

**LOWER GRANDE RONDE SUBBASINS TMDL
CHAPTER 3: BACTERIA**

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TABLE OF CONTENTS

3.1 Overview	1
3.2 Waterbodies	3
3.3 Pollutant Identification	3
3.4 Beneficial Use Identification	3
3.5 Target Identification	4
3.5.1 Applicable Water Quality Standard	4
3.5.2 Deviation from Water Quality Standard	5
3.5.3 Analytical Techniques	8
3.6 Seasonal Variation	9
3.7 Source Assessment	13
3.7.1 Point Sources	13
3.7.1.1 Sewage Treatment Plants	13
3.7.1.2 Facilities with General Permits	14
3.7.1.3 Confined Animal Feeding Operations	14
3.7.2 Nonpoint sources	14
3.7.2.1 Wallowa River	15
3.7.2.2 Spring Creek	16
3.7.2.3 Prairie Creek	17
3.7.2.4 Minam River	19
3.8 Loading Capacity and Allocations	20
3.8.1 Loading Capacity	20
3.8.1.1 Wallowa River	20
3.8.1.2 Spring Creek and Prairie Creek	21
3.8.2 Allocations	22
3.8.2.1 Wasteload Allocations	22
3.8.2.2 Load Allocations	22
3.8.3 Excess Load	23
3.9 Margin of Safety	23
3.10 Reserve Capacity	23
3.11 Water Quality Standard Attainment Analysis and Reasonable Assurances	23
3.12 References	25

FIGURES

Figure 3-1. 2004/2006 303(d) listed streams for bacteria (bolded red, purple and yellow lines) and location of sites where bacteria data was collected (1996-2004)	6
Figure 3-2. Land use and E. coli Concentrations in the Wallowa River Valley	8
Figure 3-3. Flow, precipitation, and bacterial concentrations in the Wallowa River	10
Figure 3-4. Monthly boxplot summary of E. coli concentrations including all monitoring sites on the Wallowa River (1996-2004)	10
Figure 3-5. Seasonal fecal coliform concentrations in Spring Creek, using data collected during bacteria studies in 1989 and 1999-2001	11
Figure 3-6. Seasonal fecal coliform concentrations in Prairie Creek, using data collected during bacteria studies in 1989 and 1999-2001	12
Figure 3-7. Load duration curve analysis of E. coli concentrations in relation to flow in the Wallowa River	16
Figure 3-8. E coli concentrations in individual samples collected at sites on Spring Creek from 1999 to 2001	17

Figure 3-9. Longitudinal summary of *E. coli* concentrations at sites on Spring Creek from 1999 to 2001 17
 Figure 3-10. Concentrations in individual samples collected at sites on Prairie Creek from 1999 to 2001 18
 Figure 3-11. Longitudinal summary of *E. coli* concentrations at sites on Prairie Creek from 1999 to 2001 18
 Figure 3-12. Load duration curve analysis of *E. coli* concentrations in relation to flow in the Minam River 19
 Figure 3-13. Measured loads, loading capacities and surrogate percent reductions needed to meet loading capacities in the Wallowa River 21

TABLES

Table 3-1. Wallowa River Subbasin bacteria TMDL components 1
 Table 3-2. Designated beneficial uses in the Grande Ronde Basin (OAR 340-041-0151) 3
 Table 3-3. Waterbodies included as Water Quality Limited on Oregon’s 303(d) list (2004/06) (DEQ 2007a) 5
 Table 3-4. Results of *E. coli* sampling conducted on the Wallowa and Minam Rivers from 1996 through 2004 and two tributaries to the Wallowa River in 1999-2001. 7
 Table 3-5. Flow-based loading capacities and percent reduction targets for the Wallowa River addressing the log mean criterion 21
 Table 3-6. Concentration-based percent reduction targets for Spring Creek and Prairie Creek, addressing both numeric criteria 22
 Table 3-7. Nonpoint source load allocation surrogate measures for the Wallowa River Subbasin 23

3.1 OVERVIEW

The Wallowa River Valley is home to the majority of human population and agricultural industry in the Lower Grande Ronde Subbasins. Although there are potential sources of bacteria in other parts of the Lower Grande Ronde Subbasins, at present no data are available to demonstrate fecal bacteria impairment in these areas. This Chapter presents an analysis of available water quality data and an estimate of fecal bacteria reductions necessary to achieve water quality standards in the Wallowa Subbasin. **Table 3-1** summarizes the components of this TMDL, with reference to Oregon Administrative Rule (OAR), federal Clean Water Act (CWA) and Code of Federal Regulations (CFR) requirements.

Table 3-1. Wallowa River Subbasin bacteria TMDL components

Waterbodies OAR 340-042-0040(4)(a)	Perennial and intermittent waterbodies providing recreational contact beneficial uses as defined in OAR 340-041-0151(1), Table 151A within the Wallowa River Subbasin (4 th field HUCs 17060105).
Pollutant Identification OAR 340-042-0040(4)(b)	<i>Pollutants:</i> Fecal bacteria from various sources, particularly <i>E. coli</i> as an indicator of human pathogens for recreational contact.
Beneficial Uses OAR 340-042-0040(4)(c) OAR 340-041-0151(1)	The most sensitive beneficial use in the Wallowa River Subbasin is water contact recreation.
Target Identification (Applicable Water Quality Standards) OAR 340-042-0040(4)(c) CWA §303(d)(1)	OAR 340-041-0009 provides numeric and narrative bacteria criteria. <i>E. coli</i> is used as an indicator of human pathogens for water recreational contact and may not exceed: (A) A 30-day log mean of 126 <i>E. coli</i> organisms per 100 milliliters, based on a minimum of five samples; (B) No single sample may exceed 406 <i>E. coli</i> organisms per 100 milliliters. A long-term log mean concentration was used as a surrogate measure for the 30-day log mean because of the limited data available for the analysis.
Existing Sources OAR 340-042-0040(4)(f) CWA §303(d)(1)	Fecal bacteria sources may include wildlife, livestock waste, failing residential septic systems, wastewater treatment plant malfunctions, rural residential runoff and urban runoff.
Seasonal Variation OAR 340-041-0040(4)(j) CWA §303(d)(1)	Where possible, data was evaluated seasonally. Seasonal variation is addressed using load duration curves because they incorporate all observed flows which are seasonally dependent.
TMDL Loading Capacity OAR 340-042-0040(4)(d) CWA §303(d)(1)	Loading capacities were developed targeting both the log mean criterion of 126 <i>E. coli</i> organisms per 100 ml and the maximum criterion of 406 organisms per 100 ml. Flow-based loading capacities were developed for the Wallowa River through the development of a load duration curve.

Table 3-1 (continued). Wallowa River Subbasin bacteria TMDL components

<p>Allocations OAR 340-042-0040(4)(e) OAR 340-042-0040(4)(g) OAR 340-042-0040(4)(h) 40 CFR 130.2(f) 40 CFR 130.2(g) 40 CFR 130.2(h)</p>	<p>The TMDL is divided into allocations to point sources (waste load allocations), nonpoint sources (load allocations), and a margin of safety (MOS). Allocations apply year round.</p> <p><u>Waste Load Allocations (Point Sources):</u> Waste load allocations for waste water treatment plants are expressed as the effluent concentration equal to the target criteria. Waste load allocations for facilities with general permits were assigned their current load. Confined Animal Feeding Operations (CAFOs) are assigned a zero wasteload allocation.</p> <p><u>Load Allocations (Nonpoint Sources):</u> Load allocations are expressed as both a flow-based load (Wallowa River) and as percent reduction targets needed to meet the numeric criteria. The allocations apply across all flow ranges. Nonpoint sources covered by the allocations include agriculture, urban and residential land uses. Forestry was not identified as a source of bacteria contributing to elevated <i>E. coli</i> levels.</p> <p><u>Excess Load:</u> The difference between the actual pollutant load and the loading capacity of the waterbody.</p>
<p>Surrogate Measures OAR 340-041-0040(5)(b) 40 CFR 130.2(i)</p>	<p>Percent reduction in bacterial loading or concentration needed to meet the numeric criteria were used as surrogate measures.</p>
<p>Margins of Safety OAR 340-042-0040(4)(i) CWA §303(d)(1)</p>	<p>An implicit margin of safety was used and implemented through the use of conservative assumptions in the development and interpretation of the load duration curve and the percent reduction targets and in application of the load allocations on a year-round basis.</p>
<p>Reserve Capacity OAR 340-042-0040(4)(k)</p>	<p>No explicit reserve capacity is assigned at this time for bacteria in Wallowa River Subbasin water bodies. New sources of fecal bacteria in the Subbasin may discharge into receiving waters at the applicable numeric criteria.</p>
<p>Water Quality Management Plan OAR 340-041-0040(4)(l) CWA §303(d)(1)</p>	<p>The Water Quality Management Plan (see Chapter 4) provides the framework of management strategies to attain and maintain water quality standards. This Plan provides reasonable assurance that the TMDL and associated allocations will be met. The framework is designed to work in conjunction with detailed plans and analyses provided in sector-specific or source-specific implementation plans. The strategy for attainment for this TMDL will be encouragement of bacteria-focused implementation of the Agricultural Water Quality Management Area Plan, accompanied by long term monitoring.</p>

3.2 WATERBODIES

This TMDL applies to perennial and intermittent waterbodies within the Wallowa River Subbasin providing recreational contact beneficial uses as defined in OAR 340-041-0151(1), Table 151A.

3.3 POLLUTANT IDENTIFICATION

The pollutant causing impairment is pathogenic microorganisms including bacteria, viruses, and protozoa that cause disease when ingested by people. The presence of these pathogens has traditionally been determined by their association with “indicator” bacteria that are more readily measured. In Oregon standards and this TMDL, *Escherichia coli* (*E. coli*), a species within the category of fecal coliform bacteria, is the indicator used for determining compliance and setting load allocations. These bacteria live in the gastrointestinal tract of warm-blooded vertebrate animals and are shed in their feces. The most typical *E. coli* strains do not cause illness; rather they indicate sources that are likely to include other pathogens that do cause human illness. Fecal coliform and *E. coli* have been measured in water bodies in the Wallowa River Subbasin.

3.4 BENEFICIAL USE IDENTIFICATION

Water quality standards include designation of beneficial uses, numeric and narrative criteria for individual parameters to protect those uses, and anti-degradation policies to protect overall water quality. Beneficial uses and the associated water quality criteria are generally determined by Basin and are applicable throughout the Basin (**Table 3-2**). In practice, water quality standards have been set at a level to protect the most sensitive beneficial uses and seasonal standards may be applied for uses that do not occur year-round.

The beneficial uses affected by elevated fecal bacterial concentrations in surface waters are primary water contact recreation (e.g. swimming) and shellfish harvesting in estuarine and marine waters. This TMDL is only concerned with recreational contact as the Lower Grande Ronde Subbasins have no estuarine or marine waters. Water contact recreation is considered a beneficial use in all waters throughout the year.

Table 3-2. Designated beneficial uses in the Grande Ronde Basin (OAR 340-041-0151)

The beneficial use most sensitive to bacteria is marked in grey.

