchment area.

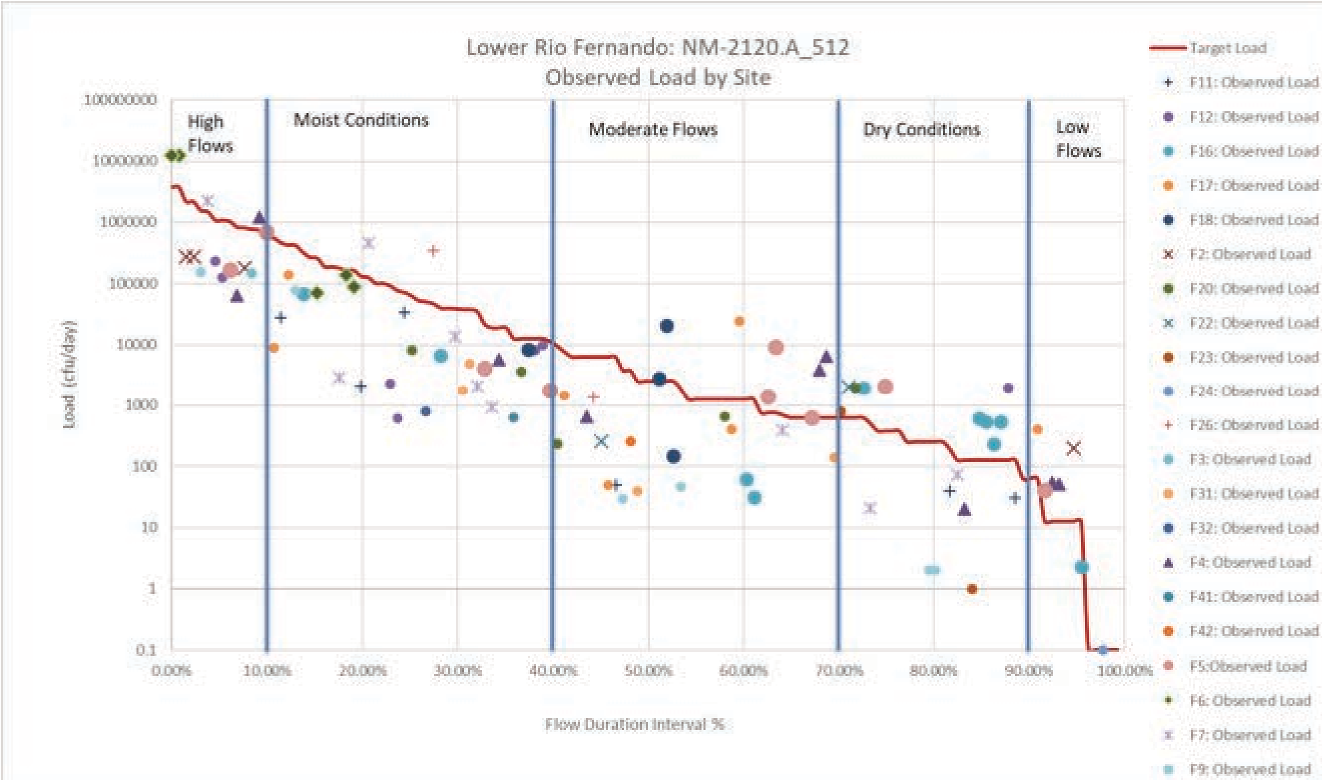

Figure 4-13: Lower Rio Fernando de Taos: Assessment Unit: NM-2120.A_512 observed load duration by site.

Analysis of the load duration curve constructed for the Lower RFdT allows us to see several patterns of *E. coli* pollution within the lower watershed. Plotting observed load categorized by sample site across the load duration curve displays the data in such a way that we can see patterns with *E. coli* exceedances at several sample sites. **During high flow conditions, the sites where exceedances occurred are at the F6 and F7 sample locations.** The F6 sample site is located just above the confluence with the RPdT in the agricultural community of Ranchitos where livestock grazing pastures are the dominant land use. Here we see two exceedances occurring during high flows and three samples were close to exceeding water quality standards during moist conditions. The two observed exceedances occurred on 5/11/2017 and precipitation data show there were two rainstorms in the two days prior to sampling. From this information stormwater runoff from adjacent livestock pastures is the most likely transport mechanism of fecal matter to the river. **At the F7 site, one exceedance was observed during high flow conditions on the same day, 5/11/2017, as the F6 site inferring that a similar transport mechanism of stormwater runoff from livestock pastures was the source of fecal matter in the river.** The other exceedance observed at this location occurred on 8/8/2017 during moist conditions. Precipitation data show rainstorms occurred in the watershed for the entire week leading up to sampling. Other *E. coli* samples from this date were taken at the F22, F24 and F4 locations, all located in the lower watershed. Exceedances were observed at the F22, F4 and F7 sites which shows the *E. coli* exceedance observed may have occurred from stormwater runoff carrying fecal matter from any part of the watershed. Potential sources of *E. coli* may have been contributed from livestock pastures as well as residential areas from pet waste and on-site treatment systems.

Exceedances at the F4 and F5 sample site locations occurred primarily during moderate flows, dry conditions and low flows. Exceedances observed during moderate flow conditions at F4 occurred on 8/13/2018 and 9/11/2018. Precipitation data shows that rainstorms occurred during the week leading up to sampling on 8/13/2018, which indicates fecal matter may have been transported from stormwater runoff carrying fecal matter from adjacent livestock pastures, pet waste, human waste or on-site treatment systems within residential areas of the catchment. Precipitation data from the exceedance observed on 9/11/2018 show there was no recent precipitation in the watershed leading up to the sampling date. **Therefore, the transport mechanism of fecal matter for this exceedance is unknown but may have been transported either by irrigation return flows or direct deposits from livestock or wildlife as well as seepage from on-site treatment systems from residential areas within the catchment**. Exceedances observed during low flow conditions at F4 occurred on 7/19/2017 and 8/8/2017. Precipitation data show rainstorms occurred prior to both sampling events. Despite stream flow measurements considered to be low flow conditions at the time of sampling, the occurrence of rainstorms within the watershed leading up to the sampling dates indicates fecal matter either from livestock, pet waste, human waste or wildlife may have been carried through runoff from adjacent livestock pastures, recreational areas and on-site treatment systems from residential areas within the catchment. Exceedances observed during moderate flow conditions at the F5 sample site occurred on 8/22 and 8/24 of 2017. As with the site F4, precipitation data show rainstorms occurred several times leading up to the sampling dates which may indicate fecal matter from livestock, wildlife, pet waste or sewage from on-site treatment systems was carried through runoff from livestock pastures, recreational areas or residential areas within the catchment.

Exceedances observed during dry conditions at the F16 sample site occurred on 2/1/2017, 8/22/2017, 8/24/2017, 6/26/2018. Precipitation data from the exceedance observed on 2/1/2017 and 6/26/2018 show there were no recent precipitation events in the area prior to either sampling event. This may indicate that fecal matter entered the stream through direct deposition on these dates from anthropogenic sources such as on-site treatment systems, illegal dumping, pet waste, human waste or a natural source from wildlife or waterfowl. Exceedances observed on 8/22/2017 and 8/24/2017 occurred during dry conditions. **Precipitation data show rainstorms occurred several times leading up to these sampling dates which may indicate fecal matter sources from livestock, pet waste, human waste, wildlife or waterfowl was carried through runoff potentially from stormwater runoff, highway/bridge/culvert runoff, construction site runoff and on-site treatment systems within this urbanized catchment area.**

4.8 Summary of Load Duration Analysis

In summary of the load duration curve analysis, processes other than flow may affect loading in the RFdT watershed and therefore created the need to consider the use of additional assessment tools, specifically the MST study to better characterize the contributions of individual sources.

The Lower segment of the RFdT sees a steep reduction in instream flow caused by diversions to agricultural irrigation ditches that divert approximately two-thirds of surface waters at the mouth of Taos Canyon. This means there are several changes in watershed processes in this portion of the watershed. The first consideration is that with reductions to stream flow, *E. coli* exceedances appear to primarily occur during times of moderate flows, dry conditions and low flows. One watershed process of concern in this portion of the watershed is return flows to the main stem from agricultural flood irrigation. The network of acequias that flood the adjacent agricultural fields and livestock pastures may increase the amount of *E. coli* runoff by picking up fecal deposits from pastures and carrying it to the river's mainstem through acequia return flows. With this delivery mechanism in mind there is potential that riparian buffer or wetland habitat improvement may help filter pollutants and reduce potential runoff from irrigation return flows to the river's main stem.

4.9 Microbial Source Tracking Study:

A Microbial Source-Tracking Study within the watershed was conducted over the course of March 26 2019 – September 23, 2019, in order to better characterize the sources of fecal contamination within assessment units. For the full MST study and results please see Appendix A. Methods and results are summarized below.

Sampling occurred regularly at five site locations and once at a 6th site. Sites were chosen based on high *E. coli* levels found in the 2017–2018 sampling described previously. Source Molecular analyzed all samples. Full methods are available in the MST Quality Assurance Project Plan - Appendix E.

Station Number (Headwaters to end)	Station Name	Latitude	Longitude	Station Rationale
1	FLJ	N 36 25.149	W 105 20.590	La Jara Canyon. Headwater at the U-turn before Angel Fire. About 100 yards from the cattle guard.
2	FRE	N 36 24.2298	W 105 20.7081	The Riparian Exclosure—a cattle pasture that is grazed 10 days a year. Straight to river from gate.
3	F16	N 36 24.010	W 105 35.013	Duncan Property –At the end of Santistevan Lane in Taos
4	F4	N 36 23.971	W 105 35.367	Fred Baca Park, near the footbridge at the bend.
5	PS3	N 36 24.288	W 105 35.885	Merris Spring at the intersection of Upper and Lower Ranchitos Roads. This spring flows into the RPdT and the RFdT depending on acequia activity.
6	F26	N 36 23.473	W 105 33.867	Los Pandos Road near where the RPdT water used to come into the RFdT. Shortly downstream from Angladas Building

Figure 4-18: Microbial Source Tracking Sample Locations List.

Figure 4-19: Map of Microbial Source Tracking Site Locations

4.9.1 Summary of the MST Report Results

Figure 4-19 shows what species were tested for at each site. Species tested for varied by site and were chosen based on results from the Watershed-based Plan. Species tested was also adjusted mid-way through the study to account for the results we were finding. For example, several of the sites were not tested for bird *at first.* After seven tests, site F16 water samples were found to have bird fecal DNA 100% of the time. Seeing this, we decided to test several other sites (FRE, F4 and PS3) for bird fecal DNA. Previously collected samples were frozen by the lab and then tested for the additional DNA markers when requested.

Site	Events	Human	Cow	Elk	Dog	Bird	Beaver
F16	7	X			X	X	
F4	14	X	X		X	X	X
FLJ	14	X	X	X	X		
FRE	14	X	X	X	X	X	
PS3	12	X	X		X	X	
F26	1	X	X		X		

Figure 4-20: Species Specific DNA Markers tested for at each Site. Blank cells indicate that the species was not sampled for at that site.

	Site	Events	Human	Cow	Elk	Dog	Bird	Beaver

	F16	7	0.29	X	X	0.71	1.00	X
	F4	14	0.21	0.00	X	0.64	0.64	0.57
	FLJ	14	0.14	0.64	0.00	0.86	X	X
	FRE	14	0.00	0.36	0.00	0.21	0.93	X
	PS3	12	0.67	0.00	X	0.08	0.92	X
	F26	1	1.00	0.00	X	1.00	X	X

Figure 4-21: The number of times each species DNA was found at each site as a proportion of the number of sample events. X's indicate that the species was not sampled for at that site.

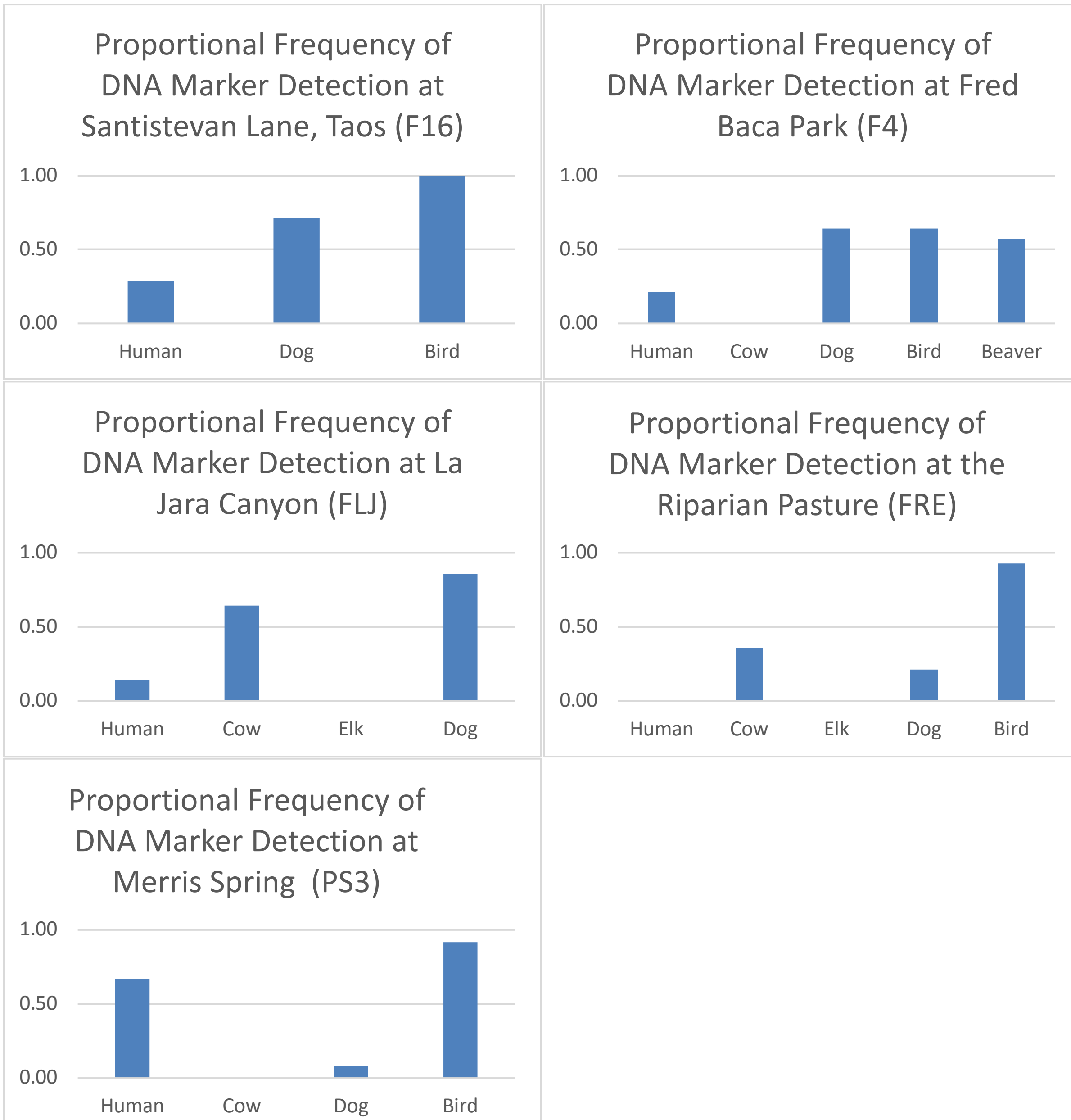

Figure 4-22: Proportional frequency graphs at each of the five MST sample sites.

