WASHINGTON STATE
DEPARTMENT OF
ECOLOGY

North Fork Palouse River Fecal Coliform Bacteria Total Maximum Daily Load Recommendations

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DEPARTMENT OF
ECOLOGY

North Fork Palouse River Fecal Coliform Bacteria Total Maximum Daily Load Recommendations

by
Anise Ahmed

Environmental Assessment Program
Olympia, Washington 98504-7710

May 2004

Waterbody Numbers:
North Fork Palouse River, NX00WG (Old WA-34-1030)
Silver Creek, VW12BW (Old WA-34-1032)
Cedar Creek, VB90TS
Clear Creek, RZ29MS
Duffield Creek, HL69VD

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Abstract

The lower 34.3-mile reach of the North Fork Palouse River within Washington State (Idaho border to Colfax) contains a segment near the city of Palouse that is on the federal Clean Water Act 303(d) list for fecal coliform bacteria. However, fecal coliform concentrations in excess of the water quality criteria have been documented in recent years throughout this reach.

This report provides a comprehensive evaluation of fecal coliform bacteria data for the North Fork Palouse River and its tributaries. Target reductions for mainstem segments, as well as mouths of tributaries, are established to bring bacterial concentrations down to within water quality standards. The target reductions are based on the "statistical roll-back method." A monitoring strategy is proposed to evaluate the effectiveness of the total maximum daily load implementation measures.

Acknowledgements

The author of this report would like to thank the following people for their contribution to this study:

- John Pearson, local citizen, for review and comments on the report.
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Introduction

The North Fork Palouse River has been placed on Washington State's 303(d) list (1996, 1998, and proposed 2002) of impaired waterbodies for not meeting the water quality standard for fecal coliform bacteria. Thus, under the federal Clean Water Act of 1972, a cleanup plan must be developed and implemented to address these impairments and bring the waterbody segments into compliance with the standard. This report is a "total maximum daily load" (TMDL) technical document that contains the allowable loads of fecal coliform bacteria to ensure that the standard is met in all segments of the NF Palouse River system at all times and locations under a reasonable worst-case scenario.

The sources of fecal coliform bacteria in the NF Palouse River watershed are both point and nonpoint in nature. Two identified point sources in the watershed are the Palouse and Garfield municipal wastewater treatment plants. Potential nonpoint sources include failing on-site sewage treatment systems, livestock operations, hobby farms, stormwater, and wildlife. Nonpoint source fecal coliform reductions are achieved primarily through "best management practices" (BMPs).

Target pollutant reductions may be either in terms of concentration, or load, or both. For the NF Palouse River watershed, the TMDL is expressed in terms of fecal coliform concentration as allowed under federal regulations [40 CFR 130.2(I)] as "other appropriate measures." The concentration measure is appropriate since the water quality standard can be directly compared to measured fecal coliform in the receiving water under all flow scenarios. The "target reductions" show the reduction necessary in fecal coliform concentrations to achieve the water quality standard. Therefore the use of a flow rate to calculate the "daily loads" is unnecessary. However, loads at the mouths of tributaries and segments of the mainstem have been established to provide a relative comparison of contributions of fecal coliform from the different tributaries. Where applicable, seasonal or annual targets have been established. Segments of the mainstem and its tributaries where BMP implementation and monitoring needs to take place have been identified.

Background

The North Fork Palouse River is a 54-mile long stream with headwaters in the Hoodoo Mountains of Idaho in Latah County, ending in the city of Colfax (Whitman County) in Washington, where it merges with the South Fork Palouse River (Figure 1). The NF Palouse River drains approximately 495 square miles, of which 127 square miles are in Washington. The NF Palouse River is part of the larger Palouse River basin that drains approximately 3281 square miles and discharges its waters into the Snake River near the city of Hooper in Washington. The Snake River itself drains into the Columbia River as it travels to the Pacific Ocean.

The segment of the Palouse River in Washington between the Idaho state line and Colfax is locally referred to as the North Fork Palouse River. From this point on, all references to NF Palouse River will mean the 34.3-mile segment between the Idaho/Washington state line and the city of Colfax.

The 127 square mile NF Palouse River drainage area in Washington consists of nearly 96% agricultural land; approximately 2% forested land, cliff areas, and rock outcrops; less than 2% urban areas; less than 1% riparian/wetland areas; and less than 1% perennial and intermittent streams. The principal land use is dryland agriculture, with predominant crops being winter and spring wheat, spring barley, peas, and lentils. The lowlands (areas adjacent to the stream and side tributaries) are primarily used as pasture (Resource Planning Unlimited, Inc, 2002).

The NF Palouse River contributes about 83% of the mean annual flow of the Palouse River at Colfax, below the confluence with the south fork.

Major tributaries of the NF Palouse River are Duffield, Cedar, Silver, and Clear creeks (Figure 2). All the creeks except Clear Creek originate in Idaho.

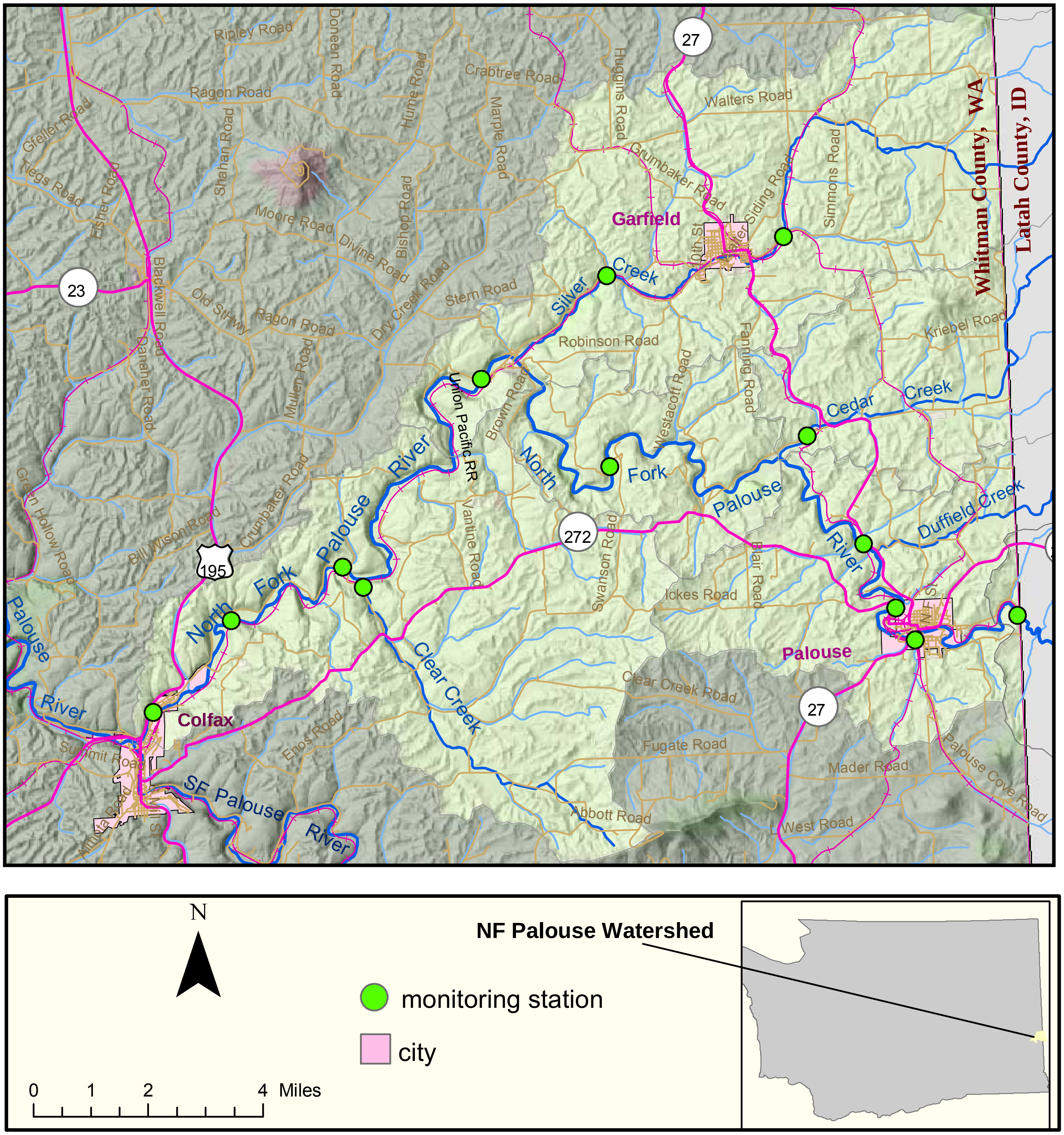

Figure 1. The North Fork Palouse River Watershed.

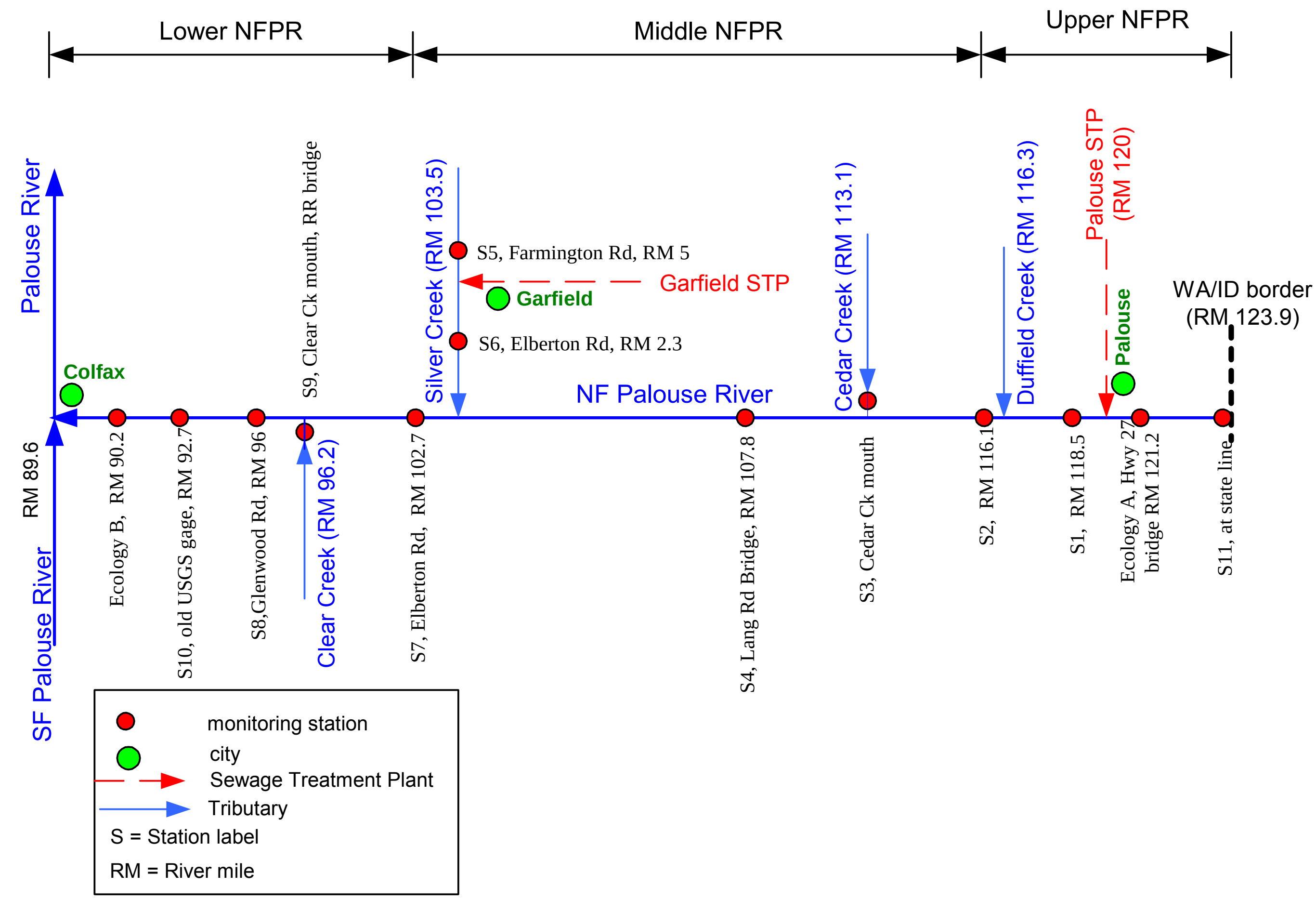

Figure 2. The North Fork Palouse River, tributaries, point sources, and monitoring stations.

Applicable Criteria

The Water Quality Standards for Washington (WAC 173-201A) designate the North Fork Palouse River and its tributaries as Class A (excellent) waters; the fecal coliform standard calls for a geometric mean of 100 colonies /100 mL with no more than 10% of samples greater than 200 colonies/100 mL. The characteristic beneficial uses designated for protection under this classification are: water supply; stock watering; fish migration; fish and shellfish rearing, spawning and harvesting; wildlife habitat; primary contact recreation; and commerce and navigation.

The new water quality standards rule (WAC 173-201A), as adopted on July 1, 2003 (not yet approved by EPA), designates the 34.3 miles of the NF Palouse River from Colfax (RM 89.6) to the Idaho border (RM 123.9) as having a primary contact recreational use (e.g., swimming and wading in the water) with the same fecal coliform standard as the old rule.

The coliform bacteria group consists of several genera of bacteria belonging to the family *enterobacteriaceae*. These mostly harmless bacteria are passed through the fecal excrement of humans, livestock, wildlife, and domesticated animals. A specific subgroup of this collection is the fecal coliform bacteria, the most common member being *Escherichia coli.*

The presence of fecal coliform bacteria in aquatic environments indicates that the water has been contaminated with the fecal material of man or other animals. Fecal coliform bacteria can enter rivers through direct discharge of waste from mammals and birds, indirectly from agricultural and storm runoff, and from untreated human sewage. Residential or commercial on-site sewage treatment system failures may allow untreated human wastes to flow into drainage ditches and nearby waters. Agricultural practices such as animal wastes washing into nearby streams during the rainy season, spreading manure and fertilizer on fields during rainy periods, and allowing unrestricted livestock access to streams can all contribute to fecal coliform contamination.

While all fecal coliform bacteria do not directly cause disease, high quantities of fecal coliform bacteria suggest the presence of disease-causing agents. The presence of fecal contamination is an indicator that a potential health risk exists for individuals exposed to this water. Some waterborne pathogenic diseases include ear infections, dysentery, typhoid fever, viral and bacterial gastroenteritis, and hepatitis A.

Bacteria are not conservative pollutants but rather die in the environment. Observed data at a monitoring station are equal to the bacterial concentrations at an upstream station, any addition of bacteria from point and nonpoint sources within the reach between stations, and any bacterial die-off during the time of travel between the stations. This document does not model the behavior of bacteria (i.e., die-off) as it travels along the stream reach but uses observed concentrations at a given station to establish reduction targets to meet water quality standards.