Beneficial Uses	Grande Ronde River (RM 39 to 165)	All Other Basin Waters
Public Domestic Water Supply ¹	X	X
Private Domestic Water Supply ¹	X	X
Industrial Water Supply	X	X
Irrigation	X	X
Livestock Watering	X	X
Fish & Aquatic Life ²	X	X
Wildlife & Hunting	X	X
Fishing	X	X
Boating	X	X
Water Contact Recreation	X	X
Aesthetic Quality	X	X
Hydro Power	X	X
Commercial Navigation & Transportation		

¹ With adequate pretreatment (filtration & disinfection) and natural quality to meet drinking water standards.

² See also Figures 151A and 151B for fish use designations for this basin.

3.5 TARGET IDENTIFICATION

3.5.1 Applicable Water Quality Standard

Bacteria criteria for Oregon's waters are contained in the Oregon Administrative Rules, section 340-41-0009. Bacteria impair the recreational use of rivers when concentrations exceed those determined through epidemiological studies to cause illness through body contact at a rate of 8 or more cases per 1000 swimmers. The indicator bacterium used by DEQ for assessing bacterial contamination for recreational waters changed in 1996 from the general class of fecal coliform bacteria to *E. coli*. In general, *E. coli* are a subset of fecal coliform bacteria. This change was made in part because *E. coli* is a more direct reflection of contamination from sources that also carry pathogens harmful to humans and is correlated more closely with human disease.

Some of the 303(d) listings in the Wallowa River Subbasin are based on the fecal coliform bacteria standard in effect prior to 1996. The freshwater criteria for fecal coliform used to be:

A log mean of 200 fecal coliform per 100 ml based on a minimum of five samples in a 30-day period with no more than ten percent of the samples in the 30-day period exceeding 400 per 100 ml.

The applicable numeric and narrative criteria for the standard adopted in 1996 are as follows:

(OAR 350-041-0009, gray shaded where not applicable in Lower Grande Ronde Subbasins):

(1) Numeric Criteria: Organisms of the coliform group commonly associated with fecal sources (MPN or equivalent membrane filtration using a representative number of samples) shall not exceed the criteria described in subparagraphs (a) and (b) of this paragraph.

(a) Freshwaters and Estuarine Waters Other than Shellfish Growing Waters:

*(A) A 30-day log mean of 126 *E. coli* organisms per 100 ml, based on a minimum of five (5) samples;*

*(B) No single sample shall exceed 406 *E. coli* organisms per 100 ml.*

(b) Marine Waters and Estuarine Shellfish Growing Waters: A fecal coliform median concentration of 14 organisms per 100 milliliters, with not more than ten percent of the samples exceeding 43 organisms per 100 ml.

(2) Raw Sewage Prohibition: No sewage shall be discharged into or in any other manner be allowed to enter waters of the state unless such sewage has been treated in a manner approved by the Department or otherwise approved by these rules;

(3) Animal waste: Runoff contaminated with domesticated animal wastes must be minimized and treated to the maximum extent practicable before it is allowed to enter waters of the state;

(4) Bacterial pollution or other conditions deleterious to waters used for domestic purposes, livestock watering, irrigation, bathing, or shellfish propagation, or otherwise injurious to public health shall not be allowed;

*(5) Effluent Limitations for Bacteria: Except as allowed in subsection (c) of this section, upon NPDES permit renewal or issuance, or upon request for a permit modification by the permittee at an earlier date, effluent discharges to freshwaters, and estuarine waters other than shellfish growing waters may not exceed a monthly log mean of 126 *E. coli* organisms per 100 ml. No single sample may exceed 406 *E. coli* organisms per 100 ml.*

This TMDL is based on analysis of all available data, including both fecal coliform and *E. coli*, but development of loading capacity and allocations are based on *E. coli* data only. The TMDL is written to address both the log mean and the maximum criteria of the standard. A long-term log mean

concentration was used as a surrogate measure for the 30-day log mean. This is because, within the limited data set available for this analysis, five samples were never collected within a 30-day period.

3.5.2 Deviation from Water Quality Standard

The Willowa River and two of its tributaries, Spring Creek and Prairie Creek, are impaired for bacteria (**Table 3-3** and **Figure 3-1**) (DEQ 2007a). These three water bodies were first listed (1998) based on fecal coliform data collected during the spring, 1989. More recent analysis of *E. coli* data used for the 2004/2006 303(d) list indicated that Prairie Creek and the Willowa River were also impaired during the summer relative to the *E. coli* standard. There was apparently not enough *E. coli* data collected on Spring Creek in any given season to evaluate for impairment on the 2004/2006 list, although exceedances of the criterion were observed in the few samples that were collected. Note that there are two different Prairie Creeks identified on the 303(d) list and shown on **Figure 3-1** (one shows as a purple line on the map and one shows as a red line).

Data used for evaluation purposes in this TMDL was collected at sites on the Willowa River, Minam River, Spring Creek and Prairie Creek (**Figure 3-1**). Most stations were sampled during the period from 1999 to 2001, although two stations are part of DEQ's ambient monitoring network (Willowa River at Minam and Minam River at Minam) and have been sampled and analyzed for *E. coli* regularly since 1996. Data from these two sites is reported for the period 1996-2004. On Prairie and Spring Creeks, *E. coli* sampling has only occurred from May through August. A summary of the data is provided in **Table 3-4** and **Figure 3-2**. Samples were collected over varying periods among stations, and some "stations" shown in **Figure 3-2** are composites of several closely located sites. **Table 3-4** shows the log mean, as well as the maximum value for all samples collected at each site or collection of sites. The cells highlighted in yellow indicate the stations where violations of one of the *E. coli* criteria were observed based on this assessment. Water quality violations were observed on the Willowa River at Minam, Willowa River near Willowa and on Prairie and Spring Creeks at numerous locations. The highest log mean and maximum concentration were measured on Spring Creek at the ODFW hatchery intake.

The results from these stations indicate that the concentrations in the Willowa River generally met water quality criteria, but those in Spring Creek and Prairie Creek generally did not. Source waters from Willowa Lake and from the Minam River Watershed were generally clean and reflect natural background conditions. There have been no violations of the single sample criterion (406 *E. coli*/100 ml) reported at the site on the Minam River since 1996.

Table 3-3. Waterbodies included as Water Quality Limited on Oregon's 303(d) list (2004/06) (DEQ 2007a)

Name	River Miles	Parameter	Year of Listing	Season
Prairie Creek*	0 to 2.4	<i>E. coli</i>	2004	Summer
Prairie Creek*	0 to 12.5	<i>E. coli</i>	2004	Summer
Willowa River	0 to 50	<i>E. coli</i>	2004	Summer
Prairie Creek	0 to 12.5	Fecal Coliform	1998	Fall/Winter/Spring
Spring Creek	0 to 4.5	Fecal Coliform	1998	Fall/Winter/Spring
Willowa River	0 to 50	Fecal Coliform	1998	Summer

* These two listings for Prairie Creek are for two different stream segments, with different LLID numbers.

Figure 3-1. 2004/2006 303(d) listed streams for bacteria (bolded red, purple and yellow lines) and location of sites where bacteria data was collected (1996-2004)

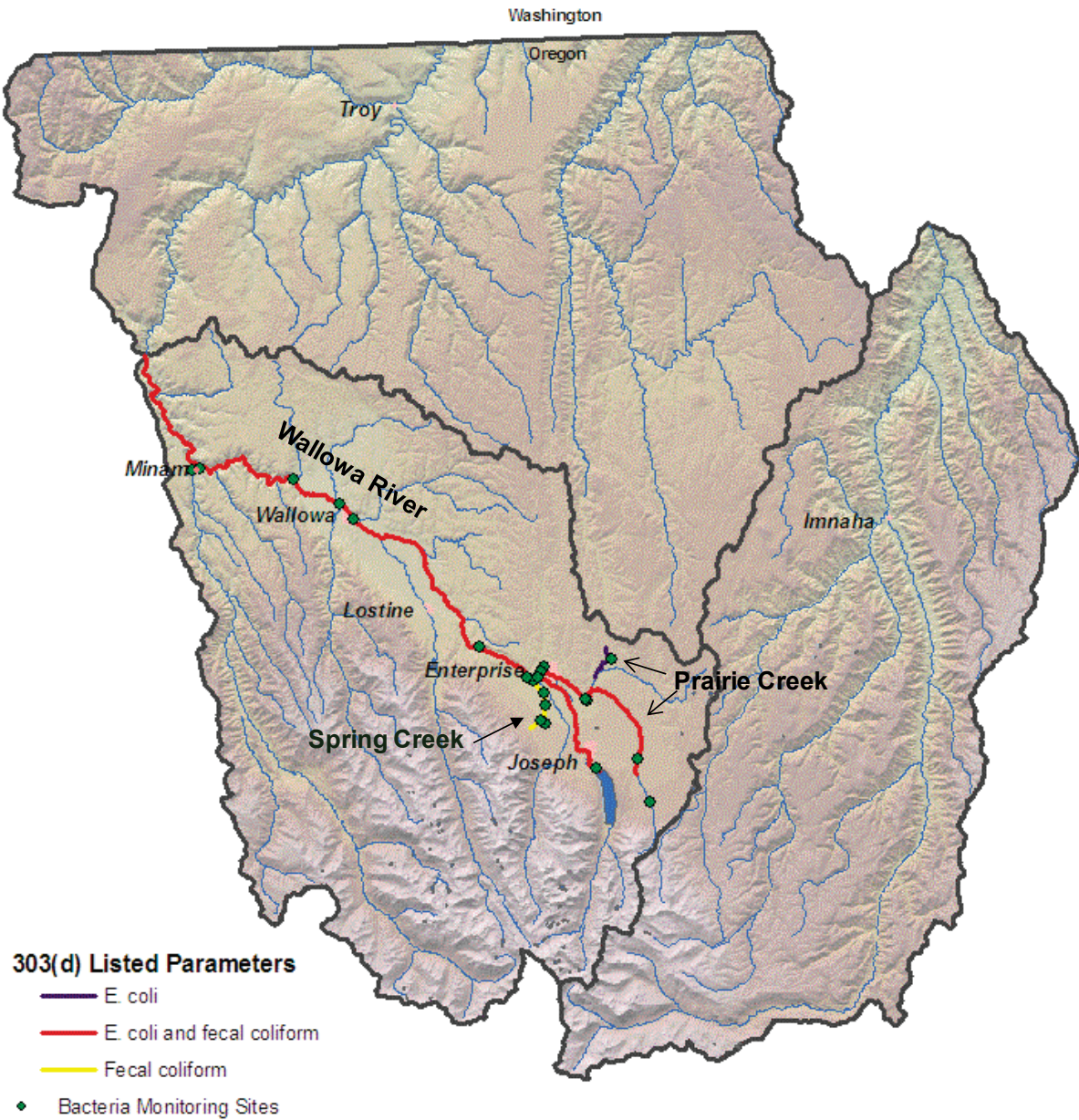


Table 3-4. Results of *E. coli* sampling conducted on the Wallowa and Minam Rivers from 1996 through 2004 and two tributaries to the Wallowa River in 1999-2001.

