6.0 Fecal Coliform

6.1 Summary

During the 1999 SWQB sampling monitoring effort in the Lower Rio Chama watershed, fecal coliform data showed several exceedances of the New Mexico water quality standard in Cañones Creek (see Table 6.1). Presence of fecal coliform bacteria is an indicator of the possible presence of other bacteria that may limit beneficial uses and present human health concerns. There are nonpoint sources of fecal coliform bacteria throughout the watershed that could be contributing to the fecal coliform levels. Two potential sources of fecal coliform bacteria have been identified in the Cañones Creek watershed. These sources include rangeland and onsite wastewater systems. Cañones Creek is listed on the 2002-2004 CWA Integrated §303(d)/§305(b) list with fecal coliform as a pollutant of concern.

Table 6.1. Results of Fecal Coliform Monitoring on Cañones Creek from 1991 Through 1999

Date	Cfu/100mL	Flow (cfs)
4/25/91	60	-----
4/22/99	**2,400**	10.74
7/28/99	**440**	3.34
10/6/99	73J	4.84

Bolded values indicate an exceedance of the standard.
J indicates that the value was estimated.

6.2 Endpoint Identification

Target Loading Capacity

Overall, the target values for fecal coliform TMDLs will be determined based on (1) the presence of numeric criteria, (2) the degree of experience in applying the indicator and (3) the ability to easily monitor and produce quantifiable and reproducible results. For this TMDL document target values for fecal coliform are based on numeric criteria.

Fecal Coliform

Cañones Creek is in the standard segment defined in 20.6.4.119 NMAC (formerly 2116), which reads:

> All perennial reaches of tributaries to the Rio Chama above Abiquiu dam except the Rio Gallina and Rio Puerco de Chama north of state highway 96 and the main stem of the Rio Chama from the headwaters of El Vado reservoir upstream to the New Mexico-Colorado line.

The state's standard leading to an assessment of use impairment is the numeric criteria stating that "The monthly geometric mean of fecal coliform bacteria shall not exceed

100/100 mL; no single sample shall exceed 200/100 mL" for the appropriate designated use of a high quality coldwater fishery (HQCWF).

Flow

Fecal coliform numbers can vary as a function of flow. As seen in the 1999 data, exceedances of the criterion occurred at both high and low flows. However, since the exceedance was much greater at the higher flow and TMDLs are calculated for each reach at a specific flow. Accordingly, the target flow was set to high flow.

When available, USGS gages are used to estimate flow. Where gages are absent or poorly located along a reach, either actual flow (measured as water quality samples are taken) is used as target flows or geomorphologic cross-sectional information is taken to model the flows. Because there was no USGS gage station on Cañones Creek, the flow used for this TMDL was the highest flow taken during the field-sampling season (6.94 MGD, taken April 20, 1999) on this reach. It is important to remember that the TMDL is a planning tool to be used to achieve water quality standards. Since flows vary throughout the year in these systems at water quality standards the target load will vary based on the changing flow (see Figure 6.1). Management of the load should set a goal attainment, not meeting the calculated target load.

Calculations

Fecal coliform standards are expressed as colonies per unit volume. Using the 30-day geometric mean criterion of 100 cfu/100 mL stream load can be calculated. The geometric mean criterion is utilized in these calculations because it is conservative. In addition, if the 200 cfu/100 mL standard was used as a target, the geometric mean criterion of 100 cfu/100 mL may not be reached. This is accomplished through application of the following conversion calculations.

Equation 1

C as cfu/100 mL * 1,000 mL/1 L * 1 L/ 0.264 gallons * Q in gallons/day = cfu/day

Where C = state water quality standard criterion,
Q = stream flow in gallons

Applying this conversion using the 100 cfu/100 mL criterion and using the stream flow of 6.94 MGD, the load may be expressed as follows:

100 cfu/100 mL * 1000mL/1 L * 1 L/ 0.264 gallons * 6940000 flow in gallons / day

This yields an assimilative loading limit in the stream of 2.629×10^{10} cfu/day at high flow.

Point sources usually have a defined critical low receiving stream flow such as a 4Q3 at which the criterion must be met. For nonpoint sources it is important to recognize that

there may be no single critical flow condition. The water quality criterion may be exceeded during low flow but it is equally likely that criterion will be violated during wet weather events when pollution is washed off the land surface or re-suspended from contaminated sediments. To address this condition, and hopefully to increase the understanding of the TMDL load determination process, a fecal coliform loading curve has been generated (Figure 6.1). This line is developed using the Equation 1, substituting 100 cfu/100 mL, for fecal coliform concentration and varying flow values. To develop this curve for Cañones Creek flow values were estimated as a percentage of the drainage area of Cañones Creek draining to the Abiquiu Dam USGS gage. This provided multiple flow values per month over the last 40 years. It represents examples of both low and high flows from the watershed. This curve is not stream dependent but is dependent upon the designated stream criterion. Therefore, it may be applied to any stream with a like fecal coliform criterion with this range of flows. This curve represents the TMDL loading allocation for fecal coliform on Cañones Creek.

