Tyson and Renfro Creeks
Bacteria Total Maximum Daily Loads

Addendum to the

St. Maries River Subbasin Assessment and Total Maximum Daily Loads

Draft

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Bacteria Total Maximum Daily Loads

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St. Joe / St. Maries Watershed Advisory Group.

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Executive Summary

The federal Clean Water Act (CWA) requires that states and tribes restore and maintain the chemical, physical, and biological integrity of the nation's waters. States and tribes, pursuant to Section 303 of the CWA, are to adopt water quality standards necessary to protect fish, shellfish, and wildlife while providing for recreation in and on the nation's waters whenever possible. Section 303(d) of the CWA establishes requirements for states and tribes to identify and prioritize water bodies that are water quality limited (i.e., water bodies that do not meet water quality standards). States and tribes must periodically publish a priority list (a "§303(d) list") of impaired waters. Currently this list must be published every two years. For waters identified on this list, states and tribes must develop a total maximum daily load (TMDL) for the pollutants, set at a level to achieve water quality standards.

This document addresses water bodies in the St. Joe River subbasin (hydrologic unit code 17010304) that are failing to support Idaho's secondary contact recreation beneficial use. The St. Joe River subbasin includes two main watersheds: the St. Joe River watershed and the St. Maries River watershed. Tyson and Renfro Creeks—both tributaries to the St. Maries River near Santa, Idaho—are failing to support the secondary contact recreation beneficial use due to high *Escherichia coli* (*E. coli*) concentrations. For more information about the St. Maries River watershed characteristics see the *St. Maries River Subbasin Assessment and Total Maximum Daily Loads* (DEQ 2003).

This addendum contains updated information on bacteria conditions in Tyson and Renfro Creeks, beneficial use support and status related to bacteria, and TMDLs for bacteria. The TMDLs are presented immediately below in section 5. Section 5 is the typical section number reserved for the actual TMDLs within subbasin assessment and TMDL documents. As such, the section numbering has been retained in this addendum.

Bacteria TMDLs were completed for Tyson Creek (assessment unit ID17010304PN013_03) and Renfro Creek (assessment unit ID17010304PN024_03) due to secondary contact recreation beneficial use impairment (Table A). *E. coli* bacteria target loads were calculated to a level that will meet Idaho water quality standards. Examples of primary and secondary contact recreation include, but are not limited to, swimming, boating, wading, and fishing. Idaho's water quality standard was developed to protect human health from the potential ingestion of surface water during such activities.

Table A. Summary of assessment outcomes

Stream	Assessment unit	Pollutant	TMDL(s) completed	Recommended changes to Integrated Report	Justification
Tyson Creek	ID17010304PN013_03	Bacteria (*E. coli*)	Yes	Move AU[a] to category 4a	TMDL completed
Renfro Creek	ID17010304PN024_03	Bacteria (*E. coli*)	Yes	Move AU[a] to category 4a	TMDL completed

[a] Assessment unit

5. Bacteria TMDL

Bacteria total maximum daily loads (TMDLs) were developed for the Tyson and Renfro Creek watersheds because water quality monitoring data indicated that the beneficial use of secondary contact recreation was not fully supported. The source of bacteria is unknown. Possible sources include domesticated and wild animals and/or human contributions.

Idaho's bacteria water quality standard is a concentration-based standard specific to *Escherichia coli* (*E. coli*). The target for these bacteria TMDLs is the Idaho water quality standard, which states the following:

> Waters designated for primary or secondary contact recreation are not to contain *E. coli* bacteria in concentrations exceeding a geometric mean of one hundred twenty-six (126) *E. coli* organisms per one hundred (100) ml based on a minimum of five (5) samples taken every three (3) to seven (7) days over a thirty (30) day period. (IDAPA 58.01.02.251.01a)

E. coli, a species of coliform bacteria, is used by the State of Idaho as an indicator organism for disease-causing human pathogens because it is relatively more abundant than other pathogens, easy to test for, and relatively harmless. Pathogens are a small subset of microorganisms (e.g., certain bacteria, viruses, and protozoa), which, if taken into the body through contaminated water or food, can cause sickness or even death. Some pathogens can also cause illness by entering the body through the skin or mucous membranes.

Direct measurement of pathogens in surface water is difficult because pathogens usually occur in very low numbers and analysis methods are often unreliable and expensive. Consequently, indicator bacteria such as *E. coli*, which often co-occur with pathogens, are tested for because they generally occur in higher concentrations and are more easily measured. *E. coli* is often measured in organisms per 100 milliliters (mL).

Water samples analyzed for the presents of *E. coli* are reported in colony forming units (cfu). A cfu is a measure of viable (alive, capable of living, developing, or reproducing) cells which can grow into a colony or cluster of bacterium. In this report organisms and cfu's are used interchangeably, and lab analysis reported in cfu's is compared to the water quality criteria of organisms.

