5.0 BACTERIA

During the 2002 SWQB sampling monitoring effort in the San Juan River watershed, fecal coliform data showed several exceedences of the New Mexico water quality secondary contact use standard for several assessment units. This data was combined with other sources of data to determine overall impairment for these assessment units. As a result, five assessment units are listed on the 2004-2006 CWA Integrated §303(d)/§305(b) list (NMED/SWQB 2004a) with fecal coliform as a pollutant of concern (see summary in Table 5.1 and data in Appendix C). 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 potential nonpoint and point sources of fecal coliform bacteria throughout the basin that could be contributing to the fecal coliform levels.

Per USEPA guidance, SWQB has proposed changing the contact use criterion from fecal coliform to *E. coli*. In anticipation of this change, *E. coli* concentrations were also measured during the 2002 SWQB and subsequent 2003 and 2004 San Juan Watershed Group (SJWG) surveys (NMED/SWQB 2004d, SJWG 2005). *E. coli* results are therefore also discussed in this TMDL document.

Table 5.1. Summary of Assessment Units Impaired for Bacteria in the San Juan River Basin

Assessment Unit	Fecal coliform: # Exceedences/ Total Samples	Fecal coliform[(a)]: %Exceedence	*E. coli*: # Exceedences/ Total Samples	*E. coli*[(a)]: %Exceedence
Animas River (San Juan River to Estes Arroyo)	2/13	15%	0/14	0%[(b)]
La Plata River (San Juan River to McDermott Arroyo)	2/6	33%	1/6	17%
La Plata River (McDermott Arroyo to CO border)	3/5	60%	3/5	60%
San Juan River (Navajo bnd at Hogback to Animas River)	9/26	35%	13/40	33%
San Juan River (Animas River to Cañon Largo)	11/41	27%	12/54	22%

Notes:
[(a)] Exceedence rates ≥ 15% result in a determination of Non Support based on the assessment protocol (NMED/SWQB 2004b)
[(b)] There are no TMDL calculations for *E. coli* in the Animas River in this document because the exceedence rate was < 15%. Thus, the determination would be Full Support.

5.1 Target Loading Capacity

Overall, the target values for bacteria 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 bacteria are based on the reduction in bacteria necessary to achieve numeric criteria. This TMDL is also consistent with New Mexico's antidegradation policy.

The segment-specific criteria leading to an assessment of use impairment for these reaches is the numeric criteria stating that "The monthly geometric mean of fecal coliform bacteria shall not exceed 200/100 mL; no single sample shall exceed 400/100 mL" for the designated contact use (NMAC 2002). The Navajo Nation Water Quality Standards for the San Juan River between the Hogback and the La Plata River are 100/100 mL geometric mean and 200/100mL single sample (NNEPA 1999). New Mexico has proposed *E. coli* criteria of 126/100 mL geometric mean and 410/100mL single sample for all assessment units discussed in this section. The Navajo Nation has adopted *E. coli* criteria of 126/100 mL geometric mean and 235/100mL the San Juan River between the Hogback and the La Plata River (NNEPA 2004).

5.2 Flow

Bacteria numbers can vary as a function of flow. Exceedences of the criterion occurred at both high and low flows in the impaired assessment units in the San Juan River basin. Therefore, the target flow was set at the critical low flow condition or 4Q3, defined as the minimum average four consecutive day flow which occurs with a frequency of once in three years (4Q3). Critical low flow was determined on an annual basis utilizing all available daily flow values rather than on a seasonal basis for these TMDLs because exceedences occurred during both low and high flow conditions.

When available, USGS gage data were used to determine 4Q3s (Table 5.2 and Appendix D). These 4Q3s were estimated through application of USGS gage data to a log Pearson Type III distribution through "*Input and Output for Watershed Data Management*" (IOWDM) software, Version 4.1 (USGS 2002a) and "*Surface-Water Statistics*" (SWSTAT) software, Version 4.1 (USGS 2002b). When necessary, 4Q3s calculated at downstream USGS gaging stations are area weighted according to USGS (1993) to determine 4Q3 values for the upstream ungaged portion (Appendix D).

It is important to remember that the TMDL itself is a value calculated at a defined critical condition, and is calculated as part of planning process designed to achieve water quality standards. Since flows vary throughout the year in these systems, the actual load at any given time will vary based on the changing flow. Management of the load to improve stream water quality should be a goal to be attained. Meeting the calculated TMDL may be a difficult objective.