These results highlight several points. Please see Appendix A for a full analysis.

1. In the upper watershed (sites FLJ and FRE) cows, bird, and dogs are the most prevalent sources of *E. coli* into the RFdT.
    a. Human detections were low (14%) and only in the FLJ site, not FRE. Detections were also too low too quantify. This indicates that the pollution is likely from camping activities in the La Jara Canyon (Forest Road #5) above site FLJ.
    b. Elk feces was not detected at all at FRE or FLJ. There are known elk populations in those areas but the time of the study (March 26- Sept 23) may not have captured the most active elk season at those sites.
    c. Cattle and dog were the most frequent markers found at site FRE, indicating that pet waste along with cattle waste are contributing to *E. coli* loading.
    d. Site FRE had a high frequency of bird DNA (93%). We were unable to test FLJ for bird DNA due to limited funding.
2. In the lower watershed (sites F16, F4 and PS3), site PS3 has the highest frequency of human fecal matter in the water samples.
    a. A high rate of 67% of the samples at site PS3 contained human DNA markers indicating that faulty septic systems are the dominant source of the *E. coli* loading at this site.
    b. Sites F16 and F4 (Just upstream of La Posta Road/RFdT crossing and Fred Baca Park) had similar frequencies of human markers at 21% and 29%, indicating that there is a source of human input closer to F16 that then slightly decreases as it reaches Fred Baca Park.
    c. Both dog and bird markers were found in higher frequency than human DNA at F4 and F16 whereas bird DNA was the highest at PS3, closely followed by human DNA.
    d. Beaver DNA was found as expected at F4. This is an active beaver pond but the frequencies of detection at the site were highest for dog and bird, then beaver, and then human.
3. While birds were not a community concern in terms of *E. coli* in the river, bird DNA markers were found at levels from 64%-100% at the 4 sites where we tested for bird DNA.
    a. Bird DNA is a natural source (wildlife) that can only be controlled through reducing private feeding of birds on the river and/or increasing in-stream flows and wetlands. Feeding birds is not a practice in the area that is known to be common at a level that would artificially inflate the bird populations on the Rio Fernando de Taos. However, we will inform the community of these findings and create bird-focused projects if needed and feasible based on community feedback.
4. Site F26 was only sampled for one time. However, it indicates that human and dog fecal matter are contributing to the *E. coli* pollution in the Los Pandos Road adjacent area of the RFdT.

a. This site was sampled for human, cow, and dog DNA after a rainstorm left puddles in this area of the river. This indicates that runoff continues to be a concern in this area and that cattle were not a source on that day.

5 Target Loads for *E. coli* and Target Load Analysis

Load analysis is critical to understanding the nature of impairment relative to stream flow. It is also critical to determining where pollution mitigation implementation is needed and has the greatest potential to reduce the impairment to the waterbody concerned. This section discusses load estimates provided in the TMDL for Upper Rio Grande and hydrology of the RFdT as it relates to potential impacts to pollutant loading and load analysis.

5.1 Load Calculation Methods:

These values are based on the reduction in bacteria (*E. coli*) necessary to achieve the numeric criteria associated with the primary contact use for the RFdT. Total Maximum Daily Loads are calculated at a specific flow and bacteria concentrations can vary as a function of flow.

SWQB determined stream flow during the 2009 sampling season taking direct in-stream flow measurements utilizing standard procedures. **Water Quality Standard exceedances occurred during lower flows. Therefore, the critical flow value used to calculate TMDLs was obtained using a 4-day, 3-year low-flow frequency (4Q3) regression model.** The 4Q3 is the annual lowest 4 consecutive day flow that occurs with a frequency of at least once every 3 years. For the RFdT the regression equation for mountainous regions above 7,500 feet in elevation is applied as the Conversion Factor.

> The geometric mean indicates the central tendency or typical value of a set of numbers, defined as the nth root of the product of n numbers. For example, the geometric mean of 2 and 8 is 4 (the square root of 2 x 8)

Measured loads for *E. coli* were calculated by substituting the arithmetic mean of observed *E. coli* data for the geometric mean criterion. Arithmetic mean was found with the sum of all *E. coli* samples (CFU/100mL) divided by the total number of samples taken. Critical flow is in millions of gallons/per day.

Percent reduction is a goal to work towards in the implementation phase of the TMDL with the ultimate goal being restoration and maintenance of in-stream water quality so that beneficial uses are met.

5.2 Load Calculation Results

Figure 5-1 lists estimated *E. coli* pollutant loads for the three impaired segments of the RFdT based on water sampling results. Relative to many bacteria TMDLs, these load reduction goals are reasonably small and appear relatively feasible. Figure 5.2 displays the likely biological sources and source activities based on knowledge of the watershed and sampling results described in Chapter 4.

AU:	Critical Flow	*E. coli* Geometric Mean (CFU/100mL)	Conversion Factor	Target Load for *E. coli*	Measured *E. coli* Arithmetic Mean (CFU/100mL)	Measured Load of *E. coli*	*E. coli* Load Reduction Required	Percent Load Reduction Needed
	(mgd)	**CFU/100ml**		**(CFU/day)**		**(CFU/day)**	**(CFU/day)**	%
NM-2120.A_512 (Upper)	0.44	126	3.79E+07	2.12E+09	218.6869	3.64E+09	1.52E+09	41.76
NM-2120.A_513 (Middle)	0.52	126	3.79E+07	2.46E+09	54.0027	1.06E+09	0.00	0.00
NM-98.A_001 (Lower)	0.1	126	3.79E+07	4.92E+08	212.9844	8.07E+08	3.15E+08	39.03

Figure 5-1: Estimated *E. coli* pollutant loads for the three impaired segments of the RFdT based on water sampling results. The Total Measured *E. coli* Load in the river is 5.51E+09 CFU/mL per day.

Biological Source	Source Activity Pathway to River	Ground water	Direct Discharge	Irrigation Returns	Storm Water
Human					
	Faulty septic tanks	X			X
	Illegal septic systems (I.e. straight pipes, cesspits, etc.)	X	X	X	X
	Illegal dumping		X		X
	Leaking sewer pipes	X	X		
	Outdoor defecation		X		X
Livestock: cattle, horses, goats, sheep, chickens					
	Animals with direct access to the river		X		X
	Grazing on irrigated fields			X	X
	Grazing on uplands and riparian areas		X		X
	Improper manure disposal		X	X	X
Wildlife: elk, deer, etc.					
	Animals with direct access to the river		X		X
	Grazing on irrigated fields			X	X
	Grazing on uplands and riparian areas		X		X

Figure 5-2: Possible sources of human and animal bacteria in the Rio Fernando de Taos.

5.3 Estimating Pollutant Loads from Specific Sources

Estimates of *E. coli* loads and sources in the RFdT watershed were determined using the Bacteria Source Load Calculator (BSLC), developed by the Center for TMDL and Watershed Studies at Virginia Polytechnic Institute. The BSLC is a spreadsheet model that characterizes how bacterial loads are spatially and temporally distributed by inventorying bacterial sources and estimating loads generated from these sources. The BSLC incorporates user-generated, watershed-specific inputs, including land use distribution and livestock, wildlife, and human population estimates, to calculate monthly and yearly bacterial loadings. Results are displayed by source (i.e. land use) in colony forming units (CFU's), per year. Land use data and additional model inputs gathered for the RFdT watershed are estimated given all of the available information and resources utilized, final numbers for the land use analysis and bacteria loading inputs are approximate and should be viewed only as carefully researched estimations.

Exact Inputs for the BSLC are available in Appendix F.

The methods and procedures for the BSLC are available in the BSLC User's Manual - Appendix G

An overall assumption is that the number and types of land uses and animals represented by the BSLC characterize the watershed appropriately for the uses of the output. The main assumption applicable to this project is that that sheep, goats, and horses do not spend significant time in confinement.

Other defining assumptions include:

- Poultry are always confined;
- All animals of a particular species are managed in the same way and/or have the same behavior
- Poultry litter is completely mixed prior to land application (i.e., calculation of poultry litter application in each sub watershed applies an amount of fecal coliform that is a conglomerate of all poultry sources in that sub watershed)
- Manure is applied first to cropland and then to pasture.

The BSLC characterizes how the bacterial loads are spatially and temporally distributed, organizing and processing source data to calculate monthly land loadings and hourly stream loadings.

The BSLC program uses a systematic process that includes the following steps:

1. Inventorying bacterial sources (including livestock, wildlife, humans, and pets);
2. Estimating loads generated from these sources;
3. Distributing estimated loads to streams and land, as a function of source type and land use; and
4. Generating bacterial load input parameters for watershed-scale simulation models.

	CFU/year	Percent Contribution	CFU/day
Agriculture	4.28E+15	87.69%	1.17E+13
Wildlife	2.42E+14	4.97%	6.64E+11
Humans	2.17E+14	4.45%	5.94E+11
Pets	1.41E+14	2.90%	3.87E+11
Total	4.88E+15	100%	**1.34E+13**

Figure 5-3: Results from the Bacteria Source Load Calculator Report Summary.

Source	Upper Rio Fernando de Taos *E. coli* Loading (CFU/year)	% of Total	Middle *E. coli* Loading (CFU/year)	% of Total	Lower *E. coli* Loading (CFU/year)	% of Total
Cropland	7.90E+12	0.51%	7.60206E+12	0.53%	1.43E+13	0.96%
Pasture	1.47E+15	95.78%	1.28301E+15	88.92%	1.32E+15	89.11%
Residential	4.88E+13	3.18%	7.4188E+13	5.14%	1.43E+14	9.60%
Forest	8.07E+12	0.53%	7.81572E+13	5.42%	4.91E+12	0.00%
Total	1.53E+15	100.00%	1.44296E+15	100.00%	1.48E+15	100.00%

Figure 5-4: Land Use Results from the Bacteria Source Load Calculator – From ReportAppendix1 Tab.

Source	Upper Segment *E. coli* Loading (CFU/year)	% of Total	Middle Segment *E. coli* Loading (CFU/year)	% of Total	Lower Segment *E. coli* Loading (CFU/year)	% Total
Cattle in streams	3.83E+12	10%	0	0.00%	0.00E+00	0.00%
Wildlife in streams	9.91E+12	25.00%	2.92E+13	44.00%	8.04E+12	18.00%
Straight pipes	2.63E+13	66.00%	3.73E+13	6.00%	3.73E+13	82.00%

Total	4.00E+13	100.00%	6.65E+13	100.00%	4.53E+13	100.00%

Figure 5-5: Source Results from the Bacteria Source Load Calculator – From ReportAppendix1 Tab.

The total modeled load using the Bacteria Source Load Calculator was **1.34E+13 CFU/mL per day** whereas the total MEASURED load using water sampling information (Figure 5.1) was, **5.51E+09 CFU/mL per day.** This means the BSLC loading results were 2,432 times larger than the measured results. This is likely due to the inputs, functions, and assumptions of the Calculator. Water sampling for this project was intensive, resulting in 315 *E. coli* samples and 61 Microbial Source Tracking Samples. **For this reason, loads estimated from sampling results were used for all load reduction estimates in this document.** The Bacteria Source Load Calculator provides an insight into probable levels of source input but because it makes so many assumptions and we were able to include Microbial Source Tracking at some sites, we will not use the BSLC measured loads any further into this Plan. **We will however use the BSLC estimates for the <u>percentage of sources</u> to estimate load reductions for each project. See Table 6-1.**

5.4 Watershed Restoration Goals:

Based on 21 months of intensive *E. coli* sampling, the BSLC and feedback from the public regarding drafts of this Watershed-based Plan, the following restoration goals were determined.

- **Remediate all sources of human waste in river**
- **Ruminant bacteria reduced by half through fencing and GI/LID approaches**
- **Storm flow bacteria and nutrient concentrations reduced by >10%**
- **Native grass, shrub, and tree buffers along river in all sub watersheds**
- **Reduce loading of fine sediment originating from roads and disturbed areas**
- **Floodplains reconnected in reaches where compatible with current land use**

6 Management Measures and Projected Load Reduction

6.1 Table of Proposed Best Management Measures:

The following 11 page section presents a menu of on-the-ground or policy projects that address the pollutant sources, impairments, and threats to watershed health discussed above. Outreach and education projects are outlined in Chapter 7. Estimating load reductions from these proposed projects is speculative. However, it is clear that these activities will have a beneficial impact on major sources of *E. coli* to the system.