Coliform bacteria are unicellular organisms found in the feces of warm-blooded animals such as humans, domestic pets, livestock, and wildlife. Coliform bacteria are commonly monitored as part of point source discharge permits (National Pollutant Discharge Elimination System [NPDES] permits), but may also be monitored for nonpoint sources. The human health effects from pathogenic coliform bacteria range from nausea, vomiting, and diarrhea to acute respiratory illness, meningitis, ulceration of the intestines, and even death. Coliform bacteria do not have a known effect on aquatic life.

Coliform bacteria from both point and nonpoint sources impact water bodies, although point sources are typically required to obtain NPDES permits and perform bacteria-reducing water treatment prior to discharge. Nonpoint sources of bacteria are diffuse and difficult to characterize. Unfortunately, nonpoint sources often have the greatest impact

on bacteria concentrations in water bodies, particularly in the case of urban stormwater and agricultural runoff.

Water Quality Data

As set forth in Idaho's water quality standards, waters that are designated for secondary contact recreation beneficial use are not to have a mean *E. coli* concentration greater than 126 *E. coli* organisms per 100 mL, based on the geographic mean of at least 5 samples taken 3–7 days apart during a 30-day period. A single water sample in exceedance of 126 *E. coli* organisms/100 mL is not considered a violation of Idaho water quality standards (IDAPA 58.01.02.251.01.b). In waters designated for secondary contact recreation, a single sample of 576 *E. coli* organisms/100 mL or greater (IDAPA 58.01.02.251.01.b.i) is used as an indicator of possible beneficial use non-support. If a single sample exceeds the trigger value of 576 *E. coli* organisms/100 mL, then additional samples (for a total of 5 minimum) must be taken 3 to 7 days apart over a 30-day period (58.01.02.251.01.a). The geometric mean of the 5 (or more) samples is then calculated to assess beneficial use support status (58.01.02.251.01.c). The 5-sample geometric mean is calculated to help determine average concentrations when the data being evaluated have the possibility of being highly skewed.

The Idaho Department of Environmental Quality (DEQ) collected water samples in Tyson Creek in 2008 and Renfro Creek in 2004 and analyzed the samples for the presence of *E. coli* (Table 1).

Table 1. *E. coli* concentrations in the Tyson and Renfro Creek watersheds

Location description	GPS coordinates	Date	*E. coli* concentration (organisms/100 mL)
Tyson Creek			
Samples collected at road crossing below large meadow, approximately 0.8 miles upstream from the confluence with St. Maries River	N 47°06'58.70" W 116°26'29.70"	7/31/2008	1,000
		8/04/2008	330
		8/07/2008	360
		8/11/2008	230
		8/14/2008	370
		Geometric mean	**399**
Renfro Creek			
Samples collected at Beneficial Use Reconnaissance Program site 2004SCDAA074, approximately 0.75 miles upstream from the confluence with St. Maries River	N 47°09'10.69" W 116°26'06.58"	9/08/2004	2,000
		9/14/2004	380
		9/17/2004	490
		9/22/2004	86
		9/27/2004	330
		Geometric mean	**402**

Since the initial sample at both locations exceeded Idaho's single sample maximum *E. coli* water quality standard of 576 organisms/100 mL, four additional water samples were collected and analyzed for the presence of *E. coli* bacteria. The geometric mean was used to evaluate and compare water quality data to Idaho water quality standards. Measured *E. coli* concentrations from both streams exceeded the Idaho water quality criterion of 126 organisms/100 mL for the 5-sample geometric mean (Table 1).

5.1 Bacteria In-stream Water Quality Targets

The goal of a TMDL is to restore impaired water to "full support of designated beneficial uses" (Idaho Code 39.3611.3615). For this bacteria TMDL specifically, *E. coli* must be reduced to a level at which full support of secondary contact recreation beneficial uses is demonstrated using the current assessment method accepted by DEQ at the time the water body is reassessed.

The numeric in-stream water quality target was set at the numeric water quality standard of 126 *E. coli* organisms/100 mL (IDAPA 58.01.02.251.01.a). Achieving *E. coli* concentrations to comply with Idaho water quality standards will support contact recreation uses.

Pollutant Load Development

In the case of bacteria impairing recreation beneficial uses, the warmer months of the year—including late spring, summer, and early fall—are considered the critical time periods to protect recreational users of surface waters from bacterial contamination. Bacteria data used in this TMDL were collected during the summer months, so little is known about bacterial contamination during the non-critical months of recreation (late fall, winter, and early spring).