5.3 Calculations

Bacteria standards are expressed as colony forming units (cfu) per unit volume. The fecal coliform criteria and proposed *E. coli* criteria used to calculate the allowable stream flow for the impaired assessment units is listed in Table 5.2.

Table 5.2. Criteria concentrations and flow values for bacteria allowable load calculations

Assessment Unit	Fecal coliform criterion used in target calculation (cfu/100ml)	*E. coli* criterion used in target calculation (cfu/100ml)	Source of selected criterion	4Q3
Animas River (San Juan River to Estes Arroyo)	200	126	NMAC 20.6.4 geometric mean criterion	89 cfs [(a)] 58 mgd
La Plata River (San Juan River to McDermott Arroyo)	200	126	NMAC 20.6.4 geometric mean criterion	0.13 cfs 0.084 mgd
La Plata River (McDermott Arroyo to CO border)	200	126	NMAC 20.6.4 geometric mean criterion	0.11cfs [(b)] 0.068 mgd
San Juan River (Navajo bnd at Hogback to Animas River)	100	126	Navajo Nation Water Quality Standards geometric mean	463 cfs [(d)] 299 mgd
San Juan River (Animas River to Cañon Largo)	200	126	NMAC 20.6.4 geometric mean criterion	374 cfs [(c)] 242 mgd

Notes:
[(a)] Determined from USGS Gage Data from Animas at Farmington, NM. This gage was used because up to 105 cfs (design capacity) is diverted into Farmer's Mutual Ditch above the top of the impaired assessment unit (upstream of Estes Arroyo). The period of record 1967 to 2002 was utilized to take into account the impact of Lemon Dam in Colorado. [(b)] Determined by area-weighting the 4Q3 from USGS Gage La Plata River near Farmington (USGS 1993).
[(c)] Determined by subtracting the 4Q3 for USGS Gage Animas at Farmington, NM, from the 4Q3 for USGS Gage San Juan River at Farmington since this gage is just downstream of the confluence with the Animas River.
[(d)] Determined from USGS Gage Data from San Juan River at Farmington, NM. This gage was used instead of San Juan River at Shiprock due to the substantial withdrawal into the Hogback Canal at the bottom of the assessment unit.

Target loads for bacteria are calculated based on 4Q3 flow values, current and proposed WQS, and conversion factors (Equation 1). The geometric mean criteria are utilized in TMDL calculations to be conservative. In addition, if the single sample criteria were used as targets, the geometric mean criteria may not be reached.

Equation 1

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

Where C = state water quality standard criterion for bacteria,
Q = stream flow in million gallons per day (mgd)

The target loads (TMDLs) predicted to attain current and proposed standards were calculated using **Equation 1** and are shown in Tables 5.3 and 5.4.

Table 5.3 Calculation of Target Loads for Fecal Coliform

Assessment Unit	4Q3 Flow (mgd)	Fecal Coliform geometric mean criteria (cfu/100mL)	Conversion Factor[(a)]	Bacteria Target Load Capacity (cfu/day)
Animas River (San Juan River to Estes Arroyo)	58	200	3.79×10^{7}	4.40×10^{11}
La Plata River (San Juan River to McDermott Arroyo)	0.084	200	3.79×10^{7}	6.37×10^{8}
La Plata River (McDermott Arroyo to CO border)	0.068	200	3.79×10^{7}	5.15×10^{8}
San Juan River (Navajo bnd at Hogback to Animas River)	299	100	3.79×10^{7}	1.13×10^{12}
San Juan River (Animas River to Cañon Largo)	242	200	3.79×10^{7}	1.83×10^{12}

Notes:
[(a)] Based on equation 1.

Table 5.4 Calculation of Target Loads for Proposed *E. coli*

Assessment Unit	4Q3 Flow (mgd)	Proposed *E. coli* geometric mean criteria (cfu/100mL)	Conversion Factor[(a)]	Target Load Capacity (cfu/day)
La Plata River (San Juan River to McDermott Arroyo)	0.084	126	3.79×10^{7}	4.01×10^{8}
La Plata River (McDermott Arroyo to CO border)	0.068	126	3.79×10^{7}	3.25×10^{8}
San Juan River (Navajo bnd at Hogback to Animas River)	299	126	3.79×10^{7}	1.43×10^{12}
San Juan River (Animas River to Cañon Largo)	242	126	3.79×10^{7}	1.16×10^{12}

Notes:
[(a)] Based on equation 1.