Factors that impact the survival of pathogens in streams include temperature, ammonia, pH, nutrients, ultra-violet (UV) radiation, and predation. Elevated temperatures can destroy viruses (Scheuerman et al., 1983), bacteria (Farrah and Bitton, 1983), and parasites (Kiff and Jones, 1984). Ward and Ashley (1977) showed that ammonia can be destructive to viruses. Watson (1980) noted that most enteric bacteria survive pH values between 5 and 8 and that outside this range they die rapidly. Under limiting substrate conditions, microbes compete for the nutrient that is limiting, and microbial growth rates decrease (Ahmed, 1990). UV radiation from sunlight is effective in the destruction of microorganisms that are near the surface of the water (Al-Azawi, 1986). However, the effectiveness of UV radiation reduces with increasing depth and turbidity. Protozoa are thought to be predators of coliform bacteria (Tate, 1978).

There is some evidence of fecal coliform regrowth in streams, particularly from chlorinated discharges after the chlorine has dissipated in the stream and/or when the discharge is dechlorinated prior to discharge (Rifai and Jensen, 2002). There is also evidence of bacteria settling to bottom of streams and becoming part of the sediment during low-flow conditions and later re-suspending when flows become higher (Rifai and Jensen, 2002). However, in relative terms, bacterial increase due to resuspension was more significant compared to regrowth.

Hay et al. (1990) noted that fecal coliform were more resistant to thermal inactivation than most enteric bacterial pathogens, and the absence of this group generally indicated the destruction of most enteric bacterial pathogens.

Water Quality and Resource Impairments

The North Fork Palouse River is listed under section 303(d) of the federal Clean Water Act. Table 1 shows the segment of the NF Palouse River included in the 303(d) list for 1996 and 1998 and that proposed for 2002/2004. These listings were based on standards for fecal coliform bacteria in the old WAC 173-201A and will not change with the new rules. This is because there is no numerical change in the standard as it applies to the listed segments.

Table 1. Stream segment in the North Fork Palouse River watershed on the 1996, 1998, and the proposed 2002/2004 303(d) list for fecal coliform bacteria.

Stream	Waterbody ID (old)	Waterbody ID (new)	Township, Range, Section	Segment	Proposed 2002	1998	1996
North Fork Palouse River	WA-34-1030	NXOOWG	16N, 46E, 06	2.62 mile segment near the town of Palouse Ecology Station A (RM 121.2)	Yes	Yes	Yes

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Historical Data, Seasonal Variation, and Critical Conditions in the NF Palouse River

Long-term fecal coliform and flow data are available at Ecology's Station A (RM 121.2) above the town of Palouse. Figure 3 shows the long-term (1992-2003) monthly fecal coliform concentrations, the water quality standards, and the mean monthly flows at this location. Individual data points exceeded the water quality standards during both high and low flows. The lowest average monthly flow was 11 cfs in September, and the highest was 759 cfs in March.

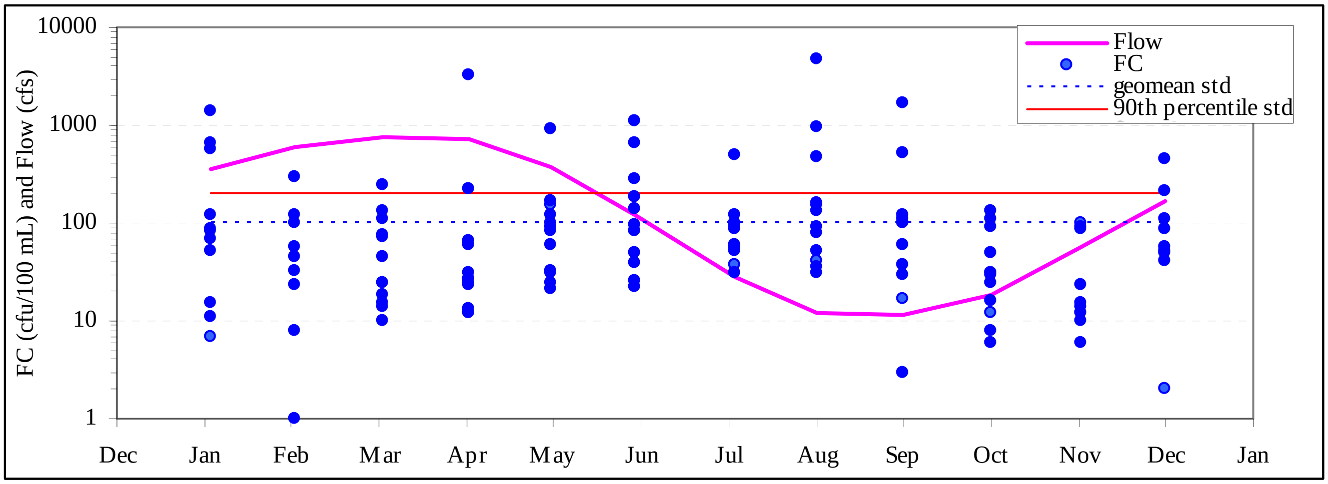

Figure 3. Historical fecal coliform concentrations at RM 121.2 (Ecology Station A), 1992-2003.

In addition to data collected by Ecology (Figure 3), the Palouse Conservation District collected fecal coliform and flow data at 11 stations in the NF Palouse River and its tributaries in 2001-2003. Figure 4 shows the fecal coliform concentrations at these stations, with the highest concentrations observed in Clear Creek.

Seasonal variation in the concentration of fecal coliform bacteria has been considered in this TMDL by applying the water quality criteria to observed fecal coliform concentrations at monthly or seasonal intervals, depending on the availability of fecal coliform data.

The critical ambient conditions determined to be appropriate for point source evaluation is the lowest 7-day average flow with a recurrence interval of 1 in 10 years (7Q10 flow). Dilution factors used in the existing National Pollutant Discharge Elimination System (NPDES) permits for point sources have been based on the 7Q10 stream flows. The critical conditions for nonpoint sources may occur during high-rainfall periods, particularly during the start of a rainfall event when bacteria are "flushed" from surface soils into the streams. The critical condition can also be during dry weather, resulting from groundwater seepage contaminated by failing on-site sewage treatment systems and/or stream access by livestock and/or wildlife.

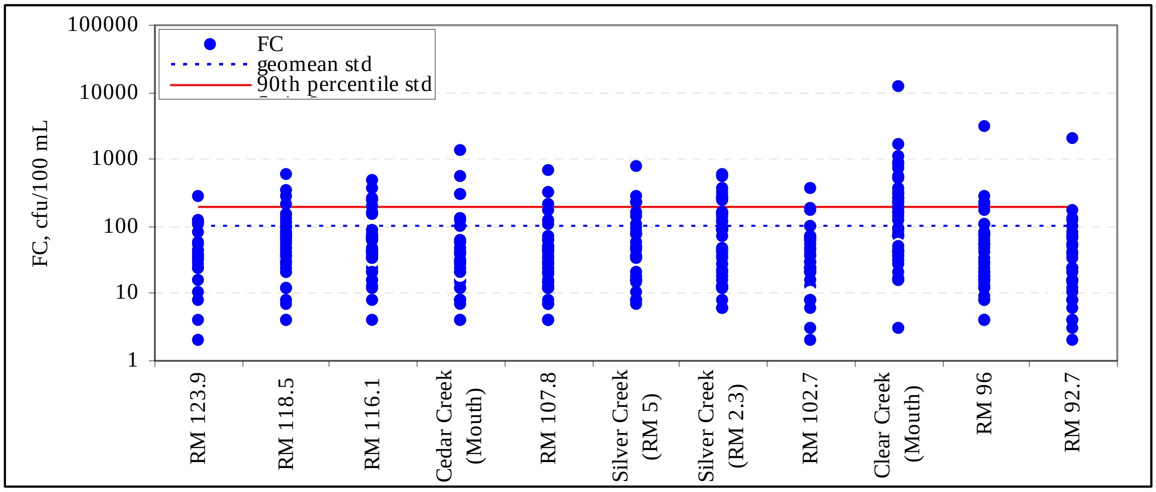

Figure 4. Fecal coliform concentrations at stations monitored by the Palouse Conservation District, 2001-2003.

Technical Analysis

The technical analysis is based on analysis of historical and recent field data. Historical data were obtained from Ecology's Environmental Information Management database. Recent data were obtained from the Palouse Conservation District.

Excel® spreadsheets were used to evaluate the data, including mass balances, statistical analyses, and plots.

The statistical roll-back method (Ott, 1995) was employed to establish fecal coliform reduction targets for the various segments of the mainstem and tributaries. This method has been employed in Washington TMDLs by Roberts (2003), Coots (1994), Joy (2000), Pelletier and Seiders (2000), and Ahmed (2004).

The roll-back method assumes that the distribution of fecal coliform concentrations follows a log-normal distribution. The cumulative probability plot of the observed data gives an estimate of the geometric mean and 90th percentile which can then be compared to the fecal coliform bacteria standards. The roll-back procedure is as follows:

a) When data are plotted on a log-scale against a linear cumulative probability function, a straight line signifies a log-normal distribution of the data.

b) The geometric mean of the data has a cumulative probability of 0.5

c) The 90th percentile of the data has a cumulative probability of 0.9. This is equivalent to the "no more than 10% samples exceeding …." criterion in the fecal coliform standard (WAC 173-201A).

d) Alternately, the 90th percentile can also be estimated by using the following statistical equation:

$$90^{th} \text{ percentile} = 10^{(\mu_{log} + 1.28 * \sigma_{log})}$$

where: μ_{log} = mean of the log transformed data

σ_{log} = standard deviation of the log transformed data

e) The target percent reduction required is the highest of the following two comparisons.

either: $$\left[\frac{observed\ 90th\ percentile - 200\ cfu/100mL}{observed\ 90th\ percentile}\right] x100$$

or: $$\left[\frac{observed\ geometric\ mean - 100\ cfu/100mL}{observed\ geometric\ mean}\right] x100$$

f) As “best management practices” for nonpoint sources and treatment technologies for point sources are implemented, and the target reductions are achieved, a new but similar distribution (same coefficient of variation) of the data is assumed to be realized with the previous mean and standard deviation reduced by the target percent reductions.

g) If the 90^{th} percentile is limiting, then the goal would be to meet a 90th-percentile fecal coliform of 200 cfu/100 mL, and no goals would be set for the geometric mean since, with the implementation of the target reductions, the already low geometric mean (<100 cfu/100mL) would only get better. Similarly, if the geometric mean is limiting, the goal would be to achieve a geometric mean of 100 cfu/100mL, with no goal for the already low (<200 cfu/100mL) 90^{th} percentile.

The procedures and assumptions discussed above were used to evaluate fecal coliform data in the respective segments of the mainstem NF Palouse River and tributaries to establish target bacterial reductions necessary to meet water quality standards.

The mainstem NF Palouse River addressed in this document extends from the mouth of the NF Palouse River (RM 89.6) to the ID/WA border (RM 123.9). Several stations have been monitored along this reach for fecal coliform bacteria by the Palouse Conservation District and the Department of Ecology. Data from these stations are evaluated, discussed, and target reductions developed in the following sections.

In this TMDL it is assumed that if the individual tributaries and segments of the mainstem NF Palouse River were to meet the water quality standard, the NF Palouse River as a whole will meet the standard prior to its confluence with the South Fork Palouse River.

For convenience, the NF Palouse River has been divided into three segments (see Figure 2):

1. Upper Mainstem Segment – ID/WA Border to Duffield Creek (RM 123.9 - 116.1)
2. Middle Mainstem Segment – Duffield Creek to Silver Creek (RM 116.1 - 102.7)
3. Lower Mainstem Segment – Silver Creek to mouth of NF Palouse River (RM 102.7 - 89.6)

Fecal coliform reduction targets for each of these segments and associated tributaries are discussed in the next section of this report. Point sources are discussed later in the report.

1. Upper Mainstem Segment

This segment extends from the Washington/Idaho border (RM 123.9) to below Duffield Creek (RM 116.1). There are four mainstem monitoring stations located in this segment (Figure 5). The City of Palouse Wastewater Treatment Plant (WWTP) also discharges to the NF Palouse River in this reach. The WWTP is discussed later in this report.

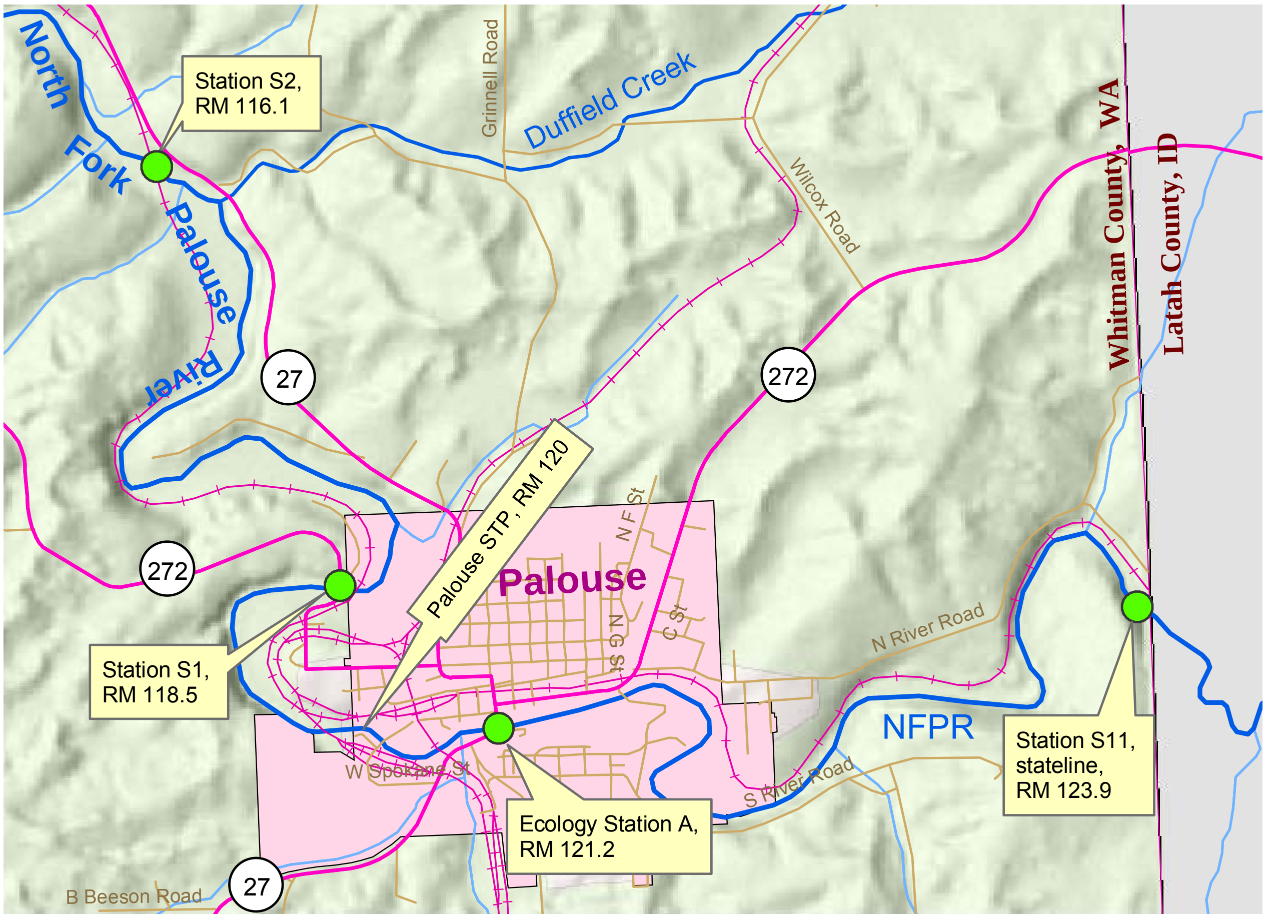

Figure 5. Locations of sampling stations and the Palouse Wastewater Treatment Plant in the Upper NF Palouse River segment.