Bacterial contamination is also highly affected by stream flow volume. Thus, this TMDL analysis developed bacteria loads based on stream flow. Stream flow was not measured during sample collection. Stream flow data are needed during load calculations because the water quality bacteria criterion is a numeric concentration-based target. The amount of bacteria present in the stream is dependent on the total volume of water. To account for the lack of stream flow data, St. Maries River discharge data collected at the U.S. Geological Survey (USGS) gaging station near Mashburn (gage number 12414900) was applied to the Tyson and Renfro Creek watersheds using the following drainage area ratio calculation:

$$Y = (A1/A2)X,$$

where

Y = estimated median stream flow (cubic feet per second) from ungaged stream;
$A1$ = drainage area (square miles) from site of interest;
$A2$ = drainage area (square miles) from gaged stream; and
X = recorded stream flow (cubic feet per second) recorded at gaging station.

The median stream flows calculated using the drainage area ratio method for the period of record (1966–2010) were used to best estimate the stream flow for the days when samples were collected. The calculated median stream flows for Tyson were greater than the measured stream flows taken during DEQ's Beneficial Use Reconnaissance Program (BURP) survey (Figure 1). The median stream flow calculated for Renfro Creek is more close to the stream flow measured during the BURP survey completed on September 8, 2004 (Figures 2). The maximum, minimum, 25th (q1) percentile, and 75th (q3) percentile were also calculated to estimate extreme high and low flows.

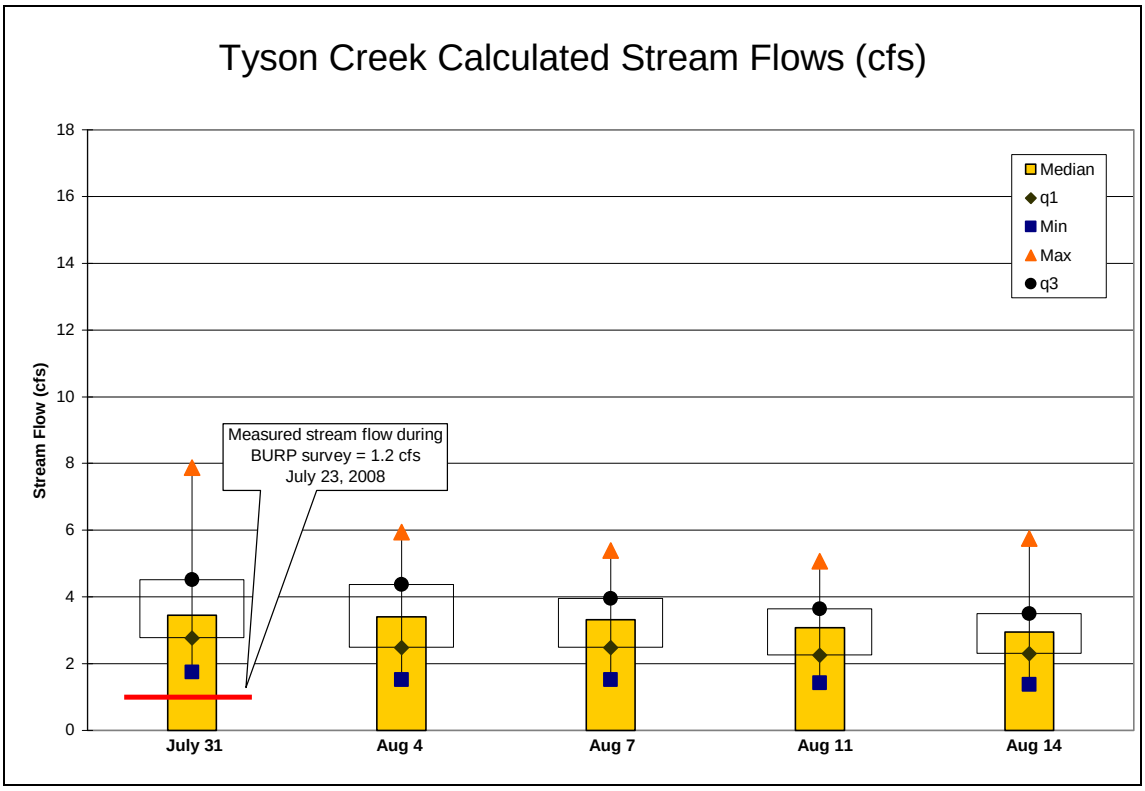

Figure 1. Tyson Creek calculated stream flows (cfs = cubic feet per second)