5.4 Waste Load Allocations and Load Allocations

5.4.1 Waste Load Allocation

There are some potential sources of point source bacteria discharge into three impaired assessment units as shown in Tables 5.5 and 5.6.

Table 5.5 Waste Load Allocations for Fecal Coliform

Assessment Unit	Facility	Design Capacity Flow (mgd)	Proposed or Current Fecal Coliform Effluent limits[(c)] (cfu/100mL)	Conversion Factor[(a)]	Waste Load Allocations (cfu/day)
Animas River (San Juan River to Estes Arroyo)	**NM0020168** City of Aztec WWTP	1.0	200	3.79×10^{7}	7.58×10^{9}
San Juan River (Navajo bnd at Hogback to Animas River)	**NM0020583** City of Farmington WWTP	6.67	100	3.79×10^{7}	2.53×10^{10}
	NM0029319 Kirtland Sewer Treatment Facility	0.05	100	3.79×10^{7}	1.90×10^{8}
	NM0020800[(b)] BIA/Nenahnezad Boarding School	0.011	100	3.79×10^{7}	4.17×10^{7}
	NM0029025 Harper Valley	0.096	100	3.79×10^{7}	3.64×10^{8}
San Juan River (Animas River to Cañon Largo)	**NM0020700** City of Bloomfield WWTP	0.9	200	3.79×10^{7}	6.82×10^{9}
	NM0028142 Blanco School	0.0024	200	3.79×10^{7}	1.82×10^{7}
	NM0030473 McGee Park	0.05	200	3.79×10^{7}	3.79×10^{8}

Notes:
[(a)] Based on equation 1.
[(b)] Permit under USEPA Region 9/ Navajo Nation EPA jurisdiction. This permit is identified for information only as this discharge and its regulation are not under New Mexico's jurisdiction
[(c)] Based on applicable New Mexico and Navajo Nation WQS.

Table 5.6 Waste Load Allocations for *E. coli*

Assessment Unit	Facility	Design Capacity Flow (mgd)	Proposed *E. coli* Effluent limits[c] (cfu/100mL)	Conversion Factor[a]	Waste Load Allocations (cfu/day)
Animas River (San Juan River to Estes Arroyo)	**NM0020168** City of Aztec WWTP	1.0	126	3.79×10^{7}	4.78×10^{9}
San Juan River (Navajo bnd at Hogback to Animas River)	**NM0020583** City of Farmington WWTP	6.67	126	3.79×10^{7}	3.19×10^{10}
	NM0029319 Kirtland Sewer Treatment Facility	0.05	126	3.79×10^{7}	2.39×10^{8}
	NM0020800[b] BIA/Nenahnezad Boarding School	0.011	126	3.79×10^{7}	5.25×10^{7}
	NM0029025 Harper Valley	0.096	126	3.79×10^{7}	4.58×10^{8}
San Juan River (Animas River to Cañon Largo)	**NM0020700** City of Bloomfield WWTP	0.9	126	3.79×10^{7}	4.30×10^{9}
	NM0028142 Blanco School	0.0024	126	3.79×10^{7}	1.15×10^{7}
	NM0030473 McGee Park	0.05	126	3.79×10^{7}	2.39×10^{8}

Notes:
[a] Based on equation 1.
[b] Permit under USEPA Region 9/ Navajo Nation EPA jurisdiction. This permit is identified for information only as this discharge and its regulation are not under New Mexico's jurisdiction
[c] Based on proposed New Mexico and Navajo Nation WQS.

5.4.2 Load Allocation

In order to calculate the LA, the WLA and MOS were subtracted from the target capacity (TMDL), as shown below in **Equation 2**.

$$WLA + LA + MOS = TMDL \qquad \textbf{Equation 2}$$

Results using a MOS of 5% (as explained in Section 5.7) are presented in Tables 5.7 and 5.8.