Washington/Idaho state line (RM 123.9)

The Palouse Conservation District measured fecal coliform concentrations at Station 11 (just west of the state line) on a monthly basis between August 2002 and September 2003. This station was added in the second year of the study period. No flows were measured. However, due to its close proximity to Ecology Station A (RM 121.2), flows were assumed to be similar for the two stations. Figure 6 shows the fecal coliform concentrations and flows during this period. Figure 7 shows that both the geometric mean and the 90th-percentile of observed fecal coliform concentrations were within the water quality standards. Therefore no bacterial reductions are required at this station. Seasonal variation could not be evaluated due to limited data. This station (RM 123.9) is being recommended for further monitoring.

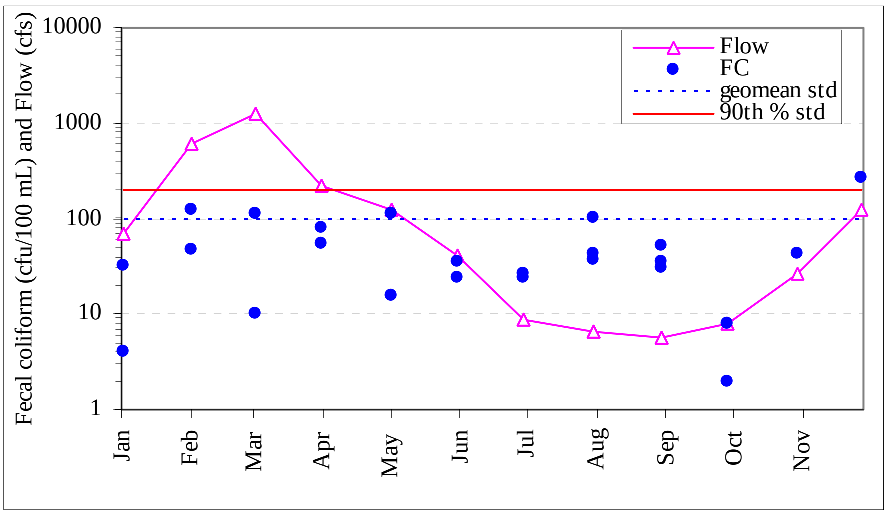

Figure 6. Fecal coliform concentrations in the mainstem NF Palouse River near the WA/ID border (RM 123.9), 2002-2003.

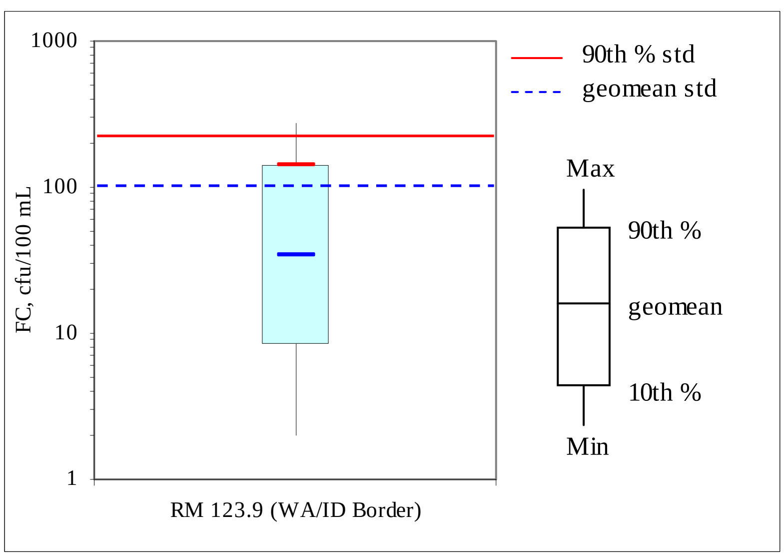

Figure 7. Fecal coliform distribution in the mainstem NF Palouse River near the WA/ID border (RM 123.9), 1992-2003.

Above City of Palouse (RM 121.2)

This station is located above the city of Palouse at RM 121.2. Ecology has monitored this station on a monthly basis since 1992. Individual data points exceeded the water quality standards throughout the monitoring period and at all flows (Figure 8). On a year-to-year basis, the annual 90th percentile concentrations showed consistently high fecal coliform concentrations (Figure 9). In order to establish a critical month with highest fecal coliform concentrations, long-term monthly geometric means and 90th percentiles were estimated as shown in Figure 10. The long-term monthly geometric mean and 90th-percentile fecal coliform concentrations exceed standards in both winter and summer seasons. The critical month with the highest exceedance of both the 90th percentile and geometric mean criteria is August. The target reduction is therefore based on long-term August concentrations as shown in Table 2.

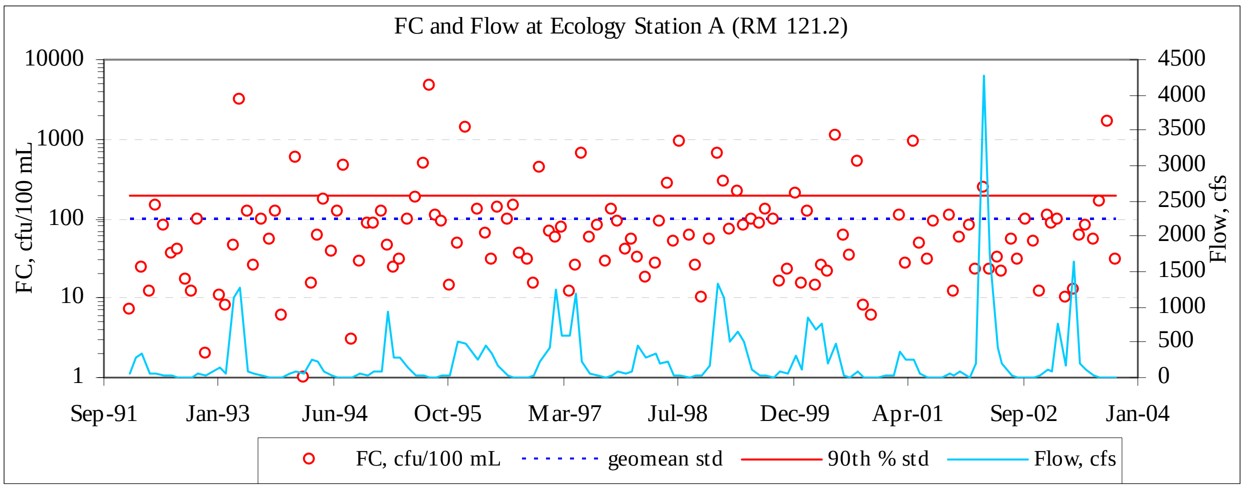

Figure 8. Fecal coliform concentrations and flow in the mainstem NF Palouse River at RM 121.2 (Ecology Station A), 1992-2003.

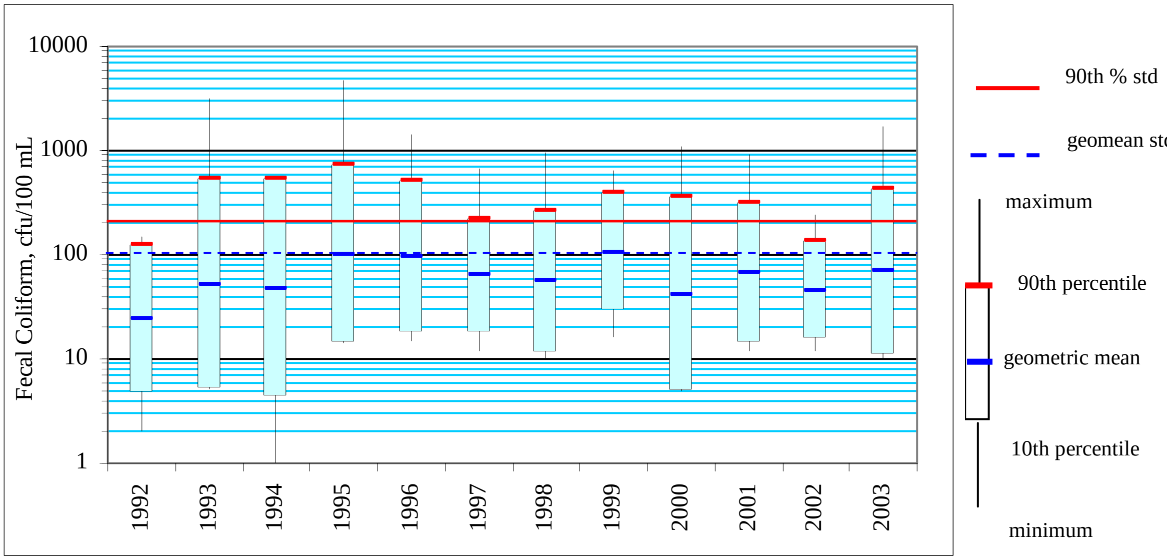

Figure 9. Annual distribution of fecal coliform concentrations in the mainstem NF Palouse River at RM 121.2 (Ecology Station A), 1992-2003.

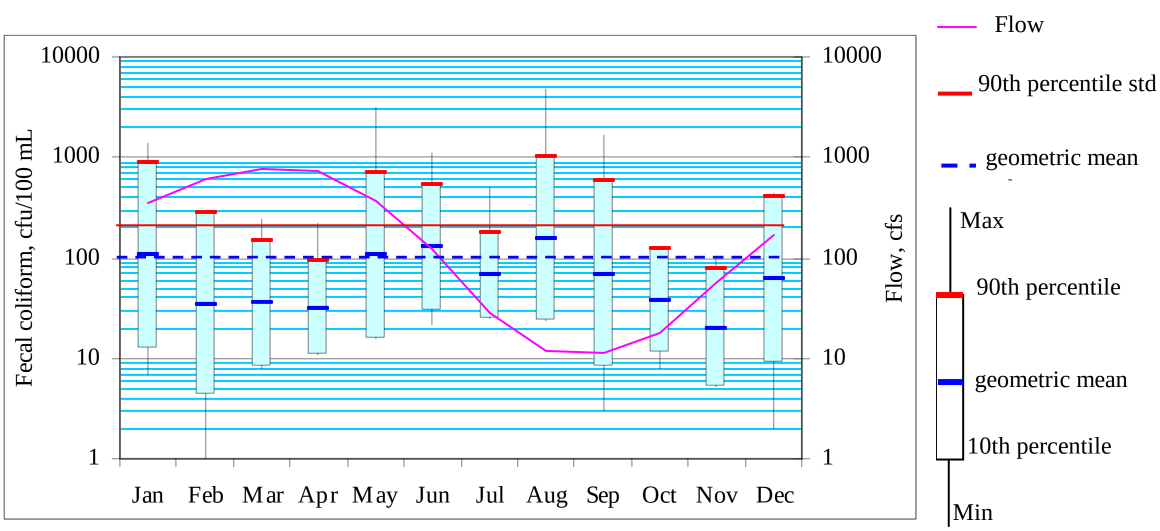

Figure 10. Long-term monthly fecal coliform distribution in the mainstem NF Palouse River at RM 121.2 (Ecology Station A), 1992-2003.

Table 2. Target fecal coliform reductions in the mainstem NF Palouse River at RM 121.2 (Ecology Station A), 1992-1993.

Location	Period	Number of samples	Geometric mean (cfu/100 mL)	90th percentile (cfu/100 mL)	Limiting Basis for reduction	Target reduction (%)
Ecology Station A (RM 121.2)	August	12	156	1022	90th percentile	80

With an average flow of 12 cfs in August and the 90th percentile concentration of 1022 cfu/100 mL, the existing fecal coliform load at RM 121.2 is 3 x 10^{11} cfu/day. The fecal coliform load following achievement of the water quality standard (i.e., 200 cfu/100 mL after 80% reduction) is 6 x 10^{10} cfu/day.

As indicated earlier, exceedance of the 90th-percentile fecal coliform standard has been observed in both the winter and summer seasons (Figure 10) at RM 121.2. Flow regimes and associated fecal coliform sources can be very different during these two periods. Both these periods should therefore be monitored. The station at this location is monitored monthly by Ecology on a long-term basis. It is recommended that monitoring continue at this station as best management practices are implemented.

NF Palouse River near Duffield Creek (RM 118.5 and 116.1)

Duffield Creek (mouth at mainstem RM 116.3) drains approximately 5,400 acres of primarily crop land with 64% of the land in Latah County, Idaho, and the rest in Whitman County, Washington. The creek consists of nine miles of intermittent streams, tributaries, and water ways. Ninety percent of the land is agricultural, 9% is used for grazing, and 1% is urban area (Resource Planning Unlimited, Inc, 2002).

Although direct measurements for fecal coliform bacteria were not made at the mouth of the creek, the Palouse Conservation District measured both flow and fecal coliform concentrations in the mainstem NF Palouse River above (RM 118.5, Station 1) and below (RM 116.1, Station 2) Duffield Creek between June 2001 through September 2003. Figures 11 and 12 show the fecal coliform concentrations and flows for these two stations. Since sufficient data were not available to evaluate bacterial concentrations on a monthly basis, a running 4-month geometric mean and 90^{th} percentile fecal coliform concentrations were estimated with a minimum of ten data points in each running 4-month period. This is shown in Figure 13. The geometric means of fecal coliform concentrations were within the water quality standards for all the running 4-month periods. The 90^{th} percentile concentrations, however, exceeded the standards in several of these periods between December and April.