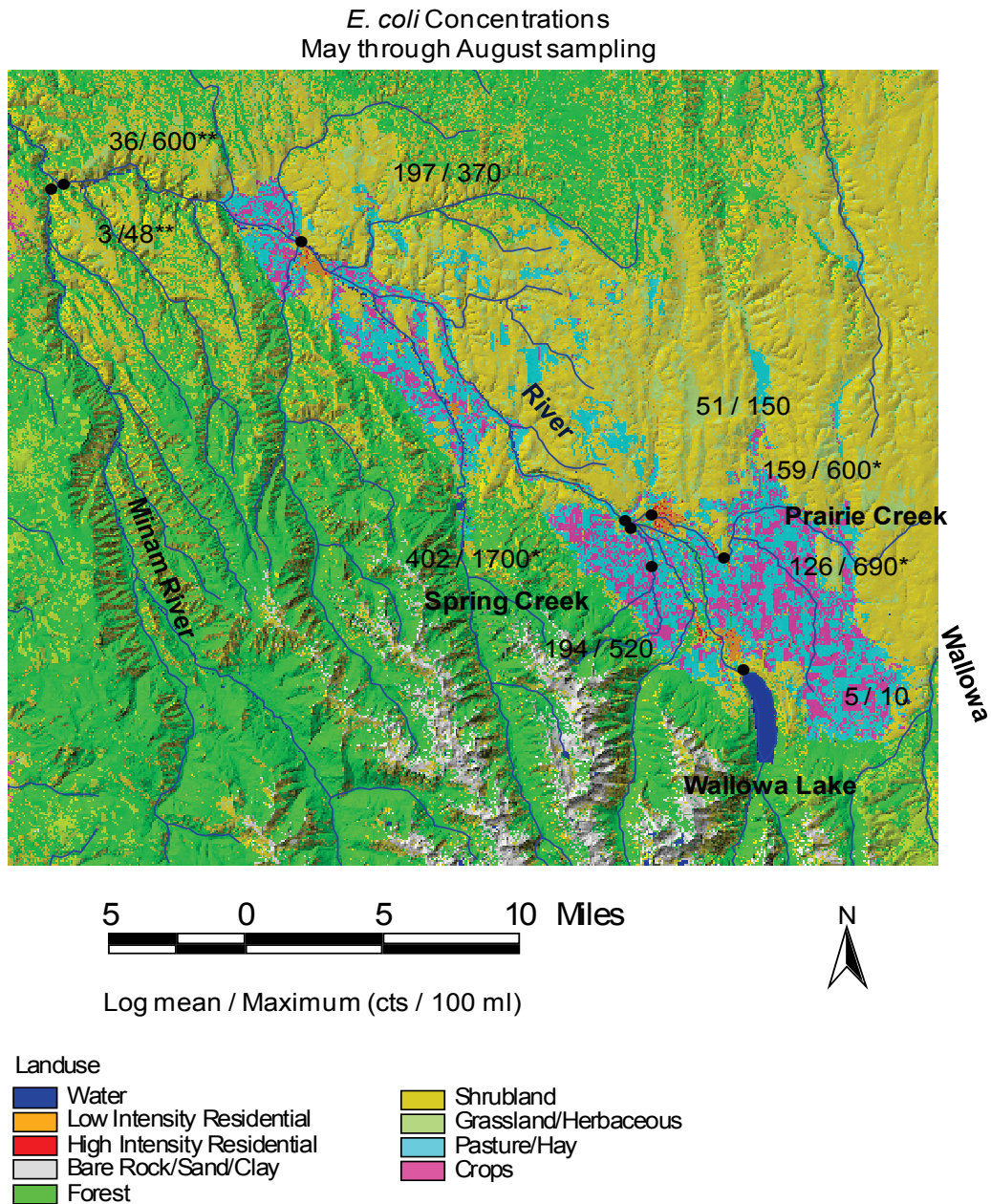
The cells highlighted in yellow indicate the stations where violations of one of the *E. coli* criteria were observed based on this assessment.

Site	LASAR #	River Mile	Months of Data Collection	# of Samples	Log* mean	Max <i>E. coli</i>	# > 406 (%)	Months of Violation**
Spring Creek								
Below ODFW hatchery	11583	0.4	Jun & Jul 2000 May 2001	4	287	550	1 (25%)	June 2000
At Hatchery Intake	11581	0.7	Jun & Jul 2000 May 2001	4	583	1700	3 (75%)	June & July 2000, May 2001
Upstream of hatchery pond	11582	0.8	Jun 1999 May 2001	3	384	600	2 (67%)	June 1999 May 2001
At Mawhin Rd.	25447	1.8	May 2001	1	--	134	0 (0 %)	None
At Eggleston Rd.	11580	2.6	Jul 2000 May 2001	3	194	520	1 (33%)	July 2000
West Fork Spring Creek at Pine Tree Rd.	25446	3.7	May 2001	1	--	348	0 (0 %)	None
On Alder Slope	11579	3.9	Jun 2000	1	--	760	1 (100%)	June 2000
Prairie Creek								
Off Walter St. in Enterprise	24072	0.6	Jul 2000 May 2001	2	--	136	0 (0 %)	None
At Greenwood St. in Enterprise	21515	0.7	Jun & Aug 1999 Jun 2000 May 2001	6	175	600	2 (33%)	June & August 1999
Downstream Joseph STP	11587	4.3	Jun & Jul 2000 May 2001	4	238	690	1 (25%)	July 2000
Upstream Joseph STP	11586	4.4	May 2001	2	--	180	0 (0 %)	None
Upstream of Enterprise at Crow Ck Rd off Hwy 82	21517	4.7	Jun & Aug 1999 Jun & Jul 2000 May 2001	7	82	610	3 (43 %)	June & August 1999, July 2000
At Highway 350	24073	11.6	July 2000	1	--	260	0 (0 %)	None
At junction of Liberty Rd and Turner Lane	25448	14.6	May 2001	1	--	800	1 (100%)	May 2001
Wallowa River								
At Minam	10410	10	Year round 1996-2004	58	36	600	3 (5 %)	June 1996, June & August 1999
Downstream of Rock Creek	11585	18.6	May 2001	2	--	142	0 (0 %)	None
Downstream of Wallowa, at Hwy 82	21518	22.2	Jun & Aug 1999	3	197	370	0 (0 %)	None
At First St. in Wallowa	24074	23.5	Jun & Jul 2000	2	--	94	0 (0 %)	None
At M.P. 60, Hwy 82	24075	37.0	Jul 2000	1	--	26	0 (0 %)	None
At Hatchery Intake	11584	41.8	Jun & Jul 2000 May 2001	4	51	150	0 (0 %)	None
Downstream of Wallowa Lake Dam	10722	50.0	Jun & Aug 1999	3	5	10	0 (0 %)	None
Minam River								
At Minam	11457	0.5	Year round 1996-2004	54	3	48	0 (0 %)	None

* Long-term log mean concentration for the period of record

**Month where violation of the single sample criterion of 406 organisms/100 ml was observed

Figure 3-2. Land use and E. coli Concentrations in the Wallowa River Valley



* Multiple monitoring sites

**Data from 1996 – 2004; data for all other sites from 1999-2001

3.5.3 Analytical Techniques

This section describes several of the analytical techniques used in this TMDL for summarizing the bacterial data collected and determining load allocations.

Log Scale Graphs. Part of the DEQ water quality standard for bacteria is expressed as a 30-day log mean. A log mean is also called a geometric mean, and is a type of average. A log mean, unlike an

arithmetic mean, tends to dampen the effect of very high values, which might bias the result if a straight average were used. This is helpful when analyzing bacteria concentrations, because levels may vary anywhere from 10 to 10,000 fold over a given period. This makes many of the calculations easier and allows the data to be displayed more clearly on graphs. Some of the graphs in this document use a “log scale” for bacteria (see **Figure 3-4** for an example). This means that values on the scale go from 1, to 10 (10^1), to 100 (10^2), to 1,000 (10^3), to 10,000 (10^4) and so forth.

Box Plots. Box Plots are used to illustrate the distribution of samples through time or among places, based on percentiles (see **Figure 3-4** for an example). The percentile indicates the percentage of sample values less than the value at that point in the distribution. In a typical box plot the upper and lower edges of the box are the 75th and 25th percentiles. Within the box, the median is also shown. By definition, the median is the 50th percentile, with 50% of values lower and 50% of values higher than the median. The ends of the “whiskers” are the extreme values in the data, excluding outliers. Moderate and extreme outliers are indicated by closed and open circles, respectively.

Load Duration Curves. DEQ used another analytical approach, a load duration curve, to examine data from sites where daily flow data were available (see **Figure 3-7** for an example). Load duration curves depict relationships between flow and pollutant loading. They offer a relatively simple and accurate methodology for determining the degree of water quality impairment. Because they are capable of illustrating relative impacts under various flow conditions, they can be used in targeting appropriate water quality restoration efforts. Development of load duration curves is described explicitly in the bacteria appendix of the Umpqua TMDL (DEQ 2006a), available on DEQ’s website. Load duration curves have been used in several different Oregon TMDLs (DEQ 2006a; 2006b; 2007b; 2008).

Load duration curves are usually established for sites having long term records of stream flow where water quality monitoring has also been conducted. Each bacterial load is based on a measured *E. coli* concentration. Bacterial loads are calculated by multiplying the concentration of a sample by the flow volume and standardizing to a 24-hour day. Bacterial loads are plotted in relation to the likelihood that a given flow rate will occur (exceedance probability on the x-axis) based on historical flow data. Low flows have a high exceedance probability, while high flows have a low exceedance probability. The range of observed flows was separated into five categories based on flow percentiles: high (<10%), transitional (10-40%), typical (40-60%), dry (60-90%), and low (>90%). These flow regimes were determined internally at DEQ.

In this TMDL, load duration curves could only be developed for the Wallowa River near Minam and the Minam River near Minam. These were the only two monitoring locations where there were long term records for both water quality and flow. Application of load duration curves to TMDL development is described further under **Section 3.7.2.1** and **Section 3.8.1.1**.

3.6 SEASONAL VARIATION

Year round data was only available at DEQ’s ambient monitoring stations on the Wallowa River at Minam (LASAR # 10410) and Minam River at Minam (LASAR 11457). Monthly log mean concentrations for data collected at the Wallowa River ambient site between 1996 and 2004 did not exceed the water quality criterion of 126 organisms/100 ml, although three samples did exceed the single sample criterion during June and August (**Figure 3-3**). Concentrations appear to be responsive to precipitation and flow variations, with highest individual and log mean concentrations in the spring/summer “runoff” season either during times of high flows or rainfall events. The source of the runoff includes spring snow melt, storm events, and flood irrigation. A similar pattern is evident when all the data from all of the sites on the Wallowa River are aggregated, with highest concentrations observed typically observed between May and August (**Figure 3-4**).

Figure 3-3. Flow, precipitation, and bacterial concentrations in the Wallowa River

Stream flows are from the Wallowa River downstream of Water Canyon (USGS flow gage # 13331450, 1995-2004); precipitation is for the City of Wallowa (Western Regional Climate Center Station #358997, 1995-2004); E. coli concentrations are from samples collected from the Wallowa River at Minam (LASAR No. 10410, 1996-2004). The numbers in parenthesis are the number of E. coli samples analyzed for each month.