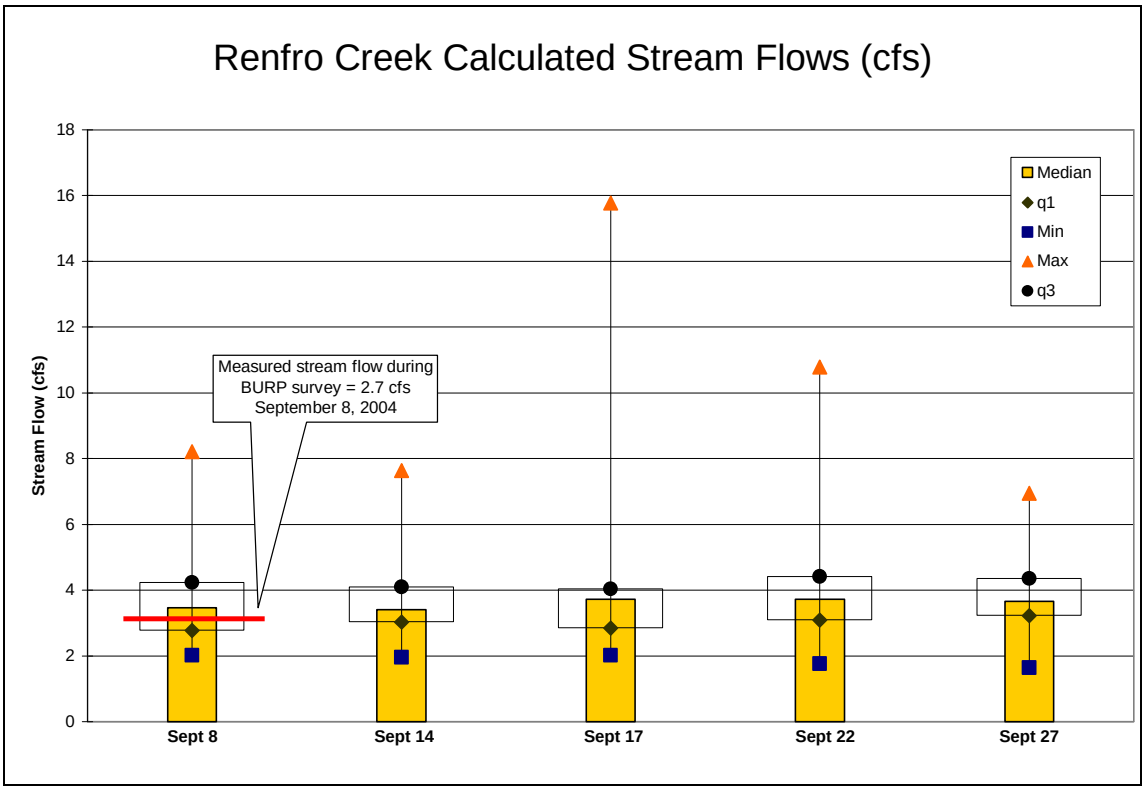

Figure 2. Renfro Creek calculated stream flows (cfs = cubic feet per second)

Stream flow is highly variable depending on sampling time, date, recent weather, watershed size, and land use. The method used to calculate stream flow for Tyson and Renfro Creeks accounted for these factors but still results in only an estimate. Using the median value from the calculated stream flows helps to account for the variability of stream flow.

The calculated stream flow in the Tyson Creek watershed may be a little greater than expected given a recent stream flow measurement. During the 2008 BURP survey, the measured stream flow was lower than the minimum calculated stream flow. If Tyson Creek does exhibit stream flows less than those calculated, the total *E. coli* load calculated will be an overestimate.

Target Selection

Bacteria targets are set at the water quality standard of 126 *E. coli* organisms/100 mL for protection of recreation beneficial uses. For any given flow volume, the number of organisms the water body can contain and still meet this target is derived from multiplying the flow (converted to milliliters) by 1.26 organisms.

For example, at 1 cubic foot per second (cfs), the number of *E. coli* that could be present and still meet Idaho water quality criteria is 35,679 organisms (Equation 1).

Equation 1. $(1\ ft^3) \times (28{,}316.85\ mL/ft^3) \times (1.26\ organisms/mL) = 35{,}679\ organisms$

Monitoring Points

To track progress towards meeting the loads identified in this TMDL, repeat sampling at the locations initially sampled (Table 1) should be conducted following the implementation of pollutant reduction projects (Figure 3).

