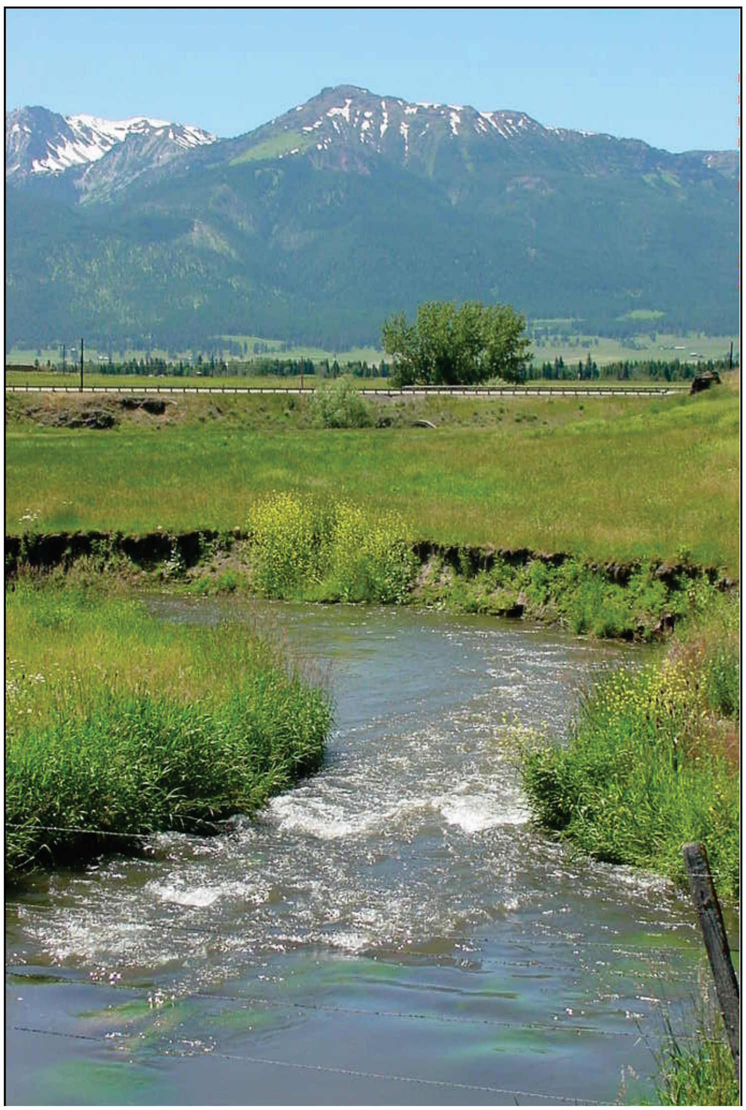
Water Quality Report

LOWER GRANDE RONDE SUBBASINS TMDLS

State of Oregon Department of Environmental Quality

September 2010



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The Department of Environmental Quality wants to thank all of the various contributors to this TMDL effort. We appreciate the patience of the local stakeholders during the lengthy development of this TMDL. DEQ had invaluable local assistance with data collection and management, community outreach, analysis, review of model input and output, and document review. Much of the TMDL development process was guided by a local TMDL Committee. DEQ believes that the participation and mutuality that characterized the TMDL development process in the Lower Grande Ronde Subbasins will facilitate progress and interaction in the years to come.

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EXECUTIVE SUMMARY

The Oregon Department of Environmental Quality (DEQ) is proposing pollution limits to protect human health and salmon and trout in the Lower Grande Ronde Subbasins. The geographic scope of these limits includes the watersheds (subbasins) of the Imnaha, Wallowa and Lower Grande Ronde Rivers, which are referred to collectively as “Lower Grande Ronde Subbasins” in this document. This document specifies Total Maximum Daily Loads (TMDLs) of pollution and planning to address water quality in the Lower Grande Ronde Subbasins.

Area water quality concerns include temperature, bacteria, sedimentation, dissolved oxygen and pH. Temperature impairment is the most widespread. **TMDLs are reported in this document for temperature and bacteria**. The sedimentation, dissolved oxygen and pH concerns were evaluated during TMDL development. Sedimentation TMDL methods and benchmarks are in development. Accordingly, a TMDL addressing sedimentation has not been prepared at this time. Sufficient data has not been collected to adequately evaluate the causes of dissolved oxygen and pH violations. Once the necessary data has been collected, TMDLs will be developed to address these parameters at a later date.

The TMDLs address discrete human sources (point sources) and diffuse landscape sources (nonpoint sources). The temperature TMDL objectives apply throughout the stream network for all three subbasins, whether perennial or not. Limits for the bacteria TMDL were set for the Wallowa River, Spring Creek and Prairie Creek and apply to upstream contributing waters.

Temperature

Waterbodies are water quality limited for temperature in all three subbasins, with 303(d) listings occurring on 533.6 miles of streams. The temperature TMDL (**Chapter 2**) identifies the primary source of human caused heating as the removal or reduction in natural streamside vegetation which increases the amount of solar radiation the stream receives. Point sources contribute very little (<1%) of the total heat load relative to nonpoint sources.

Temperature simulations carried out on the Wallowa River demonstrated that natural thermal potential (NTP) temperatures exceed the biologically based numeric criteria for most of the Wallowa River. Based on this analysis (and a similar one done for the Upper Grande Ronde River in 2000), the natural conditions criteria apply throughout the Lower Grande Ronde Subbasins and NTP (system potential) conditions are the TMDL target. Heat load allocations were calculated and expressed as the surrogate measure of system potential effective shade.

Wasteload allocations were developed for the Wallowa, Joseph and Enterprise sewage treatment plants for the critical period of April through October. All three plants were able to meet their wasteload allocations under their existing condition.

In order to implement the temperature TMDL, the DEQ requires designated management agencies to prepare plans and implement management strategies to restore or protect streamside vegetation, as well as encourage best management practices to increase stream flows, decrease warm irrigation return flows and restore more natural stream channels.

Bacteria

Waterbodies are water quality limited for fecal coliform or *E. coli* bacteria in the Wallowa River Subbasin, with 303(d) listings occurring on 69.4 miles of streams. Identified waterbodies of concern are the Wallowa River, Spring Creek and Prairie Creek. Although there are potential sources of bacteria in other parts of the Lower Grande Ronde Subbasins, at present no data are available which demonstrate bacteria impairment in these areas. The bacteria TMDL is presented in **Chapter 3** of this document.

Bacteria sources may include both point sources and nonpoint sources. There are 13 point sources with NPDES permits in the Wallowa Subbasin. Seven of these are permitted by DEQ and include sewage treatment plants, industrial facilities and fish hatcheries. There are also six Confined Animal Feeding Operations (CAFOs). The numeric criteria in the bacteria standard serve as wasteload allocation targets for the point sources administered by DEQ. When operating in compliance with the requirements of their NPDES permits, these point sources do not cause or contribute to bacteria standard violations. Because CAFOs are not allowed to discharge to waters of the state, CAFOs were allocated zero allowable loading to streams.

Bacteria loading in the Wallowa River Subbasin is dominated by non-point sources. Nonpoint source pollution comes from diffuse sources such as livestock waste, failing septic systems, pets, illegal discharges, and urban runoff. Stream flow based TMDL limits were developed for the Wallowa River. For Spring Creek and Prairie Creek, *E. coli* limits (as percent reductions) were calculated as a load allocation surrogate.

TMDL Implementation

Chapter 4 of this document is a water quality management plan (WQMP) lying out the expectations for planning and improvements through designated participants (called Designated Management Agencies). These organizations are called on to submit water quality implementation plans addressing load allocations in the TMDLs, generally within 18 months of the date of TMDL issuance. The designated participants include: Oregon Departments of Agriculture (ODA), Forestry (ODF), Transportation (ODOT), State lands (DSL) and Geology and Mine Industries (DOGAMI); U.S. Forest Service (USFS, Umatilla and Wallowa-Whitman National Forests), U.S. Bureau of Land Management (BLM), Wallowa County, and the cities of Enterprise, Joseph, Wallowa and Lostine.

LOWER GRANDE RONDE SUBBASINS TMDL
CHAPTER 1: OVERVIEW AND BACKGROUND

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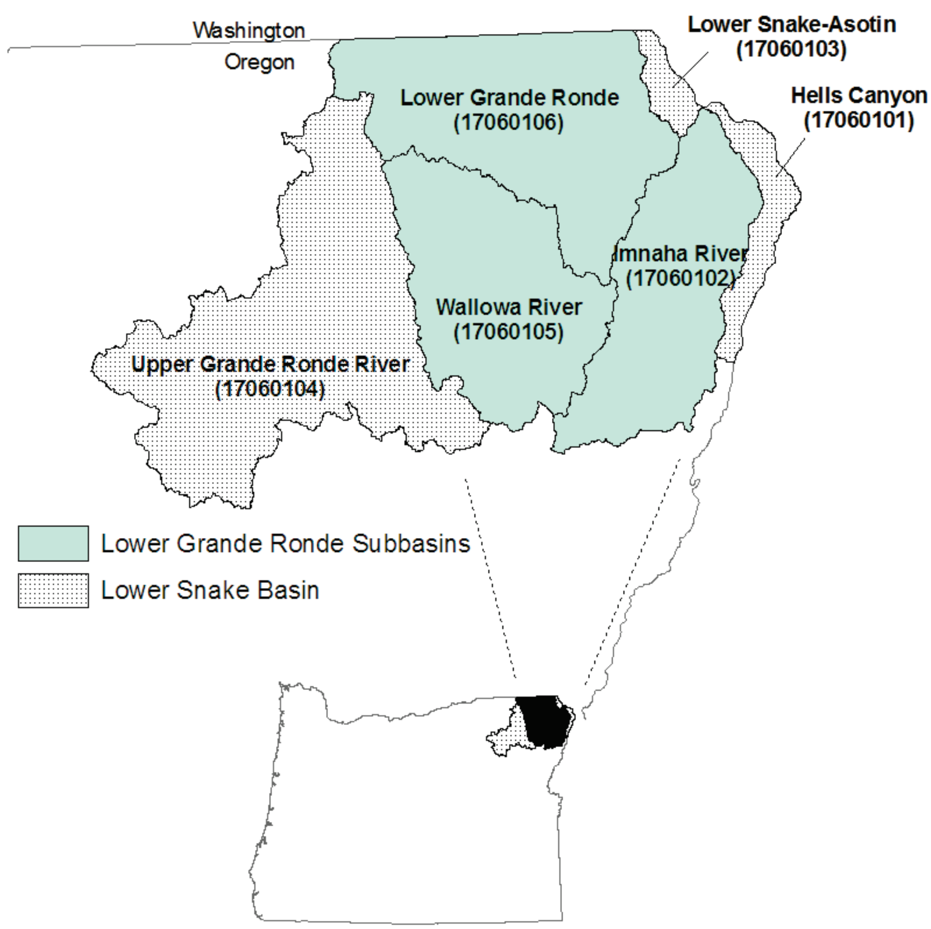
1.1 INTRODUCTION

The Oregon Department of Environmental Quality is proposing pollution limits to protect human health and salmon and trout in the Lower Grande Ronde Subbasins (**Figure 1-1**). The geographic scope of these limits is three fourth-field subbasins in the northeast corner of Oregon: Imnaha River (HUC 17060102), Wallowa River (HUC 17060105) and Lower Grande Ronde (HUC 17060106), which are referred to collectively as "Lower Grande Ronde Subbasins" in this document. These Subbasins have a combined area of approximately 2,982 square miles. The other subbasins in the Lower Snake Basin in Oregon are Upper Grande Ronde River Subbasin (HUC 17060104), Lower Snake-Asotin (HUC 17060103), and Hells Canyon (HUC 17060101). The Upper Grande Ronde River Subbasin has been addressed in another series of Total Maximum Daily Loads (TMDLs) approved in 2000 (DEQ 2000) and will not be discussed further in this document. The Snake River crosses portions of the Lower Snake-Asotin and Hells Canyon Subbasins. TMDLs for temperature, total dissolved gas, DDT, DDD, DDE and Dieldrin were completed for the Snake River/Hells Canyon in 2004, along with revised TMDLs for phosphorus, sediment and dissolved oxygen. The Snake River is still listed as impaired for mercury from river mile 173 to river mile 404. This is the only 303(d) listing in the Lower Snake-Asotin and Hells Canyon subbasins and it is beyond the scope of this document. With the completion of the Lower Grande Ronde Subbasins TMDLs, all current TMDLs needed for the Lower Snake Basin (170601) in Oregon will be completed, with the exception of the Snake River and the three parameters mentioned under **Section 1.2.3** below.

Figure 1-1. Location of the Lower Grande Ronde Subbasins



The **Lower Grande Ronde Subbasins** have several important characteristics:

- The Lower Grande Ronde Subbasin is divided by the Oregon-Washington border. There are no 303(d) listings in the state of Washington for any water bodies which originate in Oregon.
- The Imnaha River Subbasin is adjacent to the Hells Canyon Subbasin which includes a portion of the Lower Snake River and is the border between Oregon and Idaho.
- The water quality concerns are predominantly distributed nonpoint sources of pollution rather than discrete point source pollution.
- These subbasins are home to productive agricultural and forestlands and contain streams with historically viable trout and anadromous salmonid populations.

The Lower Grande Ronde Subbasins TMDLs establish water quality targets for streams in Oregon and fulfill Oregon's commitment to comply with State and Federal water quality laws. DEQ has determined current levels of pollutants and the degree to which these must be reduced to ensure compliance with water quality standards adopted to protect the beneficial uses of waters of the State. The data review and analysis contained in this document summarizes the information currently available in each of these Subbasins. The allocations developed will be used directly in setting limits on point source discharges, and should become elements in other plans that address water quality protection and restoration (e.g., permits and implementation plans). A Water Quality Management Plan (WQMP) that describes existing regulations, programs, and plans is being submitted along with these TMDLs. Results in this document will also be used as a benchmark of water quality, instream physical parameters and landscape conditions that currently exist, as well as for assessing future trends and the effectiveness of planned water quality improvement efforts.

TMDL development was guided by the local Wallowa County TMDL Committee. During TMDL development the TMDLs were called the “Wallowa County TMDLs”. For consistency with the nomenclature of other TMDLs in Oregon, this name was changed to the “Lower Grande Ronde Subbasins TMDLs” for this final document. The TMDL Committee had representation from the following interests: Oregon Departments of Forestry, Fish and Wildlife, Agriculture and Transportation; the U.S. Forest Service; the Cities of Joseph, Wallowa, Enterprise and Lostine; the Grand Ronde Model Watershed; the Nez Perce Tribe; the Wallowa County Soil and Water Conservation District; Wallowa County; The Nature Conservancy; agricultural interests (Local Advisory Committee for the Agricultural Water Quality Management Area Plan); large landowner representation; corporate forestry; irrigation; the weed board/industrial chemical fertilizer industry; and industrial manufacturing.

1.2 OREGON’S TMDL PROGRAM

1.2.1 Background

The quality of Oregon’s streams, lakes, estuaries and groundwater is monitored by the DEQ as well as other state, federal, and local organizations and groups. This information is used to determine whether water quality standards are being attained and, consequently, whether the beneficial uses of the waters are protected. Section 303(d) of the Federal Clean Water Act (CWA) requires the U.S Environmental Protection Agency (EPA), or delegated States such as Oregon, to set water quality standards and to prepare a list of water bodies that do not meet these approved water quality standards. The resulting list (the “303(d) list”) is a catalog of all waterbodies in the state that fail to meet one or more water quality criteria based on available data (see DEQ 2007).

Once a water body has been identified as water quality limited, the CWA requires the establishment of a pollutant total maximum daily load (TMDL) for that water body. TMDLs are assessments that determine the maximum amount of pollutant that can be present in a water body while meeting water quality standards. This *loading capacity* can be allocated to *point*, *nonpoint source* and future sources of pollution. Uncertainty and natural pollutant sources are accounted for as well. *Point sources* are those associated with discrete human-made conveyances such as pipes from wastewater treatment plants. *Wasteload Allocations* are portions of the total load that are allotted to point sources. *Nonpoint sources* are diffuse sources such as field runoff or excess solar radiation. *Load Allocations* are portions of TMDLs attributed to nonpoint sources, either natural or human. TMDLs are implemented via water quality management plans or administrative rules and procedures and, for point sources, permits issued through the NPDES program.

Elements of a TMDL

DEQ must address the elements of a TMDL as described in OAR 340-042-0040 (4) (a – l) in order to meet the rule as well as to attain approval from EPA. The elements are listed below:

- **Name and location** – describes the geographic area for which the TMDL is developed and includes maps as appropriate.
- **Pollutant identification** – identifies the pollutant(s) causing impairment to water quality being addressed by the TMDL.
- **Water quality standards and beneficial use identification** – identifies the relevant water quality standard and the most sensitive beneficial use(s) affected by the pollutant being addressed in the TMDL.
- **Loading capacity** – specifies the amount of a pollutant that a waterbody can receive and still meet water quality criteria.
- **Excess load** – evaluates, data allowing, the difference between the actual pollutant load in a waterbody and the loading capacity of the waterbody.
- **Sources or source categories** – identifies the pollutant sources and estimates, to the extent that data allow, the amount of actual pollutant loading from these sources.
- **Wasteload allocations** – determines the portions of the receiving water’s loading capacity to be allocated to existing point sources of pollution.
- **Load Allocations** – determines the portions of the receiving water’s loading capacity to be allocated to existing nonpoint sources of pollution or to background sources.
- **Margin of safety** – accounts for uncertainty related to the TMDL and quantifies uncertainties associated with estimating pollutant loads, monitoring, and modeling water quality.
- **Seasonal variation** – accounts for temporal changes in critical conditions, stream flow, sensitive beneficial uses, pollutant loading and water quality parameters so that water quality criteria will be attained and maintained throughout the year.
- **Reserve capacity** – an allocation for increasing pollutant loads for future growth and new or expanded sources.
- **Water Quality Management Plan (WQMP)** – provides the framework of management strategies to attain and maintain water quality standards, working in conjunction with detailed plans and analyses provided in sector-specific or source-specific implementation plans.

Each of the elements listed above is included in both of the Lower Grande Ronde Subbasins TMDLs, although the elements may not be presented in the order or by the specific heading described above. EPA has the responsibility under the Clean Water Act to approve or disapprove TMDLs that states submit. When a TMDL is officially submitted by a state to EPA, EPA has 30 days to take action on the TMDL. In the case where EPA disapproves a TMDL, EPA must establish the TMDL. EPA is not required to approve WQMPs developed for the TMDLs.

Waterbodies in the Lower Grande Ronde Subbasins have been identified as water quality limited for temperature, pH, bacteria, dissolved oxygen and sedimentation (**Table 1-1**).

Table 1-1. Waterbodies listed as "Water Quality Limited" in the Lower Grande Ronde Subbasins on DEQ's 2004/06 303(d) list

DEQ 2007, http://www.deq.state.or.us/wq/assessment/rpt0406.htm. Parameters listed in italics are not being addressed by TMDLs in this report (see discussion in Section 1.2.3).

Water Body	River Miles	Parameter	Season (Beneficial Use)	Assessment Year	Record ID
Wallowa River Subbasin					
Prairie Creek	*0 to 12.5*	*Dissolved Oxygen*	*Spring/Summer (Spawning)*	*1998*	*938*
Spring Creek	*0 to 4.5*	*Dissolved Oxygen*	*Spring/Summer (Spawning)*	*1998*	*939*
Prairie Creek*	0 to 2.4	E Coli	Summer	2004	9273
Prairie Creek*	0 to 12.5	E Coli	Summer	2004	13659
Wallowa River	0 to 50	E Coli	Summer	2004	13786
Prairie Creek	0 to 12.5	Fecal Coliform	Fall/Winter/Spring	1998	924
Spring Creek	0 to 4.5	Fecal Coliform	Fall/Winter/Spring	1998	925
Wallowa River	0 to 50	Fecal Coliform	Summer	1998	926
Wallowa River	*0 to 50*	*pH*	*Summer*	*2004*	*1151*
Bear Creek	*0 to 7.5*	*Sedimentation*	*Undefined*	*1998*	*1050*
Hurricane Creek	*0 to 7.6*	*Sedimentation*	*Undefined*	*1998*	*1051*
Lostine River	*0 to 9*	*Sedimentation*	*Undefined*	*1998*	*1044*
Minam River	*0 to 10.2*	*Sedimentation*	*Undefined*	*1998*	*1052*
Prairie Creek	*0 to 12.5*	*Sedimentation*	*Undefined*	*1998*	*1054*
Wallowa River	*0 to 50*	*Sedimentation*	*Undefined*	*1998*	*1042*
Bear Creek	2.8 to 9	Temperature	August 15 - June 15 (Spawning)	2004	13350
Bear Creek	0 to 7.5	Temperature	Year Around (Core cold water)	2004	12564
Deer Creek	0 to 10.2	Temperature	Summer (Bull trout)	1998	890
Fisher Creek	0 to 0.5	Temperature	January 1 - June 15 (Spawning)	2004	12575
Fisher Creek	0 to 5.1	Temperature	Year Around (Core cold water)	2004	13351
Howard Creek	0 to 9	Temperature	January 1 - June 15 (Spawning)	2004	12576
Howard Creek	0 to 11.2	Temperature	Year Around (Core cold water)	2004	13352
Little Bear Creek	0 to 8	Temperature	Summer (Bull trout)	1998	889
Minam River	0 to 12.6	Temperature	Year Around (Core cold water)	2004	12570
Wallowa River	0 to 53.7	Temperature	Year Around (Core cold water)	2004	12577
Lower Grande Ronde Subbasin					
Grande Ronde River	*65.9 to 104.9*	*Dissolved Oxygen*	*January 1 - May 15 (Spawning)*	*2004*	*20842*
Chesnimnus Creek	*0 to 26.4*	*Sedimentation*	*Undefined*	*1998*	*1084*
Elk Creek	*0 to 13.7*	*Sedimentation*	*Undefined*	*1998*	*1102*
Grande Ronde River	*36.3 to 80.7*	*Sedimentation*	*Undefined*	*1998*	*1059*
Chesnimnus Creek	0 to 26.4	Temperature	Year Around (Rearing & migration)	2004	12544
Courtney Creek	0 to 14.3	Temperature	Year Around (Rearing & migration)	2004	12555
Crow Creek	0 to 20.2	Temperature	Year Around (Rearing & migration)	2004	12543
Elk Creek	0 to 13.7	Temperature	Year Around (Rearing & migration)	1998	908
Grande Ronde River**	35.6 to 172.4	Temperature	Year Around (Rearing & migration)	2004	12538
Grouse Creek	0 to 1.4	Temperature	Year Around (Core cold water)	2004	12553
Joseph Creek	8.1 to 48.2	Temperature	Year Around (Rearing & migration)	2004	12539
Mud Creek	0 to 23	Temperature	Year Around (Rearing & migration)	2004	12560

Table 1-1 (continued). Waterbodies listed as "Water Quality Limited"

Water Body	River Miles	Parameter	Season (Beneficial Use)	Assessment Year	Record ID
Lower Grande Ronde Subbasin (continued)					
Peavine Creek	0 to 5.3	Temperature	Year Around (Rearing & migration)	1998	911
Salmon Creek	0 to 13.6	Temperature	Year Around (Rearing & migration)	1998	912
Sickfoot Creek	0 to 7.5	Temperature	Year Around (Rearing & migration)	2004	12565
Wallupa Creek	0 to 10.1	Temperature	Year Around (Rearing & migration)	2004	12563
Wenaha River	6.7 to 10.3	Temperature	August 15 - June 15 (Spawning)	2004	13349
Wenaha River	0 to 10.3	Temperature	Year Around (Core cold water)	2004	12558
Wildcat Creek	0 to 16	Temperature	Year Around (Rearing & migration)	2004	12562
Imnaha River Subbasin					
Big Sheep Creek	0 to 10	Temperature	Year Around (Rearing & migration)	2004	12532
Crazyman Creek	0 to 6.8	Temperature	Year Around (Bull trout)	2004	12533
Dry Creek	0 to 4.2	Temperature	Year Around (Bull trout)	2004	12537
Freezeout Creek	0 to 8.5	Temperature	Year Around (Rearing & migration)	2004	12530
Grouse Creek	0 to 17.3	Temperature	January 1 - June 15 (Spawning)	2004	20814
Grouse Creek	0 to 17.3	Temperature	Year Around (Core cold water)	2004	12531
Gumboot Creek	0 to 7.4	Temperature	Year Around (Bull trout)	2004	12536
Imnaha River	35.7 to 42.7	Temperature	August 1 - June 15 (Spawning)	2004	13347
Imnaha River	0 to 35.8	Temperature	Year Around (Rearing & migration)	2004	12529
Imnaha River	35.8 to 42.7	Temperature	Year Around (Core cold water)	2004	12528
Imnaha River	42.7 to 72.2	Temperature	Year Around (Bull trout)	2004	12527
Lightning Creek	0 to 24.8	Temperature	Year Around (Rearing & migration)	1998	827
Little Sheep Creek	0 to 26	Temperature	Year Around (Rearing & migration)	2004	12535

* These two listings for Prairie Creek are for two different stream segments, with different LLID numbers.
**The listing for temperature on the Grande Ronde River extend beyond the Lower Grande Ronde Subbasin (which ends at river mile 80.3) into the Upper Grande Subbasin. The temperature listing on the lower Grande Ronde River is covered by the temperature TMDL included here. The listing on the upper Grande Ronde River is already covered by the existing Upper Grande Ronde TMDL (approved by EPA in 2000).

1.2.2 TMDLs Addressed in this Report

This report contains TMDLs that address temperature and bacteria impairments. DEQ tracks completed TMDLs for reporting measures and the Lower Grande Ronde Subbasins TMDLs represent the completion of 44 TMDLs (**Table 1-2**). The Consent Decree between the U.S. EPA and Northwest Environmental Defense Center, John R. Churchill, and Northwest Environmental Advocates (October 17, 2000) lists the cumulative number of TMDLs to be established through 2010. EPA reports the number of TMDLs completed to the plaintiff using a different counting method than DEQ. According to current EPA policy on counting TMDLs, this TMDL addresses 37 TMDLs (**Table 1-3**). These TMDLs rely on a watershed approach and are applicable throughout the subbasins for which they were developed.

Temperature – based on the 303(d) listing of waterbodies in all three of the Lower Grande Ronde Subbasins. Further assessment demonstrated widespread violations of the biologically based numeric criteria of the temperature standard in each of the Subbasins. Analysis indicates that temperature in many of these waterbodies exceeds natural thermal potential temperatures as well. The widespread nature of temperature violations is indicative of the current condition of streams in the area, as well as the relative ease of data collection for this parameter. The temperature TMDL applies to all perennial and intermittent streams in the Lower Grande Ronde Subbasins. It should be noted that the temperature listing on the Grande Ronde River (river miles 35.6-172.4) extends upstream above the Lower Grande Ronde Subbasin (which ends at approximately river mile 80.3). The listing of the portion of the Grande Ronde River in the Upper Grande Ronde Subbasin has already been included in the existing Upper Grande Ronde TMDL (approved by EPA in 2000).

Bacteria – based on the 303(d) listing of Prairie Creek, Spring Creek, and the Wallowa River for violations of the recreational contact criterion for *E. coli* and/or fecal coliform bacteria. Prairie Creek and the Wallowa River have violated standards throughout the year, while Spring Creek violated during the fall-winter-spring season. The bacteria TMDL applies to perennial and intermittent waterbodies in the Wallowa River Subbasin.

Table 1-2. Lower Grande Ronde Subbasins streams on the 303(d) List addressed by 2010 TMDLs: DEQ Counting Method

For each parameter, the table shows number of listed miles and (number of listed segments).

Parameter	Criterion	Wallowa River Subbasin	Lower Grande Ronde Subbasin	Imnaha River Subbasin	Total
Temperature	Rearing & Migration		235.3 (12)	105.1 (5)	340.4 (17)
	Spawning	15.7 (3)	3.6 (1)	24.3 (2)	43.6 (6)
	Core Cold Water	90.1 (5)	11.7 (2)	24.2 (2)	126.0 (9)
	Bull Trout	18.2 (2)		47.9 (4)	66.1 (6)
Bacteria	E. coli – Summer	64.9 (3)			64.9 (3)
	Fecal coliform – Fall, Winter, Spring	17.0 (2)			17.0 (2)
	Fecal coliform – Summer	50.0 (1)			50.0 (1)
Total Stream Miles*		129.2	246.6	177.2	
Total TMDLs		16	15	13	44

*Streams with listings for more than one criterion were counted only once in the total stream miles. For example, if a stream was listed from river mile 0 to 10.3 for both spawning and bull trout temperature criteria, this would be represented in the total stream mile count as 10.3 miles rather than 20.6 miles.

Table 1-3. Lower Grande Ronde Subbasins 2010 TMDL Listings addressed: EPA Counting Method

Parameter	Wallowa River Subbasin	Lower Grande Ronde Subbasin	Imnaha River Subbasin	Total
Temperature	8	14	11	33
Bacteria	4			4
Total TMDLs	12	14	11	37

1.2.3 Parameters Not Being Addressed by a TMDL in this Report

Sedimentation. A TMDL has not been developed to address the sedimentation listings on Bear Creek, Hurricane Creek, Lostine River, Minam River, Prairie Creek, Wallowa River, Grande Ronde River, Chesnimnus Creek, and Elk Creek. These listings (1998) were based on professional judgment of regional biologists with concerns about the relative paucity of salmonid redds compared to historic observations, the presence of excess fine sediments, and/or concerns about channel embeddedness

(Citations from the 1998 303(d) list: USFS 1995; Wallowa County and the Nez Perce Tribe 1993). There did not appear to be much measured data to support these listings.

DEQ is reviewing the sedimentation criteria assessment methodology for determination of water quality impairment. Currently, sedimentation lacks quantitative listing criteria. TMDLs for the sedimentation listings will be developed at a future date once criteria are selected and a TMDL approach determined. In the meantime, there is much restoration work that is already taking place in the Subbasins which will reduce sources of sediment to streams. Much of this work is being done under the guidance of the *Wallowa County-Nez Perce Salmon Habitat Recovery Plan with Multi-Species Habitat Strategy* (1999) and will also be addressed through implementation of the temperature TMDL included in this document.

Dissolved Oxygen. (1) Grande Ronde River. The dissolved oxygen listing for the Grande Ronde River (from river mile 65.9 to 104.9) during the spawning time of year is a new listing on the 2004/06 list. This listing encompasses river miles in both the Upper and Lower Grande Ronde Subbasins in Oregon, with the break between the two subbasins occurring at approximately river mile 80.3. There was a previous dissolved oxygen listing in the Upper Grande River during the non-spawning time of year. This listing was addressed in the Upper Grande Ronde TMDL which was approved by EPA in 2000. Because this new listing during the spawning season encompasses both subbasins, it will be considered at a later date when DEQ has the resources to develop new TMDLs in subbasins where TMDLs have already been approved by EPA.

(2) Spring Creek and Prairie Creek. Both of these tributaries to the Wallowa River were listed for dissolved oxygen during the spawning season based on data collected in 1989. There has not been enough data collected since then to adequately evaluate the sources of impairment to dissolved oxygen on these creeks. Once the necessary data has been collected for these creeks, a TMDL will be developed to address dissolved oxygen at a later date. In the meantime, there is much restoration work that is already taking place in the Subbasins which will improve instream dissolved oxygen through reductions in temperature and sources of nutrients. Much of this work is being done under the guidance of the *Wallowa County-Nez Perce Salmon Habitat Recovery Plan with Multi-Species Habitat Strategy* (1999) and will also be addressed through implementation of the temperature and bacteria TMDLs included in this document.

pH. The Wallowa River is listed for pH from the mouth to Wallowa Lake based on data collected between 1986 and 1995. Limited grab and continuous data were collected during 1999-2001 to evaluate pH at several spots along the Wallowa River. Grab data continues to be collected every other month at DEQ's ambient monitoring site upstream of the confluence with the Minam River. Analysis of this more current data suggests that pH may still be a problem at the ambient site at times during the summer season. There has not been enough data collected to adequately evaluate the causes of the pH violations, however, it is likely that nutrient reductions and decrease in stream temperatures will improve the pH condition. Once the necessary data has been collected, a TMDL will be developed to address pH at a later date. It is likely that the data needed for Spring Creek and Prairie Creek and the Wallowa River can all be collected at the same time since similar data will be needed to address both pH and dissolved oxygen listings. In the meantime, there is much restoration work that is already taking place in the Subbasins which will improve instream pH through reductions in temperature and sources of nutrients. Much of this work is being done under the guidance of the *Wallowa County-Nez Perce Salmon Habitat Recovery Plan with Multi-Species Habitat Strategy* (1999) and will also be addressed through implementation of the temperature and bacteria TMDLs included in this document.

1.2.4 TMDL Implementation

A Water Quality Management Plan (WQMP) is developed by DEQ as a broad strategy for implementing TMDL allocations. TMDLs, WQMPs and associated planning work together to protect designated beneficial uses, such as aquatic life, drinking water supplies, and water contact recreation.

Implementation of TMDLs is critical to the attainment of water quality standards. The support of Designated Management Agencies (DMAs) in implementing TMDLs is essential. The DMAs in the Lower

Grande Ronde Subbasins include: DEQ; U.S. Forest Service (USFS); Bureau of Land Management (BLM); Oregon Departments of Agriculture (ODA), Forestry (ODF), Transportation (ODOT), State Lands (DSL), Geology and Mineral Industries (DOGAMI); Wallowa County; and the cities of Enterprise, Joseph, Wallowa and Lostine. These agencies have developed or will be developing Implementation Plans and/or are operating under NPDES permits. There are very small portions of the Wallowa and Lower Grande Ronde Subbasins that are within the boundaries of Union and Baker County. Because the areas in these two counties are so small and mostly under management by the USFS, Union and Baker Counties are not included as DMAs for this WQMP.

DEQ will submit a WQMP to EPA concurrently with submission of TMDLs even though EPA has no approval authority for the WQMP. Both the TMDLs and their associated WQMP will be submitted by DEQ to EPA as updates to the State's Water Quality Management Plan pursuant to 40 CFR 130.6. Such submissions will be a continuing update of the Continuing Planning Process.

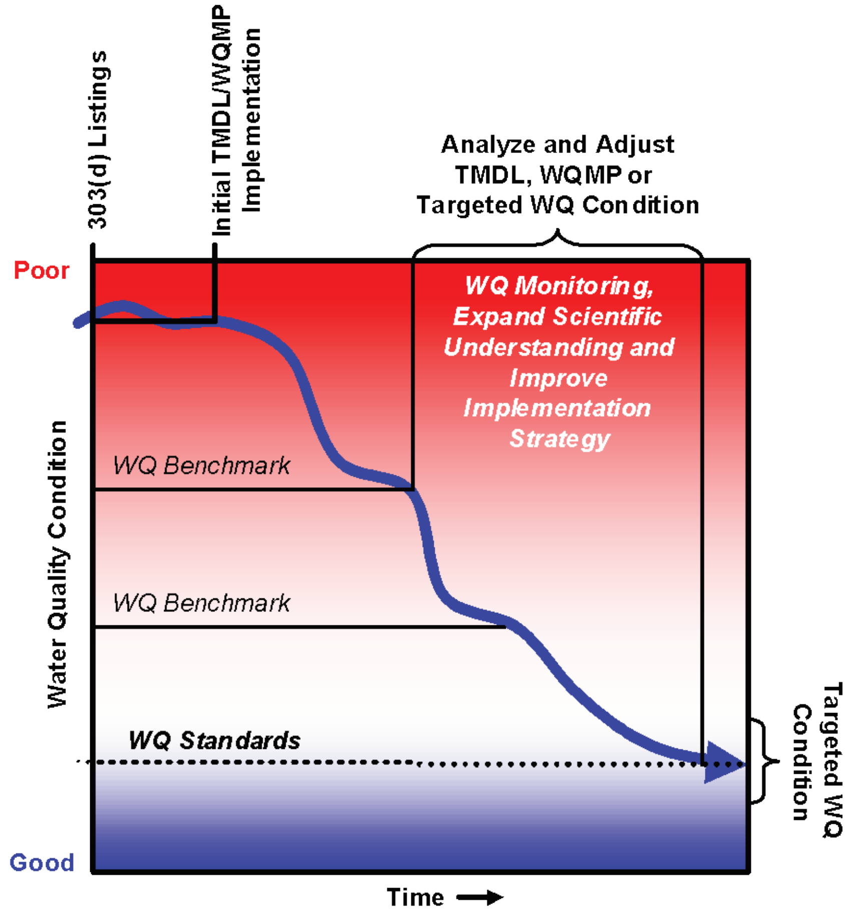
The required elements of WQMPs are defined in OAR 340-42 and are outlined below. The WQMP is included as **Chapter 4** in this report.

WQMP Elements

A. Condition assessment and problem description
B. Goals and objectives
C. Proposed management strategies
D. Timeline for implementing management strategies
E. Relationship of management strategies to attainment of water quality standards
F. Timeline for attainment of water quality standards
G. Identification of responsible participants or DMAs
H. Identification of sector-specific implementation plans
I. Schedule for preparation and submission of implementation plans
J. Reasonable assurance
K. Monitoring and evaluation
L. Public involvement
M. Planned efforts to maintain management strategies over time
N. Costs and funding
O. Citation to legal authorities

Since the relationship between management actions and pollutant load reductions is often not precisely quantifiable, DEQ applies an *adaptive management* policy to implement TMDLs. Adaptive management can be defined as a systematic process for continually improving management policies and practices by learning from the outcomes of operational programs. **Figure 1-2** is a graphical representation of this adaptive management concept. The role of adaptive management in TMDL Implementation is described further in **Chapter 4**.

Figure 1-2. Adaptive management - schematic diagram.



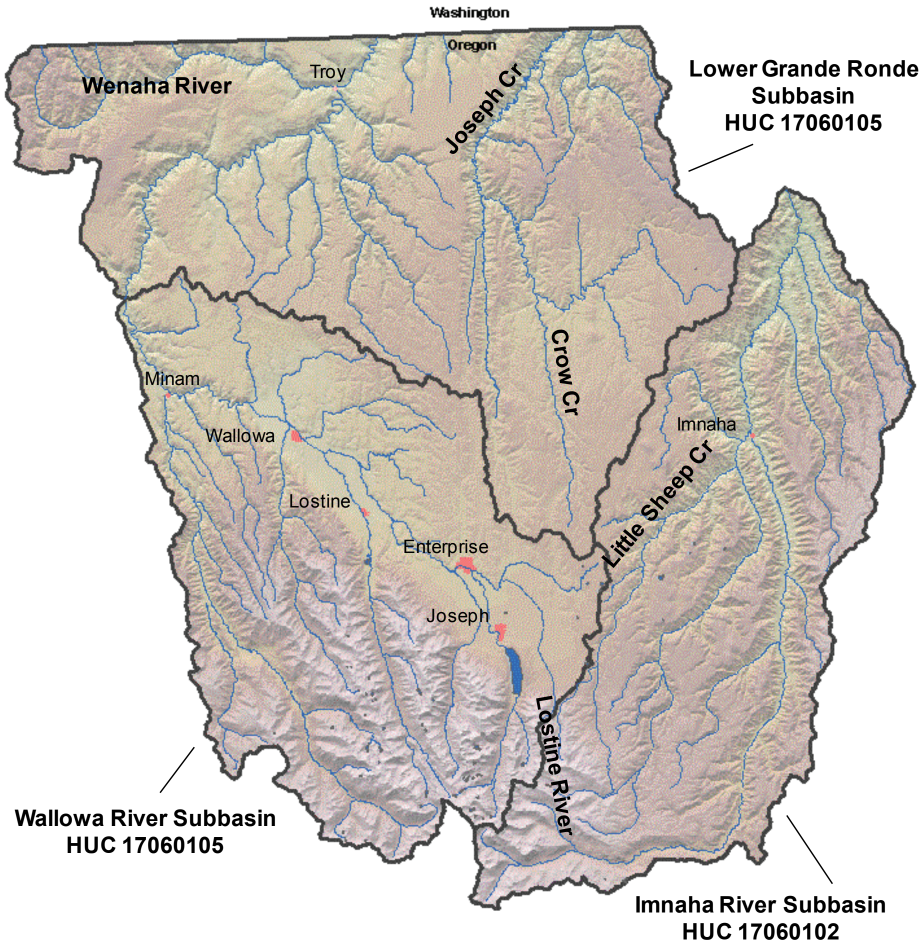
1.3 CHARACTERIZATION OF THE SUBBASINS

1.3.1 Natural Features

The Lower Grande Ronde Subbasins are home to a wide variety of natural landscapes, from arid plateaus typical of Eastern Oregon to alpine lakes and meadows at elevations up to 10,000 feet, a rarity in this part of the Pacific Northwest. The range of landscapes in the area is a result of a complex geologic history. The highest mountains in the region, the Wallowa Mountains, were formed elsewhere and moved tectonically to their current location. Later flows of lava formed the Columbia Plateau around these mountains and uplifting processes increased their elevation. A period of glaciation sculpted the surfaces of the upper elevations, forming high cirques and pan lakes, and scoured deep canyons downslope providing sediments to the valleys below. Wallowa Lake, one of the deepest lakes in Oregon at approximately 300 feet, was formed at the end of this glacial conveyor of material between two large lateral moraines and a terminal moraine near the town of Joseph.

The area is naturally divided into three large watersheds (subbasins): the Wallowa River, Imnaha River, and Lower Grande Ronde River (**Figure 1-3**). The Wallowa River flows to the Lower Grande Ronde River, which along with the Imnaha River, flows into the Snake River.

Figure 1-3. Features of the Lower Grande Ronde Subbasins



Several large rivers flow from the high Lake Basin in the Wallowa Mountains, ultimately feeding the Wallowa and Grande Ronde Rivers. These rivers are steep (high gradient), run through densely forested canyons, and move tremendous amounts of water and sediment through the watershed. The upper Wallowa River, Minam River, Lostine River, and Hurricane Creek flow down the northern slopes of these mountains and join prior to entering the Grand Ronde River. The Imnaha River, fed by several significant tributaries, flows northwest into a separate watershed and ultimately to the Snake River. All of these rivers and creeks have their origins in a relatively small area of the high Lake Basin in the Eagle Cap Wilderness of the Wallowa Mountains. The origin of water in these rivers is snowpack that melts slowly through the spring and summer.

Lands to the south of the Wallowa River are supplied with much more water than those to the north. Groundwater is relatively high in the Wallowa River Valley, with the southern slopes receiving a continual charge from the mountains. The lands to the north are drier and have no high mountains to accumulate snowpack. These hills are largely elevations of Columbia basalts that store some water, but become dry in the early summer. The plateau is dissected by relatively small creeks, some of which flow to the Wallowa River, but most of which flow northward to the lower Grande Ronde River. Average flows are lower than in creeks originating in the Wallowa Mountains, but they generally flow year around. Joseph Creek and its tributaries, Swamp Creek, Chesnimnus Creek, Crow Creek and others, drain a large proportion of this watershed. Mud Creek, Wallupa/Wildcat Creek and Grossman Creek flow to the Lower Grande Ronde River in the western part of the subbasin. To the north and west, the Wenaha River flows out of higher elevations of the Umatilla National Forest into the Lower Grande Ronde River near the town of Troy.

The origins of water in the basin determine the types of habitat they provide to some extent. All sources begin as snowmelt and/or spring flow. These creeks are habitat to a variety of plants and animals, particularly coldwater fish, such as trout and salmon. These fish require cold, clear, oxygen-rich water at all stages of life, especially during spawning. Cold water generally is richer in oxygen, but organic substances and other suspended sediments may cause depletion of oxygen in the water, inhibiting fish respiration, as well as directly covering spawning habitat. Bull trout, which require the coldest water of the salmonid fish, are generally restricted to upper reaches of creeks during warm seasons, but may have had a wider distribution in the past.

Riparian vegetation is a natural barrier to excessive solar radiation (through stream surface shade) and may intercept runoff from surrounding lands that may carry sediments and other wastes. From headwaters downstream, many creeks have sufficiently protective riparian areas to guard against stream surface warming and runoff of sediments into the water. Natural disturbances and various other activities can cause these riparian areas to be less effective than their potential. Much of the upper portions of the Wallowa and Imnaha River Subbasins are managed as wilderness area, and as such are expected to resemble natural conditions. The same is true of the Wenaha River Watershed in the Lower Grande Ronde Subbasin, which is managed as wilderness at part of the Wenaha-Tucannon Wilderness area, and includes more than 21 miles of river designated wild and/or scenic. These areas have been managed as wilderness for many years and are generally in very good condition. However, the thermal potential of riparian areas, after full recovery from earlier human disturbances and with natural processes (including natural disturbance) as the only agent of control, may not currently exist.

Diversion of water from streams for various reasons diminishes the volume of water available for instream uses. Instream uses would generally include fish and wildlife habitat and recreation. The capacity of a stream to protect against pollutants, from heat (sunlight) to sediments and bacteria, is reduced with decreased flow of water. Less water volume instream results in higher concentrations of pollutants that directly or indirectly enter the water. These diversions are most common in the Wallowa River Watershed and include several systems of canals that divert water from the major rivers for irrigation. In one case (Wallowa Valley Improvement Canal) water is diverted in the Imnaha River Watershed and conveyed to the Wallowa River Watershed for irrigation.

1.3.2 Climate

The Lower Grande Ronde Subbasins are under the influence of Pacific winds but are within the rain shadow of the Cascade Mountains to the west. Average annual precipitation in the region varies from about 8 to 80 inches, depending largely on elevation (**Figure 1-4**). Precipitation is moderate but variable in the Wallowa Valley, with precipitation likely to occur in any month. Monthly accumulations are generally greater in the fall and early spring. Significant accumulations of snow rarely last on the valley floor, but accumulation on surrounding mountains is the source of flow during the drier period of the year. Low elevations are characterized by hot, dry summers while higher elevations are characterized by cold, wet winters.

Charts of annual precipitation and temperature for three COOP (Cooperative Observer Program) weather stations are shown in **Figure 1-5** for the period 1971-2000 (Western Regional Climate Center data). Monthly climate summaries for the same three sites are shown in **Table 1-4** for the period of record for each site.

Figure 1-4. Average annual precipitation
(National Resources Conservation Service, data downloaded from NRCS website in March, 2007 http://www.wcc.nrcs.usda.gov/).

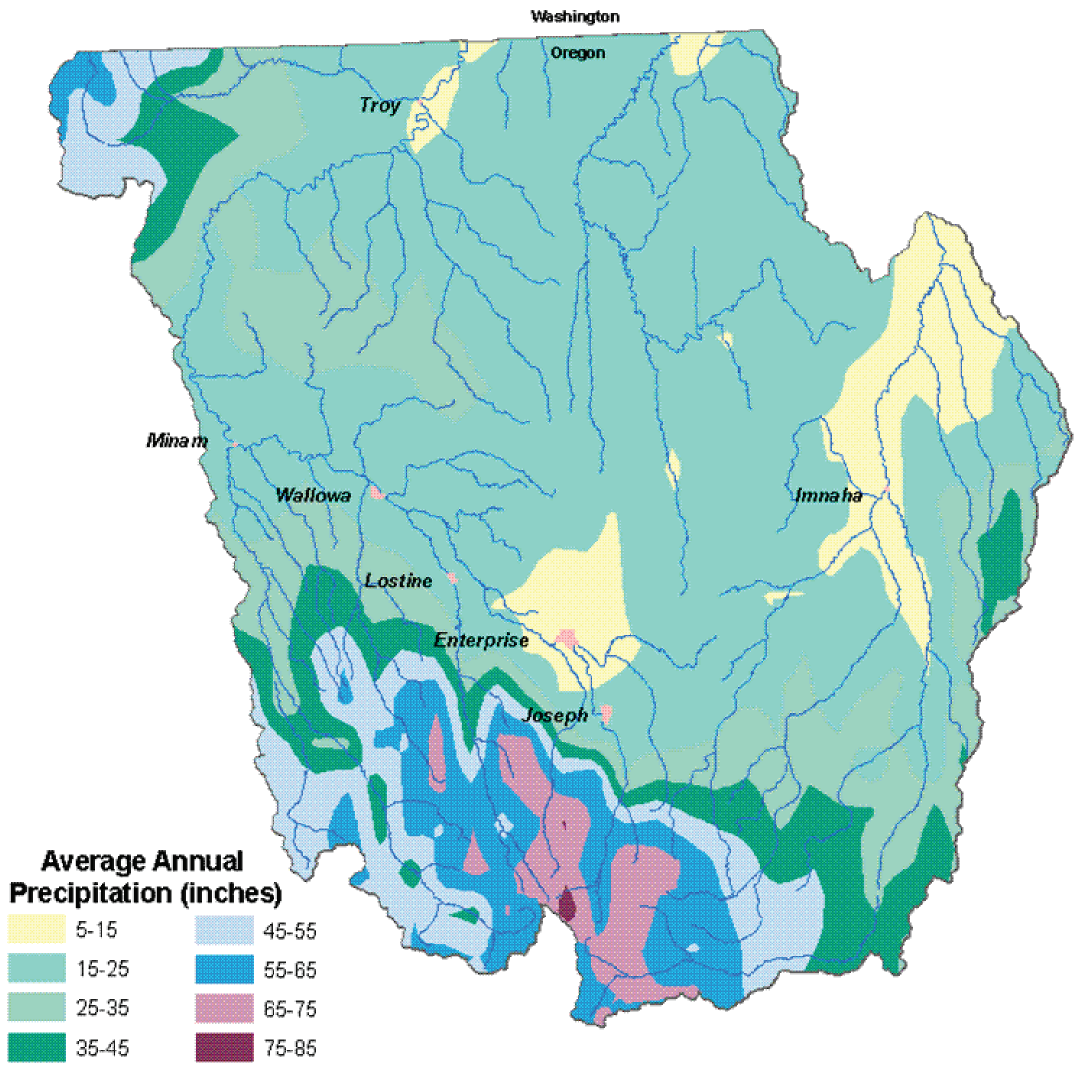
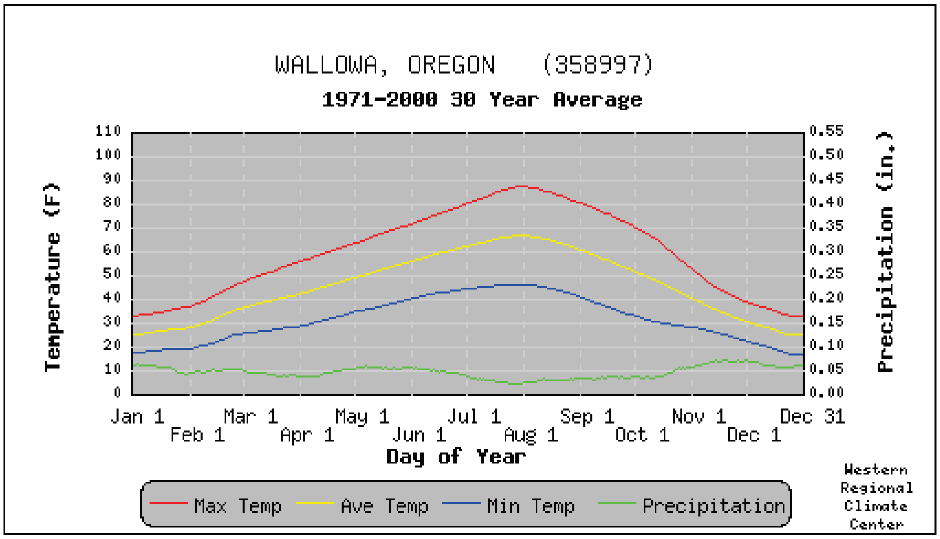
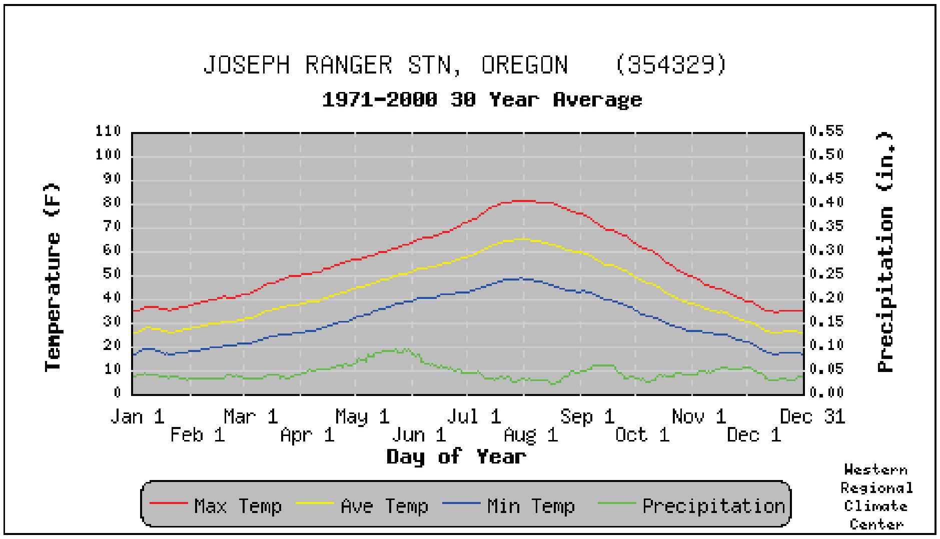


Figure 1-5. 1971-2000 average temperature and precipitation
(Western Regional Climate Center, data downloaded from website in March, 2007, http://www.wrcc.dri.edu/summary/Climsmor.html)





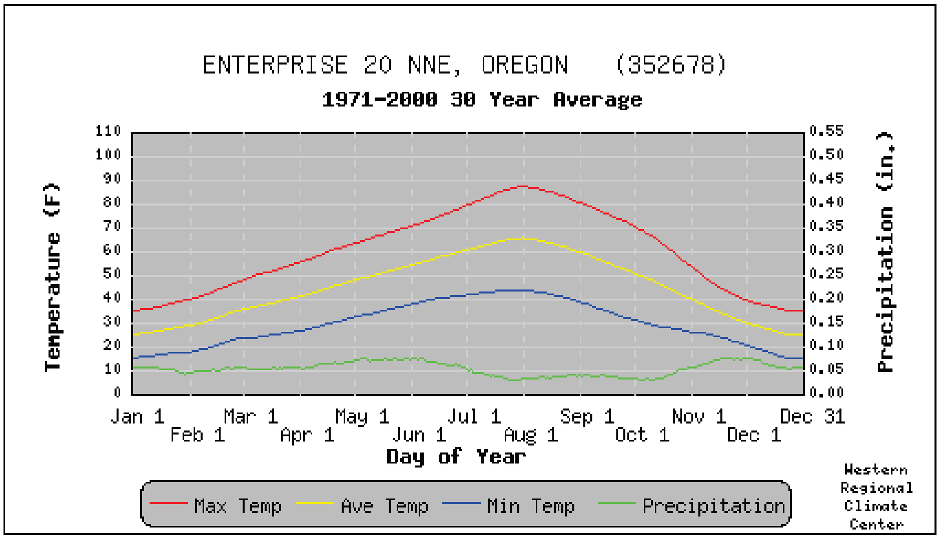


Table 1-4. Monthly climate summaries for the period of record
(Western Regional Climate Center, data downloaded from website in March, 2007 http://www.wrcc.dri.edu/summary/Climsmor.html)

Wallowa (358997)													
Period of record : 7/ 1/1948 to 10/31/2006													
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Annual**
Average Max. Temperature (F)	34.3	41.9	50.5	59.5	67.9	75.7	85.4	84.6	76.3	62.6	45.4	35.9	60
Average Min. Temperature (F)	18	22.1	26.7	31.2	37.5	42.9	45.5	43.9	37.2	30.5	25.6	20.1	31.8
Average Total Precipitation (in.)	1.89	1.37	1.4	1.43	1.86	1.47	0.74	0.87	1.04	1.43	2.01	2.03	17.55
Average Total SnowFall (in.)	12.9	6.4	3.6	0.7	0.1	0	0	0	0	0.2	5.2	10.6	39.7
Average Snow Depth (in.)	4	3	1	0	0	0	0	0	0	0	0	2	1
Percent of possible observations for period of record.													
Max. Temp.: 93.6% Min. Temp.: 93.6% Precipitation: 94.3% Snowfall: 93.6% Snow Depth: 91.3%													

Joseph Ranger Station (354329)													
Period of Record : 7/ 1/1948 to 10/31/2006													
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Annual**
Average Max. Temperature (F)	33.8	38.8	45.6	54.3	61.9	68.6	80.3	79.9	71.6	58.8	44.8	35.8	56.2
Average Min. Temperature (F)	16.4	18.8	24.1	29.5	37.1	42.1	48.1	47.5	41	32.1	25.3	17.9	31.7
Average Total Precipitation (in.)	1.31	1.11	1.45	1.83	2.46	1.94	0.87	0.96	1.06	1.31	1.38	1.35	17.03
Average Total SnowFall (in.)	11.2	9.3	9.9	4.4	0.7	0.4	0	0	0	1.4	4.4	8.5	50.2
Average Snow Depth (in.)	3	4	1	0	0	0	0	0	0	0	0	2	1
Percent of possible observations for period of record.													
Max. Temp.: 20.4% Min. Temp.: 20.3% Precipitation: 19.8% Snowfall: 19.6% Snow Depth: 19%													

Enterprise (352678)													
Period of Record : 2/13/1969 to 10/31/2006													
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Annual**
Average Max. Temperature (F)	37.1	43.8	51.8	59.6	67.9	75.5	85.1	85.7	76.1	62.7	45.3	36.6	60.6
Average Min. Temperature (F)	17.2	20.4	25.1	29.6	35.4	41	44	42.3	35.5	28.4	24.3	17.3	30
Average Total Precipitation (in.)	1.77	1.35	1.65	1.89	2.15	1.92	1.26	1.07	1.14	1.18	2.05	1.96	19.38
Average Total SnowFall (in.)	8.4	4.6	2.1	0.2	0	0	0	0	0	0	3.7	6.3	25.4
Average Snow Depth (in.)	4	2	0	0	0	0	0	0	0	0	0	2	1
Percent of possible observations for period of record.													
Max. Temp.: 98.8% Min. Temp.: 98.8% Precipitation: 99% Snowfall: 95.9% Snow Depth: 92.9%													

1.3.3 Human Population

The majority of the area in the Subbasins is contained within the boundaries of Wallowa County. Small strips of the Wallowa and Lower Grande Ronde Subbasins are within the boundaries of Union or Baker Counties. Conversely, there are small areas of Wallowa County that are not included in the Lower Grande Ronde Subbasins. The human population characterization presented here focuses on Wallowa County. The population of Wallowa County has been stable over recent decades, although there have been minor fluctuations (**Table 1-5**). All of the cities in the county except Enterprise, with slightly less than 2,000 residents, had populations of approximately 1,000 or less in 2005. These urban areas are established at lower elevations in the valley. Though there were modest increases in population in several of these cities, overall population in the county declined slightly between 2000 and 2005. Population statistics indicate that approximately 58% of county residents live in cities and 42% live in the generally rural remainder of the county. Population density is low, with approximately two people per square mile on average, though most reside in the lowlands of the Wallowa River valley.

Table 1-5. Population of cities in Wallowa County from 1970 through 2005
(Portland State University, Population Research Center, data downloaded from website in 2006 http://www.pdx.edu/prc/).

Rank	City/County	Percent Change*	Year				
			2005	2000	1990	1980	1970
106	Enterprise	2.6%	1,945	1,895	1,905	2,003	1,680
133	Joseph	3.3%	1,090	1,054	1,073	999	839
184	Lostine	-4.9%	250	263	231	250	196
145	Wallowa	0.1%	870	869	748	847	811
33	Wallowa County	-1.3%	7,130	7,226	6,911	7,273	6,247

*Percent change from 2000 census to 2005

1.3.3.1 Land Ownership

Land in the Lower Grande Ronde Subbasins is 42% privately owned and 58% publicly owned, with the majority of the latter in federal management (**Figure 1-6**). The federally managed land is largely within the Wallowa-Whitman National Forest, Hell's Canyon National Recreation Area, and Umatilla National Forest. Portions of the Wenaha-Tucannon Wilderness and Eagle Cap Wilderness are included in the Subbasins. There are four incorporated cities (Enterprise, Joseph, Wallowa, and Lostine) in the county and several smaller communities (e.g., Troy, Imnaha, and Minam).

1.3.3.2 Land Use and Economy

Land use in the Subbasins is dominated by forest lands, grasslands and scrub/shrub, with significant acreage of agricultural land and some rural residential development in the Wallowa River Subbasin (**Figure 1-7**). There are also several small urban areas, mostly within the Wallowa Valley. The Wallowa Mountains and Columbia Plateau provide the landscape of this diverse area including extensive grasslands, deeply cut river valleys, and alpine forests with mountain peaks above 10,000 feet in elevation. Much of the high elevation forest lands are managed as wilderness areas and as National Recreation Areas by the Wallowa Whitman National Forest and Umatilla National Forest, under auspices of the USFS.