Categories of on-the-ground and policy projects include:

1. Fecal Waste
2. Fencing
3. Forest/Watershed Health
4. Green Infrastructure, runoff control, erosion control
5. Septic Tanks
6. Stream/Wetland Restoration

Figure 6-1: Proposed On-The-Ground and Policy Related Projects.

Project Number	Category	Project Name	Management Objective	Detailed Description with Location	Indicator and Target Value	Methods for Estimated Percent Load Reductions	Estimated Load Reductions (CFU/day)	Need/Reason Rational
1	Fecal Waste (Lower Segment)	Homeless Shelter Waste Disposal Campaign	Decrease *E. coli* concentrations from human sources	Promote/setup the Men and Women's shelters to have portable toilets or compostable toilets on their property that are open 24/7. Project will first require communication with the property owners about what they think would help and what they are willing to do.	*E. coli* levels of less than 235 CFU's/100ml at known problem locations - near the men's shelter, and near ABC lock. Flow in lowest segment of the river all year long. Dissolved oxygen above 8 during the summer.	The load from *E. coli* in the lower section is estimated to be 807,000,000 CFU/day according to water sampling. Straight pipes ("human waste") are estimated to contribute 82% of the *E. coli* to the lower segment according to the BSLC. Assuming half of that is due to the homeless population, a reduction of 40% is applied to the 807,000,000CFU/day	322,800,000	Homeless encampments along the RFdT are common and abundant. The Men's shelter is next to the river but is only open for a few hours a night and only to sober people.
2	Fecal Waste (Whole River)	Develop Backyard Livestock Waste Management	Decrease *E. coli* concentrations from human-owned livestock sources throughout the watershed.	Create a guidance document and then work towards implementing it. Focus will be on landowners with concentrated livestock but be applicable for all levels of livestock management. Incentive for composting the waste will be developed.	*E. coli* levels of less than 235 CFU's/100ml. Flow in lowest segment of the river all year long Dissolved oxygen above 8	This project will develop and disseminate best management practices for manure and create an incentive program for landowners. Implementation of the project is expected to result in a 5% reduction in the manure entering the RFdT. Input from Agriculture are estimated at 90.07% by the BSLC (pasture and cropland). Load reduction calculated by multiplying the total load input calculated from water sampling	248,142,850	Pasture is estimated to contribute 89.11% of the *E. coli* load to the RFdT. In another breakdown of loads, Agriculture is estimated to contribute 87.69% of the *E. coli* load to the system. These estimates show us the

Project Number	Category	Project Name	Management Objective	Detailed Description with Location	Indicator and Target Value	Methods for Estimated Percent Load Reductions	Estimated Load Reductions (CFU/day)	Need/Reason Rational
						(5,510,000,000CFU/day) by 90.07% = 4,962857000 and then applying a 5% reduction to value.		importance of addressing levels of fecal waste reaching the river.
3	Fecal Waste (Upper Segment)	Implementation of Rest Rotation or Deferred Rotation Management System.	Decrease *E. coli* concentrations from the cattle grazed on Forest Service Lands and from private-land cattle grazing on the RFdT.	There are 10 Grazing pastures in the Taos Canyon (the Capulin and Flechado Allotments), where grazing occurs between June 1 and September 30. There are several private landowners who also run cattle and horses on private land.	*E. coli* levels of less than 235 CFU's/100ml in the upper and lower segments. Flow in these two segments of the river all year long. Dissolved oxygen above 8 in the summer.	Cattle in streams is estimated to contribute 10% of the *E. coli* in the upper segment. We estimate that implementing deferred rotations will reduce cattle access to the river by 10%. The estimated total load is 3.64E+09CFU/mL in the upper segment is then multiplied by 10% input from cattle, and then that number is multiplied by 10% estimated load reduction.	36,400,000	Improved infrastructure for ranching is typically cost-prohibitive without assistance from public programs.
4	Fecal Waste (Whole River)	Increased Pet Waste Disposal Resources at Trailheads and Parks	Decrease *E. coli* concentrations from human-owned pet waste	Establish pet waste disposal and pick-up services at trailheads and in parks including new signs.	*E. coli* levels of less than 235 CFU's/100ml. Flow in all segments of the river all year long. Dissolved oxygen above 8 in the summer	Pets are estimated to contribute 2.90% of the *E. coli* to the system. Assuming this project will affect all segments of the river. Assuming a 0.05% reduction in pet waste and a total load calculated at 5,510,000,000CFU/day by water sampling, pet waste is contributing 1597900000CFU/day and a	79,895,000	There are several FS trailheads and campgrounds between the NM64 and the RFdT. There are also two parks on the Rio Fernando. Community organizations would fund and

Project Number	Category	Project Name	Management Objective	Detailed Description with Location	Indicator and Target Value	Methods for Estimated Percent Load Reductions	Estimated Load Reductions (CFU/day)	Need/Reason Rational
						reduction of 1/2 a percent to that = 79895000		stock trailheads with pet paste bags and new signs.
5	Fecal Waste (Upper Segment)	Monitoring of National Forest Plan and Grazing Permits	To decrease *E. coli* loads by monitoring and advocating for proper implementation of the CNF Plan and the annual operating instructions for cattle in the RFdT watershed.	To monitor USFS Forest Plan to make sure that their standards and guidelines on public lands are enforced. Staff time to engage with the USFS on both of these topics.	Engage with USFS Staff to work in the NEPA process with the grazing permits. To request the Annual operating instructions and monitor the enforcement of those instructions.	None. This is an advocacy project that will help to decrease *E. coli* into the RFdT from runoff due to lack of enforcement of the Forest Plan or the Annual Operating Instructions on USFS lands	N/A	The USFS CNF Plan and the Annual Operating Instructions for cattle on USFS lands are both documents will facilitate proper land management, thus decreasing *E. coli* loads in the system.
6	Fecal Waste (Whole River)	Identification of Properties with Conservation Potential	To minimize livestock and pet impacts to the river by purchasing land that is available along the RFdT or by creating	Identify properties for easements or acquisitions (using Green Print and other data)	*E. coli* concentrations below 235 CFU/100ml in the lower segment of the river during the summer. Water in the lower section all summer. Dissolved oxygen above 8 in the summer.	None. Land bought cannot be predicted. It is hoped that the land purchased had livestock impacting the river and after the purchase, the livestock is no longer there or managed differently.	N/A	Due to the changes in landownership and agricultural use along the RFdT, there are opportunities for the Taos Land Trust to purchase lands or create conservation

Project Number	Category	Project Name	Management Objective	Detailed Description with Location	Indicator and Target Value	Methods for Estimated Percent Load Reductions	Estimated Load Reductions (CFU/day)	Need/Reason Rational
			conservation easements.					easements on these properties.
7	Fencing (Upper Segment)	Riparian Pasture (Site FRE) Fencing Project	Decrease *E. coli* concentrations from the cattle grazed on USFS Land (Flechado Allotment) in the Riparian Pasture for 10 days a year.	Project under way. The Riparian Pasture fence (1 mile) has been removed and the new pipe rail fence will be installed in the fall of 2019.	*E. coli* concentrations below 235 CFU/100ml before AND after the cattle use this pasture each year (10 day span). Dissolved oxygen above 8 in the summer.	Cattle in streams is estimated to contribute 10% of the *E. coli* in the upper segment. We estimate fixing the fence will reduce cattle access to this section of river by 20%. The estimated total load of 3.64E+09 in the upper segment is then multiplied by 10% input from cattle, and then that number is multiplied by a 20% load reduction.	72,800,000	The Riparian Pasture is meant to hold cattle for 10 days year but has not been functioning for at least a decade. Each summer cattle are seen in the pasture when they are not meant to be.
8	Fencing (Whole River)	Private Land Livestock and Pet Fencing Subsidies	Decrease *E. coli* concentrations from human-owned pet and livestock waste	Cost-share program. Start with finding funds for a pilot project and a willing land owner. Then get funding for several landowners at once. Fund water gaps and hardening of the gaps to decrease bank erosion.	*E. coli* levels of less than 235 CFU's/100ml. Flow in all segments of the river all year long. Dissolved oxygen above 8 in the summer	Pets are estimated to contribute 2.90% of the *E. coli* to the system. Assuming this project will affect all segments of the river. Assuming a 1% reduction in pet waste and a total load calculated at 5,510,000,000CFU/day by water sampling, pet waste is contributing 1597900000CFU/day and a reduction of 1 percent to that = 159,790,000	15,979,000	Direct access to the river by livestock and pets is common throughout the watershed.

Project Number	Category	Project Name	Management Objective	Detailed Description with Location	Indicator and Target Value	Methods for Estimated Percent Load Reductions	Estimated Load Reductions (CFU/day)	Need/Reason Rational
9	Fencing (Upper Segment)	Fencing of head cuts in FLJ	Decrease *E. coli* concentrations from the cattle grazed on Forest Service Land (Flechado Allotment) in the La Jara Pasture for 30 days a year.	Fencing of 4 repaired head cuts in the La Jara pasture - used for 30 days a year. NEPA required.	*E. coli* concentrations below 235 CFU/100ml in the fenced off head cuts Dissolved oxygen above 8 in the summer.	Cattle in streams are estimated to contribute 10% of the *E. coli* in the upper segment. The estimated total *E. coli* load of upper segment is 3.64E+09. We estimate putting up fencing around these 4 head cuts will reduce cattle access to this small section of the river by 5%. 10% of 3.64E+09 is 364,000,000. 5% of this is 18,200,000	18,200,000	Restoration of these head cuts has been approved by the USFS and included into the project funded by the Rio Grande Water Fund.
10	Green Infrastructure, Run off control, erosion control (Lower Segment)	Incentives/Subsidies for Green Infrastructure on Private Land	To decrease *E. coli* concentrations from runoff around 10 private homes and farms.	Create a voluntary program for private landowners to learn how to capture their rainwater, how to create rock gardens and how to get the water back to the river. This project will compliment project #8. Focus will be in the lower watershed.	*E. coli* concentrations below 235 CFU/100ml in the lower segment of the river during the summer. Water in the lower section all summer. Dissolved oxygen above 8 in the summer.	Agriculture was estimated to contribute 87.69% of the *E. coli* load to the river system and Pets are estimated to contribute 2.9. While this number may be high, it indicates the importance of reducing runoff to the river from these sources. If we got 10 areas of private land to install rain gardens and other GI measures, we would estimate a 30% reduction in *E. coli* levels - 5,510,000,000CFU/day input from water sampling*87.69%	420,359,553.00	This is necessary because direct access to the river by livestock is common throughout the watershed.

Project Number	Category	Project Name	Management Objective	Detailed Description with Location	Indicator and Target Value	Methods for Estimated Percent Load Reductions	Estimated Load Reductions (CFU/day)	Need/Reason Rational
						agriculture *2.90 pets*0.30 = 420,359,553		
11	Green Infrastructure, Run off control, erosion control (Whole River)	Green Infrastructure Ordinances for New Development	To decrease *E. coli* concentrations from runoff around 5 new private homes and farms a year using GI Best Management Practices.	Project #10 will help promote this project. We will advocate for the Town and County to adopt GI ordinances; a logical next step. The ordinances will be focused on new homes/farms.	*E. coli* concentrations below 235 CFU/100ml in the lower segment of the river during the summer. Water in the lower section all summer. Dissolved oxygen above 8 in the summer.	Agriculture was estimated to contribute 87.69% of the *E. coli* load to the river system. While this number may be high, it indicates the importance of reducing runoff to the river. If we got 5 newly built homes a year to install rain gardens and other GI measures, we would estimate a 5% reduction in *E. coli* levels - 5,510,000,000CFU/day input from water sampling*87.69% agriculture* 2.90% pets *0.15 = 210,904,534	210,904,534	Without town and county ordinances and community support for comprehensive green infrastructure, run off from yards and farms will continue to increase *E. coli* levels in the river.
12	Green Infrastructure, Run off control, erosion control (Lower Segment)	Improve water quality impacts from Los Pandos road to mitigate impacts on RFdT	To improve the Rio Fernando floodplain on private lands along Los Pandos Road.	One on one landowner negotiations and cost share program to rehabilitate land along the Los Pandos Road Area. This would include septic tank repairs, fencing projects, erosion control projects, and water gaps.	*E. coli* concentrations below 235 CFU/100ml in the lower segment of the river during the summer. Water in the lower section all summer. Dissolved oxygen above 8 in the summer.	Agriculture was estimated to contribute 87.69% of the *E. coli* load to the river system. While this number may be high, it indicates the importance of reducing runoff to the river. If we got 5 landowners homes a year to repair septic tanks, install fences and GI measures, we would estimate a 5% reduction in *E. coli* levels - 5,510,000,000CFU/day input from water	70,301,511	The RFdT is completely disconnected from its floodplain in the area where it parallels Los Pandos Road (lower section) and many of the houses are old and have not had recent

Project Number	Category	Project Name	Management Objective	Detailed Description with Location	Indicator and Target Value	Methods for Estimated Percent Load Reductions	Estimated Load Reductions (CFU/day)	Need/Reason Rational
						sampling*87.69% agriculture* 2.90% pets *0.05 = 70,301,511		septic inspections.
13	Septic Tanks (Lower Segment)	Private Land Septic Inspection Subsidies	To decrease *E. coli* concentrations from faulty septic tanks near the Rio Fernando	Work with the County and perhaps a Federal program to get consistent money for septic inspections and repairs/replacements. Then reach out to landowners with funding for the inspections. It costs $100-250 for a septic inspection and $300-400 to pump it. This is fairly low cost.	*E. coli* concentrations below 235 CFU/100ml in the river during the summer. Water in the lower section all summer. Dissolved oxygen above 8 in the summer.	The measured load from *E. coli* in the lower section is estimated to be 807,000,000 CFU/day according to water sampling. Straight pipes are estimated to contribute 82% of the *E. coli* to the lower segment according to the BSLC. Assuming two leaky septic tanks are found per year this project could produce a 5% reduction in *E. coli* loading in this segment: 807,000,000*82% straight pipes*5%=33,087,000	33,087,000	Septic tank best management practices are known to be an issue in this area. This project will subsidize correct use and maintenance of septic tanks.
14	Septic Tanks (Lower Segment 0	Implementation of public sewer system in upper/lower Ranchitos intersection area.	To decrease *E. coli* concentrations in the upper/lower Ranchitos Road area by installed a public sewer system and decommissioning faulty septic tanks	This area is a historic wetland with a high water table. There are many septic tanks in this area that were granted variances, many that are not inspected, and many that are very old. AB would work with NMED and the Town to advocate in that community for the need to switch.	*E. coli* concentrations below 235 CFU/100ml in Merris Spring every season. Dissolved oxygen above 8 in the summer.	The measured load from *E. coli* in the lower section is estimated to be 807,000,000 CFU/day according to water sampling. Straight pipes are estimated to contribute 82% of the *E. coli* to the lower segment according to the BSLC. Assuming approximately 100 houses are put on sewer, we estimate a 50% reduction in *E. coli* loading in this segment: 807,000,000*82%	330,870,000	Sampling from the Merris Spring near upper/lower Ranchitos Road consistently shows direct input of fecal matter into the river. NMED data show this area has been a problem area for 20 years.

