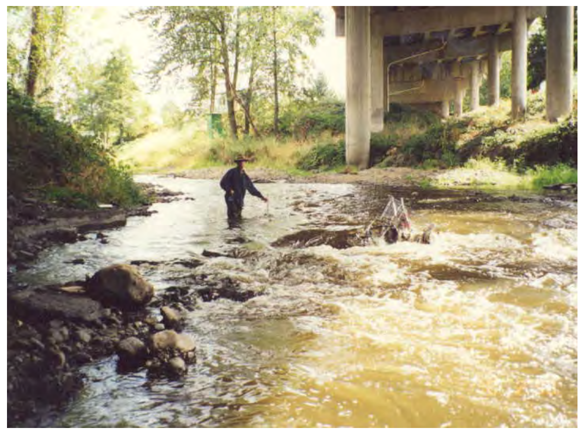
BEAR CREEK WATERSHED TMDL

Chapter I

Section 1: Introduction
Section 2: Temperature

HUC # 1710030801

Bear Creek River Mile 0.75
Kirtland Road Bridge



Bear Creek River Mile 10
Under Interstate 5 Viaduct

Bear Creek River Mile 9.5
Former Jackson St Dam Site

Outlet of Emigrant Lake Dam

July 2007
Prepared by
Oregon Department of Environmental Quality

DEQ
State of Oregon
Department of
Environmental
Quality

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Statement of Purpose

This Total Daily Maximum Load (TMDL) document has been prepared to meet the requirements of Section 303(d) of the 1972 Federal Clean Water Act.

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EXECUTIVE SUMMARY

Rogue Basin and Bear Creek watershed

Water Quality Summary

Introduction

The following document contains the required components for a Total Maximum Daily Load (TMDL) as described by the US Environmental Protection Agency (EPA) for compliance with the Federal Clean Water Act. The document and its appendices provide a thorough analysis of pollutant sources and accumulation processes in the Bear Creek watershed.

Scope

The Bear Creek watershed encompasses an area of approximately 361 square miles located in southern Oregon in Jackson County. This TMDL provides an analysis for all lands in the watershed.

Legal Requirements

Under Section 303(d) of the Clean Water Act, the EPA or its state delegates are required to develop a list of the surface waters in each state that do not meet water quality criteria. These criteria are developed by each of the states to protect "beneficial uses" and must be approved by EPA. The resulting "303(d) list" is based on the best available data and, in most cases, must be revised every two years. Water bodies that are listed as impaired must have TMDLs developed for each pollutant.

Listed Parameters

The current TMDL addresses all listings on the 2004/2006 303(d) list for the Bear Creek Watershed. According to current EPA guidance on counting TMDLs, the Bear Creek TMDL addresses 31 TMDLs, covering 311.7 stream miles (Table 1).

Table 1. Bear Creek TMDL Listings: EPA Method

Temperature: Total 138.7 miles	**19 TMDL**
Bacteria: Fecal Coliform: 10 listings. Total 120.4 miles**,** E. coli: 1 listing. Total 52.6 miles	**11 TMDL**
Sedimentation: 1 year-round listing	**1 TMDL**

Although the introduction and text of the Bear Creek TMDL uses the EPA method for calculating the total number of TMDLs, ODEQ uses a different method. ODEQ tracks completed TMDLs using the method established for the Consent Decree between the US Environmental Protection Agency (EPA) and Northwest Environmental Defense Center (NEDC), John R. Churchill, and Northwest Environmental Advocates (NWEA) (October 17, 2000). The Consent Decree lists the cumulative number of TMDLs to be established through 2010. As per the Consent Decree, the Bear Creek TMDL represents the completion of 40 TMDLs (Table 2).

Table 2. Bear Creek TMDL Listings: Consent Decree Method

Temperature: 18 rearing (May 16-Oct. 14), 3 spawning (Oct. 15-May 15). Total 138.7 miles	**21 TMDL**
Bacteria: Fecal Coliform: 5 summer, 6 fall/winter/spring, 5 year-round. Total 120.4 miles	**16 TMDL**
Bacteria: E. coli: 1 summer listing, 1 fall/winter/spring. Total 52.6 miles	**2 TMDL**
Sedimentation: 1 year-round listing	**1 TMDL**

Bear Creek currently has a TMDL in place. Approved by USEPA on December 12, 1992 it was among the first TMDLs in the State of Oregon. The TMDL addresses the non-attainment of pH, aquatic weeds and algae, and dissolved oxygen (DO) standards in the Bear Creek watershed. It has established instream concentration criteria, load and wasteload allocations for total phosphorus, ammonia nitrogen and biochemical oxygen demand that are currently used to set the targets that determine point and nonpoint source compliance. The 1992 TMDL is considered adequate and is reviewed in Section 5 of this document.

TMDL SUMMARIES

TMDL Load Capacity and Allocations:

EPA's current regulation defines loading capacity as "*the greatest amount of loading that a waterbody can receive without violating water quality standards*." (40 CFR § 130.2(f)). A loading capacity provides the reference for calculating the amount of pollutant reduction needed to bring waters into compliance with standards. The loading capacity can be divided into the sum of pollution coming from point sources plus the sum of pollution from nonpoint sources [40 CFR 130.2(i)]. Point sources in the Bear Creek watershed include National Pollutant Discharge Elimination System (NPDES) permitted facilities. Nonpoint sources include forestry, agriculture, roads, highways, bridges, rural residential and urban development. Emigrant Dam, and the three irrigation districts in the Bear Creek Valley also receive Load Allocations.

Temperature TMDL

The biologically based numeric criteria for cold water salmonids in the Bear Creek watershed is a seven (7) day moving average of daily maximum temperature not to exceed 64.4^{o}F (18.0^{o}C) during times when salmonid rearing is a beneficial use (May 16-October 14) and 55.4^{o}F (13^{o}C) during times and in waters that support salmon spawning, egg incubation and fry emergence from the egg and in gravels (October 15-May 15). Heat Source 6.0 was used to determine the thermal loading capacity for the Bear Creek mainstem based on the simulation of a watershed condition termed natural thermal potential. Natural thermal potential is defined as "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 (OAR 341-041-0002 (35)). The current total thermal load on Bear Creek is approximately 8680 MW-hr/m^2. The loading capacity under natural thermal potential conditions has been calculated as 3059 MW-hr/m^2. The difference between current load and the loading capacity is 6059 MW-hr/m^2, a load reduction of 64%.

The simulation of natural thermal potential temperatures exceeded the biologically based numeric criterion, indicating that there is no assimilative capacity available in Bear Creek. This indicates that in addition to the human use allowance, there is no additional load available to give to point or nonpoint sources above natural thermal potential. Current Rules define a human use allowance as a cumulative increase of no greater than 0.3^{0}C above the applicable criteria after complete mixing in the waterbody and at the point of maximum impact (OAR 340-041-0028 12(b)(B)). Portions of the HUA were distributed to point and nonpoint sources and reserve capacity, which when achieved will meet the temperature TMDL (Table 1).

Table 1. Allocations and Distribution of HUA.

Point Sources: Waste Load Allocations (WLA)[1]	
Ashland WWTF	No greater than 0.1^{0}C increase above the applicable criteria (18^{0}C May 16-Oct 14, 13^{0}C Oct. 15-May 15) in Ashland Creek at point of maximum impact.
Individual and General NPDES Permittees	No significant cumulative increase above the applicable criteria (Significant is defined as 0.005C).
Nonpoint sources; Load Allocations (LA)[1]	
Nonpoint Sources: (DMA authority: Ashland, Talent, Phoenix, Medford, Central Point, Jacksonville, Jackson County, ODA, ODF, USFS, BLM, ODOT).	Cumulative impact no greater than 0.05^{0}C above the applicable criteria at the point of maximum impact.
Emigrant Dam: (DMA authority: USBOR and TID)	No increase in natural thermal potential temperatures when the

	biologically-based numeric criteria are exceeded.
Irrigation Districts: (DMA authority: TID, MID, RRVID)	No greater than 0.05^{0}C increase above the applicable criteria due to management of waters by TID, MID, RRVID in Bear Creek at the point of maximum impact.
Reserve Capacity	
	No greater than 0.1^{0}C increase above the applicable criteria in Bear Creek at the point of maximum impact.