Agriculture plays an important economic role in the area, grossing approximately 41 million dollars in sales in 2004 (OSU 2005) and providing approximately one-quarter of the jobs and personal income in the county. Agricultural sales were split between crops ($21,477,000) and livestock agriculture ($19,998,000), mostly cattle and calf production.

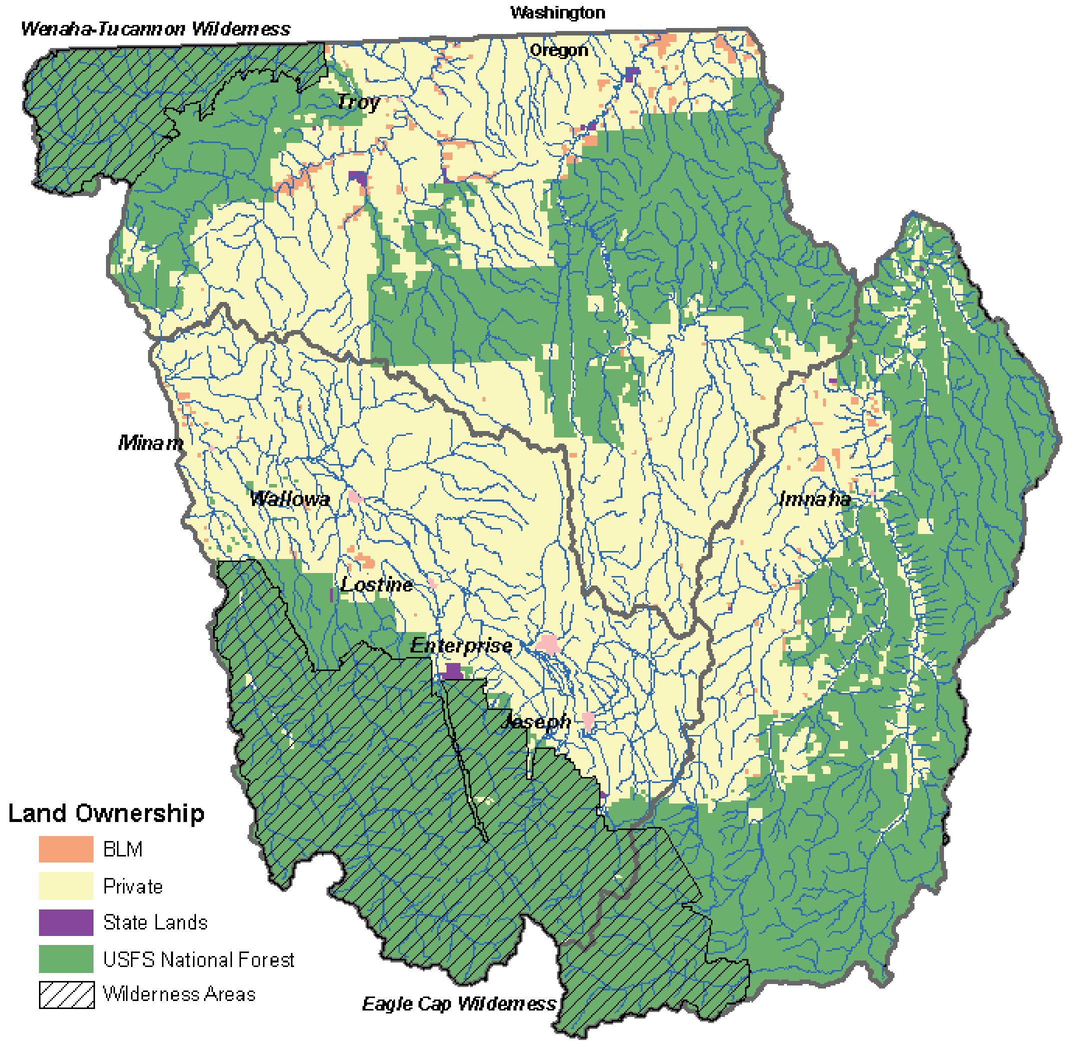
Forestry is also a significant contributor to the Wallowa County economy. Forest economic output in the county was approximately 30 million dollars in 2000, though the industry provides fewer jobs than agriculture (Sorte and Tanaka 2004).

1.3.3.3 Nez Perce Tribe

Historically, the Nez Perce Tribe had exclusive use and occupancy over an area of almost 17 million acres in the Columbia River Basin in what is presently northeast Oregon, north-central Idaho, southeast Washington and far western Montana. Two federal treaties drafted in 1855 and 1863 reduced the Tribe's land holdings to the current 750,000 acre reservation located in north-central Idaho. The Tribe has increased its holding through land acquisitions across its ceded territory, including significant land holdings in the Joseph Creek watershed.

In the Treaty of 1855, the Nez Perce reserved the exclusive right to fish on the reservation, as well as the right to fish at all "usual and accustomed places" throughout the Columbia River Basin. The Tribe further reserved the right to hunt, gather, and pasture animals on "open and unclaimed" lands, which is generally defined to include public lands.

Figure 1-6. Land ownership in the Lower Grande Ronde Subbasins
(Oregon Geospatial Data Clearinghouse, data downloaded from website in January, 2005 http://www.oregon.gov/DAS/EISPD/GEO/alphalist.shtml#L)



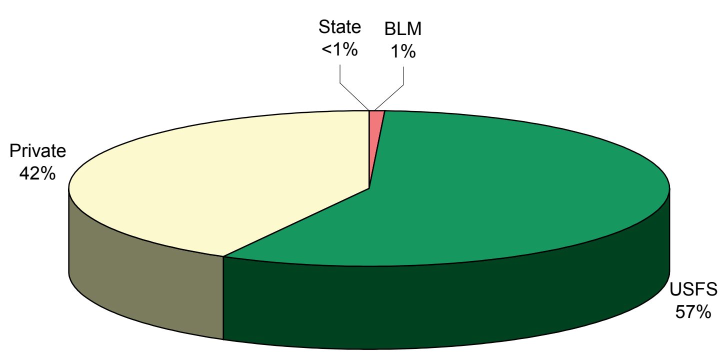
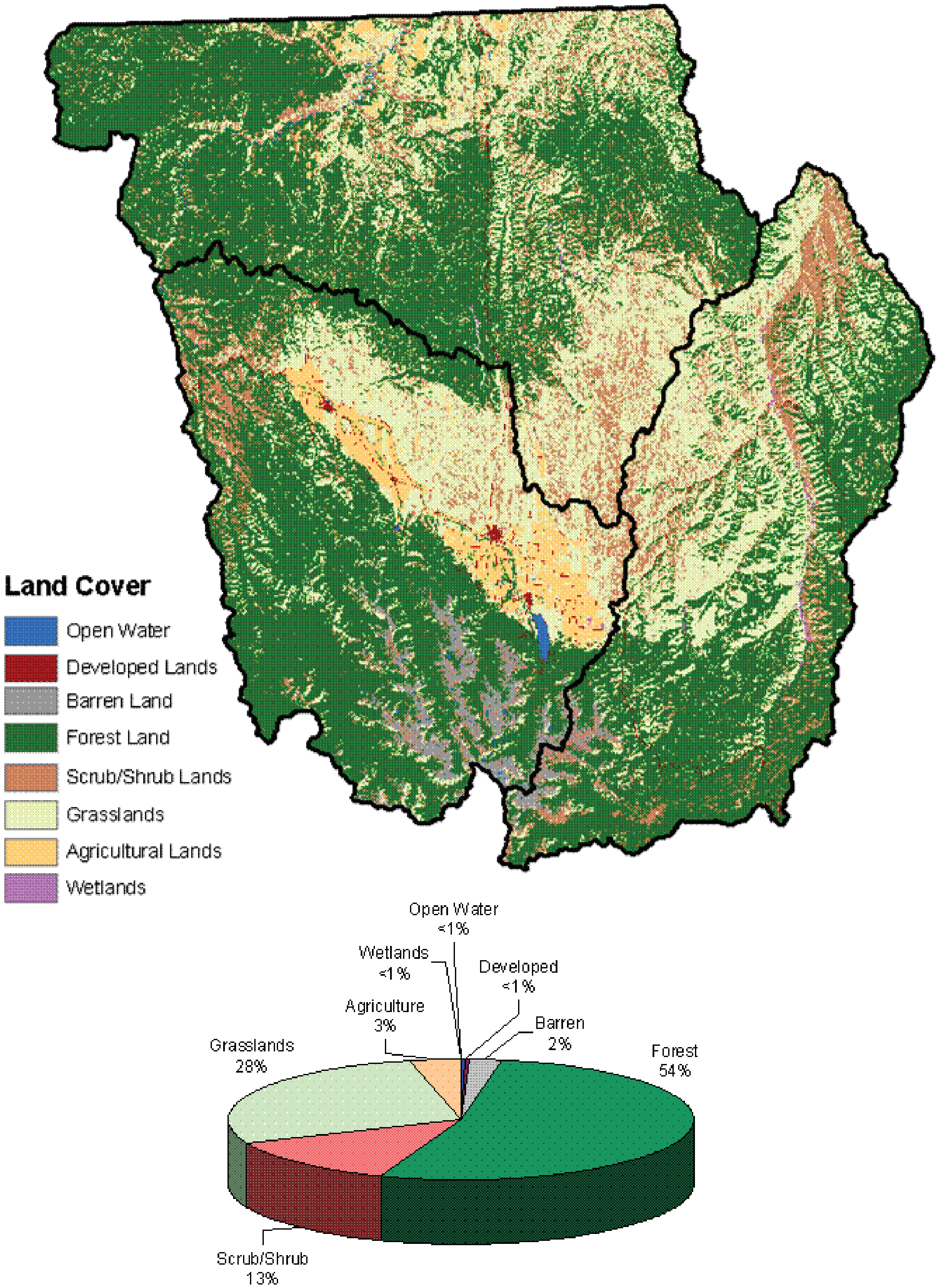


Figure 1-7. Land use distributions in the Lower Grande Ronde Subbasins
(USGS, 2001 NLCD database, data downloaded from website in April 2007 http://www.mrlc.gov/index.php)**.**



Note: For display purposes, NLCD land cover class definitions were grouped as follows: Developed Lands includes all developed lands, including open space, low intensity, medium intensity and high intensity development; Forest Land includes deciduous forest, evergreen forest and mixed forest; Agricultural Lands includes pasture/hay and cultivated crops; Wetlands includes woody wetlands and emergent herbaceous wetlands. Grasslands are areas not subjected to intensive management, such as tilling, but can be utilized for grazing. Refer to the USGS website for more detailed descriptions of land cover categories.

Tribal responsibility on ceded lands throughout the Lower Grande Ronde Subbasins is defined through their role as co-manager of the salmon resource which has been determined through treaty rights and federal court decisions. As a co-manager of these resources, the Tribe plays a central role in development and implementation of plans and projects designed to protect and enhance treaty-reserved resources, including salmon, steelhead, and other aquatic resources. Some of these key plans and their role in TMDL implementation are described further in the WQMP (**Chapter 4**). Staff from the Nez Perce Tribe were members of the Wallowa County TMDL Committee and contributed to the development of the TMDLs included in this report. Consultation and continued coordination with the Nez Perce Tribe will enhance the effective implementation of the TMDL.

1.3.4 Hydrography

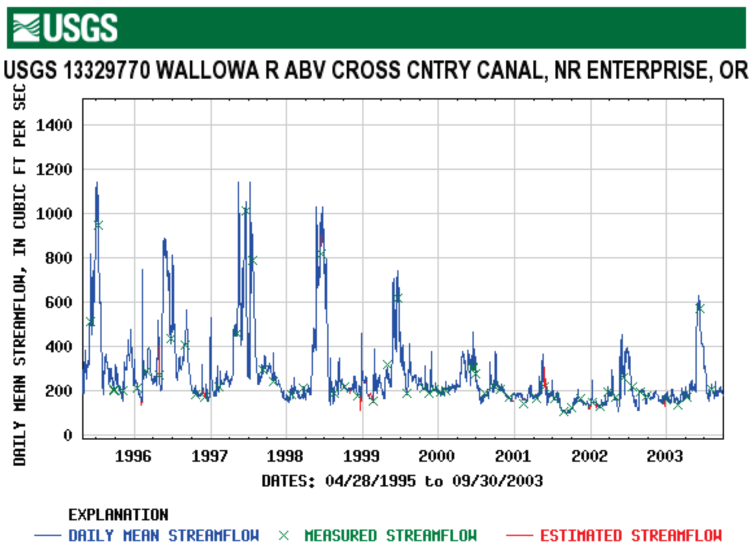
Stream flows are generally lowest in mid-summer due to decreased precipitation and increased water withdrawals (**Figure 1-8**). These patterns reflect the importance of snowmelt on both surface and groundwater volumes. Highest flows occur during late spring and early summer as mountain snows melt and fill tributaries to the major rivers. These high flows are often associated with large scale movement of sediments, resulting in turbid water and large woody debris being distributed downstream.

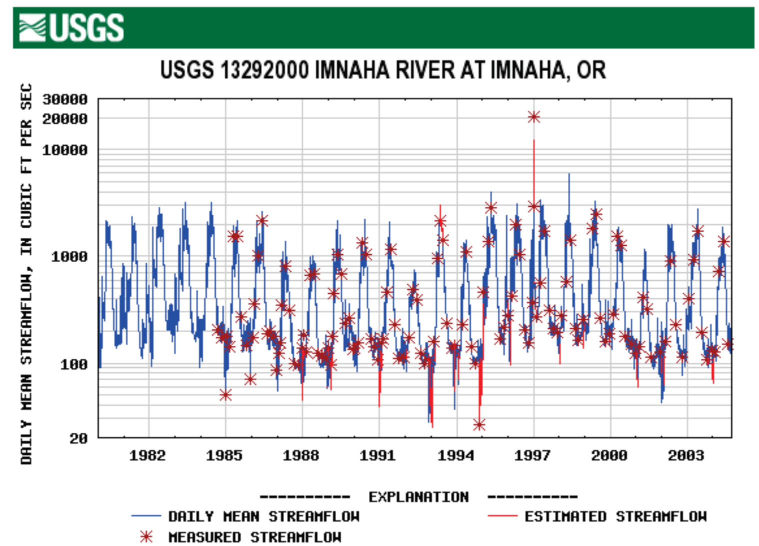
Flows in the Wallowa River are influenced by releases from the Wallowa Lake Dam and diversions to several agricultural ditch systems. Wallowa Lake is a deep (~300 feet), glacially carved lake surrounded by moraine deposits that naturally restrict the northern end where it flows to the Wallowa River. This natural dam was augmented in 1919 to allow increased water storage to allow for diversions to ditch irrigation systems that serve much of the area around Joseph and Enterprise. Other diversions from tributaries to the Wallowa River reduce instream flow in the tributaries and ultimately in the Wallowa and Lower Grande Ronde Rivers.

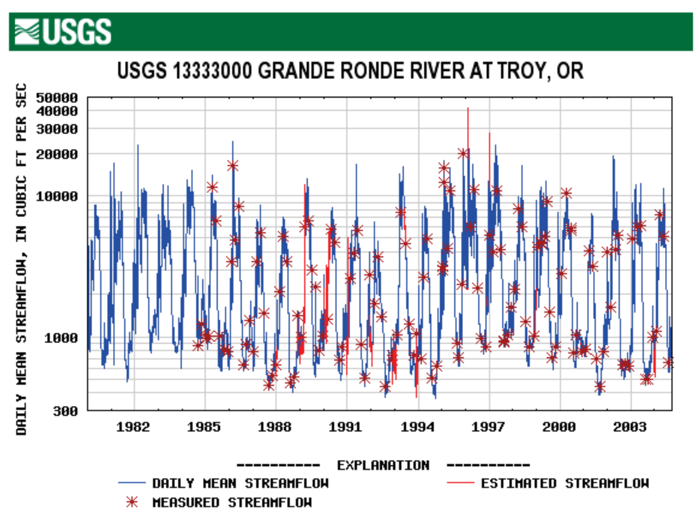
The reduction in stream flows due to agricultural diversions is observed in many of the water bodies in the Lower Grande Ronde Subbasins, with the exception of the Minam River which does not have any known irrigation withdrawals. The Lostine River is severely impacted by water diversions in the lower reach despite storage of some water for irrigation release in Minam Lake at the Lostine River headwaters. These diversions begin at river mile 19. Flows in the lower five miles of the Lostine River are augmented with Wallowa River water via the Cross Country Canal. Flows in Bear Creek are similarly severely impacted by diversions in the lower three miles of the creek. Flows in the Imnaha River Subbasin are also influenced by ditches that divert water from creeks (e.g., Big Sheep Creek to Wallowa Valley Improvement District) and carry it to the Wallowa Valley for irrigation. Additional information about the location of points of diversion is provided in **Appendix A**.

Figure 1-8. Flow profiles for three stations in the Lower Grande Ronde Subbasin since 1980 or more recently.

USGS, Oregon Water Science Center data downloaded from website in 2004 http://or.water.usgs.gov/). The stations are Wallowa River upstream of Cross-Country Canal (1995-2003); Imnaha River at Imnaha (1980-2003); and Grande Rhonde River at Troy (1980-2003).



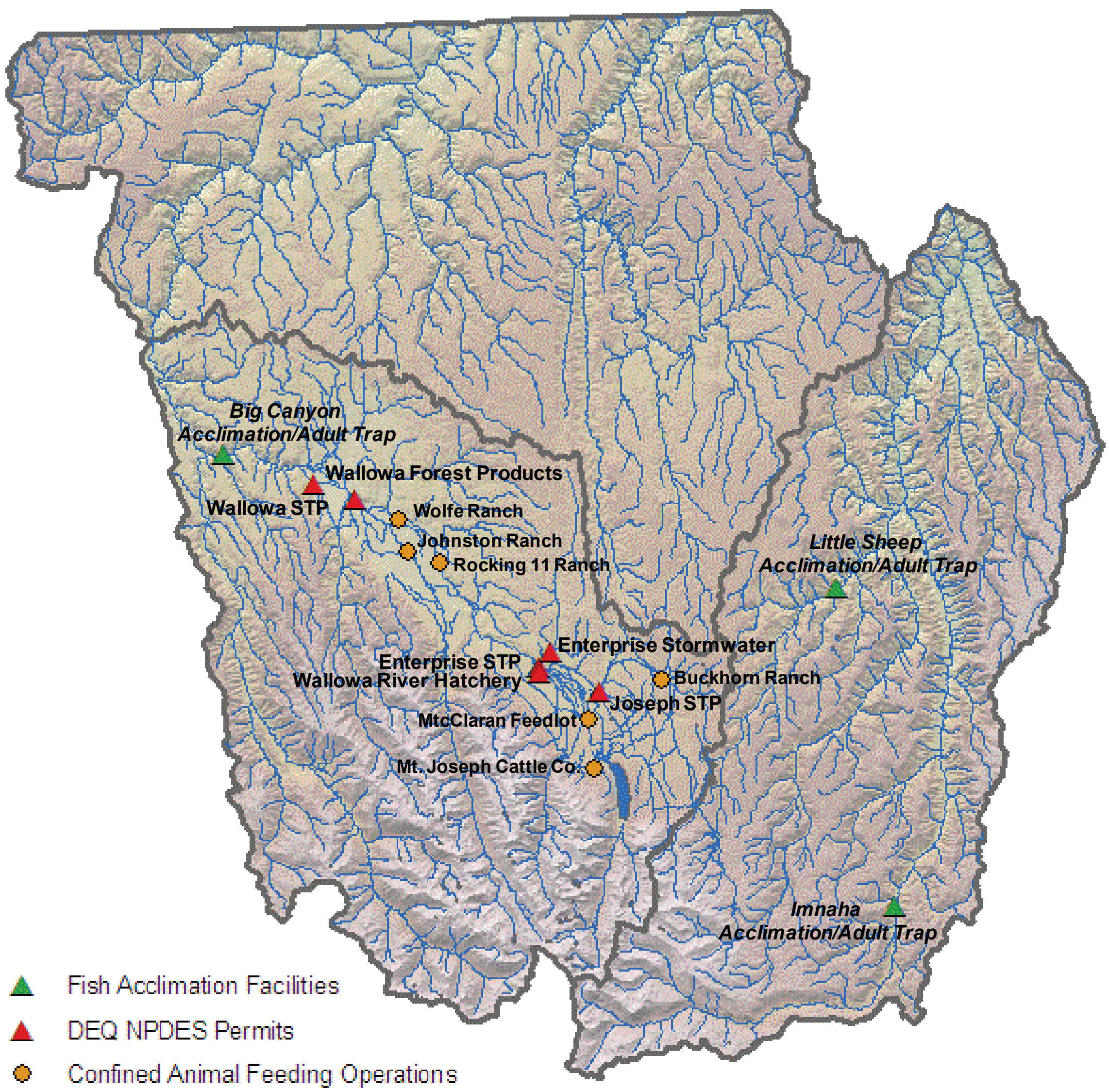




1.3.5 Point Sources

A point source is a stationary location or fixed facility, such as an industry or municipality wastewater treatment plant, that discharges pollutants through a defined conveyance, such as pipes, ditches, lagoons or wells. In the State of Oregon, DEQ administers two different types of permits to protect surface waters from point source discharges: WPCF and NPDES permits (Oregon Revised Statute (ORS 468B.050). Water Pollution Control Facilities (WPCF) permits are for waste disposal operations and do not allow for any discharge to surface waters. Therefore they are not addressed in this TMDL. The second type is the National Pollution Discharge Elimination System (NPDES) permit, a requirement of the Federal Water Pollution Control Act (Clean Water Act) and Oregon law. DEQ is the designated agency for the NPDES permit program, which includes issuing permits and conducting the compliance and monitoring for the permits. Under a Memorandum of Understanding, ODA and DEQ jointly issue NPDES individual and general permits for the Confined Animal Feeding Operation (CAFO) permit program. ODA assigns the permits and conducts the compliance and monitoring under this agreement. There are 16 point source discharges in the Lower Grande Ronde Subbasins (**Figure 1-9**), with the majority of these in the Wallowa River Subbasin. See the subsections below for more information about each of these discharges.

Figure 1-9. Point source discharges in the Lower Grande Ronde Subbasins



1.3.5.1 General and Individual NPDES Permits administered by DEQ

NPDES permits which are administered by DEQ are for any operation that has a water discharge including, but not limited to, wastewater, sewage, processing water, wash water, cooling water, etc. These discharges to surface water may occur directly through a pipe or ditch or indirectly through a storm sewer system. Certain industries and activities may also be required to obtain permits for storm water runoff from their properties. NPDES permits fall into two categories, individual and general.

There are seven permitted NPDES point-source discharges to waters within the Lower Grande Ronde Subbasins (**Table 1-6**) which are administered by DEQ. All of these are in the Wallowa River Subbasin. Three of the NPDES permits are individual permits for domestic sewage for the cities of Enterprise, Joseph and Wallowa. The other four are general permits. The City of Enterprise has a general stormwater construction permit for construction of their new wastewater treatment plant. Wallowa Forest Products has two general NPDES permits – one for stormwater and one for boiler blowdown (industrial wastewater). The Oregon Department of Fish and Wildlife (ODFW) has a general NPDES permit for fish hatchery discharge. Facility locations, identification and characteristics are described below.

In addition to these seven permitted discharges, there are also three fish acclimation facilities located in the Lower Grande Subbasins – 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.

Table 1-6. NPDES discharges in the Lower Grande Ronde Subbasins

File Number	Legal Name	Category	Class	Permit Type	Receiving Stream	River Mile
27514	City of Enterprise	Domestic	Minor	NPDES-DOM-Da	Wallowa River	40.7
116941	City of Enterprise	Stormwater	Minor	GEN12C	Trout Creek	---
44329	City of Joseph	Domestic	Minor	NPDES-DOM-Db	Prairie Creek	4.0
64580	ODFW	Individual	Minor	GEN03	Spring Creek	1.65
108221	Wallowa Forest Prod., LLC	Individual	Minor	GEN05	Wallowa River	20.0
108221	Wallowa Forest Prod., LLC	Stormwater	Minor	GEN12Z	Wallowa River	19.0
93617	City of Wallowa	Domestic	Minor	NPDES-DOM-Db	Wallowa River	23.0

City of Enterprise Sewage Treatment Plant

The City's original sewer system was placed into operation in 1915 using clay pipe, which conveyed the wastewater to a large septic tank and then discharged into Trout Creek. In 1952, an engineering study concluded that high groundwater was infiltrating into the system and increasing the daily flows. As a result, sewer lines in the high groundwater area were replaced. A new trickling filter was built in 1955, but inflow and infiltration were still a problem. Additional improvements were made to the system in 1987, which included replacement of deteriorated sewer lines, installation of a new outfall line and polishing pond, and repair of the final clarifier. High levels of infiltration and inflow (I&I) continued to occur during the spring and summer resulting from the effects of local irrigation. These activities elevated the groundwater which infiltrated the sewer system. Due to the high I&I from the elevated groundwater, this facility exceeded the original design capacity in the spring and summer, causing effluent violations to occur.

The City of Enterprise just completed an upgrade of their wastewater treatment plant to ensure compliance with water quality standards. The plant has been 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 meeting their more restrictive permit limits. The facility discharges into the Wallowa River year-around.

As of May 31, 2007, the City of Enterprise received a stormwater construction permit in association with construction of the new facility. This NPDES permit is required for construction activities which disturb more than one acre of ground. Although the construction of the new facility is now complete, the stormwater construction permit is still active.

City of Joseph Sewage Treatment Plant

The treatment facility is located about one mile north of Joseph off of Walker Lane on Valley View Road. The facility was originally placed into operation in 1967 and the last major facility modification was completed in 1997. The facility is allowed to discharge into Prairie Creek from November 1 through May 31. During the rest of the year the effluent is land applied in an adjacent field.

The City’s wastewater treatment facility consists of headworks with a mechanical screen, a manually-cleaned grit chamber and a 6-inch Parshall flume followed by a primary clarifier. The major treatment process used is Stabilization Lagoons with Aeration. Solids settled out in the clarifier are processed in a two-cell aerobic digester. Wastewater from the clarifier flows by gravity to a four-cell, synthetic-lined, 10-acre facultative lagoon system. Two of the lagoon cells are mechanically aerated. Effluent from the second cell is chlorinated and then flows through a 24-inch diameter contact pipe to the third cell. The third and fourth cells are used as dechlorination, storage and polishing ponds. Effluent from the fourth cell is measured using a 3-inch Parshall flume and discharged to Prairie Creek at river mile 4.0 through an 8-inch diameter, 9,500 feet long outfall pipe, or is pumped to the land application site.

City of Wallowa Sewage Treatment Plant

The City of Wallowa owns and operates a wastewater treatment facility that was originally constructed in 1972. The facility is located adjacent to the Wallowa River in the north end of the City. The treatment facility receives primarily domestic wastewater from residential and commercial sources. There are no categorical users that contribute to the wastewater flow to the facility.

The wastewater treatment facility consists of a two cell, facultative lagoon with a total surface area of 7.5 acres, influent Parshall flume and flow recorder, lift station, chlorination system, V-notch, effluent weir and recorder. Effluent is discharged to the Wallowa River at river mile 23.0 year-around. The facility completed its last upgrade in 2002. During that upgrade, they expanded and divided their cells and replaced their disinfection system. The facility presently serves a population of 750- 810, although the design population used for the new collection system and plant was a projected population of 1,000.

Wallowa Forest Products Industrial Discharges

The Wallowa Forest Products lumber mill is located at approximately river mile 20 on the Wallowa River approximately three miles northwest of Wallowa, Oregon. The mill site consists of log storage decks, wood waste landfill, sawmill, lumber drying kiln, boiler, and product storage areas. Wallowa Forest Products holds general permits for boiler blowdown (NPDES General Permit 500-J) and for stormwater (NPDES General Permit 1200-Z). Boiler blowdown is discharged to a sump, which flows to an unlined pond and commingled with industrial storm water prior to discharge at Outfall 001. The facility has been closed since December, 2007, although the permits are still active.

ODFW Wallowa River Hatchery

The Wallowa Fish Hatchery is located on Fish Hatchery Lane, just northeast of the City of Enterprise. It is fed by and discharges to Spring Creek which runs right next to its driveway. The hatchery is managed by the Oregon Department of Fish and Wildlife (ODFW), which holds a general permit for aquatic animal production facilities (NPDES General Permit 300J). This permit covers discharges from facilities which produce at least 20,000 pounds of fish per year, but have less than 300,000 pounds on hand at any time. There are limits set in the general permit for total suspended solids (TSS), settleable solids, temperature and pH in the discharge.

1.3.5.2 Confined Animal Feeding Operations

Confined Animal Feeding Operations (CAFOs) are generally defined as the concentrated confined feeding or holding of animals in buildings, pens or lots where the surface is prepared to support animals in wet weather or where there are wastewater treatment facilities for livestock (e.g., manure lagoons). CAFO wastes include but are not limited to manure, silage pit drainage, wash down waters, contaminated runoff, milk wastewater, and bulk tank wastewater. The CAFO permit program began in the early 1980s to prevent CAFO wastes from contaminating groundwater and surface water.

All CAFOs operate under a general NPDES permit issued and managed by the Oregon Department of Agriculture (ODA). The CAFOs covered by this permit have the potential to discharge a variety of pollutants to receiving streams throughout the state. The general permit prohibits discharge of CAFO wastes. There are some exceptions for discharges which occur under extreme rainfall events for facilities which meet certain design criteria. These criteria are not met for any of the CAFOs in the Wallowa River Subbasin (Ron Jones, personal communication), so no discharges are allowed for any of these facilities.

All land application of manure and process wastewater must be done in accordance with an ODA approved Animal Waste Management Plan (AWMP). The AWMP is required for each CAFO. The general permit refers to each site-specific AWMP. Each permitted CAFO receives a routine inspection from the area Livestock Water Quality Inspector once a year, on average. During this inspection, the operator and inspector discuss the operation and review required plans and records. The inspector views the entire operation to assure compliance with permit terms and water quality rules and laws. The inspection reports detail permit compliance in the following areas: permitted number of animals, animal confinement requirements, manure and silage containment requirements, manure application requirements, AWMP, and record keeping. Problems in any of these areas, including incomplete record keeping, can result in the issuance of a water quality advisory or a notice of noncompliance (NON). When a discharge occurs or where there is a potential for a discharge to occur, ODA may take samples of the effluent to determine bacterial concentrations. Surface water quality samples are taken when visual or anecdotal evidence of discharge is present. In the event a violation is found, the inspector works with the operator to develop a solution to the problem and a schedule to complete the corrective actions. ODA can also issue civil penalties for violations listed in NONs.

There are currently six CAFOs in the Lower Grande Ronde Subbasins (**Table 1-7, Figure 1-9**). All of these are in the Wallowa Subbasin.

Table 1-7. CAFOs located in the Lower Grande Ronde Subbasins
(data downloaded from ODA website in December,2009 http://oda.state.or.us/dbs/licenses/search.lasso?&division=nrd)

License Number	*Facility Name*	*Location*	*Expiration Date*
AG-P0155824CAFG	Goertzen's Buckhorn Ranch	Joseph	6/20/2010
AG-P0181713CAFG	Johnston Ranch	Wallowa	6/20/2010
AG-P0175766CAFG	McClaran Feedlot	Joseph	6/20/2010
AG-P0063583CAFG	Mt. Joseph Cattle Co, Inc.	Joseph	6/20/2010
AG-P1000003CAFG	Rocking 11 Ranch, LLC	Lostine	6/20/2010
AG-P0172757CAFG	Wayne/Gordon Wolfe Prtnr	Wallowa	6/20/2010

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LOWER GRANDE RONDE SUBBASINS TMDL
CHAPTER 2: STREAM TEMPERATURE

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2.1 OVERVIEW

Human activities and aquatic species that are to be protected by water quality standards are deemed beneficial uses. Water quality standards are developed to protect the most sensitive beneficial use within a waterbody of the State. The stream temperature standard is designed to protect cold water fish (salmonids) rearing and spawning as the most sensitive beneficial use.

Oregon's stream temperature standard includes both numeric and narrative criteria. Numeric biologically-based criteria are based on temperatures that protect various salmonid life stages. Narrative criteria specify conditions that deserve special attention, such as protection of cold waters. Oregon's temperature standard also includes Natural Conditions criteria which apply if DEQ determines that the biologically-based numeric temperature criteria may not be met under natural conditions at a particular site. When this determination is made, a "natural thermal potential" (NTP) temperature becomes the new criterion. Based on the analysis presented in this TMDL, the Natural Conditions criteria apply throughout the Lower Grande Ronde Subbasins and NTP conditions become the TMDL target. Exceptions occur where and when numeric targets are needed and the natural potential temperatures have not been assessed. This is typically a concern for point sources outside of the warm season.

When stream temperature data demonstrate non-attainment of a criterion, the waterbody is designated water quality limited and placed on the 303(d) list. Total Maximum Daily Loads (TMDLs) must then be completed for the 303(d) listed waterbodies. This temperature TMDL applies to all perennial and intermittent streams within the Lower Grande Ronde Subbasins.

2.1.1 Summary of Stream Temperature TMDL Approach

Stream temperature TMDLs are generally scaled to a subbasin or basin and include all perennial and intermittent surface waters with either salmonid presence or that contribute to areas with salmonid presence. Since stream temperature results from cumulative interactions between upstream and local sources, the TMDL considers all surface waters that affect the temperatures of 303(d) listed waterbodies. For example, the Lower Grande Ronde and Wallowa Rivers are water quality limited for temperature. To address these listings in the TMDL, all tributaries in the Subbasins receive load allocations.

An important step in the TMDL is to perform a source assessment which quantifies the anthropogenic contributions to stream heating. One anthropogenic contribution to solar radiation heat loading results from decreased stream surface shade. Decreased stream shade may be caused by near-stream vegetation disturbance/removal and channel morphology changes. Other anthropogenic sources of stream warming may include stream flow reductions and warm water point source effluent discharges.

Heat is the identified pollutant. Anthropogenic nonpoint and point sources are collectively not allowed to heat a waterbody more than 0.3^{o}C above the applicable criteria, after complete mixing and cumulatively at the point of maximum impact. This permitted amount of heating is called the Human Use Allowance (HUA) (OAR 340-041-0028 12(b)). Allocated conditions are expressed as solar heat load. Nonpoint source heat load allocations are translated into effective shade surrogate measures. Effective shade surrogate measures provide site-specific targets for land managers that are easily measured. Attainment of the surrogate measures ensures compliance with the nonpoint source allocations. Point source wasteload allocations are based on the applicable numeric and/or narrative criteria. In this TMDL, point sources on a given waterbody are not allowed to increase stream temperatures more than 0.2^{o}C (a portion of the 0.3^{o}C HUA) cumulatively after complete mixing with the receiving water.

Table 2-1 summarizes the components of this TMDL. **Appendix A** describes the stream temperature analysis used to develop this TMDL in greater detail than is provided in this Chapter. The purpose of the stream temperature analysis used in this TMDL was to: (1) determine temperatures for various scenarios on the Wallowa River including natural thermal potential, (2) assess heat loading for the purpose of TMDL allocation, and (3) compute readily measurable surrogates for the allocations. Heat Source, version 7.0 (Boyd and Kasper 2003) was the model used for TMDL development in this TMDL.

Table 2-1. Lower Grande Ronde Subbasins Temperature TMDL Components

Waterbodies OAR 340-042-0040(4)(a)	Perennial and intermittent streams (as identified in OAR 340-041-151; Figures 151A & 151B) in the Lower Grande Ronde Subbasins, 4th field HUCs 17060102, 17060105, and 17060106. This area generally covers Wallowa County.
Pollutant Identification OAR 340-042-0040(4)(b)	<u>*Pollutant*</u>*:* Heat from human-caused sources such as: (1) solar radiation loading, (2) warm water discharge to surface waters and (3) flow modifications that affect natural thermal regimes.
Beneficial Uses OAR 340-042-0040(4)(c) OAR 340-041-151, Table 151A	Fish and aquatic life are the most temperature-sensitive beneficial uses in the Grande Ronde Basin.
Target Identification (Applicable Water Quality Standards) OAR 340-042-0040(4)(c) OAR 340-041-0028(4)(a) OAR 340-041-0028(4)(b) OAR 340-041-0028(4)(c) OAR 340-041-0028(8) OAR 340-041-002811) *CWA §303(d)(1)*	OAR 340-041-0028 provides numeric and narrative temperature criteria. Maps and tables provided in OAR 340-041-151 specify where and when the criteria apply. Biologically based numeric criteria applicable to the Lower Grande Ronde Subbasins, as measured using the seven-day average maximum stream temperature, include: • 12.0°C during times and at locations of bull trout spawning and juvenile rearing. • 13.0°C during times and at locations of salmon and steelhead spawning. • 16.0°C during times and at locations of core cold water habitat identification. • 18.0°C during times and at locations of salmon and trout rearing and migration. Oregon water quality standards include provisions for natural conditions. When DEQ determines that the natural thermal potential of a water body exceeds these biological based criteria, as is the case with the Wallowa River, the natural thermal potential temperatures (natural conditions) are deemed the applicable criterion for that water body. DEQ has determined that the natural conditions criterion is the primary warm season target throughout the Lower Grande Ronde Subbasins. Exceptions occur where and when numeric targets are needed and the natural potential temperatures have not been assessed (such as for point sources).
Seasonal Variation OAR 340-042-0040(4)(j) *CWA §303(d)(1)*	Peak temperatures typically occur in July and August, although the biologically-based numeric criteria can be exceeded during the critical period of April-October. The TMDL applies year-around.
Existing Sources OAR 340-042-0040(4)(f) CWA §303(d)(1)	<u>Nonpoint sources</u> include excessive inputs of solar radiation because of streamside vegetation removal or reduction, anthropogenic channel disturbance, and flow modifications. <u>Point sources</u> include municipal facilities that discharge warm water to receiving streams.

Table 2-1 (continued). Lower Grande Ronde Subbasins Temperature TMDL Components

TMDL Loading Capacity and Allocations OAR 340-042-0040(4)(d) OAR 340-042-0040(4)(e) OAR 340-042-0040(4)(g) OAR 340-042-0040(4)(h) OAR 340-042-0040(4)(k) *40 CFR 130.2(f)* *40 CFR 130.2(g)* *40 CFR 130.2(h)*	*Loading Capacity:* OAR 340-041-0028 (12)(b)(B) states all anthropogenic sources of heat may cumulatively increase stream temperature no more than 0.3°C (0.5°F) above the applicable criteria at the point of maximum impact. Loading capacity is the heat load that corresponds to the natural conditions criterion plus the increases in temperature provided through the human use allowance (HUA). *Wasteload Allocations (NPDES Point Sources [PS])*: NPDES permitted point sources combined are allowed an increase in temperature of not more than 0.2ºC increase in 50% of low stream flow. Wasteload allocations apply during the critical period of April-October. *Load Allocations (Nonpoint Sources [NPS])*: Natural background heat loads from solar radiation associated with system potential near-stream vegetation are the targeted load allocation. A surrogate of system potential shade is used as a surrogate allocation. A portion (0.05°C) of the human use allowance has been allocated to nonpoint source activities to address anthropogenic heat loads in excess of background rates. *Excess Load*: The difference between the current pollutant load and the loading capacity of the waterbody is the excess heat load. For the Wallowa River, the excess hear load is 73.5 megawatts. *Reserve Capacity*: The Reserve Capacity can be summarized as: RC = HUA – (NPS HUA + PS HUA); where HUA=0.3°C, NPS HUA = 0.05°C and PS HUA = no more than 0.2°C.
Surrogate Measures OAR 340-042-0040(5)(b) *40 CFR 130.2(i)*	*Surrogate Measures* are used throughout the temperature TMDL. Effective shade targets translate nonpoint source solar radiation loads into measurable riparian vegetation targets.
Margins of Safety OAR 340-042-0040(4)(i) *CWA §303(d)(1)*	*Margins of Safety* are implicitly demonstrated in conservative critical condition assumptions for point source load calculations and are inherent in the methodology for determining nonpoint source loads**.**
Water Quality Management Plan OAR 340-042-0040(4)(l)	The Water Quality Management Plan (WQMP) (**Chapter 4**) provides the framework of management strategies to attain and maintain water quality standards and reasonable assurance that the TMDL and associated allocations will be met. The WQMP is designed to work in conjunction with detailed plans and analyses provided in sector-specific or source-specific implementation plans.

2.2 WATERBODIES

This temperature TMDL applies to all perennial and intermittent streams within the Lower Grande Ronde, Wallowa River and Imnaha River Subbasins, as identified in Figures 151A and 151B in OAR 340-041-151.

2.3 POLLUTANT IDENTIFICATION

Development of stream temperature TMDLs requires an understanding of the natural and human processes that contribute to stream warming. Temperature is the water quality parameter of concern, but heat, in particular heat from human activities or anthropogenic sources, is the pollutant of concern in this TMDL. Specifically, water temperature change is an expression of heat energy exchange per unit volume:

$$\Delta Temperature \propto \frac{\Delta Heat \quad Energy}{Volume}$$

Stream temperature is influenced by natural factors such as climate, geomorphology, hydrology, and vegetation. Human or anthropogenic heat sources may include discharges of heated water to surface waters, increases in sunlight reaching the water's surface due to the removal of streamside vegetation and reductions in stream shading, changes to stream channel form, and reductions in natural stream flows and the reduction of cold water inputs from groundwater (see **Appendix A** for a more thorough discussion of stream heating processes). The pollutant targeted in this TMDL is heat from the following sources: (1) human-caused solar radiation loading increases to the stream network, as a result of alterations in near-stream vegetation, channel morphology, and flow modifications; and (2) warm water of human origin, such as waste water treatment plants.

2.4 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 2-2**). 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.

Salmon and trout (salmonids) and other cold water species that inhabit most streams in the Lower Grande Ronde Subbasins (part of the Grande Ronde Basin as identified in OAR 340-041) are considered the beneficial uses most sensitive to stream temperature. Biologically-based numeric criteria were developed that are specific to salmonid life stages such as spawning and rearing. Criteria were also developed for critical habitat areas that serve as the core for salmonid protection and restoration efforts as well as for areas that support bull trout spawning and juvenile rearing. The complete Oregon temperature standard rule (OAR 340-041-0028) (DEQ 2007a) can be accessed at http://www.deq.state.or.us and is described further in **Section 2.5.1** below.

Table 2-2. Designated beneficial uses in the Grande Ronde Basin (OAR 340-041-0151)
Temperature-sensitive beneficial uses are 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. These figures are adapted to the specific geographic region of the Lower Grande Ronde Subbasins and are provided in **Section 3.5**.

2.4.1 Salmonid Thermal Requirements

Oregon's water temperature standard employs a logic that relies on using sensitive species as indicators of water quality impairment. If temperatures are protective of these *indicator species*, other less sensitive species will share in protection as well. Cold water aquatic organisms, such as salmon and trout and some amphibians are very sensitive to temperature, and are used as indicators of temperature impairments. Numeric temperature criteria have been adopted in the temperature standard to protect specific life stages of salmon and trout.

If stream temperatures become too hot, fish may die almost instantaneously due to denaturing of critical enzyme systems in their bodies (Hogan 1970). The ultimate *instantaneous lethal limit* occurs in high temperature ranges (upper-90°F) that are rare or unknown in the Wallowa County subbasins.

More common and widespread within the Lower Grande Ronde Subbasins are summertime stream temperatures in the 70°F to 80°F range (mid- to high-20°C range). These temperatures can cause death of cold water fish species during exposure times lasting as little as a few hours. The exact temperature at which a cold water fish succumbs to such a thermal stress depends on the temperature that the fish is acclimated, as well as particular development life-stages. This cause of mortality, termed the *incipient lethal limit*, results from breakdown of physiological regulation of vital processes such as respiration and circulation (Heath and Hughes 1973).

The most common and widespread cause of thermally induced fish mortality is attributed to interactive effects of decreased or lack of metabolic energy for feeding, growth or reproductive behavior, increased exposure and susceptibility to pathogens (viruses, bacteria and fungus), decreased food supply (impaired macroinvertebrate populations) and increased competition from warm-water-tolerant species. This mode of thermally induced mortality, termed indirect or *sub-lethal*, is delayed, and occurs weeks to months after the onset of elevated temperatures above 64°F, but less than incipient lethal limits. These conditions may hold fish in a weakened state until a short-term extreme event kills them. **Table 2-3** summarizes the modes of cold water fish mortality.

Salmon and trout can survive excessive temperatures for short durations if there are cool places available in the stream offering refuge. These “refugia” must be common enough to allow recovery to fish during upstream migration or following excursions into warmer water.

Table 2-3. Modes of thermally induced cold water fish mortality (Brett 1952; Bell 1986, Hokanson et al. 1977)

Modes of Thermally Induced Fish Mortality	Temperature Range	Time to Death
Instantaneous Lethal Limit – Denaturing of bodily enzyme systems	> 90°F > 32°C	Instantaneous
Incipient Lethal Limit – Breakdown of physiological regulation of vital bodily processes, namely: respiration and circulation	70°F - 77°F 21°C - 25°C	Hours to Days
Sub-Lethal Limit – Conditions that cause decreased or lack of metabolic energy for feeding, growth or reproductive behavior, encourage increased exposure to pathogens, decreased food supply and increased competition from warm water tolerant species	64°F - 74°F 17.8°C - 23°C	Weeks to Months

2.5 TARGET IDENTIFICATION

2.5.1 Applicable Water Quality Standard

Oregon’s water quality standard for temperature is contained in OAR 340-0411-0028 (DEQ 2007a, available online from DEQ at http://www.deq.state.or.us/wq/standards/standards.htm). The standard includes both narrative and numeric criteria designed to protect beneficial uses, such as cold water salmon and trout species, based on requirements of specific life stages. Some of the criteria specifically pertinent to this TMDL are described in further detail below. There are additional standards for antidegradation (OAR 340-041-0004) and mixing zones (OAR 340-041-0053) which also have bearing on implementation the temperature standard.

A more extensive analysis of water temperature related to aquatic life and supporting documentation for the temperature standard can be found in the 1992-1994 Water Quality Standards Review Final Issue Papers (DEQ 1995) and in EPA Region 10 Guidance for Pacific Northwest State and Tribal Temperature Water Quality Standards (USEPA 2003).

Biologically Based Numeric Criteria (OAR 340-041-0028(4))
Numeric stream temperature criteria are assessed as a seven-day average of daily maximum temperatures (7DADM). **Table 2-4** lists the numeric biologically based criteria that are applicable in the Lower Grande Ronde Subbasins. Designations of habitat use during non-spawning periods (salmon and trout rearing and migration, core cold water habitat, and bull trout uses) are illustrated in **Figure 2.1**. For Subbasin waters where fish uses are not identified the applicable criteria are the same as the nearest downstream waterbody that is identified in fish use maps. Locations and timing of salmon and steelhead spawning through fry emergence are illustrated in **Figure 2-2** and vary depending on the waterbody.

Table 2-4. Oregon's biologically-based numeric temperature criteria (DEQ 2007a)

Uses are defined for specific waterbodies in OAR 340-041-0028, Figures 151A and 151B (repeated as Figure 2-1 and Figure 2-2 in this document).

Beneficial Use	Temperature Criteria[a]	Season
Bull Trout Spawning and Rearing	12.0°C (53.6°F)	Year around
Salmon and Steelhead Spawning	13.0°C (55.4°F)	Varies by geography (refer to **Figure 2-2**)
Core Cold Water Habitat	16.0°C (60.8°F)	Year around[b]
Salmon and Trout Rearing and Migration	18.0°C (64.4 °F)	Year around[b]

a = Stream temperature is calculated using the average of seven consecutive daily maximum temperatures on a rolling basis (7-day average of the daily maximum).

b = Except during periods when superseded by spawning criteria.

Figure 2-1. Fish use designations in the Lower Grande Ronde Subbasins (from Figure 151A in OAR 340-041-0028)

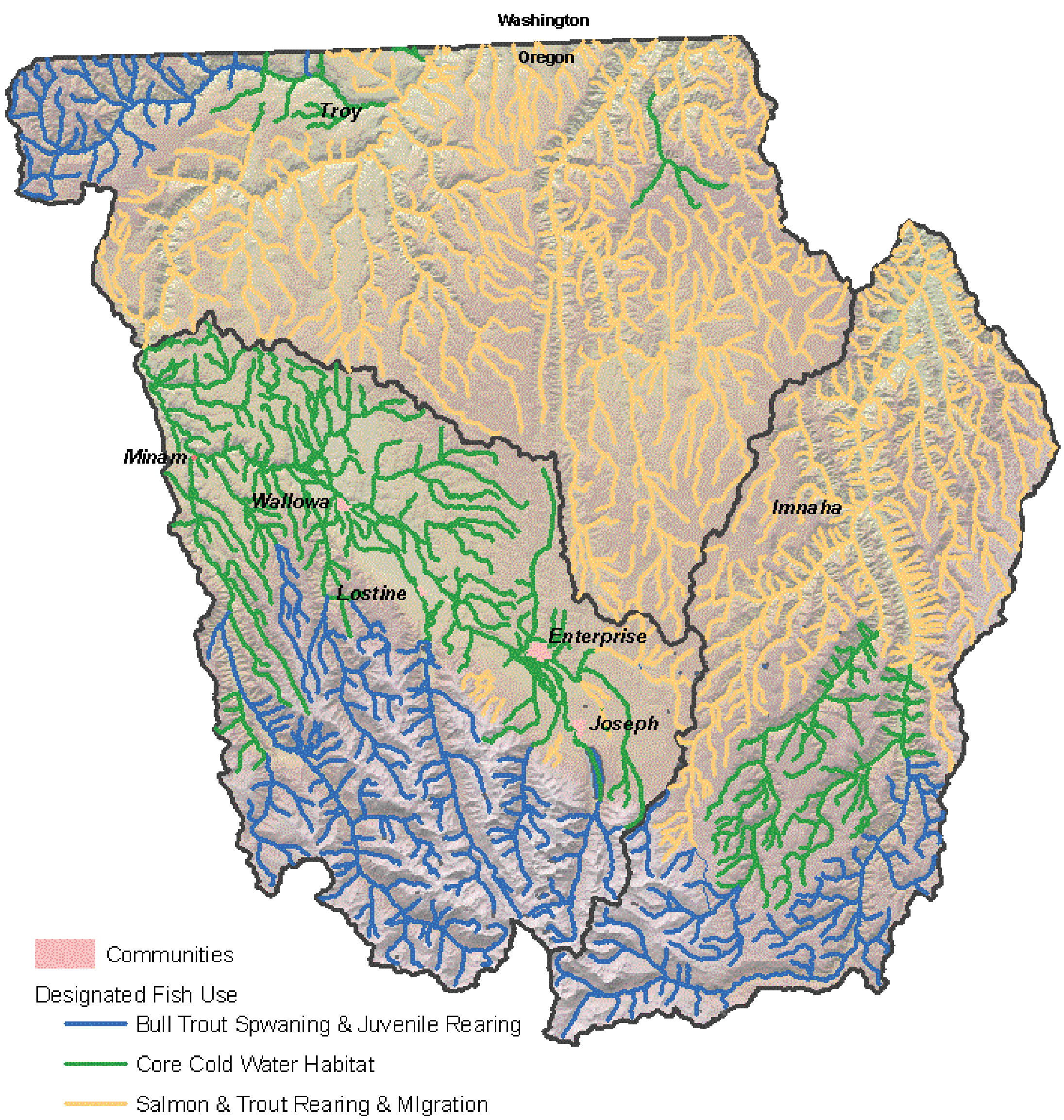
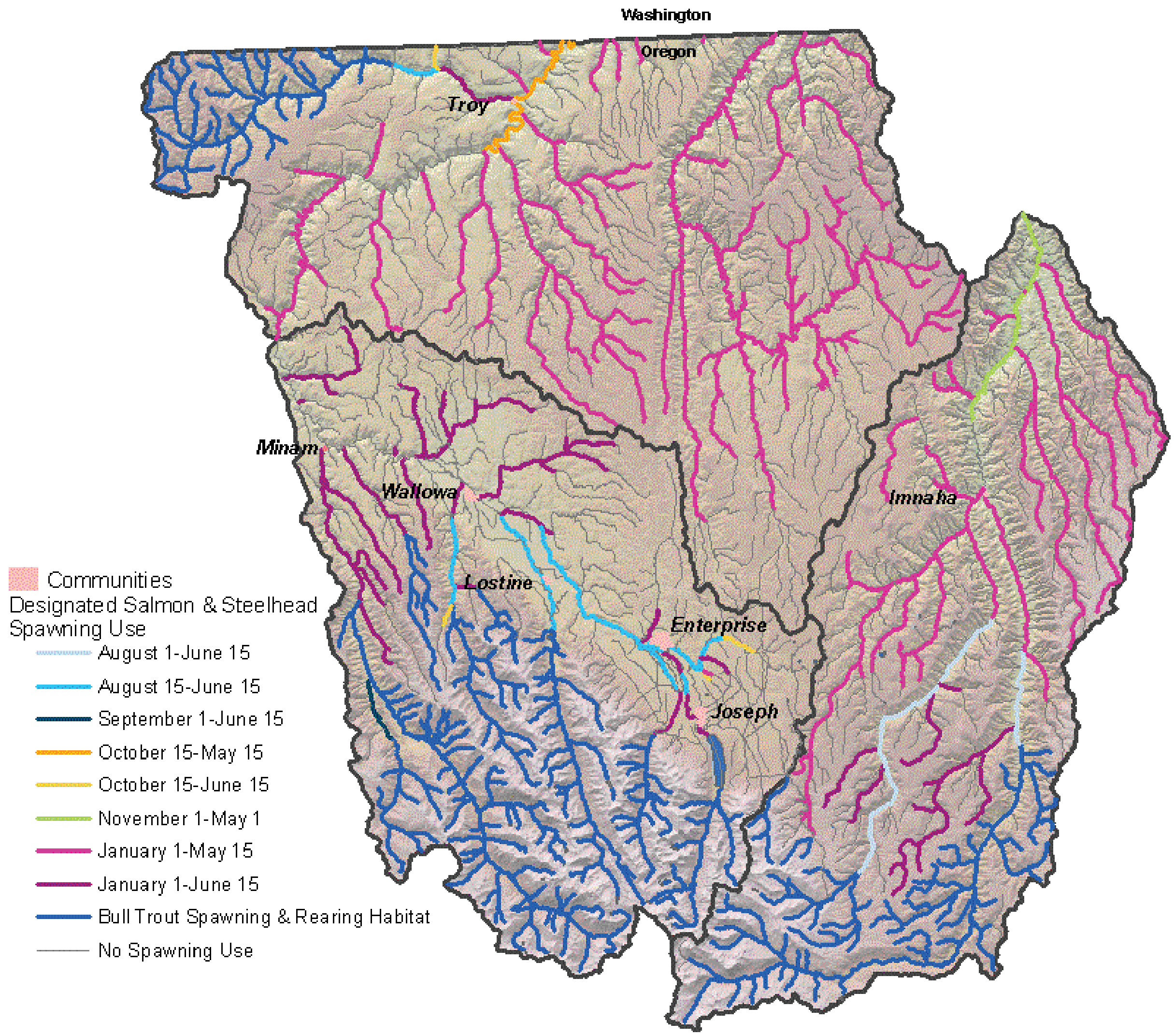


Figure 2-2. Waters designated as salmon and steelhead trout spawning habitat in the Lower Grande Ronde Subbasins (from Figure 151B in OAR 340-041-0028)



Natural Conditions Criteria (OAR 340-041-0028(8))

The Oregon temperature water quality standard includes provisions for natural conditions. ***The natural conditions criteria are the general target of this temperature TMDL***. The temperature standard states "Where the Department (DEQ) determines that the natural thermal potential of all or a portion of a water body exceeds the biologically-based criteria in section (4) of this rule, the natural thermal potential temperatures supersede the biologically based criteria, and are deemed to be the applicable temperature criteria for that water body" (OAR 340-041-0028(8)). This determination has been made by DEQ for the warm season in the Lower Grande Ronde Subbasins.

TMDLs typically attempt to quantify the natural thermal potential (NTP) of major streams through computer modeling. In this TMDL, NTP was modeled for the Wallowa River below Wallowa Lake (**Appendix A**). Simulations performed to estimate NTP stream temperatures used system potential vegetation heights and densities and natural flow conditions. For all reaches of the river that were modeled, NTP temperatures during the simulation period of August 14-Sept 2, 1999 exceeded the biologically-based core cold water criterion. Based on this analysis, NTP is the warm season target [Natural Condition Criteria, OAR 340-041-0028(8)] for the Wallowa River and all of its tributaries.

Similarly, in the TMDL completed for the Upper Grande Ronde Subbasin (DEQ 2000), natural thermal conditions were set as the target to meet water quality standards. Although an NTP analysis was not done for other Grande Ronde Basin water bodies, the natural conditions criterion is assumed applicable throughout the Lower Grande Ronde and Imnaha River Subbasins as well. NTP conditions are the target for all streams in the Lower Grande Ronde Subbasins. Exceptions occur where and when numeric targets are needed and the natural potential temperatures have not been assessed (such as for point source discharges).

Human Use Allowance (OAR 340-041-0028(12)(b))

Oregon's temperature standard contains provisions for stream heating due to human activities. The human use allowance (HUA) limits cumulative anthropogenic heating of surface waters to no more than 0.3°C (0.5°F) above the applicable criterion after complete mixing in the water and at the point of maximum impact. The HUA is considered an insignificant amount of temperature increase in surface waters. The HUA addresses heat from all human sources; point source discharges, nonpoint sources and a reserve capacity for future growth. The HUA typically does not significantly influence nonpoint source objectives (load allocations). The value is small enough to be masked by the uncertainty associated with instream measurement and modeling methods. The HUA can be significant with regard point source discharges. In this TMDL, the HUA is divided between sources, with 2/3 going to designated existing point sources, 1/6 to nonpoint sources and the remainder to reserve capacity. The amount available for reserve capacity will vary based on the presence or absence of point source discharges on a waterbody.

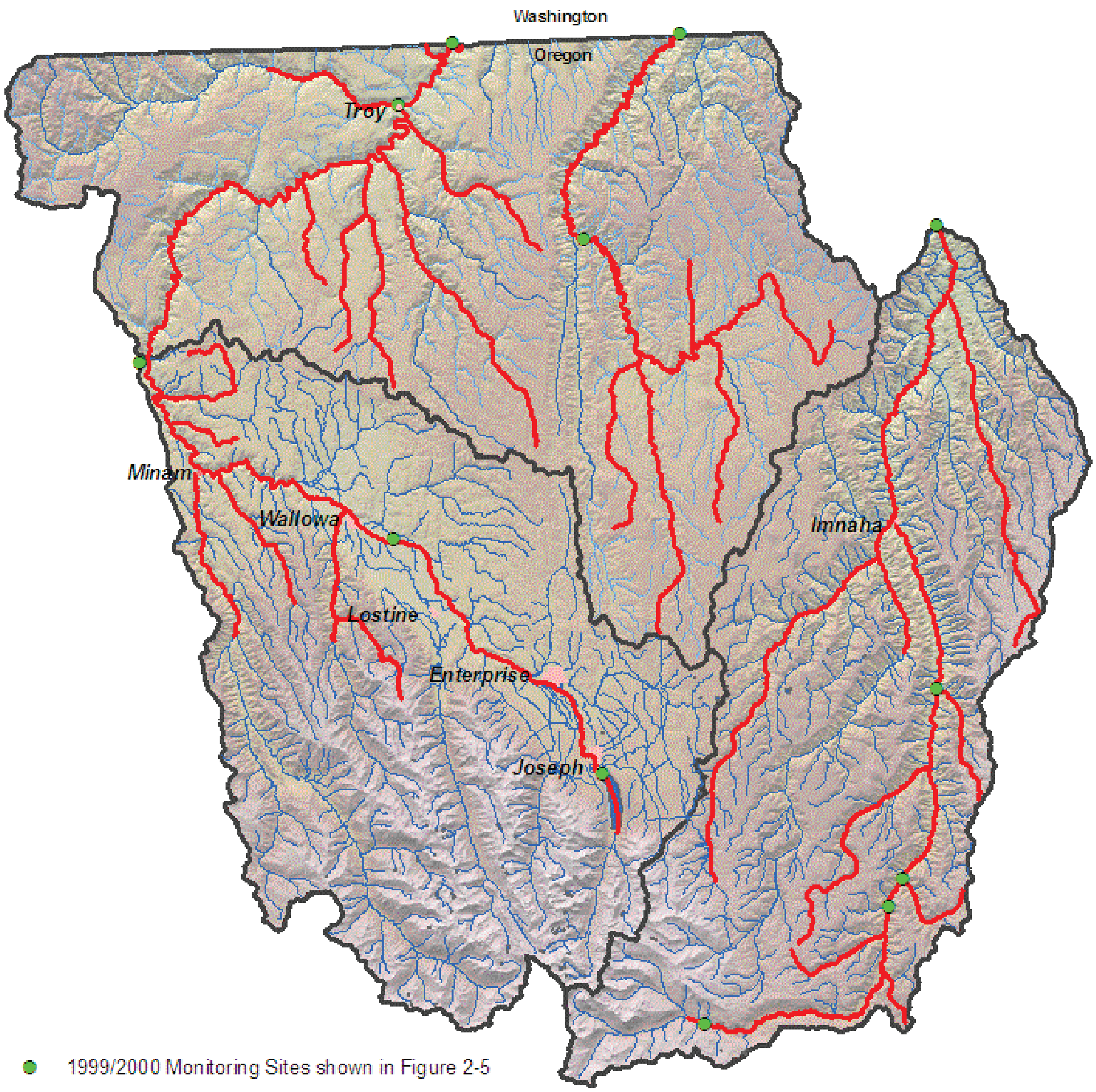
Consistency with Washington's Water Quality Standards

The Grande Ronde River and several of its tributaries originate in Oregon, but terminate in the State of Washington. Washington's water quality standard for temperature is contained in WAC 173-201A-200(1)(c) (available on-line at http://www.ecy.wa.gov/programs/wq/swqs/index.html). As with Oregon, Washington's standard contains biologically-based numeric targets along with natural conditions criteria and a human use allowance. When a water body does not meet the numeric criteria because of natural conditions, the natural conditions constitute the water quality criteria (WAC 173-201A-260(1)) and human activities may not cause more that a 0.3°C increase in the 7-day average of daily maximum temperatures (WAC173-201A-200(1)(c)(I)). The Natural Conditions criteria and HUA targeted by Oregon in this TMDL are expected to be compliant with Washington's temperature criteria at the border.