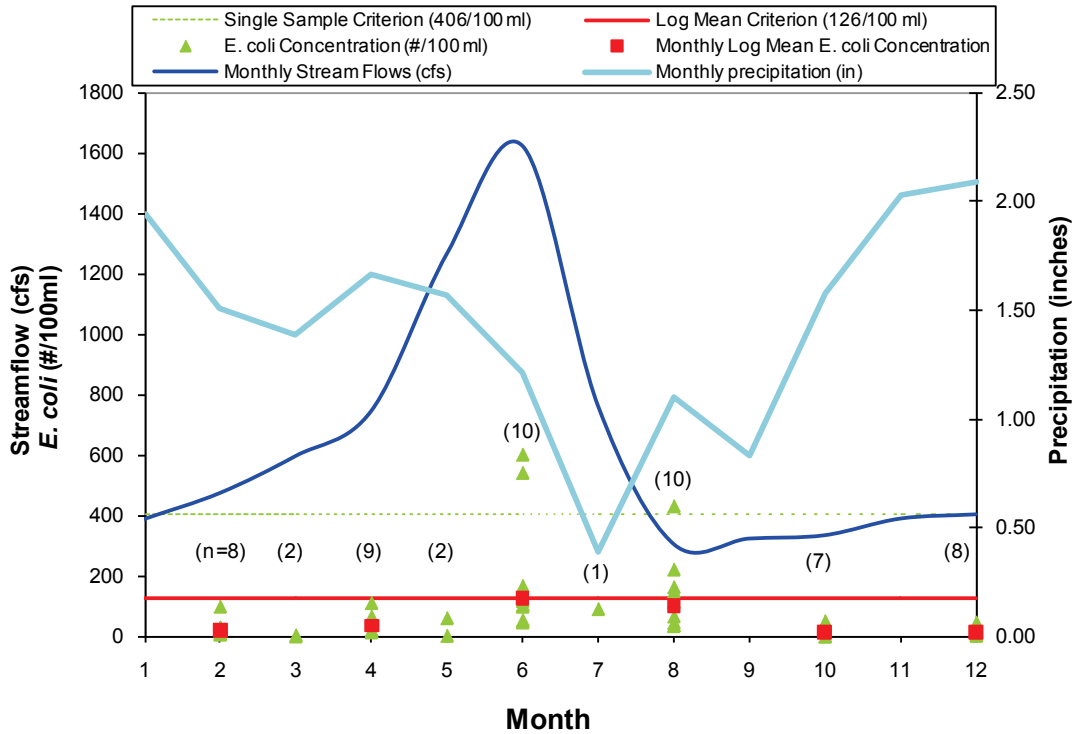
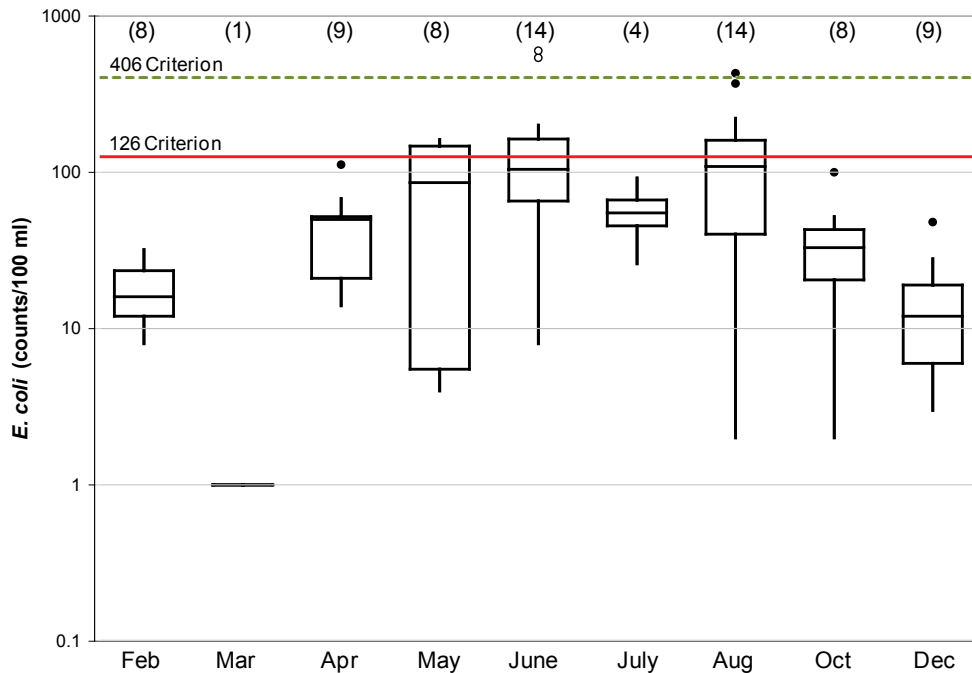


Figure 3-4. Monthly boxplot summary of E. coli concentrations including all monitoring sites on the Wallowa River (1996-2004)

The numbers in parenthesis are the number of samples analyzed for each month.



There was limited *E. coli* data available to assess seasonal trends in Spring Creek and Prairie Creek. An evaluation of fecal coliform data, however, suggests a similar trend as the Wallowa River, with the highest bacteria concentrations generally occurring between April and August (**Figure 3-5** and **Figure 3-6**). Since high flows, precipitation and land use coincide around the valley, and bacteria concentrations in tributary streams are relatively high during the spring/summer, this relationship suggests runoff during these periods carries fecal bacteria into tributaries and, ultimately to the Wallowa River.

Figure 3-5. Seasonal fecal coliform concentrations in Spring Creek, using data collected during bacteria studies in 1989 and 1999-2001

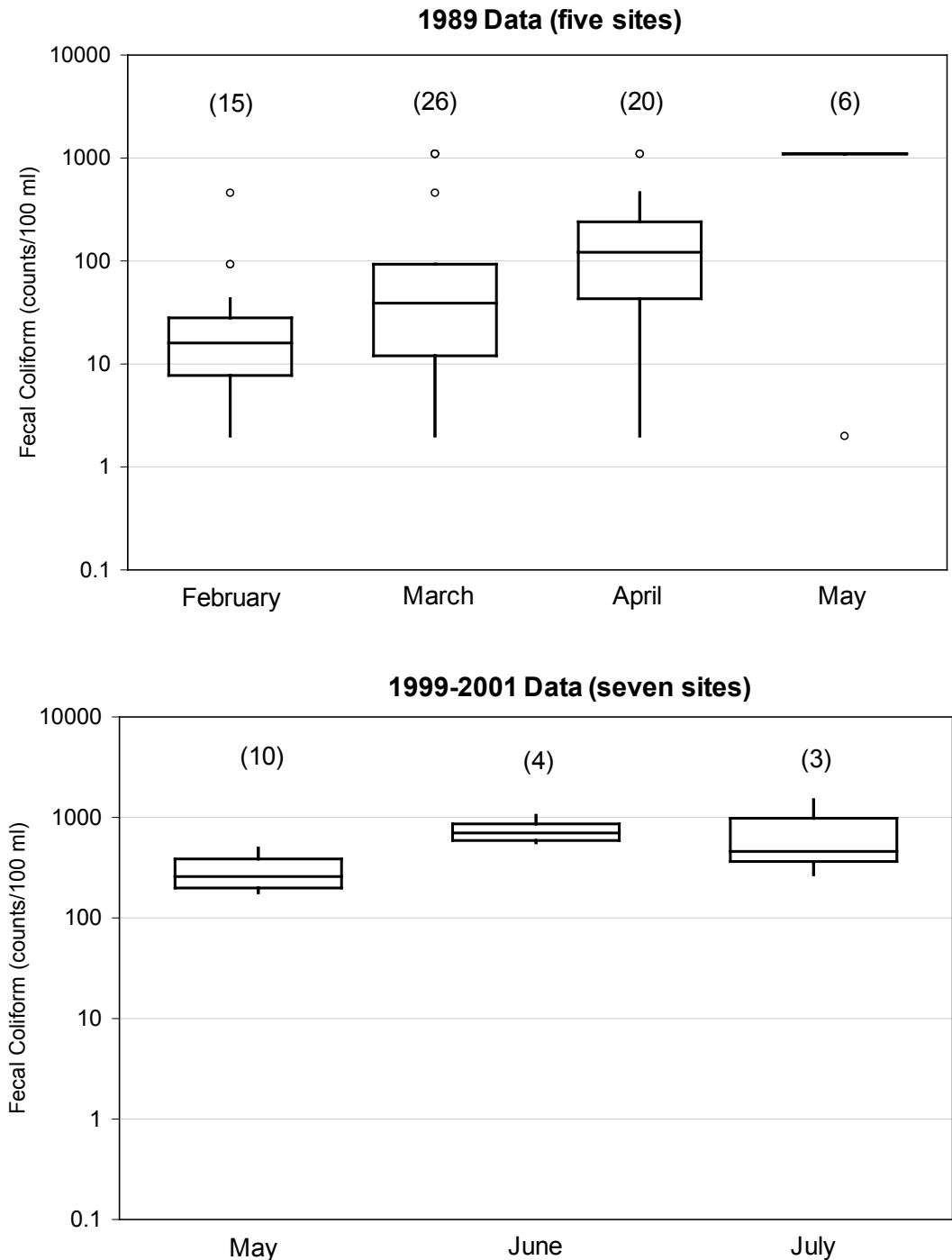
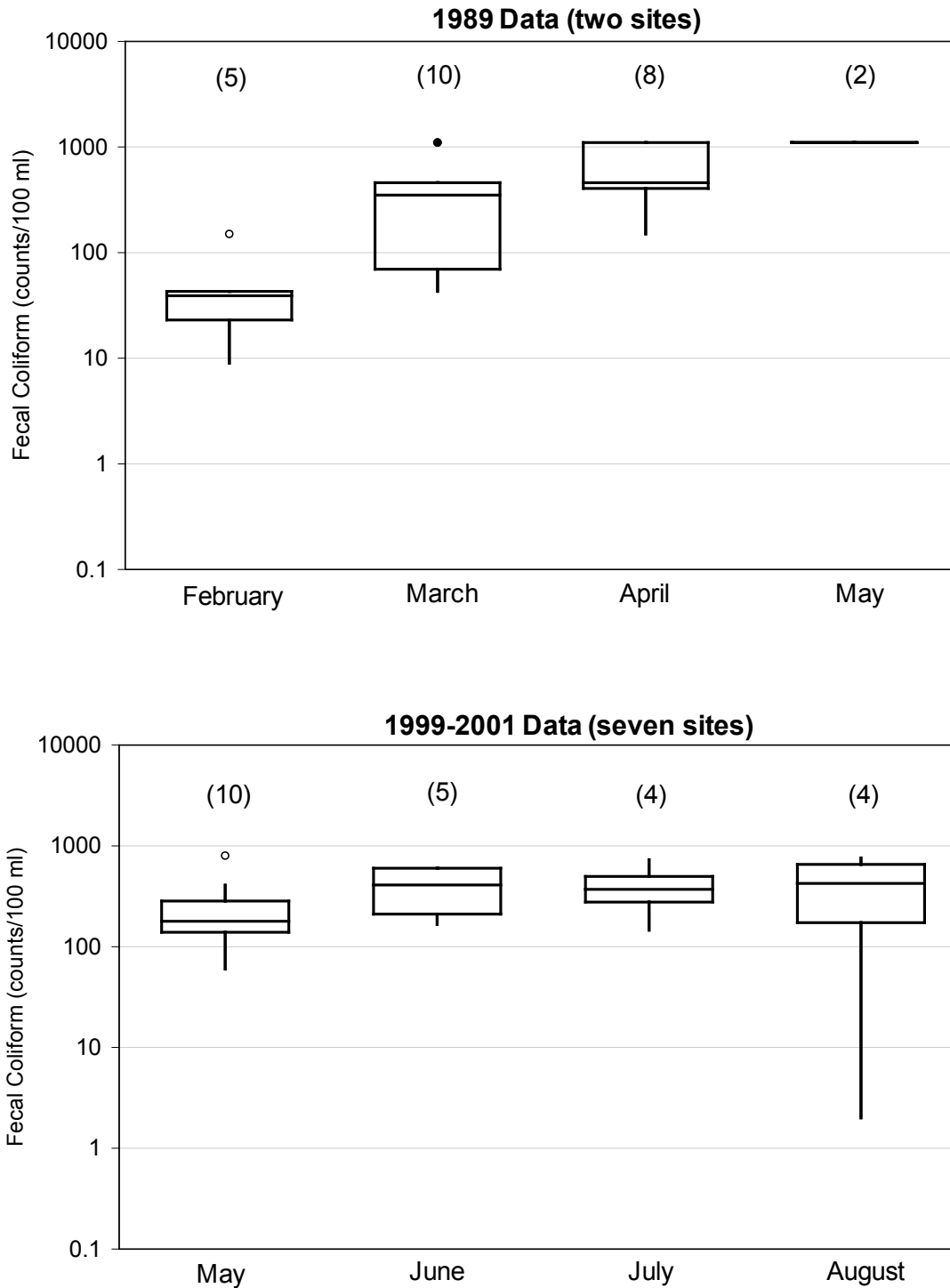