The loading capacity line is shown in Figure 6.1. For any flow value x, one can quickly determine the fecal coliform loading value. For ease in dealing with very large numbers generated from fecal coliform loading conversions, the y-value (fecal coliform concentrations), is expressed as the log 10 transformation of the fecal coliform concentration. The line formed by this series of points may be thought of as a boundary. At any given flow the loading may be below the line, within the boundary, or above the line. Fecal coliform load values falling above the line represent disproportionately high values related to the standard. Fecal coliform load values falling below the line represent low loads relative to the standard.

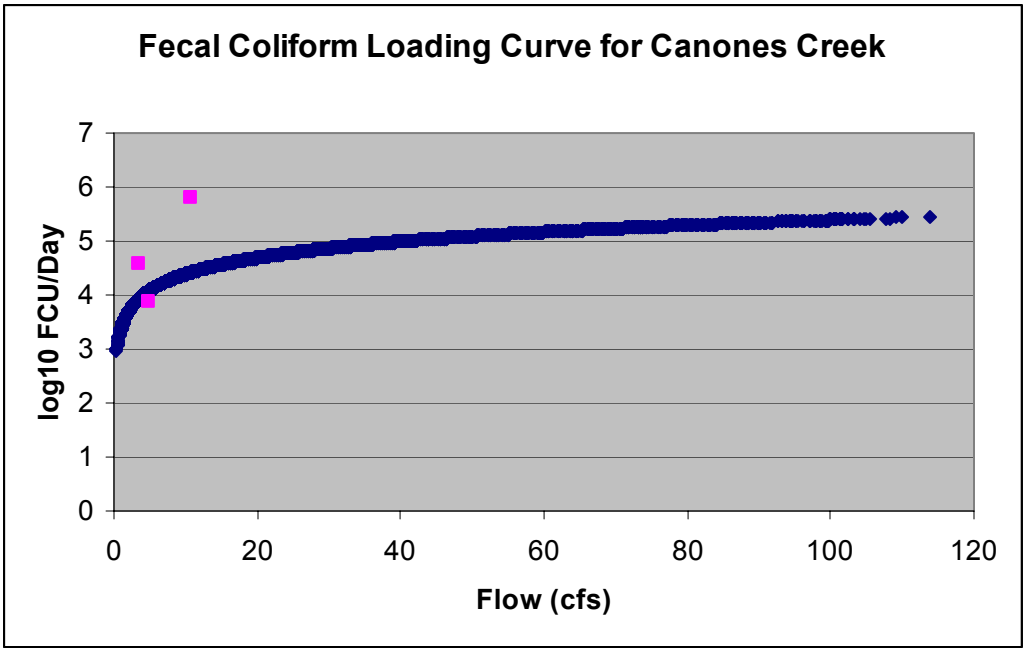

Figure 6.1. Fecal Coliform Loading Curve for Cañones Creek

Waste Load Allocations and Load Allocations

- *Waste Load Allocation*

There are no point source contributions associated with this TMDL. The waste load allocation is therefore zero.

- *Load Allocation*

The nonpoint source is calculated by subtracting the waste load allocation and the margin of safety from the final allowable capacity.

$$TMDL = WLA + LA + MOS$$
$$LA = TMDL - WLA - MOS$$
$$LA = 2.629 \times 10^{10} - 0 - 1.3 \times 10^{9}$$
$$LA = 2.5 \times 10^{10}$$

This allocation can be converted to a target concentration limit using the conversion formula:

$$2.629 \times 10^{10} \text{ cfu/day} * 1 \text{ day}/6940000 \text{ gal} * 0.264 \text{ gal}/1 \text{ L} * .1 \text{ L}/100 \text{ mL}$$

This yields a target 30-day geometric mean of 100 cfu/100 mL. With current levels reaching 2,400 cfu/100 mL in the most recent evaluations, a current measured load of fecal coliform in the watershed is been 6.3×10^{11} cfu/day. To reach the target load, a reduction of 6.0×10^{11} cfu/day in nonpoint source contributions must be achieved (see Table 6.3).

The margin of safety is estimated to be 5 percent of the target load. Results are presented in Table 6.2. Additional details on the chosen margin of safety are presented in section 6.3 below.