2.5.2 Deviation from Biologically Based Numeric Criteria

The Lower Grande Ronde Subbasins have 30 streams on the 2004/2006 303(d) list (DEQ 2007b) for not meeting the biologically based numeric criteria for temperature (**Figure 2-3**, refer back to **Table 1-1**). There is at least one listing for each of the four numeric criterion listed in **Table 2-4**. For specific information regarding Oregon's 303(d) listing procedures, and to obtain more information regarding the Lower Grande Ronde Subbasins 303(d) listed streams, visit DEQ's web page at http://www.deq.state.or.us/wq/assessment/rpt0406/search.asp.

Figure 2-3. 2004/2006 303(d) listed streams for temperature (bolded red lines)



2.6 SEASONAL VARIATION AND CRITICAL PERIOD

Maximum temperatures typically occur in July and August during warm weather and naturally low stream flow rates. This TMDL focuses the analysis during the August period as a critical condition where the core cold water and rearing/migration criteria are exceeded as identified by 1999 and 2000 temperature data. Data for most sites were collected during 1999, although data for the Imnaha River was collected in 2000.

Selected station profiles are provided to illustrate the pattern of temperatures through the summer in each of the Lower Grande Ronde Subbasins (**Figure 2-4**). The left frame of each set of plots in presents diurnal (daily) variation in temperature with time, while the right frame presents the 7DADM. In each of the legends, the sites are listed in longitudinal order starting at the most downstream location. The locations of these sites are shown in **Figure 2-3**. These profiles show a common pattern of variation on a daily scale, and maximum values generally in the midsummer period from mid July to late August.

Temperature modeling for this TMDL was done using 1999 data for the Wallowa River. To assess the representativeness of this year, inter-annual variation was assessed by comparing temperature profiles at one station among several years in the Wallowa River Subbasin (**Figure 2-5**). Most of the data used for this inter-annual comparison were collected by the Wallowa County SWCD near the town of Lostine (2000-2004), upstream of the Cross-Country Canal. This is also the site of a USGS stream flow gaging station. DEQ data was collected in 1999 at a site on the Wallowa River upstream of the Lostine River. Although there is some physical separation between these two locations, Thermal Infrared Imagery (TIR) suggests there is little difference in temperature between these sites (**Figure 2-6**). These profiles indicate that, although instream temperatures are variable both within and among years, the data for 1999 fits within this variability and does not indicate an unusual year.

The data presented in **Figure 2-5** for the site on the Wallowa River near Lostine depicts seasonal variation in stream temperature over a longer time period than the patterns shown in **Figure 2-4**. The data from this site demonstrates that there are regular exceedances of the spawning criterion observed on the Wallowa River between approximately April and October. This defines the critical period for both core coldwater and spawning criteria as April through October. During this time, one or both of the temperature criteria were commonly exceeded on the Wallowa River (**Figure 2-5**).

The Lower Grande Ronde Subbasins temperature TMDL applies year round. As will be discussed further (**Section 2.9)**, because the load allocations invoke measures that must be sustained perennially, nonpoint sources are addressed on a year-round basis, with regard to stream heating. Although the current allocation scheme does not specifically address nonpoint source loading rates during spawning periods, implementation of the potential effective shade surrogate represents a long-term perennial condition, protecting water quality to the greatest extent throughout the year. Point source wasteload allocations are defined for the critical period of April through October of each year. Through the TMDL assessment, point sources were assigned targets based on the human use allowance, the natural condition criteria during the warm season, and the various other applicable biologically based temperature criteria through the remainder of the year (**Section 2.10**). An analysis was done for each month of the year to estimate the effects of these discharges.

Figure 2-4. Observed seasonal stream temperatures

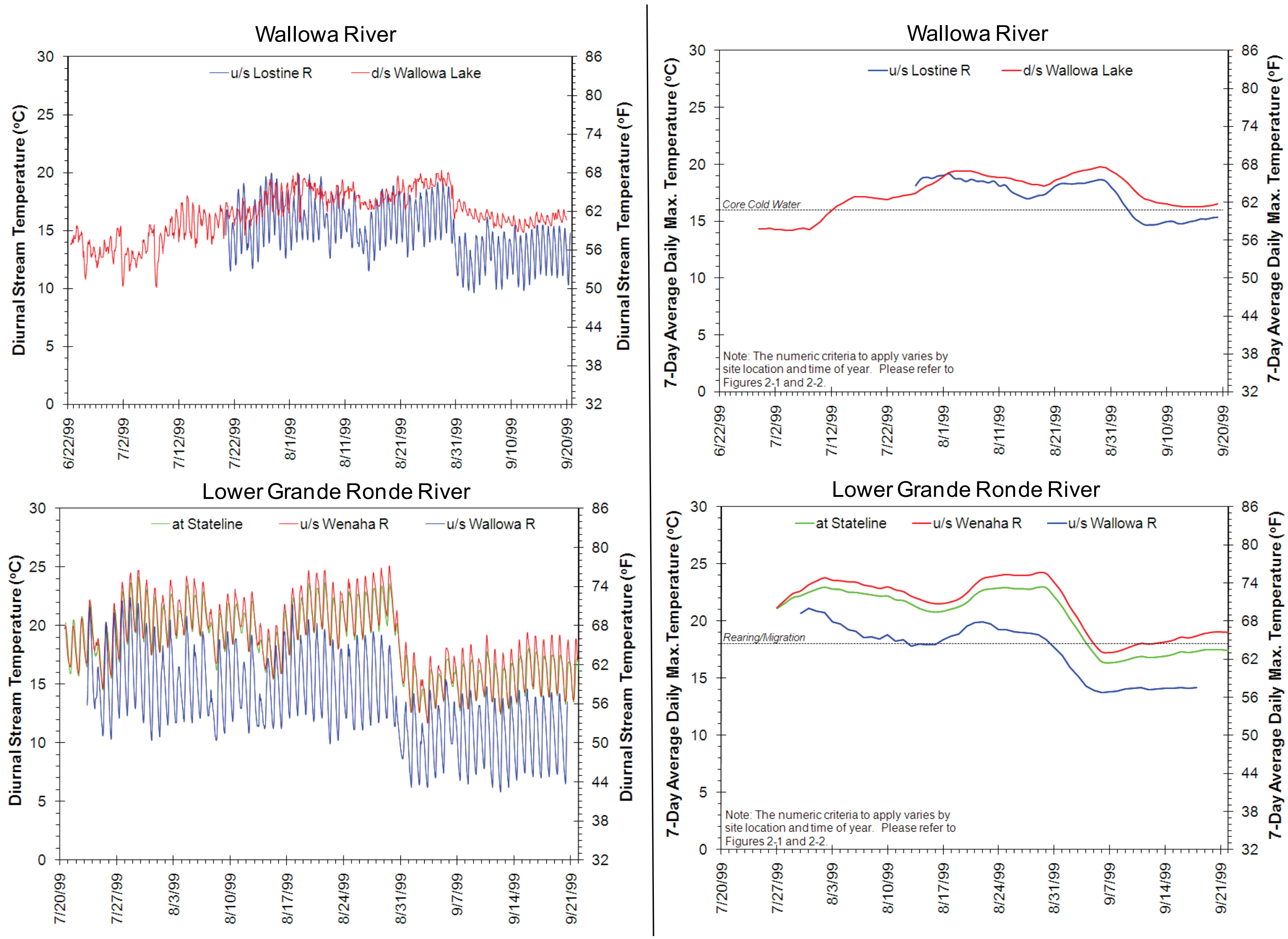


Figure 2-4 (continued). Observed seasonal stream temperatures

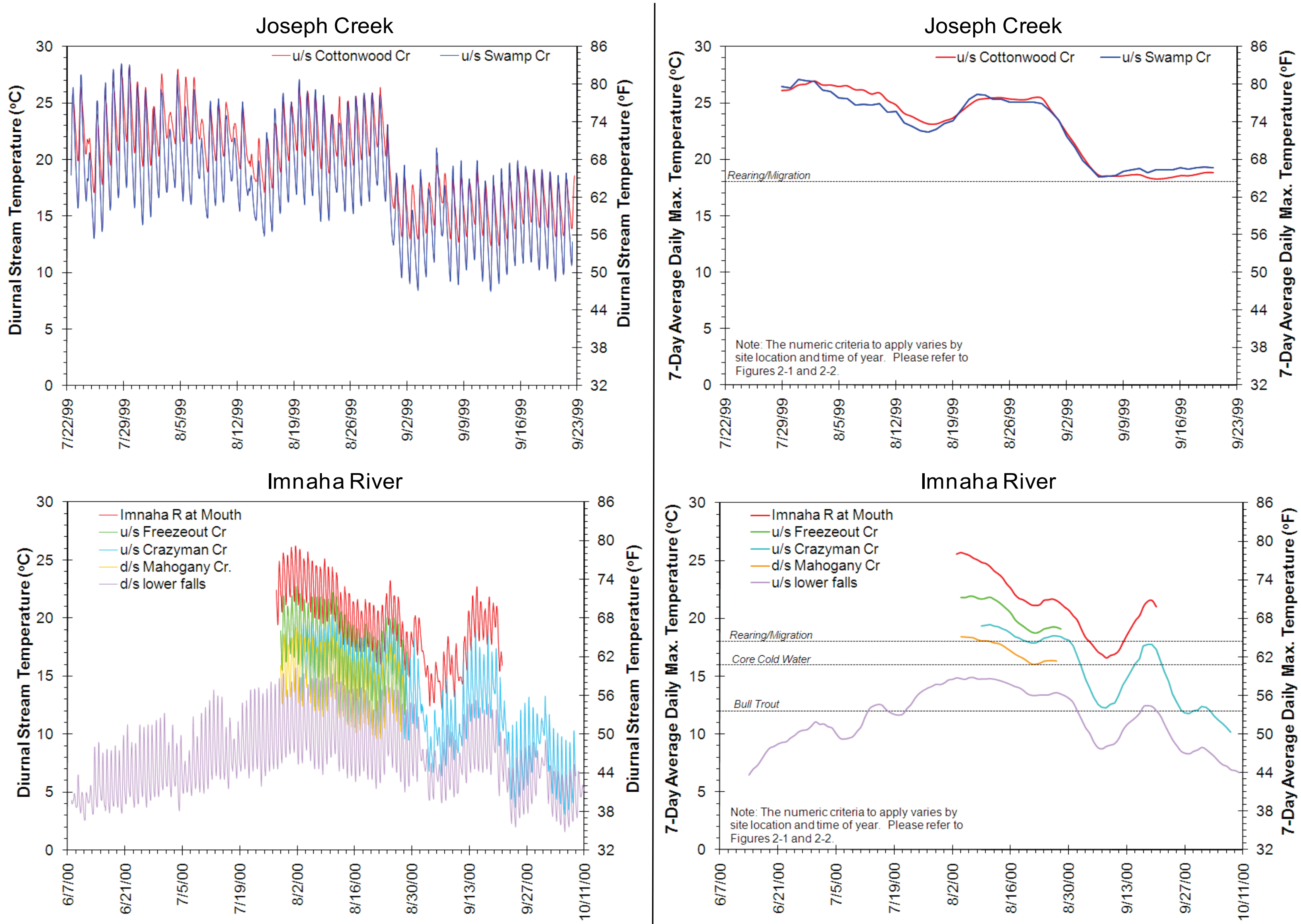


Figure 2-5. Comparison of instream temperature profiles among years on the Wallowa River near Lostine

Data for 1999 (DEQ) were collected upstream of the confluence with the Lostine River. All other years were collected by the Wallowa County SWCD at a site upstream of the Cross Country Canal near the town of Lostine.

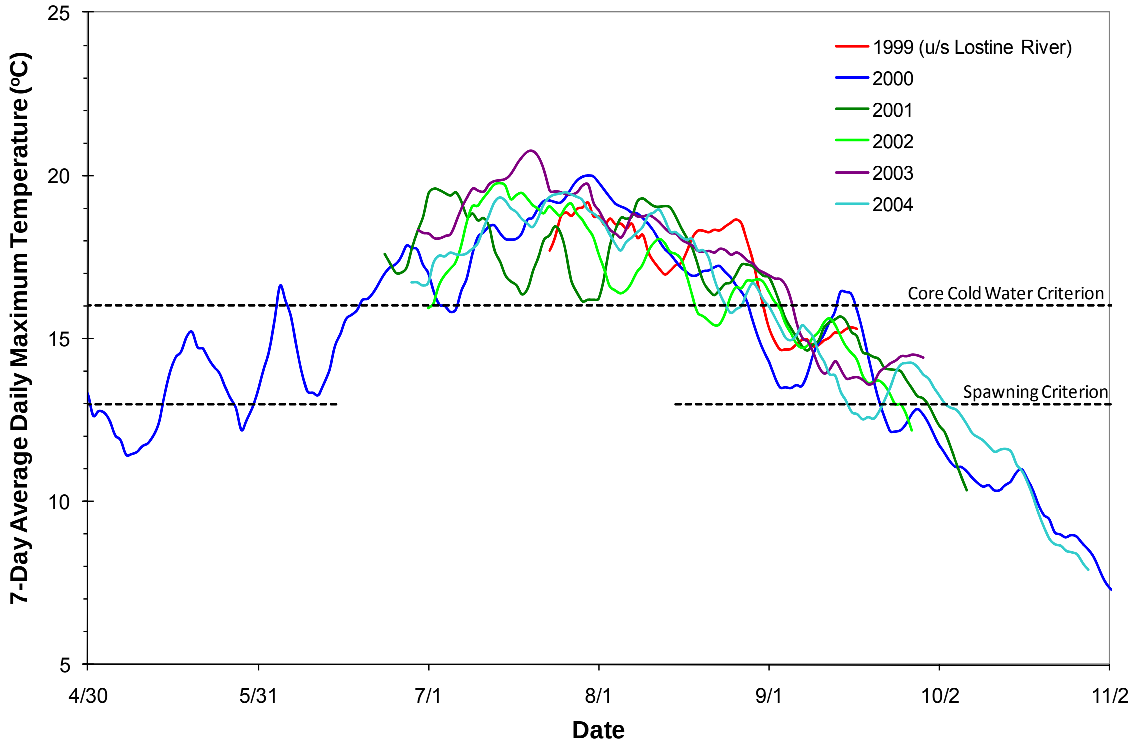
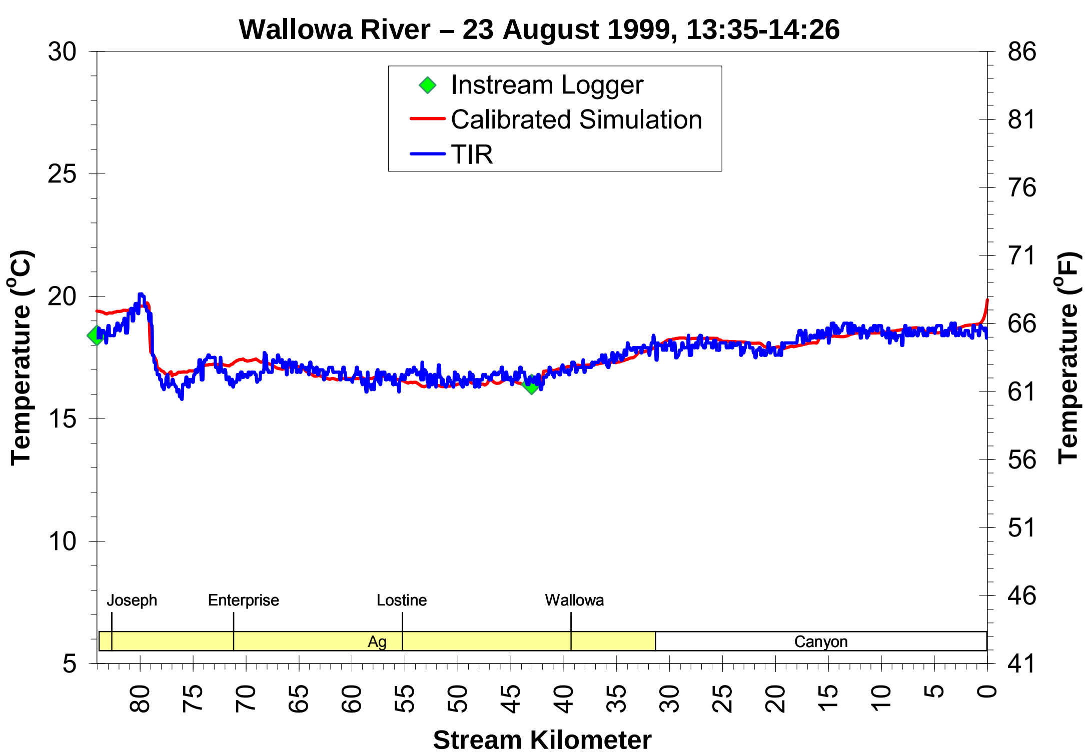


Figure 2-6. Simulated temperature profile for Wallowa River based on instream temperature measurements and Thermal Infrared Imagery (TIR)



2.7 EXISTING HEAT SOURCES

Riparian vegetation, stream morphology, hydrology, climate, and geographic location influence stream temperature. While climate and geographic location are outside of human control, riparian condition, channel morphology and hydrology are affected by land use activities. The following discussion of heat sources includes background sources as well as point and nonpoint sources. Load and wasteload allocations for these sources are described in **Section 2.9** and **Section 2.10**.

2.7.1 Natural Background Sources of Heat

Streams in Oregon are generally warmest in summer when solar radiation inputs are greatest and stream flows are low. The amount of solar energy that actually reaches the surface of a stream is determined by many factors including the position of the sun in the sky, cloud cover, local topography, stream aspect, stream width, and streamside vegetation. Streams generally warm in a downstream direction as they become wider and streamside vegetation is less effective at shading the surface of the water. Also, the cooling influences of ground water inflow and of smaller tributaries decrease as the stream becomes larger. Streams of greater volume and mass are less sensitive to natural and human sources of heat.

Historically, in the absence of human disturbance, many low elevation streams were likely warmer at times than is optimal for aquatic species. These species may not have occupied these waters during the peak heat of the summer period. Channel complexity, cool water inflows, and hyporheic exchange (groundwater inflow) are thought to provide local but important thermal refuges in these inhospitable environments during the warmest months of the year.

Natural disturbance events are essential elements for healthy and productive salmonid streams. Flooding, fire, windstorms and other natural disturbances contribute to the complexity of the riverine environment. These disturbances often affect streamside vegetation and the riparian tree canopy, potentially decreasing stream shade for decades. However, in a functional riparian community, riparian canopy and shade will recover with time and the salmon, trout and other native species will benefit from the large wood and habitat complexity these disturbance processes provide. For the purposes of this plan these disturbance processes are considered a part of the natural background thermal load.

2.7.2 Nonpoint Sources of Heat

European settlement of the Wallowa County area in the mid-1800s brought about changes in the near-stream vegetation and hydrologic characteristics of the streams. Historically, agricultural and logging practices have altered the stream morphology and hydrology and decreased the amount of riparian vegetation in the drainage. Additionally, major diversions and multiple points of diversion, as well as return flows from irrigation canals, influence stream flow levels. Conversion of forest or agricultural lands to residential development is also occurring, which can result in reduced riparian vegetation and altered hydrology. The flood plains of some streams, such as the Wallowa River, have also been affected by the development of transportation corridors. The Subbasins include urban, agricultural and forested lands.

Human-induced changes can cause streams to heat up in the following ways:

1. ***Near-stream vegetation disturbance or removal*** *reduces stream surface shading via decreased riparian vegetation height, width and/or density, thus increasing the amount of solar radiation reaching the stream surface (shade is commonly measured as percent effective shade or open sky percentage). Riparian vegetation also plays an important role in shaping the channel morphology, resisting erosive high flows and maintaining floodplain roughness.*
2. ***Channel modifications and widening*** *(increased width to depth ratios) increases the stream surface area exposed to energy processes, namely solar radiation. Channel widening decreases potential shading effectiveness of shade-producing near-stream vegetation. Loss of streamside vegetation and lack of large woody debris contribute to conditions that lead to channel widening.*
3. ***Reduction of summertime flows*** *decrease the thermal assimilative capacity of streams, causing larger temperature increases in stream segments where flows are reduced.*

4. ***Irrigation canals and ditches** are often unshaded and increase the surface area of water exposed to solar radiation. Where these irrigation waters are allowed to mix with natural stream flows, stream temperatures can increase. In addition, irrigation return flows coming off fields or pastures can contribute warm waters to streams.*

2.7.3 Point Sources of Heat

Point source discharges can be sources of stream heating. In the Lower Grande Ronde Subbasins, there are seven permitted point-source discharges administered by DEQ 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.

Of these point sources, specific wasteload allocations were developed for the three sewage treatment plants (Enterprise, Wallowa and Joseph). The wasteload allocations were developed to address both the summer season and spawning season. The Enterprise and Wallowa STPs discharge into the Wallowa River on a year-round basis, while the Joseph's STP discharges into Prairie Creek only from November 1 through May 31. The spawning season on Prairie Creek and the Wallowa River near the two discharges has been identified as August 15-June 15th (**Figure 2-2**). There is no identified spawning time period for the Wallowa River at or below the Wallowa STP. As is discussed further in **Section 2-10**, wasteload allocations were developed to address the following seasons for each STP:

- Enterprise STP: both summer and spawning seasons
- Wallowa STP: summer season
- Joseph STP: spawning season

The rest of the point sources in the Lower Grande Ronde Subbasins, all on general permits, have been determined to not have a thermal affect on their receiving waterbodies. Wallowa Forest Products holds general permits for boiler blowdown and for stormwater and the City of Enterprise holds a general stormwater construction permit for the upgrade of their STP. The volume of boiler blowdown water, which is mixed with stormwater when both occur, is very small (1,500 gal/day) with temperatures of approximately 52-55°F. This is a very small, sporadic discharge for this reach of the Wallowa River and temperature increases in the river would be unmeasurable. Stormwater is generally not considered a significant contributor of heat over a seven day period as specified in the temperature standard. This applies to both industrial stormwater permits (as with Wallowa Forest Products) and the general construction stormwater permits. Data were not available to evaluate the impact of the fish hatchery and acclimation facilities. Because the acclimation facilities are low-volume facilities which are not required to have an NPDES permit, they are assumed to have no thermal impact. The CAFOs are prohibited from discharging at any time of year. All of these sources on general permits are assigned a wasteload allocation equal to their existing operating conditions. If data collected at a later date indicates that any of these facilities do contribute to heating beyond that allowed in the Human Use Allowance, that issue will be addressed at that time and incorporated into a new permit.

2.8 LOADING CAPACITY AND ALLOCATION APPROACH

EPA's current regulation defines loading capacity as "*the greatest amount of loading that a water can receive without violating water quality standards*." (40 CFR § 130.2(f)). It provides a reference for calculating the amount of pollutant reduction needed to bring water into compliance with water quality standards. Loading capacity can be quantified and allocated as the sum of natural background heat load and allowable heat loads from nonpoint sources (load allocations) and point sources (wasteload allocations) sectors. Portions of the loading capacity may also be reserved to accommodate future growth (reserve capacity) and as an explicit margin of safety. The established loading capacity must ensure that water quality standards are met regardless of seasonal variation and foreseeable increases in pollutant loads from point or nonpoint source activities.

The loading capacity can be described as follows:

$$LC = WLA + LA_{nps} + LA_{bkgd} + MOS + RC$$

Where:
LC = Loading Capacity
WLA = Wasteload Allocation (WLA)
LA_{nps} = Load Allocation (LA) from human nonpoint sources
LA_{bkgd} = Load Allocation from natural background
MOS = Margin of Safety
RC = Reserve Capacity, such as for population growth or increased human loading

In this TMDL, loading capacity is expressed as a daily heat load in megawatts (MW). The loading capacity for the Wallowa River was assessed through deterministic computer simulation of heat and temperature during the warm season. The loading capacity for the Lower Grande Ronde Subbasins is defined as the amount of solar radiation received by the stream network under NTP conditions (encompassing the site-specific and generalized load allocations described in **Section 2.9**) plus the heat load corresponding to the Human Use Allowance (HUA). WLAs were calculated to ensure that this portion of the heat load was included in the point-source portion of the HUA (**Section 2.10**). The loading capacity varies daily, based primarily on changing stream flow, cloud cover and solar altitude. Changes in foliage add seasonal variability.

2.8.1 Allocation Approach

Heat available for human use is based on an allowable 0.3°C temperature increase after complete mixing with the waterbody, and at the point of maximum impact relative to the applicable temperature criterion. In this TMDL, the applicable temperature criterion is generally Natural Conditions. Where natural conditions have not been determined, or where the applicable biologically based criterion is the greater of the two and its application doesn't impede downstream attainment of NTP, the biologically based numeric criteria are applied as needed for existing and future point sources. The anthropogenic heat allocations in this TMDL add up to the equivalent of 0.3°C cumulative HUA (**Table 2-5**). The nonpoint source HUA apportionment may be used by any of the nonpoint source sectors located in the Lower Grande Ronde Subbasins, including agriculture, forestry, urban development, irrigation, or for heat trading. If point sources do not need all of their allotted HUA, or if no point sources discharge into a waterbody, this additional portion of the HUA will revert to Reserve Capacity. In this TMDL, no part of the loading capacity was explicitly set aside as a margin of safety (see **Section 2.11**). In the sections that follow the allocations are explained and surrogate targets, where appropriate, are designated for each source.

Table 2-5. Allocation of the Human Use Allowance (HUA) (0.3°C or 0.54°F)

Source	Portion of the Human Use Allowance	Allowed Temperature Increase
Nonpoint Source and Background	1/6	0.05°C (0.09°F)
NPDES Point Source	2/3	0.2°C (0.36°F)
Reserve Capacity*	1/6	0.05°C (0.09°F)

*The amount available for reserve capacity will vary by waterbody and depend on whether or not there are already point source discharges.

2.8.2 Loading Capacity and Excess Load for the Wallowa River

A river-specific, quantitative loading capacity was determined for the Wallowa River from the Wallowa Lake outlet to the mouth and is expressed as a daily heat load in megawatts (MW) (**Table 2-6**). Computer simulations were conducted for the period August 14-September 2, 1999, with August 23rd selected as the date to represent summer conditions for loading capacity calculations (**Appendix A**). The referenced natural background solar radiation is the loading immediately above (prior to) the stream surface, throughout the surface area of the stream network. Point sources contribute very little (<1%) of the total heat loading relative to nonpoint sources and WLAs fall within the point source HUA (discussed further in **Section 2.10**).

Excess load is the difference between the current pollutant load and the loading capacity of a water body. Because solar radiation has the largest influence on temperature, and point source heat inputs are slight in comparison, solar radiation was used as the surrogate measure to approximate the difference between the current pollutant load and the loading capacity.

The total daily heat load for the Wallowa River calculated for August 23, 1999 was 499.2 megawatts. Background loading was calculated as 425.7 megawatts, which represents an excess daily load of 73.5 megawatts. Anthropogenic nonpoint source loading along the Wallowa River needs to decrease by 15% in order to achieve the TMDL.

Table 2-6. Daily loading capacity and excess solar load for the Wallowa River (August 23, 1999)

$H_{Total\ NPS}$	$H_{SP\ NPS}$	$H_{Anthro\ NPS}$
Current Condition Solar Radiation Heat Load (Megawatts)	**Load Capacity –Background** NTP Solar Radiation Heat Load (Megawatts)	**Excess Load** Solar Radiation Heat Load (Megawatts)
499.2	425.7	73.5

where,
$H_{Total\ NPS}$ = current solar input assessed immediately above the water
$H_{SP\ NPS}$ = natural solar component of Load Capacity
$H_{Anthro\ NPS}$ = human-related solar heating

2.9 LOAD ALLOCATIONS (NONPOINT SOURCES)

Load allocation (LA) is defined as “The portion of a receiving water’s loading capacity that is attributed either to one of its existing or future nonpoint sources or to natural background sources” [OAR 340-041-0002(30)]. “Sources” means *sources of pollutants*, in this case excess heat. The Lower Grande Ronde Subbasins load allocations are defined here as the daily sum of the natural background solar heat load, throughout the stream network, and the heat load corresponding to the additional 0.05ºC HUA. Load allocations and surrogate measures were assessed during August, but apply year-round since the implementation measures of restoring system potential vegetation are in effect year-round.

In this TMDL, load allocations were simulated via two methods and through LA surrogates that more plainly define measures in the field. Load allocations were expressed as a heating rate per stream surface area (heat flux in W/m^2). The two allocation methods – site specific and generalized solar heating curves - are described below in **Sections 2.9.1** and **2.9.2**.

As allowed under EPA regulations (40 CFR 130.2(i)), this TMDL allocates “*other appropriate measures*” (or surrogate measures) in addition to heat energy loads. Effective shade is inversely proportional to heat flux, which is a measure of the daily longitudinal heating rate per stream surface area. Although a daily load allocation for heat energy is derived, it is of limited value in guiding management activities needed to solve identified water quality problems. In order for the TMDL to be more meaningful to the public and guide implementation efforts, load allocations for nonpoint source heat limits are expressed in terms of percent effective shade.

This temperature TMDL targets NTP (system potential) effective shade as the surrogate measure to meet the TMDL load allocation for nonpoint sources. System potential vegetation corresponds to no anthropogenic increase above natural background temperatures. **Appendix A** contains detailed descriptions of the methodology used to develop system potential near-stream vegetation. Although the current allocation scheme does not specifically address nonpoint source loading rates during spawning periods, implementation of the potential effective shade surrogate represents a long-term perennial condition, protecting water quality to the greatest extent throughout the year. Moreover, the allocation of NTP conditions in general allows for adjustment of expectations through time as more information regarding site-specific conditions becomes available.

The effective shade targets may not be met immediately as it can take a number of years for vegetation to mature and grow once established. In the short term, meeting the targets in this TMDL will be demonstrated by implementation of a management plan or Best Management Practices (BMPs) that adaptively target natural conditions. DEQ recognizes that even with effective management, some sites will pose challenges for the establishment of system potential vegetation. These challenges may include locations with a severely down cut channel or a water table that is no longer near the plant root zone. Restoration in these situations will take time. Reductions in effective shade will generally not be considered violations of this TMDL if DEQ determines the reduction is caused by natural disturbance or for the purpose of establishing a healthy natural riparian condition that will in time, meet the TMDL targets.

This TMDL contains two types of load allocations and surrogate measures:

1. *Site-specific* solar loading and effective shade allocations apply to the Wallowa River where longitudinal temperature simulations were completed.

2. *Generalized (non site-specific)* solar loading and effective shade curves apply to all other Lower Grand Ronde Subbasins streams covered by this TMDL where temperature, heating and shade were not simulated.

Each of these two types of allocations and surrogate measures is described in more detail below. This section also discusses additional measures of progress, such as increased stream flow and increased channel complexity, which will help streams in the Lower Grande Ronde Subbasins move towards natural conditions.

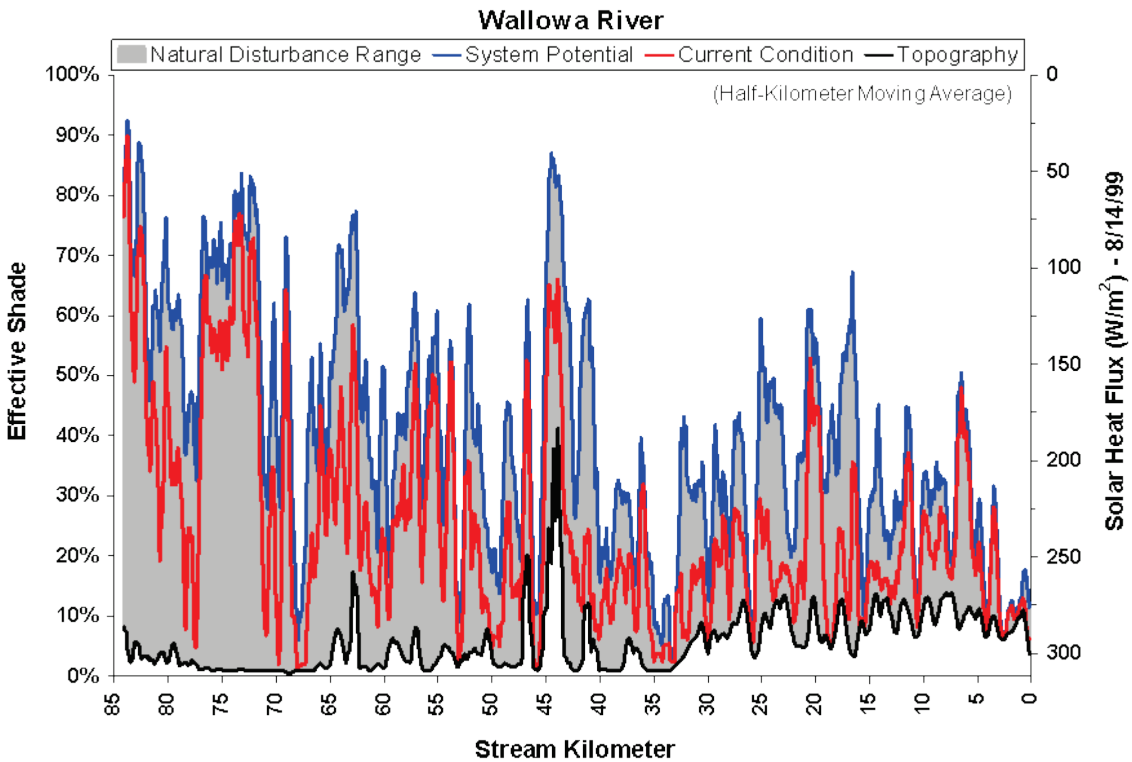
2.9.1 Site Specific Heat Load Allocations and Effective Shade Surrogates

The load allocation for the simulated Wallowa River corridor is the NTP warm season solar heating, summarized graphically in **Figure 2-7**, as a critical season longitudinal heating rate per stream surface area (heat flux in W/m^2). Heat flux was assessed at 100 meter (328 feet) intervals along the river. Effective shade is inversely proportional to heat flux and is shown in the figures as well and discussed subsequently in this section as a surrogate measure.

Current Condition is the existing solar loading and effective shade at the stream surface (mid-August), including the effects of near-stream vegetation and topography. *System Potential* is the solar loading and effective shade at the stream surface under system potential near-stream vegetation conditions. This represents NTP conditions. The N*atural Disturbance Range* indicates the solar loading and shade levels that could potentially occur in the event of natural disturbances. The lower end of that range represents that amount of shade that the stream would receive if topography was the only shade-producing feature (i.e., in the absence of vegetation). **Appendix A** contains detailed descriptions of the methodology used to develop system potential near-stream vegetation and the temperature TMDL, along with a discussion of the limitations of the assessment of system potential conditions. On average, the Heat Source model predicted Current Condition shade of 25% for the simulated Wallowa River corridor, as compared to 40% for the System Potential simulation. Topographic shade provided an average of 6% effective shade along the modeled corridor.

Caution should be used when interpreting **Figure 2-7**. This TMDL recognizes that is impossible for an entire stream to be at its maximum potential effective shade everywhere, all the time. In reality, natural disturbances will create a variety of tree heights and densities and effective shade levels could be lower than “System Potential” and be somewhere within the “Natural Disturbance Range”. Reductions in effective shade caused by natural disturbance are not considered a violation of the TMDL or water quality standards.

Figure 2-7. Wallowa River heat load allocation and effective shade surrogate (mid-August)



2.9.2 Generalized Heat Load Allocations and Effective Shade Surrogate

Generalized (non site-specific) heating curves were developed as load allocations for streams where temperature and heating were not simulated. As with site-specific heating, the generalized heat assessment of this section is expressed as both heat loading and percent effective shade. The effective shade surrogate is expressed as a solar heat load versus channel width relationship for specified stream aspects (**Figure 2-8**). The heat load and effective shade surrogates are identified by region and channel width for different types of system potential vegetation communities. The effective shade curves account for latitude, critical summertime period (August), elevation and stream aspect. Stream aspect is based on coordinate directions, such as North-South, East-West, and Northeast-Northwest.

Effective shade curves represent the *maximum* possible effective shade for a given vegetation type. The values presented within the effective shade curves represent the effective shade that would be attained if the vegetation were at its stated potential height and density. Local geology, geography, soils, climate, legacy impacts, natural disturbance rates, and other factors may prevent effective shade from reaching the values presented in the effective shade curves. The goal of this Temperature TMDL is to minimize anthropogenic impacts on effective shade. Natural conditions or natural disturbances (non-anthropogenic) that result in effective shade below the maximum potential will not be considered out of compliance with the TMDL. This TMDL recognizes that unpredictable natural disturbances may result in effective shade well below the levels presented in the effective shade curves.

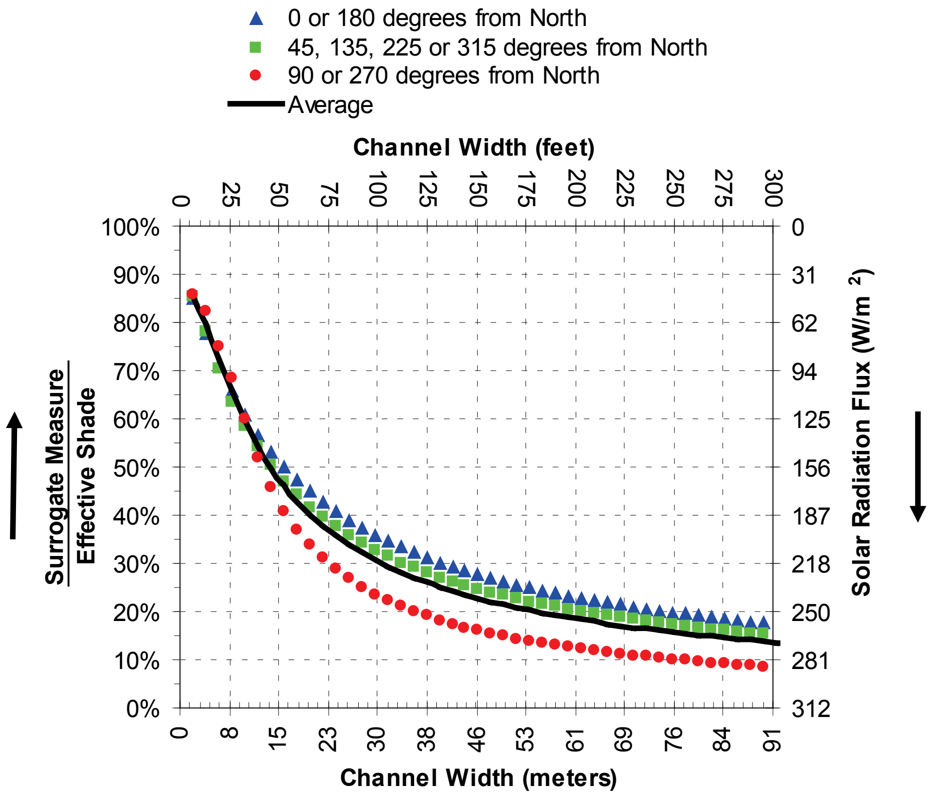
System potential vegetation communities were identified for the Lower Grande Ronde Subbasins (**Table 2-7**) and effective shade curves were developed for each community (**Figure 2-8**). The potential vegetation types and the associated height and density were determined by the Wallowa County TMDL technical committee which consisted of local experts (refer to **Chapter 1** for the list of participants). **Appendix A** provides more detailed information regarding the potential vegetation types and tree heights.

When using the effective shade curves presented in **Figure 2-8**, the determination of the appropriate system potential vegetation community is the responsibility of each designated management agency (DMA). Since there is not a map showing where each potential vegetation community is located, it is the responsibility of the resource manager to consult with the appropriate experts to make that determination. This would typically be part of implementation plan development, subject to DEQ review. In order to quantify solar loading, one would: (1) choose a stream location, (2) choose the appropriate system potential vegetation community and the corresponding chart in **Figure 2-8**, (3) measure the existing channel width, and (4) select the appropriate curve based on the channel compass direction. The effective shade indicated by the curve for that channel width is the expected shade if system potential vegetation height and density is in place. The determination of channel width should be evaluated at bankfull stage, or where bankfull indicators are lacking, at the boundary of the active channel area of disturbance. For field assessment, riffles may be the best feature to characterize a reach, consistent with various channel classification methods. TMDL attainment of effective shade targets would be assessed throughout the longitudinal profile.

There may be instances where a given stream reach may not match one of the seven generalized communities described in **Table 2-7** and **Figure 2-8** and a resource manager may have more site specific information about the appropriate system potential community. In such instances, the resource manager should describe the expected community. This determination would typically be part of implementation plan development and would be subject to DEQ review.

Figure 2-8. Generalized warm-season system potential effective shade curves for the Lower Grande Ronde Subbasins (North-South, East-West, and Northeast-Northwest refer to stream aspect)

Lodgepole, Sub-Alpine Fir >6000' Elev.: 70 Ft. Avg. Tree Height, 75% Density



Old Growth Ponderosa, Doug. Fir: 120 Ft. Avg. Tree Height, 75% Density

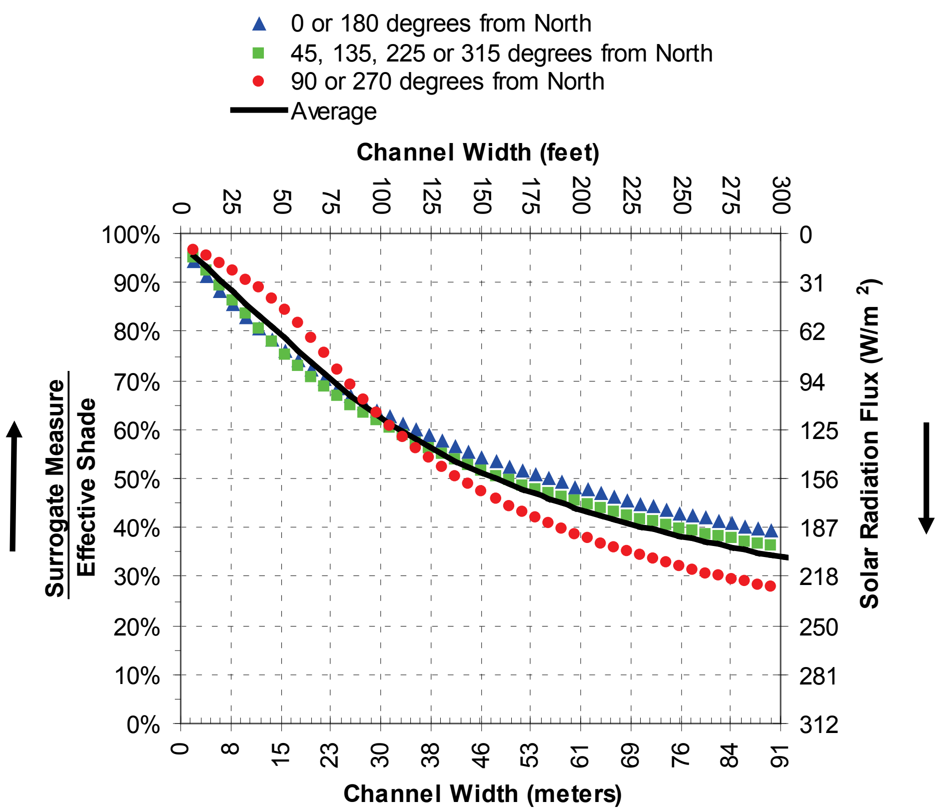
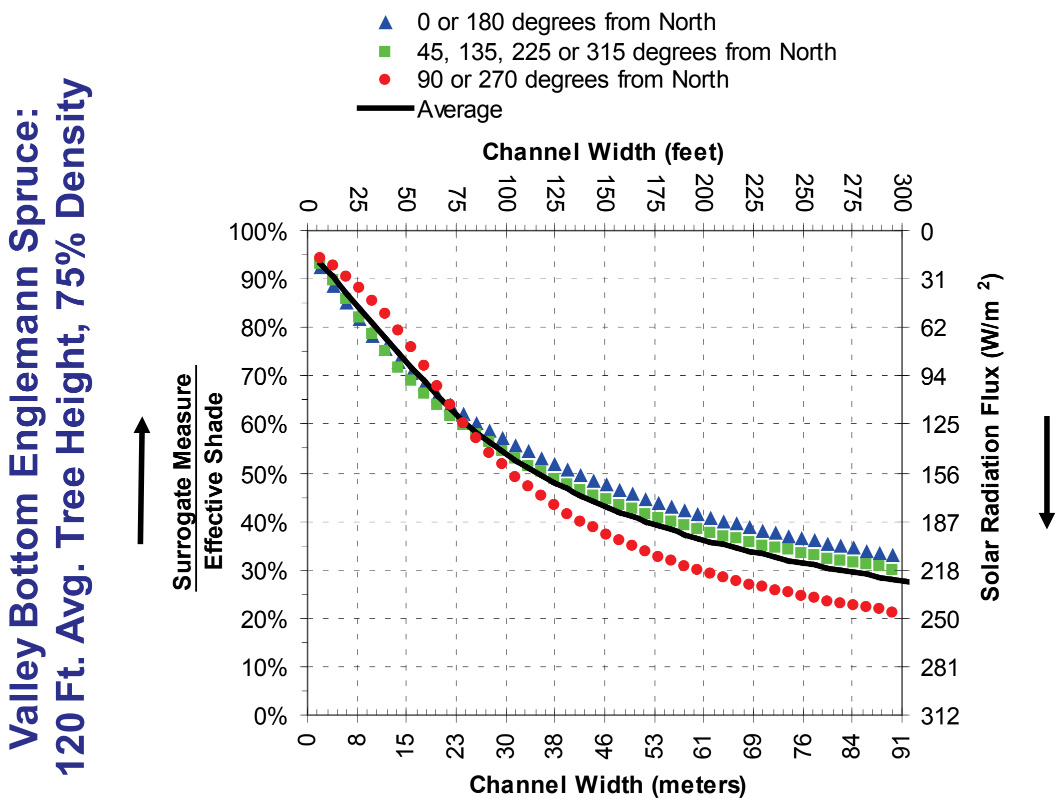


Figure 2-8 (continued). Generalized warm-season system potential effective shade curves for the Lower Grande Ronde Subbasins (North-South, East-West, and Northeast-Northwest refer to stream aspect)



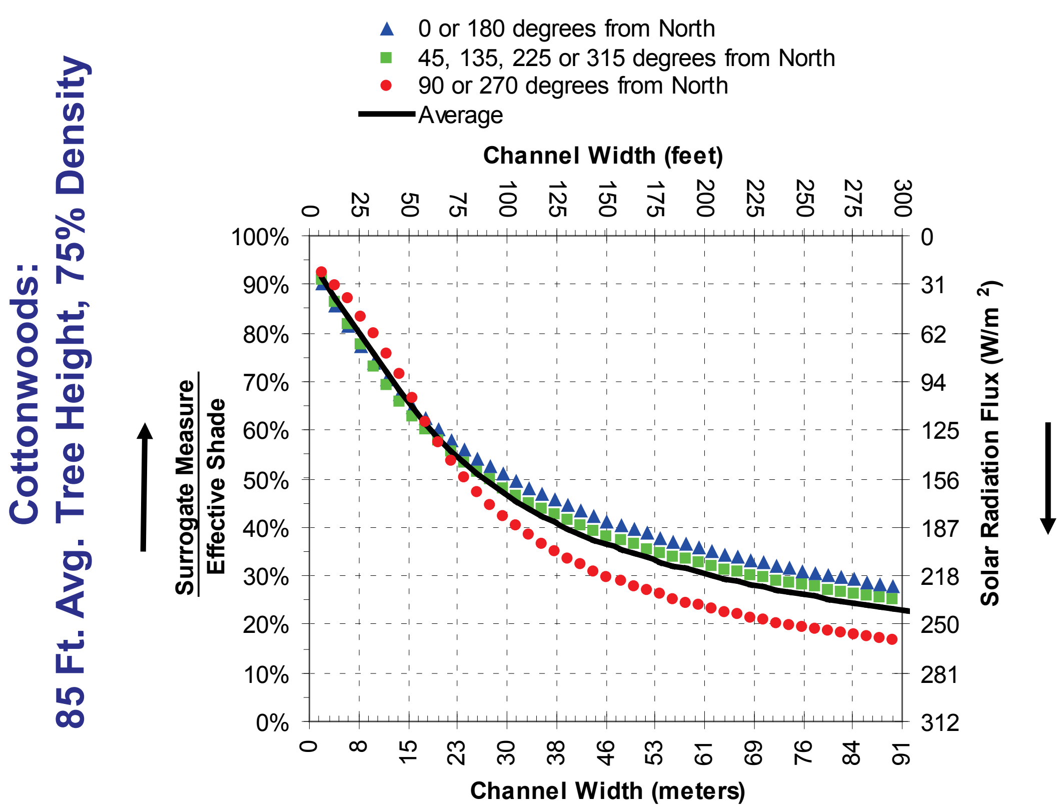
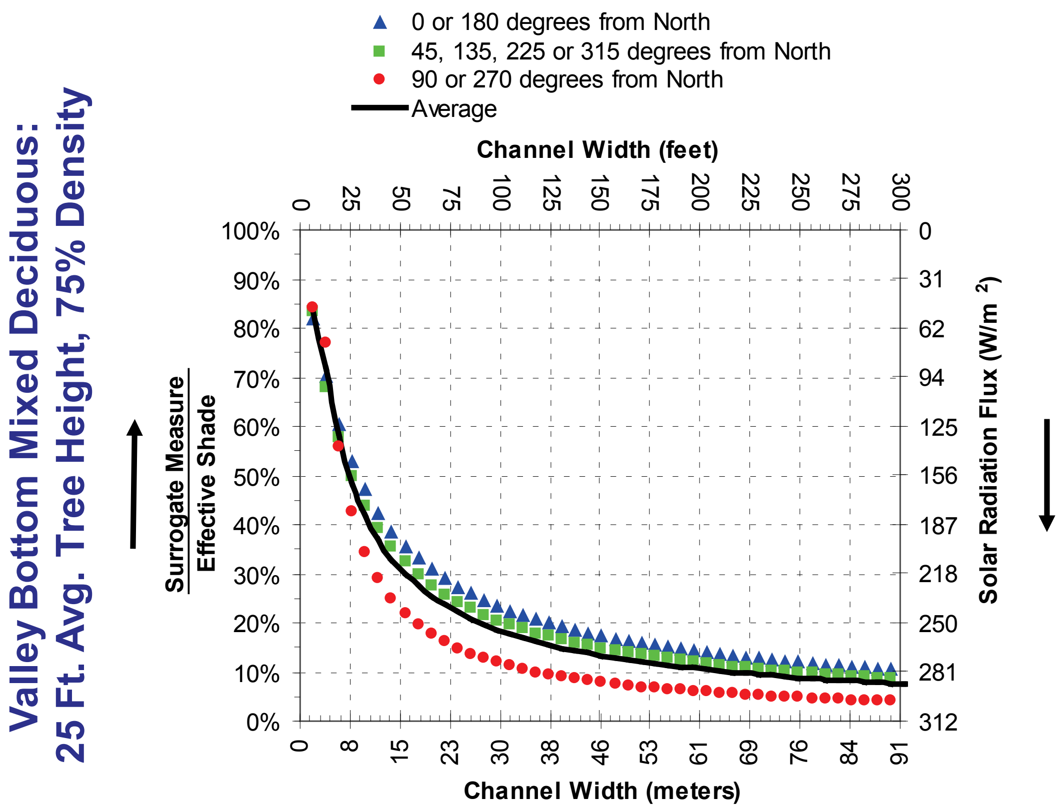


Figure 2-8 (continued). Generalized warm-season system potential effective shade curves for the Lower Grande Ronde Subbasins (North-South, East-West, and Northeast-Northwest refer to stream aspect)



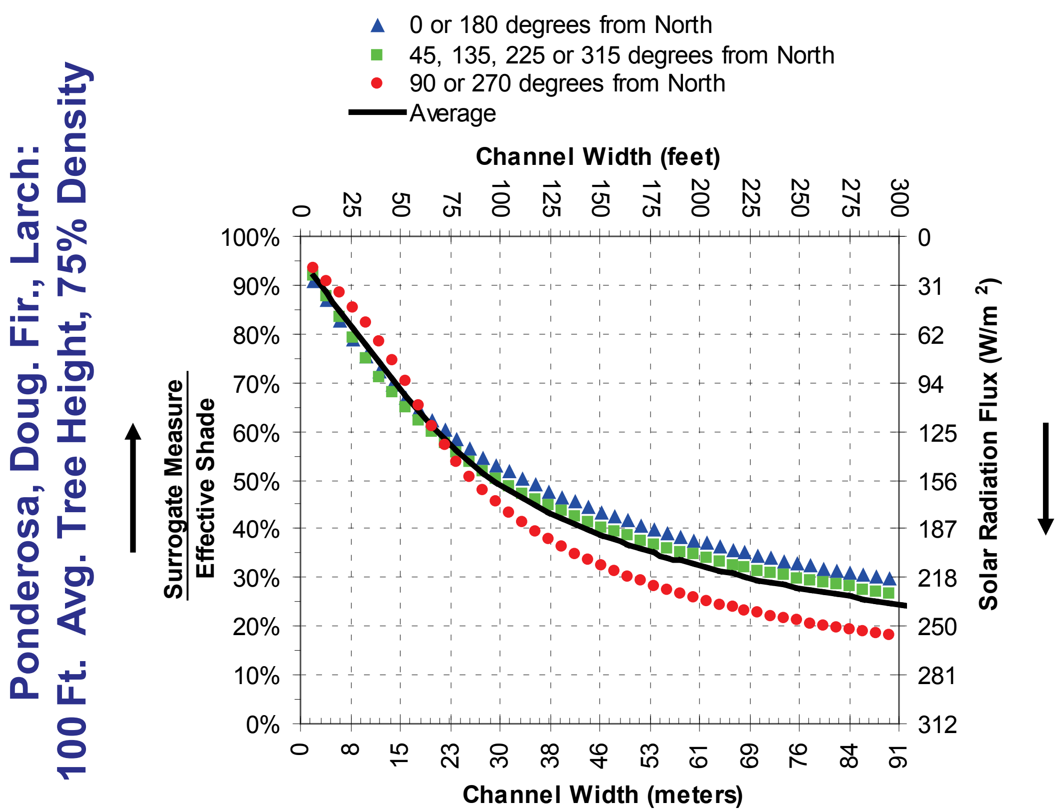


Figure 2-8 (continued). Generalized warm-season system potential effective shade curves for the Lower Grande Ronde Subbasins (North-South, East-West, and Northeast-Northwest refer to stream aspect)

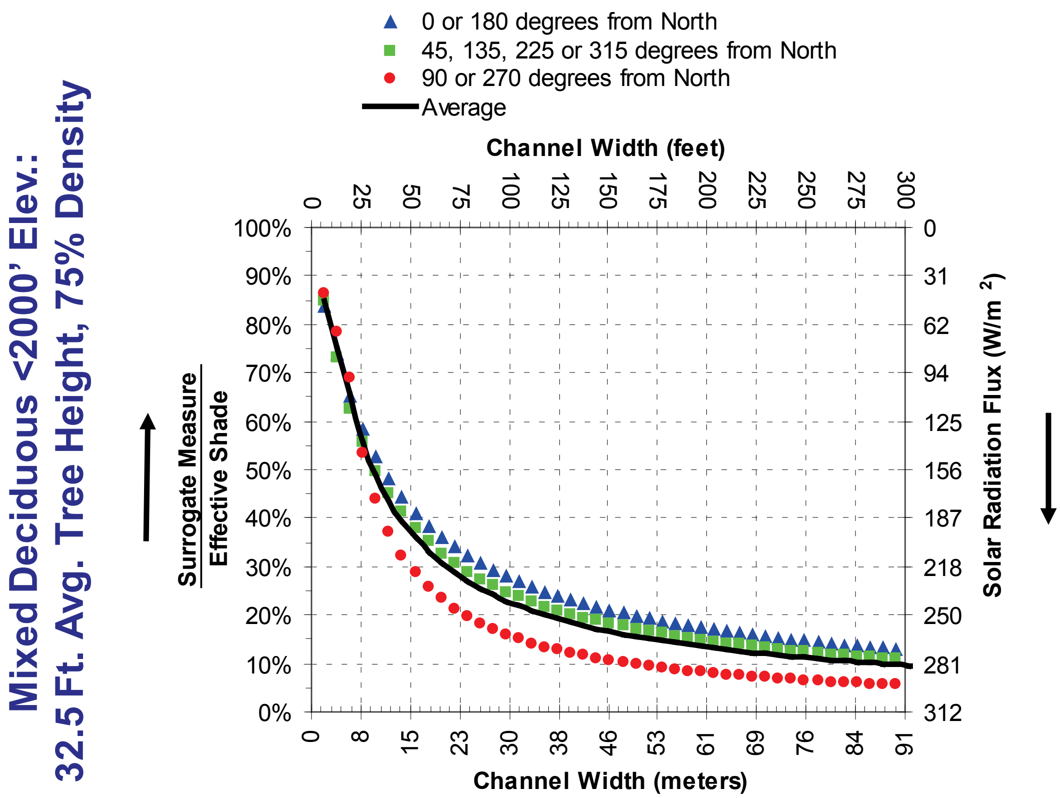


Table 2-7. System potential vegetation communities (Wallowa County TMDL Committee, 2003)

System Potential Vegetation Communities with Dominant Species Composition	Average Mature Tree height feet (meters)	Average Shade Producing Height feet (meters)
Mixed Conifer above 6000 feet: Lodgepole Pine & alpine fir	65-75 (19.8-22.9)	45-55 (13.7-16.8)
Old Growth Conifer: Ponderosa Pine & Douglas fir	120 (36.6)	120 (36.6)
Wallowa River valley bottom: Englemann Spruce	120 (36.6)	100 (30.5)
Cottonwood Galleries	80-90 (24.4–27.4)	80-90 (24.4–27.4)
Valley Bottom Mixed Deciduous: Alder, Willow, Cottonwood Hawthorne, Snowberry, Dogwood Currents, Mock Orange, Rose	25 (7.6)	25 (7.6)
Mixed Conifer: Ponderosa Pine, Douglas Fir, Larch	100-105 (30.5–32.0)	80-85 (24.4–25.9)
Mixed Deciduous <2000 feet elevation: Where alders are dominant, increase heights to as much as 35 ft (Lower Grande Ronde River, Lower Imnaha River, Lower Joseph Creek)	30-35 (9.1-10.7)	30-35 (9.1-10.7)

Measures of Progress

In addition to the previously described load allocations and surrogates, other targets can be tracked as progress is made towards a more natural heating condition. Most of these other targets, or "measures of progress" have not been evaluated in terms of temperature reduction due to limitations in assessment or model capabilities. These measures of progress are listed in **Table 2-8**. While these measures clearly lead to more natural and generally cooler streams, quantitative assessment of their cooling is often impractical. These measures are included here to increase clarity on the range of management practices and projects available to bring the stream system to a more natural thermal condition.

Natural stream flows are one measure that was quantitatively assessed in this TMDL and are included in the NTP profile for the Wallowa River (**Section 2.13**). However, flow is not a pollutant and increased flow is not included in the allocations. To surmount this incongruity, DEQ promotes flow restoration efforts and planning. In addition, we view the natural flow-based temperature profiles as providing important information. Restoration strategies are informed by this and the NTP temperature profile provides for point source temperature limits and long term evaluation of water quality standard attainment.

Table 2-8. Measures of progress.