Figure 3-6. Seasonal fecal coliform concentrations in Prairie Creek, using data collected during bacteria studies in 1989 and 1999-2001



3.7 SOURCE ASSESSMENT

3.7.1 Point Sources

Point source discharges can be sources of bacteria. In the Lower Grande Ronde Subbasins, there are seven permitted point-source discharges administered by DEQ (three individual permits for sewage treatment plants and four general permits) and six permitted Confined Feeding Animal Operations (CAFOs) administered by ODA (recall **Table 1-6**, **Table 1-7** and **Figure 1-9**). All of these are in the Wallowa River Subbasin. In addition, there are also three fish acclimation facilities - one in the Wallowa River Subbasin and two in the Imnaha River Subbasin. These are low-volume fish-holding facilities which are exempt from needing an NPDES permit.

Point sources are required by Oregon law to meet the numeric water quality criteria for fecal bacteria prior to discharge to surface waters. Generally, this means discharges will not exceed a log mean of 126 *E. coli* organisms/100ml based on five or more effluent samples in a 30-day period, and no single effluent sample will exceed 406 *E. coli* organisms/100ml. If an exceedance of the criteria is observed, the standard allows the permittee to take a series of consecutive samples following the violative sample to demonstrate compliance overall (see OAR 340-041-0009(5) for details of the re-sampling protocol).

3.7.1.1 Sewage Treatment Plants

There are three sewage treatment plants (STPs) that treat domestic sewage and discharge effluent to the Wallowa River (STPs for the Cities of Enterprise and Wallowa) or Prairie Creek (STP for the City of Joseph) and require individual facility NPDES permits. Discharge monitoring reports from 2003-2005 were analyzed for each of the three STPs and the results are discussed below. When operating in compliance with the requirements of the NPDES permits, sewage treatment facilities will not cause or contribute to bacteria water quality standard violations in the Wallowa River watershed.

City of Enterprise

Effluent from the City of Enterprise STP violated the single-sample criterion in 18 of 105 samples reported (17%) between January 2003 and January 2005. During this same period, the log mean criterion was violated in four separate months (March 2003, July 2003, November 2003, and July 2004). During this time, the city's STP was severely affected by infiltration of the collection system in the spring and early summer from local irrigation. This infiltration caused higher effluent flows than permitted, although there was no apparent relationship between effluent flow rates and bacterial concentrations. Because of the poorly functioning system, the City of Enterprise was required to upgrade their wastewater treatment plant to ensure compliance with water quality standards. The plant was upgraded to an extended aeration activated sludge system, using the Aero-Mod Sequox process. As of August, 2009 the upgrade was complete and the new facility is under operation and has been meeting its permit limits. Given the new treatment plant and the dilution of effluent with the Wallowa River, this STP is not likely to cause or contribute to the bacteria impairment in the future.

City of Wallowa

The sewage treatment plant for the City of Wallowa has generally treated effluent effectively and is not a significant source of bacteria. The concentration of *E. coli* in effluent from the sewage treatment plant for the City of Wallowa exceeded the single sample criterion on five occasions since January 2003: July 2004, December 2004, January 2005, March 2005 and January 2007. Re-sampling within 28 hours following these events demonstrated compliance with the log mean criterion so no violation occurred. Otherwise sample concentrations were generally very low. Given the low frequency of exceedances and the dilution of effluent with the Wallowa River, this STP is not likely to cause or contribute to the bacteria impairment.

City of Joseph

The sewage treatment plant for the City of Joseph has generally treated effluent effectively and is not a significant source of bacteria. There have been two events when effluent concentrations of *E. coli* exceeded the single sample criterion since January 2003: July 2003 and July 2005. Otherwise, sample concentrations were very low in treated effluent. Given the low frequency of exceedances and the dilution of effluent with Joseph Creek, this STP is not likely to cause or contribute to the bacteria impairment.

3.7.1.2 Facilities with General Permits

In addition to the individually permitted sewage treatment plants, there are three facilities in the Wallowa River Subbasin that discharge with general NPDES permits. These facilities include Wallowa Forest Products (permits for industrial stormwater and boiler blowdown), the Wallowa River fish hatchery, and the City of Enterprise (construction stormwater) (see discussion in **Chapter 1**). Given the relatively small size of the discharges, the controls required through the existing permits, and the fact that these are not considered to be significant sources of bacteria, these facilities are not likely to cause or contribute to significant water quality impairment for bacteria or to exceed available loading capacity.

3.7.1.3 Confined Animal Feeding Operations

There are six permitted CAFOs within the Wallowa River Subbasin. According to information from the Oregon Department of Agriculture, four of the six CAFOs have been issued a notice of noncompliance (NON) since 2003 (Melissa Boschee, personal communication). Most of these were either for not having a permit or for not providing an annual report. Only one of the NONs (allowing livestock to have access to the creek) had the potential to release bacteria into waters of the state. In this situation, the pens were moved and the problem was corrected.

3.7.2 Nonpoint sources

Nonpoint source pollution comes from diffuse sources as opposed to point source pollution which is discharged by individual facilities. Potential nonpoint fecal bacteria sources include livestock waste, failing residential septic systems, pets, illegal discharges and wildlife. Fecal bacteria can be deposited directly into a water body or transported into water bodies by runoff or subsurface flow. The behavior of typical nonpoint source bacterial pollution follows certain well-established patterns. Fecal material accumulates on ground surfaces within the watershed and is carried into streams and rivers during rainfall events. This pattern is observed to some degree in the Wallowa River Subbasin with the higher bacteria levels observed at higher stream flows. Higher bacteria levels are also observed in the Subbasin during the summer months. These levels are likely in part the result of the extensive irrigation system located in the valley. Irrigation water passes through canals, laterals and ditches picking up bacteria as excess water or flood irrigation runs over fields, animal pastures, along roadside ditches or urban storm drains and culverts. The sources of the fecal bacteria are not always obvious. Many of these sources overlap in space and time; for instance, a rural residential area may have a failing septic system, livestock, pets, and wildlife. The following section will provide a general discussion of nonpoint sources of bacteria followed by a specific assessment of bacteria concentrations in Wallowa River, Spring Creek, Prairie Creek and Minam River.

Agricultural Lands. Agricultural lands (pasture/hay and cultivated crops) account for approximately three percent of the land use in the Lower Grande Ronde Subbasins (refer back to **Figure 1-7**, USGS 2001), although they account for a much higher percentage of the land in the Wallowa River watershed since that is the predominate agricultural area in the Subbasins. The USDA Natural Resources Conservation Service (NRCS) estimates that twenty-nine percent of the Subbasin is rangeland and eleven percent is hayland/pastureland (NRCS 2006).

The Wallowa County-Nez Perce Salmon Habitat Recovery Plan with Multi-Species Habitat Strategy (SHRP) (1999) identifies feedlots as a “high priority” in terms of water quality in the Wallowa River (head

of Wallowa Canyon to Wallowa Lake) and Prairie Creek (mouth to Elk Fence). Although Spring Creek is not considered specifically in the Recovery Plan, it has similar patterns of livestock use and associated water quality problems. Specifically, the plan states that feedlots contribute to sedimentation, bank erosion, loss of riparian habitat, and excess nutrients. Feedlots which contribute to the aforementioned water quality limitations will also likely contribute bacteria loads. Bacteria can enter a waterbody from livestock defecating directly in the stream, runoff from watering areas that returns to the stream, through irrigation return flow or during overland flow events (rainfall, snowmelt or flood irrigation).

Rural Residential and Urban Lands. Bacteria from developed land is known to come from pets, hobby farms, and failing on-site sewage treatment systems (i.e., septic systems). Residential areas are often inter-mixed with agricultural areas and therefore it can be difficult to separate their contributions to bacteria loading. The higher percentage of impervious surface and efficient storm water delivery systems of urbanized areas can also lead to significant loading from urban areas.

Failing septic tanks can contribute to the bacteria load in a water body. Septic systems fail in a variety of different ways and may contribute to water quality problems under both runoff and non-runoff conditions. An on-site system may not be visibly failing but be located too close to streams to properly treat sewage. Failing septic tanks would contribute constant loading to the stream and therefore cause the highest concentrations at the lowest flows. This pattern has not been observed in the Wallowa River with current data. Thus, while there may be some contribution from failing on-site sewage systems, this does not appear to be the dominant source of bacteria in the Wallowa River. There is not enough data available for Spring and Prairie Creek to make that determination. There are regulatory programs in place at DEQ to ensure on-site systems do not cause or contribute to water quality violations. DEQ manages the onsite program in Wallowa County.

Forest Managed Lands. Fifty-four percent of the Lower Grande Ronde Subbasins is classified as forested (refer back to **Figure 1-7**, USGS 2001). The NRCS (2006) estimates that forty-six percent of the Wallowa River Subbasin is forestland. Bacterial contamination in forested areas can result from a variety of sources including dispersed and developed recreation, wild and domestic animal populations, and human settlements (MacDonald et al. 1991). In forested areas, high levels of fecal bacteria usually will be associated with inadequate waste disposal by recreational users, the presence of livestock or other animals in the stream channel or riparian zone, and poorly maintained septic systems (MacDonald et al. 1991). Although DEQ does not have extensive bacteria data for forested lands in the Lower Grande Ronde Subbasins, results from TMDL studies in other parts of the state (e.g. Willamette and North Coast Basins) indicate that forest lands do not generally appear to cause or contribute to bacteria water quality violations. Bacteria concentrations in Minam River, a mainly forested and undeveloped watershed, tend to be much lower than the Wallowa River, a watershed with urban, agricultural and forested land uses (see discussion below).