Table 5.7 Calculation of TMDLs for Fecal Coliform

Assessment Unit	WLA (cfu/day)	LA (cfu/day)	MOS (5%) (cfu/day)	TMDL (cfu/day)
Animas River (San Juan river to Estes Arroyo)	7.58×10^{9}	4.10×10^{11}	2.20×10^{10}	4.40×10^{11}
La Plata River (San Juan River to McDermott Arroyo)	0	6.05×10^{8}	3.19×10^{7}	6.37×10^{8}
La Plata River (McDermott Arroyo to CO border)	0	4.89×10^{8}	2.58×10^{7}	5.15×10^{8}
San Juan River (Navajo bnd at Hogback to Animas River)	2.59×10^{10}	1.05×10^{12}	5.65×10^{10}	1.13×10^{12}
San Juan River (Animas River to Cañon Largo)	7.22×10^{9}	1.73×10^{12}	9.15×10^{10}	1.83×10^{12}

.

Table 5.8 Calculation of TMDLs for Proposed *E. coli*

Assessment Unit	WLA (cfu/day)	LA (cfu/day)	MOS (5%) (cfu/day)	TMDL (cfu/day)
La Plata River (San Juan River to McDermott Arroyo)	0	3.81×10^{8}	2.00×10^{7}	4.01×10^{8}
La Plata River (McDermott Arroyo to CO border)	0	3.09×10^{8}	1.63×10^{7}	3.25×10^{8}
San Juan River (Navajo bnd at Hogback to Animas River)	3.26×10^{10}	1.33×10^{12}	7.15×10^{10}	1.43×10^{12}
San Juan River (Animas River to Cañon Largo)	4.55×10^{11}	6.47×10^{11}	5.80×10^{10}	1.16×10^{12}

The extensive data collection and analyses necessary to determine background fecal coliform loads for the San Juan River 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.

Measured loads were also calculated using **Equation 1**. In order to achieve comparability between the target capacity (i.e., TMDL values) and measured loads, the same flow rates were used for both calculations. Results are presented in Tables 5.9 and 5.10.

Table 5.9 Calculation of Measured Loads for Fecal Coliform

Assessment Unit	4Q3 Flow (mgd)	Measured Fecal Coliform Concentrations[(b)] (cfu/100mL)	Conversion Factor[(a)]	Measured Load (cfu/day)
Animas River (San Juan River to Estes Arroyo)	58	204	3.79×10^{7}	4.48×10^{11}
La Plata River (San Juan River to McDermott Arroyo)	0.084	691	3.79×10^{7}	2.20×10^{9}
La Plata River (McDermott Arroyo to CO border)	0.068	907	3.79×10^{7}	2.34×10^{9}
San Juan River (Navajo bnd at Hogback to Animas River)	299	493	3.79×10^{7}	5.58×10^{12}
San Juan River (Animas River to Cañon Largo)	242	384	3.79×10^{7}	3.52×10^{12}

Notes:
[(a)] Based on equation 1.
[(b)] The measured concentration is the arithmetic mean of the measured values used to make the impairment determination (see Appendix C)

Table 5.10 Calculation of Measured Loads for *E. coli*

Assessment Unit	4Q3 Flow (mgd)	Measured *E. coli* Concentration[(b)] (cfu/100mL)	Conversion Factor[(a)]	Measured Load (cfu/day)
La Plata River (San Juan River to McDermott Arroyo)	0.084	216	3.79×10^{7}	6.88×10^{8}
La Plata River (McDermott Arroyo to CO border)	0.068	714	3.79×10^{7}	1.84×10^{9}
San Juan River (Navajo bnd at Hogback to Animas River)	299	464	3.79×10^{7}	5.25×10^{12}
San Juan River (Animas River to Cañon Largo)	242	350	3.79×10^{7}	3.21×10^{12}

Notes:
[(a)] Based on equation 1.
[(b)] The measured concentration is the arithmetic mean of the measured values used to make the impairment determination (see Appendix C).

The load reductions necessary to meet the target loads were calculated to be the difference between the calculated TMDL (Tables 5.7 and 5.8) and the measured loads (Tables 5.9 and 5.10), and are shown in Tables 5.11 and 5.12. These load reduction tables are presented for informational purposes only.