[1]Note: Current Rules define the loading capacity as being met if a cumulative increase of no greater than 0.3^{0}C above the applicable criteria after complete mixing in the waterbody and at the point of maximum impact OAR 340-041-0028 12(b)(B). This 0.3^{0}C increase is distributed between point and nonpoint sources and reserve capacity.

The nonpoint source load allocation for the Urban DMAs, as well as Agriculture, Forestry and Transportation is defined as the amount of solar radiation that reaches a stream surface when riparian vegetation and stream channels have achieved site potential. This applies to all perennial and intermittent fish bearing streams in the watershed. Site potential shade targets are the TMDL implementation targets for urban, transportation, agriculture and forestry (ODF, BLM, USFS). The TMDL targets for selected tributaries are provided in Table 2. Targets for additional surface waters in the watershed are provided in Appendix D.

Note that in Table 17, current shade and site potential shade refer to percent-effective shade defined as the percent reduction of solar radiation load delivered to the water surface. The role of effective shade in this TMDL is to prevent or reduce heating by solar radiation and serve as a linear translator to the solar loading capacities in MW-hr/m^2. From an implementation standpoint it is important to note that any increase in shade over 80% effective shade is considered a margin of safety. At 80% further reduction in stream temperature as a function of vegetation may not be measurable for all stream flows (Boyd, 1996). At values of >80% effective shade, the stream is considered recovered and should not be a candidate for active restoration. Additional shade should come from passive management of the riparian area.

Table 2. TMDL Shade Targets for Bear Creek and Tributaries

Creek	Current Percent Effective Shade	TMDL Shade Target. [1] (Percent Effective)	% Change
Bear Creek Mainstem	15	54	39
Jackson Creek	46	88	42
Griffin Creek	47	85	38
Lazy Creek	26	82	56
Coleman Creek	67	89	21
Wagner Creek	70	91	21
Myer Creek	40	83	42
Butler Creek	21	84	63
Ashland Creek[2]	66	82	16
Neil Creek	71	88	17
Walker Creek	41	86	37
Emigrant Creek	54	85	31

1: TMDL shade target is the calculated percent effective shade provided when riparian vegetation reaches site potential.

2: Ashland Creek as shown represents the average shade from the base of Hosler Dam to the mouth (mouth to river mile 4.9). If all of Ashland Creek is included in the average (both East and West Forks), average percent effective shade from the mouth to the head waters currently is 91%, site potential shade is 94%.

Sedimentation

Reeder Reservoir is listed for sedimentation on the 2004/2006 303(d) list. The listing is due to a USFS Watershed Assessment (USFS, 1995) that stated “excessive sedimentation requires periodic sluicing of Reeder Reservoir to provide storage for drinking water supply.” The sedimentation TMDL applies to all lands within the Ashland Creek Analytical Watershed (HUC-6) which drain into Reeder Reservoir including East and West Forks of Ashland Creek and several small unnamed creeks. All land uses and ownerships were included in the TMDL including the U.S. Forest Service (USFS), and the City of Ashland. The Ashland Creek watershed is composed of granitic soil types subject to debris landslides and surface erosion. Surface erosion, erosion from roads, debris flows/slide, and stream channel erosion are possible sources of sediment into streams and Reeder Reservoir.

East and West Forks of Ashland Creek are the primary tributaries into the reservoir as well as the primary route for the conveyance of upslope sediments into the reservoir. Macroinvertebrate data has indicated that East and West Forks of Ashland Creek provides habitat in excellent condition. The survey recommended that the sites serve as reference sites for the region, and more specifically for granitic watersheds in the area. “What this site, and a handful of others in SW Oregon demonstrates, is that a granitic watershed, where stream channels are naturally storing and transporting high amounts of coarse, granitic sand, can display and maintain very high biotic integrity” (Wisseman 1997).

The sedimentation TMDL sets the loading capacity at natural background or a soil erosion rate of 3.62 cubic yards per day total for the watershed. No significant delivery of sediment to Reeder Reservoir above that which would occur naturally is permitted. Long-term monitoring and the adaptive management nature of this TMDL will be used to evaluate this goal over time. It was recommended that in addition to monitoring sedimentation in East and West Forks of Ashland Creek, Reeder reservoir be monitored to determine trends in sediment delivery and to determine potential sediment sources. Monitoring of stream cobble embeddedness or percent fines (through Wolman pebble count method) and monitoring that continues to incorporate macroinvertebrates as trend indicators for sedimentation in the East and West Forks of Ashland Creek is requested.

Bacteria

In the Bear Creek watershed, fecal bacteria loading is dominated by nonpoint sources (98.4% of loading). As in other bacterial TMDLs (Willamette, DEQ 2006; North Coast Basins, DEQ 2003; Umpqua, DEQ 2006) load duration curves were used make flow-based source assessments. However the assumptions made in these models, that high fecal counts during low flow periods (60-90% flow, called “dry weather”) indicate that point sources are the primary impact to the systems and that high fecal counts during high flow periods (10-40% flow, called “wet weather”) are indicative of nonpoint source inputs do not hold in the Bear Creek watershed. In Bear Creek the primary determinant of flow in the creeks is irrigation water delivery, operational spill and return flows, especially during the summer months. Some of the highest creek flows occur during the summer dry period when irrigation demands are the highest.

A stream flow based loading capacity was developed for Bear Creek and percent reduction targets were determined for each of 5 stream flow ranges. Percent reduction targets were also developed for primary Bear Creek tributaries. Point source waste load allocations were developed based on the percent reduction needed on the affected waterways to meet the applicable water quality standard (126 or 406 E. coli organisms per 100 ml for water contact recreation). An explicit margin of safety was applied to all percent reduction targets. DMAs for the bacteria TMDL include: NPDES permit holders including the City of Ashland and stormwater permit holders, Jackson County onsite program, Urban DMAs including the Cities of Ashland, Talent, Phoenix, Jacksonville, Central Point, Medford and Jackson County, ODA for confined animal feeding operations (CAFO) program, Federal land managers, irrigation districts, and ODA for agricultural lands.

WATER QUALITY MANAGEMENT PLAN

A Water Quality Management Plan (WQMP) is included as a companion document to this TMDL and is included in Chapter II. This document explains the roles of various land management agencies, federal, state, and local governments, as well as private landowners in implementing the actions necessary to meet the allocations set forth in the TMDLs and is intended to fulfill the requirements for implementing a TMDL as described in OAR 340-042-0080. According to the schedule set forth in the WQMP the DMAs identified have 18 months from when this TMDL becomes an executive order to develop and submit to DEQ an implementation plan.

The Bear Creek watershed DMAs and associated plans include:

- Urban DMAs – Ashland, Talent, Phoenix, Medford, Jacksonville, Central Point, Jackson County;
- Irrigation Districts - Medford, Talent, and Rogue River Valley;
- US Bureau of Reclamation; Emigrant dam;
- Oregon Department of Forestry: -State Forest Lands regulated through the Forest Practices Act;
- USFS and BLM: Federal Forest Lands - Northwest Forest Plan;
- Oregon Department of Agriculture: Private Agricultural Lands regulated through the Bear Creek Agricultural Water Quality Management Area Plan;
- Oregon Department of Transportation: routine road maintenance to protect water quality and fish habitat.

CHAPTER I. BEAR CREEK TMDL

SECTION 1. TMDL BACKGROUND

INTRODUCTION

This document seeks to clearly address the elements required by EPA for a Total Maximum Daily Load (TMDL). The TMDL and its associated Water Quality Management Plan (WQMP) were prepared by the Oregon Department of Environmental Quality (DEQ) with assistance from state, federal, and local partners.