Project Number	Category	Project Name	Management Objective	Detailed Description with Location	Indicator and Target Value	Methods for Estimated Percent Load Reductions	Estimated Load Reductions (CFU/day)	Need/Reason Rational
			as they are no longer needed.			straight pipes*50%=330,870,000		
15	Septic Tanks (Whole River)	Incentives for High Quality New Septic Tanks	To decrease *E. coli* concentrations along the entire length of the Rio Fernando.	This project will fund new septic tanks on the RFdT when they are needed after inspections. It would follow Project #13 and be a yearly funding supply available to landowners who get inspections or move into a new home.	*E. coli* concentrations below 235 CFU/100ml in all segments of the river.	The load from *E. coli* is estimated to be 5,510,000,000 CFU/day according to water sampling. Straight pipes are estimated to contribute 82% of the *E. coli* to the system according to the BSLC (= 4,518,200,000 CFU/day). Assuming two leaky septic tanks are found per year this project could produce a 5% reduction in *E. coli* loading in this segment: 807,000,000*82% straight pipes*5%=33,087,000	33,087,000	Septic tanks are expensive so best management practices are not typically followed. People get variances to pay less and install systems that are not adequate. This program will cost share this burden up to 100% depending on funding.
16	Septic Tanks (Whole River)	Tracking of septic tank inspections	To decrease *E. coli* concentrations by establishing a mechanism for notifications of needed septic tank	Work with septic tank contractors and NMED to establish a way of keeping track of when the inspections are done. Then reminders would be sent out every 5 years to each landowner.	*E. coli* concentrations below 235 CFU/100ml in all segments of the river.	It is not possible to track load reductions from this project. We will know how many people are inspecting their septic tanks through the tracking but we don't know how many were already doing that.	N/A	Septic tank inspections are expensive so best management practices are not typically followed. People do not often inspect them every 3-5

Project Number	Category	Project Name	Management Objective	Detailed Description with Location	Indicator and Target Value	Methods for Estimated Percent Load Reductions	Estimated Load Reductions (CFU/day)	Need/Reason Rational
			inspections on the RFdT					years as recommended.
17	Septic Tanks (Whole River)	Septic Tank and Floodplain Mapping Project	Decrease *E. coli* concentrations by repairing/replacing the current septic tank violators on the RFdT.	To use NMED and local information to map septic tanks along the Rio Fernando and overlay it with floodplain layers. This will identify septic tanks that are most in danger of being inundated and it will help identify locations of old septic tanks.	*E. coli* concentrations below 235 CFU/100ml in all segments of the river.	It is not possible to track load reductions from this project. There is not a map layer of septic tanks in the Taos area. There are some floodplain maps available.	N/A	There are many septic tanks within floodplains on the RFdT. This will serve to tell us which areas are going to be more prone to leaking into the river.
18	Septic Tanks (Whole River)	Mitigate Problem Septic Tanks (engage with 10 current violators in the RFdT)	Decrease *E. coli* concentrations by mitigating approximately 10 current septic tanks that are in violation of their permits.	This project would secure funds to address the current septic systems that are known to be in violation by the NMED. Septic tank contractors would be hired and best management practices would be followed when choosing a type of septic system to install.	*E. coli* concentrations below 235 CFU/100ml downstream of the locations where the septic tanks are repaired/replaced.	The load from *E. coli* is estimated to be 5,510,000,000 CFU/day according to water sampling. Straight pipes are estimated to contribute 82% of the *E. coli* to the system according to the BSLC (= 4,518,200,000 CFU/day). Assuming a 10% reduction in pollution from fixing 10 problem septic tanks, a reduction of 10% is applied to the 14,518,200,000CFU/day =45,182,000 CFU/day	45,182,000	There are many septic tanks within floodplains on the RFdT. This will serve to tell us which areas are going to be more prone to leaking into the river.
19	Septic Tanks	Remove septic tanks from floodplains	Decrease *E. coli* concentratio	Following project #17, 5-10 septic tanks will	*E. coli* concentrations below 235	The load from *E. coli* is estimated to be 5,510,000,000 CFU/day	22,591,000	There are many septic tanks within

Project Number	Category	Project Name	Management Objective	Detailed Description with Location	Indicator and Target Value	Methods for Estimated Percent Load Reductions	Estimated Load Reductions (CFU/day)	Need/Reason Rational
	(Whole River)		ns by removing 5-10 septic tanks that are within the floodplain.	be targeted for action within the floodplain	CFU/100ml downstream of the locations where the septic tanks are repaired/replaced.	according to water sampling. Straight pipes are estimated to contribute 82% of the *E. coli* to the system according to the BSLC (= 4,518,200,000 CFU/day). Assuming a 5% reduction in pollution from fixing at least 5 problem septic tanks, a reduction of 5% is applied to the 14,518,200,000CFU/day =22,591,000 CFU/day		floodplains on the RFdT. This will remove and/or fortify the septic tanks most prone to leaking into the river.
20	Stream/ Wetland Restoration (Middle and Upper Segments)	Bank Stabilization and Erosion Control in the middle and upper segments of the river	To decrease *E. coli* concentrations by contributing to project #12 using the same techniques but in the upper and middle segments of the river.	Cost share program for willow tree planting, other river/stream meandering restoration including one rock damns, plug and ponds and other restoration techniques. This project will focus on the middle and upper river segments. Focus on private land holdings and also encourage the USFS to keep RFdT Restoration as a priority.	*E. coli* concentrations below 235 CFU/100ml in the lower segment of the river during the summer. Water in the lower section all summer. Dissolved oxygen above 8 in the summer.	Similar logic as #10. The middle and upper segments had a measured load of 4,700,000,000 together. Agriculture was estimated to contribute 87.69% of the *E. coli* load to the river system and Pets are estimated to contribute 2.9. If we were to get 5 landowners to install erosion control and other projects that help to absorb runoff and slow down the river, we would expect a 5% reduction in *E. coli* levels to the river. While this number may be high, it indicates the importance of reducing runoff to the river from	597,607,350	The floodplain is not only disconnected from the river in the lower portion but also in the upper and middle segments as well.

Project Number	Category	Project Name	Management Objective	Detailed Description with Location	Indicator and Target Value	Methods for Estimated Percent Load Reductions	Estimated Load Reductions (CFU/day)	Need/Reason Rational
						these sources. - 5,510,000,000CFU/day input from water sampling*87.69% agriculture *2.90 pets*0.30 = 597,607,350		
21	Stream/ Wetland Restoration (Whole River)	Private Land Wetland Restoration Subsidies	To decrease *E. coli* concentrations by increasing the acreage of functioning wetlands along the Rio Fernando	Cost share program for private wetland development and restoration. Use existing wetland maps to identify who to approach. Secure funding and perform outreach to landowners living in and near wetland areas.	*E. coli* concentrations below 235 CFU/100ml below wetlands following restoration activities.	While load reductions cannot be calculated, wetlands slow down water and filter out pollutants including *E. coli*.	N/A	The disconnect of the floodplain from the river causes wetlands to dry up and no longer function. This has occurred all along the RFdT.
22	Stream/ Wetland Restoration (Upper Segment)	Restore La Jara Wetlands in Upper Watershed	To complete all the projects in the La Jara Wetland Assessment (4 of the projects will be accomplished in Project #9 from this list.	Implementation of the La Jara Wetland Restoration Assessment and Concept Design document. Completion of 3 more projects planned out in the document.	*E. coli* concentrations below 235 CFU/100ml below wetlands following restoration activities.	Same logic as #9. Cattle in streams are estimated to contribute 10% of the *E. coli* in the upper segment. The estimated total *E. coli* load of upper segment is 3.64E+09. We estimate completing these 3 projects will reduce cattle impact to the river by 5%. 10% of 3.64E+09 is 364,000,000. 5% of this is 18,200,000	18,200,000	The La Jara Wetland area is highly impacted by cattle, wildlife and NM64 going through it. This project will address the head cuts and incising that has occurred in the area.
23	Stream/ Wetland	Restoration and	To decrease erosion and	Identify dispersed camping sites on FR5;	*E. coli* concentrations	Humans and pets are estimated to contribute a	133,588,000	Dispersed camping is

Project Number	Category	Project Name	Management Objective	Detailed Description with Location	Indicator and Target Value	Methods for Estimated Percent Load Reductions	Estimated Load Reductions (CFU/day)	Need/Reason Rational
	Restoration (Upper Segment)	Designation of Dispersed Camping Sites on FR5	therefore *E. coli* concentrations into the Rio Fernando from recreational activity in La Jara Canyon.	design plans to modify and designate dispersed campsites. FS requires one summer of internship outreach for the project prior to implementation. Also includes Pet waste information and pet waste bags.	Below 235 CFU/100ml below wetlands following restoration activities.	Total of 7.34% of *E. coli* loading to the river. Loading in this upper segment is 3.64E+09. Multiplying this by 7.34 gives us 2,671,760,000. We estimate that designating campsites, installing pet waste bags, and performing outreach in the area will reduce *E. coli* loading in the area by 5%. This results in a reduction		allowed in the 2 miles of La Jara Canyon. Campsites are often abused. Cars are driven right up to the river edge and trees get cut down. Establishing real campsites with barriers to keep cars from eroding the river and clear signs about allowable behavior will decrease erosion and runoff into the river.
24	Stream/ Wetland Restoration (Lower Segment)	Concrete Removal From RFdT Bottom	To decrease *E. coli* loads by increasing riparian function by removing concrete from the	Near the Angladas building, the Rio Fernando has concrete poured in the bottom of it and all the way across. It is also extremely incised here. Removal of the concrete and erosion	*E. coli* concentrations below 235 CFU/100ml below wetlands following restoration activities.	The load from *E. coli* is estimated to be 5,510,000,000 CFU/day according to water sampling. If we remove the concrete from this area, water will be able to percolate to the groundwater and be filtered instead of flushed	55,100,000	Just upstream of the Angladas building is about 20 feet of concrete poured across the Rio Fernando. This keeps the surface water from interacting

Project Number	Category	Project Name	Management Objective	Detailed Description with Location	Indicator and Target Value	Methods for Estimated Percent Load Reductions	Estimated Load Reductions (CFU/day)	Need/Reason Rational
			bottom of the river.	control structures would be installed.		downstream. We estimate a 1% reduction in *E. coli* levels - 5,510,000,000CFU/day input from water sampling *0.01 = 55,100,000		with the ground water and filtering *E. coli* out of the water.

6.2 Map of Proposed Best Management Measures:

Projects with specific locations are shown on this map. Projects without specific locations can only be found in Figure 6-1. The upper, middle, and lower sections are separated by color.

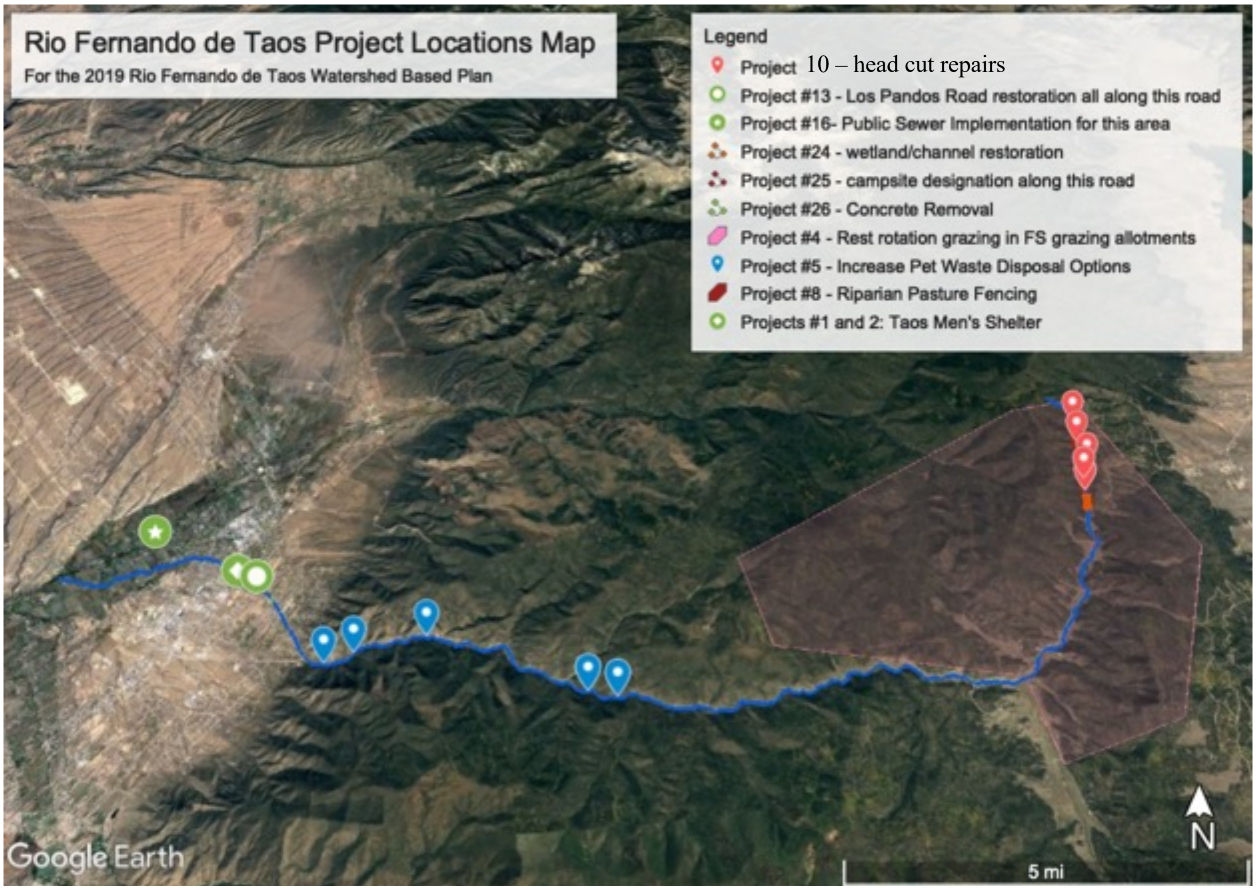

Figure 6-2: Map of each project using project numbers from the Project Table (Figure 6-1

7 Outreach Program

7.1 Summary of Outreach Management Measures

The goal of the Outreach Program is to inform stakeholders and the general public about water quality issues in the RFdT, and encourage the active participation by stakeholders in the implementation of the watershed plan. The objectives are to provide a framework to educate the public on local water quality issues (community awareness), obtain stakeholder participation in the development of BMPs to address the *E. coli* water quality impairment, and to encourage the use of the BMPs prescribed in the watershed plan.