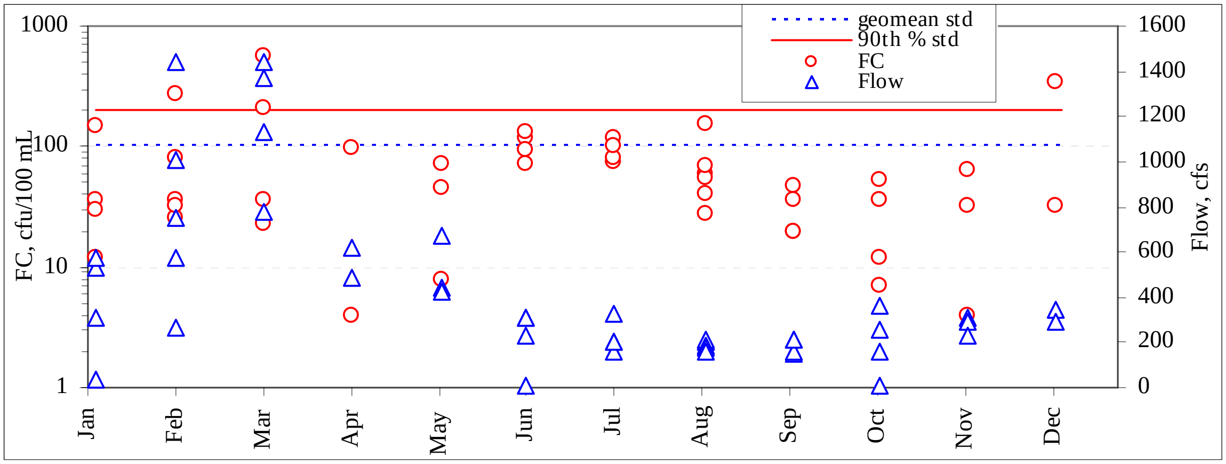

Figure 11. Fecal coliform concentrations at RM 118.5 (Station 1), 2001-2003.

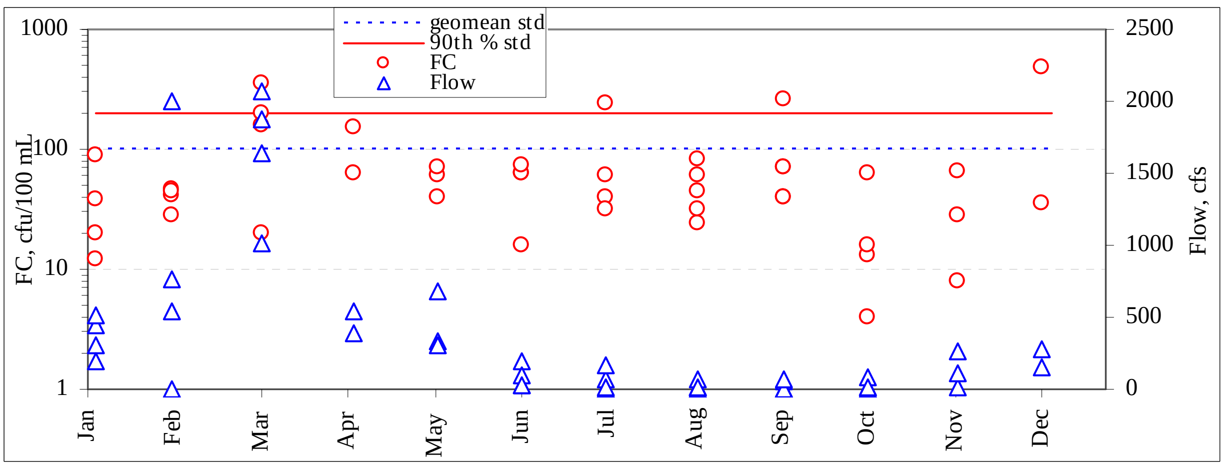

Figure 12. Fecal coliform concentrations at RM 116.1 (Station 2), 2001-2003.

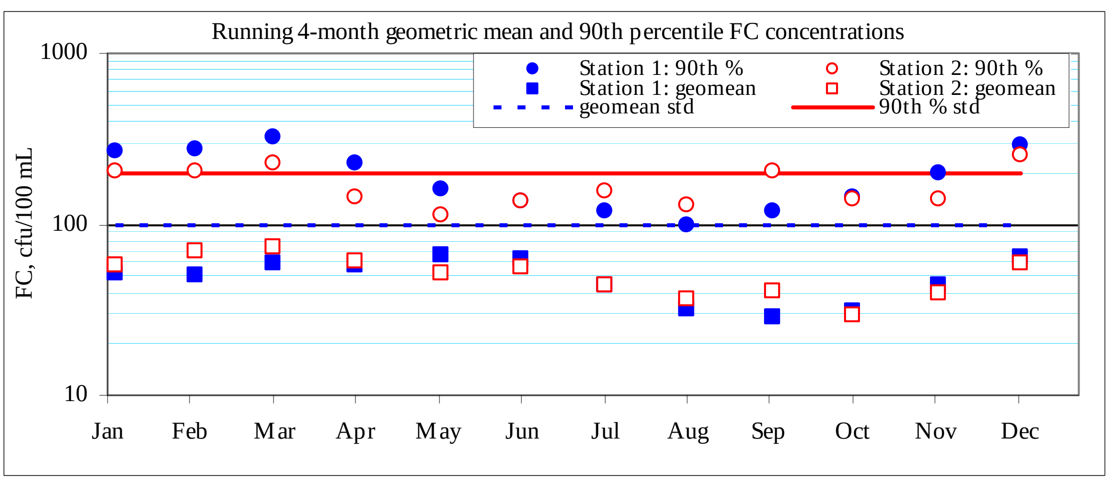

Figure 13. Fecal coliform concentrations in the mainstem NF Palouse River at RM 118.5 (Station 1) and RM 116.1 (Station 2), 2001-2003.

Table 3 shows the target reductions required for this reach based on the running 4-month critical periods shown in Figure 12. The period of December through March was chosen as the period with the highest running 4-month 90th percentile concentrations.

Table 3. Target fecal coliform reductions in the mainstem NF Palouse River (Stations 1 and 2), 2001-2003.

Location	Period	Number of samples	Geometric mean (cfu/100 mL)	90th percentile (cfu/100 mL)	Limiting basis for reduction	Target reduction (%)
Station 1 (RM 118.5)	Dec-Mar	15	64	286	90th percentile	30
Station 2 (RM 116.1)	Dec-Mar	14	60	252	90th percentile	21

To evaluate whether there is a significant difference between the concentrations of fecal coliform bacteria measured at Stations 1 and 2, a paired t-test was done. The probability that the difference in concentrations at the two stations was no different than zero was 86%, suggesting a likely insignificant addition from Duffield Creek.

Figure 14 shows that, compared to Station 1, the flow at Station 2 is relatively higher during high spring flows and lower during summer low flows. The relatively high spring flow at Station 2 is likely due to flow added by Duffield Creek. Duffield Creek is an intermittent stream with little or no flow in the summer/fall season but high flow in spring. The relatively low summer/fall flow at Station 2 is likely due to water withdrawals and/or water loss to groundwater.

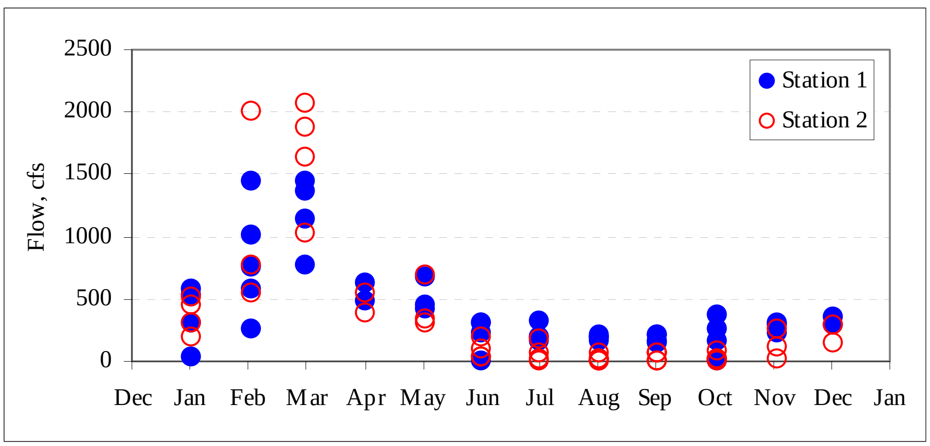

Figure 14. Flow pattern in the mainstem NF Palouse River at RM 118.5 (Station 1) and RM 116.1 (Station 2), 2001-2003.

The average flows during the Dec-Mar period at Stations 1 and 2 are 722 cfs and 906 cfs, respectively. Therefore the fecal coliform loads based on the existing 90th percentile concentrations (Table 3) are 5.1 x 10^{12} cfu/day and 5.6 x 10^{12} cfu/day, at Stations 1 and 2, respectively. The difference in the load (i.e., 0.5 x 10^{12} cfu/100 mL) is likely coming from

Duffield Creek. Whether this creates exceedance of the fecal coliform bacteria in Duffield Creek may be evaluated as follows:

- Average flow in Duffiled Creek (Dec-Mar) = 906 - 722 = 184 cfs
- The 90^{th} percentile fecal coliform concentration based on a loading of 0.5 x 10^{12} cfu/day = 111 cfu/100 mL

This indicates that Duffield Creek is likely meeting the water quality standard.

The fecal coliform loads following achievement of the 90th percentile water quality standard at Station 1 (i.e., 30% reduction) and Station 2 (21% reduction) are 3.5 x 10^{12} cfu/day and 4.4 x 10^{12} cfu/day, respectively.

2. Middle Mainstem Segment

This segment is below the city of Palouse and includes the tributaries, Cedar and Silver creeks. Two mainstem monitoring stations (one below Cedar Creek, and the other below Silver Creek) and three tributary stations (two on Silver Creek, one on Cedar Creek) are located in this segment (Figure 18). The City of Garfield Wastewater Treatment Plant (WWTP) discharges to Silver Creek between the two monitoring stations. The WWTP will be discussed later in the report.

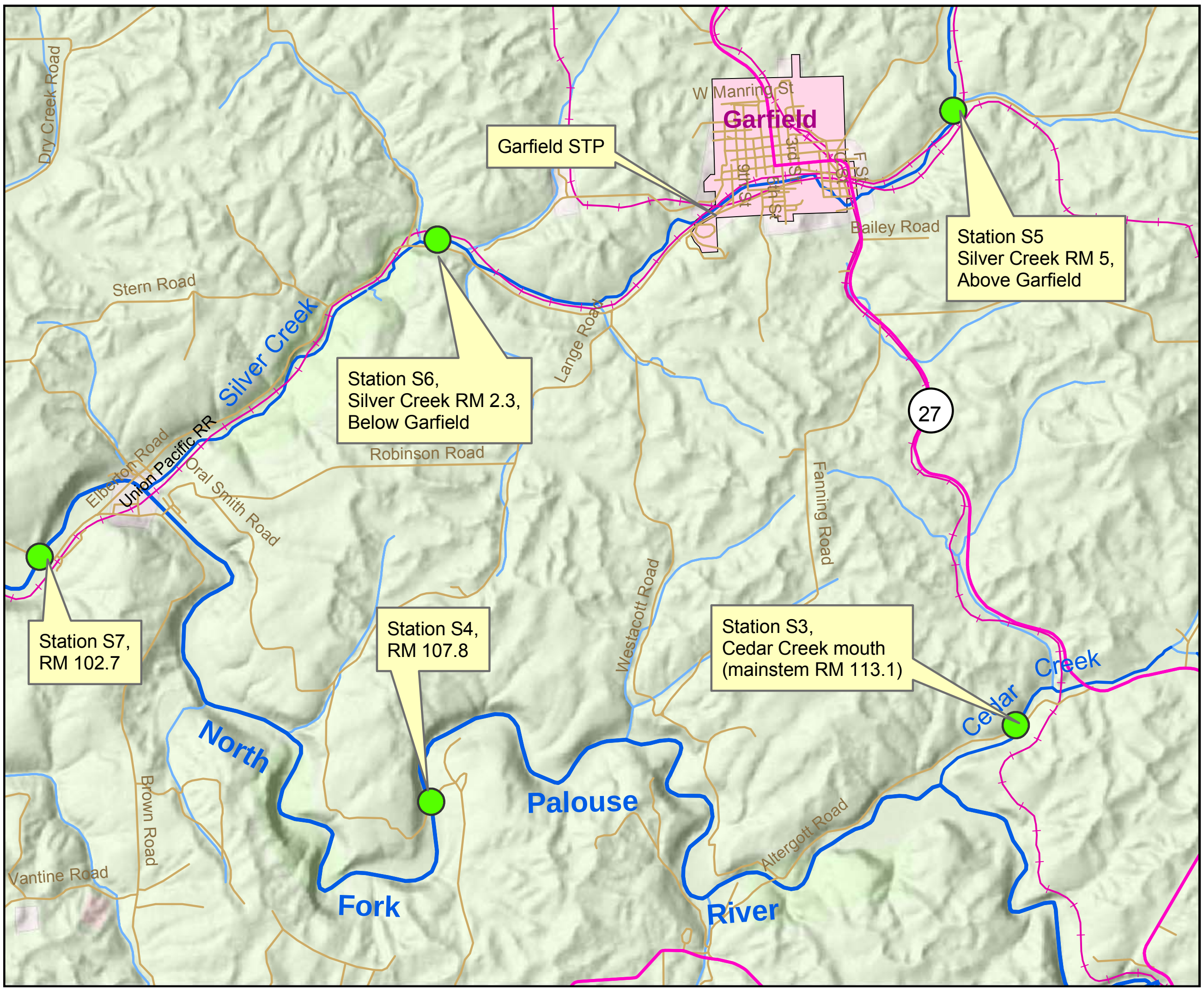

Figure 15. Locations of sampling stations and the Garfield Wastewater Treatment Plant in the Middle NF Palouse River segment.

Cedar Creek, mouth at NF Palouse River (RM 113.1)

Cedar Creek drains approximately 16,000 acres of primarily crop land. About 50% of the drainage area is in Latah County, Idaho. The other 50% of the drainage area is in Whitman County, Washington. The creek consists of 41 miles of intermittent stream, tributaries, and water ways. The Cedar Creek watershed is 85% agricultural land, with an additional 14% used for grazing, and 1% urban area (Resource Planning Unlimited, Inc, 2002). The mouth of Cedar Creek is located at NF Palouse RM 113.1.

The Palouse Conservation District measured both flow and fecal coliform concentrations near the mouth of Cedar Creek (Station 3) on a monthly basis between June 2001 and September 2003. Figure 16 shows the fecal coliform concentrations and flows during this period. Decreasing flows were associated with increased fecal coliform concentrations. High flows were observed during winter and spring while low flows were present in summer and fall. Almost all of the high fecal coliform concentrations occurred in summer and early fall with the highest concentrations observed in September.