Table 5.11 Calculation of Load Reduction for Fecal Coliform

Assessment Unit	TMDL (cfu/day)	Measured Load (cfu/day)	Load Reduction (cfu/day)	Percent Reduction[(a)]
Animas River (San Juan River to Estes Arroyo)	4.40×10^{11}	4.48×10^{11}	8.00×10^{9}	1.8%
La Plata River (San Juan River to McDermott Arroyo)	6.37×10^{8}	2.20×10^{9}	1.56×10^{9}	71%
La Plata River (McDermott Arroyo to CO border)	5.15×10^{8}	2.34×10^{9}	1.83×10^{9}	78%
San Juan River (Navajo bnd at Hogback to Animas River)	1.13×10^{12}	5.58×10^{12}	4.45×10^{12}	78%
San Juan River (Animas River to Cañon Largo)	1.83×10^{12}	3.52×10^{12}	1.69×10^{12}	48%

Notes:

[(a)] Percent reduction is the percent the existing measured load must be reduced to achieve the TMDL, and is calculated as follows: (Measured Load – TMDL) / Measured Load x 100.

Table 5.12 Calculation of Load Reduction for *E. coli*

Assessment Unit	TMDL (cfu/day)	Measured Load (cfu/day)	Load Reduction (cfu/day)	Percent Reduction[(a)]
La Plata River (San Juan River to McDermott Arroyo)	4.01×10^{8}	6.88×10^{8}	2.87×10^{8}	42%
La Plata River (McDermott Arroyo to CO border)	3.25×10^{8}	1.84×10^{9}	1.52×10^{9}	82%
San Juan River (Navajo bnd at Hogback to Animas River)	1.43×10^{12}	5.25×10^{12}	3.82×10^{12}	73%
San Juan River (Animas River to Cañon Largo)	1.16×10^{12}	3.21×10^{12}	2.05×10^{12}	64%

Notes:
[(a)] Percent reduction is the percent the existing measured load must be reduced to achieve the TMDL, and is calculated as follows: (Measured Load – TMDL) / Measured Load x 100.

It is important to note that load allocations are estimates based on a specific flow condition (i.e., low flow in this case). Under differing hydrologic conditions, the loads will change. For this reason the load allocations given here are less meaningful than are the relative percent reductions. Successful implementation of this TMDL will be determined based on achieving the current fecal coliform and proposed E. coli water quality standards.

5.5 Identification and Description of Pollutant Sources

Based on measured loads and potential contributions from existing point sources, probable point and nonpoint pollutant sources that may be contributing to observed fecal coliform loads are displayed in Table 5.13. Probable source lists for *E. coli* would be similar.

Table 5.13 Pollutant Source Summary for Fecal Coliform

Pollutant Sources	Magnitude (cfu/day)	Assessment Unit	Potential Sources[a]
Point: [b]			
Fecal coliform	7.58×10^{9}	Animas River (San Juan River to Estes Arroyo)	0.8% Municipal Point Source Discharges
	None	La Plata River (San Juan River to McDermott Arroyo)	0%
	None	La Plata River (McDermott Arroyo to CO border)	0%
	2.26×10^{10}	San Juan River (Navajo bnd at Hogback to Animas River)	0.7% Municipal Point Source Discharges
	7.22×10^{9}	San Juan River (Animas River to Cañon Largo)	0.2% Municipal Point Source Discharges
Nonpoint: [c]			
Fecal coliform	4.40×10^{11}	Animas River (San Juan River to Estes Arroyo)	99.2% Drought-related Impacts, Flow Alterations from Water Diversions, Municipal (Urbanized High Density Area), On-site Treatment Systems (Septic Systems and Similar Decentralized Systems), Source Unknown, Streambank Modifications/destabilization
	2.20×10^{9}	La Plata River (San Juan River to McDermott Arroyo)	100% Animal Feeding Operations (NPS), Drought-related Impacts, Flow Alterations from Water Diversions, Loss of Riparian Habitat, On-site Treatment Systems (Septic Systems and Similar Decentralized Systems), Rangeland Grazing, Streambank Modifications/destabilization
	2.34×10^{9}	La Plata River (McDermott Arroyo to CO border)	100% Animal Feeding Operations (NPS), Drought-related Impacts, Flow Alterations from Water Diversions, Loss of Riparian Habitat, On-site Treatment Systems (Septic Systems and Similar Decentralized Systems), Rangeland Grazing, Streambank Modifications/destabilization
	5.55×10^{12}	San Juan River (Navajo bnd at Hogback to Animas River)	99.3% Drought-related Impacts, On-site Treatment Systems (Septic Systems and Similar Decentralized Systems), Rangeland Grazing
	3.07×10^{12}	San Juan River (Animas River to Cañon Largo)	99.8% Drought-related Impacts, Flow Alterations from Water Diversions, Loss of Riparian Habitat, On-site Treatment Systems (Septic Systems and Similar Decentralized Systems), Rangeland Grazing