Oregon's TMDL Program (Generally Defined)

The quality of Oregon's streams, lakes, estuaries, and groundwater is monitored by DEQ and a variety of partners. This information is used to determine whether water quality criteria are being violated and whether the beneficial uses of the waters are being threatened. Specific State and Federal plans and regulations are used to determine if violations have occurred: these regulations include the Federal Clean Water Act of 1972 and its amendments (40 Codified Federal Regulations 131), Oregon's Administrative Rules (OAR Chapter 340**)** and Oregon's Revised Statutes (ORS Chapter 468).

The term *water quality limited* is applied to streams and lakes where required treatment processes are being used, but violations of state water quality criteria still occur. With a few exceptions, such as in cases where violations are due to natural causes, the State must establish a TMDL for any waterbody designated as water quality limited. A TMDL is the maximum amount of a pollutant (from all sources) that can enter a specific waterbody without causing a violation of water quality criteria.

The total permissible pollutant load is allocated to point, nonpoint, background, future sources of pollution and a margin of safety. Wasteload Allocations are portions of the total pollutant load that are allotted to point sources of pollution, such as sewage treatment plants or industries and are used to establish effluent limits in discharge permits. Load Allocations are portions of the TMDL that are attributed to either natural background sources, such as natural runoff or background solar loading, or from nonpoint sources, such as roads, agriculture or forestry activities. Allocations can also be set aside in reserve for future uses.

The Clean Water Act requires that each TMDL be established with a margin of safety. This requirement is intended to account for uncertainties in the available data or in the effectiveness of control actions. The margin of safety may be implicit, as in conservative assumptions used in calculating the loading capacity, wasteload allocations, and loading allocations. The margin of safety may also be explicitly stated as an added separate allocation in the TMDL calculation. The margin of safety is not meant to compensate for a failure to consider known sources. Implicit margins of safety were developed for temperature, bacteria, and sediment in this TMDL and will be discussed further in the body of the document.

DOCUMENT ORGANIZATION

As defined in OAR 340-042-0040 a Total Maximum Daily Load will contain the following elements:

- Name and Location
- Pollutant Identification
- Water Quality Standards and Beneficial Uses
- Loading Capacity
- Excess Load
- Sources and Source Catagories

- Wasteload Allocations
- Load Allocations
- Margin of Safety
- Seasonal Variation
- Reserve Capacity
- Water Quality Management Plan

WATERSHED CHARACTERIZATION

February 10th, 1827: *We started at 8 AM and proceeded on until 2 PM when we encamped on a large Fork form'd by a number of small Streams which we crossed in our travels this day…this is certainly a fine Country and probably no Climate in any Country equal to it…a country well adapted from its Soil and timber (Oaks and Pine) for cultivation.* From the Journal of Peter Skene Ogden, camped on the bluffs above Bear Creek a mile or two below the mouth of Ashland Creek. Ogden and his small party of Hudson's Bay Company trappers became the first white men to enter the upper drainage of the Rogue River (LaLande, 1987).

Geographic Setting

Map 1. Rogue Basin with Bear Creek watershed shown in Black

The Bear Creek watershed is an important part of the diverse 3,300,000 acre (5,156 square miles) Rogue River Basin (Map 1). The approximately 231,276 acre (361 square mile) Bear Creek watershed includes lands in Jackson County. Elevations in the watershed range from 1,160 feet above sea level at its confluence with the Rogue River to 7,533 feet at the summit of Mt Ashland.

Within the valley floor area the gradient of the creek is low and averages only about a 30 foot drop per mile. In the upper portions of the watershed, the gradient are radically different and some tributaries reach an average drop of over 400 feet per mile.

The watershed contains approximately 290 miles of streams, 83 named tributaries (13 of which are identified as fish bearing) and numerous unnamed tributaries (Bear Creek Watershed Council, 1995). Bear Creek empties into the Rogue River at river mile 127.

Ownership

Approximately 21% of the Bear Creek watershed is Federally managed.

The Bear Creek watershed is located entirely within Jackson County, Oregon. Jackson County has a population of 181,269 most of whom reside within the Bear Creek valley in the population centers of Ashland (19,522), Talent (5,589), Phoenix (4,060), Medford (63,154), Central Point (12,493), and Jacksonville (2235) *(US Census Bureau, Census 2000)*. These urban/non-resource zoned areas cluster predominantly along the valley bottoms along Bear Creek itself and up the valleys created by tributary streams (Map 2).

Approximately 21 percent (49,020 acres) of the watershed is publicly owned and managed by the US Forest Service, Bureau of Land Management, and US Bureau of Reclamation (BLM data, March 2007). These public lands are located primarily along the headwaters of streams in timbered mountainous terrain. These lands are managed for multiple use including water quality, timber production, livestock management, wildlife and recreation.

Zoning in the Bear Creek Watershed

Zoning designations for the Bear Creek watershed are shown below. Zoning designations are important because TMDL implementation plans are usually applied to specific land uses, i.e. agriculture, forestry, urban, rural residential etc. The TMDL implementation plan that applies is based on the specific land use that is occurring on the property.

Urban/non-resource zoned lands

- Industrial (1.1%) outside of city limits (primarily White City)
- Commercial (0.3%) outside of city limits
- Rural (6.51%) inside or outside of UGB
- Suburban(2.1%) inside or outside of UGB (Gibbon/Forest acres)
- Urban (0.1%) within UGB or UCB (White City and Hwy 99 UCBs)
- City (8.8%) all lands within city limits

Resource Zoned lands

- Aggregate Mining resource zone (0.7%)
- Farmland (34.8%) exclusive farm use (EFU)
- Forest (45.6%) open space reserve (OSR), woodland resource (WR), forest resource (FR).

Map 2. Bear Creek Watershed Zoning Map.

Geology

The Bear Creek watershed is the result of tectonic plates causing regional uplift. As elsewhere in the Rogue Basin this uplift is responsible for the steep incised canyons and narrow tributaries formed as water downcuts through a rising landscape composed of soft geologic strata and usnstable formations. The variable soils produced by the erosion of volcanic deposits most certainly have always produced high sediment yields during high flow events from the Bear Creek drainage. The upland Takelma Indian tribe who historically occupied the lower Bear Creek Valley referred to Bear Creek as "Si'kuptpat" meaning "dirty water" (La Land 1987).

Geologically Bear Creek is the point of transition between the Cascades and the Siskiyou mountains, which produces contrasting soil types and structures and natural geologic features. Bear Creek is the line of demarcation between the granitic and volcanic soils.

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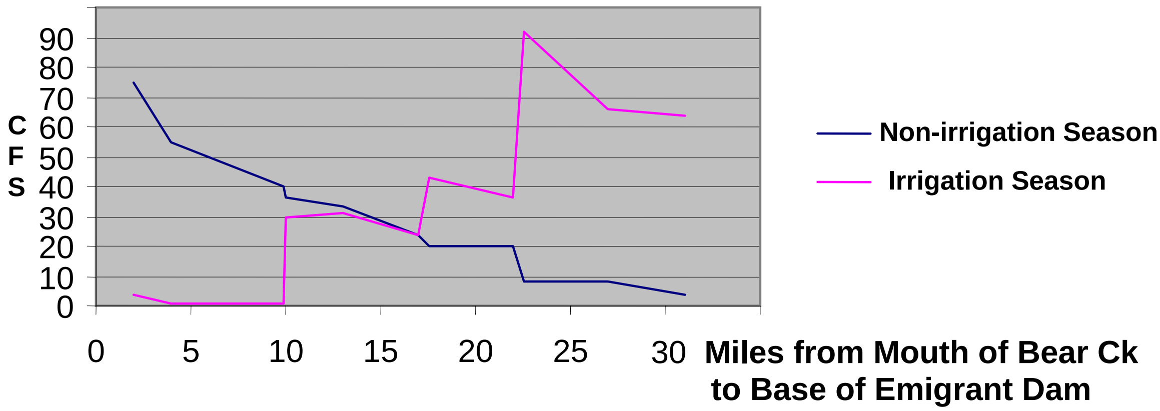
Climate and Weather

The Bear Creek watershed lies on the Pacific Northwest coast of the North American continent at approximately 42.5-north latitude and 123-west longitude. As a part of interior southwestern Oregon, the Bear Creek watershed is located in a transitional area between four very different climate zones: Pacific Maritime to the west, Oregon High Desert to the east, California Mediterranean to the south, and Northern Temperate to the north. The fluctuating boundary between these four zones results in the basin's weather being highly unpredictable, experiencing large annual fluctuations in precipitation and temperatures within longer climatic cycles. Rainfall ranges from 20 inches in the valley areas to over 60 inches at higher elevations. Significant snowfall occurs at higher elevations resulting in a major source for spring river flows, ground water re-charge and surface water for irrigation.