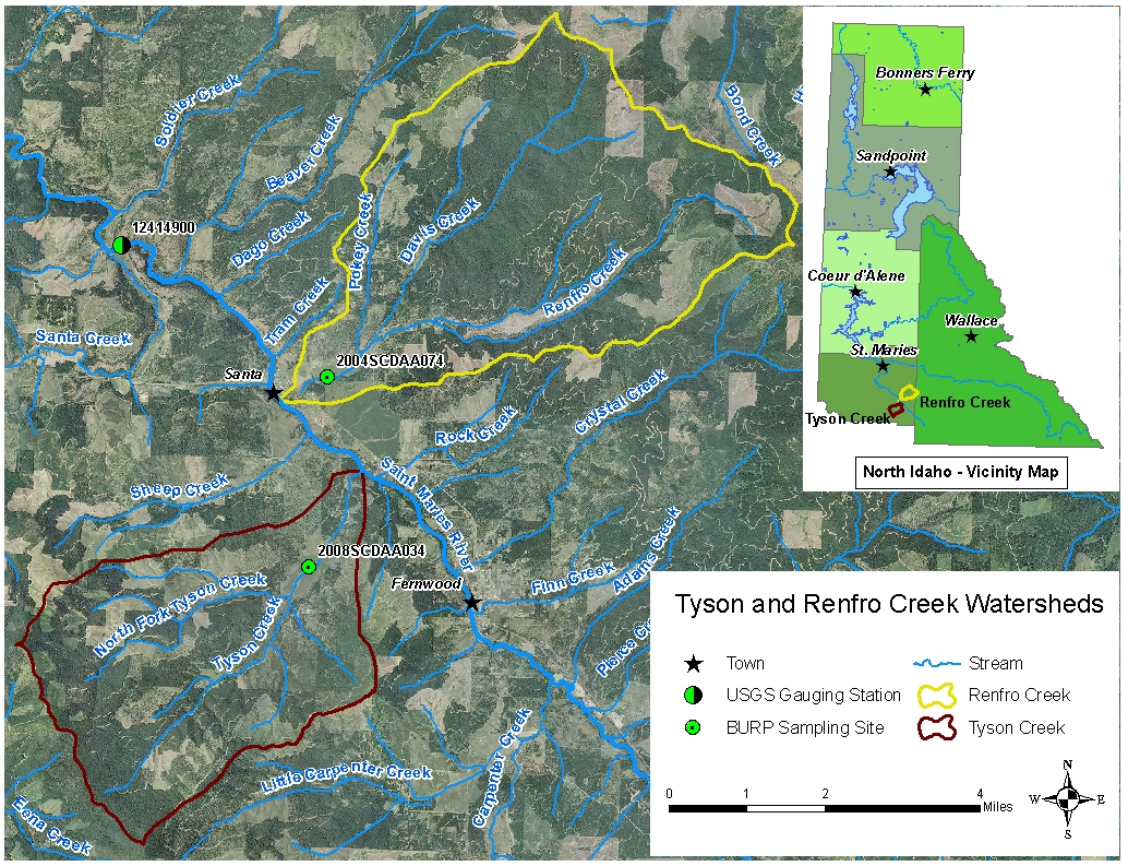

Figure 3. Tyson and Renfro Creek watersheds

Increased monitoring may be needed to ascertain the extent of bacterial contamination in the watersheds. Prior to conducting an extensive monitoring effort, a watershed tour should be conducted to help evaluate potential bacteria sources. If no anthropogenic sources (e.g., septic systems or domesticated animals) are noted, bacteria loads may be naturally occurring. If anthropogenic sources are noted, a number of methods are available for identifying contamination.

Microbial source tracking (MST) is a method to help identify sources of *E. coli* in an impaired water body. There are various types of MST methods with a range of accuracy, and it is important to understand the various types before choosing the right method with the level of accuracy desired for a project. For example, analytical methods that include analysis of genetic material are extremely accurate and can differentiate between multiple sources (e.g., human, pets, livestock, and wildlife). However, these methods are more expensive and more time and labor intensive to implement. Other less-accurate methods can identify physical or biochemical characteristics unique to a specific fecal source but may only generally differentiate between animal or human sources or between general categories of animal sources (e.g., human, dog, cattle). The decision to use MST should follow a sanitary survey of the watershed and a thorough analysis of existing monitoring data.

During summer 2009, DEQ conducted a study using MST to identify the sources of bacterial contamination in two north Idaho streams to aid in managing sources of *E. coli* for bacteria load reductions prescribed by a TMDL. Results of the study were anticipated to guide TMDL implementation for human sources of bacteria under the leadership of the Idaho Panhandle Health Department, while livestock owners would be educated and directed to agency programs to help with the cost of implementing land-use changes to protect water quality in nearby water bodies. Should the contamination be from pets, all property owners would be educated about the necessity to clean up pet waste, and wildlife sources would be considered natural background.

Results of the MST analysis of water samples were unexpected, and they presented a challenge in terms of implementing projects to meet water quality standards. On all project streams, wildlife was overwhelmingly the dominant source of *E. coli* bacteria, and no animal was a dominant offender in either of the watersheds. Although human sources made up 11% of the total *E. coli* organisms isolated within the project period, humans (septic waste) were not present in significant quantities on days when the standard was exceeded. In conclusion, determining the source of *E. coli* on two north Idaho streams using the MST technique was time and labor intensive. Lessons learned from the project were many. However, DEQ staff collectively learned that the cost and effort expended on this project was beneficial in understanding the potential for wildlife to be a significant source of *E. coli*, but was not useful for gaining information about ways to reduce *E. coli* numbers in the two watersheds.