3.7.2.1 Wallowa River

A load duration curve was developed for the Wallowa River as a method for assessing possible bacteria sources (**Figure 3-7**). The curve was developed using *E. coli* data from DEQ's ambient site at Minam (LASAR Site #10410) and flow data from the USGS gauge below Water Canyon (Gage #13331450). These two monitoring sites are located within eight miles of each other. On the graph, measured data are shown as blue dots. The continuous green and red curves represent the load at any given flow rate for the single sample maximum (green line) and log mean (red) criteria in the bacteria standard. The loading capacities were determined by multiplying the applicable criteria (126 *E. coli* /100 ml or 406 *E. coli* /100 ml) by the flow and are expressed as the number of organisms per day.

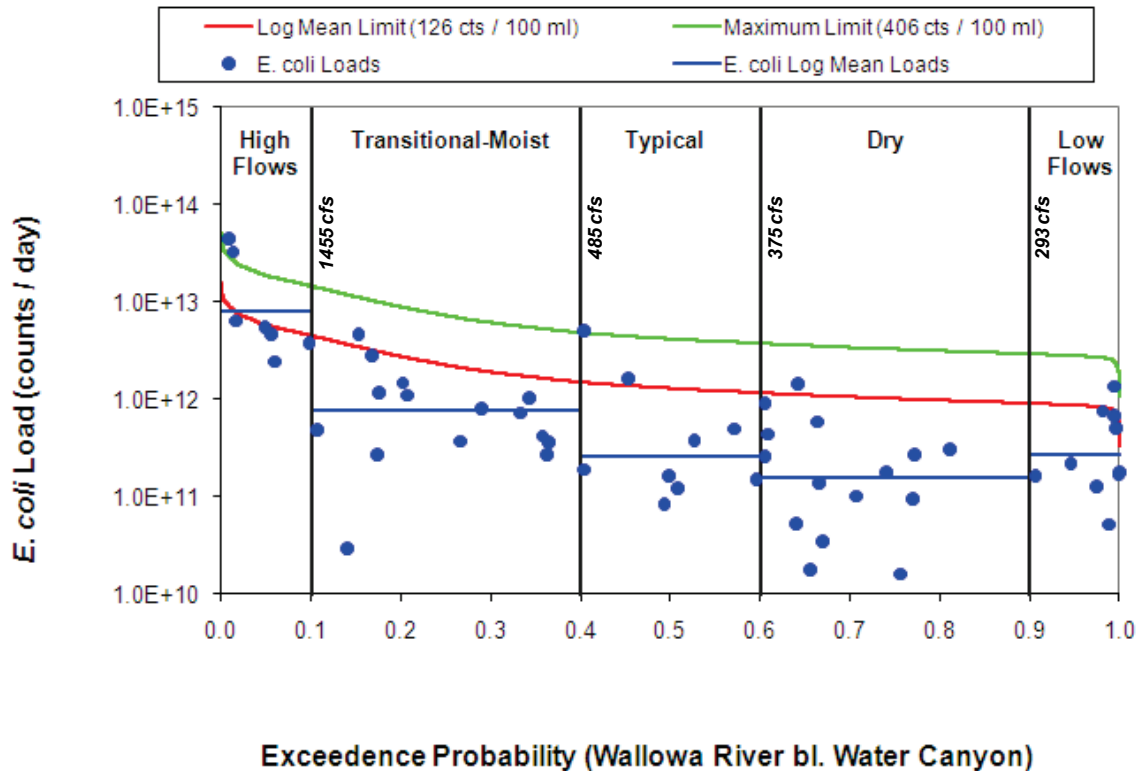
Data that plot above the maximum limit curve violated the single sample criterion. The maximum limit was exceeded at very high flows on two occasions: at flows of 2478 cfs and 3000 cfs. *E. coli* loads were slightly over the maximum limit once at the upper end of the "typical flows" (481 cfs). The higher bacteria loads associated with the high flows seen in **Figure 3-7** were observed during June sampling events (1996 and 1999). The bacteria load associated with flow of 481 cfs was observed during August, 1999.

Data that plot above the log mean limit curve do not necessarily violate the standard, but represent an instantaneous concentration greater than 126 *E. coli* organisms/100ml. The log mean of samples (horizontal blue lines) was calculated for each of five flow regimes. Log mean loads that plot above the log mean criterion indicate an overall violation of the standard for that flow regime. The only case of a violation was at high flow rates (greater than 1455 cfs), where the log mean load was above the log mean criterion limit.

Based on other TMDLs done by DEQ (DEQ 2006a; DEQ 2006b), high fecal values during high flow periods are typically indicative of nonpoint source inputs from across the landscape, generally associated with rainfall and runoff events. For the Wallowa River, these runoff events can include spring snow melt, storm events, and flood irrigation. Failing septic tanks and point sources do not appear to contribute substantially to bacterial contamination in the Wallowa River as these sources would contribute constant loading to the stream and not increased loading with increased stream flow.

Figure 3-7. Load duration curve analysis of *E. coli* concentrations in relation to flow in the Wallowa River

*Exceedance probability represents flow record from Wallowa River below Water Canyon (USGS gage 13331450) and *E. coli* data from the Wallowa River at Minam (DEQ LASAR Site 10410).*



3.7.2.2 Spring Creek

Limited *E. coli* data was collected in Spring Creek in 1999 (June and August), 2000 (June and July) and 2001 (May) (Figure 3-8 and Figure 3-9). Concentrations in Spring Creek did not appear to vary much longitudinally. This pattern suggests that there are bacterial sources throughout the watershed. Land-use in this watershed is predominantly pasture, livestock operations, crops, and rural residential.

Figure 3-8. E coli concentrations in individual samples collected at sites on Spring Creek from 1999 to 2001

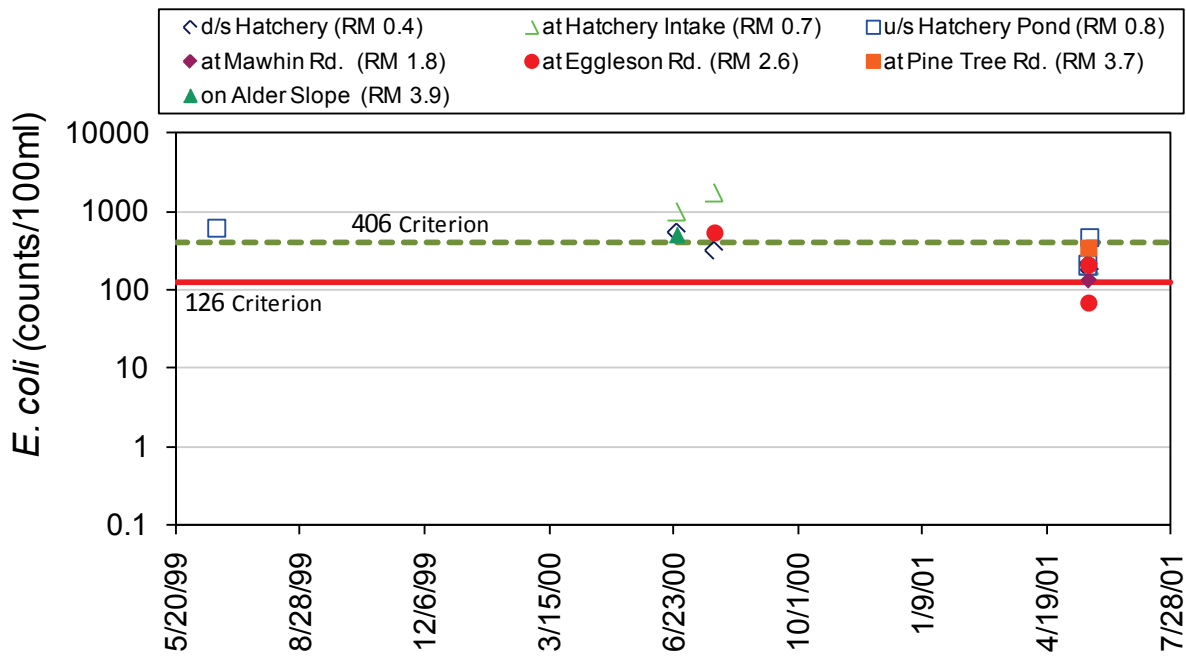
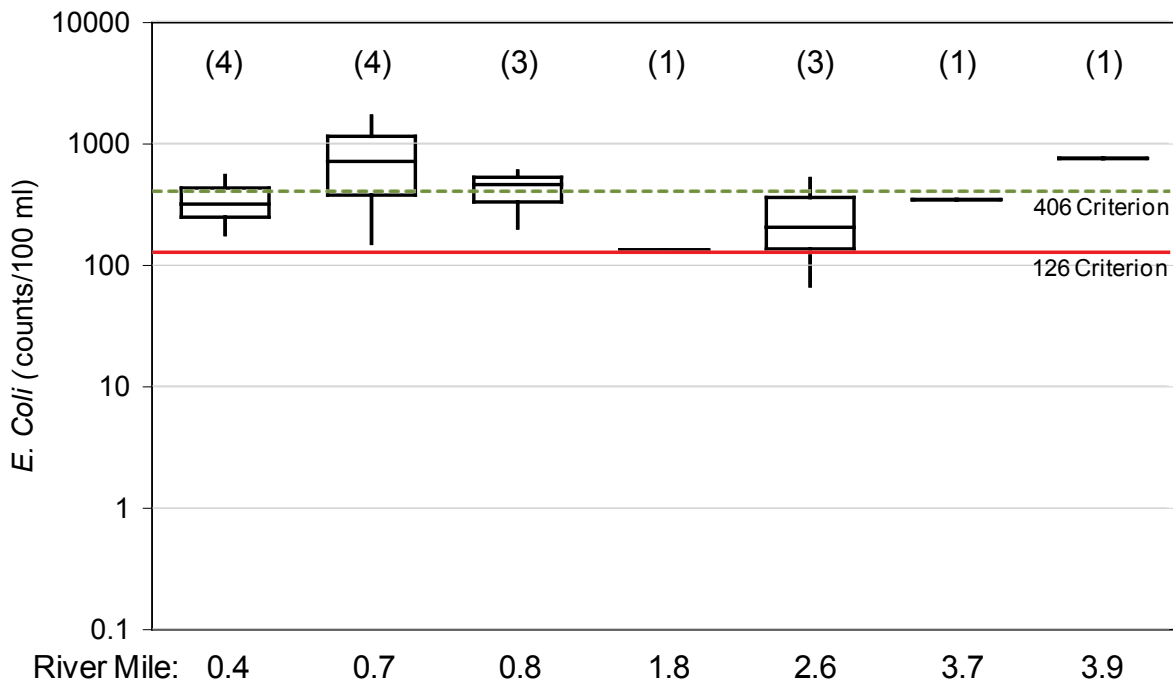


Figure 3-9. Longitudinal summary of E. coli concentrations at sites on Spring Creek from 1999 to 2001



3.7.2.3 Prairie Creek

Limited *E. coli* data was collected in Prairie Creek in 1999 (June and August), 2000 (June and July) and 2001 (May) (Figure 3-10 and Figure 3-11). As for Spring Creek, concentrations in Prairie Creek did not appear to vary much longitudinally, again suggesting that there are bacterial sources throughout the

watershed. Land-use in this watershed is predominantly pasture, livestock operations, crops, and rural residential. Prairie Creek is augmented for irrigation with water from Wallowa Lake, Big Sheep Creek and Little Sheep Creek at several locations along the creek. This augmentation increases stream flows above natural flows (SHRP 1999) and could reduce bacteria concentrations through dilution.