Hydrology

The total discharge from Bear Creek varies considerably from year to year, ranging from a low of about 20000 AF/year in 1931 to 230,000 AF/year in 1965 (RVCOG, 1999) with an annual mean flow of 112 CFS (12 St. gage, USGS data). Historically, the annual stream flows (measured in Medford) have shown more variability that annual precipitation rates because of the effects of storage and irrigation diversion activities. It has been estimated that there are approximated 290 miles of natural creeks in the Bear Creek watershed and greater than 250 miles of irrigation canals (main canals only) RVCOG 1999. Under the current scenario natural stream flows within the Bear Creek watershed are greatly diminished by the end in June and replaced by irrigation conveyance flows which result in artificially high flow conditions for the upper reaches of Bear Creek (above the TID diversion in Ashland) and unnaturally low flows in the system below the MID diversion in Medford (Figure 1).

Figure 1. Generalized Discharge in Bear Creek



Note: adapted from Bear Creek Watershed Council 1995

Overview of Irrigation and Water Storage

Irrigated agriculture began in the Bear Creek watershed over 150 years ago with the first water right in the state of Oregon being granted to Joseph Wagner in 1851. The development of irrigation delivery and storage systems in the Bear Creek valley has significantly altered the landscape of the valley from natural conditions. Irrigation water is conveyed to the farms by some 250 miles of high and low canals which run parallel to Bear Creek on the uplands above the valley floor. Most canals are unlined ditches with significant leakage (in some areas up to 20% of water diverted is lost through canal leakage). In addition to the natural water yield of the Bear Creek watershed, water is imported from both the Applegate Subbasin and the Klamath Basin to meet irrigation needs. Water rights for over 143,00 acre/ft is available for import into the watershed. Imported water in addition to natural flows is stored in Emigrant lake, Fourmile lake, Howard Prairie lake, Fish lake, Hyatt lake, and Agate Reservoirs (Figure 2 and Table 1).

The long term average annual flow yield for Bear Creek, measured at the Medford gauging station, is 82,590 acre feet per year (112 cfs average, Source: USGS Medford gage, Bear Creek River Mile 11.0). This yield represents natural flows plus the contribution of imported waters. Imported waters are brought into the Bear Creek basin at several points. It is estimated that approximately 33,000 AF are imported from the Klamath Basin, plus a junior water right on imported water from the Applegate Subbasin (0.26-6.15 CFS April-Sept, Cohen et. al, 1999). These inter-basin transfers play a large role on the availability, quantity, and quality of water during certain times of the year. This stored water is used primarily for agriculture and insures that during most years water is available for all those who have rights in the Bear Creek basin. The future of these inter-basin transfers are currently under discussion between water users in the Klamath River Basin and the Bureau of Reclamation.

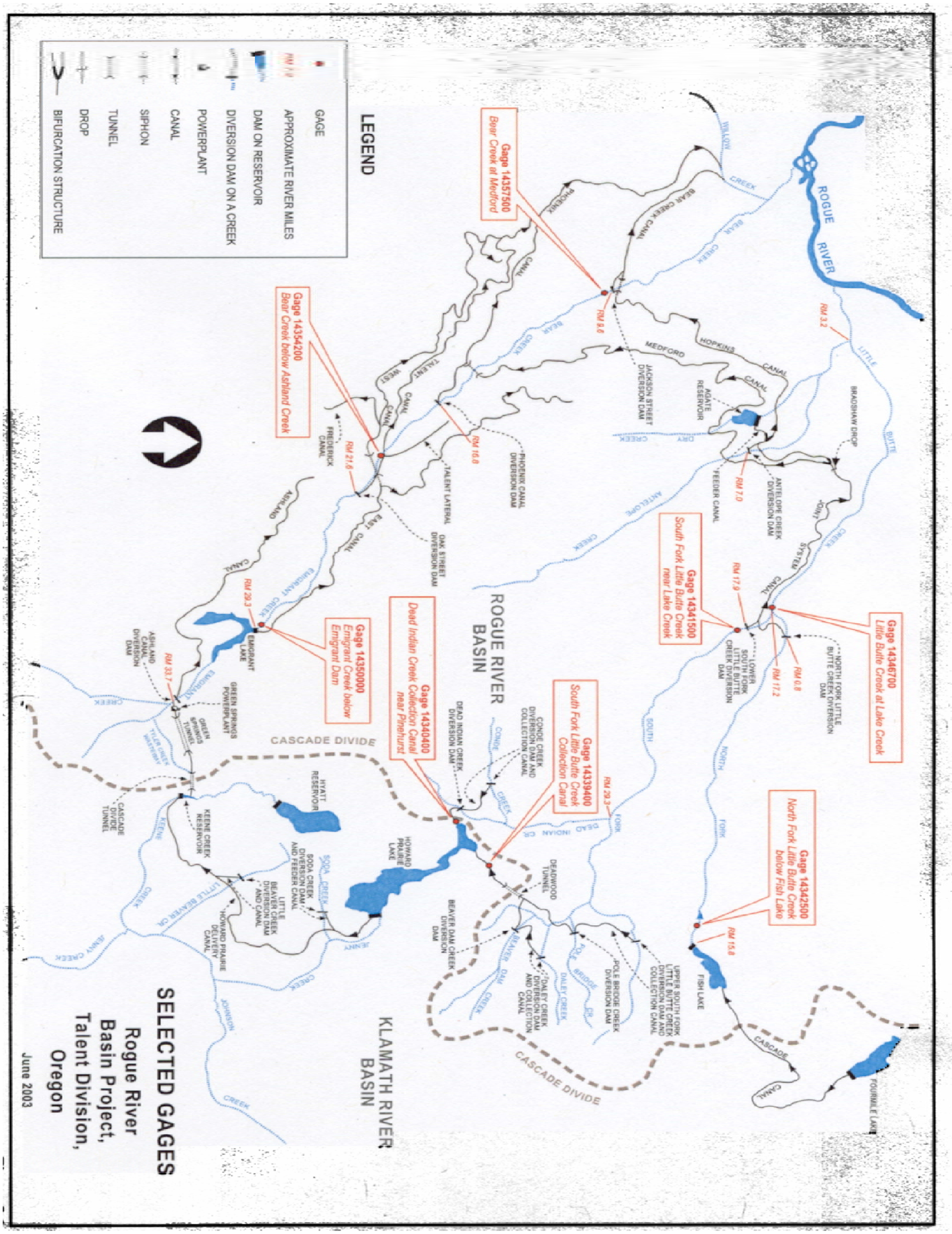
Table 1. Stored Water for Use in the Bear Creek Watershed.