Measure	Suggested Objective
Sinuosity	General increase
Bank stability	General increase
Channel width:depth ratio	General reduction where increased by human activities, Rosgen (1996) channel types can be used to develop targets
Upland and bank erosion	General reduction where increased by human activities
Decreased channel width and/or increased channel complexity (increased pool frequency & large woody debris; increased space for overflow/side channels, oxbows, off-channel pools, and other wetlands; and other enhancements to hyporheic exchange).	Support natural channel evolution with decreased bank and riparian disturbance.
Increased active floodplain area	Setback levees, increased space, vertical channel stability
Increased stream flow	Maintain or increase instream flows during the critical season (at a minimum, June to September) by limiting water withdrawals, improved flow management, and/or flow augmentation.
Decreased irrigation return flows	Better management of irrigation systems to reduce irrigation return flows to streams.
Vegetative buffer width	Sufficient to allow for maximum vegetation density and resilience

2.10 WASTELOAD ALLOCATIONS (POINT SOURCES)

A *wasteload allocation* (WLA) is the amount of pollutant that a point source can contribute to the stream without violating water quality criteria. WLAs were developed for point sources that discharge heated effluent with a potential to increase temperatures in receiving waterbodies of the Wallowa River Subbasin. The Enterprise, Wallowa and Joseph sewage treatment plants (STPs) are the three point sources where specific WLAs were calculated for this TMDL (refer back to **Section 1.3.5.1** for a more detailed description of all of the point sources). As discussed in **Section 2.7.3**, we determined that the facilities on general permits with DEQ (Enterprise stormwater construction, Wallowa Forest Products stormwater and boiler blowdown, and Wallowa Fish Hatchery) did not have a reasonable potential to impact stream temperatures. Therefore, these facilities are allocated their current heat load. The facilities' impact is expected to be negligible but may utilize a portion of the 0.2°C point source HUA should further analysis indicate otherwise. Because the CAFOs in the Subbasins are not allowed to discharge to surface waters, they are assigned a WLA of zero.

In order to ensure water quality standard attainment, each WLA was calculated to ensure that each discharge would not cause an increase in stream temperature more than the point source HUA of 0.2°C above the applicable instream criterion. Wasteload allocations were calculated based on temperature and flow of the river, given the 0.2°C allowable increase and 50%[1] of the available instream flow for dilution. Information about the discharges and the appropriate applicable numeric criteria are summarized in **Table 2-9**.

Table 2-9. Facility discharge information and applicable biologically-based numeric criteria

Facility	Receiving Stream (river mile)	Season of Discharge	Applicable Criterion	Season the Criterion Applies
Enterprise	Wallowa River (40.7)	Year around	Spawning	August 15-June 15
			Core cold-water	June 16-August 14
Wallowa	Wallowa River (23.0)	Year around	Core cold-water	Year around
Joseph	Prairie Creek (4.0)	November 1-May 31	Spawning	August 15-June 15

A Reasonable Potential Analysis of the capacity to increase river temperature beyond the allowable HUA increase was calculated from river temperature, effluent temperatures and flows from discharge monitoring reports for each STP. We assumed the highest effluent temperature reported for a given facility in recent years, and conservatively low river flows. The thermal effects of each discharge were determined for each month of the year to ensure that the appropriate temperature criteria were not exceeded. A separate analysis was also done of the combined effects of the Enterprise and Wallowa STPs on the Wallowa River.

The following equations, variables, and assumptions were used to calculate temperature increase due to the discharge and the thermal wasteload allocations:

Equations:

1.

2. $H_{WLA} = (HUA)(Q_{PS} + Q_R)(0.1186)$

and,

[1] Although100% of the stream flow is allowed for mixing following the development of the TMDL, only 50% of the stream flow was used in this analysis. This reduction in the allowable stream flow to be used for dilution is part of the Margin of Safety for the analysis. This decision is also in keeping with DEQ's Antidegradation Policy ((OAR 340-041-0004(9)(c)) which states that "…Oregon's water bodies have a finite capacity to assimilate waste. Unused assimilative capacity is an exceedingly valuable resource…"

3. $$T_{WLA} = \frac{(Q_{PS} + Q_R)(T_R + HUA) - (Q_R)(T_R)}{Q_{PS}}$$

Where,

ΔT_R = Change in River Temperature
Q_{PS} = Point Source Flow (cfs)
Q_R = Upstream River Flow ((50% of low stream flow (cfs))
T_{WLA} = Wasteload Allocation Temperature (°C)
T_R = Applicable Temperature Criterion or Upstream Natural Thermal Potential Temperature for Receiving Stream (°C)
T_E = Effluent Temperature (°C)
S = Dilution Ratio (River Flow:Effluent Flow in percent)
HUA = Human Use Allowance (0.2°C)
H_{WLA} = Wasteload Allocation Heat Load (MW)
0.1186 = Conversion Factor into Megawatts

Further details about the reasonable potential analysis and the development of the WLAs for each facility are described further in **Sections 2.10.1** - **2.10.3**. The analyses were based on very conservative assumptions for inputs into the equations above. A summary of the WLAs is provided in **Table 2-10**. For all three facilities, the reasonable potential analyses calculated that there was no likelihood of increasing receiving stream temperatures beyond the allowable increase of 0.2^{o}C above the applicable criterion, therefore effluent limits beyond the current permits are not required. The critical period was determined to be the April-October (refer back to **Section 2.6**) so WLAs apply during these months of the year. Effluent temperature limits may be calculated during permit development with T_{WLA} as defined above where appropriate.

Table 2-10. Wasteload allocations for point source discharges in the Lower Grande Ronde Subbasins (critical period of April-October)
Variables indicated in the first row of this table refer to variables used in Equations 1-3 presented on the previous two pages.

		Q_R*	Q_{PS}	T_E	T_R	HUA		H_{WLA}**		T_{WLA}	
Facility Name	Receiving Water	Receiving Water Low Flow (cfs)	Facility Design Flow (cfs)	Point Source Effluent Temp. (°C)	Max Daily Site Potential River Temp. (°C)	Human Use Allowance (HUA) (°C)	Proportion of Stream Allowed for Mixing (max = 100%)	Allowable Point Source Heat Loading in Zone of Dilution (MW/day)	Percent Reduction in Point Source Heat Load	Maximum Allowable Effluent Temp. (°C)	Months when WLA applies
Joseph STP	Prairie Creek	28.3*	0.23	Variable by Month	NA***	0.2	50%	0.34**	None	Existing Condition	April - May
Enterprise STP	Wallowa River	112*	1.53	21.1	17.0	0.2	50%	1.36**	None	Existing Condition	April - October
Wallowa STP	Wallowa River	112*	0.31	23.3	15.5	0.2	50%	1.33**	None	Existing Condition	April - October

* For the Joseph STP, represents the measured low monthly low stream flow during the critical period for Prairie Creek. For the Enterprise and Wallowa STPs, represents the annual 7Q10 low flow based on gage data for Wallowa River above Cross Country Canal (USGS No. 13329770)
** Heat load may also be flow based as conditions vary through the year. The WLA presented here is conservative and based on the assumption of low flow conditions occurring year-around.
*** Water body was not simulated for temperature – no natural thermal potential temperature established

2.10.1 Joseph Sewage Treatment Plant

Flow Data. Flows for Prairie Creek were based on readings of a rated staff gage on Prairie Creek near the point of discharge. The staff gage was read on most regular business days by staff at the Joseph STP and reported in their discharge monitoring reports. There was a good record for the discharge seasons of 2008 and 2009. The lowest flow rate for each month in the record was determined and used as the monthly low flow estimate in the reasonable potential analysis. There was not enough data available to calculate the 7Q10[2] low flow for this creek. Flows were estimated to be the highest in the month of May.

The average dry-weather design flow of the facility is 0.044 MGD (0.23 cfs). During a mixing zone study conducted by DEQ in December 2008 (DEQ 2009), the discharge was estimated to be 0.15 MDG. Effluent flow rates used in the reasonable potential analysis were based on a discharge rate of 0.15 MGD, since this was estimated to be more representative of flows during the fall-winter-spring time period when the facility discharges to Joseph Creek.

Temperature Data. Effluent and stream temperature data were collected by staff at the Joseph STP. The temperature of Prairie Creek upstream of the wastewater discharge during the winter period is likely naturally controlled since there are no point sources of heat and solar radiation is at a minimum during the discharge period. Instream temperature data from the winters of 2005-6 and 2006-7 demonstrated that the creek was well below the spawning criterion during much of this period, though it did increase above the criterion in the spring. Effluent temperatures were obtained from discharge monitoring reports for discharge years 2005-6 and 2006-7. The highest effluent temperature reported for each month at the facility was used to estimate the maximum likely effluent temperature for the monthly reasonable potential analyses.

The most complete temperature record is for the 2006-7 discharge season. During most of this period, effluent temperature was below the stream temperature, indicating the effluent was not capable of increasing stream temperature (**Figure 2-9**). In the two discharge seasons for which there is a continuous record of temperature, effluent temperatures were below stream temperature until mid-to-late May and below the spawning criterion until early to mid-May. Although the stream temperature exceeded the spawning criterion in early to mid-April of each year, there is no evidence that the wastewater discharge is contributing to these elevated temperatures.

Reasonable Potential Analysis. The parameters used in the reasonable potential analysis for the Joseph STP are shown in **Table 2-11**. Although based on relatively little measured data, the analysis indicated that a violation of the instream temperature criterion or the TMDL allocation is very unlikely. In the analysis, thermal load limits were established for the months when discharge occurs (November-May) based on 50% of the available instream flow for dilution and an allowable stream temperature increase of 0.2^{o}C (HUA). Estimated dilution ratios for the seven months, assuming a discharge flow of 0.15MGD, ranged from 58:1 in March to 99:1 in November.

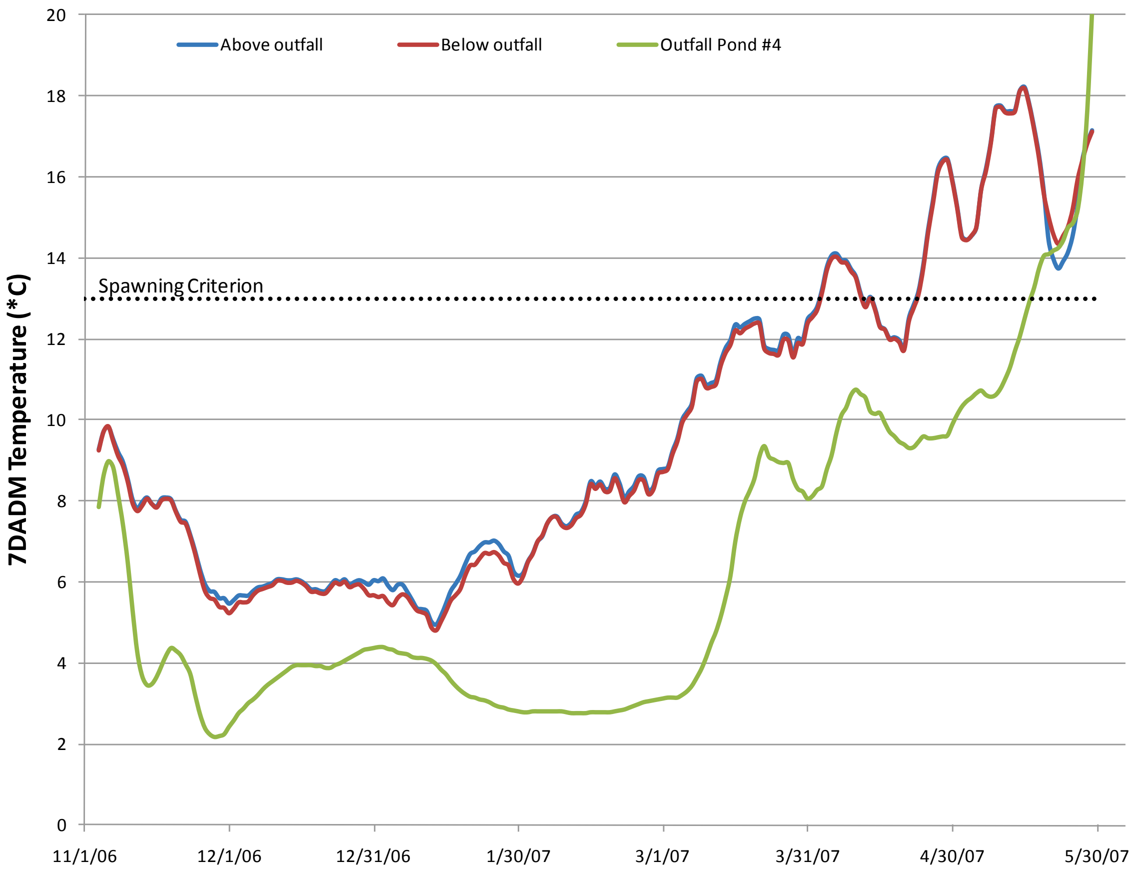
Based on the conservative assumptions of limiting the available stream flow to 50%, using the minimum measured monthly effluent flows, and using the maximum measured monthly effluent temperatures, WLAs were calculated for each month of discharge (**Table 2-11**). The loads were flow dependent. Because the critical period for this TMDL has been defined as April-October, WLAs only apply during the months of April and May. To be conservative and consistent with the low flow approach used for the Wallowa River (see **Section 2.10.2**), the WLA for the month with the lowest flow during the critical period (0.34 MW/day) applies during the entire period of discharge.

The analysis indicates that the STP discharge from this facility will not increase river temperatures beyond the human use allowance under any permitted conditions during the months of discharge. The analysis

[2] The 7Q10 flow is the 7-day average low flow with a 10-year return interval.

does indicate stream temperatures are likely to rise above 13°C in April of each year, and that effluent temperature from the STP is elevated during the last two or three weeks of the discharge season in May. However, the discharge is very small during this time of year relative to instream flow and there is no reasonable potential of violating the WLA. During the next permit revision for this STP the evaluation report and permit conditions will need to address the influence of the discharge during April and May of each year to ensure that the allocated HUA of 0.2°C is not violated.

Figure 2-9. Temperature profiles (7-day average of daily maximum temperatures) of Prairie Creek upstream and downstream of the Joseph STP outfall and the STP effluent in holding lagoon during 2006-2007



2.10.2 Enterprise and Wallowa Sewage Treatment Plants

Flow Data. River flows for the Wallowa River were based on an analysis of a USGS gage downstream of Enterprise (Wallowa River above Cross-Country Canal – Gage # 13329770). To determine the critical condition for temperature effects from effluent discharge, the 7Q10 river flow was determined on a yearly and monthly basis for the period from 1996 through 2009. The annual 7Q10 flow for this period was 112 cfs, with monthly values ranging from 115 cfs in August to 194 cfs in June. In the reasonable potential analyses, the annual 7Q10 flow was used to determine the likelihood of exceeding the appropriate temperature in all months. Because the annual 7Q10 is necessarily at least as low as any of the monthly values, this is a conservative approach and adds additional margin of safety to the allocations.

Effluent flow rates for the cities of Enterprise and Wallowa were the average dry-weather design flow rates provided in each facility's NPDES permit, 0.99MGD (1.53 cfs) and 0.203 MGD (0.31 cfs), respectively. A cumulative effects analysis (**Section 2.10.3**) looking at the combined effects of the two facilities simply added these flow rates.

Temperature Data. Estimates of ambient instream temperatures for the reasonable potential analysis varied depending on the month of analysis. Heat Source modeling of the Wallowa River indicated August was the critical month and provided an estimate of NTP temperature at points along the River. The NTP temperature in Enterprise (kilometer 67.5 in the model) was 17.0°C and in Wallowa (kilometer 37.5 in the model) it was 15.5°C. These temperatures were used for the reasonable potential analysis in August. The appropriate biologically based numeric temperature criterion was used for all other months.

Effluent temperatures were based on discharge monitoring reports from 2008 and 2009 for the Wallowa STP and 2006-2009 for the Enterprise STP. The highest effluent temperature reported for each month at each facility estimated the effluent temperature for the monthly reasonable potential analyses.

Reasonable Potential Analyses. The parameters used in the reasonable potential analysis for the Enterprise and Wallowa STPs are shown in **Table 2-12** and **Table 2-13** respectively. In each analysis, WLAs were established for each month of the year based on 50% of the available instream flow for dilution and an allowable stream temperature increase of 0.2^{o}C (HUA). The calculations indicate that the STP discharges from each facility will not increase river temperatures beyond the human use allowance under any permitted conditions during any month of the year. For the Enterprise STP, the months of May, June, September and October came close to exceeding the HUA, but it was never exceeded. The limitation of available flow to only 50% and use of the annual 7Q10 for all months is very conservative and ensures the facilities are incapable of causing a violation of the water quality standard. This leaves additional reserve capacity in the system, and the remaining 50% of flow for dilution should be reserved specifically for future needs of point source discharges. The WLAs for the Enterprise and Wallowa STPs were calculated to be 1.36 MW/day and 1.33 MW/day, respectively, and apply during the critical period of April through October.

2.10.3 Cumulative Effects Analysis

A cumulative effects analysis was done to assess the combined effects of the Wallowa and Enterprise STPs on the Wallowa River (**Table 2-14**). The Joseph discharge was not included in this analysis because it does not discharge during the summer period (July/August) for the Wallowa River, and effects of the discharge diminish during the fall-winter-spring when the Joseph STP discharges to Prairie Creek. In this analysis, it was assumed that both Wallowa and Enterprise STPs were discharging to the Wallowa River at Wallowa with a combined flow of 1.193 MGD (1.85 cfs), a flow-weighted monthly average effluent temperature. This cumulative effects analysis determined that the combined effects of the two treatment plants discharging at a single site near Wallowa would not cause an increase greater than the HUA in the Wallowa River when fully mixed. The greatest increase was observed in the month of August, when the calculated temperature increase was 0.16°C (0.29°F) above the NTP temperature.

Table 2-11. Input parameters and results of Reasonable Potential Analysis for the Joseph STP

Joseph STP		Discharge					No Discharge Allowed							Discharge	
		Spawning						Core Cold Water			Spawning				
	Variable*	January	February	March	April	May	June 1-15	June 16 - August 14			August 15-31	September	October	November	December
Maximum Effluent Temp (°C)	T_E	4.7	7.6	11.2	12.2	24.5	NA	NA	NA	NA	NA	NA	NA	11.5	4.7
Applicable Temperature Criterion (°C)**	T_R	13.0	13.0	13.0	13.0	13.0	13.0	16.0	16.0	16.0	13.0	13.0	13.0	13.0	13.0
Effluent Flow (mixing zone study measurement)	Q_{PS}	0.15 MGD													
Minimum Monthly Stream Flow (cfs)	Q_R***	28.3	28.3	26.3	28.3	34.9	NA	NA	NA	NA	NA	NA	NA	45.3	34.9
Dilution Ratio with 50% of stream flow	S	62	62	58	62	76	NA	NA	NA	NA	NA	NA	NA	99	76
Calculated Stream Temperature Increase (°C)	ΔT_R	-0.13	-0.09	-0.03	-0.01	0.15	NA	NA	NA	NA	NA	NA	NA	-0.02	-0.11
WLA (MW/day)	H_{WLA}	0.34	0.34	0.32	0.34	0.42	NA	NA	NA	NA	NA	NA	NA	0.54	0.42

* Variables used in WLA equations on page 27.
** Based on biologically-based numeric criteria
*** Q_R is the monthly minimum flow shown in the table multiplied by 0.5 (50% of the stream flow)

Table 2-12. Input parameters and results of Reasonable Potential Analysis for the Enterprise STP

Enterprise STP															
		Spawning						Core Cold Water			Spawning				
	Variable*	January	February	March	April	May	June 1-15	June 16-30	July	August 1-14	August 15-31	September	October	November	December
Maximum Effluent Temp (°C)	T_E	7.0	10.5	10.0	15.4	19.3	19.2	19.2	20.6	20.6	20.6	19.9	18.9	11.0	10.8
Applicable Temperature Criterion (°C)**	T_R	13.0	13.0	13.0	13.0	13.0	13.0	16.0	16.0	17.0	17.0	13.0	13.0	13.0	13.0
Effluent Flow (avg. dry-weather design flow)	Q_{PS}	0.99 MGD													
Minimum 7Q10 Stream Flow	Q_R***	112 cfs													
Dilution Ratio with 50% of stream flow	S	38													
Calculated Stream Temperature Increase (°C)	ΔT_R	-0.16	-0.07	-0.08	0.06	0.17	0.17	0.09	0.12	0.10	0.10	0.18	0.16	-0.05	-0.14
WLA (MW)	H_{WLA}	1.36	1.36	1.36	1.36	1.36	1.36	1.36	1.36	1.36	1.36	1.36	1.36	1.36	1.36

* Variables used in WLA equations on page 27.
** Based on NTP temperatures at Enterprise in August and biologically-based numeric criteria during the rest of the year
*** Q_R is the 7Q10 minimum flow shown in the table multiplied by 0.5 (50% of the stream flow)

Table 2-13. Input parameters and results of Reasonable Potential Analysis for the Wallowa STP

Wallowa STP													
		Core Cold Water											
	Variable*	January	February	March	April	May	June	July	August	September	October	November	December
Maximum Effluent Temp (°C)	T_E	3.3	4.4	6.1	11.1	16.7	19.4	20.6	20.6	18.3	15.0	8.3	7.2
Applicable Temperature Criterion (°C)**	T_R	16.0	16.0	16.0	16.0	16.0	16.0	16.0	15.5	16.0	16.0	16.0	16.0
Effluent Flow (avg. dry-weather design flow)	Q_{PS}	0.203 MGD											
Minimum 7Q10 Stream Flow	Q_R***	112 cfs											
Dilution Ratio with 50% of stream flow	S	179											
Calculated Stream Temperature Increase (°C)	ΔT_R	-0.07	-0.06	-0.06	-0.03	0.00	0.02	0.03	0.03	0.01	-0.01	-0.04	-0.05
WLA (MW)	H_{WLA}	1.33	1.33	1.33	1.33	1.33	1.33	1.33	1.33	1.33	1.33	1.33	1.33

* Variables used in WLA equations on page 28.
** Based on NTP temperatures at Enterprise in August and biologically-based numeric criteria during the rest of the year
*** Q_R is the 7Q10 minimum flow shown in the table multiplied by 0.5 (50% of the stream flow)

Table 2-14. Input parameters and results of Reasonable Potential Analysis results for the Enterprise and Wallowa STP combined

Enterprise-Wallowa STPs Combined													
		Core Cold Water											
	Variable*	January	February	March	April	May	June	July	August	September	October	November	December
Maximum Effluent Temp (°C)	T_E	6.4	0.0	9.3	14.7	18.9	19.2	20.6	0.0	19.6	18.2	10.5	10.2
Applicable Temperature Criterion (°C)**	T_R	16.0	16.0	16.0	16.0	16.0	16.0	16.0	15.5	16.0	16.0	16.0	16.0
Effluent Flow (avg. dry-weather design flow)	Q_{PS}	1.193 MGD											
Minimum 7Q10 Stream Flow	Q_R***	112 cfs											
Dilution Ratio with 50% of stream flow	S	31											
Calculated Stream Temperature Increase (°C)	ΔT_R	-0.31	-0.21	-0.21	-0.04	0.09	0.00	0.15	0.16	0.12	0.07	-0.17	-0.19
WLA (MW)	H_{WLA}	1.37	1.37	1.37	1.37	1.37	1.37	1.37	1.37	1.37	1.37	1.37	1.37

* Variables used in WLA equations on page 28.
** Based on NTP temperatures at Enterprise in August and biologically-based numeric criteria during the rest of the year
*** Q_R is the 7Q10 minimum flow shown in the table multiplied by 0.5 (50% of the stream flow)

2.11 MARGIN OF SAFETY

The Clean Water Act requires that each TMDL be established with a margin of safety (MOS). The statutory requirement that TMDLs incorporate a MOS is intended to account for uncertainty in available data or in the actual effect controls will have on loading reductions and receiving water quality. A MOS is expressed as unallocated assimilative capacity or conservative analytical assumptions used in establishing the TMDL (e.g., derivation of numeric targets, modeling assumptions or effectiveness of proposed management actions).

The MOS for the Lower Grande Ronde Subbasins Temperature TMDL is implicit, based on conservative analytical assumptions and numeric targets. These conservative assumptions include:

- Conservatively low estimates for groundwater inflow were used in the stream temperature calibration. Specifically, unless measured or inferred from a mass balance analysis, groundwater inflow was assumed to be zero. Generally, groundwater has a cooling influence on stream temperatures via mass transfer/mixing. These underestimates of groundwater influence are considered a margin of safety.
- Conservatively low estimates of wind speed were used in the stream temperature calibration. Simulations were performed with wind speeds at zero or at low levels of recorded data. Wind speeds influence evaporation, a cooling influence on stream temperatures. The underestimation of wind speed is considered a margin of safety.
- Cooler microclimates associated with mature natural near-stream land cover were not accounted for in the simulation methodology.
- The natural condition simulation used to develop the NTP river temperatures used riparian vegetation overhang values of zero. As riparian vegetation increases, particularly during the late seral stages, the potential for vegetation to overhang the stream is very high. More area of stream that is shaded from direct sunlight keeps streams from warming. This conservative estimate of overhang is considered a margin of safety.
- Simulations of point source impacts using Reasonable Potential Analyses were used to develop waste load allocations. A number of conservative assumptions were used, including: sources were discharging at their effluent design flows and maximum effluent temperatures at all times; the annual 7Q10 low flow was used for all months of the year; and only 50% of the available stream flow was used to determine dilution. Waste load allocations do not exceed the human use allowance at any time of year nor is it expected that all sources will be discharging at their maximum levels at the same time or all the time. These conservative factors will yield a cooler river and is considered a margin of safety.
- DEQ allocated one-sixth of the human use allowance to non point sources but is basing the load allocation on system potential conditions. DEQ considers this conservative methodology to be part of the implicit margin of safety.

For further information regarding stream temperature modeling assumptions, refer to **Appendix A**.

2.12 RESERVE CAPACITY

There is an explicit allocation for reserve capacity throughout the Lower Grande Ronde Subbasins set aside for future growth and new, expanded or unidentified sources. The general framework of the TMDL allocates 0.05°C or 1/6th of the HUA to reserve capacity, at the points of maximum impact. On streams without any point sources, an additional 0.2°C will be available for reserve capacity. In addition, reserve capacity will likely be available during much of the year due to the conservative assumptions used in developing WLAs for existing point sources. Reserve capacity is available for use by either nonpoint or point sources to accommodate future growth as well as to provide an allocation to any existing source that may not have been identified during the development of this TMDL.

2.13 WATER QUALITY STANDARD ATTAINMENT ANALYSIS & REASONABLE ASSURANCES

Oregon Administrative Rule 340-042-0040(4)(l)(F) calls for the WQMP to include a timeline for attainment of water quality standards. For point sources, this is addressed through DEQ's NPDES permitting program. As was described in **Section 2.10**, point sources currently have little or no measurable impact on current stream temperatures in the Wallowa Subbasin and are already operating within their WLAs under the terms of their existing permits. For nonpoint sources, this is approached through an adaptive process, wherein TMDL implementation plans include milestones. Plans will be revised as capacity for and mechanisms of improvement are better understood.

At this time, minimum time frames can only be roughly estimated. On smaller order streams where vegetation or flow diversion is the thermal control, attainment could occur within 1-15 years. On larger order streams and where channel evolution is needed, many decades may elapse before natural conditions are approached, not considering the amount of time before that trajectory is enabled from a land use perspective.

Attainment timing is informed by estimation of the current departure from water quality standards. The general target of the temperature standard in the Lower Grande Ronde Subbasins is a temperature pattern reflecting natural conditions. The existing departure from this goal, along the modeled corridor of the Wallowa River (outlet of Wallowa Lake to the confluence with the Grande Ronde River), is portrayed in **Figure 2-10**. **Figure 2-10** compares the current stream temperatures with the NTP conditions for the warmest seven days of the simulation period (August 23-August 29, 1999). Simulations were performed to estimate NTP stream temperatures using the following:

- System potential vegetation heights and densities
- Natural flow conditions – no withdrawals, no point sources
- Reduced tributary temperatures[3]

Because the simulations were run over a 20-day period, the moving seven-day average of the daily maximums (7DADM) could be calculated. The peak values of the 7DADM were then selected for the simulation period and plotted in the figure. The results are intended to represent the critical summer time period when stream temperatures reach their yearly maximums and aquatic life is at the greatest risk of thermal impairment. For reference purposes, the applicable biologically-based numeric quality criterion is included on the chart. Further discussion about the simulation methodology is included within **Appendix A.**

Figure 2-10 demonstrates that NTP temperatures exceeded the biologically based criteria for most of the Wallowa River. Based on this analysis, the Natural Conditions criteria apply to the Wallowa River and all of its tributaries and NTP conditions are the TMDL target. Similarly, in the TMDL completed for the Upper Grande Ronde Subbasin (DEQ 2000), natural conditions were set as the target to meet water quality standards. Although an NTP analysis was not done for other Grande Ronde Basin water bodies, the natural condition criterion is assumed applicable throughout the Lower Grande Ronde and Imnaha River Subbasins as well. Exceptions occur where and when numeric targets are needed and the natural potential temperatures have not been assessed (such as for point source discharges).

The following discussion of potential natural and anthropogenic activities affecting stream temperatures in the Wallowa River was largely derived from *Wallowa County-Nez Perce Salmon Habitat Recovery Plan with Multi-Species Habitat Strategy* (1999) (SHRP) and is indicative of the kinds of issues that relate to

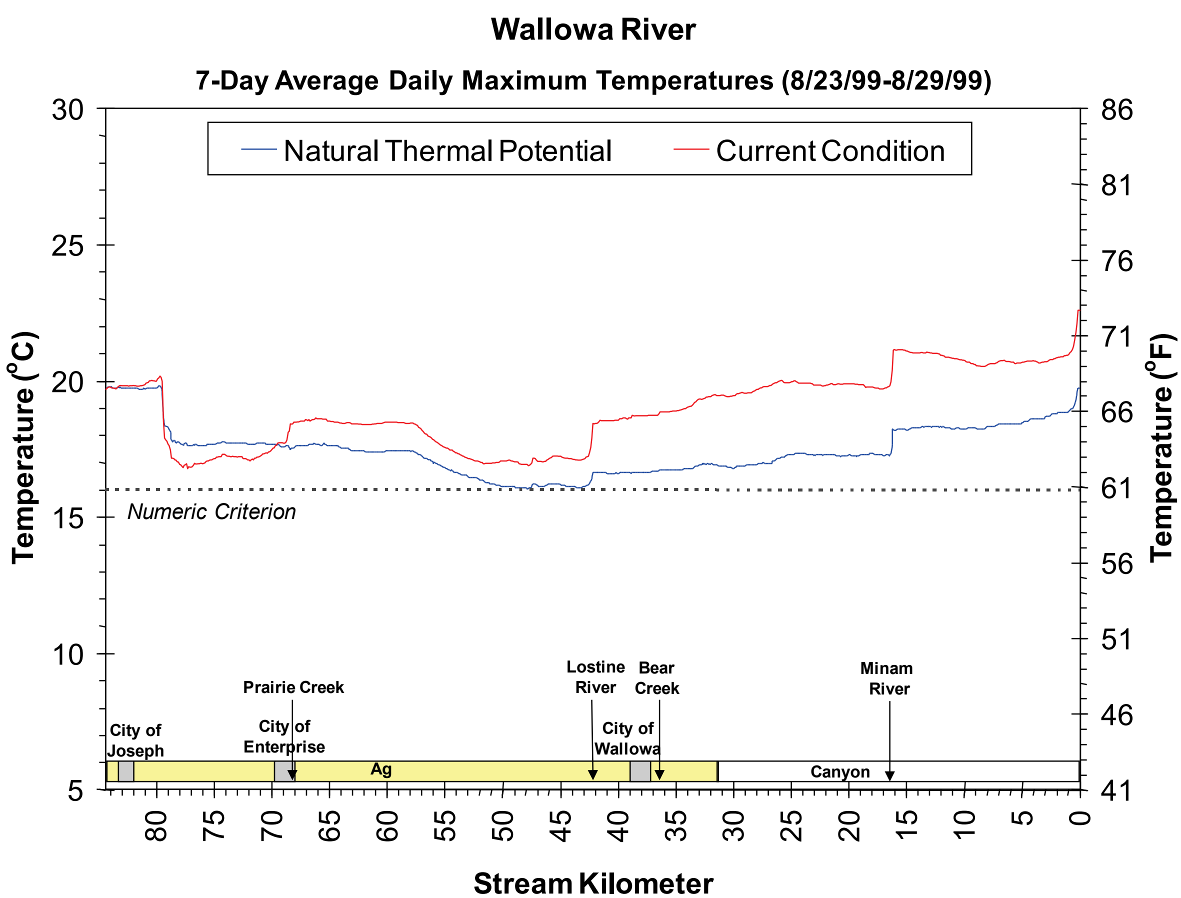
[3] If tributary temperatures exceeded the numeric criteria, then temperatures were set to approximate the temperature of other cooler temperatures in the Subbasin under this scenario. Tributaries that currently were below the numeric criteria were left at their current temperature.

achievement of NTP conditions along the Wallowa River. This discussion refers to thermal effects seen in **Figure 2-10**.

The Wallowa River rises in the Eagle Cap Wilderness, flows north to Wallowa Lake and then northwest to join the Grande Ronde River. Major tributaries to the Wallowa River include Prairie Creek, the Lostine River, Bear Creek and the Minam River. There are a number of diversions from the Wallowa River, with the largest ones located below Wallowa Lake and near stream kilometer 55. Anthropogenic activities that affect stream temperatures include: reduction of riparian vegetation and shade levels primarily through recreation, grazing, and logging activities and the location of roads and railroads; manipulation of instream flows through instream diversions and impoundments; and irrigation return flows.

Three to four kilometers below the outlet of Wallowa Lake, large inputs of groundwater cause stream temperatures to decrease significantly. It is interesting to note that the simulated Wallowa River temperatures are warmer under potential flow conditions between stream kilometers 69 and 79. This is likely due to the fact that large volumes of water are diverted into canals just below the Wallowa Lake outlet. Leaving this water instream dampens the cooling effects that springs have on the river at approximately stream kilometer 79. The effects of this scenario can be observed quite a ways downstream. It is also interesting to note that both the Lostine and Minam Rivers appear to increase the temperature of the Wallowa River under both current conditions and natural thermal potential conditions. Finally, it should be noted that the presence of the road and railroad along the river below the community of Wallowa will likely conflict with attainment of system potential vegetation along much of this reach.

Figure 2-10. Wallowa River temperature simulation results (maximum 7DADM)



2.13.1 Implementation Responsibilities

The Water Quality Management Plan (WQMP) (**Chapter 4**) provides the framework of management strategies needed to attain and maintain water quality standards. Designated Management Agencies (DMAs) are identified in the WQMP. These agencies are responsible for developing and implementing plans (called Implementation Plans) to fulfill TMDL load allocations and surrogate measures. The agency Implementation Plans typically stem from their existing programs, and must meet the requirements of OAR 340-042. The process for identifying DMAs is straightforward. DEQ identifies existing jurisdictional responsibility for water quality in the areas where the load allocations apply. For example, the Oregon Department of Agriculture is the DMA for areas near the stream in which agriculture land use is predominant. Through management planning, projects and ongoing assessment, the DMAs are expected to ensure that all feasible steps are taken toward attainment of the load allocations and surrogate measures identified in the TMDLs.

Much restoration and conservation planning and implementation has already commenced, in a manner supportive of TMDL attainment. And, in much of the Subbasins, more restoration is needed and long term planning needs to provide for maintenance of effort over time. The SHRP describes the potential anthropogenic activities affecting the stream corridors for many of the streams in the TMDL geographic area. Restoration measures are described in the Stream Analysis Section, with management suggestions made on a reach-by-reach basis. In addition, Appendix B of the SHRP includes a Problems/Solutions Summary that includes specific guidance on management measures that can be used to address a number of water quantity, water quality, and stream structure issues. Reasonable assurance of implementation is represented by the initiative and commitment shown in the development of this plan.

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LOWER GRANDE RONDE SUBBASINS TMDL
CHAPTER 3: BACTERIA

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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 (4th field HUCs 17060105).
Pollutant Identification OAR 340-042-0040(4)(b)	*Pollutants*: Fecal bacteria from various sources, particularly *E. coli* 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. *E. coli* is used as an indicator of human pathogens for water recreational contact and may not exceed: (A) A 30-day log mean of 126 *E. coli* organisms per 100 milliliters, based on a minimum of five samples; (B) No single sample may exceed 406 *E. coli* 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 *E. coli* 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

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)**	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. *Waste Load Allocations (Point Sources)*: 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. *Load Allocations (Nonpoint Sources)*: 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 *E. coli* levels. *Excess Load:* The difference between the actual pollutant load and the loading capacity of the waterbody.
Surrogate Measures **OAR 340-041-0040(5)(b)** **40 CFR 130.2(i)**	Percent reduction in bacterial loading or concentration needed to meet the numeric criteria were used as surrogate measures.
Margins of Safety **OAR 340-042-0040(4)(i)** **CWA §303(d)(1)**	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.
Reserve Capacity **OAR 340-042-0040(4)(k)**	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.
Water Quality Management Plan **OAR 340-041-0040(4)(l)** **CWA §303(d)(1)**	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.

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 Wallowa 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 Wallowa 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 Wallowa 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 (Wallowa 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 Wallowa River at Minam, Wallowa River near Wallowa 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 Wallowa River generally met water quality criteria, but those in Spring Creek and Prairie Creek generally did not. Source waters from Wallowa 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	*E. coli*	2004	Summer
Prairie Creek*	0 to 12.5	*E. coli*	2004	Summer
Wallowa River	0 to 50	*E. coli*	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
Wallowa 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)

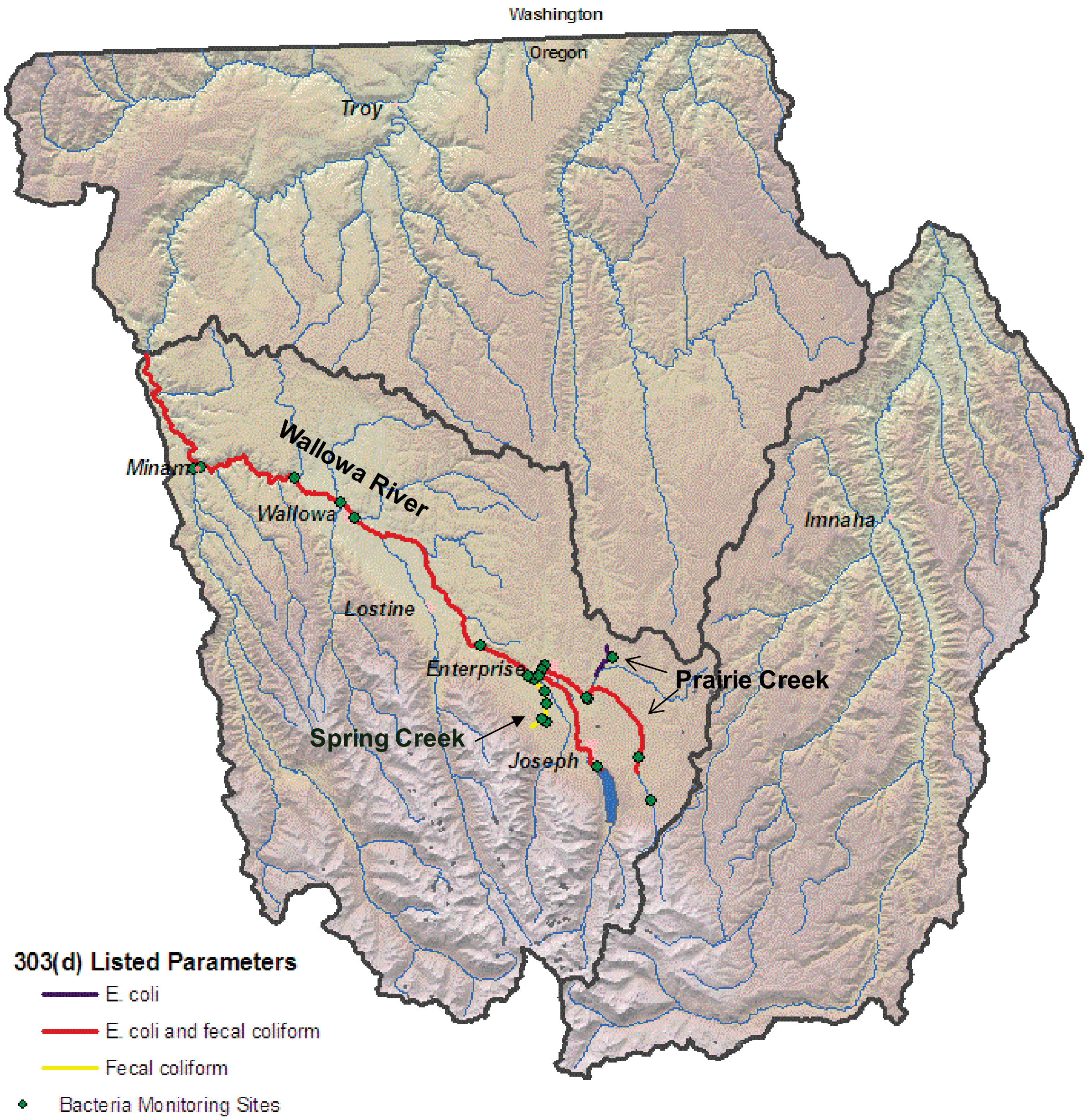


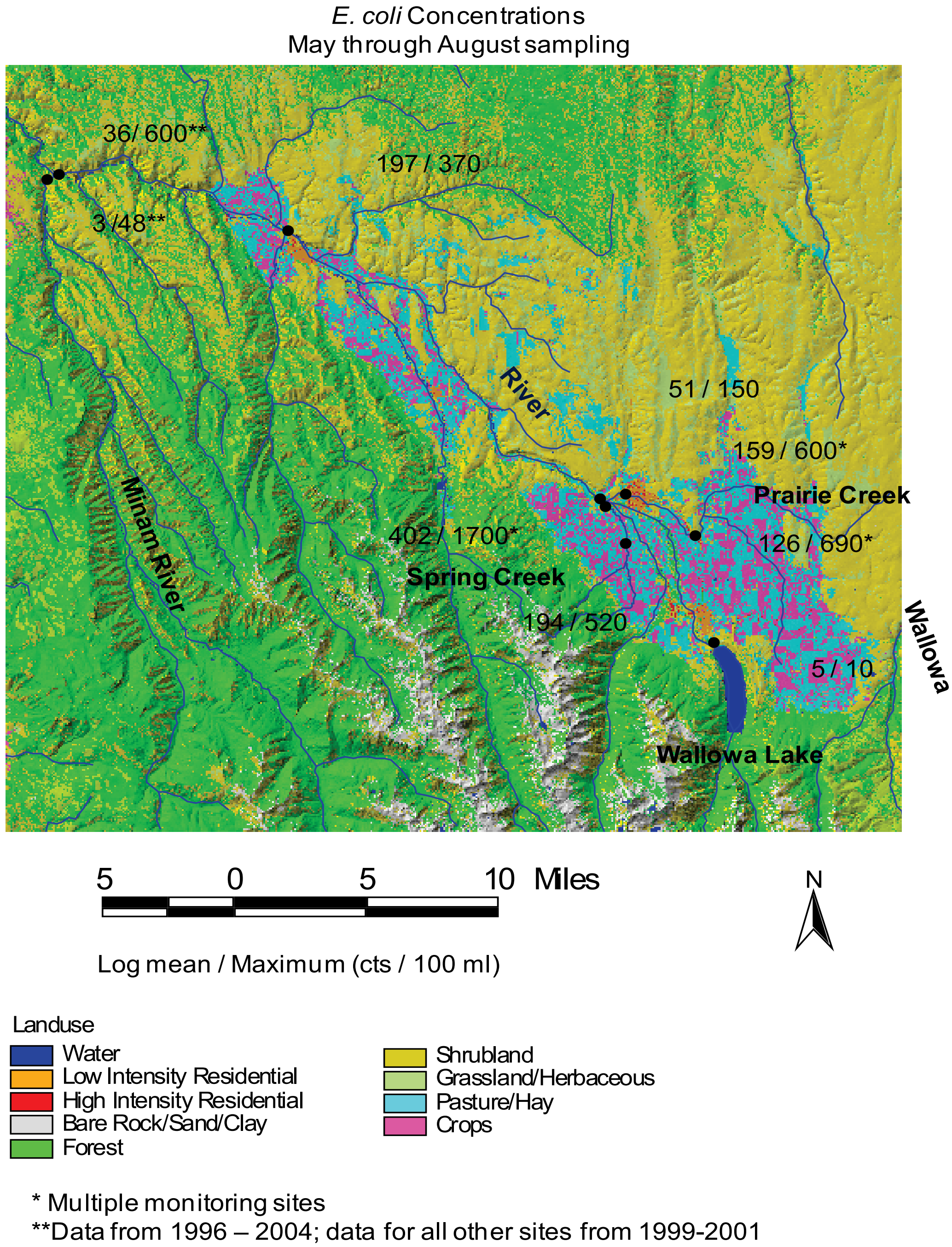
Table 3-4. Results of *E. coli* sampling conducted on the Wallowa and Minam Rivers from 1996 through 2004 and two tributaries to the Wallowa River in 1999-2001.

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 *E. coli*	# > 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 Eggleson 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



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 75^{th} and 25^{th} 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.

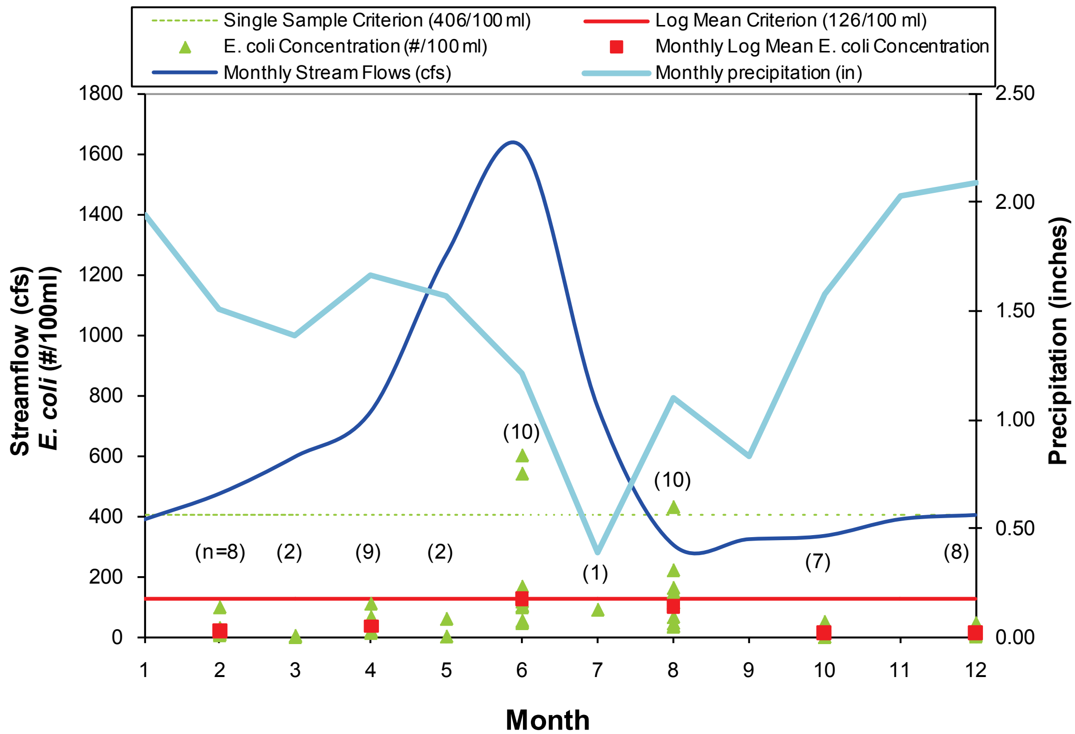
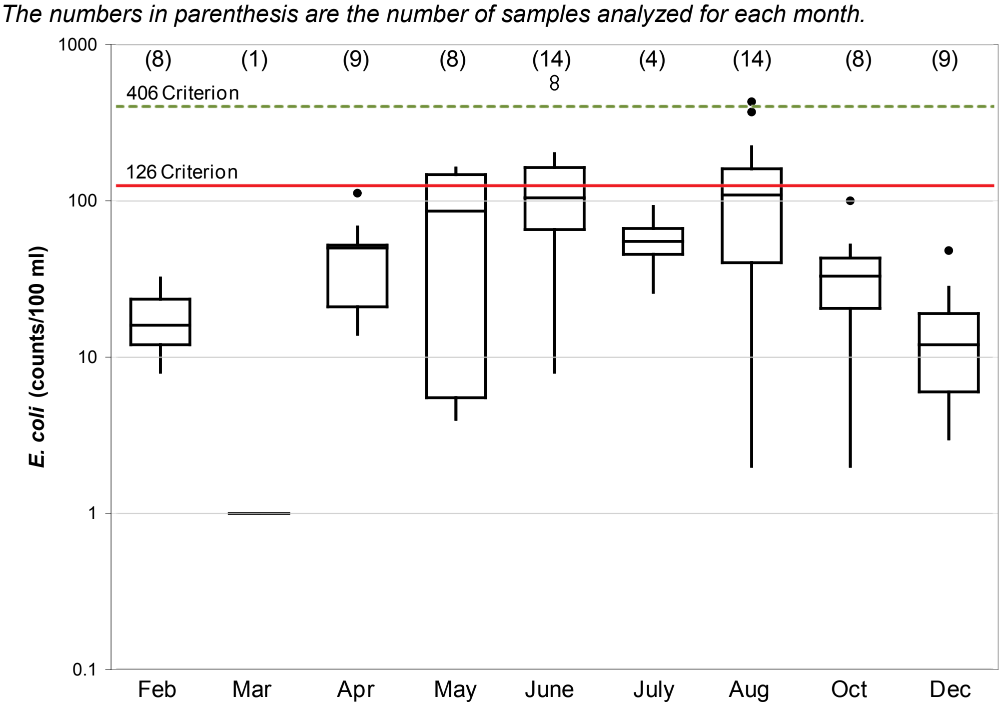


Figure 3-4. Monthly boxplot summary of E. coli concentrations including all monitoring sites on the Wallowa River (1996-2004)

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

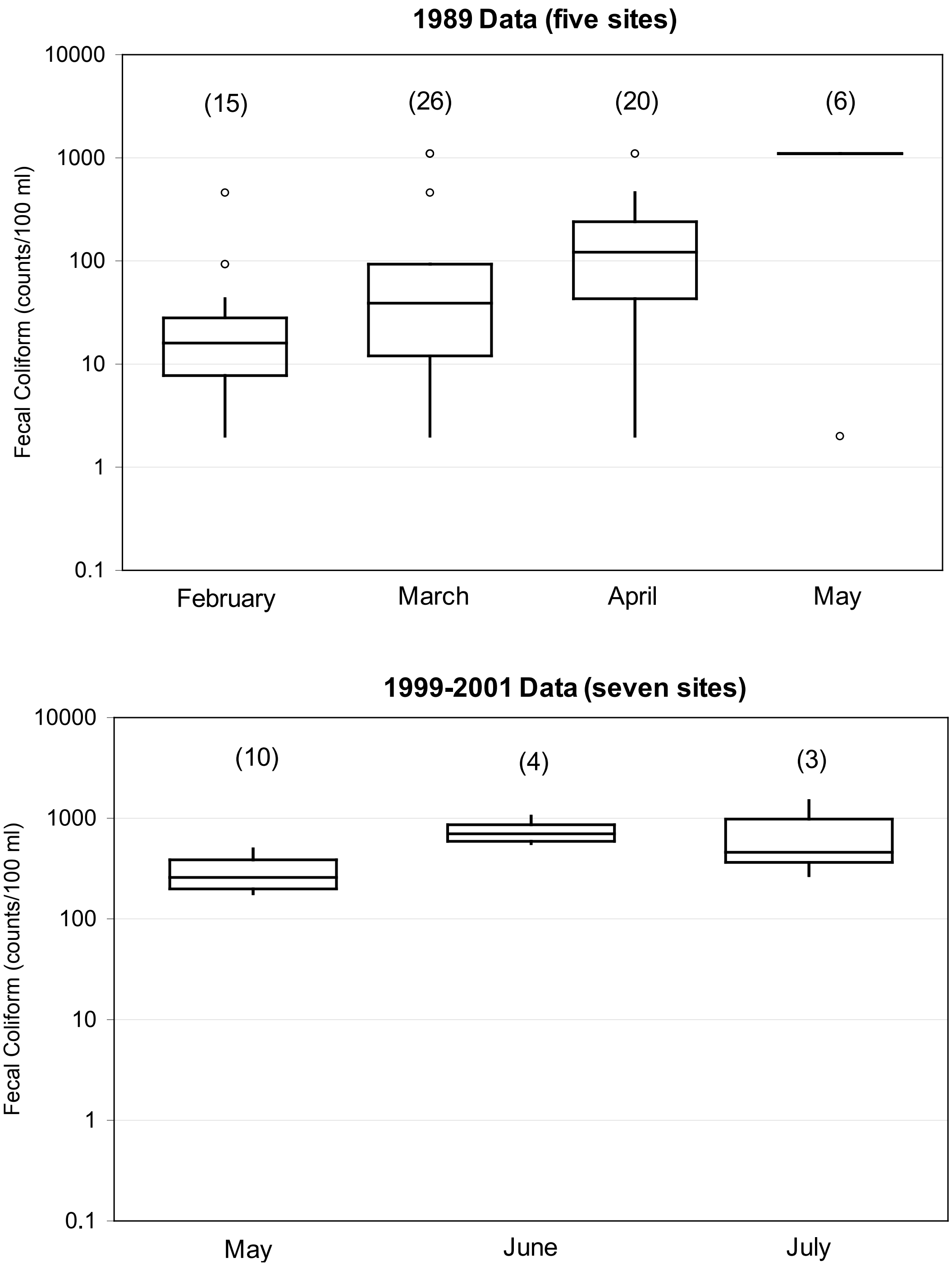
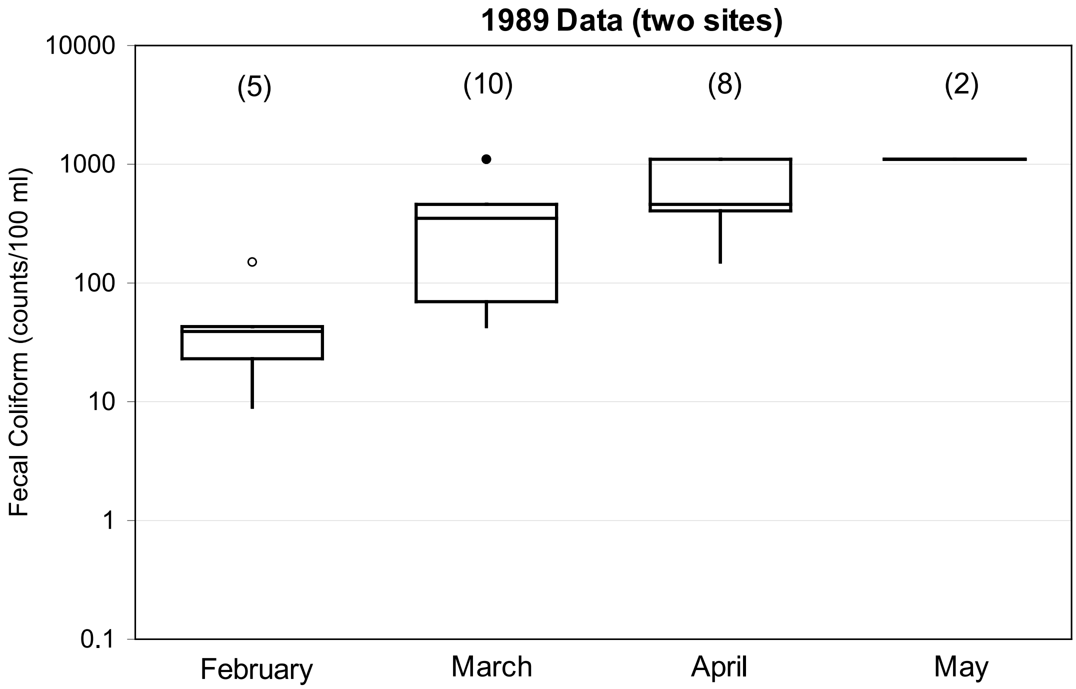
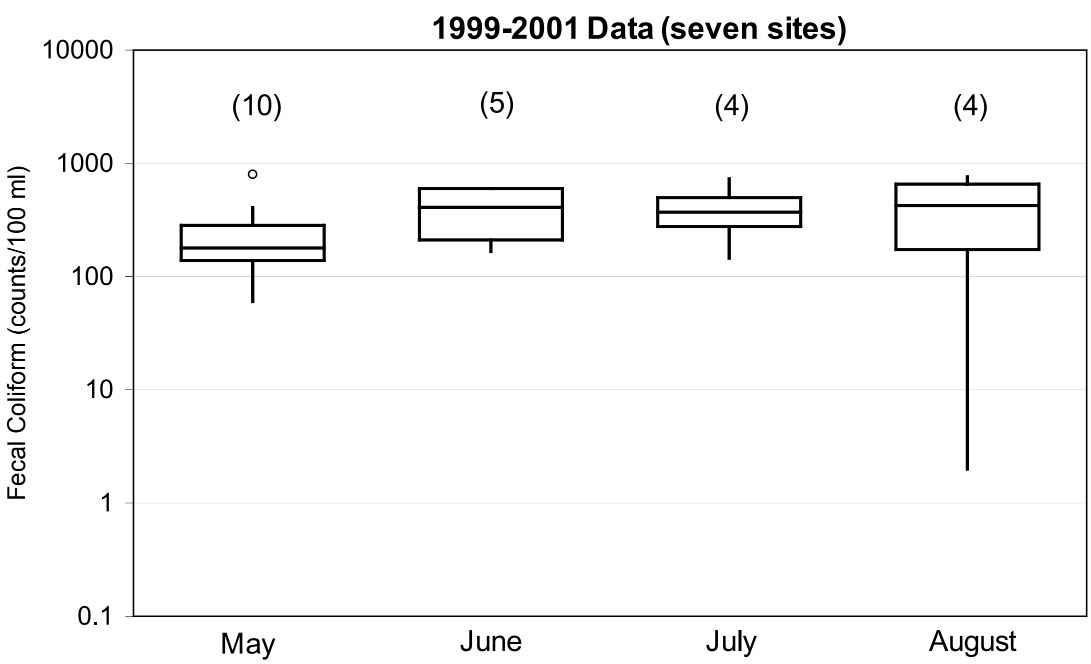


Figure 3-6. Seasonal fecal coliform concentrations in Prairie Creek, using data collected during bacteria studies in 1989 and 1999-2001





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

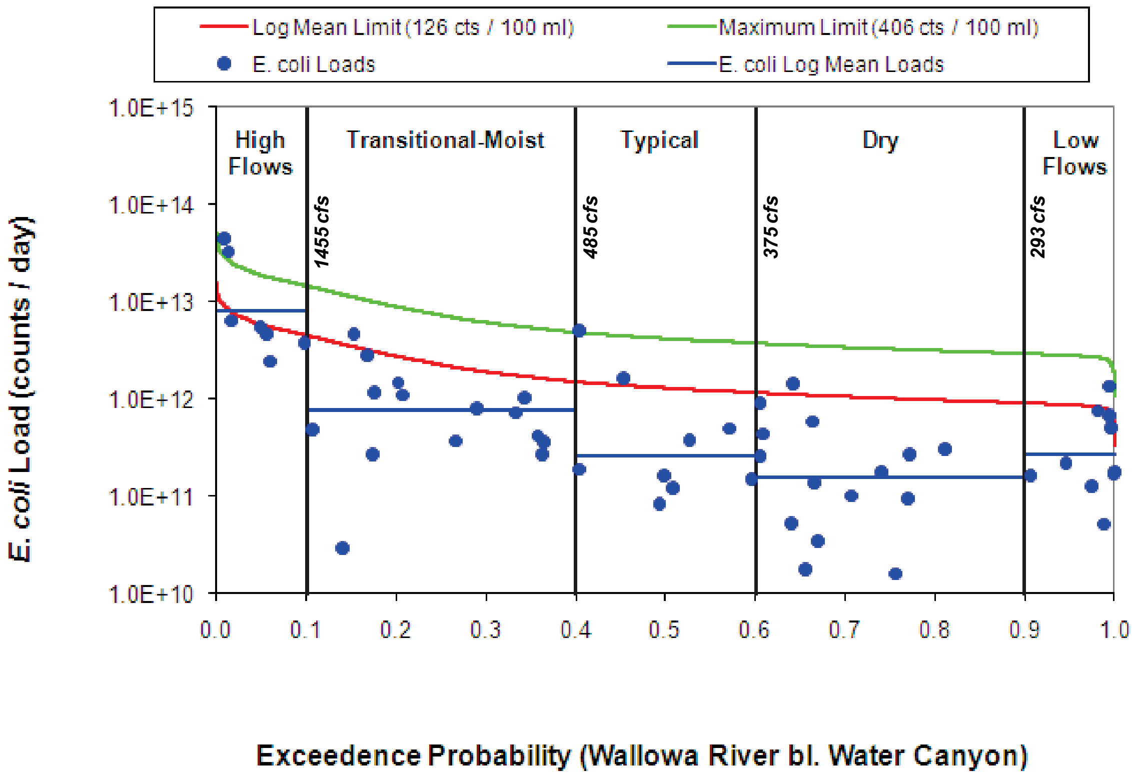
A load duration curve was developed for the Wallowa River as a method for assessing possible bacteria sources (**Figure 3-7**). The curve was developed using *E. coli* data from DEQ's ambient site at Minam (LASAR Site #10410) and flow data from the USGS gauge below Water Canyon (Gage #13331450). These 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