5.2 Bacteria Load Capacity

The TMDL goals are based on conditions that meet Idaho water quality standards (IDAPA 58.01.02.251.01.a). The bacteria load capacity is based on stream flow and the *E. coli* water quality standard of 126 organisms/100 mL. Flow (cfs) was converted to milliliters and then multiplied by 1.26 organisms. A flow of 1 cfs can contain 35,679 *E. coli* organisms at load capacity.

5.3 Estimates of Existing Bacteria Loads

There are no permitted point source dischargers within the Tyson or Renfro Creek watersheds. Sources are attributed to background loading (wild animals) and anthropogenic sources (domesticated animals and/or human contributions). *E. coli* loads were calculated using the analytical results reported from field samples and calculated stream flows (Table 2). A 10% margin of safety was calculated in the load to account for errors associated with TMDL calculations and to ensure protection of beneficial uses.

Table 2. Numbers of *E. coli* organisms at load capacity (minus 10% margin of safety), existing load, reduced load, and percent load reduction necessary for Tyson and Renfro Creeks

Measured *E. coli* concentration (organisms/ 100 mL)[a]	Calculated median discharge (cfs)[b]	Load at water quality standard (organisms/ 100 mL)	10% margin of safety (organisms/ 100 mL)	Target load (organisms/ 100 mL)	Existing load (organisms/ 100 mL)	Reduction necessary (organisms/ 100 mL)	Reduction (%)
Tyson Creek							
1,000	3.5	124,877	12,488	112,390	991,090	878,700	89
330	3.4	121,309	12,131	109,178	317,715	208,537	66
360	3.3	117,741	11,774	105,967	336,404	230,437	69
230	3	107,038	10,704	96,334	195,386	99,052	51
370	2.9	103,470	10,347	93,123	303,840	210,717	69
Average		**114,887**	**11,489**	**103,398**	**428,887**	**325,489**	**69**
Renfro Creek							
2,000	3.5	124,877	12,488	112,390	1,982,180	1,869,790	94
380	3.4	121,309	12,131	109,178	365,854	256,675	70
490	3.7	132,013	13,201	118,812	513,384	394,573	77
86	3.7	132,013	13,201	118,812	90,104	0	0
330	3.7	132,013	13,201	118,812	345,749	226,937	66
Average		**128,445**	**12,845**	**115,601**	**659,454**	**549,595**	**61**

[a] mL = milliliter

[b] cfs = cubic feet per second. Stream flow was not measured during sample collection. Stream flow was calculated using river discharge measured at the U.S. Geological Survey gaging station on the St. Maries River near Mashburn (gage number 12414900).

E. coli concentrations receded during the sampling period (Tyson Creek, July 31–August 14, 2008, and Renfro Creek, September 8–September 27, 2004) (Figures 4 and 5). Receding concentrations may be due to a multitude of factors, including cooler weather, increases in stream flow, or removal of bacteria source(s).