Reservoir	Date completed	Approximate Storage capacity in Acre Feet (AF)
Fourmile Lake	1922	15600
Fish Lake	1908	7900

Agate Reservoir	1966	4700
Emigrant Reservoir	Addition 1960	39000
Howard Prairie Reservoir	1959	59800
Hyatt Lake	1922	16200
Keene Creek Reservoir	1956	260
CURRENT TOTAL STORAGE		144,480 AF

NOTE: Due to limitations in water delivery, not all water in storage is available for irrigation usage in any given year. Source: Talent Irrigation District Website: www.talentid.org

Figure 2. Bear Creek Water Storage, Canals, and Irrigation Districts.



Irrigation Districts

Irrigation Season in the Bear Creek Valley is legally defined as April 1 through October 31 when Bear Creek and many major tributaries become conveyance systems for the 3 large districts in the valley: Talent Irrigation District (TID), Medford Irrigation District (MID), and Rogue River Valley Irrigation District (RRVID). In addition approximately 30 cfs of streamflow is allocated to the districts for frost control between February 15 and April 1.

Talent Irrigation District (TID) manages Howard Prairie Lake, Hyatt Lake, Keen Creek reservoir and Emigrant reservoir. TID uses these sources of stored water in addition to natural stream flow water rights and irrigation water recovered from return flows to supply irrigation water to the southern end of the Bear Creek valley. TID supplies water to 3300 users on 16,400 acres (BCLAC, 2004).

Medford Irrigation District (MID) uses Rogue River Basin Project – Talent Division water (7.5117%) for irrigation in the central portion of the Bear Creek watershed. In addition to stored water, MID picks up TID return flows from the mainstem of Bear Creek. MID supplies approximately 12,800 acres (BCLAC, 2004).

Rogue River Valley Irrigation District (RRVID) uses Rogue River Basin Project – Talent Division water (3.7559%), live stream flow water rights, in addition to a 1/3 share of Fourmile and Fish lake waters and Agate Reservoir for irrigation in the northern portion of the Bear Creek watershed. In addition to stored water, RRVID picks up TID and MID return flows from the mainstem of Bear Creek. RRVID supplies 8,400 acres (BCLAC, 2004).

In addition to the irrigation districts, there are private irrigation rights and ditch associations operating on Bear Creek and some of its major tributaries which cumulatively may take up to 15-20 CFS from the system (RVCOG, 1999).

In sum total there are approximately 6000 irrigation accounts within the 3 irrigation districts (Jim Pendleton, Pers. Communication). According to the Bear Creek Local Agricultural Committee report 2004 "Small acreage landowners (those with five acres or less) make up 80 percent of the irrigation district accounts in the Bear Creek watershed. Many of these small operations may have livestock and/or flood irrigation systems, and without careful management in place, water quality problems can be significant. Given current population growth, there is every indication that this segment of the community will continue to grow and affect traditionally "rural" areas of the watershed".

Emigrant Dam

Emigrant Dam is owned by the USBOR and operated by TID. It is a part of the USBOR Rogue River Basin Talent Division project which includes Fourmile Lake, Fish Lake, Howard Prairie Lake, Hyatt Lake, and Agate lake. It is located 7.5 miles southeast of Ashland, on Emigrant Creek. The reservoir was originally constructed by TID in 1924. The original 110-foot-high thin-arch concrete dam was incorporated into a 204-foot-high earthfill structure with enlargement by the Bureau of Reclamation in 1961. The dam is 204 feet high and has a crest elevation of 2254 feet. The reservoir´s total capacity is 40,500 acre-feet (active 39,000 acre-feet). The enlarged reservoir re-regulates Green Springs Powerplant discharges and provides additional storage for irrigation. The dam releases water from the bottom of the reservoir, there is currently no way to regulate the temperature of Emigrant Dam discharge.

A preliminary proposal was submitted to the Federal Energy Commission in 2001 to develop a 935kW hydroelectric project at Emigrant dam. The proposal was withdrawn in 2003.

Hosler Dam

Hosler Dam is located just below the confluence of the east and west forks of Ashland Creek, above the City of Ashland. It is owned and operated by the City of Ashland. The dam was constructed in 1928 creating Reeder Reservoir. It is 25 feet thick at its base and 7 feet thick at the top, rising 110 feet. The concrete dam holds back a maximum of 850 acre feet (277 million gallons) of water reserves. There is a small hydroelectric generating plant located at the base of the dam with an installed capacity of 810 kW. The project is currently operated under FERC, Reeder Gulch, project number #1107-005. This project is exempt from the requirements of Part I of the Federal Power Act and does not require a FERC license. This exemption is made in perpetuity and is subject to mandatory terms and conditions set by federal and state fish and wildlife agencies and by the Commission, and does not convey the right of eminent domain. Access roads and to a lesser extent the Forest Service Roads within the Reeder Reservoir watershed have contributed surface erosion to the reservoir and to Ashland Creek below the reservoir. Roads are not surfaced and therefore can contribute large volumes of silt and coarse sediment to the reservoir (USFS, 1995).

Bear Creek Watershed Fisheries

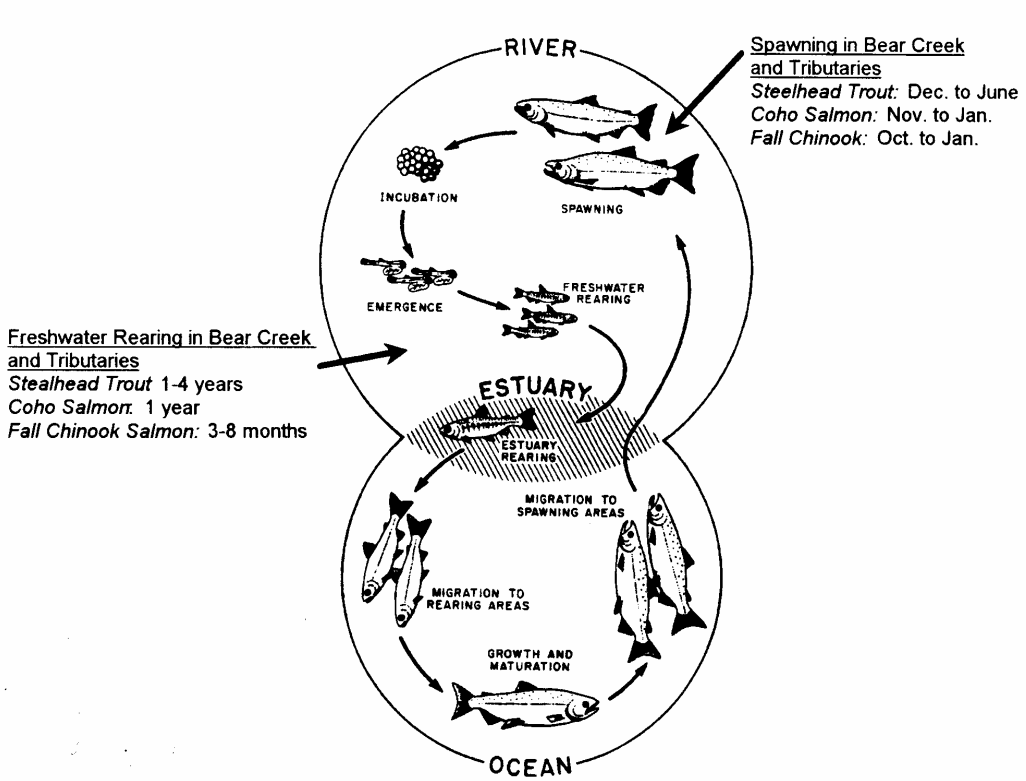
Bear Creek has a small population of coho, fall chinook, winter and summer steelhead, and resident trout (rainbow and cutthroat). Winter steelhead and fall chinook are the primary anadromous species using the Bear Creek system. In addition, pacific anadromous lamprey, western brook lamprey, reticulate sculpin, and Klamath smallscale sculpin have been found in the system. Nonnative species also exist in the watershed: redside shiner, speckeled dace, large and small mouth bass, black crappie, bluegill, catfish, brown bullhead, yellow perch, carp, goldfish and others (USFS, 1995).