Notes:
[(a)] From the 2004-2006 Integrated 303(d)/305(b) list. This list of probable sources is based on staff observation and known land use activities in the watershed. These sources are not confirmed or quantified at this time. Point source percentage calculated as WLA magnitude divided by measured load. Nonpoint source percentage is the remainder when this value is subtracted from 100%.
[(b)] Current potential point source contributions (based on WLA calculations)
[(c)] Measured load minus current potential point source contributions

5.6 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 B 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 5.13 (Pollutant Source Summary) identifies and quantifies potential sources of nonpoint source impairments along the reach as determined by field reconnaissance and assessment.

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

Among the potential sources of bacteria are poorly maintained or improperly installed (or missing) septic tanks, livestock grazing of valley pastures and riparian areas, upland livestock grazing, and wildlife (such as geese, which are numerous in some areas). Very high fecal coliform concentrations have been measured in water sampled from ephemeral drainages flowing south to the San Juan River west of the La Plata River (such as Shumway Arroyo), which drain a sparsely vegetated area with little permanent settlement and some livestock grazing (SJWG 2005). The September 2004 SJWG sampling effort demonstrated that ephemeral flow from sparsely populated watersheds can increase bacteria levels in the San Juan River. The effect of Cañon Largo was very dramatic, and Kutz Canyon also seemed to increase *E. coli* levels in the San Juan as well. Other tributaries and inflows had relatively low levels of *E. coli* (NMED/SWQB 2004d). The area between Blanco and Bloomfield is sparsely populated relative to other parts of the San Juan River valley, but livestock grazing of irrigated pasture and riparian areas does occur. The bacteria loading from Cañon Largo and other ephemeral drainages probably originate almost entirely from a combination of livestock and wildlife transported downstream during runoff events. Directly on the La Plata River between La Plata and the state line, a livestock feeding and holding area exists which, though small enough to not be recognized as a concentrated animal feeding operation requiring a discharge permit, probably contributes significant bacteria loading to the La Plata River (SJWG 2005) (Photo 5.1).

Between the bridge on the Bollack Ranch and the Bisti Bridge, where relatively high loading also is evident, lie several potential sources of bacteria including portions of Farmington that are not connected to municipal sewer lines, urban runoff, irrigated pasture, and wildlife (especially geese). These potential sources are also found between the Bisti and Fruitland Bridges, which

also bracket the communities of Kirtland and most of Fruitland, where the majority of households utilize septic tanks (SJWG 2005).

Photo 5.1 Livestock feeding/holding area on the La Plata River north of La Plata, NM

In order to determine exact sources and relative contributions, further study is needed. SWQB and the San Juan Watershed Group have been discussing the development of a Bacterial Source Tracking (BST) study to identify all sources of bacteria loading to help develop the most efficient implementation plan to address the impairment.

5.7 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 these bacteria TMDLs, the margin of safety was developed using a combination of conservative assumptions and explicit recognition of potential errors in flow calculations. Therefore, this margin of safety is the sum of the following two elements:

- *Conservative Assumptions*

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

  A more conservative limit of the geometric mean value, rather than the current and proposed standards which allow for higher concentrations in individual grab samples, was to calculate loading values.

- *Errors in calculating flow*

  4Q3s low flow values were determined based on USGS gaging data. There is inherent error in all flow measurements. A conservative MOS for this element is therefore 5 percent.

5.8 Consideration of Seasonal Variability

During the 2002 water quality survey, bacteria exceedences occurred during both high and low flow events. Based on this data, there is no single critical condition for bacteria. 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. Because of the uncertainty involved, there will be no seasonal allocations for fecal coliform in these TMDLs.

5.9 Future Growth

According to the calculations, the overwhelming source of bacteria loading is from nonpoint sources. Estimates of future growth are not anticipated to lead to a significant increase in bacteria concentrations that cannot be controlled with BMP implementation in this watershed.