Figure 3-10. Concentrations in individual samples collected at sites on Prairie Creek from 1999 to 2001

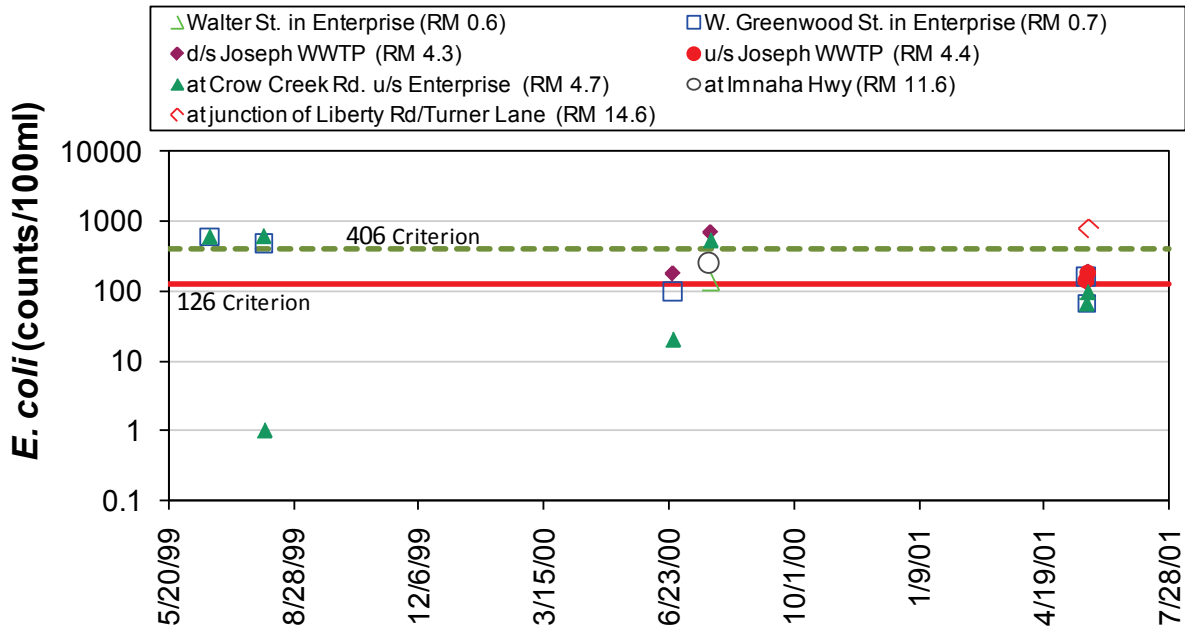
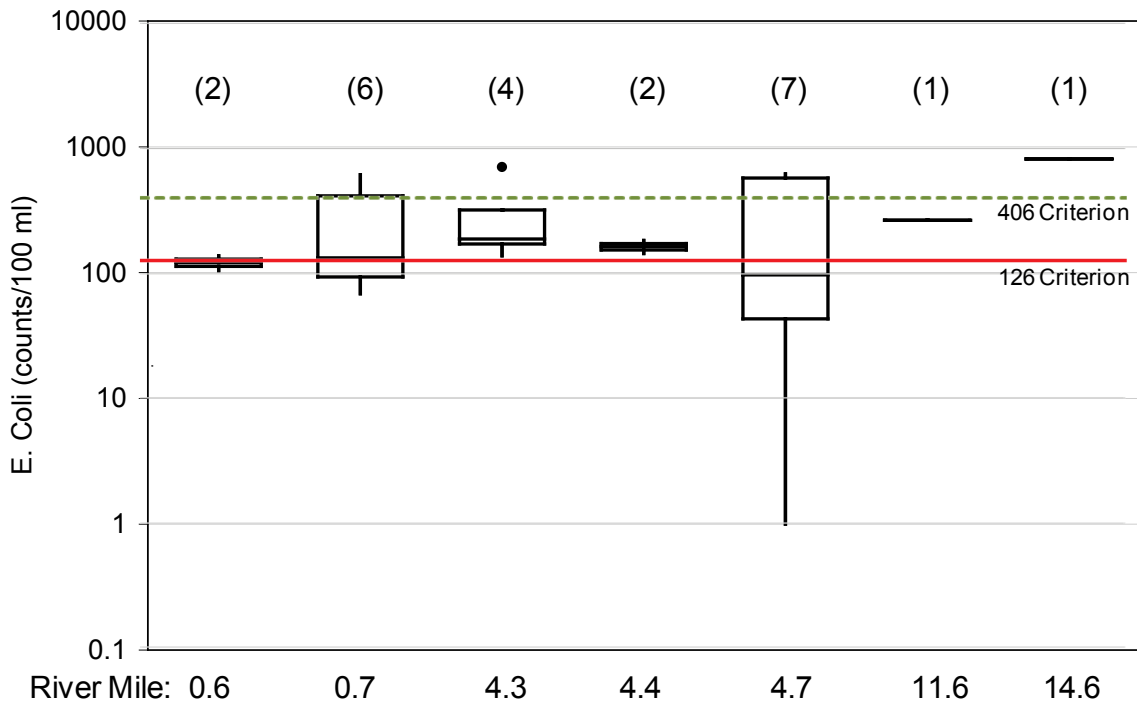


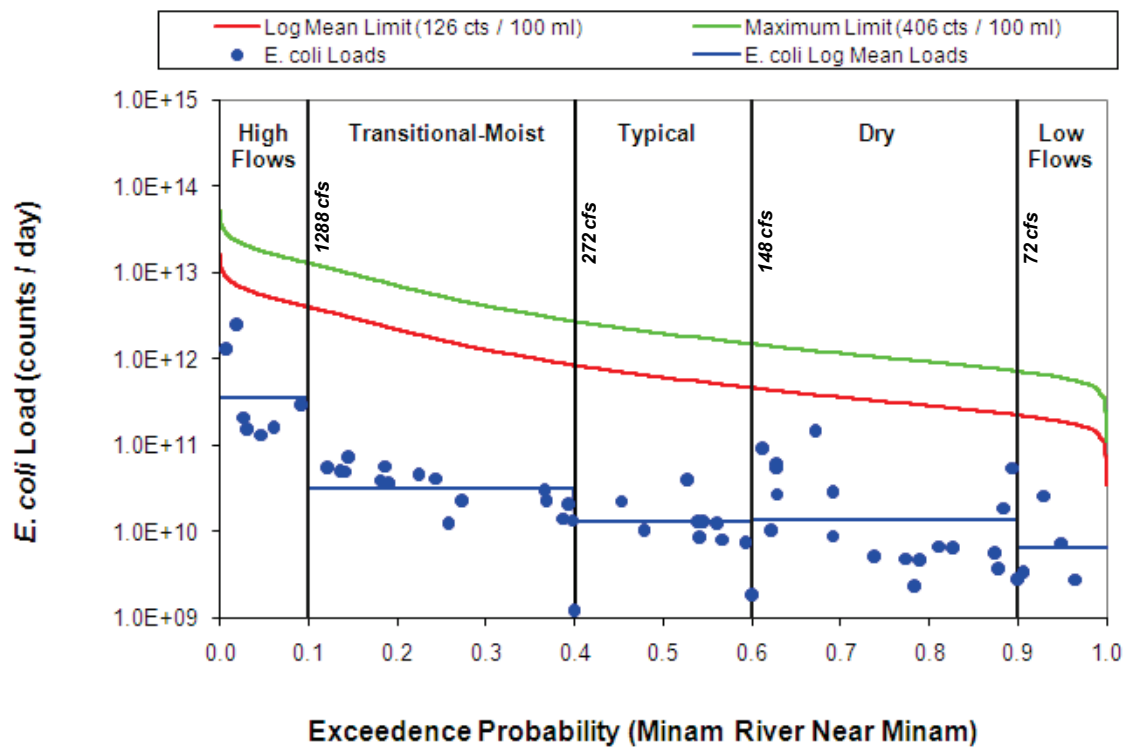
Figure 3-11. Longitudinal summary of E. coli concentrations at sites on Prairie Creek from 1999 to 2001



3.7.2.4 Minam River

In comparison with these more developed watersheds, DEQ was also able to assess bacterial loads from a relatively undisturbed, forested watershed by looking at data from the DEQ ambient monitoring site (LASAR #11457) on the Minam River at the USGS gage (Gage #13331500). This site receives water coming off the Eagle Cap Wilderness, with little or no human influence. There is the possibility of seeing bacteria sources from wildlife, however concentrations in samples at this site never exceeded either of the bacteria criteria. The log mean of the *E. coli* data collected at this site between 1996 and 2004 was 3 cts/100 ml (refer back to **Table 3-4**). The maximum *E. coli* concentration measured during this time was 48 cts/100 ml. A load-duration curve analysis similarly did not show exceedances of the bacteria criteria at any flows (**Figure 3-12**). The load information from the Minam River represents natural background conditions.

Figure 3-12. Load duration curve analysis of *E. coli* concentrations in relation to flow in the Minam River
*Exceedance probability represents flow record from Minam River near Minam (USGS gage 13331500) and *E. coli* data from the Minam River at Minam (ODEQ LASAR Site 11457).*



3.8 LOADING CAPACITY AND ALLOCATIONS

This TMDL establishes allocations of loading capacity to all sources as appropriate to ensure water quality standards are not violated. Allocations are generally distributed in one of more of the following categories: point sources (wasteload allocations), nonpoint sources (load allocation), reserve capacity and margin of safety where:

Loading Capacity = Wasteload Allocations + Load Allocations + Reserve Capacity + Margin of Safety

Loading capacities were developed to address both the log mean and maximum *E. coli* criteria. In addition to the loading capacity, this TMDL uses percent reductions in *E. coli* loads and *E. coli* concentrations as surrogate load allocations. These surrogate targets are simpler to conceptualize and implement.