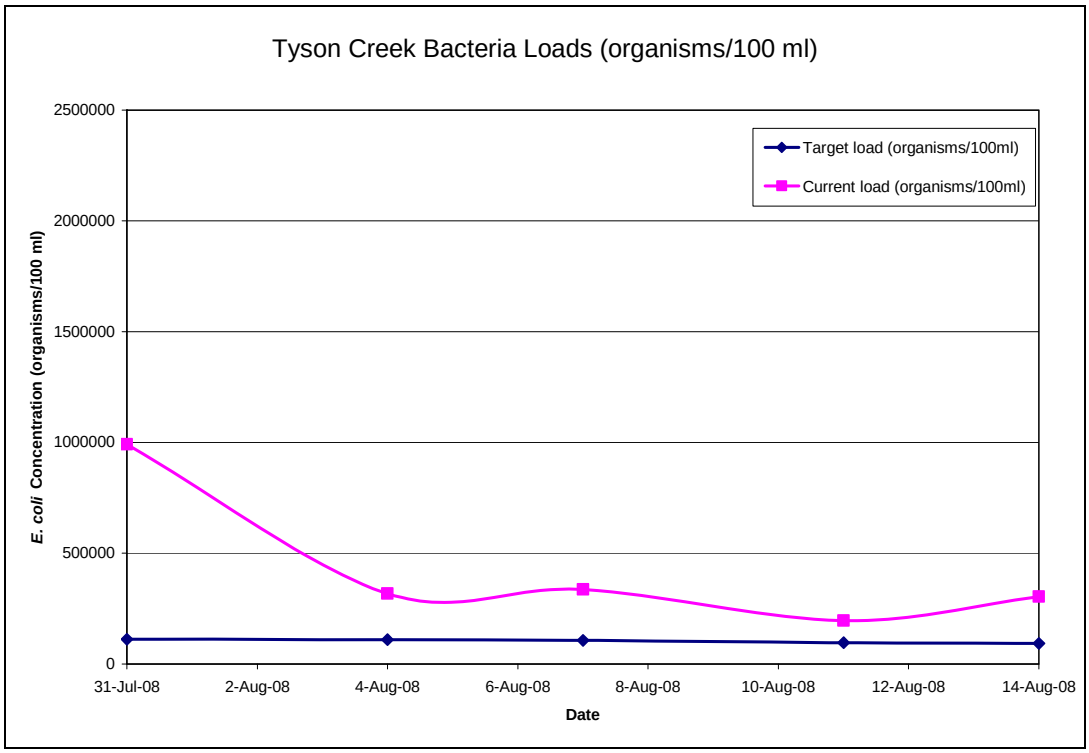

Figure 4. Tyson Creek bacteria loads (organisms per 100 milliliters)

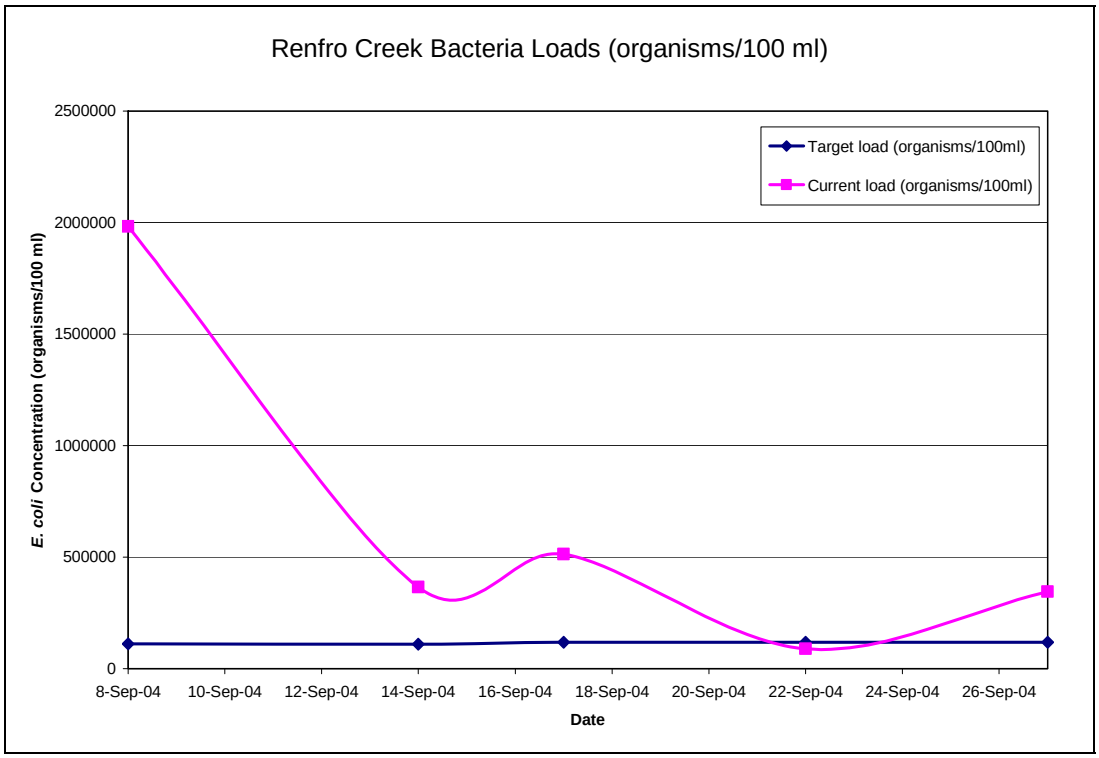

Figure 5. Renfro Creek bacteria loads (organisms per 100 milliliters)

5.4 Bacteria Load Allocation

With no point sources in the watershed, the wasteload allocation in this TMDL is zero. Because the wasteload allocation is zero, the entire bacteria load is available for load allocation. The calculated load allocation is attributed to background loading (wild animals) and anthropogenic sources (domesticated animals and/or human contributions).

Wasteload Allocation

There are no known NPDES-permitted point sources in the affected watersheds. Thus, there are no wasteload allocations. Should a point source be proposed that would increase bacteria concentrations, all possible actions should be taken to protect against surface water contamination. All future land-use activities resulting in a point source discharge will be subject to agency review, compliance with TMDL pollutant loads, and state and federal regulations.

Margin of Safety

E. coli loading analyses included a 10% margin of safety by subtracting 10% from the load capacity.

Seasonal Variation

Elevated *E. coli* concentrations are most likely to impact recreational uses during the warm summer months. During these months, warmer water temperatures allow for bacteria to be more long-lived in the water column and persons are most likely to come into contact with and ingest surface water during recreational activities such as boating, swimming, or fishing.