The Rio Fernando Revitalization Collaborative will be the key leader in this effort. Driven by past knowledge and efforts, in 2017, the RFdT Collaborative has set out to improve the water quality and ecological function of the RFdT watershed, restore its acequia systems strengthening working land capacity, and connect people to the river and its watershed. The Rio Fernando de Taos Revitalization Collaborative is formed by a group of concerned individuals, organizations, and government entities to address its watershed management and restoration needs. The Rio Fernando de Taos Revitalization Collaborative envisions a revitalized RFdT watershed that builds on traditions and embraces innovation to connect people to ecosystems, cleaner water, and vibrant agriculture.

Outreach projects fall within one of the categories outlined in Chapter 6: Fecal Waste, Forest/Watershed Health, GI/Run off/Erosion Control, Septic Tanks and Stream/Wetland Restoration. Outreach projects arose as on-the-ground and policy projects were flushed out. It became apparent that many of the on-the-ground and policy projects would be ineffective or very difficult without a strong outreach component. It is also clear through examples world-wide that education is the first step in changing behaviors over the long term; making the outreach projects just as vital as the on-the-ground and policy projects for improving the RFdT's water quality into the future.

Figure 7-1: Proposed Education/Outreach Related Projects

Project #	Category	Project Name	Management Objective	Detailed Description with Location	Need/Reason Rational
1	Education: Fecal Waste	Education on Livestock Waste Management	To reduce *E. coli* loading through landowner education of best management practices for livestock.	One free public event each year with composting options and presentations. The creation of a factsheet with waste management options for different situations.	We are unaware of any waste management composting practices being used around the RFdT. Educating landowners on their options will supply them with the resources they need to begin the process.
2	Education: Fecal Waste	Homeless Shelter and Alcohol/Drug Addiction Rehab Promotion	Decrease *E. coli* concentrations from human sources.	Promote existence of shelters and drug addiction programs in general. PSA's, letters to the editor about connection to clean water.	This project will work to supplement on-the-ground project #1. It will help us to keep the reduction in human waste down by 15%.
3	Education: Forest/ Watershed Health	Watershed Interpretive Signs	To reduce *E. coli* loading through promotion of healthy watershed information and common *E. coli* inputs	Signs educating the public on watershed, forest restoration and watershed health at trailheads. Signs will include specific actions that people can take to decrease *E. coli* in the river.	There is a gap in knowledge about human impacts on watersheds and what a healthy watershed looks like.
4	Education: Forest/ Watershed Health	Promote land restoration practices that mimic natural fire regimes	To reduce bacteria loading from catastrophic fire in the RFdT Watershed.	Promote Rio Grande Water Fund principals, promote USFS BMPs and forest contractors. Advocate for responsible management of the Pueblo Ridge Project and potentially other restoration projects proposed in the Rio Fernando watershed.	From the RGWF Vision: "Water is life and livelihood. Nowhere is that a truer statement than in New Mexico. Each year, large and severe wildfires, and the post-fire flooding, increasingly put our water sources at risk."
5	Education: Green Infrastructure, Run off control, erosion control	Green Infrastructure Workshops	To reduce *E. coli* loads by encouraging Green Infrastructure practices along the RFdT.	A day long workshop once a year focused on the Rio Fernando and reducing runoff in the river. Specific landowner activities that will benefit the river will be discussed in depth.	Impervious surfaces cause polluted runoff to enter the RFdT. More Green Infrastructure and private landowner improvements will reduce the runoff.

Project #	Category	Project Name	Management Objective	Detailed Description with Location	Need/Reason Rational
6	Education: Green Infrastructure, Run off control, erosion control	Ongoing Education of County and Town Elected Officials/Decision Makers Regarding GI/LID	To reduce *E. coli* loads by educating ToT and TC officials on the benefits of GI/LID approaches.	Presentations once a year at ToT and Taos County Meetings including GI/LID informational handouts and updates. Specifically, will include why these approaches benefit the ToT and TC.	Educated and motivated ToT and County officials will improve the use of GI in TC.
7	Education: Green Infrastructure, Run off control, erosion control	Roads and Riparian Corridors Outreach.	To reduce *E. coli* loading through education of the community on best management practices for roads/driveways and engagement with NMDOT.	Work with NMDOT and TC on planning Highway widening projects due to high traffic. Educate private land-owners (factsheet, presentations) and proper engineering of driveways to avoid erosion and additional sediment loading.	High sediment levels in the RFdT and high active erosion due to roads and driveways add nutrients and waste to the river that promotes *E. coli* growth.
8	Education: Green Infrastructure, Run off control, erosion control	Develop RFdT Corridor Green Infrastructure development plan	To create a GI/LID Plan to guide -the-ground Projects 10, 11, and 12.	This project will be completed before Projects # 10,11 and 12. It will help to guide landowner outreach for those projects. A Plan will be developed that focuses on finding and detailing opportunities for GI/LID projects along the RFdT.	Creating a plan for what is possible throughout the RFdT corridor will allow for more targeted outreach and easier planning for all of the GI/LID projects identified in this table.
9	Education: Pet Waste	Scoop the Poop educational campaigns	To reduce *E. coli* loading through education of the community on the impacts of pet waste on the RFdT.	This project would fund newspapers adverts, radio adverts, and other forms of outreach to encourage pet waste cleanup around the RFdT.	An educational campaign is needed to mitigate recreation- based impacts on the river.
10	Education: Septic Tanks	Private Land Septic Education Series—Voluntary Compliance	To reduce *E. coli* loading through education of the community on the impacts of septic tanks on the watershed.	Two free public events twice a year focused on how landowners can have best management practices around their septic tank (inspections every 3-5 years, etc.).	*E. coli* research indicates several locations where septic systems are a likely source in this watershed.

Project #	Category	Project Name	Management Objective	Detailed Description with Location	Need/Reason Rational
11	Education: Septic Tanks	Septic Tank BMP Mailing	To reduce *E. coli* loading through a positive messaging campaign about BMPs for septic tanks.	Utility bill mailing—Outreach flier on proper septic care, permitting, and stopping illegal dumping.	Utility bill mailings are known to work well in this area. Septic tanks were shown to contribute to the *E. coli* impairment on the RFdT through sampling efforts.
12	Education: Stream/ Wetland Restoration	Reconnect the RFdT with its Flood Plain Campaign.	To reduce *E. coli* loading through a positive messaging campaign about the importance of floodplains and functioning riparian systems.	On-the-ground projects 17 and 19 would be connected to this but this is the outreach component—newspaper articles, short video, radio shows, blogs encouraging the whole community to work on their section of the RFdT	Gaps exist in understanding in this community about where the RFdT is and what negatively impacts the river.
13	Education: Stream/ Wetland Restoration	Wetland Restoration Education Series	To reduce *E. coli* loading through a positive messaging campaign about the importance of wetlands in functioning riparian systems.	What you can do to improve your riparian areas. Promote private land restoration by giving free workshops with easy techniques for landowners to improve their riparian habitat.	Gaps exist in understanding in this community about where the RFdT is and what negatively impacts the river. We would focus on incision of the river and the importance of materials in the river to create pools
14	Education: Stream/ Wetland Restoration	Create Riparian Zones Action Team (Citizen-led Science).	To reduce *E. coli* loading by creating a team of people/volunteers to pursue and foster riparian zones and wetlands on private lands	This would be the action component of Project #11. People that go to that education series would form this team. This would be programmatic; volunteers go to private land and do wetland restoration day projects.	Citizen science projects can be very effective if there is enough interest. Empowering private landowners to help each other restore their lands would increase ecosystem function throughout the watershed.

8 TECHNICAL AND FINANCIAL ASSISTANCE

8.1 Technical Assistance Resources

The Rio Fernando de Taos Revitalization Collaborative is an opportunity for the members to exchange information about water quality and quantity, ecosystem integrity, and the quality of life in the RFdT watershed. The Rio Fernando de Taos Revitalization Project is a collaborative comprised of individuals, organizations and government entities working together to support and implement meaningful and lasting revitalization projects in the RFdT watershed. The Rio Fernando de Taos Revitalization Collaborative intends to improve water quality and ecological function, restore irrigation systems, strengthen working land capacity, and connect people to the river and its watershed.

Including the RFdT Collaborative members, the following individuals and agencies were identified and engaged during the stakeholder process.

Members of the Rio Fernando Working Groups since 2012
C. O'Donnell, Taos County Commissioner
K. Ortez de Jones, Taos Land Trust
J. Torres and V. Fernandez, Taos Valley Acequia Association
L. McCarthy and C. Haffey, The Nature Conservancy
F. Hahn, Town of Taos Council Member
G. Miller, John Littlefield, Melvin Herrera, US Forest Service Carson National Forest
P. Vigil, Taos Soil and Water Conservation District
R. Romero, Independent contractor
N. Sanchez, Planning Department Taos County
M. Bogar, New Mexico Environment Department
Mark Henderson, Independent contractor
Ben Wright, Taos Land Trust
Over 100 community members from meetings and email lists.
Over 200 residents sent mail about the project.
30 or more people updated each year on the plan at Water Sentinels Trainings.
The Taos Valley Watershed Coalition was updated on the Plan at meetings when possible.
Neighborhood associations
UNM, Climate Change Corp and the Master's Program
Rocky Mtn. Youth Corps
High School Class Presentations, 30+ students

8.2 Financial Assistance Resources

A variety of funding programs that assist watershed groups in watershed protection and restoration are known through AB's 31 year history of securing grant funds and working with partners. Information on each program is detailed to provide insight to specific funding opportunities for the RFdT watershed. The United States Environmental Protection Agency's Catalog of Federal Funding Sources for Watershed Protection provides an overview of potential federal and nonfederal funding sources: https://www.epa.gov/nps/funding-resources-watershed-protection-and-restoration

Below details large funding mechanisms for major projects. Other funders likely to contribute to projects in this plan are:

- The LOR (current funder of RFdT Collaborative)
- Patagonia Environmental Grants
- New Mexico Acequia Association
- TSWCD
- The Rio Grande Water Fund (current funder of RFdT restoration)
- US Forest Service and the National Environmental Education Foundation (NEEF)
- Other Private Funders

1) NPS Implementation Grants [CWA Section 319(h)]

The 319(h) program funds projects and programs in concurrence with Section 319(h) of the CWA and are geared toward addressing NPS pollution. Projects like the development of a water pollution remediation plan, the design and implementation of BMP's, hiring technical experts, and public outreach and education programs are eligible for 319(h) funding. States are required to provide a 40 percent nonfederal match.

The New Mexico Environment Department releases a request for proposals for 319(h) funding yearly between February and April. Stream and river segments with a written TMDL and included in the NMED 303(d) list are eligible for this funding.

2) National Water Quality Initiative

The National Water Quality Initiative will work in priority watersheds (identified by a state's 319(h) program) to help farmers, ranchers, and forest landowners improve water quality and aquatic habitats in impaired streams. The Natural Resources Conservation Service will help producers implement conservation and management practices through a system's approach to control and trap nutrient and manure runoff. Qualified producers will receive assistance for installing conservation practices such as cover crops, filter strips, terraces, and manure management BMPs. The Natural Resources Conservation Service invested approximately $30 million in targeted assistance to help farmers and ranchers improve water quality in high-priority streams and rivers across the country in 2018.

3) The Environmental Justice Small Grants Program

The Environmental Protection Agency's Environmental Justice Small Grants Program supports and empowers communities working on solutions to local environmental and public health issues. The program is designed to help communities understand and address exposure to multiple environmental harms and risks. The Rio Fernando de Taos Revitalization Collaboration has submitted a proposal to this grant program for acequia repairs and outreach but was denied funding.