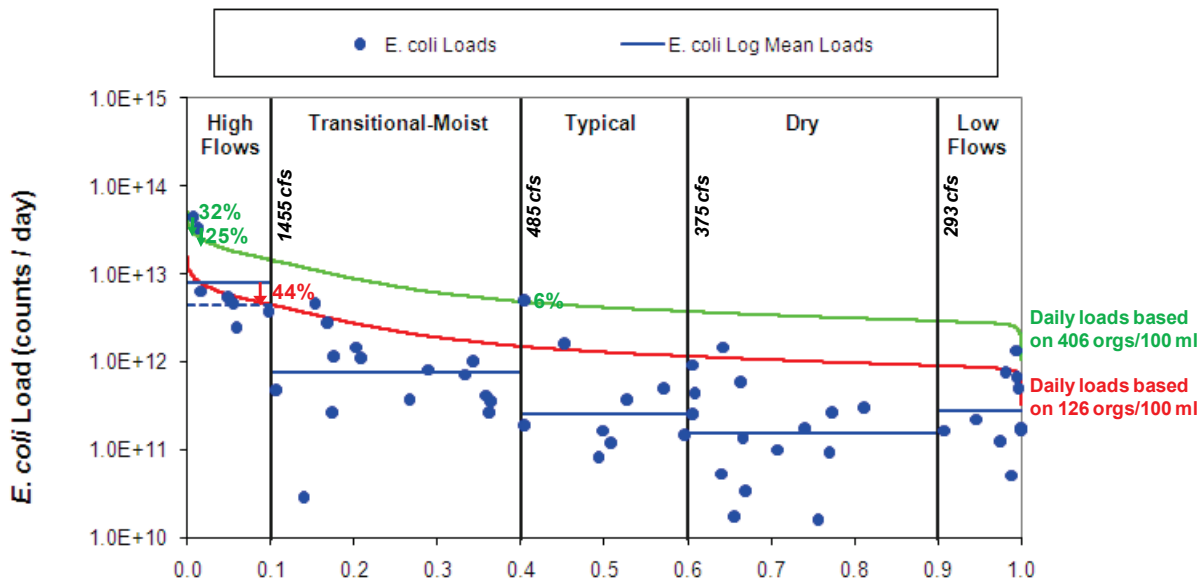
3.8.1 Loading Capacity

3.8.1.1 Wallowa River

Loading capacity was determined for the Wallowa River using the load duration curve developed for the monitoring site above the confluence with the Minam River (**Figure 3-13**). The loading capacity was first developed targeting the log mean criterion of 126 *E. coli* organisms per 100 milliliters. Recall that the red line in the curve represents the maximum bacteria load that will achieve the 126 *E. coli* organisms per 100 ml water quality criteria under all flow conditions. Current log mean loads were calculated for each of the five flow regimes (solid blue lines). A generalized loading capacity was then calculated for each range of flows by calculating the *E. coli* log mean load which was less than or equal to the load associated with the lowest flow for each range (**Table 3-5**). The dashed blue line in the high flow range of **Figure 3-13** is an example. Current loading rates were lower than the loading capacity in all but the highest flow regime. At high flows (greater than 1,455 cfs), a 44% reduction in load is needed from current conditions to meet the log mean criterion.

In addition to meeting the log mean criterion, the TMDL also needs to ensure compliance with the maximum criterion of 406 organisms/100 ml. There were three sampling events on the Wallowa River where values exceeded the maximum criterion. The *E. coli* concentrations observed on these three dates were 600, 540 and 430 organisms/100 ml. The loading capacity, current load and percent reduction need to meet the criterion were calculated for each of these points. The percent reductions needed to meet the criterion were 32%, 25%, and 6%, respectively (**Figure 3-13**). Whereas the generalized log mean loading capacities are tabulated (**Table 3-5**), the continuum of loading capacities for the maximum criteria are graphically illustrated (**Figure 3-13**).

Figure 3-13. Measured loads, loading capacities and surrogate percent reductions needed to meet loading capacities in the Wallowa River



Exceedence Probability (Wallowa River bl. Water Canyon)

Note: The green line represents the *E. coli* loading capacity of 406 organisms/100 ml. The amount of reduction necessary to achieve this loading capacity is shown in percent (green text). The red line represents the *E. coli* loading capacity of 126 organisms /100ml. The solid blue lines are placed at the log mean of all data within each flow range. For flow ranges with loading capacity exceedance, the amount of reduction necessary to achieve the loading capacities is shown in percent (in red text).

Table 3-5. Flow-based loading capacities and percent reduction targets for the Wallowa River addressing the log mean criterion

	Range of Flows				
	High Flow (Above 1,455 cfs)	Transitional (485 to 1,455 cfs)	Typical (375 to 485 cfs)	Dry (293 to 375 cfs)	Low Flow (Below 293 cfs)
Loading Capacity (Org./day) (based on 126 <i>E. coli</i> per 100 ml criterion)	4.48 x 10 ¹²	1.49 x 10 ¹²	1.16 x 10 ¹²	9.03 x 10 ¹¹	4.78 x 10 ¹¹
Current Load (Org./day) (log mean of <i>E. coli</i> loads)	8.02 x 10 ¹²	7.52 x 10 ¹¹	2.54 x 10 ¹¹	1.57 x 10 ¹¹	2.74 x 10 ¹¹
Percent Reduction needed to meet 126 <i>E. coli</i> per 100 ml criterion	44%	0%	0%	0%	0%

3.8.1.2 Spring Creek and Prairie Creek

Because there is insufficient data to calculate load duration curves for Spring Creek or Prairie Creek, loading capacities as such are not established. The percent concentration reduction needed to meet both numeric criteria is used as a TMDL surrogate for loading capacity for these creeks. The concentration-based percent reduction targets were calculated by comparing the highest observed *E. coli* values (either as a log mean or single sample) to the appropriate criterion (Table 3-6).

Table 3-6. Concentration-based percent reduction targets for Spring Creek and Prairie Creek, addressing both numeric criteria

	Spring Creek	Prairie Creek
Surrogate Loading Capacity (organisms/100 ml) (126 <i>E. coli</i> /100 ml criterion)	126	126
Highest observed concentration (organisms/100 ml) (log mean of <i>E. coli</i> organisms/100 ml)	341	153
Percent reduction needed to meet 126 <i>E. coli</i> per 100 ml criterion	63%	18%
Surrogate Loading Capacity (organisms/100 ml) (406 <i>E. coli</i> /100 ml criterion)	406	406
Highest observed concentration (organisms/100 ml) (maximum number of <i>E. coli</i> /100 ml)	1700	800
Percent reduction needed to meet 406 <i>E. coli</i> per 100 ml criterion	76%	49%

3.8.2 Allocations

The calculation and distribution of wasteload and load allocations is described below. The allocations are expressed as surrogate measures for pollutant load. Wasteload allocations are expressed as concentrations and load allocations as percent reductions. The allocations apply to all sources within the Subbasin.

3.8.2.1 Wasteload Allocations

General and Individual Permits Administered by DEQ. Wasteload allocations for the three sewage treatment plants in the Wallowa River Subbasin are expressed as a surrogate measure which is the effluent concentration allowed by the bacteria standard: 126 *E. coli* org./100 ml as a log mean based on a minimum of 5 samples in a 30-day period and no single sample exceeding 406 *E. coli* org./100 m. When operating properly, they will not cause or contribute to water quality violations.

As identified in the source assessment the facilities with general permits are not likely to cause or contribute to the bacteria impairment. Therefore, these facilities are allocated their current pollutant load and their impacts are expected to be negligible. Additionally, similar future facilities with new general NPDES permits are not expected to contribute to these impairments and are allocated the same loading rate.

Confined Animal Feeding Operations Administered by ODA. CAFOs are managed in the State of Oregon to ensure no discharge of fecal bacteria under normal conditions. Discharge is allowed under conditions of an extreme rainfall event, defined in the permit as greater than the 25-year, 24-hour rainfall, if the facility meets certain design requirements. According to the ODA Livestock Water Quality Specialist for the area, none of the facilities in the Wallowa River Subbasin meet these requirements (Ron Jones, personal communication), so discharge is not allowed. Because no discharge is allowed for CAFOs in the Wallowa River Subbasin, the CAFOs are each allocated zero load.

3.8.2.2 Load Allocations

This section determines the portion of the receiving water's loading capacity that is allocated to existing nonpoint sources of pollution. These sources include agriculture, urban and residential land uses. Forestry has not been identified as a source of bacteria contributing to elevated *E. coli* levels. The surrogate measure used is a percent reduction target.

Specific load allocation surrogates were developed for the Wallowa River, Spring Creek and Prairie Creek (**Table 3-7**). Percent reduction targets needed to meet both *E. coli* criteria were calculated for each stream. Targets are both load and concentration based and are described in the previous section. These allocations apply across all flow ranges. The load allocation surrogate for the Wallowa River applies throughout the Wallowa River Subbasin, with the exception of the more specific surrogates developed for Spring Creek and Prairie Creek.

Table 3-7. Nonpoint source load allocation surrogate measures for the Wallowa River Subbasin

	Wallowa River	Spring Creek	Prairie Creek	Other Wallowa River tributaries
Percent Reduction needed to meet 126 <i>E. coli</i> per 100 ml criterion	44%	63%	18%	44%
Percent Reduction needed to meet 406 <i>E. coli</i> per 100 ml criterion	32%	76%	49%	32%

3.8.3 Excess Load

Excess load is the difference between the actual pollutant load and the loading capacity of a water body. There is currently an excess bacterial load in the Wallowa River Subbasin that results in violations of water quality standards. Nonpoint source loading needs to be reduced by 18-76% (depending on location and applicable criteria) in order to achieve compliance with this TMDL.

3.9 MARGIN OF SAFETY

A margin of safety (MOS) is integral to the allocation process in TMDLs. The margin of safety may be an explicit reduction in the allocations to loads and wasteloads or it can be implicit in the procedures used for analysis and modeling. An implicit margin of safety presumes that conservative assumptions will result in less of the true available load being allocated to sources. The margin of safety applied to the bacteria TMDL for the Wallowa River Subbasin is implicit. For the Wallowa River, the load allocation applies across all flow ranges. Since load reductions are primarily needed only under high flows, this approach will lead to larger reductions than necessary for some flow regimes and for some stations and is part of the MOS. For Spring Creek and Prairie Creek, the percent reduction targets were developed by comparing the highest observed *E. coli* concentrations to the criterion. This is a conservative approach, and as with the Wallowa River, will lead to larger reductions than are necessary during most of the year and at most stations.

3.10 RESERVE CAPACITY

The reserve capacity is an allocation for increases in pollutant loads from future growth and new or expanded sources. An explicit value was not assigned for reserve capacity. Rather, future point sources in the Wallowa River will be required to meet water quality criteria at the end-of-pipe discharge. Therefore, any additional point sources will not contribute to digressions from the criteria.

3.11 WATER QUALITY STANDARD ATTAINMENT ANALYSIS AND REASONABLE ASSURANCES

The load allocations provided in this TMDL were based on targeting both the log mean criterion of 126 *E. coli* organisms per 100 milliliters and the maximum criterion of 406 *E. coli* organisms per 100 milliliters. The analyses demonstrated that, for the three waterbodies with sufficient data, these criteria will be met

with the specified surrogate percent *E. coli* reductions required. Best management practices (BMP) that control fecal bacteria need to be implemented to target both criteria of the standard.

The Water Quality Management Plan (WQMP) (**Chapter 4**) provides the framework of management strategies to attain and maintain water quality standards. The framework is designed to work in conjunction with detailed plans and analyses provided in sector-specific or source-specific implementation plans. The WQMP provides reasonable assurance that the TMDL and associated allocations will be met. Bacteria reduction is generally correlated to the emplacement of strategic management practices, and dramatic improvements can take place within a single year's time. One of the primary strategies for attainment for this TMDL will be encouragement of bacteria-focused implementation of the Agricultural Water Quality Management Area Plan, accompanied by long term monitoring.

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