Coho salmon in the Rogue Basin belong to the Southern Oregon-Northern California Coast Evolutionary Significant Unit (ESU) which occurs between Cape Blanco, Oregon and Punta Gorda, California. This ESU is listed under the Federal Register (2002) as threatened by NOAA Fisheries. Steelhead in the Rogue including the Bear Creek watershed belong to the Klamath Mountain Province ESU, which is inclusive of the Klamath River in California north to the Elk River in Oregon. A recent status review concluded that the listing of Steelhead in this ESU was not warranted (Federal Register, 2001).

All salmonids require a cold freshwater environment for spawning. Each species, however, differs in the extent to which they rear in fresh water. All salmonid species dig a nest (redd) in the gravel bottom of streams where the eggs are deposited by the female and fertilized by the male. Incubation of the egg depends upon the species and is water temperature dependent. After incubation, an alevin (a small fry with an attached egg yolk sac) emerges from the egg into the gravel. Once the egg sac has been completely absorbed, the alevins emerge from the gravel as developed fry (Figure 3).

The salmonid life cycle involves a complex web of instream habitats, ocean conditions and harvest pressure that all combine to impact salmonid populations. Listed below is a brief description of specific habitat needs by species as found in the Bear Creek watershed.

Figure 3. Anadromous Salmonid Lifecycle in the Bear Creek Watershed



Coho Salmon (Oncorhynchus kisutch)

Coho are most linked to the complex riverine habitats that were once prevalent in the Bear Creek. Spawning of wild coho in the Bear Creek was linked to the mainstem and tributaries. Coho prefer pools, glides, or slow velocity areas with overhead cover for rearing. Juveniles are territorial and prefer plunge pools, lateral scour pools, and glides during the summer months. They spend the winter months in low gradient braided channel areas where side channels, sloughs, and beaver ponds, are present before migrating to the ocean. They depend on smaller streams that have wide riparian areas with marshes and side channels and pools in off-channel areas, alcoves along the edges of streams and rivers and beaver dams for summer and winter freshwater habitat. These fish must remain in freshwater habitat, generally tributary streams for one year. Urbanization, agriculture, water withdrawals and loss of stream/floodplain connectivity in the greater Bear Creek watershed inhibit the recovery of coho salmon (USFS, 1995).

Chinook Salmon (Oncorhynchus tshawytscha)

Most spawning and rearing occurs in the lower segments of larger tributaries and the mainstem of the Bear Creek. Mainstem river edge habitat is used for refuge by fry in the early spring prior to their migration downstream to the estuary.

Steehhead (Oncorhynchus mykiss)
Steelhead are rainbow trout which migrate to the ocean. Of the three anadromous species present in the Bear Creek, steelhead are the most adaptive. The Bear Creek is home to two distinct runs of steelhead: summer run and winter run. In the absence of barriers, steelhead will spawn and rear throughout the watershed, but prefer headwater streams or upper segments of streams. Juvenile steelhead reside in small streams and in the mainstem of Bear Creek if temperatures are cool. Unlike the salmon which prefer pools and glides, steelhead are able to rear in fast-moving water. This trait and their variable stay in fresh water from one to four years make them very adaptive to changing habitat conditions, but also most susceptible to high water temperatures. They can compensate somewhat for elevated stream temperatures by seeking turbulent water with more oxygen. Many of the streams preferred by steelhead for spawning dry up in the summer. In addition, irrigation diversions, water withdrawals and low flows limit adult access to spawning tributaries, forcing steelhead to spawn in the mainstem Bear Creek, resulting in lower juvenile survival rates.

Resident Trout (Oncorhynchus species)
Bear Creek and Rogue Rivers' resident rainbow population is somewhat unusual for coastal basins. Resident cutthroat and rainbow populations are generally located in headwater streams. In the simplified aquatic and riparian habitat of lower elevation streams, cutthroat and rainbow are out competed by juvenile steelhead and non-native fish (USFS, 1995).

WATER QUALITY IMPAIRMENTS

The existence of water quality problems in the Bear Creek watershed has been acknowledged and documented for many years. Studies supported by the Clean Water Act Section 208 planning grants in the 1970s identified problems related to fecal bacteria, low flows, sediment, turbidity, nutrients, and temperature. In 1992 Bear Creek was among the first watersheds in the state to have an established TMDL. The Bear Creek TMDLs were approved by USEPA on December 12, 1992. In order to address the non-attainment of pH, aquatic weeds and algae, and dissolved oxygen (DO) standards in the Bear Creek watershed, TMDLs were developed establishing instream concentration criteria, load and wasteload allocations for total phosphorus, ammonia nitrogen and biochemical oxygen demand. These existing TMDLs are still in place and used to determine point and nonpoint source compliance. The 1992 TMDL is reviewed in Section 5 of this document.

The 2004/2006 303(d) list indicates that the Bear Creek watershed does not meet water quality standards for temperature, bacteria, and sedimentation at certain times of the year (Table 2). This TMDL will address the following:

- Temperature: Total 138.7 miles, 19 TMDLs.
- Bacteria: Fecal Coliform, 5 summer listings, 6 fall/winter/spring, 5 year-round. Total 120.4 miles; E. coli: 1 summer listing, 1 fall/winter/spring. Total 52.6 miles, 11 TMDLs
- Sedimentation: 1 year-round listing. 1 TMDL.

Note: A total of 31 TMDLs, covering 311.7 stream miles are addressed in this TMDL (Table 2). Note also that on the DEQ website (www.oregon.gov/DEQ) the Bear Creek watershed 303(d) listings are included in the Middle Rogue section. The remainder of the Middle Rogue 303(d) listings including: Battle Creek, Birdseye Creek, Cold Creek, East Fork Evans, Evans Creek, Galls Creek, Pleasant Creek, Ramsey Canyon, Rock Creek, Salt Creek, Savage Creek, and West Fork Evans Creek will be addressed in the Rogue TMDL scheduled for completion in 2007.

Table 2. 2004/2006 303(d) Listings Addressed in the Bear Creek Watershed TMDL

TEMPERATURE					
Record ID	**Waterbody Name**	**River Mile**	**Parameter**	**Season**	**List Date**
3940	Bear Creek	0 to 26.3	Temperature	Summer	1998

3942	Butler Creek	0 to 5.2	Temperature	Summer	1998
4423	Carter Creek	0 to 4.8	Temperature	Summer	1998
3944	Coleman Creek	0 to 6.9	Temperature	Summer	1998
3946	Emigrant Creek	0 to 3.6	Temperature	Summer	1998
4422	Emigrant Creek	5.6 to 15.4	Temperature	Summer	1998
8149	Gaerky Creek	0 to 4.6	Temperature	Summer	2002
4425	Hobart Creek	0 to 1	Temperature	Summer	1998
3953	Jackson Creek	0 to 12.6	Temperature	Summer	1998
8016	Jackson Creek	0 to 12.6	Temperature	October 1 - May 31	2002
3954	Larson Creek	0 to 6.7	Temperature	Summer	1998
8022	Lazy Creek	0 to 4.5	Temperature	Summer	2002
3955	Lone Pine Creek	0 to 5	Temperature	Summer	1998
3957	Meyer Creek	0 to 5.3	Temperature	Summer	1998
8026	Neil Creek	0 to 4.8	Temperature	October 1 - May 31	2002
3958	Neil Creek	0 to 4.8	Temperature	Summer	1998
8031	Payne Creek	0 to 2.1	Temperature	Summer	2002
4424	Tyler Creek	0 to 4	Temperature	Summer	1998
4326	Wagner Creek	6 to 7.4	Temperature	Summer	1998
3967	Wagner Creek	0 to 6	Temperature	Summer	2002
8036	Walker Creek	0 to 6.7	Temperature	October 1 - May 31	2002
Total number of miles listed for rearing temperature					114.6
Total number of miles listed for spawning temperature					24.1