4) EPA Environmental Justice Collaborative Problem Solving Grant

The Environmental Protection Agency's Environmental Justice Collaborative Problem-Solving Cooperative Agreement Program provides funding for eligible applicants for projects that address local environmental and public health issues within an affected community. The Collaborative Problem-Solving Program assists recipients in building collaborative partnerships to help them understand and address environmental and public health concerns in their communities. The Rio Fernando de Taos is a current grantee of an EPA EJ Collaborative Problem-Solving Grant. This is funding for the MST research component of the WBP. It will also fund the RFdT Collaborative from Fall 2019–Fall 2020

5) USDA Rural Development Agency

The United States Department of Agriculture Rural Development provides funding opportunities in the form of payments, grants, loans, and loan guarantees, for the development and commercialization of vital utility services. This includes funding rural water and wastewater systems to help address water quality. Their opportunities include:

Rural Utilities Service Water & Environmental Programs

- Circuit Rider Program
- Emergency Community Water Assistance Grants
- Grants for Rural and Native Alaskan Villages
- Household Water Well System Grants
- Individual Water & Wastewater Grants
- SEARCH - Special Evaluation Assistance for Rural Communities and Households
- Solid Waste Management Grants
- Water & Waste Disposal Grants to Alleviate Health Risks on Tribal Lands and Colonies
- Water & Waste Disposal Loans & Grants
- Water & Waste Disposal Loan Guarantees
- Water & Waste Disposal Predevelopment Planning Grants
- Water & Waste Disposal Revolving Loan Funds
- Water & Waste Disposal Technical Assistance & Training Grants

More information can be found at https://www.rd.usda.gov/programs-services/all-programs

6) State Revolving Funds

The State Revolving Fund (SRF) is a fund administered by a state for the purpose of providing low-interest loans for investments in water and sanitation infrastructure (e.g., sewage treatment, storm water management facilities, and drinking water treatment) as well as for the implementation of NPS pollution control and estuary protection projects. A State Revolving Fund receives its initial capital from federal grants and state contributions and then emits bonds that are guaranteed by the initial capital. Finally, the fund revolves through the repayment of principal and the payment of interest on outstanding loans. There are currently two SRFs:

1. .The Clean Water State Revolving Fund created in 1987 under the CWA.
2. The Drinking Water State Revolving Fund created in 1997 under the Safe Drinking Water Act.

8.3 Technical and Financial Assistance Needs for On-the-Ground and Policy

While the load reductions shown in chapter 5 are important for prioritizing individual projects, many more factors are involved in making decisions on which projects to implement.

Though the parties responsible for implementation vary, it is likely that, whether listed in the table or not, AB and the RFdT Collaborative will act as support and impetus for the projects laid out in this plan. We will be actively working with their partners to encourage project implementation. As lead of this 319 Project, AB has worked hard to include the majority of its partners and current projects in this plan. Due to the formation and development of the RFdT Collaborative, a few projects listed are already underway.

Two rankings were performed to help prioritize projects. *Ease* of the project was ranked based on cost and effort required to complete the project. Projected Pollutant Load Reduction was based on recorded loads from the sampling project and the Bacteria Source Load Calculator Results (BSLC section of Chapter 4) when specific numbers had been calculated. For projects where exact load reductions were not able to be calculated, level of load reduction expected is based on the sources identified in this document to be contributing to *E. coli* in the river, and on partner discussions and stakeholder opinions.

Amigos Bravos and the RFdT Collaborative will use this document as its guide in seeking new funding and working towards its goal of removing sources of water quality impairment in the RFdT Watershed, with the eventual goal of removing the RFdT from the 303(d) list of impaired waters.

Table 8-1 shows technical and financial assistance needs for on-the-ground and policy projects. **The following table is sorted by Projected Pollutant Load Reduction and secondarily sorted by the Ease column.** It shows all proposed on-the-ground and policy project.

Project Number	Categor y	Project Name	Management Objective	Project Lead	Partners	Cost Estimate/Range ($)	Ease (1-easy, 5 Difficult)	Projected Pollutant Load Reduction (1–5, 1=highest Priority)
2	Fecal Waste	Develop Livestock Waste Management	Decrease *E. coli* concentrations from human-owned livestock sources throughout the watershed.	AB	Taos Soil and Water Conservation District, other agricultural groups, private farmers, grazing permittees, Quivera Coalition	$5,000 to create the plan. Unknown amount needed to actually implement the livestock waste management plan alternatives on private lands.	2	1
1	Fecal Waste	Homeless Shelter Waste Disposal Campaign	Decrease *E. coli* concentrations from human sources	Taos Men's Shelter/Heart of Taos	AB, NMED, private landowners, Dreamtree Project, Heart of Taos Women's shelter, CAV	$5000 to buy the portable toilets and $200 per month to empty each one.	3	1

Project Number	Category	Project Name	Management Objective	Project Lead	Partners	Cost Estimate/Range ($)	Ease (1-easy, 5 Difficult)	Projected Pollutant Load Reduction (1–5, 1=highest Priority)
11	Green Infrastructure, Run off control, erosion control	Green Infrastructure Ordinances For New Development	To decrease *E. coli* concentrations from runoff around 5 new private homes and farms a year using GI Best Management Practices.	AB	RFdT Revit Collab, Town, County, TNC, TLT, TVAA, private land owners	$5,000 in staff time to write an ordinance and advocate for it.	3	1
10	Green Infrastructure, Run off control, erosion control	Incentives/subsidies for Green Infrastructure on Private Land	To decrease *E. coli* concentrations from runoff around 10 private homes and farms.	AB	Bio Habitats, Taos Soil and Water Conservation District	$5,000 per year for staff time, $10,000-$20,000 in supplies for landowners (rocks, trees etc.)	4	1
20	Stream/ Wetland Restoration	Bank Stabilization and Erosion Control in the Middle and Upper Segments of the RFdT	To decrease *E. coli* concentrations by contributing to project #12 using the same techniques but in the upper and middle segments of the river.	AB	Watershed Artisans, USFS, NMED, Taos SWCD, Taos County, Quivira Coalition, private property owners	$100,000+	4	1

Project Number	Category	Project Name	Management Objective	Project Lead	Partners	Cost Estimate/Range ($)	Ease (1-easy, 5 Difficult)	Projected Pollutant Load Reduction (1–5, 1=highest Priority)
14	Septic Tanks	Implementation of public sewer system in upper/lower Ranchitos Road intersection area.	To decrease *E. coli* concentrations in the upper/lower Ranchitos Road area by installed a public sewer system and decommissioning faulty septic tanks as they are no longer needed.	Town or County	NMED, Town, County, private landowners, RFdT Revit Collab	$2 million	5	1
5	Fecal Waste	Monitoring of National Forest Plan and Grazing Permits	To decrease *E. coli* loads by monitoring and advocating for proper implementation of the Carson National Forest Plan and the annual operating instructions for cattle in the Rio Fernando watershed.	AB	FS, grazing permittees, TNC, TLT	$2,000 per year in staff time.	1	2

Project Number	Category	Project Name	Management Objective	Project Lead	Partners	Cost Estimate/Range ($)	Ease (1-easy, 5 Difficult)	Projected Pollutant Load Reduction (1–5, 1=highest Priority)
6	Fecal Waste	Identification of Properties with Conservation Potential	To minimize livestock and pet impacts to the river by purchasing land that is available along the Rio Fernando or by creating conservation easements.	TLT	RFdT Revit Collab, Private land owners, AB, TSWCD	$100,000+	1	2
4	Fecal Waste	Increased Pet Waste disposal Resources at Trailheads and Parks	Decrease *E. coli* concentrations from human-owned pet waste	TLT	RFdT Revitalization Collaborative, AB, TNC, trail groups, Rocky Mountain Youth Corp	$2,000 each year to buy the supplies. $2,000 for implementation and checking sites each year.	1	2
23	Stream/ Wetland Restoration	Restoration and Designation of Dispersed Camping Sites on FR5	To decrease erosion and therefore *E. coli* concentrations into the Rio Fernando from recreational activity in La Jara Canyon.	FS	AB, RFdT Revit Collab	$15,000 from FS for outreach intern, $30,000-$50,000 for campsite implementation (car-blocking poles, fire pits, signs, etc.)	2	2

Project Number	Category	Project Name	Management Objective	Project Lead	Partners	Cost Estimate/Range ($)	Ease (1- easy, 5 Difficult)	Projected Pollutant Load Reduction (1–5, 1=highest Priority)
24	Stream/ Wetland Restoration	Concrete Removal from Rio Fernando Bottom	To decrease *E. coli* loads by increasing riparian function by removing concrete from the bottom of the river.	AB	OSE, NMED, private land owners, TSWCD, RFdT Revit Collab	$50,000 to a contractor to remove the concrete $20,000 to contract to install erosion control structures. $10,000 in staff time to manage the project and get the Army Corp Permits needed.	2	2
7	Fencing	Riparian Pasture (Site FRE) Fencing Project	Decrease *E. coli* concentrations from the cattle grazed on USFS Land (Flechado Allotment) in the Riparian Pasture for 10 days a year.	AB	RGWF, TNC, Robert Valencia Fencing (All Around Fencing), FS, Watershed Artisans	$120,000 - secured	3	2
12	Green Infrastructure, Run off control, erosion control	Improve Water Quality Impacts from Los Pandos Road to Mitigate Impacts on RFdT	To improve the Rio Fernando floodplain on private lands along Los Pandos Road.	County Roads Department, NMDOT	RFdT Revit Collab, BioHabitats, AB, private land owners	$100,000+	3	2

Project Number	Category	Project Name	Management Objective	Project Lead	Partners	Cost Estimate/Range ($)	Ease (1-easy, 5 Difficult)	Projected Pollutant Load Reduction (1–5, 1=highest Priority)
17	Septic Tanks	Septic Tank and Floodplain Mapping Project	Decrease *E. coli* concentrations by repairing/replacing the current septic tank violators on the Rio Fernando	AB	mapping contractor, NMED, TSWCD, private landowners, RFdT Revit Collab	$20,000 for mapping contractors, $5,000 to manage the project.	1	3
16	Septic Tanks	Tracking of Septic Tank Inspections	To decrease *E. coli* concentrations by establishing a mechanism for notifications of needed septic tank inspections on the Rio Fernando	NMED	AB, RFdT Revit Collab	$20,000 to establish the project. $5,000 per year to maintain it.	2	3
13	Septic Tanks	Private Land Septic Inspection Subsidies	To decrease *E. coli* concentrations from faulty septic tanks near the Rio Fernando	AB	NMED, Town, County, private landowners, RFdT Revit Collab	At least $50,00 to start and then $100,000+ more to give to landowners.	2	3

Project Number	Category	Project Name	Management Objective	Project Lead	Partners	Cost Estimate/Range ($)	Ease (1-easy, 5 Difficult)	Projected Pollutant Load Reduction (1–5, 1=highest Priority)
15	Septic Tanks	Incentives for High Quality New Septic Tanks	To decrease *E. coli* concentrations along the entire length of the Rio Fernando.	AB	NMED, Town, County, private landowners, RFdT Revit Collab	$20,000 per year is enough for about 2 new septic tanks per year	2	3
21	Stream/ Wetland Restoration	Private Land Wetland Restoration Subsidies	To decrease *E. coli* concentrations by increasing the acreage of functioning wetlands along the Rio Fernando	AB	Quivera, TU, TLT, TNC, RFdT Revit Collab	$50,000 per project approximately	3	3
3	Fecal Waste	Implementation of Rest Rotation or Deferred Rotation Management System.	Decrease *E. coli* concentrations from the cattle grazed on Forest Service Lands on the Rio Fernando and from private-land cattle grazing.	FS (federal lands) and AB (private lands)	Rio Fernando Revitalization Collaborative, TSWCD, Quivira Coalition, private landowners	In-kind staff time to have discussions with the USFS. $2,000 to reach out to private landowners.	3	3

Project Number	Categor y	Project Name	Management Objective	Project Lead	Partners	Cost Estimate/Range ($)	Ease (1- easy, 5 Difficult)	Projected Pollutant Load Reduction (1–5, 1=highest Priority)
18	Septic Tanks	Mitigate Problem Systems (engage with 10 current Violators in the Rio Fernando)	Decrease *E. coli* concentrations by mitigating approximately 10 current septic tanks that are in violation of their permits.	AB	Private landowners, NMED, RFdT Revit Collab, septic installation contractors	Approximately $10,000 per tank - $100,000 total	4	3
9	Fencing	Fencing of Head Cuts in FLJ	Decrease *E. coli* concentrations from the cattle grazed on Forest Service Land (Flechado Allotment) in the La Jara Pasture for 30 days a year.	AB	Grazing Permittee, FS, Watershed Artisans	$75,000-secured to fix the head cuts. $5,000 to fence them.	1	4
22	Stream/ Wetland Restorat ion	Restore La Jara Wetlands in Upper Watershed	To complete all the projects in the La Jara Wetland Assessment (4 of the projects will be accomplished in Project #9 from this list.	AB	Watershed Artisans, USFS, grazing permittee	203000 as estimated in the La Jara Assessment Document	2	4

Project Number	Categor y	Project Name	Management Objective	Project Lead	Partners	Cost Estimate/Range ($)	Ease (1- easy, 5 Difficult)	Projected Pollutant Load Reduction (1–5, 1=highest Priority)
19	Septic Tanks	Remove Septic Tanks from Floodplains	Decrease *E. coli* concentrations by removing 5-10 septic tanks that are within the floodplain.	AB	Private landowners, NMED, RFdT Revit Collab, septic installation contractors	Approximately $10,000 per tank - $100,000 total	3	4
8	Fencing	Private Land Livestock and Pet Fencing Subsidies	Decrease *E. coli* concentrations from human-owned pet and livestock waste	AB	Taos Soil and Watershed Conservation District, Cattle Growers Association, TNC, Quivera private stakeholders	$100,000+	3	5

Table 8-1***:*** **Technical and Financial Assistance Needs for on-the-ground and policy projects. The following table is sorted by Projected Pollutant Load Reduction and secondarily sorted by the Ease column. It shows all proposed on-the-ground and policy projects purposed in order of *E. coli* reduction potential.**