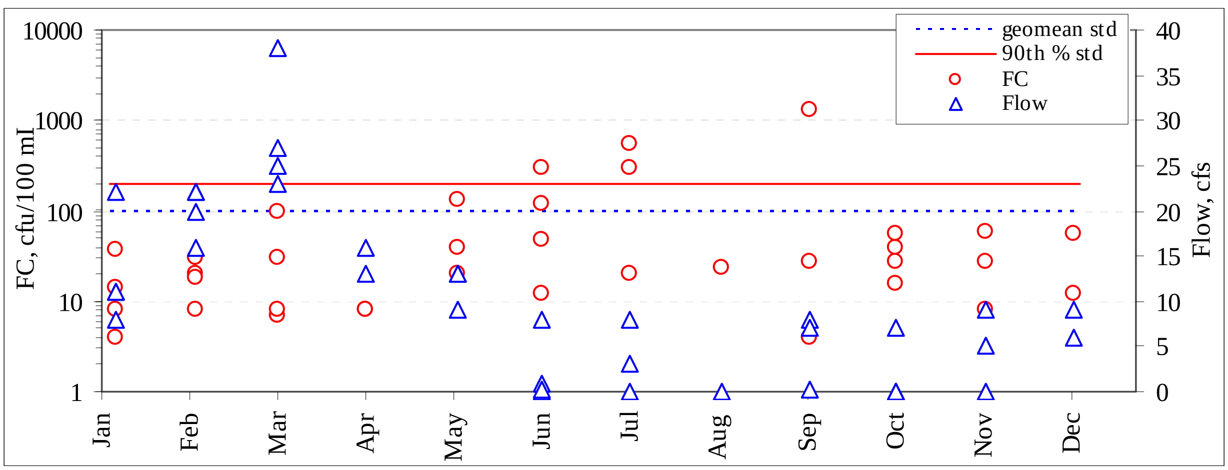

Figure 16. Fecal coliform concentrations and flows near the mouth of Cedar Creek at RM 113.1 (Station 3), 2001-2003.

Since sufficient data were not available to evaluate bacterial concentrations on a monthly basis, a running 4-month geometric mean and 90th percentile fecal coliform concentrations were estimated with a minimum of ten data points in each of the running 4-month periods. This is shown in Figure 17. The geometric mean of fecal coliform concentrations was within the water quality standards for all the running 4-month periods. The 90th percentile concentrations, however, exceeded the standards in several of these periods between April and September, with the highest cumulative concentrations observed in June through September.

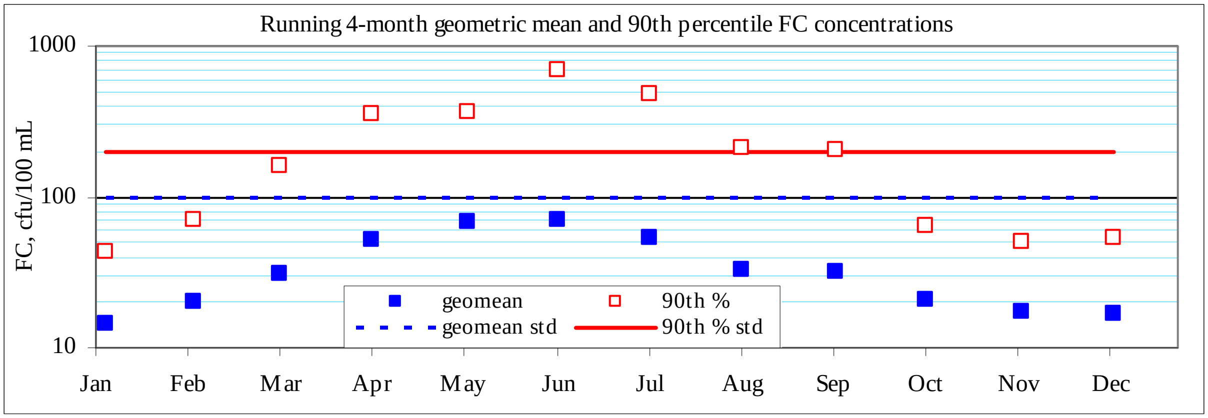

Figure 17. Fecal coliform concentrations near the mouth of Cedar Creek at RM 113.1 (Station 3), 2001-2003.

Table 4 shows the target reductions required for this reach based on the running 4-month critical periods shown in Figure 17. The period of June through September was the critical period with the highest running 4-month 90^{th} percentile concentration.

Table 4. Target fecal coliform reductions near the mouth of Cedar Creek at RM 113.1 (Station 3), 2001-2003.

Location	Period	Number of samples	Geometric mean (cfu/100 mL)	90^{th} percentile (cfu/100 mL)	Limiting basis for reduction	Target reduction (%)
Station 3 (RM 113.1)	June-Sept	11	71	703	90^{th} percentile	72

With an average flow of 3.9 cfs (June-Sept) and the 90th percentile concentration of 703 cfu/ 100 mL, the existing fecal coliform load at the mouth of Clear Creek is 6.8 x 10^{10} cfu/day. The fecal coliform load following achievement of the water quality standard (i.e., 62% reduction) is 1.9 x 10^{10} cfu/day.

Lang Road Bridge (RM 107.8)

This station is located between Cedar and Silver creeks. The Palouse Conservation District measured both flow and fecal coliform concentrations at Station 4 (RM 107.8) on a monthly basis from June 2001 through September 2003. Figure 18 shows the fecal coliform concentrations and flows during this period. High flows were observed during winter and spring while low flows were present in summer and fall.

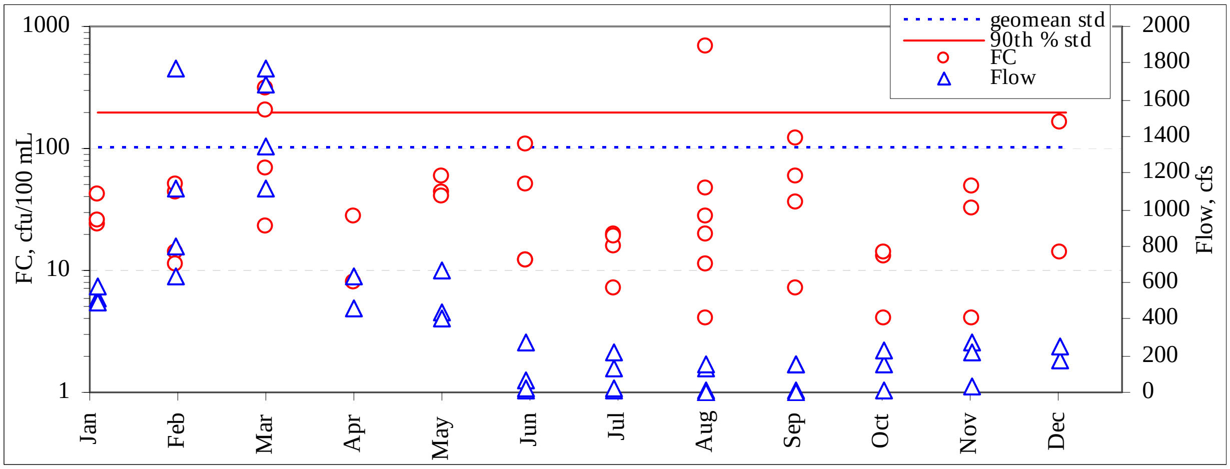

Figure 18. Fecal coliform concentrations and flows in the mainstem NF Palouse River at RM 107.8 (Station 4), 2001-2003.

Since sufficient data were not available to evaluate bacterial concentrations on a monthly basis, a running 4-month geometric mean and 90th percentile fecal coliform concentrations were estimated with a minimum of ten data points in each of the running 4-month periods. This is shown in Figure 19. Both the geometric mean and 90th percentile fecal coliform concentrations were within the water quality standards for all the running 4-month periods. Therefore, no target reductions will be required at this location.

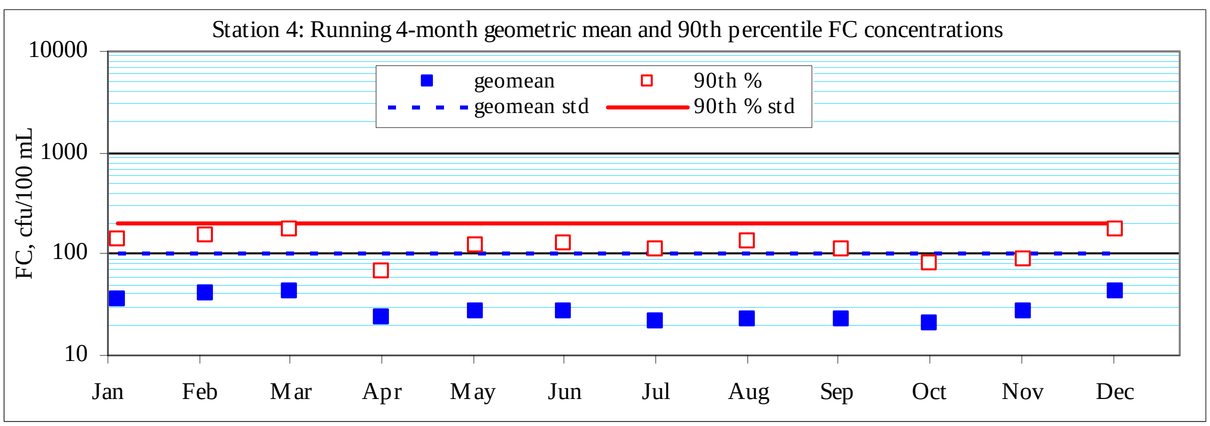

Figure 19. Fecal coliform concentrations in the mainstem NF Palouse River at RM 107.8 (Station 4), 2001-2003.

Silver Creek, mouth at NF Palouse River (RM 103.5)

Silver Creek drains approximately 28,500 acres of primarily crop land. About 17% of the drainage area is in Latah County, Idaho. The rest of the drainage area is in Whitman County, Washington. The creek consists of three miles of perennial stream and an additional 78 miles of intermittent stream, tributaries, and water ways. The Silver Creek watershed is 77% agricultural land, with an additional 16% used for grazing, 2% urban area, and 5% non-intensive use land (Resource Planning Unlimited, Inc, 2002). The mouth of Silver Creek is located at RM 103.5.

The Palouse Conservation District measured both flow and fecal coliform concentrations at two locations (Silver Creek RM 5 and RM 2.3) on a monthly basis from June 2001 through September 2003. Station 5 is above the Garfield Wastewater Treatment Plant, and Station 6 is below. Figures 20 and 21 show the fecal coliform concentrations and flows for these two stations. Elevated concentrations were observed during both low-flow and high-flow conditions.

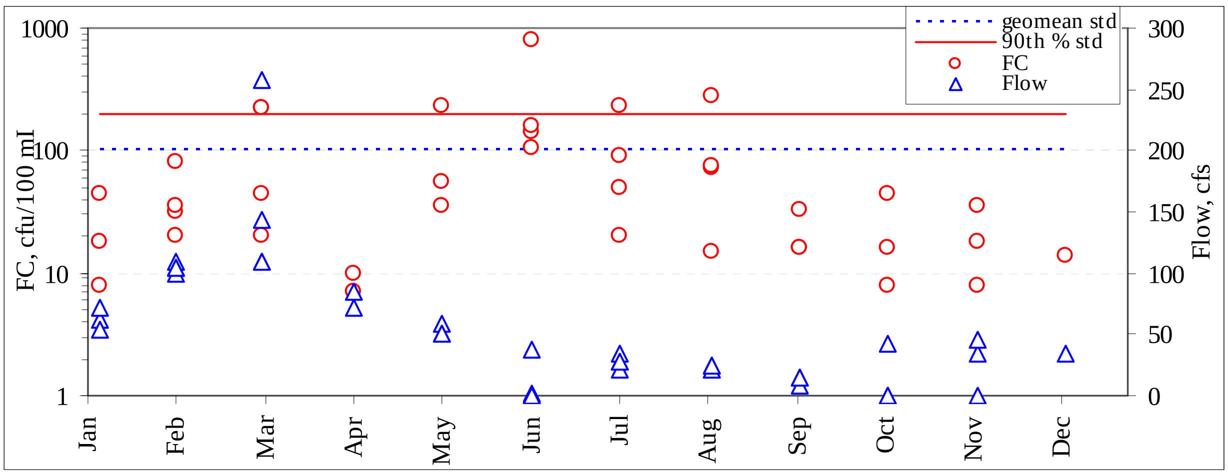

Figure 20. Fecal coliform concentrations and flows in Silver Creek at RM 5 (Station 5), 2001-2003.

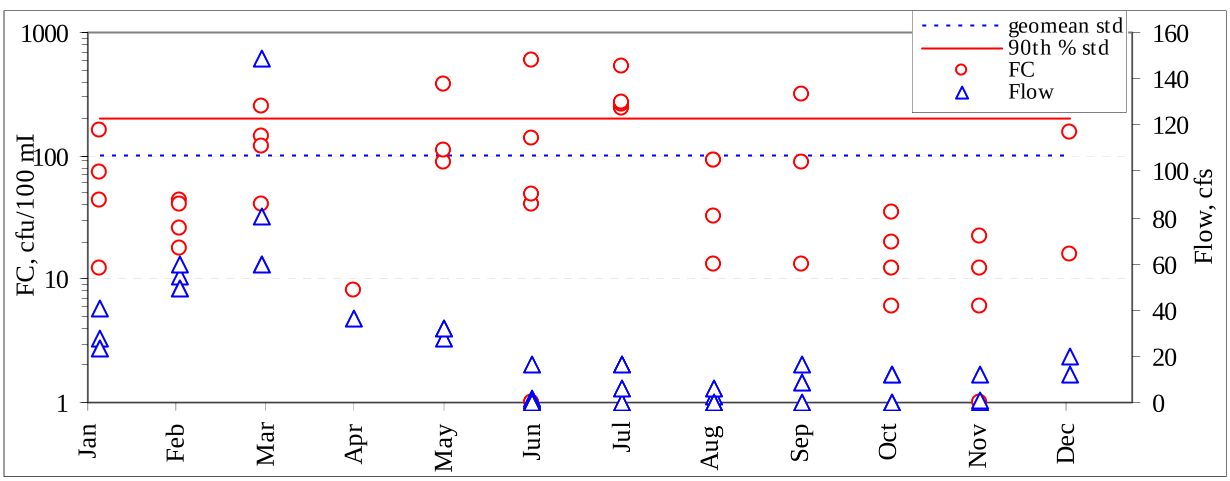

Figure 21. Fecal coliform concentrations and flows in Silver Creek at RM 2.3 (Station 6), 2001-2003.

Since sufficient data were not available to evaluate bacterial concentrations on a monthly basis, a running 4-month geometric mean and 90th percentile fecal coliform concentrations were estimated with a minimum of ten data points in each running 4-month period. This is shown in Figure 22. The geometric mean of fecal coliform concentrations was within the water quality standards for all the running 4-month periods. The 90th percentile concentrations, however, exceeded the standards in several of these periods between February and July.