BACTERIA					
Record ID	**Waterbody Name**	**River Mile**	**Parameter**	**Season**	**List Date**
4085	Ashland Creek	0 to 2.8	Fecal Coliform	Fall/Winter/Spring	1998
4357	Ashland Creek	0 to 2.8	Fecal Coliform	Summer	1998
4360	Bear Creek	0 to 26.3	Fecal Coliform	Summer	1998
4086	Bear Creek	0 to 26.3	Fecal Coliform	Fall/Winter/Spring	1998
16882	Bear Creek	0 to 26.3	E. coli	Fall/Winter/Spring	2004
16883	Bear Creek	0 to 26.3	E. coli	Summer	2004
4088	Butler Creek	0 to 5.2	Fecal Coliform	Fall/Winter/Spring	1998
4089	Coleman Creek	0 to 6.9	Fecal Coliform	Year Around	1998
4090	Crooked Creek	0 to 4.3	Fecal Coliform	Summer	1998
4404	Crooked Creek	0 to 4.3	Fecal Coliform	Fall/Winter/Spring	1998
4093	Griffin Creek	0 to 14.4	Fecal Coliform	Summer	1998
4405	Griffin Creek	0 to 14.4	Fecal Coliform	Fall/Winter/Spring	1998
4095	Jackson Creek	0 to 12.6	Fecal Coliform	Year Around	1998

4096	Larson Creek	0 to 6.7	Fecal Coliform	Year Around	1998
4097	Lazy Creek	0 to 4.5	Fecal Coliform	Year Around	1998
4098	Meyer Creek	0 to 5.3	Fecal Coliform	Summer	1998
4406	Meyer Creek	0 to 5.3	Fecal Coliform	Fall/Winter/Spring	1998
4100	Payne Creek	0 to 2.1	Fecal Coliform	Year Around	1998
Total number of miles listed Summer fecal coliform					29.6
Total number of miles listed Fall/Winter/Spring fecal coliform					58.3
Total number of miles listed for year-round fecal coliform					32.8
Total number of miles listed Summer E. coli					26.3
Total number of miles listed Fall/Winter/Spring E. coli					26.3

SEDIMENTATION					
Record ID	**Waterbody Name**	**River Mile**	**Parameter**	**Season**	**List Date**
4280	Reeder Reservoir/Ashland Creek	4.9 to 5.4	Sedimentation	Year-round	1998
Total number of miles listed Sedimentation					Reservoir

[1] Once a TMDL is developed, effected parameters are removed from the 303(d) list. i.e. parameters covered under the 1992 Bear Creek TMDL are not shown on the 2004/2006 303(d) list shown above.

Bear Creek Oregon Water Quality Index (OWQI)

The DEQ has conducted water quality monitoring in the Rogue Basin since the mid 1980s and has used this water quality data to calculate Oregon Water Quality Index (OWQI) scores. OWQI is a single number which expresses water quality by integrating measurements of eight carefully selected water quality parameters; temperature, dissolved oxygen, biochemical oxygen demand, pH, ammonia+nitrate nitrogen, total phosphates, total solids, fecal coliform. The index was developed for the purpose of providing a simple, and concise method for expressing the significance of regularly generated laboratory data, and was designed to aid in the assessment of water quality for general recreational uses.

DEQ submits the results of the OWQI on an annual basis. The reports address trends over the previous 10 years, for example the 2004 report addressed the water years 1994-2003, the 2005 report addressed the water years 1995-2004, and the 2006 report addressed the water years 1996-2005. These 3 most recent reports indicate that although Bear Creeks water quality is below standards, the creek is showing significant improvements. In the 2004 report Bear Creek was the most improved waterway in the state (+16.7 OWQI units,@ 99% significance). In 2005 it was the second most improved waterway (+12.2 OWQI units,@ 99% significance) and in 2006 it was again the second most improved waterway (+7.5 OWQI units,@ 99% significance) in the state of those tested. In addition in 2006 the status of the Bear Creek based on its OWQI scores was upgraded from very poor to poor. See the DEQ website at http://www.deq.state.or.us/lab/wqm/wqimain.htm for more information.

BENEFICIAL USES

The Oregon Environmental Quality Commission (OEQC) has adopted numeric and narrative water quality standards to protect designated *beneficial uses*. 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. Cold-water aquatic life such as salmon and trout are the most sensitive *beneficial uses* occurring in the Bear Creek watershed (DEQ, 1995). The specific beneficial uses for the Bear Creek watershed are presented in Table 3 (Oregon Administrative Rules OAR 340–041–0271, Table 271A, November 2003).

Table 3. Beneficial Uses in the Bear Creek Watershed (OAR 340-041-0271, Table 271A)

Beneficial Use	***Bear Creek Mainstem***	***Bear Creek Tributaries***	***Beneficial Use***	***Bear Creek Mainstem***	***Bear Creek Tributaries***
Public Domestic Water Supply[1]		✓	Commercial Navigation & Trans.		
Private Domestic Water Supply[1]	✓	✓	Fish and Aquatic Life[2]	✓	✓
Industrial Water Supply	✓	✓	Wildlife and Hunting	✓	✓
Irrigation	✓	✓	Fishing	✓	✓
Livestock Watering	✓	✓	Water Contact Recreation	✓	✓
Boating	✓	✓	Hydro Power**		✓
Aesthetic Quality	✓	✓			

1. With adequate pre-treatment (filtration and disinfection) and natural quality to meet drinking water standards.
2. See figures 271A and 271B for fish use designations for this watershed.

APPLICABLE WATER QUALITY STANDARDS

Temperature Standard: OAR 340-041-0028(1)-(13)
The standard that now applies to the Bear Creek watershed was approved by EPA on March 2, 2004 and is found in OAR 340-041-0028 (4) (a-c) (ODEQ 2004). Excerpts of the standard read as follows:

> *(4) Biologically Based Numeric Criteria. Unless superseded by the natural conditions criteria described in section (8) of this rule, or by subsequently adopted site-specific criteria approved by EPA, the temperature criteria for State waters supporting salmonid fishes are as follows:*
>
> *(a) The seven-day-average maximum temperature of a stream identified as having salmon and steelhead spawning use on subbasin maps and tables set out in OAR 340-041-0101 to OAR 340-041-0340: Tables 101B, and 121B, and Figures 130B, 151B, 160B, 170B, 220B, 230B, 271B, 286B, 300B, 310B, 320B, and 340B, may not exceed 13.0 degrees Celsius (55.4 degrees Fahrenheit) at the times indicated on these maps and tables;*
>
> *(b) The seven-day-average maximum temperature of a stream identified as having core cold water habitat use on subbasin maps set out in OAR 340-041-101 to OAR 340-041-340: Figures 130A, 151A, 160A, 170A, 220A, 230A, 271A, 286A, 300A, 310A, 320A, and 340A, may not exceed 16.0 degrees Celsius (60.8 degrees Fahrenheit);*
>
> *(c) The seven-day-average maximum temperature of a stream identified as having salmon and trout rearing and migration use on subbasin maps set out at OAR 340-041-0101 to OAR 340-041-0340: Figures 130A, 151A, 160A, 170A, 220A, 230A, 271A, 286A, 300A, 310A, 320A, and 340A, may not exceed 18.0 degrees Celsius (64.4 degrees Fahrenheit);*

8) Natural Conditions Criteria. Where the department 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.

12(b) Human Use Allowance. Insignificant additions of heat are authorized in waters that exceed the applicable temperature criteria as follows:

(A) Prior to the completion of a temperature TMDL or other cumulative effects analysis, no single NPDES point source that discharges into a temperature water quality limited water may cause the temperature of the water body to increase more than 0.3 degrees Celsius (0.5 Fahrenheit) above the applicable criteria after mixing with either twenty five (25) percent of the stream flow, or the temperature mixing zone, whichever is more restrictive; or

(B) Following a temperature TMDL or other cumulative effects analysis, waste load and load allocations will restrict all NPDES point sources and nonpoint sources to a cumulative increase of no greater than 0.3 degrees Celsius (0.5 Fahrenheit) above the applicable criteria after complete mixing in the water body, and at the point of maximum impact.