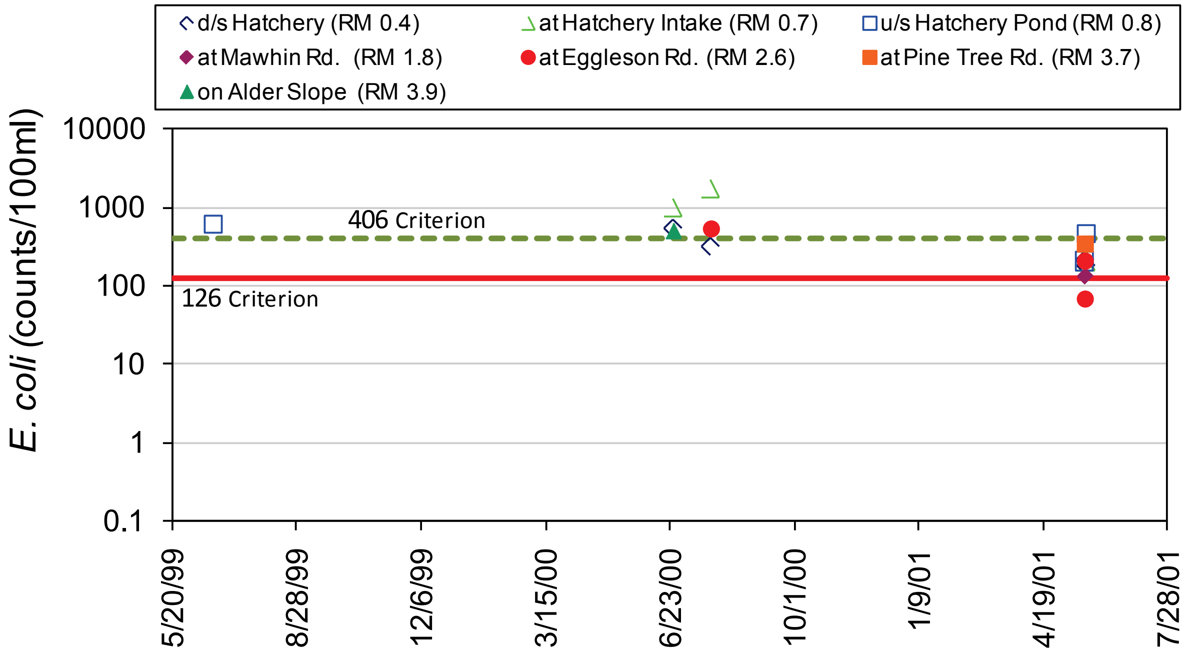
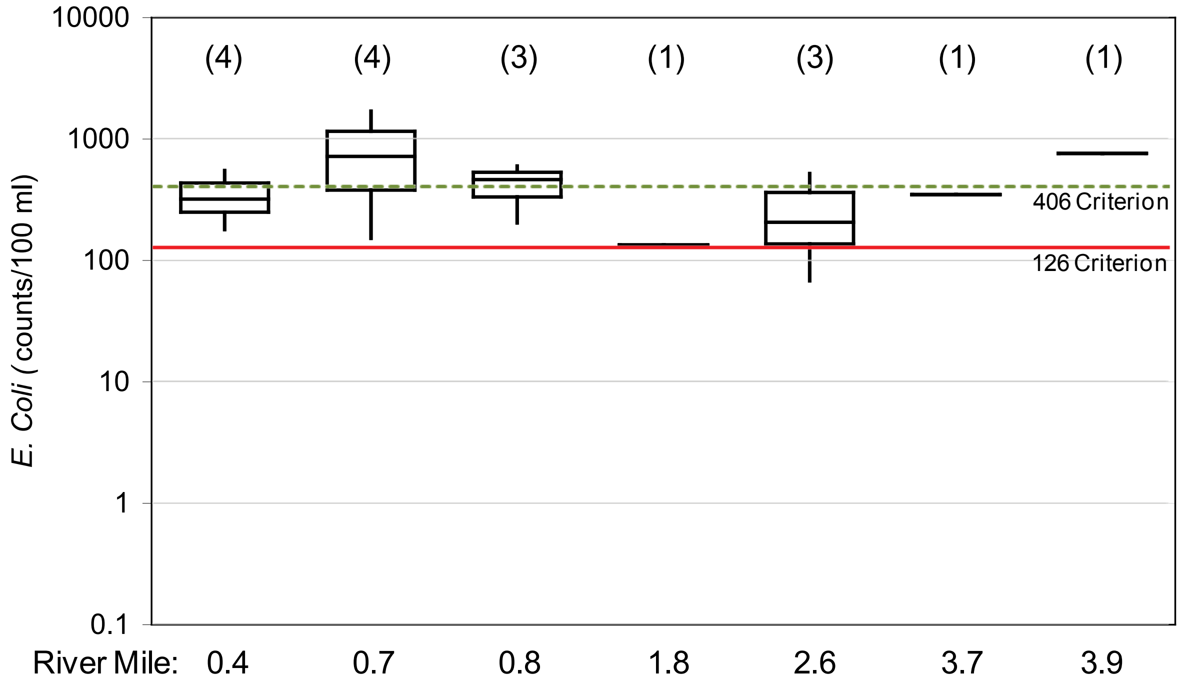


Figure 3-9. Longitudinal summary of E. coli concentrations at sites on Spring Creek from 1999 to 2001



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

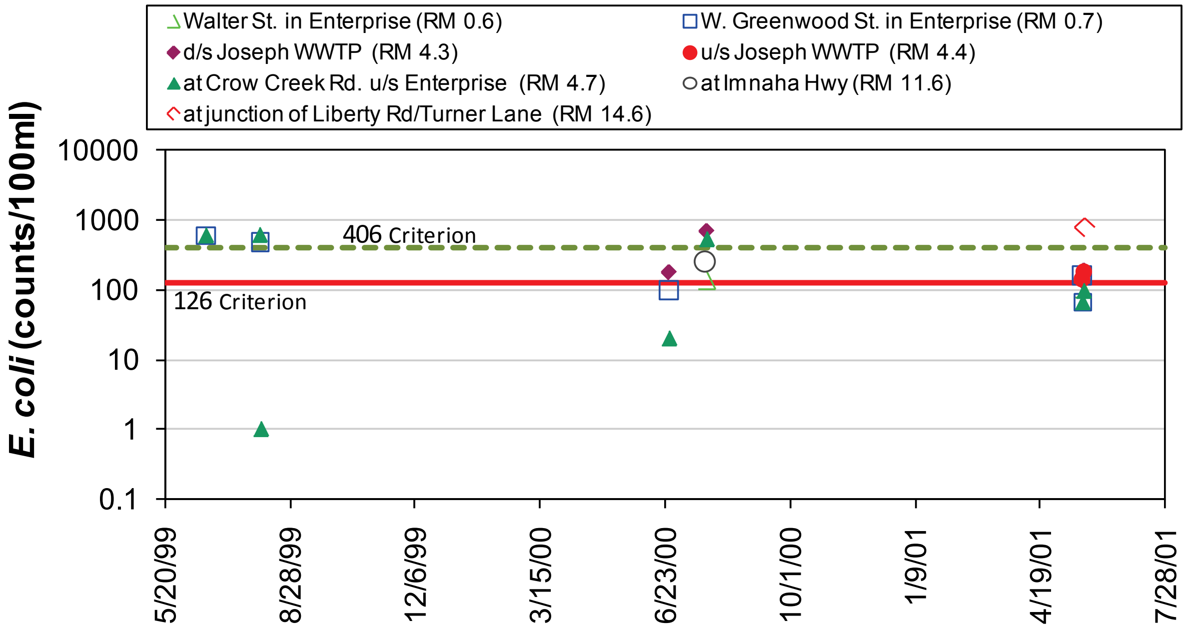
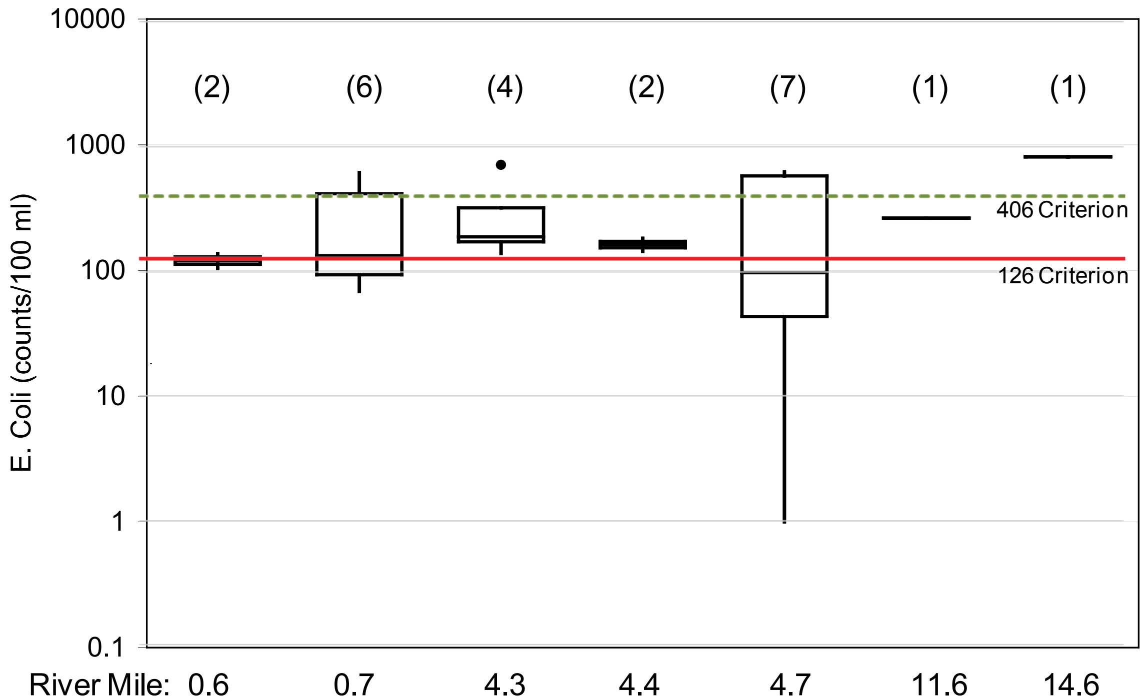


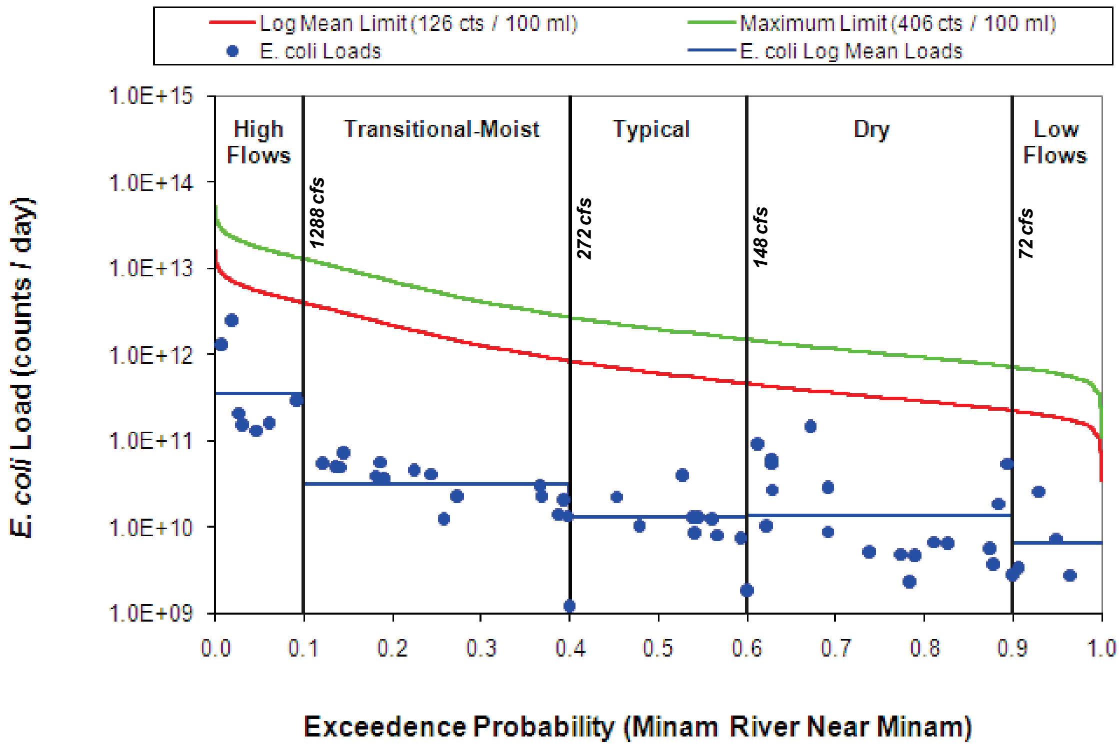
Figure 3-11. Longitudinal summary of E. coli concentrations at sites on Prairie Creek from 1999 to 2001



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.

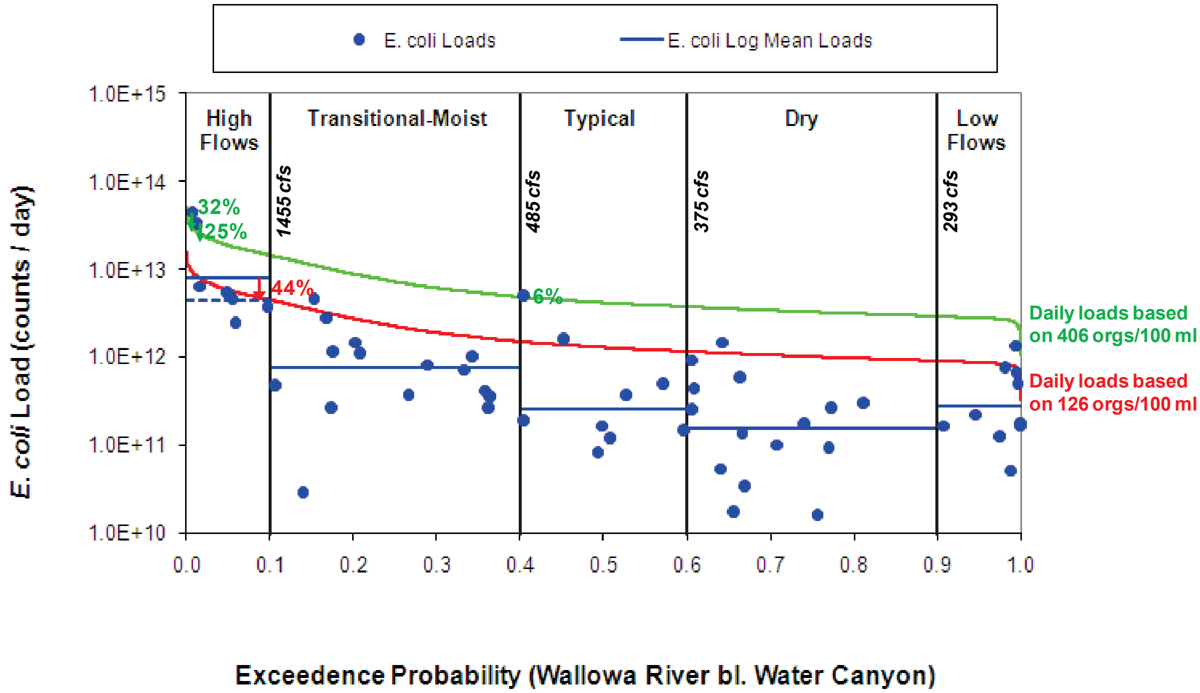
3.8.1 Loading Capacity

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



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 *E. coli* per 100 ml criterion)	4.48×10^{12}	1.49×10^{12}	1.16×10^{12}	9.03×10^{11}	4.78×10^{11}
Current Load (Org./day) (log mean of *E. coli* loads)	8.02×10^{12}	7.52×10^{11}	2.54×10^{11}	1.57×10^{11}	2.74×10^{11}
Percent Reduction needed to meet 126 *E. coli* 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 *E. coli*/100 ml criterion)	126	126
Highest observed concentration (organisms/100 ml) (log mean of *E. coli* organisms/100 ml)	341	153
Percent reduction needed to meet 126 *E. coli* per 100 ml criterion	63%	18%
Surrogate Loading Capacity (organisms/100 ml) (406 *E. coli*/100 ml criterion)	406	406
Highest observed concentration (organisms/100 ml) (maximum number of *E. coli*/100 ml)	1700	800
Percent reduction needed to meet 406 *E. coli* 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 *E. coli* per 100 ml criterion	44%	63%	18%	44%
Percent Reduction needed to meet 406 *E. coli* 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 use 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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LOWER GRANDE RONDE SUBBASINS TMDL
CHAPTER 4: WATER QUALITY MANAGEMENT PLAN

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4.1 INTRODUCTION

A Total Maximum Daily Load (TMDL) defines the amount of a pollutant that can be present in a water body while meeting water quality standards. A Water Quality Management Plan (WQMP) is developed by DEQ as a broad strategy for implementing TMDL allocations. TMDLs, WQMPs and associated planning work together to protect designated beneficial uses, such as aquatic life, drinking water supplies, and water contact recreation. These TMDLs and WQMP address the geographic area included in the Lower Grande Ronde Subbasins.

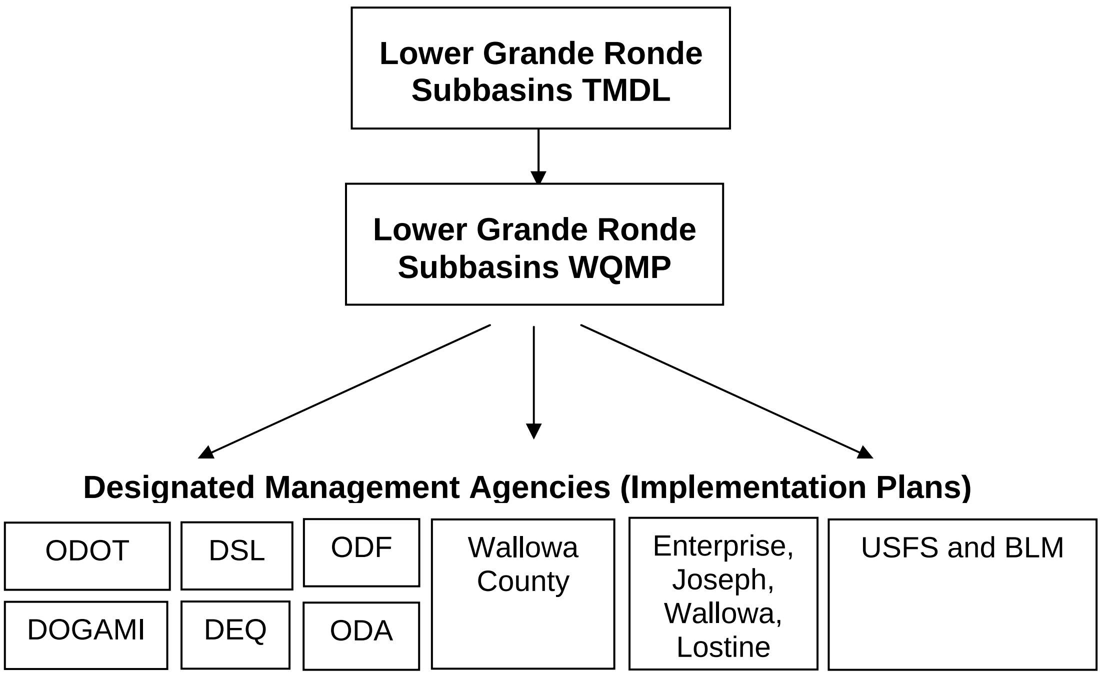
In December of 2002, the State of Oregon's Environmental Quality Commission (EQC) adopted a rule commonly referred to as the "TMDL rule" (OAR 340-042). The TMDL rule defines DEQ's responsibilities for developing, issuing, and implementing TMDLs as required by the federal Clean Water Act (CWA). The WQMP is one of the twelve TMDL elements called for in the TMDL rule. Oregon Administrative Rule 340-042-0040-(4)(l) states the following:

> *(l) Water quality management plan (WQMP). This element 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.*

Accordingly, implementation of this TMDL is addressed through two different scales of planning. The WQMP itself serves as a multi-sector framework plan for the area covered by the TMDLs. It describes and references various plans and programs that are specific to a given land use or management sector. The sector-specific plans, or *TMDL Implementation Plans*, comprise a second tier of planning prepared by the local land use or water quality authority (Designated Management Agencies). A Designated Management Agency (DMA) is defined in the TMDL Rule as "a federal, state or local governmental agency that has legal authority over a sector or source contributing pollutants, and is identified as such by the Department of Environmental Quality in a TMDL." This organizational process is represented schematically in **Figure 4-1**. Because the DMAs will require some time to fully develop these Implementation Plans once the TMDLs are finalized, the first iterations of the Implementation Plans are not expected to completely describe management efforts.

This WQMP establishes timelines to develop Implementation Plans. DEQ and the DMAs will work collaboratively to assure that the WQMP and TMDL Implementation Plans collectively address the elements described in **Section 4.2**. In short, this document is a starting point and foundation for the WQMP elements being developed by DEQ and the DMAs. If the Department identifies other responsible DMAs at a later time, then the DMA list will be revised. ***It should be noted that individual Implementation Plans are only referenced in this document; they are not attached as appendices.***

Figure 4-1. TMDL/WQMP/Implementation plan schematic



Agency abbreviations are for: Oregon Departments of Transportation (ODOT), Geology and Mine Industries (DOGAMI), State Lands (DSL), Environmental Quality (DEQ), Forestry (ODF) and Agriculture (ODA), US Forest Service (USFS) and Bureau of Land Management (BLM)

Nez Perce Tribe. The Nez Perce Tribe is not identified as a DMA in this WQMP. Tribal responsibility on ceded lands throughout the Lower Grande Ronde Subbasins is defined through their role as co-manager of the salmon resource which has been determined through treaty rights and federal court decisions. As a co-manager of these resources, the Tribe plays a central role in development and implementation of plans and projects designed to protect and enhance treaty-reserved resources, including salmon, steelhead, and other aquatic resources. Consultation and continued coordination with the Nez Perce Tribe will enhance the effective implementation of the TMDL

The Nez Perce Tribes have participated in the following planning processes which will assist in the implementation of TMDL goals:

1. *The Wallowa County-Nez Perce Salmon Habitat Recovery Plan with Multi-Species Habitat Strategy* (1999)
2. The Columbia River Inter-Tribal Fish Commission (CRITFC) Plan (1998), *Wy-Kan-Ush-Mi Wa-Kish-Wit, Spirit of the Salmon, The Columbia River Anadromous Fish Restoration Plan of the Nez Perce, Umatilla, Warm Springs and Yakama Tribes*
3. The Northwest Power and Conservation Council's Subbasin Planning process.

In the 1990s, staff from the Nez Perce Department of Fisheries Restoration Management played an important role in developing the *Wallowa County-Nez Perce Salmon Habitat Recovery Plan with Multi-Species Habitat Strategy* (*SHRP*). A committee consisting of Wallowa County citizens, agency professionals and the Nez Perce Tribe worked together to prepare the Plan which has the laudable mission to "…develop a management plan to assure that watershed conditions in Wallowa County provide the spawning, rearing, and migration habitat required to assist in the recovery of Snake River salmonids by protecting and enhancing conditions as needed." A more in-depth discussion of the SHRP is included in **Element H** of **Section 4.2**.

In 1995 CRITFC and the four Columbia Basin treaty-tribes (the Nez Perce, Umatilla, Warm Springs, and Yakama Tribes) took the initiative to develop and implement, *Wy-Kan-Ush-Mi Wa-Kish-Wit*, a cooperative plan to restore the fisheries resource in the Columbia River Basin above Bonneville Dam. This Restoration Plan stresses the importance of healthy connected riparian habitat for restoration of anadromous fish populations. *Wy-Kan-Ush-Mi Wa-Kish-Wit* identifies the watershed needs for 23 subbasins including the Grande Ronde (including the Wallowa) and Imnaha subbasins. The Grande Ronde plan states the need for water quality improvement such as increasing near stream land cover to reduce stream heating and reduction of sediment, nutrients and bacteria sources. The Imnaha plan includes recommended actions to mitigate problems such as sediment, limited large woody debris and loss of riparian vegetation.

The Nez Perce Tribe was also a partner in the subbasin planning that took place throughout the Columbia River Basin and was completed in 2005. The subbasin planning process was initiated by the Northwest Power and Conservation Council's 2000 Fish and Wildlife Program. The Council is responsible for mitigating the impact of hydropower dams on fish and wildlife in the Columbia River Basin. The program complements a basin-wide fish and wildlife vision with biological objectives and action strategies. The program will be implemented through locally developed subbasin plans that will be consistent with the basin-wide vision and objectives and its underlying foundation in ecological science. In the area covered by the Lower Grande Ronde Subbasins TMDLs, plans were developed for the Grande Ronde Subbasin and the Imnaha Subbaasin (Northwest Power and Planning Conservation Council, 2005a and 2005b). The Nez Perce were the lead agency in the Imnaha Subbasin planning effort. The Tribe has demonstrated commitment to seeing the principles and priorities developed in the subbasin planning incorporated into on the ground land management strategies and practices.

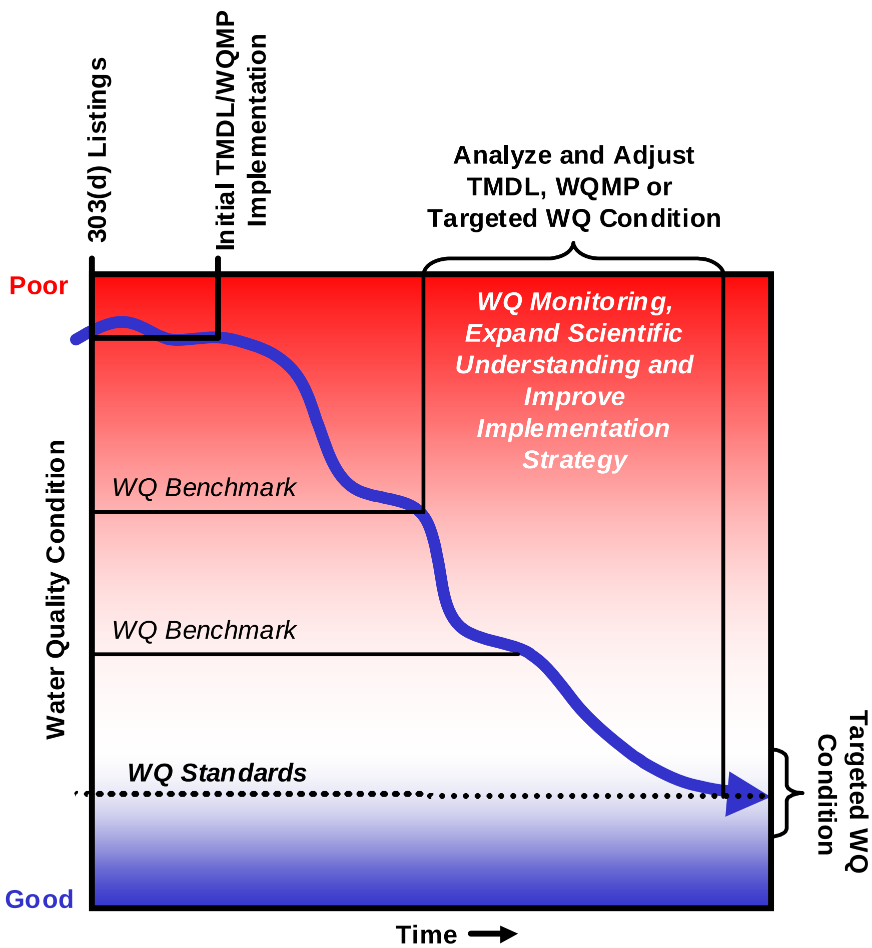
4.1.1 Adaptive Management

DEQ recognizes that the relationship between management actions and pollutant load reductions is often not precisely quantifiable. DEQ applies an *adaptive management* policy to implement TMDLs. *Adaptive management can be defined as a systematic process for continually improving management policies and practices by learning from the outcomes of operational programs.* In employing an adaptive management approach to the TMDLs and the WQMP, DEQ has the following expectations and intentions:

- In the short term, the DEQ anticipates reviewing TMDL and WQMP progress on an "as needed" basis. DEQ resources are currently concentrating efforts on completing TMDL development throughout the state.
- In conducting its review DEQ will evaluate progress towards achieving the TMDLs (and water quality standards) and the success of implementing the WQMP.
- DEQ expects that each DMA will also monitor and document its progress in implementing the provisions of its implementation plan. This information should be provided to DEQ for its use in reviewing the TMDL.
- As implementation of the WQMP and the associated implementation plans proceeds, DEQ expects that DMAs will develop benchmarks for attainment of TMDL surrogates that can then be used to measure progress.
- Where performance of the implementation plans or effectiveness of management techniques is found to be inadequate, DEQ expects the DMAs to revise their plan components to address the deficiencies.
- When DEQ in consultation with the DMAs, concludes that all feasible steps have been taken to meet the TMDL, its associated surrogates and water quality standards, and that the TMDL or the associated surrogates and standards are not practicable, the TMDL may be reopened and revised it as appropriate.
- DEQ will consider reopening the TMDL should new information become available indicating that the TMDL or its associated surrogates need revision.

Figure 4-2 is a graphical representation of this adaptive management concept.

Figure 4-2. Adaptive management - schematic diagram



4.1.2 TMDL Implementation Discussion

The Clean Water Act and related Oregon Administrative Rules (OARs) target water quality standards attainment or that all feasible steps will be taken towards achieving the highest quality water possible. The Lower Grande Ronde Subbasins TMDLs establish numerical loadings to limit pollutant levels in order to achieve water quality standards.

Existing water quality conditions in the Subbasins are expressions of hundreds of years of natural disturbance and human activities. Reversing these conditions may take decades of concerted stakeholder efforts before approaching the desired TMDL goals. In order to achieve the desired water quality conditions as quickly as possible, implementation strategies need to commence as quickly as possible. Some of the factors to be considered for the lengthy recovery time are:

- Complex natural systems (ecology, stream hydrology, channel morphology) recover slowly.
- Despite the best and most sincere efforts, natural disturbance events beyond the control of humans may interfere with or delay attainment of the TMDL and/or its associated surrogates. Such events

may include: floods, fire, insect infestations, and drought. DMAs will not be considered out of compliance with the TMDLs due to the effects of natural disturbances.

- System loadings are calculated using mathematical models and other analytical techniques designed to simulate and/or predict extremely complex physical, chemical and biological processes. DEQ uses the best data and pollutant loading estimates that are currently available, however the models and techniques are simplifications of extremely complex processes. As such, they are "best estimates" of how waterways in the Lower Grande Ronde Subbasins will respond to WQMP implementation measures.
- Building stakeholder acceptance and program support through education and outreach programs takes time.
- Technological controls for nonpoint source pollution are evolving. It may take one or more iterations to develop effective pollution abatement techniques.
- New information or analytical techniques may trigger the need to revise the TMDL and/or water quality goals.
- It is possible that after executing all reasonable best management practices, some TMDLs cannot be met.

TMDL Implementation Compliance and Enforcement:
TMDL implementation is generally enforceable by DEQ, other state and federal agencies, and by local government. However, it is envisioned that sufficient initiative exists to achieve water quality goals with minimal enforcement. Should the need for additional effort emerge, it is expected that the responsible agency will work with land managers using education, technical support or enforcement. Instances of inadequate action towards progress may necessitate the need for enforcement. This could occur first through direct intervention from land management agencies (e.g. ODF, ODA, counties, and cities), and secondarily from DEQ. The latter may be based on DEQ orders to implement management goals leading to water quality standards.

It is important to note that:

- *The DEQ considers a nonpoint source found to be in compliance with its approved implementation plan to be in compliance with the TMDL. Nonpoint sources will not be considered out of compliance with the TMDL due to the effects of natural disturbances.*
- *If the WQMP has been fully implemented, all feasible management practices have yielded maximum expected effects, and the TMDL or its interim targets have not been achieved, then the DEQ will reopen the TMDL and adjust it or its interim targets as necessary.*

4.2 TMDL WATER QUALITY MANAGEMENT PLAN AND IMPLEMENTATION PLAN GUIDANCE

On December 12, 2002, the State of Oregon's Environmental Quality Commission adopted rules (Oregon Administrative Rules (OAR 340-042) establishing procedures for developing, issuing and implementing TMDLs as required by the Federal Clean Water Act. The rules include a list of the required WQMP elements. These elements serve as the framework for this WQMP and are listed below.

Water Quality Management Plan Elements per OAR 340-042 0040(4)(l)

A. Condition assessment and problem description
B. Goals and objectives
C. Proposed management strategies
D. Timeline for implementing management strategies
E. Relationship of management measures to attainment of water quality standards
F. Timeline for attainment of water quality standards

G. Identification of responsible participants, including DMAs
H. Identification of sector-specific implementation plans
I. Schedule for preparation and submission of implementation plans
J. Reasonable assurance
K. Monitoring and evaluation
L. Public involvement
M. Planned efforts to maintain management efforts over time
N. Costs and funding
O. Citation to legal authorities

The following sections A-O provide a further discussion of each of these WQMP elements.

TMDL Implementation Plan – Expected Components

Some of the elements listed above are sufficiently addressed in the WQMP and others are partly or largely deferred to the DMA programs. The Oregon Administrative Rules in OAR 340-042 clarify DEQ's expectation of TMDL Implementation Plan content, as follows:

> 340-042-0080(2): "The Oregon Department of Forestry will develop and enforce Implementation Plans addressing state and private forestry sources as authorized by ORS 527.610 through 527.992 and according to OAR chapter 629, divisions 600 through 665. The Oregon Department of Agriculture will develop Implementation Plans for agricultural activities and soil erosion and enforce associated rules as authorized by ORS 568.900 through 568.933 and according to OAR chapter 603, divisions 90 and 95."
>
> 340-042-0080(3): "Persons, including DMAs other than the Oregon Department of Forestry or the Oregon Department of Agriculture, identified in a WQMP as responsible for developing and revising sector-specific or source-specific Implementation Plans must:
>
> (a) Prepare an Implementation Plan and submit the plan to DEQ for review and approval according to the schedule specified in the WQMP. The Implementation Plan must:
>
>> (A) Identify the management strategies the DMA or other responsible person will use to achieve load allocations and reduce pollutant loading;
>>
>> (B) Provide a timeline for implementing management strategies and a schedule for completing measurable milestones;
>>
>> (C) Provide for performance monitoring with a plan for periodic review and revision of the Implementation Plan;
>>
>> (D) To the extent required by ORS 197.180 and OAR chapter 340, division 18, provide evidence of compliance with applicable statewide land use requirements; and
>>
>> (E) Provide any other analyses or information specified in the WQMP.
>
> (b) Implement and revise the plan as needed.

General discussion of the expected content of TMDL Implementation Plans can be found in *TMDL Implementation Plan Guidance (*DEQ, 2007a). DEQ also has a portion of its website devoted to TMDL Implementation Guidelines and Tools (http://www.deq.state.or.us/wq/TMDLs/implementation.htm). There are guidance documents provided here, such as the *Water Quality Model Code and Guide Book* (DEQ and Oregon Department of Land Conservation and Development, 2000), as well as examples of TMDL Implementation Plans. DEQ expects Implementation Plans to be submitted within 18 months of the issuance of the TMDL.

(A) Condition Assessment and Problem Description

A detailed condition assessment and problem description are provided in the preceding chapters of this document. In brief, the primary issue of concern is that the water quality standards are not being met perennially in portions of the Lower Grande Ronde Subbasins (which includes the Imnaha River Subbasin, the Wallowa River Subbasin and the Lower Grande Ronde Subbasin). **Table 4-1** summarizes the status of 303(d) listings in the three subbasins covered by the TMDLs included in this document.

Table 4-1. Lower Grande Ronde Subbasins streams on the 303(d) List addressed by 2009 TMDLs
For each parameter, the table shows number of listed miles and number of listed segments (x).

Parameter	Wallowa Subbasin	Lower Grande Ronde Subbasin	Imnaha Subbasin	Total
Temperature – Rearing & Migration		235.3 (12)	105.1 (5)	340.4 (17)
Temperature – Spawning	15.7 (3)	3.6 (1)	24.3 (2)	43.6 (6)
Temperature – Core Cold Water	90.1 (5)	11.7 (2)	24.2 (2)	126.0 (9)
Temperature – Bull Trout	18.2 (2)		47.9 (4)	66.1 (6)
E. coli – Summer	64.9 (3)			64.9 (3)
Fecal coliform – Fall, Winter, Spring	17.0 (2)			17.0 (2)
Fecal coliform – Summer	50.0 (1)			50.0 (1)
Total Stream Miles with One or More Listings*	129.2	246.6	177.2	

*Streams with more than one listing were counted only once in the total stream miles.

A description of the lower Grande Ronde Subbasins is provided in **Chapter 1** of this document**.** **Chapter 2** provides a condition assessment for temperature. The biologically-based numeric temperature criteria are exceeded throughout much of the stream network in all three subbasins. Surface water temperatures in the Lower Grande Ronde Subbasins are heavily influenced by human activities. Specifically, elevated summertime stream temperatures attributed to human activities may result from the following conditions:

- Riparian vegetation disturbance that reduces stream surface shading, riparian vegetation height, and riparian vegetation density (shade is commonly measured as percent effective shade);
- Channel widening (increased width to depth ratios) due to factors such as loss of riparian vegetation that increases the stream surface area exposed to energy processes, namely solar radiation;
- Reduced flow volumes (from irrigation, industrial, and municipal withdrawals)
- Increased high temperature discharges from point sources or from irrigation return flows; and
- Disconnected floodplains which prevent/reduce groundwater discharge into the river.

Chapter 3 provides a condition assessment for bacteria. Violations of the State's bacteria standard have been observed in the Wallowa River, Spring Creek and Prairie Creek in the Wallowa River Subbasin. Potential fecal bacteria sources include livestock waste, failing residential septic systems, wastewater treatment plants, pets, and illegal discharges. Although there a variety of possible sources of bacteria, the assessment provided in the TMDL and in the Wallowa County-Nez Perce *SHRP* (1999) indicates that a likely source of bacterial contamination in the Wallowa River valley appears to be from livestock feed lots and associated pastures. This contamination could enter streams either through runoff or through irrigation return flows. The Wallowa River Valley is home to the majority of human population and agricultural industry in the Lower Grande Ronde Subbasins. Although there is considerable livestock grazing in other parts of the subbasin (i.e., Imnaha and Lower Grande Ronde Subbasins), at present no data is available to demonstrate a consistent violation of water quality standards for fecal bacteria in these areas. 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.

(B) Goals and Objectives

The overall goal of this WQMP is to provide a mechanism to achieve compliance with water quality standards for each of the 303(d) listed parameters and streams in the Lower Grande Ronde Subbasins. Specifically, the WQMP describes all DMA Implementation Plans that are or will be in place to reduce nonpoint source discharges to the level of the load allocations and point source discharges to the level of the waste load allocations described in the TMDLs. This WQMP is preliminary in nature and is designed to be adaptive as more information is gained regarding the pollutants, allocations, management measures, and other related areas.

(C) Proposed Management Strategies

DEQ acknowledges that restoration and conservation planning and implementation has already commenced, in a manner supportive of TMDL attainment. And, in much of the Subbasins, more restoration is needed and long term planning should provide for maintenance of effort over time, including areas where load allocations are currently being met. As described previously, DEQ is reliant on the DMAs for programs and projects providing strategies to minimize stream heating and reduce bacteria inputs. Management strategies should include outreach, effectiveness monitoring and inventory and tracking of water quality management practices. Implementation Plans should identify targeted TMDL allocations and the sources of water quality impairment addressed by proposed measures.

A list of conditions for management agencies to target is described below, although this list is not exhaustive. Many of these suggested measures are discussed further in the Wallowa County-Nez Perce *SHRP* (1999) in the Stream Analysis Section, with management suggestions made on a reach-by-reach basis. In addition, Appendix B of the SHRP includes a Problems/Solutions Summary that includes specific guidance on management measures that can be used to address a number of water quantity, water quality, and stream structure issues.

Stream Temperature:

- Riparian Restoration. Healthy riparian vegetation is needed, including shade producing types. There is potential for continuous stands of riparian trees and herbaceous vegetation along most of the Subbasins perennial streams, though in some situations this will require considerable evolution in channel shape. DEQ realizes this could take decades. System potential shade producing vegetation is described and referenced in **Section A2.3.5** of **Appendix A**. Although DEQ does not specify required vegetation types, the TMDL does require a level of heat reduction that is dependent on the height and density of riparian vegetation and is reflective of system potential vegetation communities. For overall ecological benefits and consistency with programs directed to fish and wildlife habitat restoration, native vegetation is generally optimal. Passive or active restoration of riparian vegetation could be applied. In some cases, the necessary riparian vegetation may already be present, but more time is needed for the vegetation to mature. In other cases, active vegetation planting and/or stream fencing may be required.

- Stream flow. Increased instream flow, where depleted, will ultimately be needed to achieve the water quality standard for temperature. Increasing stream flow can be achieved by a variety of specific management measures, including: improving irrigation efficiency and allowing conserved water to be used for instream purposes, leasing instream water during minimum flow times, and reducing diversions. Note that the TMDL calls for heat reduction, and although restored flow levels will help achieve this goal, increased flow is not required by the TMDL.

- Channel Condition. A stable and natural channel form will typically be narrower and/or more complex than the existing state for many streams in the Subbasins. Passive or active restoration could be applied. Increased sinuosity will lead to attainment of a more natural channel width/depth, as will restoration of the length and complexity of the stream channel. Removal of levees, dikes, berms, weirs or other water control structures could be helpful for naturalizing channels, as could removing structural bank protections.

- Upland Management. Upland management that reduces erosion and sediment runoff will support attainment of a more natural channel form. Retaining adequate watershed vegetation can also reduce rapid surface runoff and promote infiltration and aquifer recharge which can increase groundwater flows into some streams. Finally, maintaining healthy watershed conditions by reducing fuel loads can help provide an optimal, sustainable supply of water.

- Irrigation Return Flows. Limiting irrigation return flows of warm water can also help meet the heat reduction called for in the TMDL.

Bacteria: Based on the bacteria assessment of the Wallowa Subbasin provided in the TMDL, one of the most likely sources of excess bacterial contamination comes from feedlots and associated pastures. Senate Bill 1010 is the process used by the Oregon Department of Agriculture (ODA) to address nonpoint source water quality issues on agricultural lands. Once load allocations are finalized, it will be ODA's responsibility to ensure that implementation of the Agricultural Water Quality Management Area Plan will result in the achievement of the load allocation. ODA also administers the CAFO program which regulates concentrated animal operations through a general NPDES permit. The general permit prohibits discharge of CAFO wastes to waterbodies.

Septic systems and urban/suburban stormwater runoff are other possible sources of bacterial contamination within the Subbasins. While the data evaluated in this TMDL did not indicate these were a likely source of bacteria in the Wallowa River, they might be in other areas. On-site septic systems in Wallowa County are regulated by DEQ. Management of stormwater runoff falls under the jurisdictions of Wallowa County and local municipalities.

Best management practices addressing bacterial reductions should be applied through the watershed, particularly along the major waterways. Example management strategies include:

- Livestock fencing of riparian areas
- Re-location of animal feedlots that are near streams, providing off-channel watering and feeding
- Providing wetlands and/or filter strips to improve quality of feedlot runoff
- Limiting irrigation return flows of water which contain bacterial contamination
- Further evaluation of possible effects of leaking septic systems and/or stormwater runoff on stream water quality
- Conduct on-site septic systems inspection and maintenance
- Implement stormwater BMPs to promote infiltration, filtration, retention, and detention
- Perform routine maintenance of stormwater systems
- Continued monitoring by point sources to ensure compliance with the terms of their permits and water quality standards.
- Outreach and education

(D) Timeline for Implementing Management Strategies

Individual DMA-specific Implementation Plans will address timelines for completing measurable milestones as appropriate. Timelines should be as specific as possible and should include a schedule for BMP installation and/or evaluation, monitoring schedules, reporting dates and milestones for evaluating progress. Time frames for TMDL attainment and Implementation Plan submittal are addressed in **Elements F** and **I** below. NPDES permits are scheduled for re-evaluation/issuance every five years. New and renewed permits will incorporate TMDL wasteload allocations.

DEQ recognizes that natural resource organizations, local jurisdictions and landowners have been active in watershed restoration both directly and through outreach. This report does not attempt a timeline for addressing the many ongoing and voluntary efforts.

(E) Relationship of Management Measures to Attainment of Water Quality Standards

For point sources of pollution, ODEQ will issue permits that include specific discharge limitations and compliance schedules that ensure wasteload allocations and water quality standards are met or will be attained within a reasonable timeline. Permits are reviewed and renewed on a five-year cycle. The CAFO general permit is also renewed on a five-year cycle, with the current permit expiring in 2014.

For nonpoint sources of pollution, DMA-specific Implementation Plans will include specific management strategies and timelines. It is expected that the management measures within each Implementation Plan will be directly linked to the reduction of pollutant loading and attainment of water quality standards. DMAs are expected to prepare an annual report and undertake an evaluation of the effectiveness of their plans every five years to gauge progress toward attaining water quality standards. If it is determined that an Implementation Plan is not sufficient to achieve the load allocation, the DMA will be required to revise the plan accordingly. All of these actions, taken together, will target attainment of water quality standards.

The objective of the Temperature TMDL is the attainment of natural thermal potential conditions that will result when solar heating is reduced to the level of the load allocations, as accomplished by improving vegetation, channel and flow conditions. **Chapter 2** of this document (Temperature TMDL) and **Appendix A** provide a discussion on the relationship among riparian vegetation, channel morphology, and flow management measures and their affect on temperature. Management strategies should be clearly linked to the load allocations and their surrogates.

As discussed in **Chapter 3** of this document (Bacteria TMDL) and **Element C** above, attainment of water quality standards for bacteria will primarily rely on reducing bacteria delivered to streams by various means including riparian protection, erosion control and stormwater control and treatment, low impact development, various agriculture and irrigation practices, and through implementation of the Agricultural Water Quality Management Area Plan, accompanied by long term monitoring.

(F) Timeline for Attainment of Water Quality Standards

The timeline for attainment is not explicit and will vary across the Subbasins and by pollutant. DEQ recognizes that where implementation involves significant habitat restoration or reforestation, water quality standards may not be met for decades. In addition, DEQ recognizes that technology for controlling nonpoint source pollution is, in some cases, in the development stages and will likely take one or more revisions to develop effective techniques. DEQ does expect that water quality standards will be attained as soon as feasible given technical, political, and economic constraints.

The time span for attainment of the natural conditions criterion for temperature relies on reductions in nonpoint source heat input. Modeling indicates that both vegetation and flow can have dramatic effects on heat reduction, depending on the stream. For vegetation, once passive or active restoration is underway and larger vegetation begins to establish, substantial improvement could take place in one to three decades. For flow, substantial improvements could be seen within a single year’s time with the restoration of instream flows to a natural condition. Bacteria reduction is generally correlated to the emplacement of strategic management practices, and dramatic improvements can take place within a single year’s time.

DMAs are expected to provide time-lines for TMDL implementation efforts, to the extent feasible. In subsequent TMDL and Implementation Plan review, this should enable further estimation of time frames for water quality standard attainment.

(G) Identification of Responsible Participants, including DMAs

While everyone living in the Subbasins share responsibility for preventing water pollution, certain entities are recognized under this TMDL as having specific responsibilities for implementing this TMDL and are required to take necessary actions to meet their assigned load and wasteload allocations. This section identifies the DMAs responsible for implementing management strategies and developing and revising sector-specific or source-specific Implementation Plans to accomplish that. Implementation Plans are expected to cover all lands and activities which impact stream heating or bacterial loading within the geographic area covered by the TMDL. A more detailed discussion of each organization's responsibilities is provided in **Element H**. DMAs are not responsible for controlling pollution arising from land use activities occurring outside of their area of jurisdictional authority. Nor are they responsible for controlling stream heating that occurs as the result of natural disturbances.

Although they are not named as DMAs at this time, irrigation districts and ditch associations have been identified as a sector which potentially contributes pollutants to waterbodes in the Lower Grande Ronde Subbasins. Irrigation districts and ditch associations control operations related to irrigation water transport and delivery. Their operations are considered nonpoint sources that have the potential to influence the quantity and timing of both heat and bacteria delivery to downstream river reaches. While irrigation district and ditch association operations themselves are not primary sources of fecal bacteria, the laterals and canals that are used to convey water can play a major role in transporting bacterial contamination across the landscape and into surface waters. Water travelling through the laterals and canals also has the potential to heat up, introducing warm waters to streams as return flow.

Irrigation districts and ditch associations are encouraged to implement best management practices. To reduce the potential of polluted return flows, districts/associations may contact users directly or work in conjunction with ODA and the SWCD to inform irrigation users of effective irrigation practices, manure management and other practices to keep fecal organisms and heat out of the irrigation system and out of surface waters. If data becomes available at a later date which indicates that the canals and laterals are a source of pollution, the irrigation districts and/or ditch associations may be designated as DMAs at that time and be required to develop Implementation Plans that will achieve the load allocations established by the TMDLs.

The following is a list of DMAs for the Lower Grande Ronde Subbasins which has been identified at this time:

Oregon Department of Environmental Quality (DEQ)

- NPDES permitting and enforcement
- WPCF permitting and enforcement
- Section 401 water quality certifications for removal and fill activities
- On-site septic system permitting and enforcement
- Nonpoint Source TMDL Implementation Program
- Technical assistance
- Financial assistance

Oregon Department of Agriculture (ODA)

- Agricultural Water Quality Management Area Plan (AWQMAP) development, implementation, enforcement, and revision.
- CAFO permitting and enforcement
- Technical assistance
- Rules under Senate Bill 1010 to clearly address TMDL and Load Allocations as necessary.
- Riparian area management
- Oregon Conservation Reserve Enhancement Program

Oregon Department of Forestry (ODF)

- Forest Practices Act (FPA) implementation
- Revise statewide FPA rules and/or adopt subbasin specific rules as necessary.
- Riparian area management

Oregon Department of Transportation (ODOT)

- Implementation of Stormwater Pollution Prevention and Control Plan and Erosion and Sedimentation Control Plan
- Design, construction, operation and maintenance of state highways and state highway storm systems

Oregon Department of State Lands (DSL)

- Public land and waterway management
- Removal-fill activities
- Wetland management
- Land leasing and mining activities

Oregon Department of Geology and Mine Industries (DOGAMI)

- Aggregate mining activities in waterways or floodplains
- Riparian area protection/enhancement; streambank stabilization
- Implementation and enforcement of permits

Federal Land Management Agencies (BLM and Forest Service)

- Following standards and guides
- Development and implementation of Water Quality Restoration Plans

Wallowa County

- Construction, operation and maintenance of County roads and stormwater systems
- Land use planning/permitting
- Maintenance, construction and operation of parks and other county owned facilities and infrastructure
- Riparian area management

Cities of Joseph, Enterprise and Wallowa

- Construction, operation and maintenance of a wastewater treatment plant and sanitary sewer system
- Construction, operation and maintenance of city roads and stormwater systems
- Land use planning/permitting
- Maintenance, construction and operation of parks and other city owned facilities and infrastructure
- Riparian area management

City of Lostine

- Construction, operation and maintenance of city roads and stormwater system
- Land use planning/permitting
- Maintenance, construction and operation of parks and other city owned facilities and infrastructure
- Riparian area management

(H) Identification of Implementation Plans

The planning efforts described in this Element provide for TMDL implementation in the Lower Grande Ronde Subbasins. DEQ expects that Implementation Plans will be developed and/or updated by DMAs as needed to layout all feasible steps toward meeting the TMDLs. Expected elements of TMDL Implementation Plans were listed previously. DEQ has developed a guidance document, entitled *TMDL Implementation Plan Components* (DEQ, 2007a), to help DMAs draft TMDL Implementation Plans and identify strategies that can be used to meet wasteload and load allocations. This document can be downloaded from: http://www.deq.state.or.us/wq/TMDLs/implementation.htm. This website also provides examples of Implementation Plans developed in other parts of the state which can also be used as a source of information for DMAs. DEQ expects Implementation Plans to be submitted within 18 months of the issuance of the TMDL.

In addition to the specific Plans described below, Wallowa County partnered with the Nez Perce Tribe in 1992 to develop a natural resource management plan for Wallowa County that would provide economic growth, entitled *The Wallowa County-Nez Perce Salmon Habitat Recovery Plan with Multi-Species Habitat Strategy (SHRP)* (1999). The *SHRP*'s "…strategy is to create guidelines for habitat improvement. The concept of the Plan is to develop on-the-ground projects through Coordinated Resource Management Plans, action plans and watershed assessments. Projects are implemented to correct problems identified in watershed analysis." Appendix B of the *SHRP* includes a Problems/Solutions Summary that includes guidance on decreasing stream temperature, turbidity, nutrients, and livestock waste and improving channel morphology. Wallowa County posts a copy of the SHRP on its web site at: http://www.co.wallowa.or.us/salmonplan/. The document was prepared in 1993, revised in 1999, and updated in 2002. All DMAs are encouraged to utilize the *SHRP* and its recommendations in development of their Implementation Plans.

The following identifies the status of sector-specific or source specific implementation plans of DMAs as of the writing of this document.

Point Sources – NPDES Permits

Individual and General DEQ Permits

DEQ administers NPDES permits for surface water discharge and is delegated to do so by EPA. The NPDES permit is a federal permit, required under the Clean Water Act for discharge of waste into waters of the United States.

Individual-facility NPDES permits are unique to a discharge facility. General NPDES permits address categories of facilities or aggregate pollutant sources, such as fish hatcheries or storm water. As described in **Section 1.3.5** of the TMDL, there are presently three individual-facility NPDES permits issued in the Wallowa Subbasin (sewage treatment plants for the Cities of Enterprise, Joseph and Wallowa) and four General NPDES permits (stormwater and boiler blowdown for Wallowa Forest Products, construction stormwater for the City of Enterprise, and aquatic animal production for ODFW). During the TMDL analysis, it was determined that the general permit discharges were not likely to contribute to exceedances of temperature or bacteria standards. The wasteload allocations for these facilities are their existing condition. Any future permits must address these TMDLs as appropriate given their location and season of discharge.

Current Status and DEQ Expectations:
The Temperature TMDL establishes wasteload allocations (WLAs) for the Enterprise, Wallowa and Joseph sewage treatment facilities (See **Section 2.10** of the TMDL). The WLAs are 1.36 MW/day, 1.34 MW/day and 0.34 MW/day, respectively, and will be incorporated into their NPDES permits upon renewal. Reasonable potential analyses were done for all three facilities which indicate that there is no reasonable potential for violating the WLAs or the numeric temperature under their existing conditions of operation. The Bacteria TMDL establishes WLAs for the Cities of Enterprise, Wallowa and Joseph. The WLAs are expressed as the effluent concentration allowed by the bacteria standard: monthly log mean of 126 *E. coli* organisms/100 ml and no single sample above 406 *E. coli* organsms per 100 ml. For all three plans, this is equal to the conditions specified in their current permits. If any of the general permit discharges are later shown to contribute to exceedances of water quality criteria, that issue will be addressed at that time and incorporated into a new permit.

CAFO General Permits

All CAFOs operate under a general NPDES permit issued and managed by ODA. The general permit prohibits discharge of CAFO wastes to waterbodies of the State. There are currently six CAFOs in the Wallowa River Subbasin

Current Status and DEQ Expectations:
DEQ expects continued administration and enforcement of CAFO permits by ODA.

Nonpoint Sources

Agriculture

The Oregon Department of Agriculture is the DMA responsible for regulating agricultural activities that affect water quality through the Agricultural Water Quality Management Act (Senate Bill 1010) and Senate Bill 502. TMDL implementation for agriculture will therefore be carried out through existing regulatory and non-regulatory programs. ODA has the ability to assess civil penalties when local operators do not follow their local Agricultural Water Quality Management Area rules.

SB1010 directs ODA to work with local communities, including farmers, ranchers, and environmental representatives, to develop Agricultural Water Quality Management Area Plans (AgWQMAP) and rules throughout the State. SB502 stipulates that ODA “shall develop and implement any program or rules that directly regulate farming practices that are for the purpose of protecting water quality and that are applicable to areas of the state designated as exclusive farm use zones or other agricultural lands.” Further, ODA policy states that plans and rules will be "reviewed on a biennial basis and ODA in consultation with ODEQ will assess whether the plan and rules are sufficient to meet and address water quality concerns established under the 303(d) or TMDL process or other triggering mechanisms". Progress reports, which are submitted to the Board of Agriculture after the biennial review process, are developed based on data collected by Local Management Agencies and ODA on progress of implementation of the plans and rules. Reports to the Board of Agriculture and Director will include statistics on numbers of farm plans developed and types of management practices being employed. These reports will be available to DEQ for review in assessing implementation progress.

Local Management Agencies are funded to conduct outreach and education, develop individual farm plans for operations in the planning area, work with landowners to implement management practices, and help landowners secure funding to cost-share water quality improvement practices. The Local Management Agency for the Lower Grande Ronde Subbasins is the Wallowa County Soil and Water Conservation District working under contract to ODA.

Current Status:
ODA adopted the first Wallowa County AgWQMAP and rules on September 20, 2001. In 2003, ODA decided to delay its first biennial review process for the Wallowa County AgWQMAP until the Lower Grande Ronde Subbasins TMDLs were completed. Due to delays in completion of the TMDLs, ODA reconvened the Local Advisory Committee in 2005 to conduct the next scheduled biennial review, even though TMDLs were not completed. Since that time, biennial reviews have been conducted in 2007 and 2009. The AgWQMAP and Rules, as well as a 2009 Progress Report, are available from ODA’s website at: http://oregon.gov/ODA/NRD/water_agplans.shtml.

DEQ Expectations:
DEQ expects that, once the TMDLs are completed and approved by EPA, that the next biennial review will address the temperature and bacteria TMDLs - including identifying how progress toward achievement of the surrogate measures for load allocations will be approached.

Non Federal Forest Lands

The Oregon Department of Forestry is the DMA, by statute, for water quality protection from nonpoint source discharges or pollutants resulting from forest operations on non federal forestlands in Oregon. ODF’s water quality authority is provided through the Forest Practices Act (FPA). TMDL implementation for forestry will therefore be carried out through existing regulatory and non-regulatory programs.

By statute, forest operators conducting operations in accordance with the FPA are considered to be in compliance with Oregon's water quality standards. The FPA does have provisions for both criminal and civil penalties if forest operators do not comply with water protection regulations. Additionally, whenever a violation occurs, the responsible party is obligated to repair the damage.

Examples of forestland water protection best management practices include:

- Roads not located in riparian management areas, flood plains, or wetlands;
- Stream crossing structures designed for 50 year flows;
- Maintain riparian vegetation with a 20-foot no harvest zone of trees and a 10-foot zone no disturbance of all understory vegetation that is near the high water level of the stream or river (except all intermittent streams which have no protections);
- Minimize disturbance to beds and banks of streams, lakes, and all wetlands more than ¼ acre in size; and
- Minimize slash that may enter waters of the state during felling, bucking, limbing or yarding.

Additional information about the requirements of the Forest Practices Act can be found at the Oregon Department Forestry website: http://www.oregon.gov/ODF/lawsrules.shtml.

Coordination between ODF and DEQ is guided by a Memorandum of Understanding (MOU) signed in April of 1998. This MOU was designed to improve the coordination between the ODF and DEQ in evaluating and proposing possible changes to the forest practice rules as part of the TMDL process. ODF and DEQ are involved in several statewide efforts to analyze the existing FPA measures and to better define the relationship between the TMDL load allocations and the FPA measures designed to protect water quality.

An evaluation of rule adequacy has been conducted (also referred to as the "Sufficiency Analysis") through the analysis of water quality parameters that can potentially be affected by forest practices. This statewide demonstration of forest practices rule effectiveness in the protection of water quality addressed the following specific parameters:

1) Temperature
2) Sediment
3) Turbidity
4) Aquatic habitat modification
5) Bio-criteria

The Sufficiency Analysis report (ODF and DEQ, 2002) has been externally reviewed by peers and other interested parties. The report is available for viewing at: http://www.deq.state.or.us/wq/nonpoint/links.htm. The report provides background information and assessments of BMP effectiveness in meeting water quality standards. The report concludes overall FPA adequacy at the statewide scale with due consideration to regional and local variation in effects. Achieving the goals and objectives of the FPA will ensure the achievement and maintenance of water quality goals. The report offers recommendations to highlight general areas where current practices could be improved in order to better meet the FPA goals and objectives and in turn provide added assurance of meeting water quality standards.