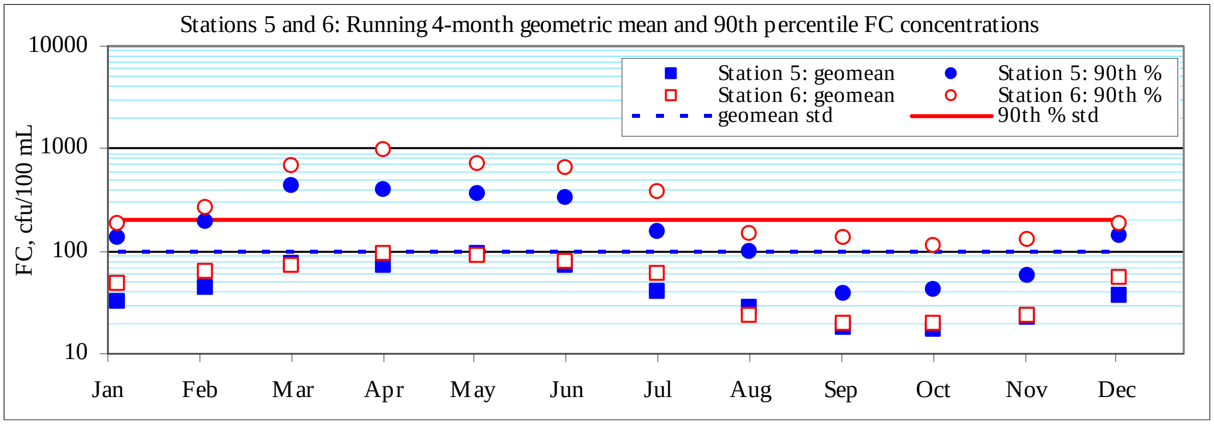

Figure 22. Fecal coliform concentrations in Silver Creek (Stations 5 and 6), 2001-2003.

Table 5 shows the target reductions required for Stations 5 and 6 based on the running 4-month critical periods shown in Figure 22. The period of March through June shows the highest 90th percentile concentrations on a running 4-month basis.

Table 5. Target fecal coliform reductions in Silver Creek at RM 5 (Station 5) and RM 2.3 (Station 6), 2001-2003.

Location	Period	Number of samples	Geometric mean (cfu/100 mL)	90th percentile (cfu/100 mL)	Limiting basis for reduction	Target reduction (%)
Station 5 (RM 5)	Mar-June	13	75	435	90th percentile	54
Station 6 (RM 2.3)	Mar-June	13	93	954	90th percentile	79

The average flows at Stations 5 and 6 during March through June are 75 and 38 cfs, respectively. Therefore, the existing fecal coliform loads at Stations 5 and 6, based on 90th percentile fecal coliform concentrations (Table 5), are 8 x 10^{11} cfu/day and 8.8 x 10^{11} cfu/day, respectively. The fecal coliform loads at stations 5 and 6, following achievement of the water quality standard, are 3.7 x 10^{11} cfu/day and 1.9 x 10^{11} cfu/day.

Elberton Road (RM 102.7)

This station is located in the mainstem NF Palouse River between Silver and Clear creeks. The Palouse Conservation District measured fecal coliform concentrations and flow at Station 7 (RM 102.7) on a monthly basis from August 2001 through September 2003. Figure 23 shows the fecal coliform concentrations and flows during this period. High flows were observed during spring while low flows were present in summer and fall.

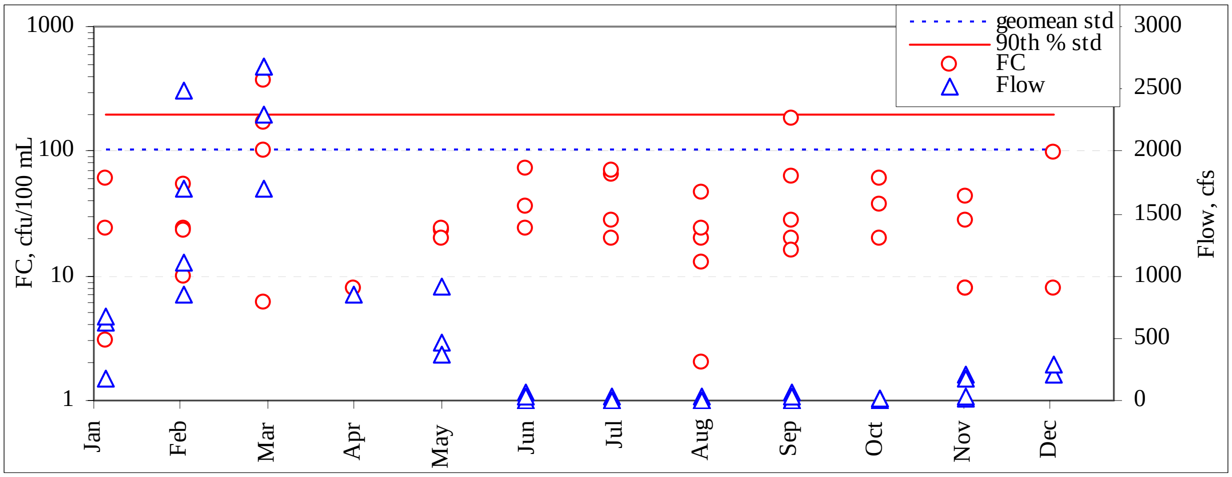

Figure 23. Fecal coliform concentrations and flows in the mainstem NF Palouse River at RM 102.7, 2001-2003.

Since sufficient data were not available to evaluate bacterial concentrations on a monthly basis, a running 4-month geometric mean and 90th percentile fecal coliform concentrations were estimated with a minimum of ten data points in each of the running 4-month periods. This is shown in Figure 24. Both the geometric mean and 90th percentile fecal coliform concentrations were within the water quality standards for all the running 4-month periods. Therefore, no target reductions will be required at this location.

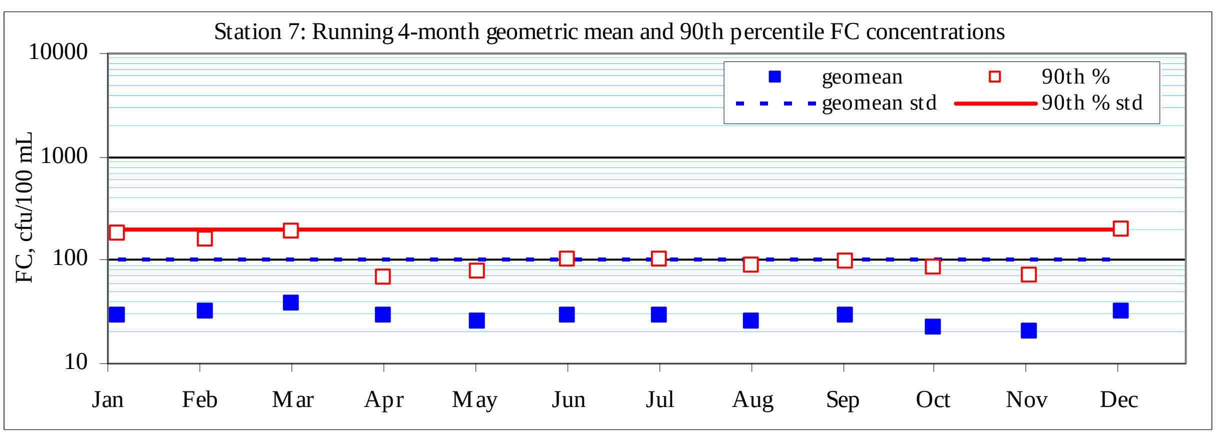

Figure 24. Fecal coliform concentrations in the mainstem NF Palouse River at RM 102.7, 2001-2003.

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3. Lower Mainstem Segment

This is a 13-mile segment extending from the confluence of the North and South Fork Palouse River (RM 89.6) to just below Silver Creek (RM 102.7). Clear Creek, a tributary to the NF Palouse River, is located at RM 96.2. There are three mainstem monitoring stations located between Clear Creek and the mouth of the NF Palouse River (Figure 25). Data from these stations are discussed below.

Figure 25. Locations of sampling stations in the Lower NF Palouse River segment.

Clear Creek, mouth at NF Palouse River (RM 96.2)

Clear Creek drains approximately 12,400 acres of primarily crop land in Whitman County, Washington. The creek consists of two miles of perennial stream and an additional 43 miles of intermittent stream, tributaries, and water ways. The Clear Creek watershed is 92% agricultural land, with an additional 5% used for grazing, 1% urban area, and 2% non-intensive use land (Resource Planning Unlimited, Inc, 2002). The mouth of Clear Creek is located at the NF Palouse River, RM 96.2.

The Palouse Conservation District measured both flow and fecal coliform concentrations at the mouth of Clear Creek (Station 9) on a monthly basis between June 2001 and September 2003. Figure 26 shows the fecal coliform concentrations and flows during this period. High flows were observed during winter and spring while low flows were present in summer and fall. Almost all of the high fecal coliform concentrations occurred in summer and early fall with the highest concentrations observed in October.

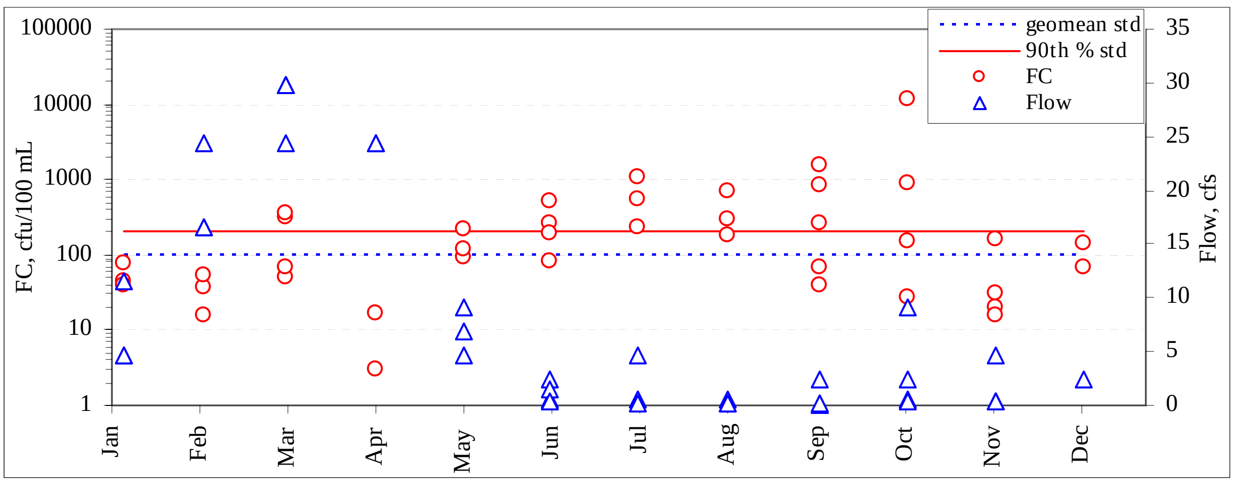

Figure 26. Fecal coliform concentrations and flows at the mouth of Clear Creek (Station 9), 2001-2003.

Since sufficient data were not available to evaluate bacterial concentrations on a monthly basis, a running 4-month geometric mean and 90th percentile fecal coliform concentrations were estimated with a minimum of ten data points in each running 4-month period. This is shown in Figure 27. Both the geometric mean and the 90th percentile concentrations exceeded the standards during May through August with the 90th percentile concentrations also exceeding in the other months of the year except November. The critical 4-month period showing the highest exceedance of the water quality criteria was between July and October.

Table 6 shows the target reductions required at the mouth of Clear Creek based on the running 4-month critical period shown in Figure 27. The period of July through October shows the highest running 4-month 90th percentile concentrations.

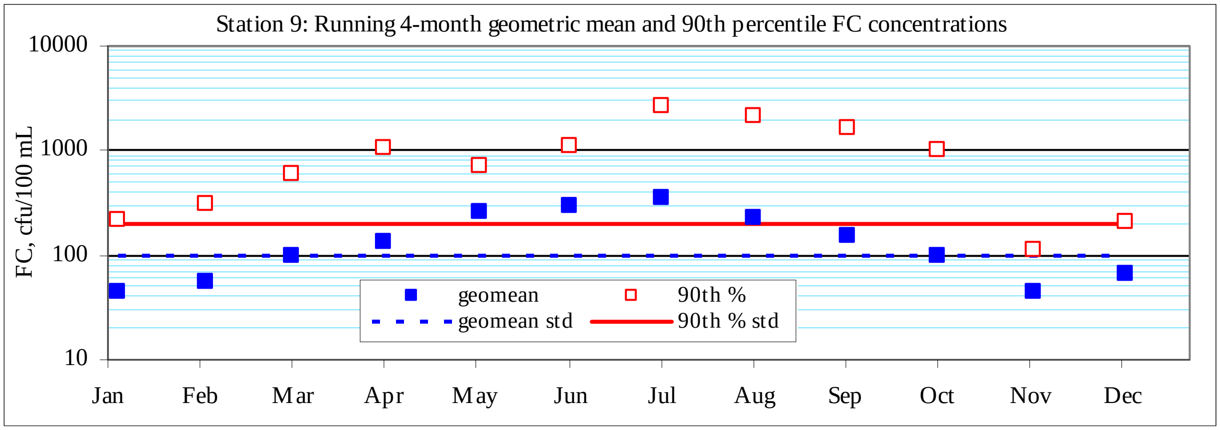

Figure 27. Fecal coliform concentrations at the mouth of Clear Creek (Station 9), 2001-2003.

Table 6. Target fecal coliform reductions at the mouth of Clear Creek (Station 9), 2001-2003.

Location	Period	Number of samples	Geometric mean (cfu/100 mL)	90^{th} percentile (cfu/100 mL)	Limiting basis for reduction	Target reduction (%)
Station 9 (RM 96.2)	July-Oct	15	360	2622	90^{th} percentile	92

The average flow in the July-Oct period (2001-2003) was1.4 cfs. Using the 90th percentile concentrations in Table 6, the existing fecal coliform load at the mouth of Clear Creek is 9×10^{10} cfu/day. The fecal coliform load following achievement of water quality standard is 7×10^{9} cfu/day (i.e., following approximately 92% reduction).

Glenwood Road (RM 96)

Station 8 (RM 96) is located right below Clear Creek (RM 96.2). The Palouse Conservation District measured fecal coliform concentrations and flow at this station on a monthly basis from August 2001 through September 2003. Figure 28 shows the fecal coliform concentrations and flow during this period. High fecal coliform concentrations are associated with both low and high flows. High flows were observed during spring while low flows were present in summer and fall. The highest fecal coliform concentrations were observed in the month of March.

Since sufficient data were not available to evaluate bacterial concentrations on a monthly basis, a running 4-month geometric mean and 90^{th} percentile fecal coliform concentrations were estimated with a minimum of ten data points in each running 4-month period. This is shown in Figure 29. The geometric mean fecal coliform concentrations met the water quality criterion in all months of the year. However, the 90^{th} percentile concentrations on a running 4-month basis exceeded the criterion during December through March.