Bacterial contamination in streams can be highly variable depending on types of sources the bacteria's short-lived nature, and seasonal hydrology. The concentrations recorded during summer sampling that have been used in this load analysis may be the result of summer low flow conditions or seasonal land-use activities. One cannot conclude from these data that *E. coli* contamination is high during other times of the year. More sampling would be needed to adequately characterize the nature of bacterial contamination throughout the year. *E. coli* concentrations may vary throughout the year, but the target identified in this TMDL and in the Idaho water quality standards applies year-round.

Background Conditions

The bacteria TMDLs are based on existing water quality standards to protect recreational beneficial uses of Tyson and Renfro Creeks. Background bacteria conditions (i.e., contributions from wild animals) are unknown but should be investigated. *E. coli* TMDL levels should be adjusted based on the source or sources of the background bacteria.

5.5 Implementation Strategies

Successful implementation will depend on land owner participation. The source or sources of bacterial contamination is unknown in the Tyson and Renfro Creek watersheds. Likely sources of contamination include wildlife (e.g., elk, deer, and turkey),

humans (e.g., failing or inadequate septic treatment), and domesticated animals (e.g., cows, horses, pigs, dogs, and cats). The potential sources could be many, and finding a single source may be difficult. To help determine the source of contamination, multiple samples can be collected within the watershed to try and narrow down the sources. Sampling above and below an anticipated source would help to direct implementation actions.

Tyson and Renfro Creeks are unique, and a complete field evaluation will be needed before implementation activities begin. The implementation plan will be written and implemented by Idaho's designated management agencies (DMAs). The type of practice found to be contributing to the bacteria load will be the responsibility of the DMAs to implement. In addition to the DMAs, the public, through the watershed advisory group (WAG) and other equivalent organizations or processes, will be provided with opportunities to be involved in developing the implementation plan to the maximum extent practical. The Idaho DMAs responsible for management activities include the following:

- Idaho Department of Lands for timber harvest activities, oil and gas exploration and development, and mining activities
- Idaho Soil and Water Conservation Commission for grazing and agricultural activities
- Idaho Transportation Department for public road construction
- Idaho State Department of Agriculture for aquaculture
- DEQ for all other activities

Approach

TMDLs will be implemented through the continuation of ongoing pollution control activities in the watershed. The designated WAG, DMAs, local organizations, and other appropriate public process participants are expected to do the following:

- Develop best management practices (BMPs) to achieve load allocations.
- Give reasonable assurance that management actions will meet load allocations through both quantitative and qualitative analysis of management measures.
- Adhere to measurable milestones for progress.
- Develop a timeline for implementation, including cost and funding.
- Develop a monitoring plan to determine if BMPs are being implemented, if individual BMPs are effective, and if load allocations are being met.

The responsible DMA will recommend specific control actions and then submit the implementation plan to DEQ. DEQ will act as a repository for the implementation plan and conduct 5-year reviews of progress toward TMDL goals.

Discussion

Multiple BURP sites have been sampled within the Tyson and Renfro Creek watersheds. During the visits, field crews noted cattle either in or near the streams. The two most

recent BURP surveys, Tyson Creek 2008 and Renfro Creek 2004, noted heavy grazing and a reduced riparian community. Based on the field observations, the land-use activity should be investigated when developing implementation activities.

5.6 Conclusions

Two pollutant/assessment unit combinations were addressed in this TMDL (Table 3). Water samples collected during BURP surveys within the Tyson and Renfro Creek watersheds in 2008 and 2004, respectfully, contained *E. coli* concentrations in exceedance of Idaho water quality standards to protect secondary contact recreation beneficial use. Following the collection and analysis of the first sample, 4 additional samples were taken 5 to 7 days apart to properly assess against Idaho water quality standards. A geometric mean was calculated from the 5 samples, and this mean exceeded Idaho water quality criteria.

Table 3. Summary of assessment outcomes

Stream	Assessment unit	Pollutant	TMDL(s) completed	Recommended changes to Integrated Report	Justification
Tyson Creek	ID17010304PN013_03	Bacteria (*E. coli*)	Yes	Move AU[a] to category 4a	TMDL completed
Renfro Creek	ID17010304PN024_03	Bacteria (*E. coli*)	Yes	Move AU[a] to category 4a	TMDL completed

[a] Assessment unit

References Cited

DEQ (Idaho Department of Environmental Quality). 2003. St. Maries River Subbasin Assessment and Total Maximum Daily Loads. Boise, ID: DEQ.

IDAPA 58.01.02.251. Water Quality Standards, Surface Water Quality Criteria for Recreation Use Designations.