Current Status:
The Forest Practice Rules apply in non-federal forest areas in the Lower Grande Ronde Subbasins. Watershed-specific rules have not been established in the Subbasins.

DEQ Expectations:
DEQ has not identified water quality impairment that is specific to forest management in the Subbasins. DEQ expects ongoing implementation of the Forest Practices Act.

Transportation

The Oregon Department of Transportation is the DMA for the regulation of water quality related to roads, highways and bridges under their jurisdiction. ODOT has worked with DEQ to develop a statewide TMDL program focused on managing TMDL pollutants associated with the operation, construction, and maintenance of ODOT roads, highways, and bridges. A MOU is currently being developed that will formalize a proactive, collaborative, and adaptive manner whereby the TMDL management goals and requirements as defined in Oregon Administrative Rules (OAR, Division 42, TMDLs) will be met.

ODOT has developed a single TMDL management plan that is implemented statewide rather than individual TMDL management plans for multiple water quality limited waterbodies across the state. By developing a single, statewide, management plan, ODOT:

- Streamlines the evaluation and approval process for TMDL watershed management plans.
- Provides consistency to ODOT highway management practices in all TMDL watersheds.
- Eliminates duplicative paperwork and staff time developing and participating in numerous TMDL management plans.

The ODOT TMDL management plan addresses management of all TMDL pollutants associated with ODOT facilities. Of TMDL pollutants, ODOT considers sediment and temperature to be the primary pollutants of concern associated with ODOT owned and maintained facilities, properties located within the highway right-of-way, and maintenance facilities. DEQ is still in the process of identifying TMDL pollutants that limit beneficial uses of waterways across Oregon. TMDL allocations are established by watershed. Because of this, some individual watersheds may have unique pollutant management needs that require special consideration under the ODOT watershed management plan. ODOT will work with DEQ or local watershed management agencies (e.g. County and Municipal Road Departments), to address local transportation related watershed concerns as needs arise.

Major components of a Statewide Implementation Plan will be executed through the core regulatory programs that ODOT is already required to comply with. These regulatory programs are: NPDES Municipal Separate Storm Sewer System Phase I and 1200CA permits, 401 Dredge & Fill Certification, and the Underground Injection Control programs. These programs are the core elements of their statewide Implementation Plan, however the MOU also describes the process that will be used to identify any gaps relative to meeting the TMDL requirements in a given basin or sub-basin. This process will allow an efficient use of both ODOT and DEQ staff in implementing specific actions and goals and identifying appropriate effectiveness monitoring to gauge how its actions are contributing to achieving TMDLs goals in each basin and across the state.

Current Status and DEQ Expectations:
Continued participation in MOU development and on-going implementation of ODOT's TMDL Implementation Plan.

State Lands

The Department of State Lands administers the state´s removal-fill permits and is responsible for leasing range and agricultural land and waterways for a variety of business activities. Many of the elements required in an implementation plan will likely be addressed through the implementation of existing regulatory programs and activities.

Current Status and DEQ Expectations:
DSL does not presently have an Implementation Plan. DEQ expects that a Plan will be developed and suggests that DSL may work with DEQ to develop a statewide implementation plan, as has been done by other State agencies.

Mining and Geology

The Oregon Department of Geology and Mining Industries regulates mining and quarry activities. Extraction operations are commonly located in or near floodplains. This can lead directly or indirectly to channel morphology and vegetation disturbance leading to increased stream heating. This qualifies DOGAMI as a DMA. Many of the elements required in an implementation plan will likely be met through the implementation of the 1200A General Permit and through DOGAMI's Best Management Practices Manual.

Current Status and DEQ Expectations:
DOGAMI does not presently have an Implementation Plan. DEQ expects that a Plan will be developed and suggests that DOGAMI may work with DEQ to develop a statewide implementation, as has been done by other State agencies. As a starting point, DEQ will work with DOGAMI to identify whether existing and planned regulated operations have potential adverse water quality impacts.

Federal Lands

The U.S. Forest Service and the Bureau of Land Management are the DMAs for federal lands in the Subbasins. In July 2003, both agencies signed memoranda of agreement with DEQ defining how water quality rules and regulations regarding TMDLs will be met. The agencies will develop Water Quality Restoration Plans (WQRPs) which will be the equivalent of TMDL Implementation Plans. In addition, BLM and USFS developed *the Northwest Forest Plan (NWFP) Temperature TMDL Implementation Strategies: Evaluation of the Northwest Forest Plan Aquatic Conservation Strategy (ACS) and Associated Tools* (the Strategy) (2005). DEQ conditionally approved the Strategy in September 2005 as the temperature TMDL implementation mechanism under the Clean Water Act.

Activities on lands managed by the USFS in the Lower Grande Ronde Subbasins follow standards and guidelines listed in the respective amended Land Resource Management Plans for the Wallowa-Whitman and Umatilla National Forests. Two important Plan amendments were adopted in 1995 which provide the federal agencies with interim strategies for managing fish-producing watersheds in eastern Oregon, Washington, Idaho, and portions of California. One amendment, known as PACFISH (USDA & USDI 1995), pertains to anadromous fish-producing watersheds, while the other one, known as INFISH (USDA 1995), pertains to inland native fish. PACFISH and INFISH provide interim direction for establishment and management of Riparian Habitat Conservation Areas (RHCAs) and standards and guidelines for Key Watersheds. According to PACFISH, most USFS watersheds in the Lower Grande Ronde Subbasins have been designated as Key Watersheds. The RHCAs include riparian corridors, wetlands, intermittent streams, and other areas that help maintain the integrity of aquatic ecosystems by: (1) influencing the delivery of coarse sediment, organic matter, and woody debris to streams, (2) providing root strength for channel stability, (3) shading the stream, and (4) protecting water quality by establishing interim buffer widths.

Current Status:
WQRPs have not yet been developed for any Federal lands within the Lower Grande Ronde Subasins.

DEQ Expectations:
DEQ expects submission of WQRPs reflecting evaluation of the forest condition relative to natural thermal potential and planning to address any deviations from NTP and long term maintenance of NTP conditions. It is expected that WQRPs will build on the existing protections provided by the Land Resource Management Plans and PACFISH/INFISH. It is also expected that WQRPs will address bacterial contributions to the Wallowa River watershed, such as from livestock grazing, where appropriate.

Urban and Rural Sources

Responsible participants for implementing DMA-specific TMDL Implementation Plans for urban and rural sources were identified in **Element G** above. These include: Wallowa County and the cities of Joseph, Wallowa, Enterprise and Lostine. *TMDL Implementation Plan Guidance* (DEQ, 2007a), provides useful guidance to assist urban and rural sources in developing Implementation Plans. This document can be downloaded from the DEQ website: http://www.deq.state.or.us/wq/TMDLs/implementation.htm.

Oregon cities and counties regulate land use activities through local comprehensive plans and related development regulations. This authority begins with a broad charge given to them by the Oregon constitution and the Oregon legislature to protect public health, safety, and general welfare. Oregon's land use planning system, administered through the Oregon Department of Land Conservation and Development , provides a unique opportunity for local jurisdictions to address water quality protection and enhancement. Many of the land use goals have direct links to water quality, particularly Goals 5 (Natural Resources, scenic, and historic areas and open spaces, OAR 660-015-0000(5)), Goal 6 (Air, water, and land resources quality, 660-015-0000(6)), and Goal 7 (Areas subject to natural hazards). In the case of Goal 5, there is a specific rule that requires local jurisdictions to protect significant riparian areas and wetlands from development. Goal 6 has no developed guidance or rules about how local jurisdictions should protect and enhance water quality, but provides a sound framework for new ordinances that address a wide variety of water quality objectives, based on state or federal regulations, including these TMDLs.

Urban, residential, and rural sources can contribute significant amounts of pollution to waterways. Counties and municipalities can play an important role in pollution prevention and water quality improvement by:

- Raising public awareness of the impacts of urban, residential, commercial, runoff on surface water quality
- Providing access to practical information (BMPs) to ensure septic systems function properly
- Providing public education and oversight of riparian area management

It should be noted that DEQ manages on-site sewage disposal in Wallowa County through the State's Onsite Wastewater Management Program. The Program's goal is to ensure that septic systems are properly sited, installed, operated and maintained to protect land, water and public health. Wallowa County and the municipalities can assist DEQ by providing outreach and educational materials to landowners.

Wallowa County

Each county is required to have a comprehensive plan and accompanying development ordinances to be in compliance with state land use planning goals. While the comprehensive plan must serve to implement statewide planning goals mandated by law, counties also have a wide degree of local control over how resource protection is addressed in their community.

Wallowa County has demonstrated great leadership and initiative in addressing natural resource issues. For almost two decades the County has been cooperatively working with land owners to promote healthy riparian conditions and improved water quality. Wallowa County amended its Land Use Plan to include the Wallowa County-Nez Perce *SHRP* (1999) to guide land resource management. In 1995 the County Court adopted a Resolution that the *SHRP* would be implemented on all County lands. Under the *SHRP* umbrella the County, in cooperation with the Nez Perce Tribe, is taking significant steps toward continual improvement of watersheds, fisheries habitat and water quality.

In 1996 the Wallowa County Court appointed the Wallowa County Natural Resource Advisory Committee (NRAC) to advise the Court on natural resource matters affecting the County. The NRAC is comprised of members representing landowner, industry, professional, environmental, state, tribal, federal, county, and community interests. A technical committee provides specific natural resource expertise to the NRAC. The NRAC reviews proposed County projects for consistency with the *SHRP* and other natural resource provisions of the County's Comprehensive Land Use Plan.

<u>Current Status:</u>
In a December 4, 2003, letter to the County, DEQ affirmed that Wallowa County's Comprehensive Land Use Plan in conjunction with the *SHRP* provided the functionality to serve as the County's TMDL Implementation Plan. However, because the Comprehensive Land Use Plan was developed prior to the

TMDL, the letter noted that some key technical components required in TMDL implementation plans were absent and would need to be addressed once TMDLs were completed.

DEQ Expectations:
Upon approval of the Lower Grande Ronde Subbasins TMDLs, it is DEQ's expectation that Wallowa County will develop a TMDL Implementation Plan that will achieve the load allocations established by the TMDLs. The County can either develop its own Plan, or work with the Nez Perce Tribe and other stakeholders to provide the necessary modifications to the *SHRP*. It is expected that the Plan will incorporate existing management strategies, as well as include an assessment of ways in which County operations could be modified to better meet TMDL load allocations. Management strategies could include: education about riparian protection, evaluation of roads located along perennial streams for impediments to temperature load allocation attainment, restoration of river shading and/or channel condition on County owned properties, and consideration of riparian protection ordinances and low impact development building practices.

Municipalities

The municipalities of Enterprise, Joseph, Wallowa and Lostine will be responsible for developing and submitting TMDL Implementation Plans. The scope and scale of the Plans will likely be different due to the size and jurisdiction of the different DMAs.

Current Status and DEQ Expectations:
Enterprise, Joseph, Wallowa and Lostine do not currently have a TMDL Implementation Plan. Upon approval of the Lower Grande Ronde Subbasins TMDLs it is DEQ's expectation that they will develop and submit an Implementation Plan that will achieve the load allocations established by the TMDLs. It is expected that the Plans will incorporate existing management strategies, as well as include an assessment of ways in which City operations could be modified to better meet TMDL load allocations. Management strategies could include: education about riparian protection, evaluation of roads located along perennial streams for impediments to temperature load allocation attainment, restoration of river shading and/or channel condition on City owned properties, and consideration of riparian protection ordinances and low impact development building practices.

(I) Schedule for Preparation and Submission of Implementation Plans

This element specifies a timeline for the preparation and submission of Implementation Plans by DMAs. In accordance with OAR 340-042-0060, TMDLs are issued as a DEQ order, effective on the date signed by the Director. DEQ will notify all affected NPDES permittees and DMAs identified in this document and persons who provided formal comment on the draft TMDL within 20 business days of TMDL issuance. DEQ expects that DSL, DOGAMI, USFS, BLM, Wallowa County, Enterprise, Joseph, Wallowa and Lostine will fulfill the planning and evaluation expectations of **Element H** with 18 months of the date of receipt of their notification letter. ODA follows a two year timeline from the last AgWQMAP review as specified by rule.

OAR 340-042-0080(3) defines the required elements of a TMDL implementation plans. The main elements are as follows:

- Management strategies the DMA will use to achieve load allocation(s) and reduce pollutant loading;
- A timeline for implementing management strategies and a schedule for completing measurable milestones;
- Performance monitoring with a plan for periodic review and revision of the implementation plan;
- Evidence of compliance with applicable statewide land use requirements; and
- Any other required elements if specified in this WQMP.

DEQ review and approval of TMDL Implementation Plans is called for in OAR 340-042. Following approval of the TMDL implementation plan, DMAs will be expected to submit to DEQ an annual status report briefly describing the status of management strategies that implement TMDL pollutant allocations or reductions. Every fifth year DMAs will need to submit an evaluation report. The report will describe the effectiveness of the management strategies identified in the TMDL Implementation Plan and put into place during the preceding four years. The report will indicate whether implementation of their plan is adequately meeting the pollutant reduction goals. If they determine it does not, the report will describe the steps they will take to modify their plan. In addition, DMAs may be required to review and revise their TMDL implementation plan as needed following DEQ's reevaluation or revision of the TMDL.

(J) Reasonable Assurance

This element of the WQMP is intended to provide reasonable assurance that the WQMP (along with the associated DMA-specific Implementation Plans) will be implemented and that the TMDL and associated allocations will be met.

There are several programs that are either already in place or will be put in place to help assure that this WQMP will be implemented. Some of these are traditional regulatory programs such as specific requirements under NPDES discharge permits. Other programs address nonpoint sources under the auspices of state law (for forested and agricultural lands) and voluntary efforts. The status of these different programs in the Subbasins was summarized in **Element H** above.

Should any responsible participant fail to comply with their obligations under this WQMP, DEQ will take all necessary action to seek compliance. Such action will first include negotiation, but could evolve to issuance of DEQ or Commission Orders and other enforcement mechanisms.

(K) Monitoring and Evaluation

Monitoring and evaluation has three basic components: 1) monitoring the implementation of TMDL Implementation Plans and activities as identified in this document; 2) evaluating the effectiveness of management practices; and 3) tracking water quality trends to ensure TMDL wasteload and load allocations are being achieved and water quality criteria are being met. DEQ generally expects that DMAs will monitor implementation efforts and that DEQ and various natural resource organizations including DMAs will participate in effectiveness and water quality monitoring.

The information generated by each of the agencies/entities gathering data in the Subbasins will be pooled and used to determine whether management actions are having the desired effects or if changes in management actions and/or TMDLs are needed. This detailed evaluation (refer to **Element M**) will be planned, as feasible, roughly on a five year cycle. If progress is insufficient, then the appropriate management agency will be contacted with a request for additional action. This monitoring and feedback mechanism is a major component of the "reasonable assurance of implementation" for this WQMP.

Although collaborative monitoring capabilities and plans have not yet been developed in response to an approved TMDL, it is anticipated that monitoring efforts will consist of some of the following types of activities:

- Reports on the numbers, types and locations of projects, BMPs and educational activities completed
- BMP efficacy evaluation
- Instream monitoring to track progress towards achieving water quality numeric criteria
- Monitoring riparian vegetation communities and shade to assess progress towards achieving NTP targets established in the temperature TMDL

As available, DEQ will contribute resources and training to design and/or implement quality water monitoring efforts. The monitoring program of the Grande Ronde Model Watershed is another source of monitoring expertise to assist in monitoring efforts, if staff and resources are available.

(L) Public Involvement

DEQ believes that public involvement is essential to any successful water quality improvement process. There was public involvement throughout the TMDL development process and public involvement in implementation will be important as well. Each DMA will be responsible for outreach efforts relating to their ongoing land management and TMDL implementation. DEQ will also promote public involvement through direct association and contact with existing public groups that work toward restoration and environmental protection in the Lower Grande Ronde Subbasins. These groups include: the Grande Ronde Model Watershed, the Wallowa County Natural Resources Advisory Committee, SB1010 Local Advisory Committee, the Wallowa County Soil and Water Conservation District, USFS, and ODFW.

(M) Maintaining Management Strategies over Time

DEQ administers a TMDL implementation program that will oversee the combined efforts of DMA Implementation Plans and DEQ permitting programs. As addressed in **Elements E** and **H**, each DMA will develop and/or review their TMDL Implementation Plan or program for its effectiveness in addressing load allocations. Each DMA will submit an annual report describing the implementation efforts underway and noting changes in water quality. DEQ will review these submittals and recommend changes to individual Implementation Plans if necessary. The 303(d) listing and TMDL process and the management planning associated with WQRPs, forest practices, agricultural and transportation planning are ongoing by design. Taken together, these efforts should ensure that management strategies are maintained over time.

(N) Costs and Funding

One purpose of this element is to describe estimated costs and demonstrate that there is sufficient funding available to begin WQMP implementation. Another purpose is to identify potential future funding sources for project implementation. The cost of restoration projects varies considerably and can range from zero cost, or even profit due to improvements, to full channel reconstruction and land acquisition which can cost hundreds of thousands of dollars per river mile. Restoration can be passive or active. Passive restoration results from removing stresses to the channel, vegetation and floodplain and allowing the river system to naturally recover. This can be accomplished through measures such as fencing or allowing natural vegetation to grow between farm fields and streams. Active restoration involves channel construction, installation of structures to capture sediment or re-direct water, etc., and tends to cost more than passive. Different measures are appropriate for different management styles, land uses, and types of geomorphic or vegetative impairment. Given these complexities and uncertainties, a cost analysis is not attempted here. DMAs will be expected to provide a fiscal analysis of the resources needed to develop, execute and maintain the programs described in their Implementation Plans.

DMAs and other natural resource organizations are already implementing numerous natural resource enhancement efforts and projects in the Subbasin which are relevant to the goals of the plan, through a variety of funding sources. Financial assistance is provided through a mix of cost-share, tax credit, and grant funded incentive programs designed to improve on-the-ground watershed conditions. Some of these programs, due to the sources of their funding, have specific qualifying factors and priorities. **Table 4-2** shows a partial list of assistance programs available in the Subbasin.

Grant funds are available for improvement projects on a competitive basis. Field agency personnel assist landowners in identifying, designing, and submitting eligible projects for these grant funds. For private landowners, the recipient and administrator of these grants is generally the local Soil and Water Conservation District or watershed council.

Table 4-2. Partial list of funding sources for natural resource enhancement projects

Program	Agency/Source
Oregon Plan for Salmon and Watersheds	OWEB
Environmental Quality Incentives Program	USDA-NRCS
Wetland Reserve Program	USDA-NRCS
Conservation Reserve Enhancement Program	USDA-NRCS
Stewardship Incentive Program	ODF
Access and Habitat Program	ODFW
Partners for Wildlife Program	USFWS
Conservation Implementation Grants	ODA
Conserved Water Program and other water projects	OWRD
Nonpoint Source Water Quality Control (EPA 319)	DEQ/USEPA
Riparian Protection/Enhancement	USACE
Oregon Community Foundation	OCF
Watershed Initiative Grants	USEPA
Clean Water State Revolving Funds (SRF) Low Interest Loans	DEQ/USEPA
Community-based Restoration Program	NOAA-Fisheries

(O) Citation of Legal Authorities

The implementation of TMDL waste load and load allocations and the associated implementation plans are generally enforceable by DEQ, other state and federal agencies, or local governments. It is envisioned that sufficient initiative exists to achieve water quality goals with minimal enforcement. Should the need for additional effort emerge, it is expected that the responsible agency will work with land managers to overcome impediments to progress through education, technical support or enforcement. Enforcement may be necessary in instances of insufficient action towards progress. This could occur first through direct intervention from land management agencies (e.g. ODF, ODA, counties and cities) and secondarily through DEQ. The latter may be based on departmental orders to implement management strategies leading to attainment of water quality standards.

Clean Water Act Section 303(d)

Section 303(d) of the 1972 Federal Clean Water Act as amended requires states to develop a list of rivers, streams and lakes that cannot meet water quality standards without application of additional pollution controls beyond the existing requirements on industrial sources and sewage treatment plants. Such water bodies are referred to as "water quality limited". Water quality limited waterbodies must be identified by the EPA or by a state agency which has been delegated this responsibility by EPA. In Oregon, this responsibility rests with DEQ. DEQ updates the list of water quality limited waters every two years. The list is commonly known as the 303(d) list. Section 303 of the Clean Water Act further requires that TMDLs be developed for all waters on the 303(d) list. DEQ also has this responsibility.

Endangered Species Act, Section 6

Section 6 of the 1973 Federal Endangered Species Act as amended encourages States to develop and maintain conservation programs for federally listed threatened and endangered species

Oregon Revised Statute

The DEQ is authorized by law to prevent and abate water pollution within the State of Oregon pursuant to the following statute:

ORS 468B.020.

(1) Pollution of any of the waters of the state is declared to be not a reasonable or natural use of such waters and to be contrary to the public policy of the State or Oregon, as set forth in ORS 468B.015.

(2) In order to carry out the public policy set forth in ORS 468B.015, ODEQ shall take such action as is necessary for the prevention of new pollution and the abatement of existing pollution by:

- *(a) Fostering and encouraging the cooperation of the people, industry, cities and counties, in order to prevent, control and reduce pollution of the waters of the state; and*
- *(b) Requiring the use of all available and reasonable methods necessary to achieve the purposes of ORS 468B.015 and to conform to the standards of water quality and purity established under ORS 468B.048.*

ORS 468B.025 No person shall cause pollution of any waters of the state or place or cause to be placed any wastes in a location where such wastes are likely to escape or be carried into the waters of the state by any means.

NPDES and WPCF Permit Programs

DEQ administers two different types of wastewater permits in implementing ORS 468B.050. These are: the NPDES permits for waste discharge; and WPCF permits for waste disposal. The NPDES permit is also a Federal permit and is required under the Clean Water Act. The WPCF permit is a state program. As permits are renewed they will be revised to insure that all 303(d) related issues are addressed in the permit.

Oregon Administrative Rules

OAR 340-042 contains Department rules for TMDL establishment, issuance, implementation, and public participation. The following Oregon Administrative Rules provide numeric and narrative criteria for TMDL parameters of concern in the Subbasins:

TMDL Parameter	Applicable Rules
Temperature	OAR 340-041-0028
Bacteria	OAR 340-041-0009

Oregon Forest Practices Act

The Oregon Forest Practices Act was enacted in 1971. The Oregon Department of Forestry is the designated management agency for regulation of water quality on non-federal forest lands. The Board of Forestry has adopted water protection rules, including but not limited to OAR Chapter 629, Divisions 635-660, which describes BMPs for forest operations. The Environmental Quality Commission, Board of Forestry, DEQ and ODF have agreed that these pollution control measures will be relied upon to result in achievement of state water quality standards. Forest operators conducting operations in accordance with the Forest Practices Act are considered to be in compliance with water quality standards. A 1998 Memorandum of Understanding between both agencies guides the implementation of this agreement, as described in **Element H**.

ODF and DEQ statutes and rules also include provisions for adaptive management that provide for revisions to FPA practices where necessary to meet water quality standards. These provisions are described in ORS 527.710, ORS 527.765, ORS 183.310, OAR 340-041-0026, OAR 629-635-110, and OAR 340-041-0120.

Oregon Senate Bill 1010 (Agriculture Water Quality Management Act)

The Oregon Department of Agriculture has primary responsibility for water pollution control from agriculture sources. This is accomplished through the Agriculture Water Quality Management program authorities granted ODA under Senate Bill 1010 adopted by the Oregon State Legislature in 1993 (ORS 569.000 through 568.933) and Senate Bill 502 adopted 1995 (ORS 561.191).

SB1010 directs ODA to work with local communities, including farmers, ranchers, and environmental representatives, to develop Agricultural Water Quality Management Area Plans and rules throughout the State. SB502 stipulates that ODA "*shall develop and implement any program or rules that directly regulate farming practices that are for the purpose of protecting water quality and that are applicable to areas of the state designated as exclusive farm use zones or other agricultural lands*." The plans are accompanied by regulations in OAR 603-90 and portions of OAR 603-95, which are enforceable by ODA. As discussed in **Element H**, TMDL implementation coordination between ODA and DEQ is guided by an MOA signed in 1998.

Local Ordinances

Within the TMDL Implementation Plans, the DMAs are expected to describe their specific legal authorities to carry out the management measures they choose to meet the TMDL allocations. Legal authority to enforce the provisions of a City's NPDES permit would be a specific example of legal authority to carry out management measures.

4.3 TMDL-RELATED PROGRAMS, INCENTIVES AND VOLUNTARY EFFORTS

TMDLs in Oregon are designed to coordinate with and support other watershed protection and restoration efforts. Watershed enhancement in the Subbasins is ongoing and is, for the most part, consistent with or directly implements the load allocations of the TMDL. While regional programs are in place, much of the restoration is locally based. A summary of on-going implementation plan activities in the Lower Grande Ronde Subbasins is provided in **Table 4-3**.

Table 4-3. Ongoing Implementation Plan activities

Implement *The Wallowa County-Nez Perce Salmon Habitat Recovery Plan with Multi-Species Habitat Strategy*	Wallowa Co./Nez Perce Tribes
Oversee implementation of ordinances, policies and guidelines to improve/protect surface water quality	Wallowa Co.
Encourage and promote use of BMPs for urban sources	Wallowa Co.
Ensure all forest activities on federal lands comply with standards and guidelines listed in district forest plan, PACFISH, and BMPs defined in the implementation for Clean Water Act	Wallowa Whitman & Umatilla National Forests
Ensure all forest activities on state and private land complies with Oregon Forest Practices Act	ODF
Implement *Wy-Kan-Ush-Mi Wa-Kish-Wit*	Nez Perce Tribes
Implement monitoring and evaluation program	USFS, ODFW, Wallowa SWCD, DEQ, ODF, ODA, Nez Perce Tribes, Grande Ronde Model Watershed
Implement Imnaha and Grande Ronde Subbasin Plans developed through the Northwest Power and Conservation Council's 2000 Fish and Wildlife Program	USFS, ODFW, Wallowa SWCD, DEQ, ODF, ODA, Nez Perce Tribes, Grande Ronde Model Watershed

4.3.1 The Oregon Plan for Salmon and Watersheds (Oregon Plan)

The Oregon Plan represents a major process, unique to Oregon, to improve watersheds and restore endangered fish species. The Plan consists of four essential elements:

(1) Coordinated Agency Programs: Many state and federal agencies administer laws, policies, and management programs that have an impact on salmonids and water quality. These agencies are responsible for fishery harvest management, production of hatchery fish, water quality, water quantity, and a wide variety of habitat protection, alteration, and restoration activities. Previously, agencies conducted business independently. Water quality and salmon suffered because they were affected by the actions of all the agencies, but no single agency was responsible for comprehensive, life-cycle management. Under the Oregon Plan, all government agencies that impact salmon are accountable for coordinated programs in a manner that is consistent with conservation and restoration efforts.

(2) Community-Based Action: Government, alone, cannot conserve and restore salmon across the landscape. The Oregon Plan recognizes that actions to conserve and restore salmon must be worked out by communities and landowners, with local knowledge of problems and ownership in solutions. Watershed councils, soil and water conservation districts, and other grassroots efforts are vehicles for getting the work done. Government programs provide regulatory and technical support to these efforts, but local people will do the bulk of the work to conserve and restore watersheds. Education is a fundamental part of the community based action. People must understand the needs of salmon in order to make informed decisions about how to change their way of life to accommodate clean water and the needs of fish. Development and implementation of the *Wallowa County-Nez Perce Salmon Habitat Recovery Plan with Multi-Species Habitat Strategy* is an excellent example of a community-based action.

(3) Monitoring: The monitoring program combines an annual appraisal of work accomplished and results achieved. Work plans are used to determine whether agencies meet their goals as promised. Biological and physical sampling are conducted to determine whether water quality and salmon habitats and populations respond as expected to conservation and restoration efforts.

(4) Appropriate Corrective Measures: The Oregon Plan includes an explicit process for learning from experience, discussing alternative approaches, and making changes to current programs. The Plan emphasizes improving compliance with existing laws rather than arbitrarily establishing new protective laws. Compliance is achieved through a combination of education and prioritized enforcement of laws that are expected to yield the greatest benefits to salmon.

4.3.2 Landowner Assistance Programs

A variety of grants and incentive programs are available to landowners in the subbasin. These incentive programs are aimed at improving the health of the watershed, particularly on private lands. They include technical and financial assistance, provided through a mix of state and federal funding. This assistance is administered by several organizations, including but not limited to: the Grande Ronde Model Watershed, the Wallowa County Soil and Water Conservation District, the Oregon Department of Forestry, the Oregon Department of Fish and Wildlife, DEQ, and the National Resources Conservation Service. These services include site evaluations, technical project design, stewardship/conservation plans, and referrals for funding as appropriate. This assistance and funding is further assurance of implementation of the TMDL WQMP. A list of funding sources or programs is provided in **Element N** of **Section 2.2**.

4.3.3 Voluntary Measures

There are voluntary, non-regulatory, watershed improvement programs that are in place and addressing water quality concerns in the County. These programs provide both technical expertise and partial funding. Examples of activities promoted and accomplished through these programs include: planting of conifers, hardwoods, shrubs, grasses and forbs along streams; relocating legacy roads that may be detrimental to water quality; replacing problem culverts with adequately sized structures, and improvement/ maintenance of legacy roads known to cause water quality problems. These activities have been and are being implemented to improve watersheds and enhance water quality. Many of these efforts are helping resolve legacy water quality issues.

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LOWER GRANDE RONDE SUBBASINS TMDLS
APPENDIX A: STREAM TEMPERATURE ANALYSIS

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A1. INTRODUCTION

This appendix provides information about the temperature and shade assessment for the Lower Grande Ronde Subbasins. The assessment was completed to support the Total Maximum Daily Load (TMDL) and implement the Oregon water quality standard for temperature. The specific required components of the TMDL are provided in **Chapter 2** of the TMDL document. This appendix provides additional background information about stream heating processes, the methodology and data used for temperature TMDL development, and stream simulation results.

The lands within the Lower Grande Ronde Subbasins occupy 2,982 square miles in northeastern Oregon. This area includes three 4th field hydrologic unit subbasins: Wallowa River Subbasin (17060105), Imnaha River Subbasin (17060102), and the Lower Grande Ronde Subbasin (17060106). While the stream temperature TMDL considers all surface waters within the Lower Grande Ronde Subbasins, the TMDL analysis largely focuses on the Wallowa River where both stream temperature modeling and site specific shade analyses were completed. Generalized effective shade curves were developed to cover the rest of the waterbodies in the Subbasins where site specific simulations were not performed.

A1.1 Overview of Temperature and Stream Heating Processes

Parameters that affect stream temperature can be grouped as near stream vegetation and land cover, channel morphology, and hydrology (**Figure A-1**). Many of these stream parameters are interrelated (i.e., the condition of one may impact one or more of the other parameters). These parameters affect stream heat transfer processes and stream mass transfer processes to varying degrees. The analytical techniques employed to develop this temperature TMDL are designed to include all of the parameters, along with latitude, elevation, humidity, air temperature and wind speed.

Many parameters exhibit considerable spatial variability. For example, channel width measurements can vary greatly over small stream lengths. Some parameters can have a diurnal and seasonal temporal component as well as spatial variability. The current analytical approach developed for this stream temperature assessment relies on ground level and remotely sensed spatial data. Techniques employed in this effort are statistical and deterministic modeling of hydrologic and thermal processes.

A1.1.1 Stream Heating Processes

Stream temperature is an expression of heat energy per unit volume, which in turn is an indication of the rate of heat exchange between a stream and its environment. The heat transfer processes that control stream temperature include solar radiation, long wave radiation, convection, evaporation and bed conduction (Wunderlich 1972; Jobson and Keefer 1979, Beschta and Weatherred 1984, Sinokrot and Stefan 1993, Boyd 1996, Johnson 2004). With the exception of solar radiation, which only delivers heat energy, these processes are capable of both introducing and removing heat from a stream. **Figure A-2** displays the stream heat transfer processes, along with mass transfer, that are considered in this analysis.

When a stream surface is exposed to midday solar radiation, large quantities of heat will be delivered to the stream system (Brown 1969, Beschta et al. 1987). Some of the incoming solar radiation will reflect off the stream surface, depending on the elevation of the sun. All solar radiation outside the visible spectrum (0.36μ to 0.76μ) is absorbed in the first meter below the stream surface and only visible light penetrates to greater depths (Wunderlich 1972). Sellers (1965) reported that 50% of solar energy passing through the stream surface is absorbed in the first 10 cm of the water column. Removal of riparian vegetation, and the shade it provides, contributes to elevated stream temperatures (Rishel et al. 1982, Brown 1983, Beschta et al. 1987, Johnson and Jones 2000, Johnson, 2004). Channel widening can similarly increase the solar radiation load. The principal source of heat energy delivered to the water column is solar energy striking the stream surface directly (Brown 1970). Exposure to direct solar radiation will often cause a dramatic increase in stream temperatures. The ability of riparian vegetation to shade the stream throughout the day depends on vegetation height, width, density and position relative to the stream, as well as stream aspect.

Figure A-1. Factors that affect stream temperature

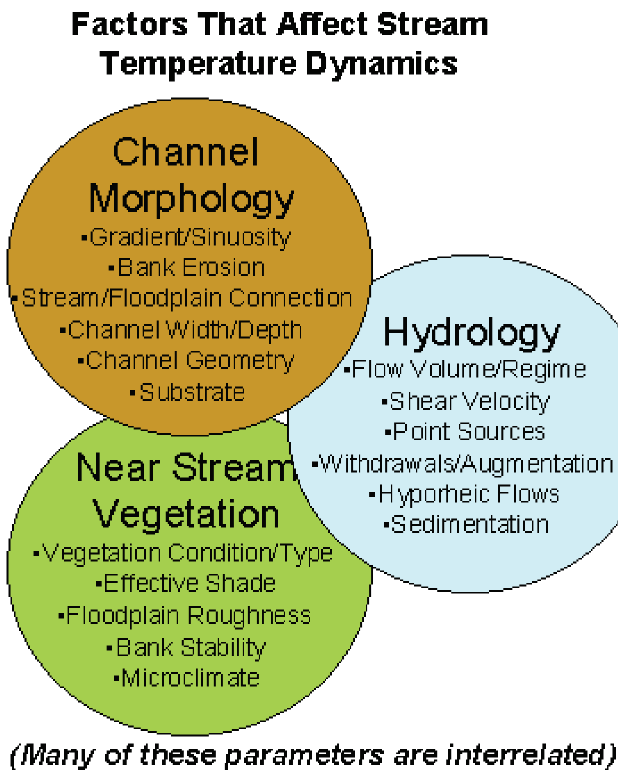
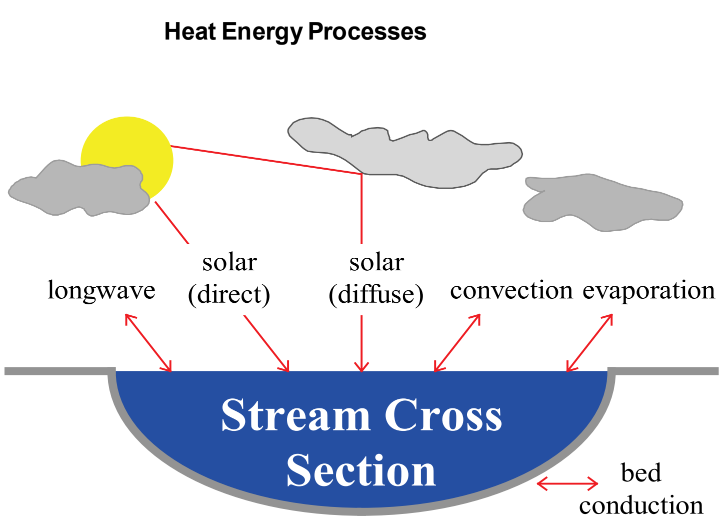


Figure A-2. Heat transfer processes



Both the atmosphere and vegetation along stream banks emit long wave radiation that can heat the stream surface. Water is nearly opaque to long wave radiation and complete absorption of all wavelengths greater than 1.2μ occurs in the first 5 cm below the surface (Wunderlich 1972). Long wave radiation has a cooling influence when emitted from the stream surface. The net transfer of heat via long wave radiation usually balances so that the amount of heat entering is similar to the rate of heat leaving the stream (Beschta and Weatherred 1984, Boyd 1996).

Evaporation occurs in response to internal energy of the stream (molecular motion) that randomly expels water molecules into the overlying air mass. Evaporation is the most effective method of dissipating heat from a given volume of water (Parker and Krenkel 1969). As stream temperatures increase, so does the rate of evaporation. Air movement (wind) and low vapor pressures increase the rate of evaporation and accelerate stream cooling (Harbeck and Meyers 1970).

Convection transfers heat between the stream and the air via molecular and turbulent conduction (Beschta and Weatherred 1984). Heat is transferred in the direction of decreasing temperature. Air can have a warming influence on the stream when the stream is cooler, or vice versa. The amount of convective heat transfer between the stream and air is low (Parker and Krenkel 1969, Brown 1983). Nevertheless, this should not be interpreted to mean that air temperatures do not affect stream temperature.

Depending on streambed composition, shallow streams (less than 20 cm) may allow solar radiation to warm the streambed (Brown 1969). Large cobble (> 25 cm diameter) dominated streambeds in shallow streams may store and conduct heat as long as the bed is warmer than the stream. Bed conduction may cause maximum stream temperatures to occur later in the day, possibly into the evening hours.

The instantaneous heat transfer rate experienced by the stream is the summation of the individual processes:

$$\Phi_{Total} = \Phi_{Solar} + \Phi_{Longwave} + \Phi_{Evaporation} + \Phi_{Convection} + \Phi_{Conduction}.$$

Solar Radiation (Φ_{Solar}) is a function of the solar angle, solar azimuth, atmosphere, topography, location and riparian vegetation. Simulation is based on methodologies developed by Ibqal (1983) and Beschta and Weatherred (1984). *Longwave Radiation* ($\Phi_{Longwave}$) is derived by the Stefan-Boltzmann Law and is a function of the emissivity of the body, the Stefan-Boltzmann constant and the temperature of the body (Wunderlich, 1972). *Evaporation* ($\Phi_{Evaporation}$) relies on a Dalton-type equation that utilizes an exchange coefficient, the latent heat of vaporization, wind speed, saturation vapor pressure and vapor pressure (Wunderlich, 1972). *Convection* ($\Phi_{Convection}$) is a function of the Bowen Ratio and terms include atmospheric pressure, and water and air temperatures. *Bed Conduction* ($\Phi_{Conduction}$) simulates the theoretical relationship ($\Phi_{Conduction} = K \cdot dT_b / dz$), where calculations are a function of thermal conductivity of the bed (K) and the temperature gradient of the bed (dT_b/dz) (Sinokrot and Stefan 1993). Bed conduction is solved with empirical equations developed by Beschta and Weatherred (1984).

The primary source of heat energy is solar radiation, both diffuse and direct. Secondary sources of heat energy include long-wave radiation from the atmosphere and streamside vegetation, streambed conduction and in some cases, groundwater exchange at the water-stream bed interface. Several processes dissipate heat energy at the air-water interface, namely: evaporation, convection and back radiation. Heat energy is acquired by the stream system when the flux of heat energy entering the stream is greater than the flux of heat energy leaving. The net energy flux provides the rate at which energy is gained or lost per unit area and is represented as the instantaneous summation of all heat energy components.

A1.1.2 The Dynamics of Shade

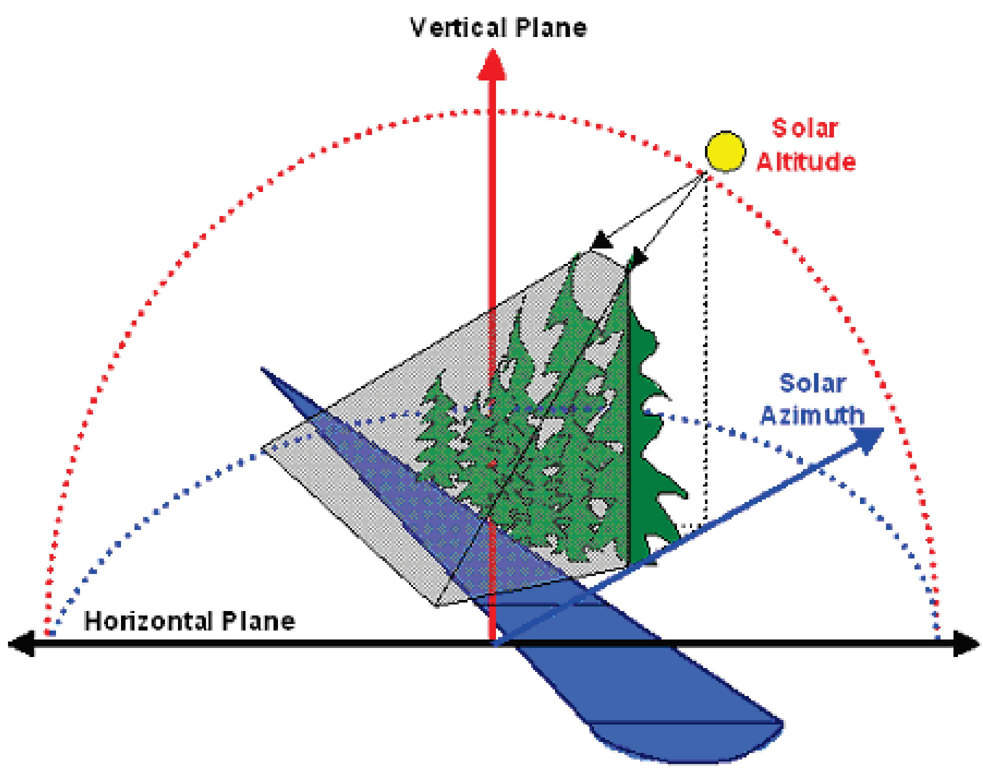
Stream surface shade is a function of several landscape and stream geometric relationships. Some of the factors that influence shade are listed in **Table A-1**. Geometric relationships important for understanding the mechanics of shade are displayed in **Figure A-3**. In the Northern Hemisphere, the earth tilts on its axis toward the sun during summertime months allowing longer day length and higher solar altitude, both of which are functions of solar declination (i.e., a measure of the earth's tilt toward the sun). Geographic position (i.e., latitude and longitude) fixes the stream to a position on the globe, while aspect provides the stream/riparian orientation. Riparian height, width and density describe the physical barriers between the stream and sun that can attenuate and scatter incoming solar radiation (produce shade). The solar position has a vertical component (altitude) and a horizontal component (azimuth) that are both functions of time/date (solar declination) and the earth's rotation (i.e., hour angle). While the interaction of these shade variables may seem complex, the math that describes them is relatively straightforward geometry, much of which was developed decades ago by the solar energy industry.

Solar altitude and solar azimuth are two measurements of the sun's position. When a stream's orientation, geographic position, riparian condition and solar position are known, shading characteristics can be simulated.

Table A-1. Factors that influence stream surface shade

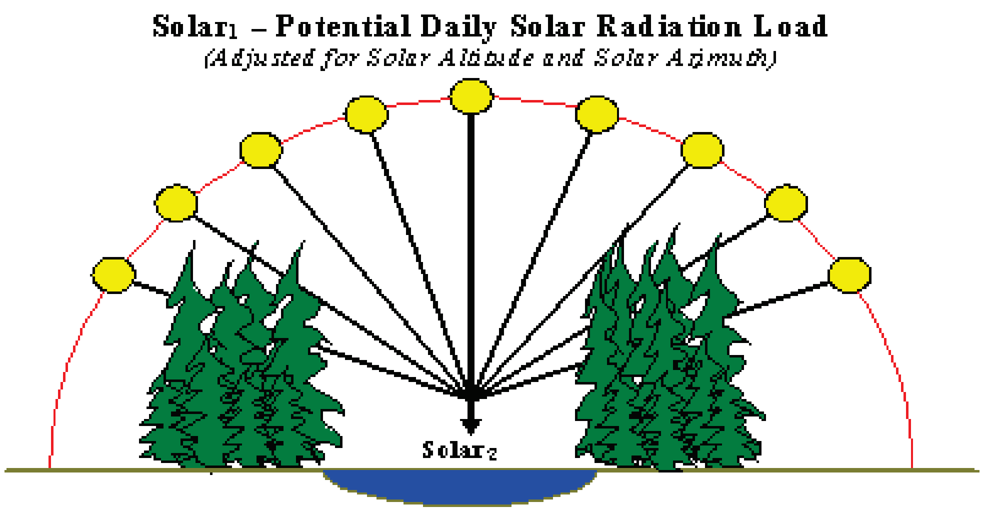
Description	***Measure***
Season/Time	Date/Time
Stream Characteristics	Aspect, Near-Stream Disturbance Zone Width
Geographic Position	Latitude, Longitude
Vegetative Characteristics	Buffer Height, Buffer Width, Buffer Density
Solar Position	Solar Altitude, Solar Azimuth

Figure A-3. Geometric relationships that affect stream surface shade



Percent effective shade is perhaps the most straightforward stream parameter to monitor and calculate and is easily translated into quantifiable water quality management and geometric relationships that affect stream surface shade recovery objectives. **Figure A-4** demonstrates how effective shade is monitored and calculated. Using solar tables or mathematical simulations, the *potential daily solar load* can be quantified. The *measured solar load (current conditions)* at the stream surface can easily be measured with a Solar Pathfinder© or estimated using mathematical shade simulation computer programs (Boyd 1996, Park 1993).

Figure A-4. Effective shade – defined



Effective Shade Defined:

$$\text{Effective Shade} = \frac{(\text{Solar}_1 - \text{Solar}_2)}{\text{Solar}_1}$$

Where,

Solar_1: Potential Daily Solar Radiation Load
Solar_2: Measured Daily Solar Radiation Load at Stream Surface

A1.1.3 Limitation of Stream Temperature TMDL Approach

The purpose of stream temperature modeling is to: (1) determine temperatures for various scenarios including natural thermal potential (NTP), (2) assess heat loading for the purpose of TMDL allocations, (3) compute readily measurable surrogates for the allocations, and (4) better understand heat controls at the local and subbasin scale. Heat Source, version 7.0 (Boyd and Kasper 2003) was the model used for TMDL development in the Lower Grande Ronde Subbasins. The data used in the models and the simulation results are presented in the remainder of this appendix. Limitations of the data and simulation methodology are mentioned in subsequent sections, however, DEQ feels that it is important to acknowledge some of the limitations to this analytical effort up front. The limitations include the following:

1. The scale of this effort is large with obvious challenges in capturing spatial variability in stream and landscape data. Available spatial data sets for land cover and channel morphology are coarse, while derived data sets are limited to aerial photo resolution and human error.
    - Riparian vegetation was mapped from Digital Orthophoto Quads (DOQs) and USFS GIS vegetation data and placed within general height categories. For example, trees identified as

"Large Conifers" were assigned a single height of 93.7 feet throughout the Lower Grande Ronde Subbasins, when in reality, "Large Conifer" heights ranged between 70 and 120 feet. It is not feasible to assign actual heights to each tree mapped using DOQs. These general height categories became Heat Source inputs and are one source of modeling imprecision. Similarly, riparian vegetation densities were also estimated for different vegetation categories, with a single density associated with each category. In the real world, vegetation densities are variable and this variability is not accounted for in the simulations.

- Heat Source breaks the stream into 50-meter segments. Inputs (vegetation, channel morphology, etc.) are averaged for each 50-meter segment, which means that the simulation may not account for some of the real world variability. For example, isolated pools or riffles within a 50 meter reach will not be included as unique features.
- Stream elevations and gradients were sampled and calculated from 10-meter digital elevation models (DEMs). DEMs have a certain level of imprecision associated with them and may be a source of uncertainty in the simulation results.

2. Current analytical methods fail to capture some upland, atmospheric and hydrologic processes. At a landscape scale, these exclusions can lead to errors in analytical outputs.
   - Methods are not currently available to simulate riparian microclimates at a landscape scale. Regardless, recent studies (Anderson et. al. 2007 and Rykken et. al. 2007) indicate that forested microclimates play an important, yet variable, role in moderating air temperature, humidity fluctuations and wind speeds.
   - Existing air temperature and relative humidity data were used from various weather stations in the Subbasins. This data, however, may not capture natural variations in air temperature and relative humidity along the stream. For example, temperatures may change as the landscape changes over short distances along the stream. These are similar to the microclimates created by vegetation cover.
   - The actual position of the sun within the sky can only be calculated with an uncertainty of 10-15%. The sun's position is important when determining a stream's effective shade. Solar position is another source of modeling imprecision.
   - Sinuosity change is typically not simulated, because the selected simulation methods are spatially explicit.
   - Heat Source always assumes that the wetted stream is flowing directly down the center of the active channel, and effective shade calculations are based upon that assumption. In reality, a stream migrates all over the active channel. This is another source of modeling imprecision.

3. Quantification techniques for estimating potential subsurface inflows/returns and behavior within substrate are not employed in this analysis. Groundwater exchanges and hyporheic flows are difficult to measure and may not always be accounted for within stream temperature modeling.

4. Current analysis is focused on a defined critical condition – a three-week period during a single summer. This time period is intended to represent a critical condition for aquatic life when stream flows are low, radiant heating rates are high and ambient conditions are warm. However, there are several other important time periods where fewer data are available and the analysis is less explicit. For example, spawning periods have not received treatment comparable to that of the seasonal maximum stream temperature.

5. Land use patterns vary through the drainage from heavily impacted areas to areas with little human impacts. However, it is extremely difficult to find large areas without some level of either current or past human impacts. The development of Natural Thermal Potential (NTP) conditions that estimate stream conditions when human influences are minimized is statistically derived and based on stated assumptions within this document. Limitations to stated assumptions are presented where appropriate. It should be acknowledged that as better information is developed these assumptions will be refined.

- In some cases, there is not scientific consensus related to riparian, channel morphology and hydrologic potential conditions. This is especially true when confronted with highly disturbed sites, meadows and marshes, and potential hyporheic/subsurface flows.
- “Natural” flows were included in the NTP simulation. Estimates were used to create the existing flow mass balance, and withdrawals were estimated for the current condition, based on thermal infrared aerial data, the OWRD points of diversion database, and instream flow measurements. “Natural” flows are estimates based on removing the assumed anthropogenic impacts on the current flow regimes.
- Stream velocities and depths were calculated by Heat Source for the “natural” flow conditions based on measured channel dimensions and substrate composition. These estimated velocities and depths for the “natural” flows may have some error associated with them since they have not been verified through field measurements.
- Natural stream conditions may have had more groundwater connection, wetland areas, and hyporheic interactions prior to anthropogenic disturbances. These conditions are not included in the NTP scenario. Stream restoration may increase groundwater connectivity which could reduce the NTP temperatures.
- Increased channel complexity and more coarse woody debris are not accounted for in the NTP simulation. Including these factors may result in cooler NTP temperatures.

While these assumptions outline potential areas of weakness in the methodology used in the stream temperature analysis, DEQ has undertaken a comprehensive approach. All important stream parameters that can be accurately quantified are included in the analysis. In the context of understanding of stream temperature dynamics, these areas of limitations should be the focus for future studies.

A2. AVAILABLE DATA

A2.1 Ground Level and Remote Sensing Data

Stream temperature, flow, and stream habitat surveys have been collected by the following local stakeholders:

- Oregon Department of Environmental Quality (DEQ)
- U.S. National Forest (USFS)
- Oregon Department of Fish and Wildlife (ODFW)
- Wallowa County Soil and Water Conservation District (SWCD)
- Nez Perce Tribe
- Oregon Water Resources Department (OWRD)

The data collection methods include both ground level measurements and remote sensing. Most of the data used in this modeling effort was collected during the summers of 1999 and 2000, although much of the ground level data has been collected other years as well. The remote sensing data (thermal infrared) was collected in 1999. The data used in this assessment is available from DEQ upon request. Much of the temperature data is also available through the DEQ website in the LASAR database (http://www.deq.state.or.us/lab/lasar.htm).

A2.1.1 Stream Temperature Data

Two types of stream temperature data were collected in 1999 and 2000:

- Continuous instream monitoring data
- Thermal infrared (TIR) data

It should be noted that not all of the data collected in 1999 and 2000 and presented in this section was used in the TMDL simulations described in this Appendix. A summary of the TIR and continuous temperature data collected throughout the Subbasins is summarized in this section. Only the Wallowa River temperature data (and data at the mouths of tributaries) was used in the TMDL temperature simulations.

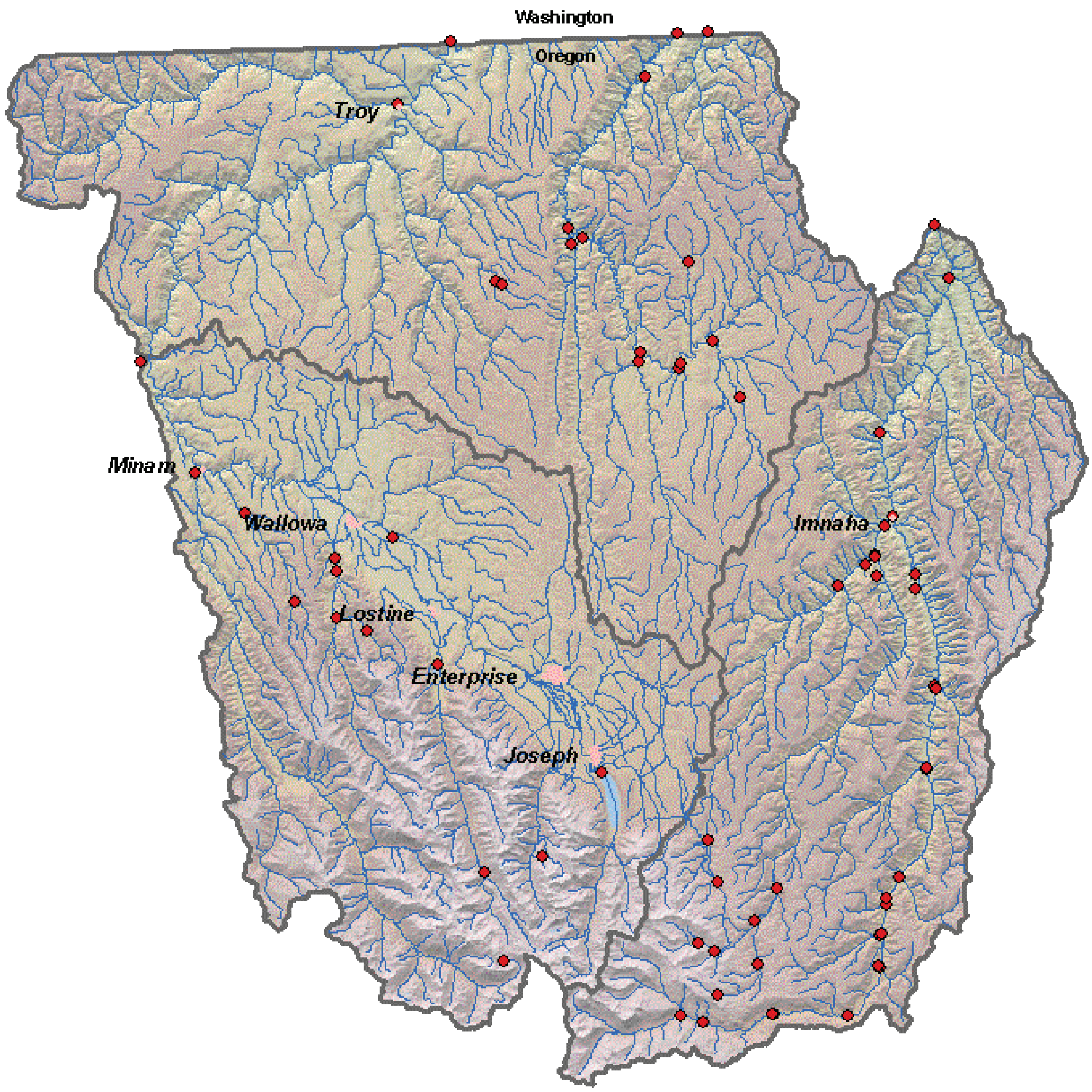
Continuous Data

Continuous temperature data were collected at a number of locations using thermistors[1] and data from these devices were routinely checked for accuracy. Continuous temperature data were collected in 1999 and/or 2000 at eighty-one sites (**Figure A-5**).

In this TMDL analysis, the continuous data was used to: calibrate stream emissivity for the TIR; calibrate stream statistics and assess the temporal component of stream temperature; and calibrate temperature simulations.

[1] Thermistors are small electronic devices that are used to record stream temperature at one location for a specified period of time, usually spanning several summertime months.

Figure A-5. Continuous stream temperature measurement locations in 1999 and 2000



TIR Data

Thermal imagery data measures the temperature of the outermost portions of the bodies/objects in the image (i.e., ground, riparian vegetation, stream). The bodies of interest are opaque to longer wavelengths and there is little, if any, penetration of the bodies.

TIR data was remotely sensed from a sensor mounted on a helicopter that collected digital data directly from the sensor to an on-board computer at a rate that insured the imagery maintained a continuous image overlap of at least 40%. The TIR detected emitted radiation at wavelengths from 8-12 microns (long-wave) and recorded the level of emitted radiation as a digital image across the full 12-bit dynamic range of the sensor. Each image pixel contained a measured value that was directly converted to a temperature. Each thermal image has a spatial resolution of less than one-half meter/pixel. Visible video sensor captured the same field-of-view as the TIR sensor. GPS time was encoded on the recorded video as a means to correlate visible video images with the TIR images during post-processing.

Data collection was timed to capture maximum daily stream temperatures, which typically occur between 14:00 and 18:00 hours. The helicopter was flown longitudinally over the center of the stream channel with the sensors in a vertical (or near vertical) position. In general, the flight altitude was selected so that the stream channel occupied approximately 20-40% of the image frame. A minimum altitude of approximately 300 meters was used both for maneuverability and for safety reasons. If the stream split into two channels that could not be covered in the sensor's field of view, the survey was conducted over the larger of the two channels.

Instream thermistors were distributed in each subbasin prior to the survey to ground truth (i.e., verify the accuracy) the radiant temperatures measured by the TIR. TIR data can be viewed as GIS point coverages or TIR imagery.

Direct observation of spatial temperature patterns and thermal gradients is a powerful application of TIR derived stream temperature data. Thermally significant areas can be identified in a longitudinal stream temperature profile and related directly to specific sources (i.e., water withdrawal, tributary confluence, land cover patterns, etc.). Areas with stream water mixing with subsurface flows (i.e., hyporheic and inflows) are apparent, and often dramatic, in TIR data. Thermal changes captured with TIR data can be quantified as a specific change in stream temperature or a stream temperature gradient that results in a temperature change over a specified distance.

DEQ contracted with Watershed Sciences, Inc. to collect TIR data in the Lower Grande Ronde and Wallowa River Subbasins during 1999. TIR data was not collected in the Imnaha River Subbasin. The TIR-derived temperatures for each stream are shown in **Figure A-6**. In this TMDL analysis, the TIR data for the Wallowa River were used to: measure surface temperatures; develop longitudinal temperature profiles; develop flow mass balances; map/identify significant thermal features; indicate subsurface hydrology, groundwater inflow and/or springs; and validate simulated stream temperatures.

Figure A-7 displays the measured TIR profiles for each of the streams sampled in the Lower Grande Ronde and Wallowa River Subbasins (note: tributary/spring temperatures are from TIR imagery). **Figures A-8** through **A-16** depict TIR longitudinal graphic profiles and digital video imagery for selected areas of interest.

It is important to note that thermal stratification can be identified in TIR imagery and by comparison with the instream temperatures loggers. In unstratified streams, temperature measurements from bottom-anchored thermistors and TIR should be the same, within the range of measurement uncertainty. In the case of the Lower Grande Ronde Subbasins TIR flights, no stream reaches were identifiably stratified. The streams where TIR data was collected were fully mixed.