Sewer infrastructure and waterway restoration projects are expensive and long-term solutions to the problems related to human waste reaching our waterways. The cheapest, short-term solutions involve outreach and education to the general public and specific stakeholder groups, in order to change individual behaviors that may be contributing to pollution. While the results of these efforts can be difficult to quantify in terms of load reductions, they are still worthwhile. It should also be noted that these outreach efforts are likely to also benefit the nearby RPdT which has *E. coli* pollution issues as well. **The table below displays the Education/Outreach projects in order of highest to lowest estimated load reduction priorities .**

Project Number	Category	Project Name	Management Objective	Project Lead	Partners	Cost Estimate/Range	Ease (1-easy, 5 Difficult)	Projected Pollutant Load Reduction (1-5, 1=highest Priority)
3	Education: Forest/Watershed Health	Watershed Interpretive Signs	To reduce *E. coli* loading through promotion of healthy watershed information and common *E. coli* inputs	FS or TNC	TNC, TLT, AB	$15,000 to buy signs, $15,000 for design time and collaboration with partners.	1	1
4	Education: Forest/Watershed Health	Promote land restoration practices that mimic natural fire regimes	To reduce bacteria loading from catastrophic fire in the Rio Fernando Watershed	RFdT Revitalization Collaborative	AB, TLT, Taos County CWPP	$2,000 per year for outreach.	1	1
11	Education: Septic Tanks	Septic Tank BMP Mailing	To reduce *E. coli* loading through a positive messaging campaign about best management practices for septic tanks.	AB	Kit Carson Electric, NM Gas Company, RFdT Revit Collab, TSWCD,	2000 for the mailing creation and 2000 in staff time to create it and work on it with partners	1	1
1	Education: Fecal Waste	Education on Livestock Waste Management	To reduce *E. coli* loading through landowner education of best management practices for livestock.	AB	TCWCD, USFS, RFdT Revit Collab, TVAA	$2,500 per year for event planning, supplies, and factsheet creation.	2	1

Project Number	Category	Project Name	Management Objective	Project Lead	Partners	Cost Estimate/Range	Ease (1-easy, 5 Difficult)	Projected Pollutant Load Reduction (1-5, 1=highest Priority)
2	Education: Fecal Waste	Homeless Shelter and Alcohol/Drug Addiction Rehab Promotion	Decrease *E. coli* concentrations from human sources.	Taos Men's Shelter/Heart of Taos	AB, NMED, private landowners, Dreamtree Project, Heart of Taos Women's shelter, CAV	Taos Men's Shelter/Heart of Taos	2	1
6	Education: Green Infrastructure, Run off control, erosion control	Ongoing Education of County and Town Elected Officials/Decision Makers Regarding GI/LID	To reduce *E. coli* loads by educating Town and County officials on the benefits of GI/LID approaches.	AB	Town, County, BioHabitats	$1,000/year in staff time to attend meetings and events where GI//LID can be highlighted.	1	2
5	Education: Green Infrastructure, Run off control, erosion control	Green Infrastructure Workshops	To reduce *E. coli* loads by encouraging GI practices along the Rio Fernando	BioHabitats Consulting	AB	$3,000/year for event planning, supplies, outreach, etc.	2	2
10	Education: Septic Tanks	Private Land Septic Education Series - Voluntary Compliance	To reduce *E. coli* loading through education of the community on the impacts of septic tanks on the watershed.	NMED and AB	TNC, private citizens, Town, County	$5,000 per year for event planning, supplies, and factsheet creation.	2	2

Project Number	Category	Project Name	Management Objective	Project Lead	Partners	Cost Estimate/Range	Ease (1-easy, 5 Difficult)	Projected Pollutant Load Reduction (1-5, 1=highest Priority)
8	Education: Green Infrastructure, Run off control, erosion control	Develop RFdT Corridor Green Infrastructure development plan	To create a GI/LID Plan to guide Projects 10, 11, and 12.	AB	BioHabitats, RFdT Collaborative, stakeholders	$10,000 for consultant to make the plan.	1	3
9	Education: Pet Waste	Scoop the Poop educational campaigns	To reduce *E. coli* loading through education of the community on the impacts of pet waste on the Rio Fernando.	TLT	AB, FS, Trail groups, private citizens	$2,000 per year on advertisements. $1,000 for design.	2	3
12	Education: Stream/Wetland Restoration	Reconnect the Rio Fernando with its Flood Plain Campaign.	To reduce *E. coli* loading through a positive messaging campaign about the importance of floodplains and functioning riparian systems.	AB	Watershed Artisans, Keystone Restoration, private landowners, FS, Taos News, KNCE, KTAO, KUNM	$2,000 per year on adverts, $1,000 for design time.	2	3

Project Number	Category	Project Name	Management Objective	Project Lead	Partners	Cost Estimate/Range	Ease (1-easy, 5 Difficult)	Projected Pollutant Load Reduction (1-5, 1=highest Priority)
7	Education: Green Infrastructure, Run off control, erosion control	Roads and Riparian Corridors Outreach	To reduce *E. coli* loading through education of the community and engagement with NM DOT.	AB	NMED, USFS, Taos County, NMDOT, Rio Don Fernando Watershed group, private land owners	$10,000 to implement a year-long outreach campaign including events.	3	3
13	Education: Stream/Wetland Restoration	Wetland Restoration Education Series	To reduce *E. coli* loading through a positive messaging campaign about the importance of wetlands in functioning riparian systems.	AB	Quivera Coalition, Watershed Artisans, Keystone Restoration, private landowners, FS	$3,000 per year for event planning, supplies, outreach, and informational materials.	3	4
14	Education: Stream/Wetland Restoration	Create Riparian Zones Action Team (Citizen Science)	To reduce *E. coli* loading by creating a team of people/volunteers to pursue and foster Riparian zones and wetlands on private lands	AB	Quivera Coalition, Watershed Artisans, Keystone Restoration, private landowners, FS, TU, TSWCD, RFdT Revit Collab	$10,000 to launch the project-staff time to perform outreach and design the program.	2	5

Figure 8-2: Technical and Financial Assistance Needs for Outreach Projects. This table is sorted by Projected Pollutant Load Reduction and secondarily sorted by the Ease column

9 IMPLIMENTATION SCHEDULE AND MEASURABLE MILESTONES

9.1 Action Plan and Milestones

The following general implementation schedule (Figure 9-1) was developed to encompass the primary tasks set out in this watershed plan. It includes a series of action items to obtain funding, implement projects and disseminate information. Any action selected for implementation for all years is already in place and ongoing.

Figure 9.1: Action Plan Table 2020–2024

Actions	2020	2021	2022	2023
Grant Writing to Secure Funding For:				
Developing stakeholder outreach materials for outreach projects	x	x		
Best Management Project Implementation	x	x	x	x
Continued operation of the RFdT Collaborative	x	x	x	x
Forge Partnerships:				
Expand the RFdT Collaborative's capacity to complete projects	x	x	x	x
Work with the ToT and NMED to begin discussions about the Upper Ranchitos/Lower Ranchitos Road area sewer system project (#14)	x	x	x	x
Expand relationship with TSWCD and TVAA and local farmers	x	x	x	x
Project Implementation:				
Select implementation project (site selection, management measures, implementation schedule, and estimated load reduction goal derived from WBP)	x	x	x	
Secure funding	x	x		
Begin project implementation – hire contractors, purchase equipment, etc.	x			
Monitor implementation schedule for progress	x	x	x	x
Report project results, evaluate project success, and make recommendations	x	x	x	x
Stakeholder Engagement:				

Seek increased participation in the RFdT Collaborative from larger stakeholder community	x	x		
Conduct public meetings through the RFdT Collaborative to increase stakeholder input	x	x	x	x
Outreach:				
Maintain https://www.riofernando.org/ with dedicated section on *E. coli* impairment and restoration projects.	x	x	x	x
Develop and disseminate outreach materials to address septic tank and livestock waste issues and solutions.	x	x	x	
Participate in at least one community outreach event annually to promote healthy watersheds, restoration activities, and RFdT Collaborative awareness.	x	x	x	x

9.2 Implementation Schedule and Milestones

Timing of projects will depend on funding and willing partners. Goals for the schedule are shown in the tables below.

Figure 9.2: Table of Management Measures with Implementation Schedule and Milestones—on-the-ground and policy projects

Project #	Category	Project Name	Management Objective	Detailed Description	Implementation Schedule	Measurable Milestones
1	Fecal Waste	Homeless Shelter Waste Disposal Campaign	Decrease *E. coli* concentrations from human sources	Promote/setup the Men and Women's shelters to have portable toilets or compostable toilets on their property that are open 24/7. Project will first require communication with the property owners about what they think would help and what they are willing to do.	2022–>annually	Completion of discussions with homeless shelters. Completion of project design. Completion of implementation of the project
2	Fecal Waste	Develop Livestock Waste Management	Decrease *E. coli* concentrations from human-owned livestock sources throughout the watershed.	Create a guidance document and then work towards implementing it. Focus will be on landowners with concentrated livestock but be applicable for all levels of livestock management. Incentive for composting the waste will be developed.	2023–2025	Completion of the design document. Implementation of activities identified in the document. # of landowners who start composting
3	Fecal Waste	Implementation of rest rotation or deferred rotation management system.	Decrease *E. coli* concentrations from the cattle grazed on Forest Service Lands on the RFdT and from private-land cattle grazing.	There are 10 Grazing pastures in the Taos Canyon Watershed, (the Capulín and Flechado Allotments) where grazing occurs between June 1 and September 30. There are several private landowners who also run cattle and horses on private land.	2020–>annually	Negotiations with USFS permittees. Educational workshops about grazing best management measures for private landowners.
4	Fecal Waste	Increased Pet Waste disposal Resources at Trailheads and Parks.	Decrease *E. coli* concentrations from human-owned pet waste.	Establish pet waste disposal and pick-up services at trailheads and in parks including new signs.	2022–2023	New signs and bags at trailheads and parks.
5	Fecal Waste	Monitoring of National Forest Plan and Grazing Permits	To decrease *E. coli* loads by monitoring and advocating for proper implementation of the CNF Plan and the annual operating instructions for cattle in	To monitor USFS Forest Plan to make sure that their standards and guidelines on public lands are enforced. Staff time to engage with the USFS on both of these topics.	Already occurs—continue annually	Yearly request of Annual Operating Instructions. Detailed analysis of the final USFS Forest Plan Document and identification of specific aspects that should be enforced.

Project #	Category	Project Name	Management Objective	Detailed Description	Implementation Schedule	Measurable Milestones
			the Rio Fernando watershed.			
6	Fecal Waste	Identification of Properties with Conservation Potential	To minimize livestock and pet impacts to the river by purchasing land that is available along the RFdT or by creating conservation easements.	Identify properties for easements or acquisitions using green print and other data.	Already occurs by the Rio Fernando Collaborative—continue annually	# of easements along the RFdT that are secured.
7	Fencing	Riparian Pasture (Site FRE) Fencing Project	Decrease *E. coli* concentrations from the cattle grazed on USFS Land (Flechado Allotment) in the Riparian Pasture for 10 days a year.	Project under way. The Riparian Pasture fence (1 mile) has been removed and the new pipe rail fence will be installed in the fall of 2019.	2018–2020	Completion of the fence. Annual reports from the rangeland manager on the effectiveness of the fence.
8	Fencing	Private Land Livestock and Pet Fencing Subsidies	Decrease *E. coli* concentrations from human-owned pet and livestock waste.	Cost-share program. Start with finding funds for a pilot project and a willing land owner. Then get funding for several landowners at once. Fund water gaps and hardening of the gaps to decrease bank erosion.	2025–2030	Completion of 5 fencing projects.
9	Fencing	Fencing of head cuts in FLJ	Decrease *E. coli* concentrations from the cattle grazed on USFS Land (Flechado Allotment) in the La Jara Pasture for 30 days a year.	Fencing of 4 repaired head cuts in the La Jara pasture used for 30 days a year. NEPA required.	2021–2022	Completion of fencing 4 head cuts.

Project #	Category	Project Name	Management Objective	Detailed Description	Implementation Schedule	Measurable Milestones
10	Green Infrastructure, Run off control, erosion control	Incentives/subsidies for Green Infrastructure on Private Land	To decrease *E. coli* concentrations from runoff around 10 private homes and farms.	Create a voluntary program for private landowners to learn how to capture their rainwater, how to create rock gardens and how to get the water back to the river. This project will compliment project #8 encouraging landowners to fence off their pets and livestock from the river. Focus will be in the lower watershed.	2025–>annually	Planning for the project complete. Funding secured. Fencing projects completed.
11	Green Infrastructure, Run off control, erosion control	Green Infrastructure Ordinances for New Development	To decrease *E. coli* concentrations from runoff around 5 new private homes and farms a year using GI BMPs.	Outreach project #10 will help promote this project. Once the community and landowners see the benefits of regulating river access, advocating for the ToT and TC to adopt GI ordinances will be a logical next step and have community support. The ordinances will be focused on new homes/farms.	2022–2023	Creation of an ordinance that can be used for the ToT and the TC.
12	Green Infrastructure, Run off control, erosion control	Improve water quality impacts from Los Pandos Road to mitigate impacts on RFdT	To improve the RFdT floodplain on private lands along Los Pandos Road.	One on one landowner negotiations and cost share program to rehabilitate land along the Los Pandos Road Area. This would include Septic tank repairs, fencing projects, erosion control projects, and water gaps.	2025–>annually	Secured of funding. Outreach to landowners. Project implementation.
13	Septic Tanks	Private Land Septic Inspection Subsidies	To decrease *E. coli* concentrations from faulty septic tanks near the RFdT.	Work with TC and perhaps a federal program for steady funding for septic tank inspections and repairs/replacements. Then reach out to landowners with funding for the inspections.	2022–>annually	Secured funds. Outreach to stakeholders. Completion of as many projects as can be funded.
14	Septic Tanks	Implementation of Public Sewer System in Upper/Lower Ranchitos	To decrease *E. coli* concentrations in the upper/lower Ranchitos area by installing a	This area is a historic wetland with a high water table. There are many septic tanks in this area that were granted variances, many that are not inspected, and many that are very old. The	2025–2030	Approval of ToT Town Council to work on the project. Successful outreach to the Merris Springs neighborhood