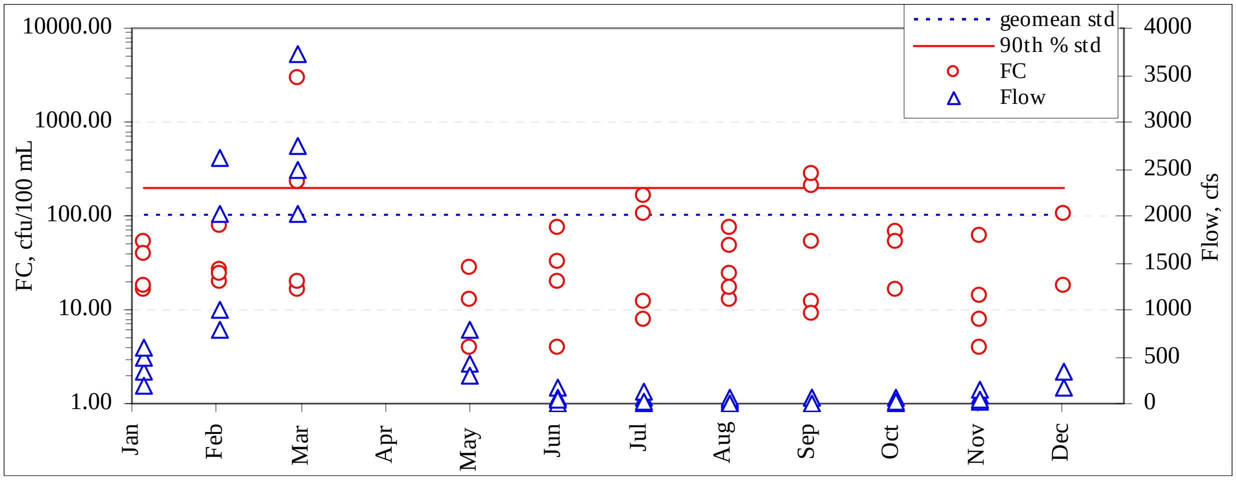

Figure 28. Fecal coliform concentrations and flows in the mainstem NF Palouse River at RM 96.2 (Station 8), 2001-2003.

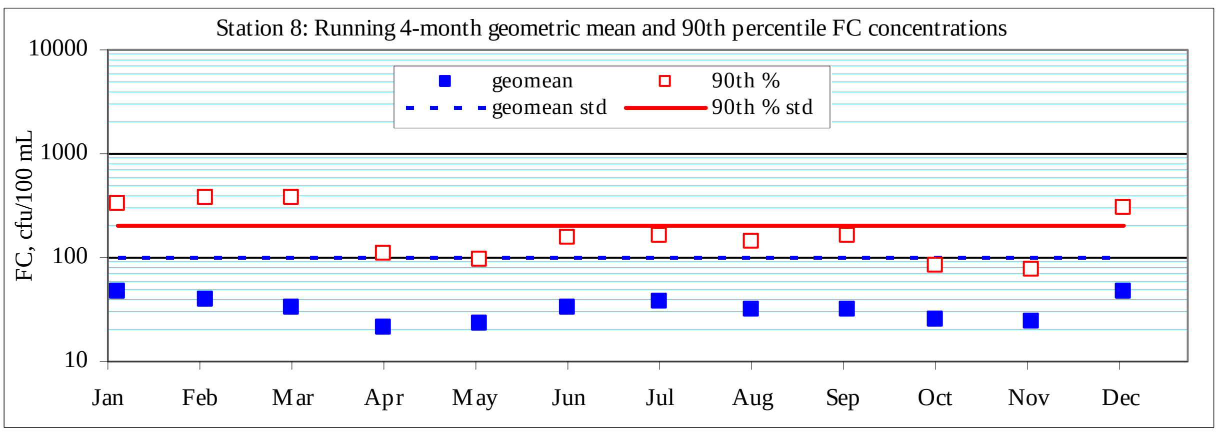

Figure 29. Fecal coliform concentrations in the mainstem NF Palouse River at RM 96.2 (Station 8), 2001-2003.

Table 7 shows the target reductions required at the mainstem Station 8 (RM 96.2) based on the running 4-month critical period shown in Figure 29. The period of December through March shows the highest running 4-month 90^{th} percentile concentrations.

Table 7. Target fecal coliform reductions in the mainstem NF Palouse River at RM 96.2 (Station 8), 2001-2003.

Location	Period	Number of samples	Geometric mean (cfu/100 mL)	90^{th} percentile (cfu/100 mL)	Limiting basis for reduction	Target reduction (%)
Station 8 (RM 96)	Dec-Mar	11	34	378	90^{th} percentile	47

The average flows in the Dec-Mar period (2001-2003) was 1395 cfs. Therefore the fecal coliform load based on the 90th percentile concentration (Table 7) is 1.3 x 10^{13} cfu/day. After meeting the 90th percentile water quality standard, the loading in Dec-Mar would be 6.8 x 10^{12} cfu/day.

At the old USGS gage (RM 92.7)

Station 10 (RM 92.7) is located almost half way between Clear Creek (RM 96.2) and the confluence of the North Fork and South Fork Palouse Rivers (RM 89.6). The Palouse Conservation District measured fecal coliform concentrations at this station on a monthly basis from August 2001 through September 2003. No flow was measured. However, due to close proximity to Station 8 (RM 96), it is assumed that the flow at Station 10 (RM 92.7) and Station 8 (RM 96) are similar. Figure 30 shows the fecal coliform concentrations and estimated flow during the study period. High flows were observed during spring while low flows were present in summer and fall.

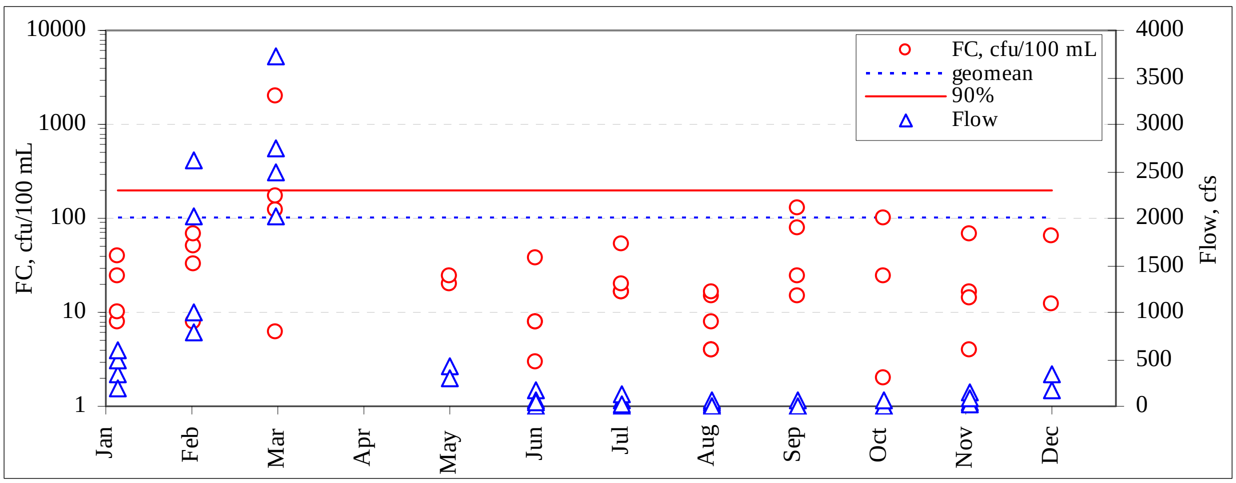

Figure 30. Fecal coliform concentrations and flows in the mainstem NF Palouse River at RM 92.7 (Station 10), 2001-2003.

Since sufficient data were not available to evaluate bacterial concentrations on a monthly basis, a running 4-month geometric mean and 90th percentile fecal coliform concentrations were estimated with a minimum of ten data points in each running 4-month period. This is shown in Figure 31. The geometric mean fecal coliform concentrations met the water quality criterion in all months. However, the 90th percentile fecal coliform concentrations on a running 4-month basis exceeded the criterion during December through March.

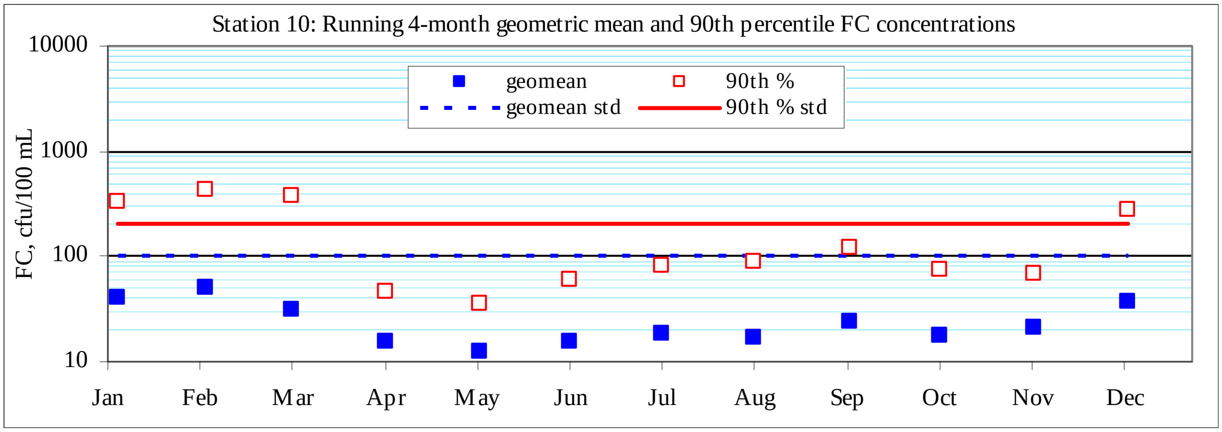

Figure 31. Fecal coliform concentrations in the mainstem NF Palouse River at RM 92.7 (Station 10), 2001-2003.

Table 8 shows the target reductions required at the mainstem Station 8 (RM 96.2) based on the running 4-month critical period shown in Figure 31.

Table 8. Target fecal coliform reductions in the mainstem NF Palouse River at RM 92.7 (Station 10), 2001-2003.

Location	Period	Number of samples	Geometric mean (cfu/100 mL)	90^{th} percentile (cfu/100 mL)	Limiting basis for reduction	Target reduction (%)
Station 10 (RM 92.7)	Dec-Mar	10	50	431	90^{th} percentile	54

The average flows in the Dec-Mar period (2001-2003) was 1395 cfs. Therefore the fecal coliform load based on the 90^{th} percentile concentration (Table 8) is 1.5 x 10^{13} cfu/day. After meeting the 90^{th} percentile water quality standard, the loading in the Dec-Mar period would be 6.9 x 10^{12} cfu/day.

Near Colfax (RM 90.2)

Ecology Station B (RM 90.2) is located near the town of Colfax, right above the confluence of the north and south forks of the Palouse River. Ecology measured fecal coliform concentrations at this station on a monthly basis from October, 2001 through September, 2002. No flow was measured. However, due to close proximity to Station 10 (RM 92.7) and Station 8 (RM 96), it is assumed that the flow at Ecology Station B is similar to the other two stations. Figure 32 shows the fecal coliform concentrations and flow during the study period. High flows were observed during spring while low flows were present in summer and fall.

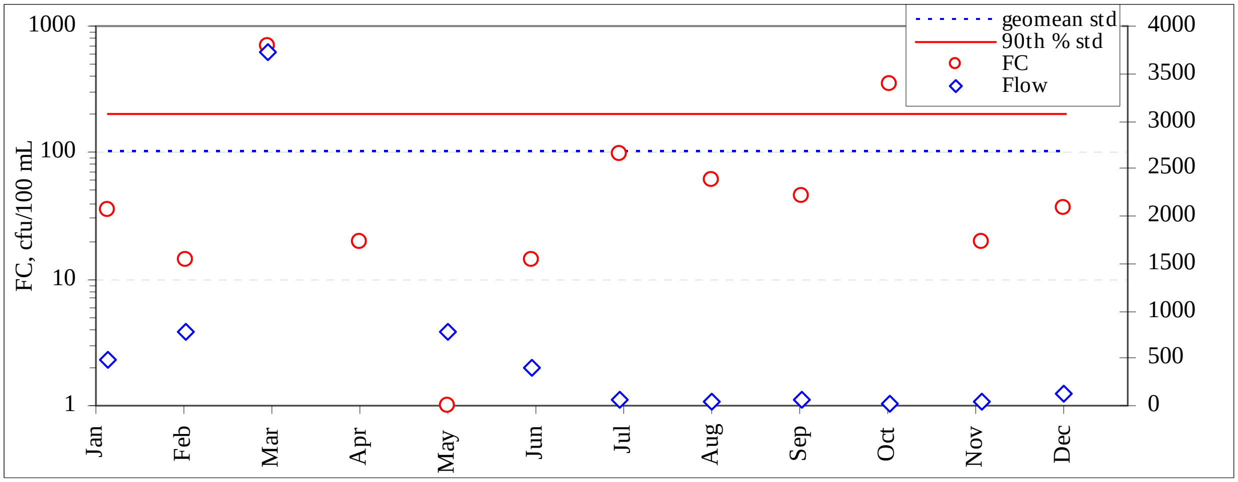

Figure 32. Fecal coliform concentrations and flows in the mainstem NF Palouse River at RM 90.2 (Ecology Station B), 2001-2002.

Figure 33 shows that the geometric mean of observed fecal coliform concentrations were within the water quality criterion of 100 cfu/100 mL. However, the 90th percentile concentration exceeds the water quality criterion of 200 cfu/100 mL. A target reduction of 36%, on an annual basis, is assigned to this station as shown in Table 9. Seasonal variation could not be evaluated due to limited data.

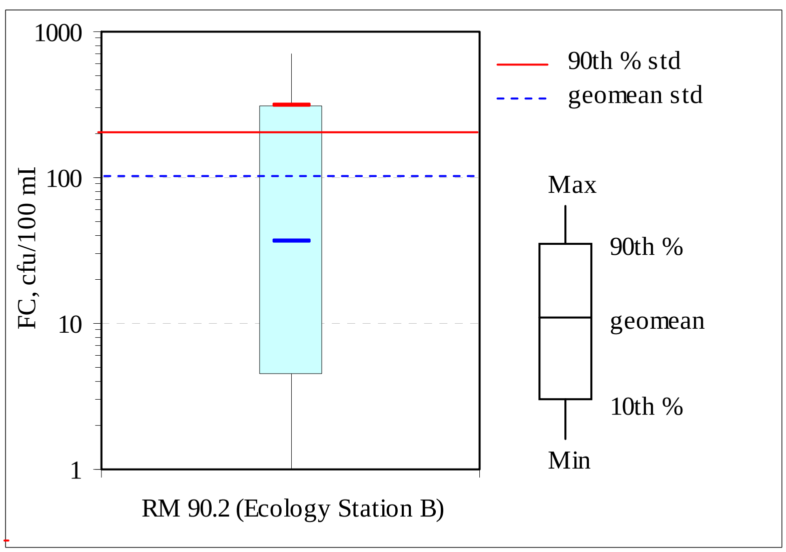

Figure 33. Distribution of fecal coliform concentrations in the mainstem NF Palouse River at RM 90.2 (Ecology station B), 2001-2002.