Figure A-6. River sampled TIR temperatures on the Lostine River, Bear Creek, Minam River, Wallowa River, Lower Grande Ronde River, Chesnimnus Creek, and Joseph Creek

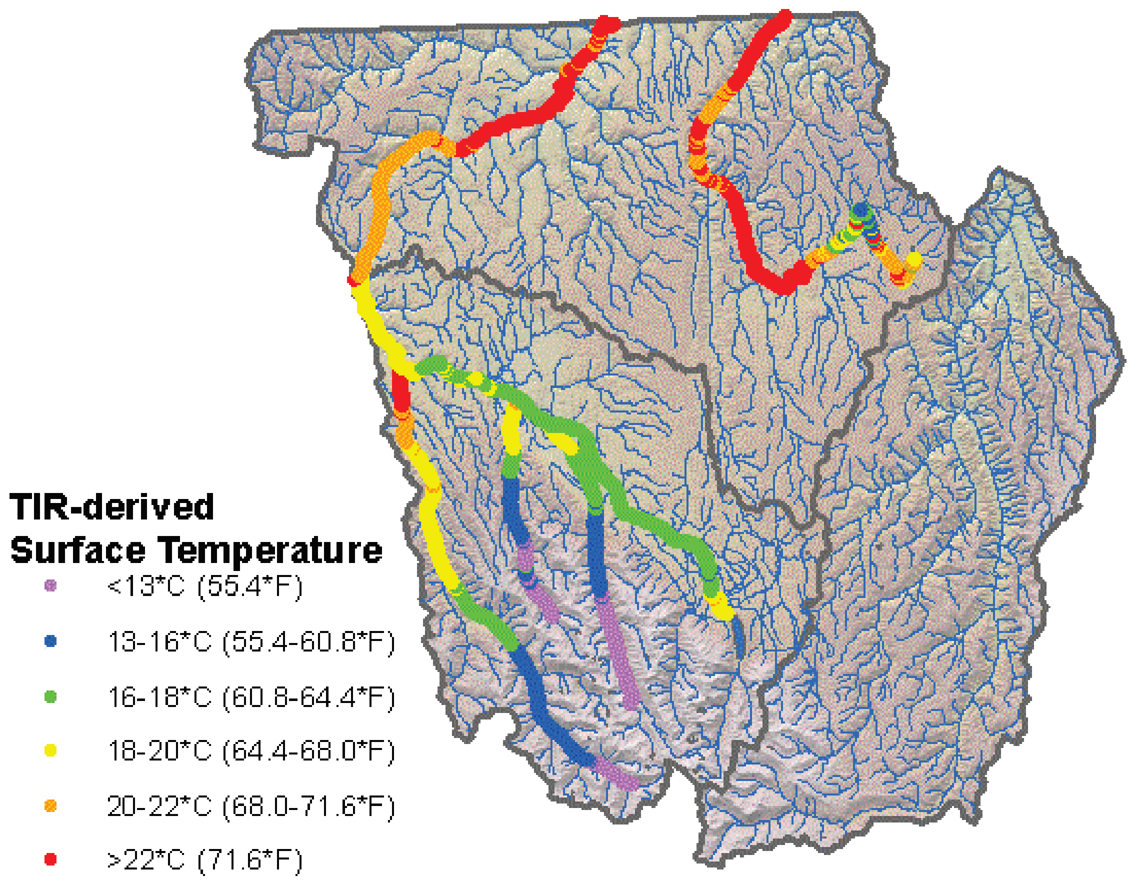
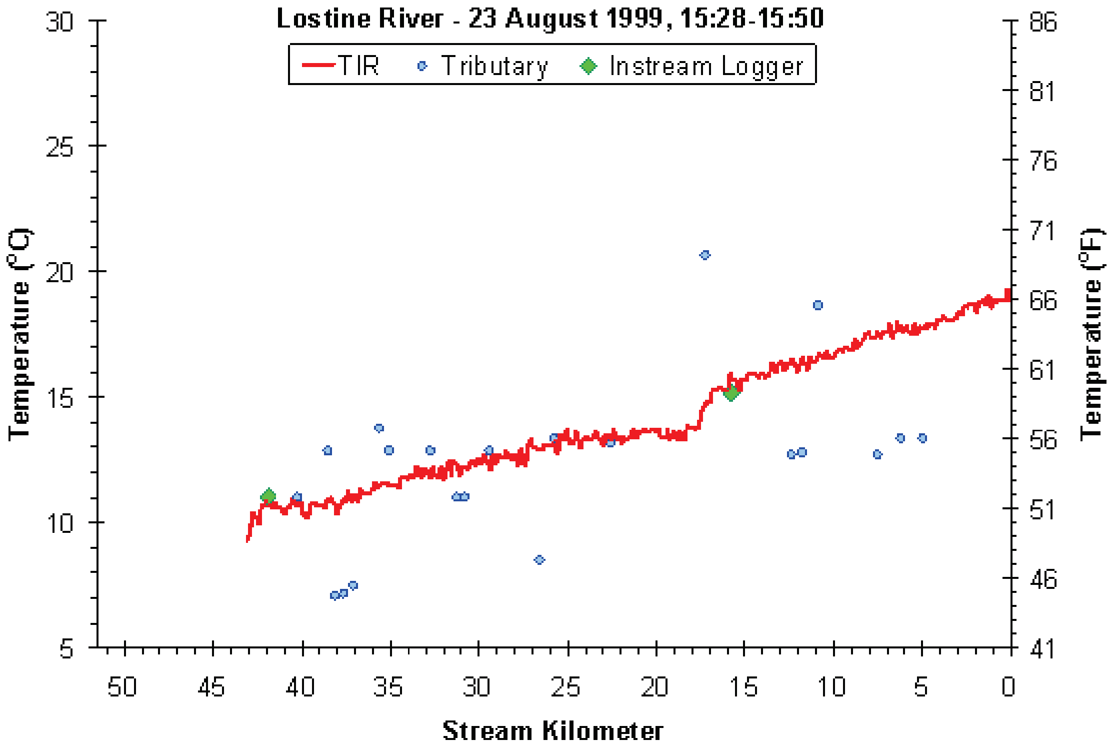


Figure A-7. Measured stream temperature longitudinal profiles



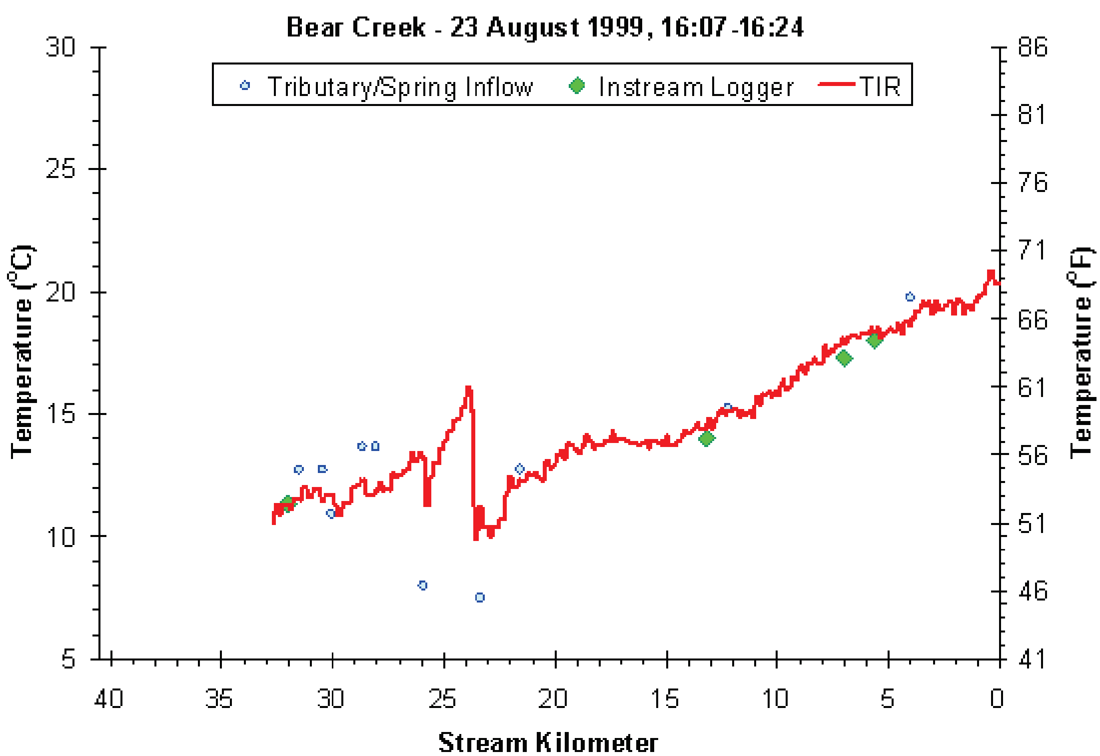
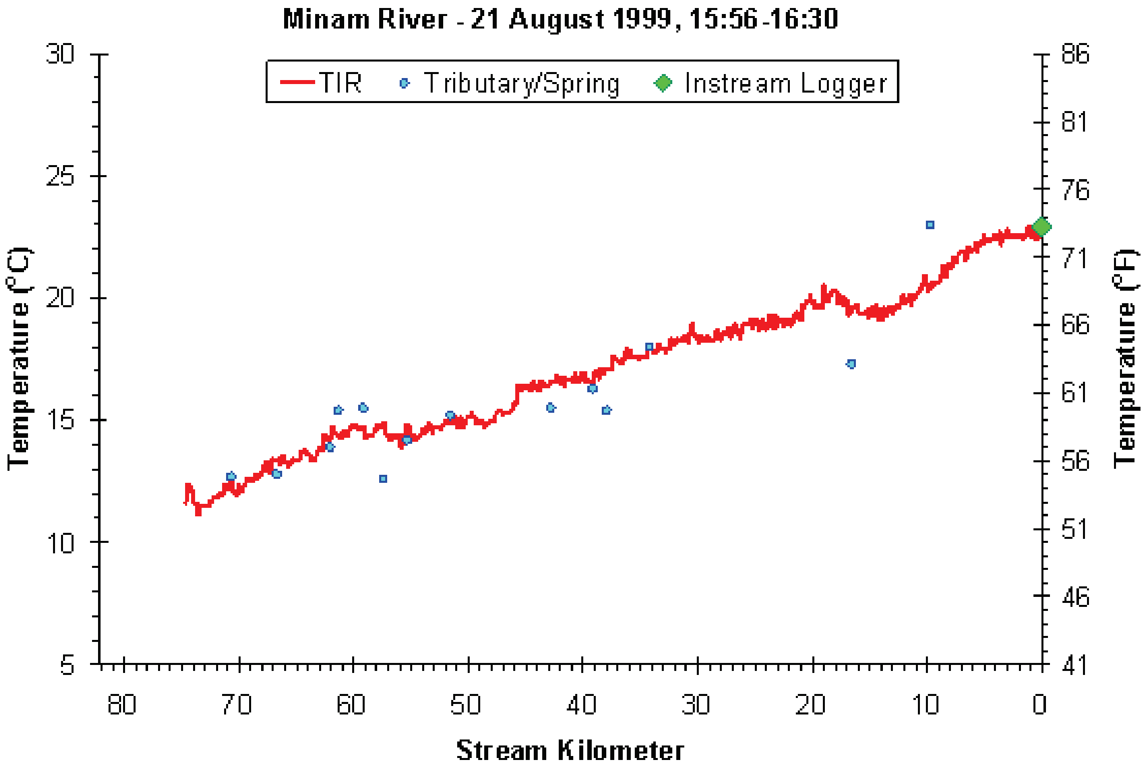


Figure A-7 (continued). Measured stream temperature longitudinal profiles



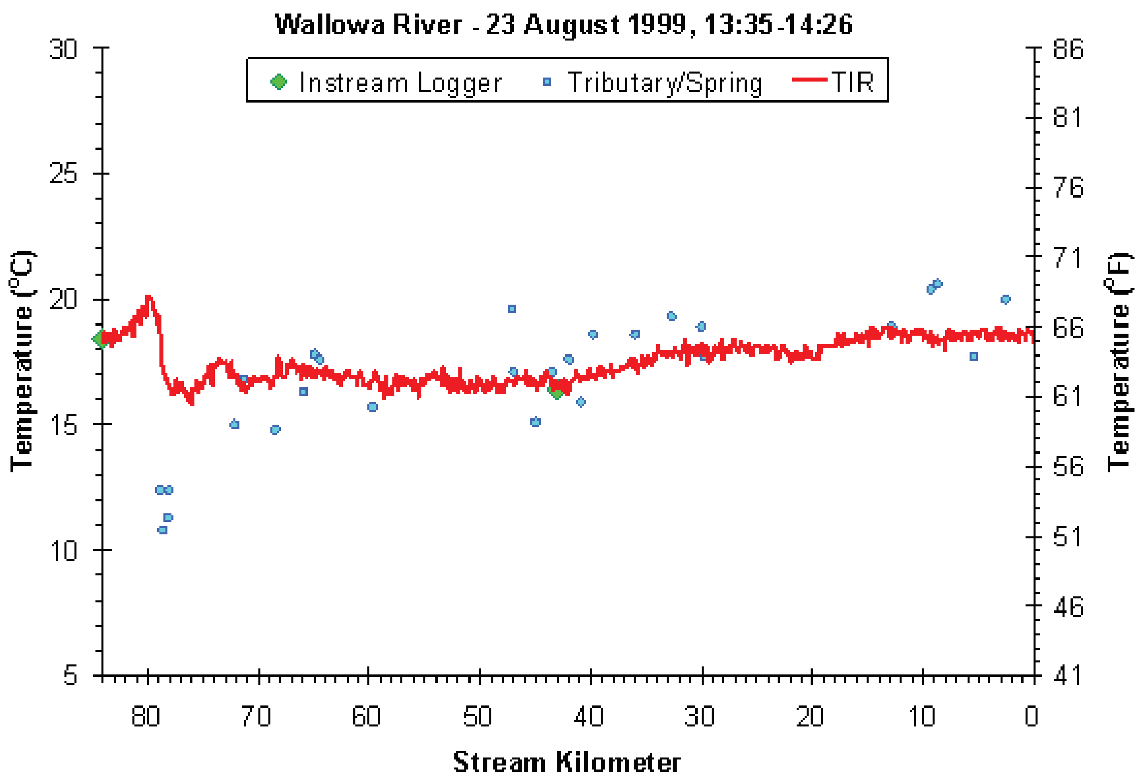
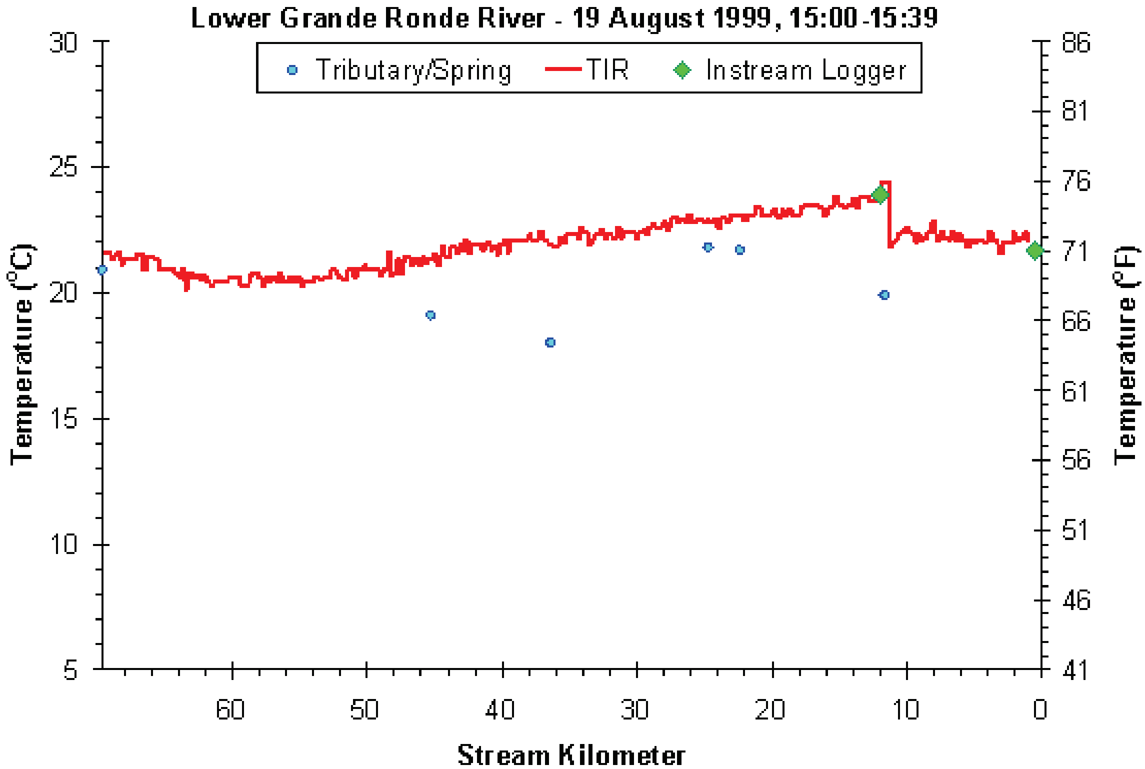


Figure A-7 (continued). Measured stream temperature longitudinal profiles



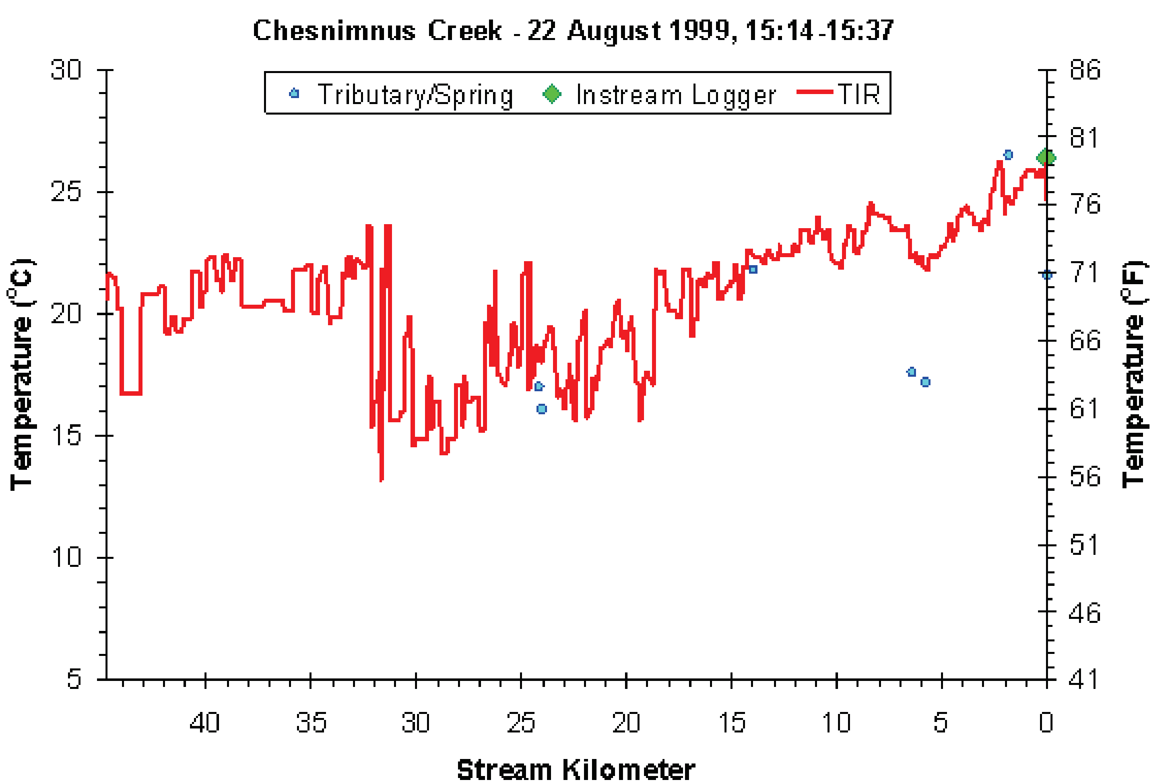


Figure A-7 (continued). Measured stream temperature longitudinal profiles

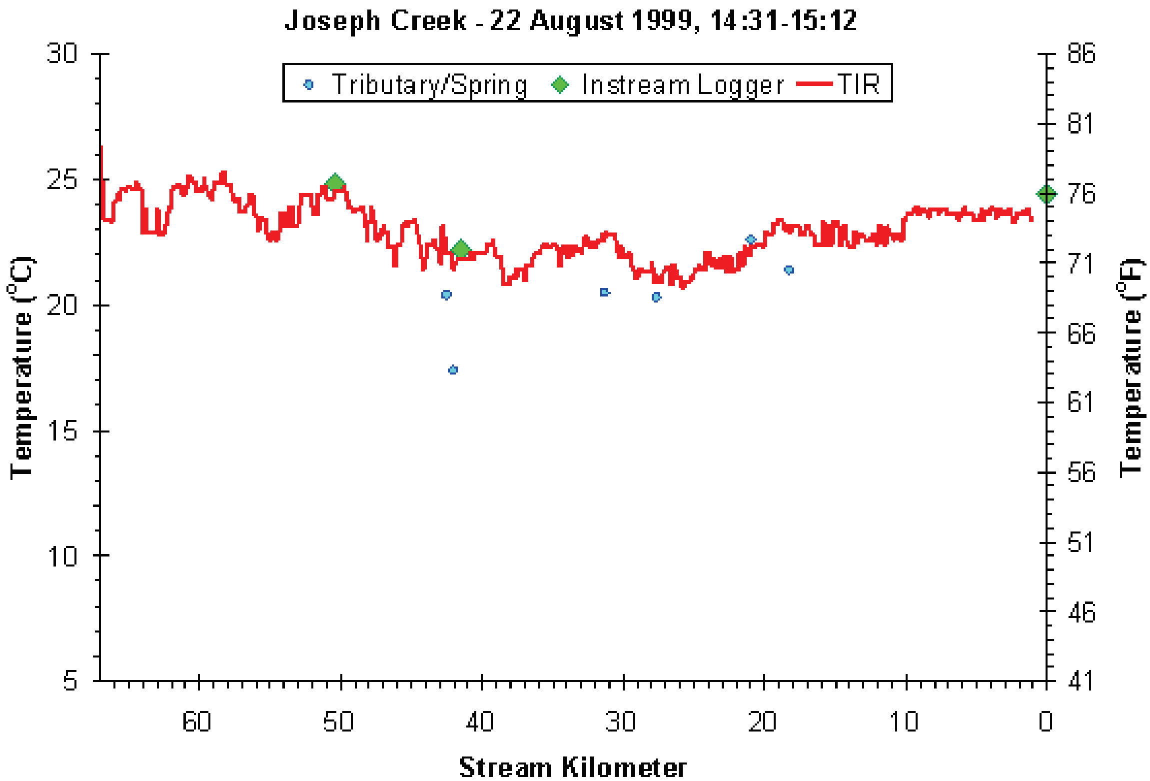
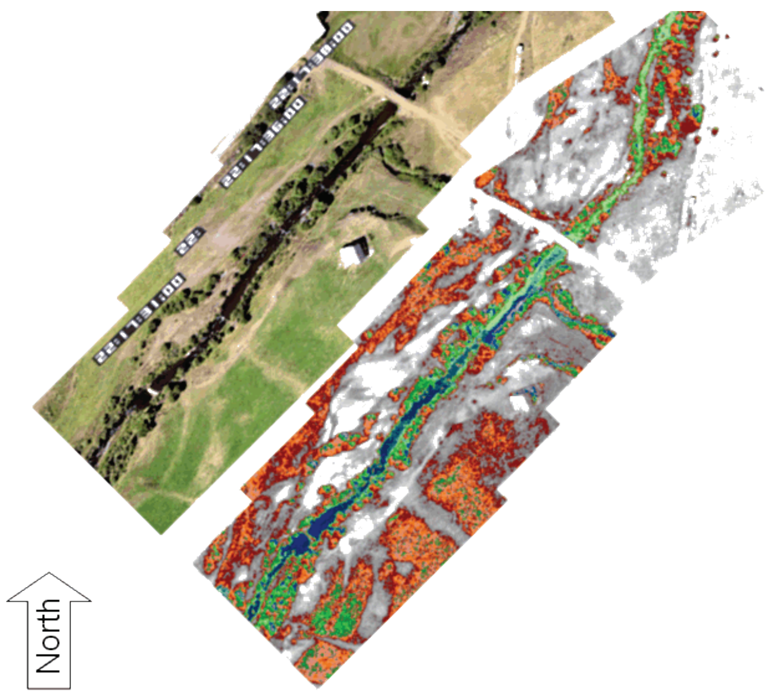


Figure A-8. Chesnimnus Creek at Butte Creek confluence

Chesnimnus Creek is flowing from the top of the image to the bottom, and Butte Creek confluence is just downstream the bridge



Temperature Scale (°F)

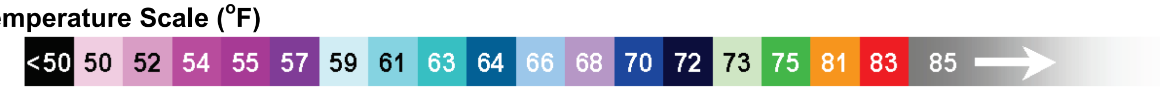
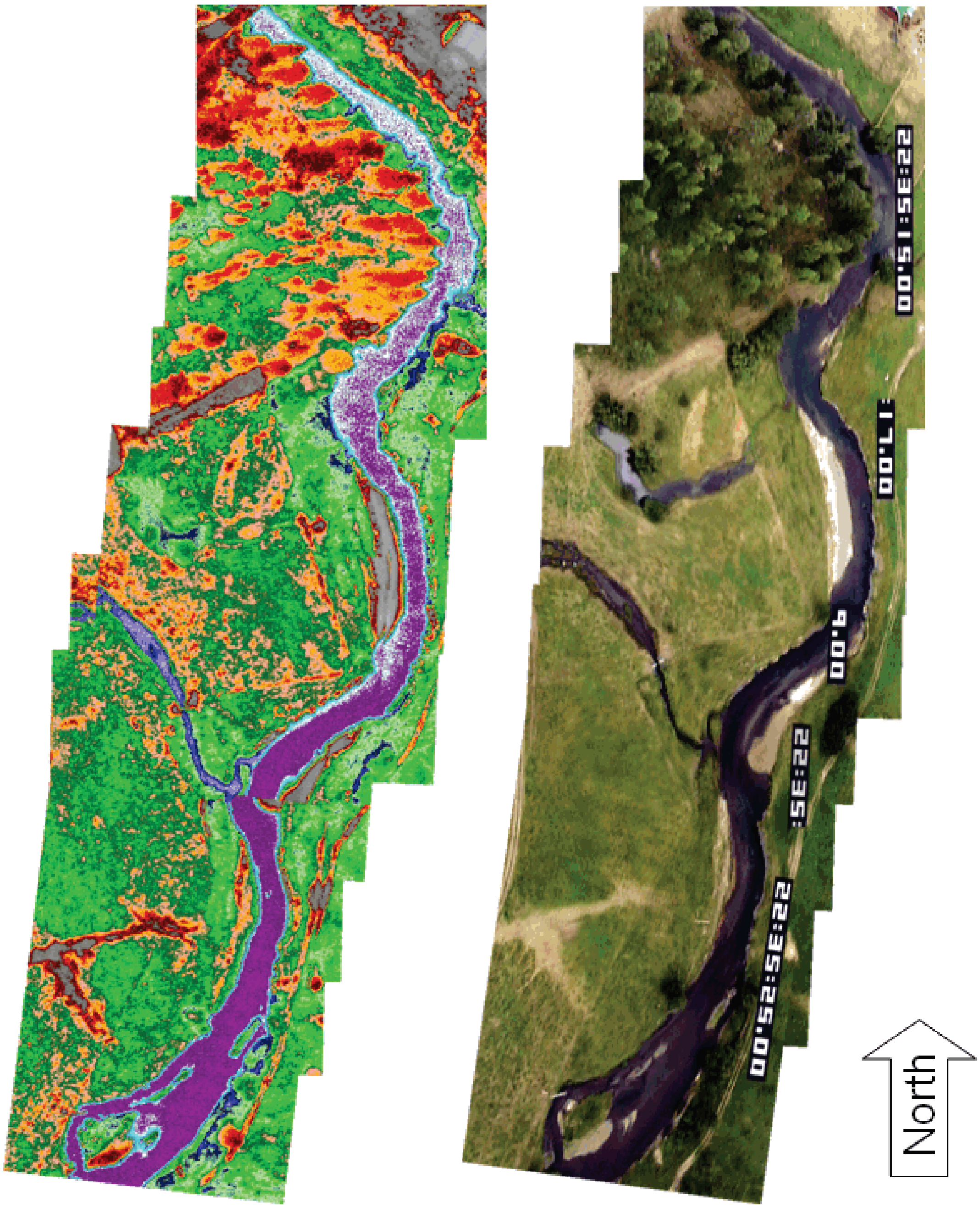


Figure A-9. Lostine River at inflow from Lostine Reservoir

The Lostine River (~57°F) is flowing from the bottom of the image to the top, while reservoir water (~70°F) is returning to the stream from the left side of the image

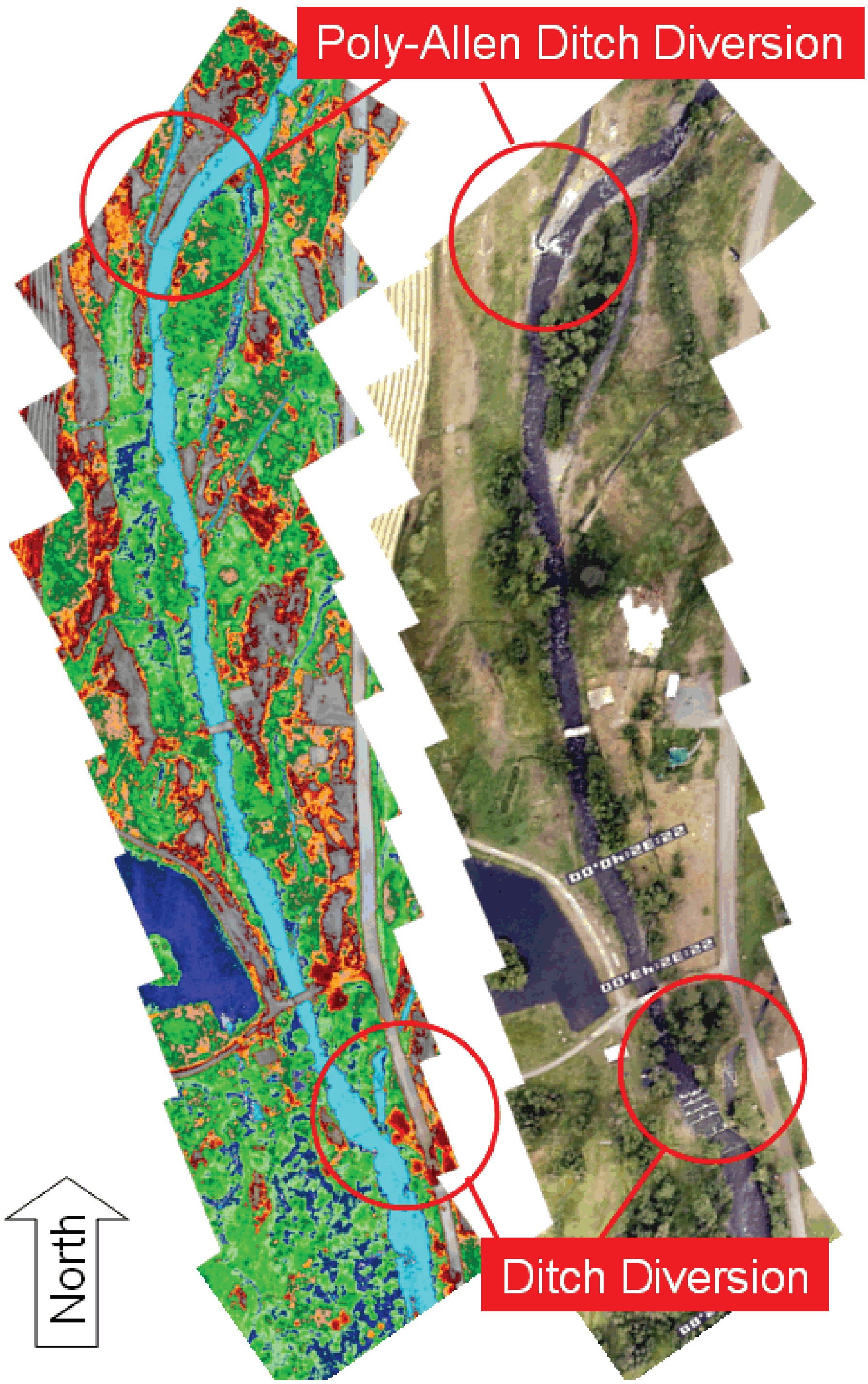


Temperature Scale (°F)

<50	50	52	54	55	57	59	61	63	64	66	68	70	72	73	75	81	83	85

Figure A-10. Lostine River Diversions

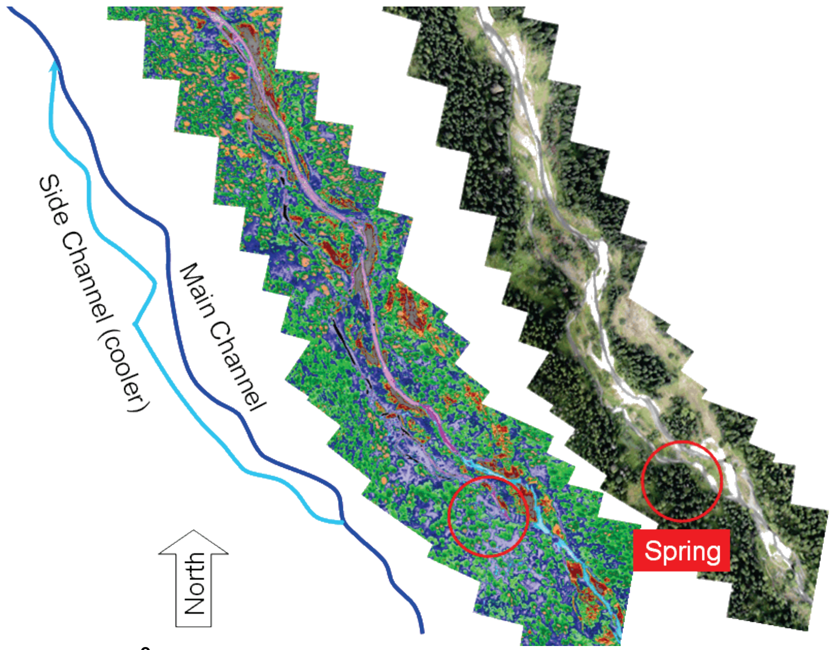
The Lostine River is flowing from the bottom of the image to the top. There are instream structures and diversion ditches visible in the day video and TIR images.



Temperature Scale (°F)

<50 | 50 | 52 | 54 | 55 | 57 | 59 | 61 | 63 | 64 | 66 | 68 | 70 | 72 | 73 | 75 | 81 | 83 | 85

Figure A-11. Bear Creek at river mile 14.1, near Dobbin Creek.
This stretch of river has a complex channel system with cool side channels and springs. Note how the temperature changes from about 61°F to the low 50's as a spring and cool side channel waters mix with the mainstem.



Temperature Scale (°F)

<50	50	52	54	55	57	59	61	63	64	66	68	70	72	73	75	81	83	85

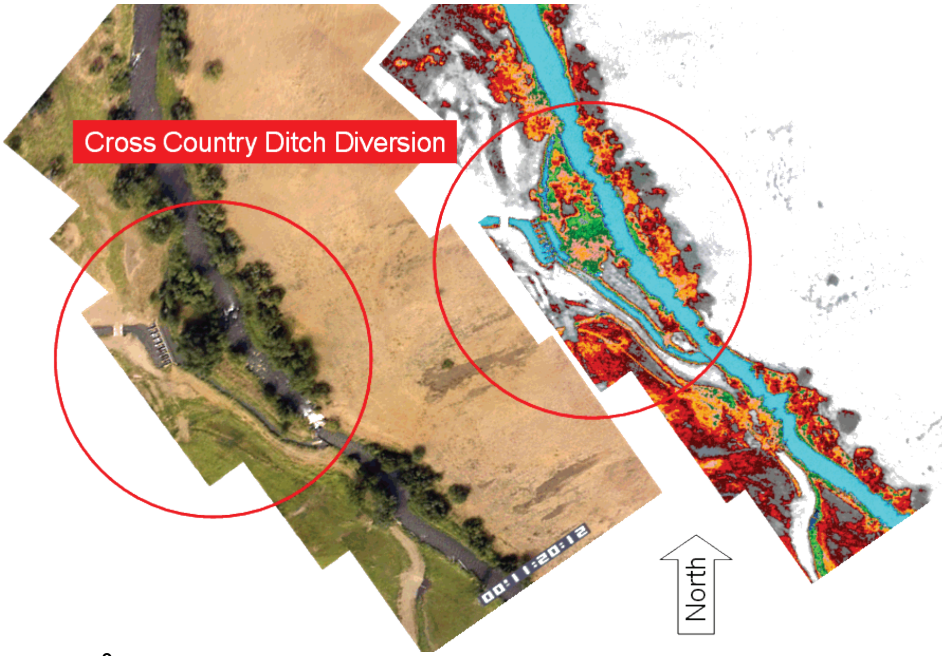
Figure A-12. Grande Ronde River at Wenaha River confluence
The Grande Ronde River (~74°F) is flowing up from the bottom to the right of the image, while the Wenaha River (~68°F) is entering at the north side of the bend.

Temperature Scale (°F)

<50	50	52	54	55	57	59	61	63	64	66	68	70	72	73	75	81	83	85

Figure A-13. Wallowa River at Cross Country Ditch diversion

The Wallowa River is flowing from the bottom to the top of the image, while the diversion for the Cross Country Ditch is visible on the left side.

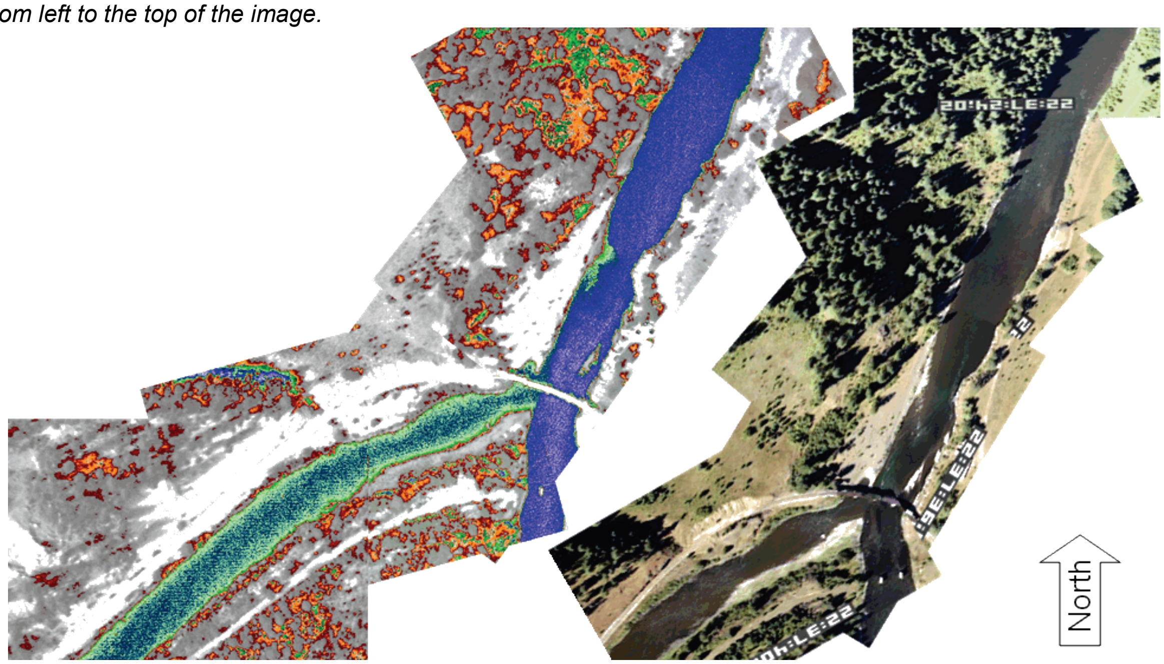


Temperature Scale (°F)

<50	50	52	54	55	57	59	61	63	64	66	68	70	72	73	75	81	83	85 →

Figure A-14. Wallowa River at mouth/Grande Ronde River confluence

The Wallowa River is flowing from the bottom right of the image, while the Grande Ronde River is flowing from the bottom left to the top of the image.



Temperature Scale (°F)

<50	50	52	54	55	57	59	61	63	64	66	68	70	72	73	75	81	83	85 →

Figure A-15. Wallowa River at Lostine River confluence

The Wallowa River is flowing from the left to the right of the image, while the Lostine River is entering form the bottom of the image. A temperature gradient is visible for a short distance downstream of the confluence, before completely mixing at the bend.

Temperature Scale (°F)

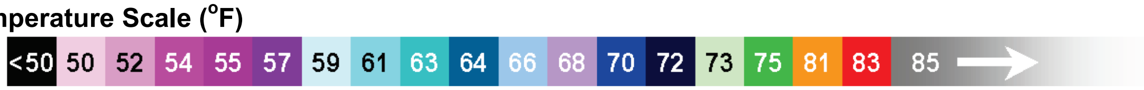
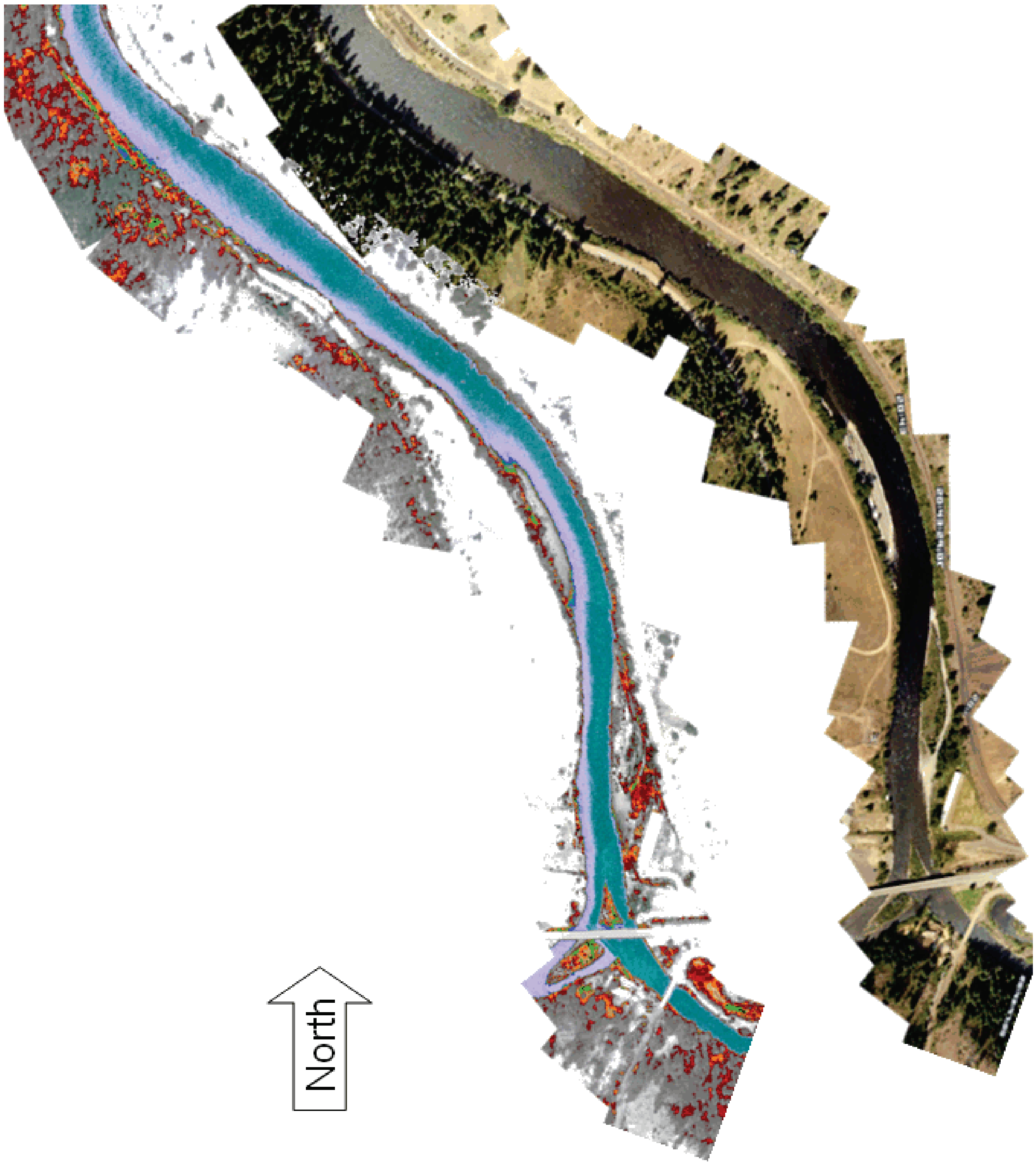


Figure A-16. Wallowa River at Minam River confluence

The Wallowa River (~64°F) is flowing from the bottom to the top of the image, while the Minam River (~68°F) is entering on the left. The thermal gradient is apparent the entire length of the image (~1/4 mile). Complete mixing occurs after the bend seen at the top of this image.



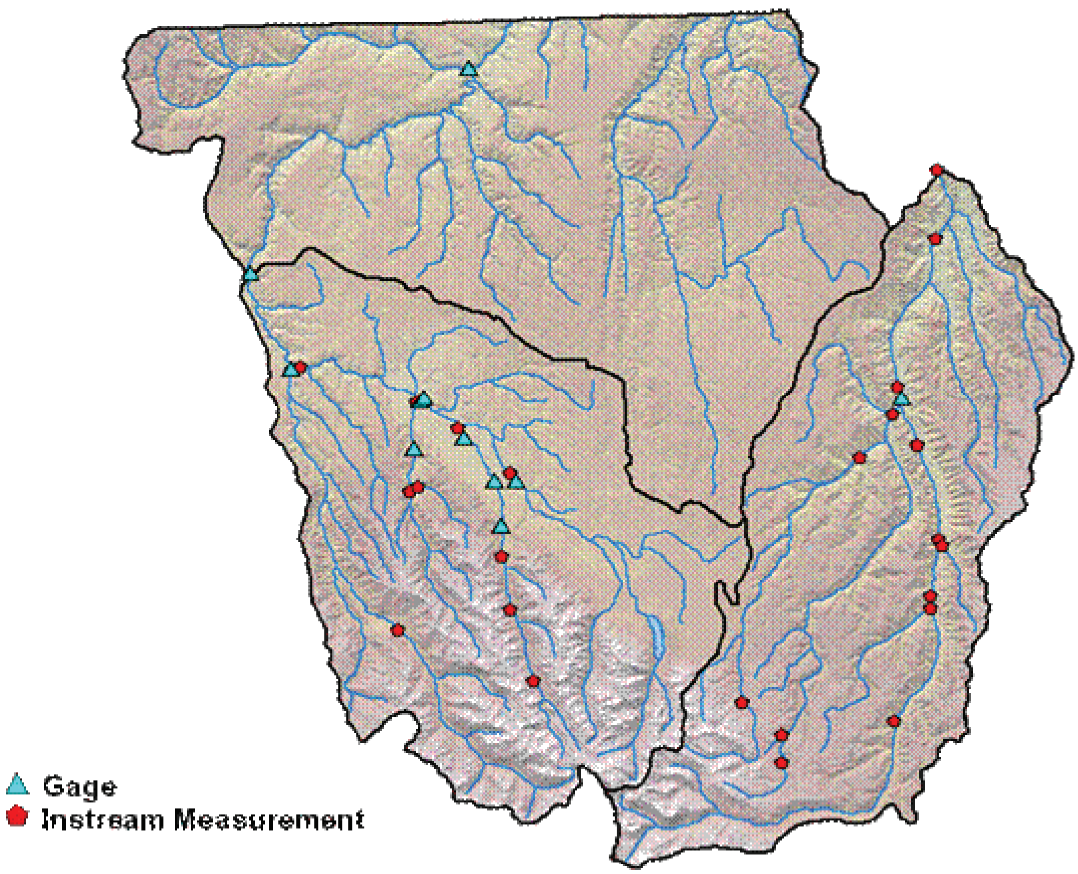
Temperature Scale (°F)

<50	50	52	54	55	57	59	61	63	64	66	68	70	72	73	75	81	83	85

A2.1.2 Flow Volume – Gage Data and Instream Measurements

Flow volume data was collected at several sites during the critical stream temperature period in late August of 1999 and 2000 by DEQ (**Figure A-17**). Where applicable, these instream measurements were used to develop flow mass balances for the Wallowa River temperature model. In addition to flow rate data, wetted width, depth and velocity measurements were also made at these sites. This data were used to corroborate the simulated stream hydraulics. Data from one USGS gage and OWRD gages was also used in the analysis.

Figure A-17. Flow measurement locations (August, 1999 and 2000).
DEQ collected instream measurements during this period.

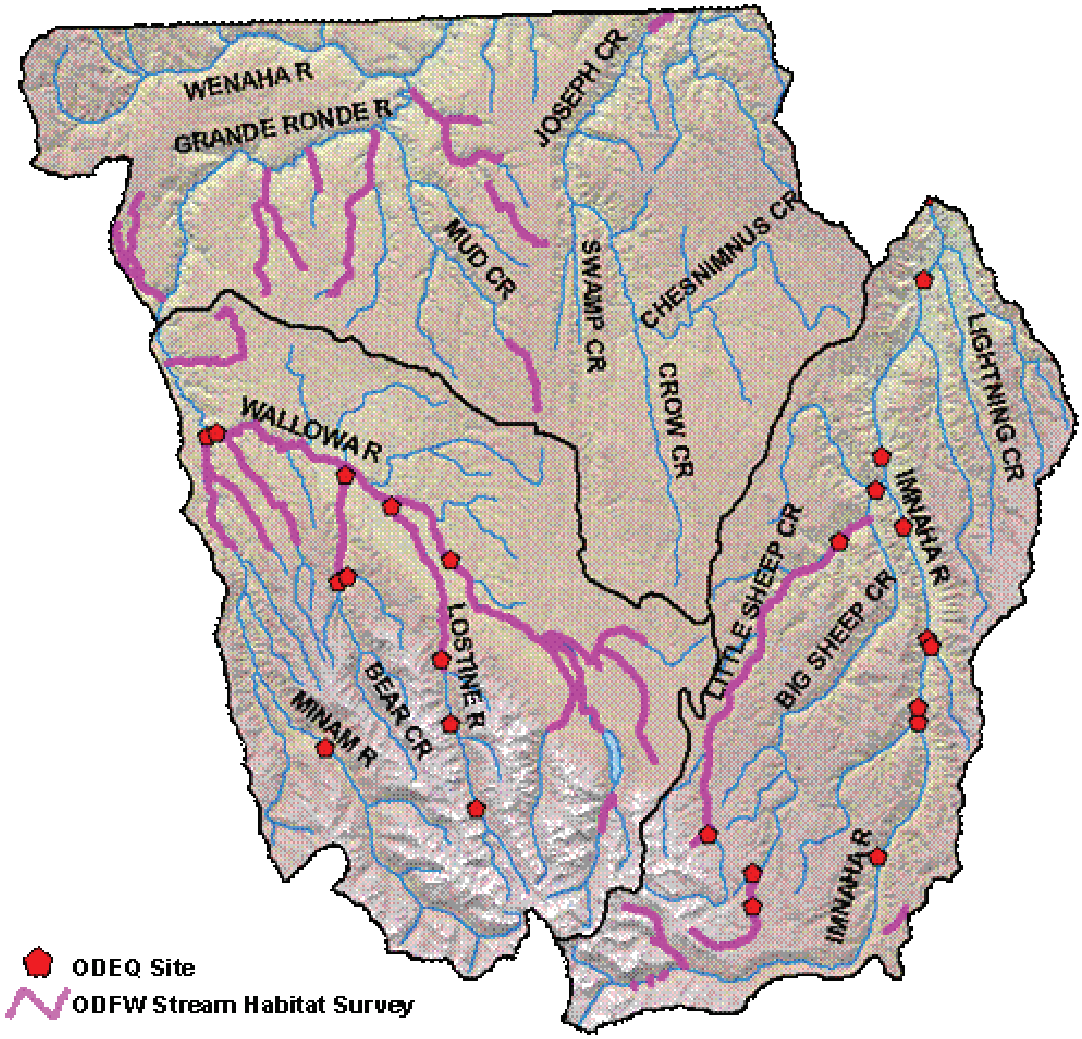


A2.1.3 Stream Habitat Surveys

During the summers of 1999 and 2000, Oregon DEQ collected ground-level habitat data at several locations in the Lower Grande Ronde Subbasins, focusing on the Wallowa River and Imnaha River Subbasins. Stream survey data focused on near stream vegetation classification and measurements, channel morphology measurements, and stream shade measurements.

ODFW has also collected stream habitat data (ODFW 1999). Their data sets also focus on channel morphology, near stream land cover, and stream shade measurements. **Figure A-18** displays the DEQ and ODFW stream survey locations.

Figure A-18. Ground level stream habitat survey sites



A2.2 GIS Data

This stream temperature TMDL relies extensively on GIS data. Water quality issues in the Lower Grande Ronde Subbasins are interrelated, complex and spread over hundreds of square miles. The TMDL analysis strives to capture these complexities using the highest resolution data available. The GIS data used to develop this TMDL are listed below in **Table A-2** and further described below.

Table A-2. Spatial data and application

Spatial Data	Application
10-Meter Digital Elevation Models (DEM)	Measure stream elevation and gradient Measure valley shape and landform Measure topographic shade angles
Aerial Imagery – Digital Orthophoto Quads	Map near stream vegetation Map stream position and channel edges Map channel morphology and aspect Map road, developments, and other structures
Water Rights Information System (WRIS) and Points of Diversion (POD) Data	Map locations and estimate quantities of water withdrawals

A2.2.1 10-Meter Digital Elevation Model (DEM)

Digital Elevation Model (DEM) data files are representations of cartographic information in a raster form. DEMs consist of a sampled array of elevations for a number of ground positions at regularly spaced intervals. The U.S. Geological Survey, as part of the National Mapping Program, produces these digital cartographic/geographic data files. Ten-meter DEM grid elevation data is rounded to the nearest meter for ten-meter pixels (vertical resolution is approximately one meter in flat terrain).

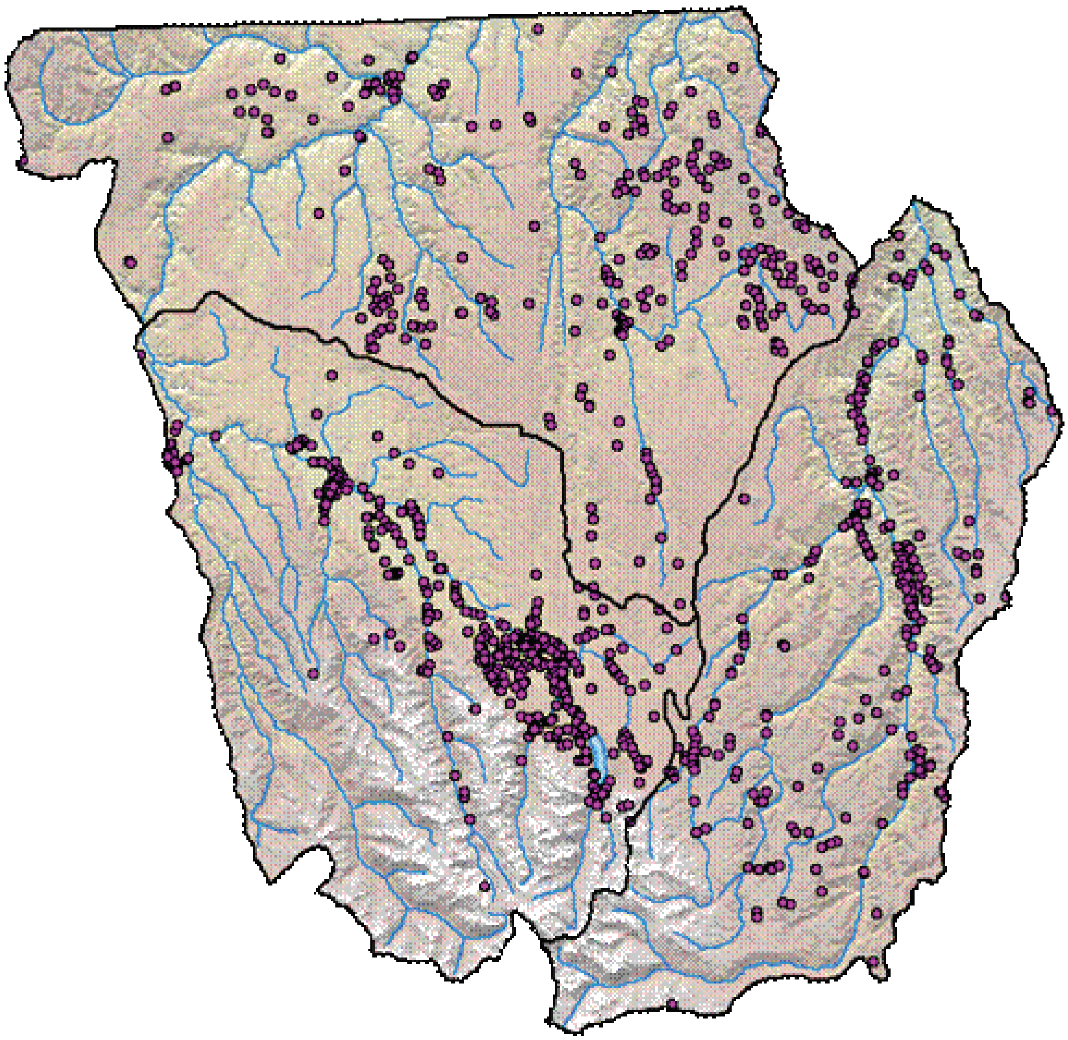
A2.2.2 Aerial Imagery – Digital Orthophoto Quads

A digital orthophoto quad (DOQ) is a digital image of an aerial photograph in which camera distortion has been removed. In addition, DOQs are projected in map coordinates combining the image characteristics of a photograph with the geometric qualities of a map. The digital orthophotos used in this report were black-and-white with one-meter pixels covering a USGS quarter quadrangle. The images were collected in May through July of 1994, 1995 and 1996, and were provided through the Natural Resources Conservation Service National Cartography and Geospatial Center. Color DOQ imagery (NAIP, 2005) became available in 2007, but were not used in this TMDL because the modeling work had already been completed.

A2.2.3 WRIS and POD Data – Water Withdrawal Mapping

Flow is diverted throughout the Lower Grande Ronde Subbasins during the summer for irrigation purposes. The Oregon Water Resources Department (OWRD) maintains the Water Rights Information System (WRIS). WRIS is a database used to monitor information related to water rights. A separate database tracks points of diversions (POD). These two databases were linked by DEQ to map the locations of diversions, rates of water use and types of water use in the Lower Grande Ronde Subbasins (**Figure A-19**). Consumptive use was estimated using these data and incorporated in developing mass balance flow profiles for the Wallowa River. There are over 1,000 permitted water rights in the Subbasins.

Figure A-19. Mapped points of diversion in Lower Grande Ronde Subbasins derived from the WRIS and POD databases (OWRD data, DEQ database programming and mapping)



A2.3 Derived Data and Sampled Parameters

Sampling numeric GIS data sets for several landscape parameters and performing simple calculations was done to derive spatial data for several stream parameters for the Wallowa River. Sampling density was user-defined and generally matched any GIS data resolution and accuracy. The sampled parameters used in the stream temperature/shade analysis were:

- Stream Position and Aspect
- Stream Elevation and Gradient
- Maximum Topographic Shade Angles (East, South, West)
- Channel Width
- TIR Temperature Data Associations
- Near Stream Vegetation

Most of these parameters were derived using TTools Version 7 (Boyd and Kasper 2003). TTools is a set of ArcView GIS tools that are designed to automatically sample spatial data sets and assemble an input database for Heat Source modeling (both shade and temperature modeling). The methodologies used for deriving this data in the Lower Grande Ronde Subbbasins Temperature TMDL analysis are described below.

In addition to these derived landscape parameters, stream flows were derived using a mass balance method. Stream flow measurements were taken at a limited number of locations as described in **Section A2.1.2**. The mass balance method was used to calculate stream flows in areas where field measurements were not collected.

A2.3.1 Stream Position and Aspect

Stream position was assessed by digitizing the stream centerline for each modeled stream. This polyline was segmented into 50-meter reaches (separated by nodes). The latitude/longitude and aspect (downstream direction) were calculated at each node. An aspect of zero would by north, 90 (east), 180 (south), and 270 (west).

A2.3.2 Stream Elevation and Gradient

Stream elevation was sampled from the 10-meter DEM at each of the segmented TTools nodes. Gradients were calculated from the elevation of the stream node and the distance between nodes.

A2.3.3 Topographic Shade Angle

The maximum topographic shade angles to the west, south and east were measured using the 10-meter DEM at each of the segmented nodes. The topographic angle represents the vertical angle to the highest topographic feature as measured from a flat horizon. The sampling routine extended 10.0 kilometers (6.2 miles) in each direction.