Project #	Category	Project Name	Management Objective	Detailed Description	Implementation Schedule	Measurable Milestones
		Road Intersection Area.	public sewer system and decommissioning faulty septic tanks.	NMED agrees that this area should be put on a sewer system. AB would work with NMED and the Town to advocate in that community for the need to switch.		
15	Septic Tanks	Incentives for High Quality New Septic Tanks	To decrease *E. coli* concentrations along the entire length of the RFdT.	This project will fund new septic tanks on the Rio Fernando when they are needed after inspections. It would aid Project #16 and be a yearly funding supply available to landowners who get inspections or move into a new home.	2022–>annually	Secured funding. Willing landowners. Project planning. Project completion.
16	Septic Tanks	Tracking of Septic Tank Inspections	To decrease *E. coli* concentrations by establishing a mechanism for notifications of needed septic tank inspections on the RFdT.	Work with septic tank contractors and NMED to establish a way of keeping track of when the inspections are done. Then reminders would be sent out every 5 years to each landowner.	2025–>ongoing	A project plan developed to track septic inspections. Funding secured for the project. Project implemented.
17	Septic Tanks	Septic tank and Floodplain Mapping Project	Decrease *E. coli* concentrations by repairing/replacing the current septic tank violators on the RFdT.	To use NMED and local information to map septic tanks along the RFdT and overlay it with floodplain layers. This will identify septic tanks that are most in danger of being inundated and it will help identify locations of old septic tanks.	2021	A hired mapping contractor. A completed map. Outreach to landowners
18	Septic Tanks	Mitigate Problem Septic Tanks (engage with 10 current violators in the RFdT)	Decrease *E. coli* concentrations by mitigating approximately 10 current septic tanks that are in violation of their permits.	This project would secure funds to address the current septic systems that are known to be in violation by the NMED. Septic contractors would be hired and best management practices would be followed when choosing a type of septic system to install.	2022–2026	Funding secured. 10 Tanks in violation are repaired or replaced
19	Septic Tanks	Remove Septic Tanks from Floodplains.	Decrease *E. coli* concentrations by removing 5–10 septic tanks that are	Following project #17, 5–10 septic tanks will be targeted for action within the floodplain.	2025–2030	Funding secured. 10 Tanks moved out of the floodplain or modified to be floodplain-safe.

Project #	Category	Project Name	Management Objective	Detailed Description	Implementation Schedule	Measurable Milestones
			within the floodplain.			
20	Stream/Wetland Restoration	Bank Stabilization and Erosion Control in the Middle and Upper Segments	To decrease *E. coli* concentrations by contributing to project #12 using the same techniques but in the upper and middle segments of the river.	Cost share program for willow tree planting, other river/stream meandering restoration including one rock damns, plug and ponds and other restoration techniques. This project will focus on the middle and upper river segments.	2025–2035	Secured funding. Willing landowners. Project planning. Project completion
21	Stream/Wetland Restoration	Private Land Wetland Restoration Subsidies	To decrease *E. coli* concentrations by increasing the acreage of functioning wetlands along the RFdT.	Cost share program for private wetland development and restoration. Use existing wetland maps to identify whom to approach. Secure funding and perform outreach to landowners living in and near wetland areas.	2030–>annually	Secured funding. Willing landowners. Project planning. Project completion.
22	Stream/Wetland Restoration	Restore La Jara Wetlands in Upper Watershed	To complete all the projects in the La Jara Wetland Assessment (4 of the projects will be accomplished in Project #10 from this list.	Implementation of the La Jara Wetland Restoration Assessment and concept Design Document. Completion of 3 projects listed in the document.	2022–2024	Discussions with USFS about executing these last 3 projects from the La Jara Wetland Assessment Document. Secured Funding. Hiring of Watershed Artisan or another contractor. Completion of each of the three projects.
23	Stream/Wetland Restoration	Restoration and Designation of Dispersed Camping Sites on FR5	To decrease erosion and therefore *E. coli* concentrations into the Rio Fernando from recreational	Identify dispersed camping sites on FR5; design plans to modify and designate dispersed campsites. USFS requires one summer of internship outreach for the project prior to implementation.	2021–2023	Plan for interns to perform outreach at the location. Completion of intern program. Plan for each campsite. Implementation of

Project #	Category	Project Name	Management Objective	Detailed Description	Implementation Schedule	Measurable Milestones
			activity in La Jara Canyon.			each campsite plan.
24	Stream/Wetland Restoration	Concrete Removal From RFdT Bottom	To decrease *E. coli* loads by increasing riparian function by removing concrete from the bottom of the river.	Near the Angladas building, the RFdT has concrete poured in the bottom of it and all the way across. It is also extremely incised here. Removal of the concrete and erosion control structures would be installed.	2021	Plan to remove the concrete. Discussion with contractors. Chosen contractor. Permits approved. Removal of the concrete.

Figure 9.3: Table of Management Measures with Implementation Schedule and Milestones – **Outreach projects**

Project #	Category	Project Name	Management Objective	Detailed Description	Implementation Schedule	Measurable Milestones
1	Education: Fecal Waste	Education on Livestock Waste Management	To reduce *E. coli* loading through landowner education of best management practices for livestock.	One free public event each year with composting options and presentations. The creation of a factsheet with waste management options for different situations.	2020–2022	Completion of annual event. Continued attendance. Adaptation of the event as time goes on.
2	Education: Fecal Waste	Homeless Shelter and Alcohol/Drug Addiction Rehab Promotion	Decrease *E. coli* concentrations from human sources	Promote existence of shelters and drug addiction programs in general. PSA's, letters to the editor about connection to clean water.	2020, annually	Feedback from partners and landowners on project implementation. RFdT monitoring phones. Level of community interest in the project.
3	Education: Forest/Watershed Health	Watershed Interpretive Signs	To reduce *E. coli* loading through promotion of healthy watershed information and	Signs educating the public on watershed, forest restoration and watershed health at trailheads. Signs will include specific actions that people	2020–2022	Completion of 1 or more signs.

Project #	Category	Project Name	Management Objective	Detailed Description	Implementation Schedule	Measurable Milestones
			common *E. coli* inputs.	can take to decrease *E. coli* in the river.		
4	Education: Forest/ Watershed Health	Promote land Restoration Practices that Mimic Natural Fire Regimes.	To reduce bacteria loading from catastrophic fire in the RFdT Watershed.	Promote Rio Grande Water Fund principals, promote USFS BMPs and forest contractors. Advocate for responsible management of the Pueblo Ridge Project and potentially other restoration projects proposed in the Rio Fernando watershed.	Ongoing	Continued collaboration with the TNC and RGWF.
5	Education: Green Infrastructure, Run off control, erosion control	Green Infrastructure Workshops	To reduce *E. coli* loads by encouraging GI BMPs along the RFdT.	A day long workshop once a year focused on the RFdT and reducing runoff in the river. Specific landowner activities that will benefit the river will be discussed in depth.	Ongoing	Completion of yearly workshop
6	Education: Green Infrastructure, Run off control, erosion control	Ongoing Education of County and Town Elected Officials/Decision Makers Regarding GI/LID.	To reduce *E. coli* loads by educating Town and County officials on the benefits of GI/LID approaches.	Presentations once a year at ToT and TC Meetings including GI/LID informational handouts and updates. Specifically, will include why these approaches benefit the ToT and TC.	Ongoing	Completion of 2 meetings per year, one Town and one County
7	Education: Green Infrastructure, Run off control, erosion control	Roads and Riparian Corridors Outreach	To reduce *E. coli* loading through education of the community and engagement with NMDOT.	Yearlong Outreach campaign targets at driveways/road BMPs. Work with NMDOT and TC on planning Highway widening projects due to high traffic. Educate private land-owners (factsheet, presentations) and proper engineering of	2022–2024	Completion of one or more road-based projects next to the RFdT.

Project #	Category	Project Name	Management Objective	Detailed Description	Implementation Schedule	Measurable Milestones
				driveways to avoid erosion and additional sediment loading.		
8	Education: Green Infrastructure, Run off control, erosion control	Develop RFdT Corridor Green Infrastructure Development Plan	To create a GI/LID Plan to guide Projects 10, 11, and 12.	This project will be completed before Projects # 10,11 and 12. It will help to guide landowner outreach for those projects. A Plan will be developed that focuses on finding and detailing opportunities for GI/LID projects along the Rio Fernando Corridor.	2021-2022	This project will be monitored by staff through regular meetings with BioHabitats.
9	Education: Pet Waste	Scoop the Poop educational campaigns	To reduce *E. coli* loading through education of the community on the impacts of pet waste on the RFdT.	This project would fund newspapers adverts, radio adverts, and other forms of outreach to encourage pet waste clean-up around the RFdT.	2022–2024	Completion of Design phase. Each year completed of the implementation phase.
10	Education: Septic Tanks	Private Land Septic Education Series—Voluntary Compliance	To reduce *E. coli* loading through education of the community on the impacts of septic tanks on the watershed.	Two free public events twice a year focused on how landowners can have best management practices around their septic tank (inspections every 5 years, etc.).	Ongoing	Completion of two workshops a year
11	Education: Septic Tanks	Septic Tank BMP Mailing	To reduce *E. coli* loading through a positive messaging campaign about best management practices for septic tanks.	Utility bill mailing: Outreach flyer on proper septic care, permitting, and stopping illegal dumping.	2020	Creation of the mailing with stakeholder input. Plans with two companies to do the mailing.

Project #	Category	Project Name	Management Objective	Detailed Description	Implementation Schedule	Measurable Milestones
12	Education: Stream/ Wetland Restoration	Reconnect the RFdT with its Flood Plain Campaign.	To reduce *E. coli* loading through a positive messaging campaign about the importance of floodplains and functioning riparian systems.	On-the-ground projects 17 and 19 would be connected to this but this is the outreach component-newspaper articles, short video, radio shows, blogs encouraging the whole community to work on their section of the RFdT.	2021–2023 1.	Completion of media tasks throughout the year.
13	Education: Stream/ Wetland Restoration	Wetland Restoration Education Series	To reduce *E. coli* loading through a positive messaging campaign about the importance of wetlands in functioning riparian systems.	Annual event. What you can do to improve your riparian areas. Promote private land restoration by giving free workshops with Easy techniques for landowners to improve their riparian habitat. Focus on incision of the river and the importance of materials in the river to create pools.	2022–2024	Completion of two workshops a year
14	Education: Stream/ Wetland Restoration	Create Riparian Zones Action Team (Citizen Science).	To reduce *E. coli* loading by creating a team of people/volunteers to pursue and foster riparian zones and wetlands on private lands.	This would be a next step from of Project #11. People that go to that education series would form this team. This would be programmatic; volunteers go to private land and do wetland restoration day projects.	2,025	Outreach during other projects for interested landowners and volunteers. Plans for the operation of the team and creation of the team.

10 EVALUATION CRITERIA AND MONITORING PLAN

10.1 Evaluation Criteria

The measurement of success for this watershed restoration plan will be attainment of water quality standards. The NMED will perform water quality sampling on the Rio Fernando as regularly scheduled and Amigos Bravos and Sierra Club Water Sentinels will continue yearly sampling at four places on the Rio Fernando. As the data becomes available, we can reevaluate our program and make course corrections if needed.

Our criteria for success can also include the following quantitative standards to measure our success in meeting our project milestones;

- Number of meetings, project participation and outreach events
- Valuable partnerships created and maintained
- Amount of funding received per year to implement restoration projects
- Number of BMP's implemented as gauged by number of acres, or feet of restoration work etc.

For a large-scale evaluation of the Watershed-based Plan, the following criteria have been developed to determine if the project objectives are making progress toward meeting the overall goal. We will create and provide forms for projects to collect this information.

- Implementation Project Oversight – Was the management measure implemented as intended and designed?

- Mitigation Performance – What was the percent efficiency/effectiveness of the management measure toward meeting load reduction expectations for that practice?

- Mitigation Performance – What was the percent reduction in *E. coli* loading for a particular management measure relative to the TMDL target load?

- Mitigation Performance (if applicable): What was the performance of a management measure relative to other measures? Which are most efficient and economical?

- Watershed-Based Plan Performance: Are the prescribed management measures being implemented and performing as expected?

- Overall Load Reduction: What is the combined impact of the implemented management measures? Have the combined management measures reduced the *E. coli* loading down to the target TMDL load?

10.2 Monitoring Plan

The Monitoring Plan for the Rio Fernando de Taos will focus on the cause of water quality impairment and will utilize the methods we have established in this document. The watershed coordinator will work with the project funder and the landowner to implement the agreed upon monitoring protocol at each site.

The core monitoring activities to determine the effectiveness of projects are:

1) Photopoint Monitoring: A standard photopoint monitoring program will be developed and implemented for each project. Before and after photographs followed by yearly photographs if effective at most sites. When necessary, more frequent photos will be taken.

2) *E. coli Concentration* Monitoring: The same IDEXX methods described in this Plan will be used to measure *E. coli* concentrations in the surface water of the Rio Fernando. Sampling will be done at least three times a year at four locations and more when funding allows.

3) On-going NMED SWQB monitoring consists of two year surveys every 8-10 years. This is followed by listing/delisting decisions in the 3030d/305b Integrated Report. Amigos Bravos submits our thrice-yearly data on the Rio Fernando to this process.

Other necessary monitoring will be completed as projects are implemented (i.e., wetland soil assessments, physical visits to check on structures or plantings, etc.). Monitoring of Outreach projects will be in the form of standard evaluation forms, number of participants, etc.

We will assess the parameters of each project pre and post restoration to monitor the effectiveness of restoration projects over time. This will help provide for adaptive management strategies if implementation is not having the results we anticipated.

All monitoring data will be logged onto standardized forms and will be stored in an electronic file and a physical binder. Proper training in an established monitoring protocol will take place before any data is collected.

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