Table 6.2 Calculation of TMDL for Fecal Coliform

Location	WLA (cfu/day)	LA (cfu/day)	MOS (5 percent) (cfu/day)	TMDL (cfu/day)
Cañones Creek	0	2.5×10^{10}	1.3×10^{9}	2.629×10^{10}

The extensive data collection and analyses necessary to determine background fecal coliform loads for Cañones Creek watershed were beyond the resources available for this study. It is therefore assumed that a portion of the load allocation is made up of natural background loads.

The load reduction that would be necessary to meet the target load was calculated to be the difference between the calculated TMDL (Table 6.2) and the measured load, and is shown in Table 6.3.

Table 6.3. Calculation of Load Reduction for Fecal Coliform

Location	TMDL (cfu/day)	Measured Load (cfu/day)	Load Reduction (cfu/day)
Cañones Creek	2.629×10^{10}	6.3×10^{11}	6.0×10^{11}

It is important to note that these load allocations are estimates based on a high flow condition. It is conceivable, due to differing hydrologic conditions that lesser loads may not exceed water quality standards. Likewise, it is possible that greater load conditions could exceed the water quality standards under certain hydrologic conditions. For this reason the load allocations given here are less meaningful than are the relative percentage reductions. Compliance with this TMDL will be determined based on achieving the nonpoint source 30-day geometric mean of 100 cfu/100 mL.

Identification and Description of Pollutant Sources

Table 6.4 Pollutant Source Summary

Pollutant Sources (percent from each)	**Magnitude** (WLA + LA + MOS)	**Location**	**Potential Sources**
Point: (0 percent)	0		None
Nonpoint: (100 percent) • Fecal Coliform		Cañones Creek	Rangeland and Onsite Wastewater Systems

Linkage Between Water Quality and Pollutant Sources

SWQB fieldwork includes an assessment of the potential sources of impairment (SWQB/NMED 1999). The Pollutant Source(s) Documentation Protocol form and Potential Sources Summary Table in Appendix D provides an approach for a visual analysis of a pollutant source along an impaired reach. Although this procedure is subjective, SWQB feels that it provides the best available information for the identification of potential sources of impairment in this watershed. Table 6.4 (Pollutant Source Summary) identifies and quantifies potential sources of nonpoint source impairments along the reach as determined by field reconnaissance and assessment. A further explanation of the sources follows.

Cañones Creek
The primary sources of impairment along this reach have been identified as rangeland and on-site wastewater systems. Notes from field visits in 2002 documented bank erosion and cattle grazing in the riparian zone.

According to the Water Quality Survey of this watershed (SWQB/NMED 1991), activities that may contribute to water quality impairments are livestock grazing,

recreation, and silviculture. In addition, the Cañones Creek sampling station was also located below the town of Canones and below the irrigation return flows of this community.

Additional fecal coliform sampling would need to be conducted to more fully characterize sources of fecal coliform bacteria in the Cañones Creek watershed. However, sufficient data exist to support development of a fecal coliform TMDL to address the stream standards violations.

6.3 Margin of Safety (MOS)

TMDLs should reflect a margin of safety based on the uncertainty or variability in the data, the point and nonpoint source load estimates, and the modeling analysis. For this TMDL, there will be no margin of safety for point sources, since there are none. Also, for the nonpoint sources the margin of safety is estimated to be primarily implicit with MOS is 5% of the sum of the WLA and LA for Cañones Creek. This margin of safety is sum of the following two elements:

- *Conservative Assumptions*

  A conservative assumption, treating fecal coliform as a conservative pollutant, that is a pollutant that does not readily degrade in the environment, was used in developing these loading limits.

  Using a more conservative limit of 100 cfu/100 mL, when the standard allows up to 200 cfu/100 mL for individual grab samples, to calculate loading values.

- *Errors in calculating flow*

  Flow estimates were based on actual flows measured in the field at the time of sampling. A conservative MOS for this element is **5 percent**.

6.4 Consideration of Seasonal Variability

During the 1999 water quality survey, fecal coliform exceedances occurred during both high and low flow events. There is no single critical condition for fecal coliform. Higher flows may flush more nonpoint source runoff containing fecal coliform. It is possible the criterion may be exceeded under a low flow condition when there is insufficient dilution of the point source. Evaluation of seasonal variability for potential nonpoint sources is difficult due to limited available data. However, some observations may be made from the available data. Samples collected during the warm weather or high flow period in 1999 yielded high fecal coliform levels. Samples collected in October 1999, which is beyond the warm weather season, yielded lower fecal counts. This allows inference that seasonal inputs may account, in part, for the elevated fecal counts. Additional information will be needed to support or refute this observation. Because of the uncertainty involved, there will be no seasonal allocations for fecal coliform in this TMDL.

6.5 Future Growth

Since most (94 percent) of this watershed is managed by the USFS, it is not likely that growth will occur and lead to a significant increase for fecal coliform, other than a natural increase, that cannot be controlled with best management practice implementation in this watershed.