Table 9. Target fecal coliform reductions in the mainstem NF Palouse River at RM 90.2 (Ecology Station B), 2001-2002.

Location	Period	Number of samples	Geometric mean (cfu/100 mL)	90^{th} percentile (cfu/100 mL)	Limiting basis for reduction	Target reduction (%)
Ecology Station B (RM 90.2)	Annual	12	37	313	90^{th} percentile	36

With an annual average flow of 594 cfs, loading at the existing 90^{th} percentile concentration (Table 9) is 4.5 x 10^{12} cfu/day. After meeting the 90^{th} percentile water quality standard, the annual average loading would be 2.9 x 10^{12} cfu/day.

Point Sources

All point sources in the watershed should meet the water quality standards for fecal coliform bacteria either at the end-of-pipe or at the edge of an authorized mixing zone. There are two major point sources of fecal coliform bacteria in the NF Palouse River watershed:

- City of Palouse Wastewater Treatment Plant (WWTP) at RM 120
- City of Garfield WWTP at Silver Creek RM 4.3

Both facilities have NPDES permits that limit the fecal coliform concentrations in the effluent. These are discussed below.

City of Palouse Municipal Wastewater Treatment Plant

This facility was issued NPDES permit No. WA-004480-6 in 2000. The permit contains effluent limits for fecal coliform bacteria of 100 cfu/100 mL and 200 cfu/100 mL as monthly and weekly geometric means, respectively. This is equivalent to meeting the water quality standards at "end-of-pipe". In addition, the facility has a 300-ft mixing zone at its outfall in NF Palouse River with a dilution factor of 1.5 at the edge of the chronic zone. The loading from the plant based on a maximum monthly design flow of 0.28 MGD and the weekly geometric mean limit of 200 cfu/100 mL is 2.1 x 10^9 cfu/day. Evaluation of monthly discharge monitoring reports over the last three years (2001-2003) showed 100% compliance with the monthly geometric mean limit and 85% compliance with the weekly geometric mean limit (Figure 34).

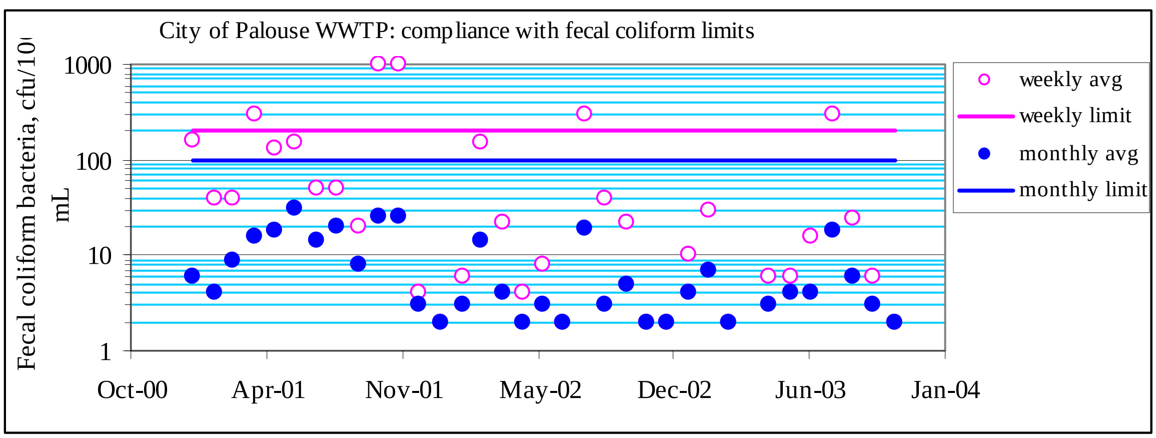

Figure 34. Fecal coliform concentrations in City of Palouse WWTP effluent, 2001-2003.

City of Garfield Municipal Wastewater Treatment Plant

This facility was issued NPDES permit No. WA-004482-2 in 2000. The permit contains effluent limits for fecal coliform bacteria of 100 cfu/100 mL as both monthly and weekly geometric means. This is equivalent to meeting the water quality standards at "end-of-pipe." In addition, the facility has a 300-ft mixing zone at its outfall in Silver Creek with a dilution factor of 1.03 at the edge of the chronic zone. The loading from the plant based on a maximum monthly design flow of 0.07 MGD is 5.3×10^8 cfu/day. Evaluation of monthly discharge monitoring reports over the last year (2003) showed that the mean fecal coliform concentrations have been consistently below 30 cfu/100 mL. Evaluation of monthly discharge monitoring reports over the last three years (2001-2003) showed 100% compliance with the monthly geometric mean limit and 97% compliance with the weekly geometric mean limit (Figure 35).

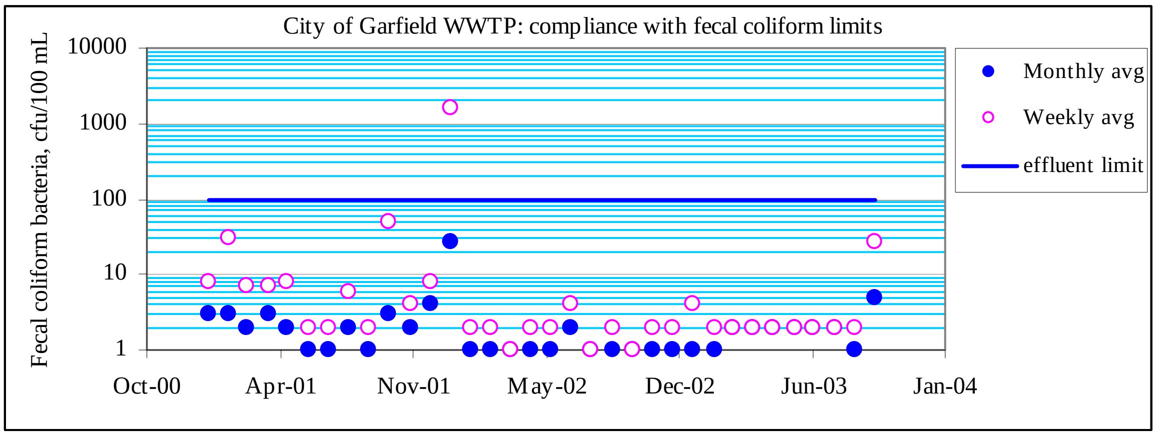

Figure 35. Fecal coliform concentrations in City of Garfield WWTP effluent, 2001-2003.

Loading Capacity Summary

"Loading capacity" means the maximum amount of pollution a waterbody can withstand and still fulfill beneficial uses (i.e., meet state water quality standards). In this TMDL report, it is assumed that if the individual tributaries and the various segments of the mainstem NF Palouse River were to meet the water quality standard, the NF Palouse River as a whole would meet the standard prior to its confluence with the South Fork Palouse River.

Load Allocation

Load allocations are the nonpoint source reductions needed in each segment for the load capacity to be met. Individual load allocations for the tributaries and mainstem are summarized in Table 10.

Table 10. Summary of target load reductions necessary to comply with fecal coliform water quality standards.

Reach	Loading capacity (cfu/day)	Target reduction (%)	Basis	Critical period
Upper Mainstem Segment (Border to Duffield Creek), RM 123.9 – RM 116.1				
Mainstem RM 123.9: Station 11 (WA/ID State line)	no reduction required*			
Mainstem RM 121.2: Station Ecology A	6×10^{10}**	80**	90th % std	August
Mainstem RM 118.5: Station 1	3.6×10^{12}	30	90th % std	Dec-Mar
Duffield Creek at mouth (NFPR RM 116.3)	no reduction required*			
Mainstem RM 116.1: Station 2	4.4×10^{12}	21	90th % std	Dec-Mar
Middle Mainstem Segment (Duffield Creek to Silver Creek), RM 116.1 – RM 102.7				
Cedar Creek at mouth (NFPR RM 113.1): Station 3	1.9×10^{10}	72	90th % std	June-Sept
Mainstem RM 107.8: Station 4	no reduction required			
Silver Creek (mouth at NFPR RM 103.5)				
RM 5: Station 5	3.7×10^{11}	54	90th % std	Mar-June
RM 2.3: Station 6	1.9×10^{11}	79	90th % std	Mar-June
Mainstem RM 102.7: Station 7	no reduction required			
Lower Mainstem Segment (Silver Creek to mouth of NFPR), RM 102.7 – RM 89.6				
Clear Creek at mouth (NFPR RM 96.2): Station 9	7×10^{9}	92	90th % std	July-Oct
Mainstem RM 96: Station 8	6.8×10^{12}	47	90th % std	Dec-Mar
Mainstem RM 92.7: Station 10	6.9×10^{12}	54	90th % std	Dec-Mar
Mainstem RM 90.2: Ecology Station B	2.9×10^{12}	36 †	90th % std	Annual

NFPR – North Fork Palouse River
* based on limited data, further monitoring recommended
** based on long-term data
† annual average basis

Wasteload Allocation

Wasteload allocations are effluent limits recommended for point sources for meeting water quality standards either at the end-of-pipe or at the edge of an authorized mixing zone. The existing water quality based effluent limits contained in NPDES permits, issued by Ecology, in the NF Palouse River watershed are deemed protective of the water quality standards. The existing effluent limits for the major point sources in the NF Palouse River watershed are summarized in Table 11.

Table 11. Summary of effluent limitations for fecal coliform bacteria in NPDES permits for point sources.

Point Sources	Geometric Mean (cfu/100 mL)	
	Monthly	Weekly
City of Palouse WWTP	100	200
City of Garfield WWTP	100	100

Margin of Safety

The margin of safety for this TMDL study is implicit through the use of conservative assumptions, summarized below.

The target reductions recommended in this report for the various segments of the mainstem North Fork Palouse River and its tributaries are based on observed fecal coliform concentrations. Compliance with the water quality standards will ultimately be achieved through best management practice (BMP) implementation and a follow-up monitoring plan. However, it is likely that BMPs may reduce bacteria concentrations in excess of the target reductions. For example, if a source of high bacterial concentration is eliminated, higher reduction of bacteria than the target may result.

The estimated targets do not account for any bacterial die-off in the water column or during travel from the source to the stream. As sources are removed from the stream, bacterial travel time from the source to the stream during a storm event would increase. This would allow for greater exposure of the bacteria to the environment and potential die-off.

Target reductions were based on seasonal evaluations where sufficient data were available. BMPs based on seasonal targets will substantially reduce the annual load at the various segments and tributaries.

Target reductions were based on a 90th percentile of fecal coliform distributions which takes into account the variability of the data. This is more conservative than the 10th percentile water quality criterion which allows for 10% of the samples to exceed the criterion without considering the distribution of the data.

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Monitoring Strategy Recommendations

The North Fork Palouse River watershed consists of several segments and tributaries that do not meet the Washington State water quality standard for fecal coliform bacteria. To address the listings in a comprehensive manner, the following monitoring strategy is recommended:

- Use the highest fecal coliform reduction targets to prioritize where resources should be first invested.
- Begin implementation of best management practices (BMPs) first at the most upstream segment, tributary, or sub-tributary. Monitoring should follow wherever BMPs are implemented.
- As the segment, tributary, or sub-tributary with the worst problem is brought into compliance with standards, the monitoring station should be moved to a less severe area where the next set of BMPs would be implemented.

Ongoing monitoring of water quality trends and activity implementation is essential in order to:

- Show where water quality is improving
- Help locate sources of pollution
- Help indicate effectiveness of cleanup activities
- Document achievement of compliance with state water quality standards

A comprehensive monitoring plan will be included in the *Detailed Implementation Plan* for the NF Palouse River, to be developed by the Department of Ecology within one year of the approval date of this TMDL.

If ambient or other monitoring data show that progress towards targets is not occurring or if targets are not being met, compliance water quality monitoring will occur. Compliance monitoring will be designed to verify preliminary data and then identify the specific sources of fecal coliform loading. Sampling over time will be adjusted to locate the source by narrowing the geographic area where contamination is occurring.

Tributaries

Mouths of tributaries should be monitored so that the overall effects of BMPs implemented in the tributary can be evaluated.

- Clear Creek should be monitored from June through October and from February through March.
- Cedar Creek should be monitored from May through September.
- Duffield Creek should be monitored initially for one year for both flow and fecal coliform bacteria.

- Silver Creek should be monitored from March through September. Concentrations of fecal coliform bacteria measured at Silver Creek RM 5 (Station 5) likely reflect contributions by nonpoint sources. However, the increase in fecal coliform bacteria between RM 5 (Station 5) and RM 2.3 (Station 6) is likely from urban sources. The city of Garfield is between these two stations. Lack of flow also may play a role in the elevated fecal coliform concentrations at Station 6. Flow at Station 6 is lower than the flow at Station 5 (Figure 36). Both Stations 5 and 6 should be monitored during and following BMP implementation.

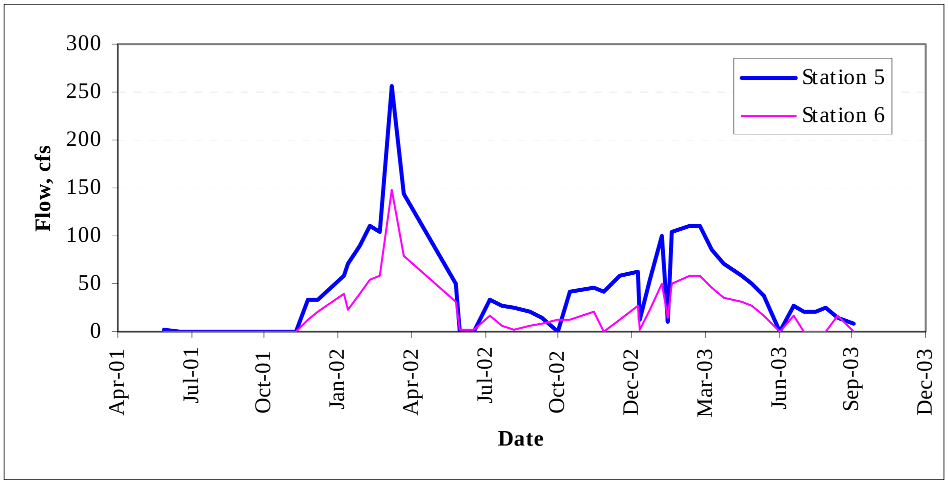

Figure 36. Flow at Stations 5 and 6 in Silver Creek, 2001-2003.

Mainstem

In general, monitoring locations and periods for the mainstem NF Palouse River should follow those presented in Table 13. However, Station 11 (RM 123.9 at the Washington/Idaho border) should continue to be monitored monthly. Data collected at this station should be evaluated to establish the need for BMP implementation above the state line.

The number of monitoring stations can be reduced. For example, only one station (Ecology Station B, RM 90.2) is needed between Clear Creek and the mouth of the NF Palouse River in Colfax, unless there are reasons for establishing additional stations. Stations where no reductions have been required (Stations 4 and 5) may be eliminated from future monitoring.

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