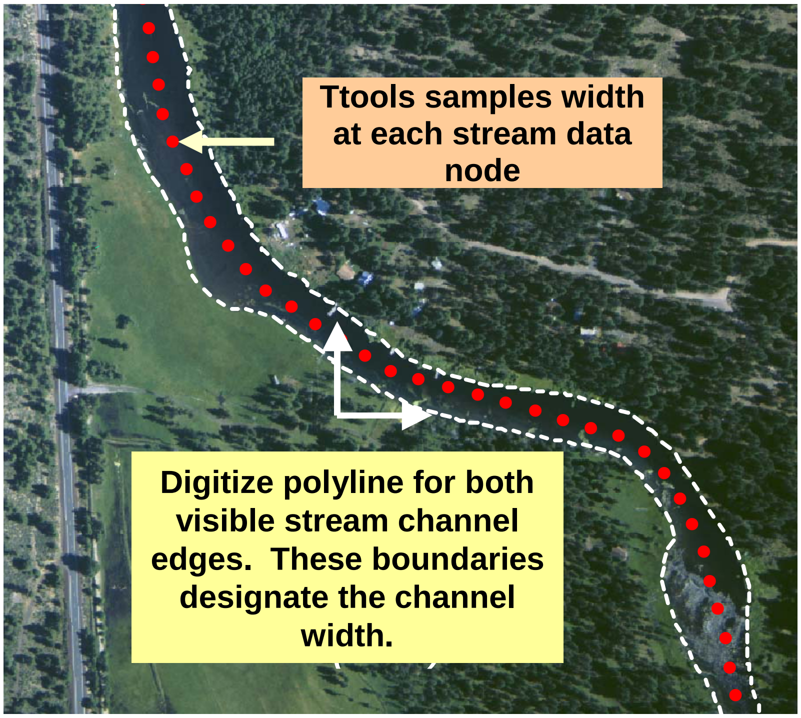
A2.3.4 Channel Width Assessment

Channel width is an important component in stream heat transfer and mass transfer processes. Effective shade, stream surface area, wetted perimeter, stream depth and stream hydraulics are all highly sensitive to channel width. Accurate measurement of channel width across the stream network, coupled with other derived data, allows a comprehensive analytical methodology for assessing channel morphology. The steps listed below were used for determining channel widths in the TMDL analysis.

Step 1. Using the DOQs, the right and left banks (looking in the downstream direction) of the Wallowa River were digitized (**Figure A-20** shows an example of the digitization process). All digitized line work was completed at a 1:5,000 map scale or less. These channel boundaries establish the channel width, which is defined for purposes of the TMDL, as the width between shade-producing near-stream vegetation.

Step 2. The distance between each of the digitized banks (perpendicular to the stream aspect) was then measured at each of the segmented TTools nodes.

Figure A-20. Digitized channel centerline (stream data nodes), right bank, and left bank



A2.3.5 Near Stream Vegetation

The role of near stream vegetation in maintaining a healthy stream condition and water quality is well documented and accepted in scientific literature ((Barton et al. 1985, Beschta et al. 1987, Coleman and Kupfer 1996, Karr and Schlosser 1978, Malanson 1993, Osborne and Wiley 1988, Roth et al. 1996, Steedman 1988, Zelt et al. 1995). The list of important impacts that near stream vegetation has upon the stream and the surrounding environment is long and warrants listing.

- Near stream vegetation plays an important role in regulating radiant heat in stream thermodynamic regimes.
- Channel morphology is often highly influenced by vegetation type and condition by affecting flood plain and instream roughness, contributing coarse woody debris, and influencing sedimentation, stream substrate compositions and stream bank stability.
- Near stream vegetation creates a thermal microclimate that generally maintains cooler air temperatures, higher relative humidity and lower wind speeds along stream corridors.
- Riparian and instream nutrient cycles are affected by near stream vegetation.

With the recognition that near stream vegetation is an important parameter in influencing water quality, DEQ made the development of vegetation data sets in the Lower Grande Ronde Subbasins a high priority.

A2.3.5.1 Current Condition Vegetation

Variable vegetation conditions in the Lower Grande Ronde Subbasins require a higher resolution mapping than is currently available with existing GIS data sources. DEQ used GIS to digitally map and identify near stream vegetation along the Wallowa River below Wallowa Lake as described below (**Steps 1** through **3**) and as illustrated in **Figure A-21**. More detailed information can be found in *Analytical Methods for Dynamic Open Channel Heat and Mass Transfer: Methodology for Heat Source Model*

Version 7.0 (Boyd and Kasper 2003), which can be downloaded from the DEQ website. (http://www.deq.state.or.us/wq/TMDLs/tools.htm).

Step 1. DEQ created vegetation polygons using the DOQs. Using the digitized stream channel, vegetation was mapped 100 meters (300 feet) from each channel edge. Within this zone, polygons were drawn to capture visually alike vegetation features. All digitized line work was completed at a 1:5,000 map scale or less.

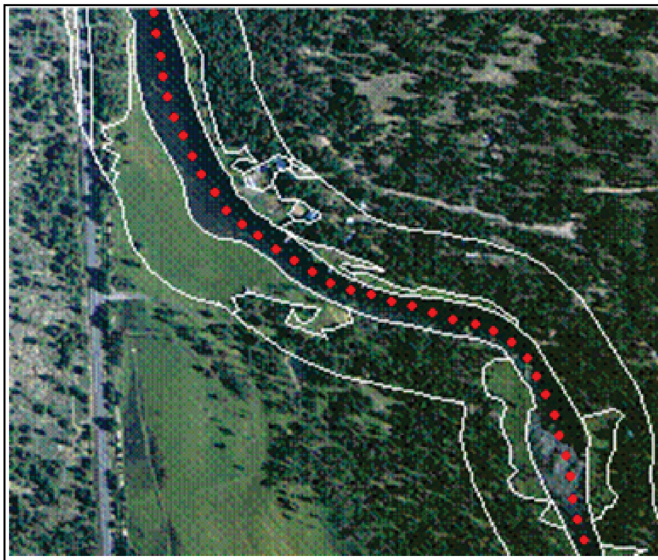
Step 2. Basic vegetation types were categorized and assigned to individual polygons. Vegetation types were classified as deciduous, coniferous, grass, barren, and other general descriptions. **Table A-3** summarizes the numeric codes and descriptions used to uniquely identify each of the digitized land cover polygons. Height values and densities were estimated based on field measurements taken during the habitat surveys, as well information gained from USFS vegetation data for the Wallowa-Whitman National Forest (described further below).

Step 3. Automated sampling was conducted on the classified vegetation spatial data set in two-dimensions using TTools. At each node along the stream centerline, the vegetation polygons were sampled. The polygons were sampled in a radial pattern, using a 15-meter outwards step, out to 60 meters from the stream centerline. This sampling rate resulted in 928 measurements of vegetation per every mile of stream.

USFS Vegetation Data. The USFS maintains a GIS coverage of existing vegetation for the Wallowa-Whitman National Forest (USFS 2001) that was used to assist in classification of existing vegetation. The USFS vegetation coverage consists of thousands of polygons, each with a unique vegetation type, density, and diameter at breast height (DBH) range. The USFS vegetation coverage was classified based on aerial photograph analysis and ground level data collection. Tree growth curves (Wallowa Valley Ranger District Cruise Statistics) were used to translate USFS diameter at breast height classes to tree height values (**Table A-4**).

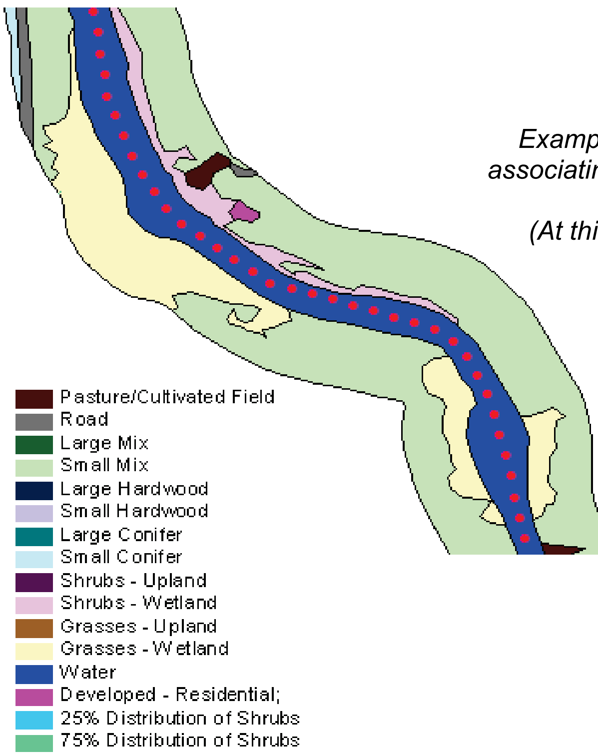
The USFS vegetation coverage was then spatially analyzed to determine average existing height values for the different forest types along riparian areas throughout the Lower Grande Ronde Subbasins. As can be seen in **Figure A-22**, the majority of “large” trees fell within 70 to 120 feet, while the majority of “small” trees were between 10 and 60 feet. These two ranges were then separately analyzed to determine an average height value for large and small conifer stands (i.e., the DEQ-digitized vegetation). It was determined that the spatial average USFS stand height was 93.7 feet for the larger trees, and 32.2 feet for the smaller trees. These values were then applied to the DEQ vegetation classifications (**Table A-3**).

Figure A-21. Steps for digitizing and classifying vegetation



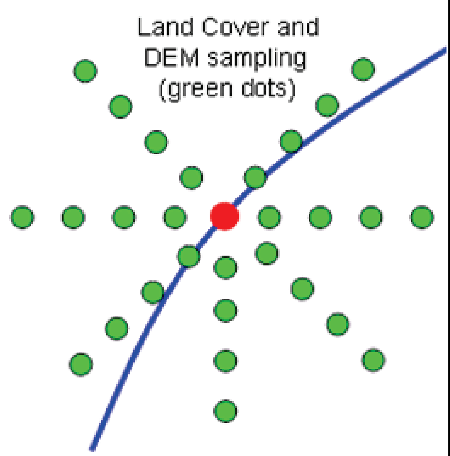
Example of polygon mapping of vegetation from aerial color imagery

(At this point only the line work is complete And no data is associated with the polygons.)



Example of classification of vegetation polygons, associating a vegetation type to each of the polygons.

(At this point a vegetation type numeric code is associated with each polygon.)



TTools radial sampling pattern for vegetation (sampling interval is user defined). Sampling occurs for every stream data node at four user-defined intervals every 45 degrees from north (north is not sampled since the sun does not shine from that direction in the northern hemisphere). A database of vegetation type is created for each stream data node.

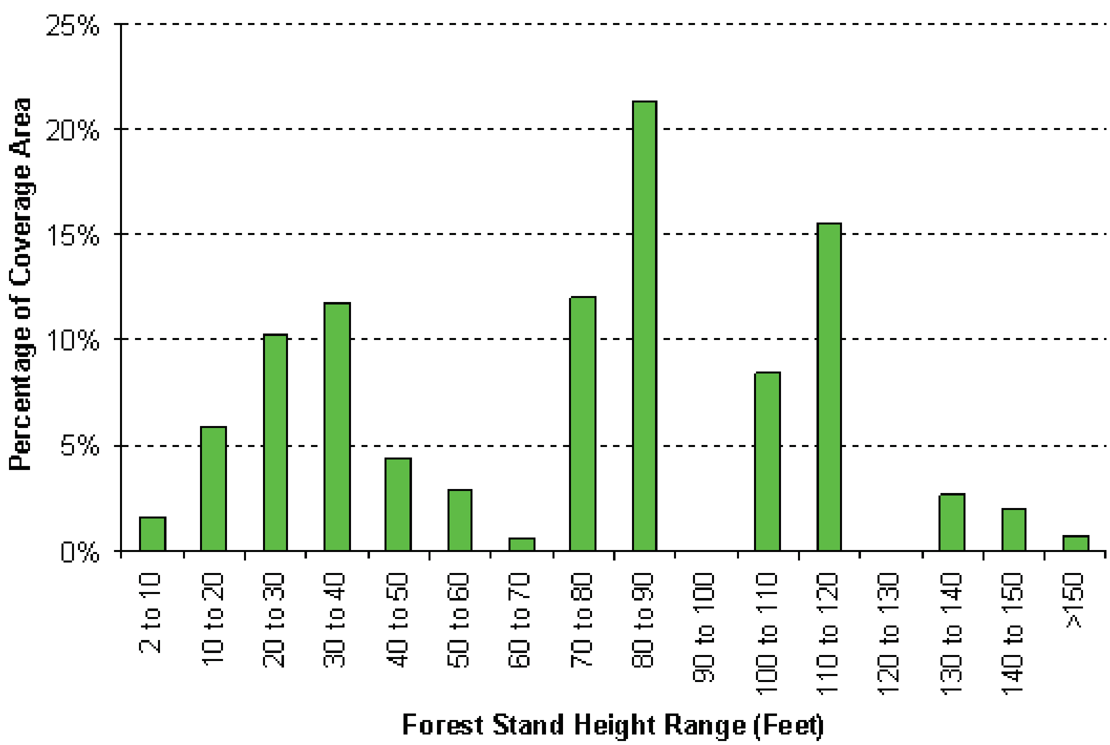
Table A-3. Summary of existing vegetation classifications

Code	Land Cover Description	Height (feet)	Density
301	Water	0	0%
302	Pasture/Cultivated Agriculture	3	90%
303	Tree Farm	15	65%
304	Barren – Rock	0	0%
305	Barren – Bank	0	0%
308	Barren – Clearcut	0	0%
309	Barren – Soil	0	0%
310	Steep/rocky/non-vegetated natural	0	0%
400	Road	0	0%
401	Forest Road	0	0%
402	Railroad	0	0%
500	Large Mixed Conifer-Hardwood	81.9	65%
501	Small Mixed Conifer-Hardwood	24.9	65%
550	Large Mixed Conifer-Hardwood	81.9	25%
551	Small Mixed Conifer-Hardwood	24.9	25%
555	Large Mixed Conifer-Hardwood	81.9	10%
600	Large Hardwood	70	65%
601	Small Hardwood	24.9	65%
650	Large Hardwood	70	25%
651	Small Hardwood	24.9	25%
655	Large Hardwood	70	10%
700	Large Conifer	93.7	65%
701	Small Conifer	32.2	65%
750	Large Conifer	93.7	25%
751	Small Conifer	32.2	25%
755	Large Conifer	93.7	10%
800	Upland Shrubs	5	65%
850	Upland Shrubs	5	25%
801	Wetland Shrubs	10	65%
851	Wetland Shrubs	10	25%
900	Grass - upland	3	90%
3011	Active River Channel	0	0%
3248	Developed - House-sized Structures	20	100%
3249	Developed - Industrial Sized Structures	30	100%
3252	Dam or Weir	0	0%
3255	Canal	0	0%
3256	Dike	0	0%
3300	Hatchery	0	0%
3400	Sewage Pond	0	0%
3025	Tree Farm	15	65%
3257	Canal	0	0%

Table A-4. Wallowa Valley Ranger District local DBH/height chart

Cruise Statistics Derived From 4 Sales *(Note: Cruise statistics derived from "thinning from below" prescription (intermediate and suppressed component). Residual stocking of similar size classes consist of codominant and dominant trees and would reflect consistently greater heights.)*			
	Tree Height (Feet)		
DBH	Ponderosa	Douglas Fir	Grand Fir
5	32	32	33
6	38	37	39
8	46	49	50
10	52	55	55
12	56	58	60
14	62	66	67
16	69	70	73
18	76	80	82
20	85	89	91

Figure A-22. USFS average vegetation coverage height ranges for riparian areas in the Lower Grande Ronde Subbasins



A2.3.5.2 System Potential Vegetation

System potential vegetation refers to the vegetation which can grow and reproduce on a site given the natural plant biology, site elevation, soil characteristics, and climate. Potential near stream vegetation is essentially the mature species composition, height, and density of vegetation that would occur in the absence of human disturbances. Potential near stream vegetation does not include considerations for resource management, human use or other legacy human disturbance. Natural disturbance regimes (i.e., fire, disease, wind-throw, etc.) are also not accounted for in this definition. It is assumed that despite natural disturbance, potential near stream vegetation types (as defined) will survive and recover from a natural disturbance event. That said, DEQ views natural disturbance as an essential part of a dynamic ecosystem and does therefore not expect continuous attainment of shade targets representing un-disturbed conditions. This is further articulated in water quality standard rules and in **Chapter Two**.

Since near stream vegetation is a controlling factor in stream temperature regimes, the condition and health of vegetation is considered a primary parameter in the TMDL. System potential vegetation is a key condition targeted in the TMDL. DEQ worked with members of the Wallowa County TMDL Committee to determine system potential near stream vegetation for the areas covered by the Lower Grande Ronde Subbasins TMDL (**Table A-5**). Through simple assumptions regarding land cover succession and by examining land cover types adjacent to major anthropogenic disturbance areas (i.e., clearcuts, roads, cultivated fields, etc., it was possible to develop a rule set that could be used to estimate ***natural potential vegetation*** conditions. For example, small conifers were assumed to have the potential to become large conifers. The methodology for applying potential vegetation in the temperature model for the Wallowa River was based on the following general rules:

Rules for Developing System Potential Near Stream Vegetation

1. Barren areas that could grow vegetation (i.e., clearcut areas, embankments, forest roads, etc.) were assigned the nearest adjacent non-developed vegetation type.
2. Developed areas that could grow vegetation were assigned the nearest adjacent vegetation type.
3. Pastures, cultivated fields and lawn vegetation types were assigned the mixed deciduous component, unless completely surrounded by a different forest type.
4. Instream and channel structures (i.e., dikes, canals, etc.) that could grow vegetation were assigned the nearest adjacent vegetation type.
5. Water and barren rock cannot grow vegetation and were not changed.
6. Steep and rocky slopes where soil conditions and/or aspect prohibit tree growth were left unchanged.
7. The conifer vegetation type was assumed to grow to undisturbed potential height and density.
8. The hardwood vegetation type was assumed to grow to undisturbed potential height and density.
9. The mixed conifer/hardwood vegetation type was assumed to grow to undisturbed potential height and density.

Using the rules described above, automated near stream vegetation sampling (**Steps 1-3** in **Section A2.3.5.1**) was repeated to determine the natural system potential condition for each stream reach. Potential tree heights were determined based on local expertise and are consistent with regional plant guide literature (Johnson and Simon 1987, Johnson 1998). Potential near stream vegetation conditions were used in stream temperature modeling scenarios for the Wallowa River to target Natural Thermal Potential (NTP) conditions, quantify the impacts of nonpoint source solar radiation loads, and ultimately to develop nonpoint source load allocations for the TMDL.

The potential near stream vegetation communities identified in **Table A-5** were also used in developing the generalized effective shade curves used to set load allocations for all other streams in the Lower Grande Ronde Subbasins (other than the Wallowa River).

Table A-5. Potential Vegetation Communities (Wallowa County TMDL Committee, 2003)

Potential Vegetation Communities with Dominant Species Composition	Average Mature Tree Height feet (meters)	Average Shade Producing Height feet (meters)
Mixed Conifer above 6000 feet: Lodgepole Pine & alpine fir	65-75 (19.8-22.9)	45-55 (13.7-16.8)
Old Growth Conifer: Ponderosa Pine & Douglas fir	120 (36.6)	120 (36.6)
Wallowa River valley bottom: Englemann Spruce	120 (36.6)	100 (30.5)
Cottonwood Galleries	80-90 (24.4–27.4)	80-90 (24.4–27.4)
Valley Bottom Mixed Deciduous: Alder, Willow, Cottonwood Hawthorne, Snowberry, Dogwood Currents, Mock Orange, Rose	25 (7.6)	25 (7.6)
Mixed Conifer: Ponderosa Pine, Douglass Fir, Larch	100-105 (30.5–32.0)	80-85 (24.4–25.9)
Mixed Deciduous <2000 feet elevation: Where alders are dominant, increase heights to as much as 35 ft (Lower Grande Ronde River, Lower Imanha River, Lower Joseph Creek)	30-35 (9.1-10.7)	30-35 (9.1-10.7)

A2.3.6 Mass Balance Analysis

Where available, TIR sampled stream temperature data can be used to develop a mass balance for stream flow using minimal ground level data collection points. Simply identifying mass transfer areas is an important step in quantifying heat transfer within a stream network. The TIR temperature data was used to identify mass transfer areas occurring in the Wallowa River. **Figure A-23** displays the longitudinal flow mass balance derived from measured flows, OWRD points of diversion data, and TIR temperature data. The “potential flow” shown on the chart assumes that there are no withdrawals, diversions, or returns.

All stream temperature changes that result from mass transfer processes (i.e., tributary confluence, point source discharge, groundwater inflow, etc.) can be described mathematically using the following relationship:

$$T_{mix} = \frac{(Q_{up} \cdot T_{up}) + (Q_{in} \cdot T_{in})}{(Q_{mix})} = \frac{(Q_{up} \cdot T_{up}) + (Q_{in} \cdot T_{in})}{(Q_{up} + Q_{in})}$$

where,

Q_{up}: Stream flow rate upstream from mass transfer process
Q_{in}: Inflow volume or flow rate
Q_{mix}: Resulting volume or flow rate from mass transfer process ($Q_{up} + Q_{in}$)
T_{up}: Stream temperature directly upstream from mass transfer process
T_{in}: Temperature of inflow
T_{mix}: Resulting stream temperature from mass transfer process assuming complete mix

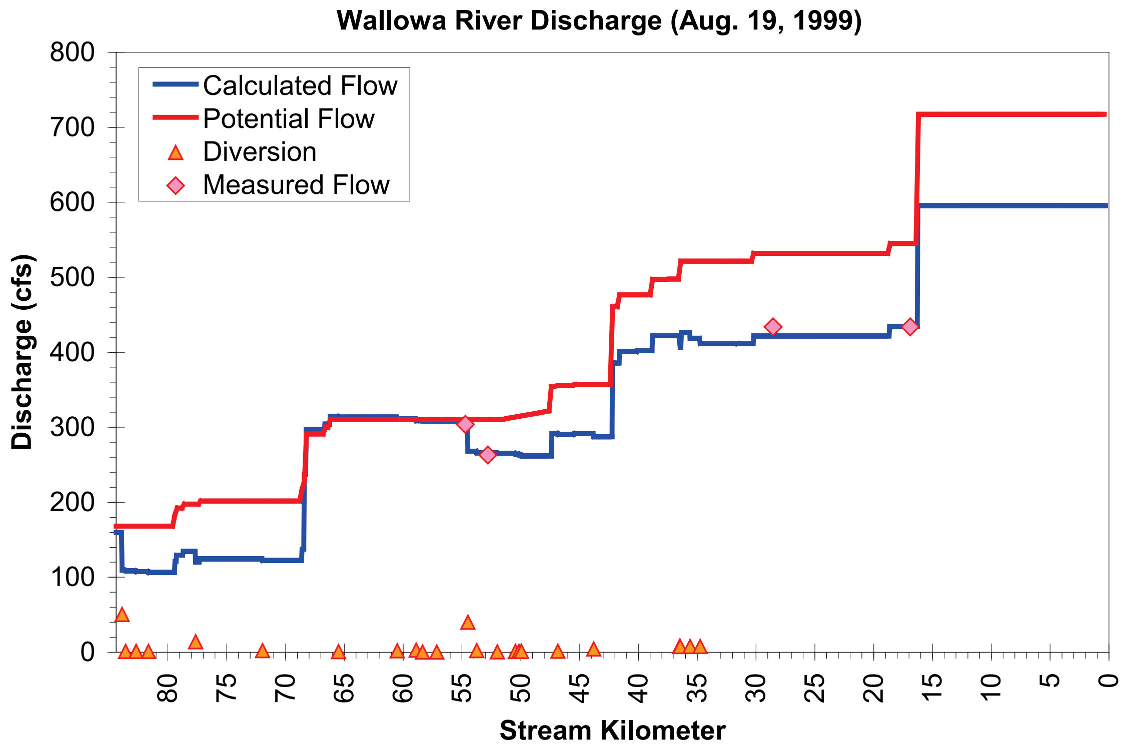
All water temperatures (i.e., T_{up}, T_{in} and T_{mix}) are apparent in the TIR sampled stream temperature data. Provided that at least one instream flow rate is known the other flow rates can be calculated.

Water volume losses are often visible in TIR imagery since diversions and water withdrawals usually contrast with the surrounding thermal signature of landscape features. Highly managed stream flow regimes can become complicated where multiple diversions and return flows mix or where flow diversions and returns are unmapped and undocumented. In such cases it becomes important to establish the direction of flow (i.e., influent or effluent). With the precision afforded by TIR sampled stream temperatures, effluent flows are generally indicated when temperatures are the same (because of the low probability of an inflow with precisely the same temperature as the receiving stream). Temperature differences indicate that the flow is influent. This holds true even when observed temperature differences are very small. The rate of water loss from diversions or withdrawals cannot be easily calculated. Oregon DEQ estimates water withdrawal flow rates from the water right information maintained by OWRD.

Discussion of Assumptions and Limitations for Mass Balance Methodology

1. **Small mass transfer processes are not accounted**. A limitation of the methodology is that only mass transfer processes with measured ground level flow rates or those that cause a quantifiable change in stream temperature with the receiving waters (i.e., identified by TIR data) can be analyzed and included in the mass balance. For example, a tributary with an unknown flow rate that cause small temperature changes (i.e., less than $\pm 0.5^oF$) to the receiving stream cannot be accurately included. *This assumption can lead to an under estimate of influent mass transfer processes.*
2. **Limited ground level flow data limit the accuracy of derived mass balances**. Errors in the calculations of mass transfer can become cumulative and propagate in the methodology since validation can only be performed at sites with known flow rates. *These mass balance profiles should be considered estimates of a steady state flow condition*.
3. **Water withdrawals are not directly quantified**. Instead, water right data is obtained from the POD and WRIS OWRD databases. An assumption is made that these water rights are being used if water availability permits. *This assumption can lead to an over estimate of water withdrawals.*
4. **Water withdrawals are assumed to occur only at OWRD mapped points of diversion sites.** There may have been additional diversions occurring throughout the stream network. *This assumption can lead to an underestimate of water withdrawals and an under estimate of potential flow rates.*
5. **It is not possible to determine the amount of return flows derived from ground water withdrawals relative to those derived from instream withdrawals.** Some of the irrigated water comes from ground water sources. Therefore, one should assume that portions of the return flows are derived from ground water sources. Return flows can occur over long distances from irrigation application and generally occur at focal points down gradient from multiple irrigation applications. It is not possible to estimate the portion of irrigation return flow that was pumped from ground water rights. In the potential flow condition all return flows are removed from the mass balances. *This assumption can lead to an under estimate of potential flow rates.*
6. **Return flows may deliver water that is diverted from another watershed.** In some cases, irrigation canals transport diverted water to application areas in another drainage. This is especially common in low gradient meadows, cultivated fields and drained wetlands used for agriculture production. The result is that accounting for a tributary flow in the potential flow condition is extremely difficult. DEQ is unable to track return flows to withdrawal origins between drainage areas. *When return flows are removed in the potential flow condition this assumption can lead to an under estimate of potential tributary flow rates.*

Figure A-23. Longitudinal flow mass balance for the Wallowa River



A3. SIMULATIONS

The data sources described in the previous Chapter were used to set up site-specific Heat Source models for temperature and effective shade for the Wallowa River. All solar radiation loads are the clear sky received loads that account for Julian time, elevation, atmospheric attenuation and scattering, stream aspect, topographic shading, near stream vegetation, stream surface reflection, water column absorption and stream bed absorption. An overview of stream heat transfer processes is provided in **Section A1.1**.

Model Used

- Heat Source, version 7.0[2]

Simulation Extent

- Wallowa Lake outlet to the mouth (84.4 miles or 135.8 kilometers)

Simulation Period

- August 14 – September 2, 1999

Simulation Resolution

- Time step: one minute
- Input distance step: 50 meters
- Output distance step: 100 meters

A3.1 Overview of Modeling Purpose, Valid Applications & Limitations

An overview of the different components of the models is provided in **Sections A3.1.1** – **A3.1.4** below, including modeling purpose, valid applications and limitations for each type of analysis.

A3.1.1 Near Stream Vegetation Analysis

Modeling Purpose

- Quantify existing near stream vegetation types and physical attributes.
- Develop a methodology to estimate potential conditions for near stream vegetation.
- Establish threshold near stream vegetation type and physical attributes for the stream network, below which vegetation conditions are considered to deviate from a potential condition.
- Develop near stream vegetation input parameters for the Effective Shade Analysis (**Section A3.1.2**).

Valid Applications

- Estimate current condition near stream vegetation type and physical attributes.
- Estimate potential condition near stream vegetation type and physical attributes.
- Identify site-specific deviations of current near stream vegetation conditions from threshold potential conditions.

[2] *Heat Source* documentation "*Analytical Methods for Dynamic Open Channel Heat and Mass Transfer: Methodology for Heat Source Model Version 7.0*" (Boyd and Kasper, 2003) is available on-line at http://www.deq.state.or.us/wq/TMDLs/tools.htm.

Limitations

- Methodology is based on ground level and GIS data such as vegetation surveys and digitized polygons from DOQs. Each data source has accuracy considerations.
- Associations used for vegetation classification are assigned median values to describe physical attributes, and in some cases, this methodology significantly underestimates landscape variability.

A3.1.2 Effective Shade Analysis

Modeling Purpose

- Simulate current condition effective shade levels over stream network.
- Simulate potential condition effective shade levels based on channel width and vegetation types and physical attributes over stream network.
- Calculate solar heat flux associated with both current condition and potential condition effective shade levels.
- Establish threshold effective shade values for the stream network, below which current conditions are considered to deviate from a potential condition.
- Provide vegetation type specific shade curves that allow target development where site-specific targets are not completed (i.e., establish relationships between effective shade and channel width, for a specified aspect and vegetative condition).
- Develop shade and heat flux parameters for use in the Stream Temperature Analysis (**Section A3.1.4**).

Valid Applications

- Estimate current condition effective shade and heat flux over the stream network.
- Estimate potential condition effective shade and heat flux over the stream network.
- Identify site-specific deviations of current effective shade conditions from threshold potential conditions.

Limitations

- Limitations for input parameters apply (i.e., near stream vegetation type and physical attributes).
- The period of simulation is valid for effective shade values that occur in late August.
- Assumed channel widths where they were not measurable from aerial photographs may reduce accuracy of the effective shade simulation.

A3.1.3 Hydrology Analysis

Modeling Purpose

- Map and quantify surface and subsurface flow inputs and withdrawal outputs.
- Develop a mass balance for the stream network by quantifying existing instream flow volume.
- Quantify average velocity and average stream depth as a function of flow volume, stream gradient, average channel width and channel roughness.
- Develop a potential mass balance that estimates flow volumes when withdrawals and artificial surface returns are removed.
- Develop hydrology input parameters for use in the Stream Temperature Analysis (**Section A3.1.4**).

Valid Applications

- Estimate current condition flow volume, velocity and stream depth.
- Estimate natural potential condition flow volume, velocity and stream depth.
- Identify site specific deviations of current mass balance from the threshold potential mass balance.

Limitations

- Small mass transfer processes are not accounted.
- Limited ground level flow data limit the accuracy of derived mass balances.
- Water withdrawals are not directly quantified
- Water withdrawals are assumed to occur only at OWRD mapped points of diversion.
- Return flows are oversimplified.
- It is not possible to determine the amount of return flows derived from ground water withdrawals relative to those derived from instream withdrawals.
- Return flows may deliver water that is diverted from another watershed.
- Inter-annual variations are not simulated.
- Intra-annual variations are not simulated.

A3.1.4 Stream Temperature Analysis

Modeling Purpose

- Analyze current condition stream temperature over stream network during low flow/warm season.
- Analyze natural potential condition stream temperature based on potential vegetation types and physical attributes and flow volume over stream network.
- Establish threshold stream temperature values for the stream network, above which current conditions are considered to deviate from a natural potential condition.
- Evaluate temperature differences between conditions with and without anthropogenic warming.
- Provide riparian condition and temperature goals that are protective of beneficial uses.
- Provide a robust methodology for stream heating and temperature analysis, provided data and analytical constraints.

Valid Applications

- Estimate critical condition stream temperatures over the stream network.
- Estimate natural potential critical condition stream temperatures over the stream network.
- Identify site-specific deviations of current stream temperatures from natural potential conditions.
- Analyze the sensitivity of single or multiple parameters on stream temperature regimes.
- Identify stream temperature distributions during low flow/warm season.

Limitations

- Limitations for input parameters apply (i.e., channel morphology, near stream vegetation type and physical attributes and hydrology).
- Accuracy of the methodology is limited to validation statistics of results.
- Stream temperature results are limited to the Wallowa River. Application of the stream temperature output to other streams within or outside of the Subbasins is not valid.
- The period of simulation is valid for stream temperature values that occur in mid to late August.

- Inter-annual variations are not simulated.
- Intra-annual variations are not simulated.

A3.2 Effective Shade Analysis

Effective shade can be thought of as the amount of daily solar radiation directed toward the stream that is blocked by features such as topography and vegetation. Factors that influence stream surface effective shade and are incorporated into the simulation methodology include the following:

Season/Time: Date/Time
Stream Morphology: Aspect, Channel Width, Incision
Geographic Position: Latitude, Longitude, Topography
Land Cover: Near Stream Vegetation Height, Width, Density
Solar Position: Solar Altitude, Solar Azimuth

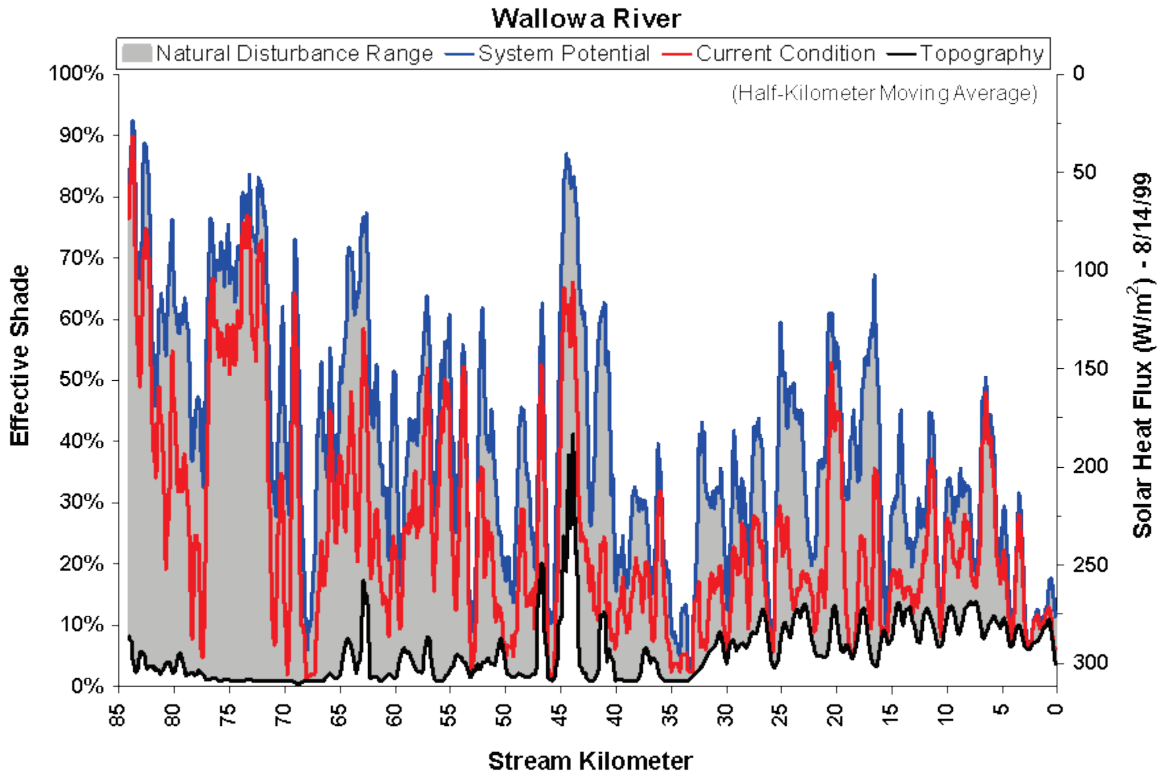
A3.2.1 Site-Specific Effective Shade Simulations

Site-specific effective shade and heat flux simulations were performed for the Wallowa River. Three different effective shade scenarios were simulated, as shown in **Table A-6**. Once the current condition effective shade model was calibrated, a potential near stream vegetation scenario was simulated. Natural site potential vegetation was estimated as described in **Section A2.3.5**. The amount of shade provided by topographic features was also determined. This scenario provided the lower end of the *Natural Disturbance Range*, indicating the amount of shade that the stream would receive if topography was the only shade-producing feature (i.e. in the absence of vegetation). The results of the simulations are shown in **Figure A-24**.

Table A-6. Site-specific effective shade simulations

Scenario 1:	Current Condition: This simulation establishes current effective shade by modeling the vegetation and anthropogenic landcover that was present at the time of the DOQ was produced (1994/1995).
Scenario 2: (TMDL Loading Capacity)	System Potential Vegetation: The simulation establishes effective shade that would be possible under natural conditions.
Scenario 3:	Topographic Shade: The scenario establishes the effective shade from natural topography by removing all vegetation and anthropogenic landcover such as houses and buildings.

Figure A-24. Effective shade – Current Condition and System Potential during late August

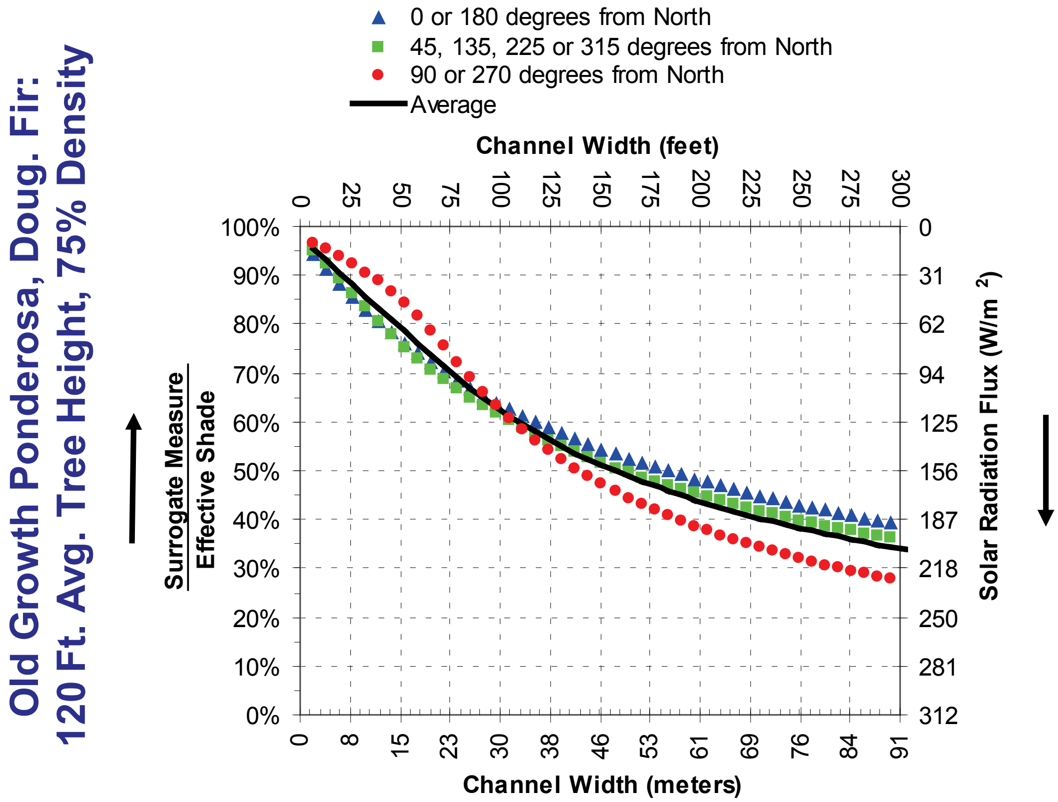


A3.2.2 Generalized Effective Shade Curves

Generalized effective shade curves were developed for streams where site-specific effective shade simulations were not completed. The effective shade curves account for latitude, critical summertime period (August), elevation and stream aspect and display effective shade levels for potential vegetation communities as a function of channel width. Stream aspect is based on coordinate directions, such as North-South, East-West, and Northeast-Northwest**.**

The potential vegetation communities and the associated height and density were determined by the Wallowa County TMDL Committee as shown in **Table A-5**. The results of the shade curve development are shown in **Figure 2-8** in the TMDL document. An example is shown here in **Figure A-25**. Refer to **Section 2.9.2** in the TMDL document for additional discussion of the use of the curves.

Figure A-25. Generalized warm-season system potential effective shade curve for the Old Growth Conifer Community in the Lower Grande Ronde Subbasins (North-South, East-West, and Northeast-Northwest refer to stream aspect.)



A3.3 Total Daily Solar Heat Load Analysis

Solar heat is established as a primary pollutant in stream heating processes. The total daily solar heat load is the cumulative (entire stream surface area) solar heat received by a stream over one day during the critical period (i.e., July/August period). For the purposes of this analytical effort, the total solar heat load (H_{solar} in the equation below) is the longitudinal sum of the products of the daily solar heat flux and surface area of exposure for each stream reach (i.e., for each stream data node every 50 meters).

$$H_{solar} = \Sigma(\Phi_{solar} * A_y) = \Sigma\ (\Phi_{solar} * W_{wetted} * dx)$$

Background (NTP) levels of solar heat estimate the portion of the total daily solar heat load that occurs when anthropogenic nonpoint sources of heat are minimized. The total daily solar load is calculated for both the current condition (H_{solar}) and the potential condition ($H_{Solar}^{Background}$). The anthropogenic nonpoint source total daily solar load is the difference between the existing total daily solar load and the background total daily solar load (see equation below).

$$H_{solar}^{NPS} = H_{solar} - H_{Solar}^{Background}$$

where,

A_y:	Stream surface area unique to each stream segment (m^2)
dx:	Stream segment length and distance step in the methodology (m)
Φ_{solar}:	Solar heat flux unique to each stream segment ($MW\ m^{-2}$)
H_{solar}:	Total daily solar heat load delivered to the stream (MW)
H_{solar}^{NPS} :	Portion of the total daily solar heat load delivered to the stream that originates from anthropogenic nonpoint sources of pollution (MW)
$H_{Solar}^{Background}$:	Portion of the total daily solar heat load delivered to the stream that originates from solar input not affected by human activities (MW)
W_{wetted}:	Wetted width unique to each stream segment (m)

The total daily heat load analysis was done for the Wallowa River. Of the total daily heat loading that occurs during the summertime critical condition, 85% is attributed to natural background sources and 15% is from anthropogenic nonpoint sources.

A3.4 Stream Temperature Simulations

Stream temperature modeling was done on the Wallowa River. Site specific shade modeling was done as described in **Section A3.2**. In addition to effective shade and flux, hydraulic parameters and stream temperature were simulated every 100 meters longitudinally as well. Simulations were completed for a 20-day period (August 14-September 2, 1999). Prediction time steps were limited by stability considerations for the finite difference solution method. Simulation periods represent the critical summertime period. The limitations and assumptions for each of the different analysis included in Heat Source are described in **Sections A3.1.1-A3.1.4**.

A3.4.1 Model Validation - Simulation Accuracy

For the purposes of this analytical effort, validation refers to the statistical comparison of measured and simulated data. Standard error statistics were calculated for TIR derived spatial temperature data sets and instream measured temporal temperature data sets (**Table A-7**). Each measurement of temperature is discrete and was used to assess model accuracy. Simulation outputs are only accurate to levels that exceed the validation statistics. A statistically significant simulated result is one that produces a temperature change greater than validation statistics listed in **Table A-7**.

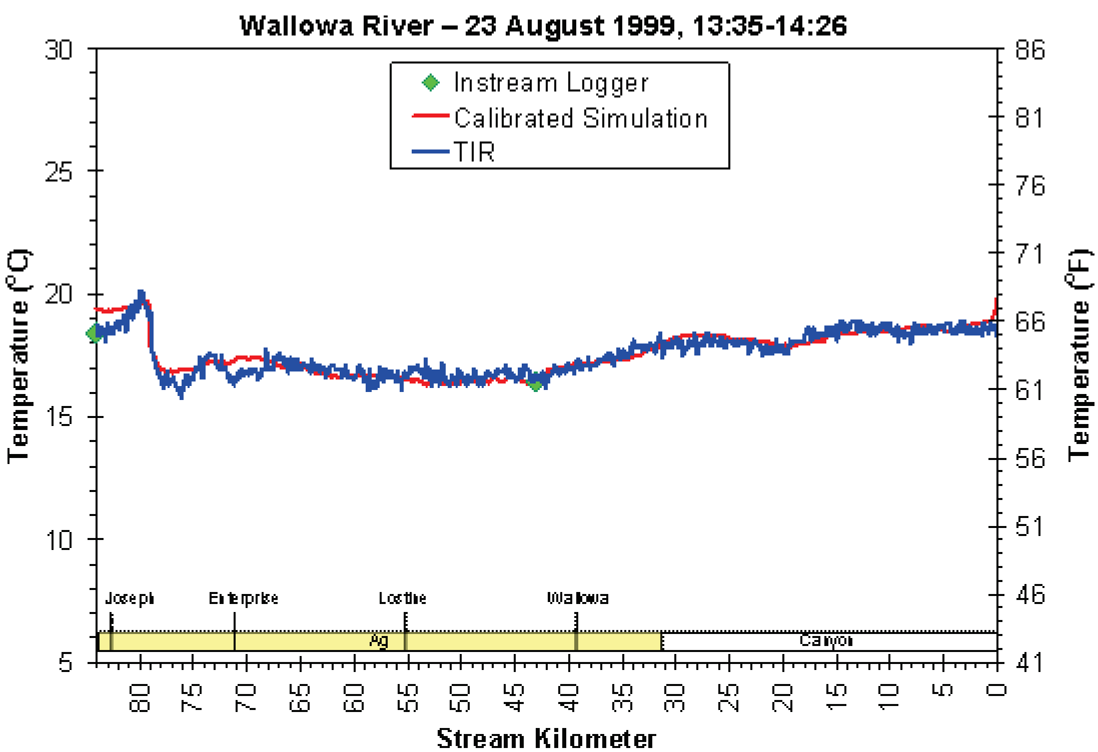
Stream temperatures derived from TIR data offer an extremely robust validation data set for spatial stream temperature simulation tools. Since the TIR temperature data is continuous, the number of simulated temperatures available for model validation is limited to model resolution. With TIR temperature data, the spatial scalability for any given methodology is unlimited by validation data. This represents a significant improvement over previous data sources.

Spatial and temporal data is stratified in the validation to test for biases in the simulation methodology. Since TIR temperature data sets are robust spatially, there is a possibility that the simulation could be calibrated to the specific time when TIR data was obtained, yet perform poorly for other periods of the day. However, validation statistics demonstrate that this is not the case. **Figure A-26** displays the measured TIR temperatures versus the simulated temperatures.

Table A-7. Stream temperature simulation validation

	Validation Statistic	Wallowa River Model Performance
Temporal Instream Data	Samples (n)	240
	Standard Error (°C)	0.5
Spatial TIR Derived Data	Samples (n)	845
	Standard Error (°C)	0.4

Figure A-26. Stream temperature simulation calibration



A3.4.2 Simulated Scenarios

Once the current condition stream temperature model was calibrated for the Wallowa River, three different scenarios were then simulated by changing one or more stream input parameters and then re-running the model over the 20-day simulation period (**Table A-8**). The simulated scenarios focused largely on estimated natural potential conditions for vegetation and derived flow mass balances. Combinations of these potential conditions were also simulated to investigate the cumulative thermal effect of attaining defined conditions.

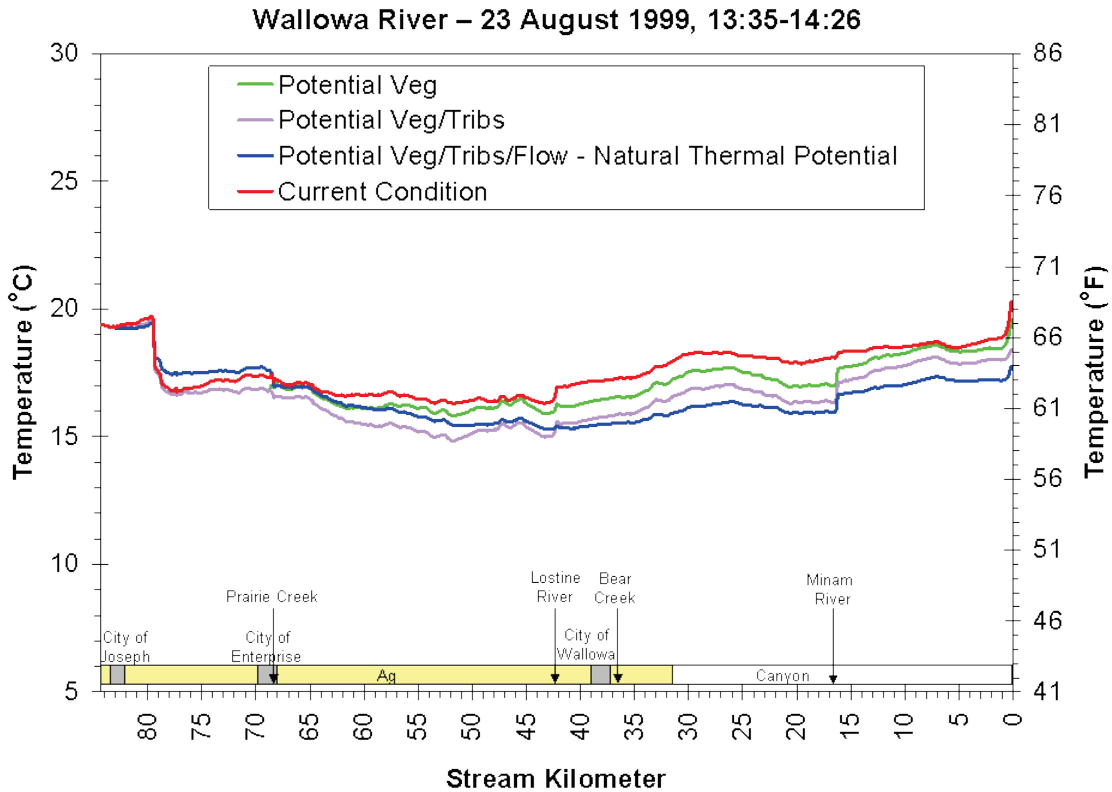
Table A-8. Summary of simulated scenarios

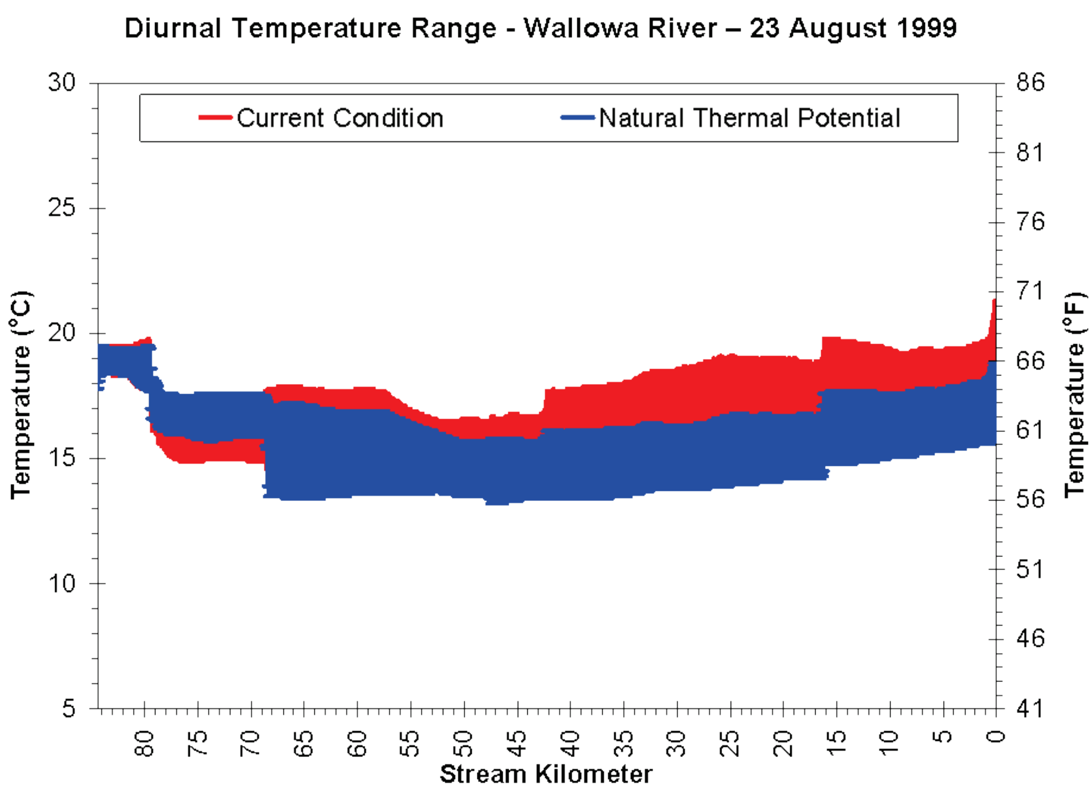
Current Condition	Current Condition (August 1999)
Potential Veg	System Potential Near Stream Vegetation Current Flows
Potential Veg/Tribs	System Potential Near Stream Vegetation Reduced Tributary Temperatures[3] Current Flows
Potential Veg/Tribs/Flow (Natural Thermal Potential)	System Potential Near Stream Vegetation Reduced Tributary Temperatures Natural Flows (no water withdrawals)

Figure A-27 compares the results of the four simulations with results displayed for the day the TIR data was collected. The top graph shows the simulated temperatures for each scenario that would have been observed at the time the TIR data was collected. The bottom graph compares the diurnal temperature range observed on that day under current condition and natural thermal potential conditions. Model output was also available for every hour of the 20-day simulation period. This enabled calculation of the moving seven-day average of the daily maximums (7DADM), providing for comparison of simulated natural condition and biologically-based temperature standard criteria, which is based on the 7DADM statistic. The results of this analysis are provided in **Section 2.13** of the main TMDL document.

[3] If tributary temperatures exceeded the numeric criteria, then temperatures were set to approximate the temperature of other cooler temperatures in the Subbasin under this scenario. Tributaries that currently were below the numeric criteria were left at their current temperature.

Figure A-27. Wallowa River temperature simulation results





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Appendix B: Abbreviations

7DADM	Seven-day average of daily maximum temperatures
AWQMAP	Agricultural Water Quality Management Area Plan
AWMP	Animal Waste Management Plan
Ave, Avg	Average
bkgd	Background
BLM	United States Bureau of Land Management
BMP	Best Management Practice
ºC	Degrees Celsius
CAFO	Confined Animal Feeding Operation
cm	Centimeter
CFR	Code of Federal Regulations
cfs	Cubic Feet Per Second
COOP	Cooperative Observer Program
CRITFC	Columbia River Inter-Tribal Fish Commission
CWA	Clean Water Act
DBH	Diameter at Breast Height
DEM	Digital Elevation Model
DEQ	Oregon Department of Environmental Quality
dl	Deciliter (100 milliliters)
DMA	Designated Management Agency
DOGAMI	Oregon Department of Geology and Mineral Industries
DOQ	Digital Orthophoto Quadrangle
d/s	Downstream
DSL	Oregon Department of State Lands
E	Effluent
E. Coli	*Escherichia coli*
EPA	United States Environmental Protection Agency
ºF	Degrees Fahrenheit
FPA	Forest Practices Act
ft	Feet
gal	Gallons
GIS	Geographic Information Systems
GPS	Global Position Sensor
HUA	Human Use Allowance
HUC	Hydrologic Unit Code
I&I	Infiltration and inflow
km	Kilometer
LA	Load Allocation
LASAR	Laboratory Analytical Storage and Retrieval Database
LC	Loading Capacity
Log	Logarithmic
m	Meter
ml	Milliliter
MAO	Mutual Agreement and Order

Max	Maximum
MGD	Million Gallons per Day
Min	Minimum
MOU	Memorandum of Understanding
MOS	Margin of Safety
MPN	Most Probable Number
MW	Megawatt
NAIP	National Agriculture Imagery Program
NLCD	National Land Cover Database
NOAA	National Oceanic and Atmospheric Administration
NON	Notice of Noncompliance
NPDES	National Pollutant Discharge Elimination System
NPS	Nonpoint Source
NRAC	Natural Resource Advisory Committee
NRCS	Natural Resources Conservation Service
NTP	Natural Thermal Potential (Natural Condition Criteria, OAR 340-041)
OAR	Oregon Administrative Rules
OCF	Oregon Community Foundation
ODA	Oregon Department of Agriculture
ODEQ	Oregon Department of Environmental Quality
ODF	Oregon Department of Forestry
ODFW	Oregon Department of Fish and Wildlife
ODOT	Oregon Department of Transportation
Org	Organisms
ORS	Oregon Revised Statutes
OSU	Oregon State University
OWEB	Oregon Watershed Enhancement Board
OWRD	Oregon Department of Water Resources
POD	Point of Diversion
PS	Point Source
Q	Flow
R	River
RC	Reserve Capacity
RHCA	Riparian Habitat Conservation Area
S	Dilution Ratio
SB	Senate Bill
STP	Sewage Treatment Plant
SHRP	Salmon Habitat Recovery Plan
SWCD	Soil and Water Conservation District
T	Temperature
TIR	Thermal Infrared Radiometry(synonym for Forward Looking Infrared Radiometry)
TMDL	Total Maximum Daily Load
Tribs	Tributaries
USACE	United States Army Corps of Engineers
USDI	United States Department of the Interior

USFS	United States Forest Service
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
u/s	Upstream
Veg	Vegetation
W	Watt
WLA	Wasteload Allocation
WPCF	Water Pollution Control Facilities
WQMP	Water Quality Management Plan
WQRP	Water Quality Restoration Plan
WRIS	Water Rights Information System

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Appendix C: Description of Selected Terms

Anthropogenic	Generated or caused by humans or activities related to humans.
303(d) Listing	Listing of a water body for not meeting water quality standards in accordance with Section 303(d) of the Clean Water Act.
Criteria, Biologically Based Criteria	Typically used herein in the context of water quality standards. The ‘criteria’ is the numeric or narrative target of the standard, designed to protect beneficial uses. Biologically based criteria are derived from studies of the requirements of aquatic organisms, often fish. Other criteria, such as the *protecting cold water criteria*, may target other provisions of water quality standards such as the anti-degradation policy.
Designated Management Agency (DMA)	Organization responsible for Implementation Planning designed to attain TMDL load allocations and surrogates. OAR 340-042-0030: Federal, state or local government agency that has legal authority over a sector or source contributing pollutants, and is identified as such by the DEQ in a TMDL.
Human Use Allowance (HUA)	Potentially allowable anthropogenic temperature difference in excess of applicable water quality criteria. OAR 340-041-0028 (12)(b): Insignificant additions of heat (0.3^{o}C) are authorized in waters that exceed the applicable temperature criteria.
Hydrologic Unit Code (HUC)	A nesting classification of watersheds. A multi-scale numeric code used by the U.S.Geological Survey to classify major areas of surface drainage in the United States.
Implementation Plan	A sector-specific or source-specific plan developed by each DMA which fully describes their efforts to achieve their applicable TMDL allocations. (OAR 340-042-0080)
Load Allocation (LA)	OAR 340-041-0002(30): The portion of a receiving water’s loading capacity that is attributed either to one of its existing or future nonpoint sources or to natural background sources.
Loading Capacity (LC)	OAR 340-041-0002(31): The greatest amount of loading that a water body can receive without violating water quality standards.
Log mean	The nth root of the product of n samples. The log mean of a data set can be calculated by taking the arithmetic mean of the logarithms of each value. Also called geometric mean.
Nonpoint Source	Diffuse landscapes source of pollution
Natural Thermal Potential (NTP)	OAR 340-041-0002(41): The determination of the thermal profile of a water body using best available methods of analysis and the best available information on the site-potential riparian vegetation, stream geomorphology, stream flows, and other measures to reflect natural conditions. NTP is referenced in the Natural Conditions Criteria (OAR 340-041-028 (8)).
Near Stream Disturbance Zone	The corridor between shade-producing near-stream vegetation or other features related to channel morphology and vegetation.

Point Source	Localized human-made source of pollution, conveyed to water body via human made conveyance.
Reserve Capacity	OAR 340-041-0002(49): The portion of a receiving stream's loading capacity that has not been allocated to point sources or to nonpoint sources and natural background as waste load allocations or load allocations, respectively.
Subbasin	4th field of the Hydrologic Unit Code classification of watersheds.
Surrogate	An alternative target to a load allocation, a measure to achieve a load allocation, expressed typically in units or measures other than mass per time.
Total Maximum Daily Load (TMDL)	OAR 340-041-002(65): The sum of the individual waste load allocations for point sources and load allocations for nonpoint sources and background.
Wasteload Allocation (WLA)	OAR 340-041-0002(67): The portion of a receiving water's loading capacity that is allocated to one of its existing or future point source of pollution.
Water Quality Management Plan (WQMP)	The element of a TMDL which provides the framework of management strategies to attain and maintain water quality standards. The WQMP identifies sector-specific Implementation Plans which have been or will be identified by Designated Management Agencies. (OAR 34-042-0040(l))