Fish use maps 271A and 271B for the Bear Creek Subbasin temperature water quality standards can be found at: http://www.deq.state.or.us/wq/rules/div041tblsfigs.htm#f1.

Bacteria (OAR 340-041-0009)

Until 1996 DEQ assessed bacterial contamination using fecal coliform bacteria, since then *E. coli* has been used. Bacterial criteria for the waters of the Bear Creek watershed are contained in the Oregon Administrative Rules (OAR 340-041-0009). The current recreational contact standard is a 30-day log mean of 126 *E. coli* organisms per 100 ml, based on a minimum of five samples, with no single sample exceeding 406 *E. coli* organisms per 100 ml. A water body is considered water quality limited if more than 10% of the samples exceed 406 org./100 ml or the 30-day log mean is greater than 126 org./100 ml (Table 4).

Table 4. Water Quality Standards for Bacteria in the Rogue Basin

Beneficial Use	Standard and Description
Freshwaters and Estuarine Waters Other than Shellfish Growing Waters (Water Contact Recreation)	(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.
Freshwaters and Estuarine Waters (Water Contact Recreation) prior to 1996:	(A) A 30-day log mean of 200 fecal coliform organisms per 100 milliliters, based on a minimum of five samples; (B) No more than 10% of samples greater than 400 fecal coliform organisms per 100 milliliters.

Sedimentation OAR 340-041-0007(13)

The standard that applies to the Bear Creek watershed is OAR 340-041-0007(13). (ODEQ 2004).

> "The formation of appreciable bottom or sludge deposits or the formation of any organic or inorganic deposits deleterious to fish or other aquatic life or injurious to public health, recreation, or industry may not be allowed."

SECTION 2. TEMPERATURE TMDL

Summary of Temperature TMDL Development and Approach

Temperature Issues in the Bear Creek Watershed

Salmonids, often referred to as cold water fish, and some amphibians are highly sensitive to temperature. In particular, Chinook salmon (Oncorhynchus tshawytscha) and coho salmon (Oncorhynchus kisutch) are among the most temperature sensitive of the cold water fish species in the Bear Creek watershed. Excessive summer water temperatures have been recorded in a number of tributaries and in Bear Creek. These high summer temperatures are reducing the quality of rearing and spawning habitat for chinook and coho salmon, steelhead and resident rainbow trout. The high water temperatures in the Bear Creek watershed are due to increased solar radiation on the waters surface as a result of riparian vegetation removal or alteration as well as the discharge or conveyance of waters that have been warmed. Activities that may impact riparian vegetation or result directly in the discharge warmer waters into the Bear Creek system include urban and rural residential development near streams and rivers, reservoir management, irrigation water return flows, past forest management within riparian areas, NPDES regulated point sources, agricultural land use within the riparian area, road construction and maintenance.

Scope

All perennial and intermittent fish bearing streams that drain to Bear Creek are included in this temperature TMDL. All land uses and ownerships are included in this TMDL: lands managed by the State of Oregon, Bureau of Reclamation, Irrigation districts, the U.S. Forest Service (USFS) and Bureau of Land Management (BLM), private forestlands, agricultural lands, rural residences, transportation uses and urbanized areas.

Applying Oregon's Temperature Standard

Oregon's water temperature standard employs a logic that relies on using salmonids as the indicator. If temperatures are protective of these indicator species, other species will share in this protection. As a result of water quality criteria exceedances for temperature, 23 stream reaches(approximately 162 stream miles) in the Bear Creek watershed are on Oregon's 2004/2006 303(d) list. The reduction in thermal loading needed to meet the water quality criteria for temperature is evaluated in this TMDL. Attainment of the temperature criteria relies on simulating the thermal profile of Bear Creek under conditions termed "natural thermal potential". Natural thermal potential is defined as site potential vegetation, geomorphology, stream flows and other measures to reflect natural conditions.

Temperature TMDL Overview

Potential thermal pollutants identified include human-caused increases in solar radiation due to changes in riparian vegetation, warm water discharges due to dams, irrigation district management, and NPDES permitted sources. The resultant TMDL loading capacities are expressed as pollutant loading limits plus a Human Use Allowance (HUA) for both point and nonpoint sources of pollution. The human use allowance is a cumulative increase of no greater than 0.3^0C above the applicable criteria after complete mixing in the waterbody and at the point of maximum impact (OAR 340-041-0028 12(b)(B)). The 0.3^0C cumulative increase is distributed between point and nonpoint sources and reserve capacity. Allocations take the form of numeric loads, percent reduction targets as well as percent effective shade targets for identified watershed sources. Since natural thermal potential temperatures exceed 64.4F, DEQ rules state that achieving natural thermal potential conditions are considered compliance with the TMDL.

Table 5. Temperature TMDL Component Summary

Waterbodies **OAR 340-042-0040(4)(a)**	All Perennial and intermittent fish bearing streams (as identified by ODFW, USFW or NOAA Fisheries) within the Bear Creek Watershed, HUC (Hydrologic Unit Code) **1710030801**
Pollutant Identification **OAR 340-042-0040(4)(b)**	<u>*Pollutants*</u>*:* Human caused temperature increases from (1) warm water discharge to surface waters (2) increased solar radiation loading, and (3) flow modification that affects natural thermal regimes including reservoir operations that influence the timing of maximum seasonal stream temperatures.
Beneficial Uses **OAR 340-041-0271,** **Table 271A**	Beneficial uses impaired include fish and aquatic life, and fishing.
Target Identification **Applicable Water Quality Standards** **OAR 340-041-0028(4)(a)** **OAR 340-041-0028(4)(c)** ***CWA §303(d)(1)***	OAR 340, Division 41 provides numeric and narrative temperature criteria. Figures 271A, 271B specify where and when the criteria apply. Biologically based numeric criteria applicable to the Bear Basin, as measured using the seven day average of the daily maximum stream temperature include: 13.0°C during times and at locations of salmonid and steelhead spawning. (October 15-May 15) 18.0°C during times and at locations of salmon and trout rearing and migration. (May 16-October 14)
Existing Sources **OAR 340-042-0040(4)(f)** ***CWA §303(d)(1)***	<u>Nonpoint sources</u> include excessive inputs of solar radiation due to the removal or reduction in stream side vegetation. Reservoir, irrigation districts and dam operations are considered nonpoint sources that influence the quantity and timing of heat delivery to down stream river reaches. <u>Point sources</u> include municipal and industrial facilities that discharge warm water to receiving streams.
Seasonal Variation **OAR 340-042-0040(4)(j)** ***CWA §303(d)(1)***	Peak temperatures typically occur in mid-July through mid-August but anthropogenic heat loads are of concern and addressed from October 15- May 15 for the spawning criteria, May 16 – October 14 for the non-spawning criteria.
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)***	<u>*Loading Capacity*</u>*:* Oregon Administrative Rule 340-041-0028 (12)(b)(B) states that all anthropogenic sources of heat may cumulatively increase stream temperature no more than 0.3ºC (0.5 ºF) above the applicable criteria at the point of maximum impact. Loading capacity for Bear Creek is the heat load that corresponds to the Natural Conditions Criteria plus the small increase in temperature of 0.3ºC provided with the human use allowance. For Bear Creek the loading capacity at natural thermal potential is 3059 MW-hr/m^2. <u>*Excess Load*</u>: The difference between the actual pollutant load and the loading capacity of the waterbody is the excess heat load. In Bear Creek the difference between the heat load that meets applicable temperature criteria and current heat loads is 6059 MW-hr/m^2. <u>*Load Allocations (Nonpoint Sources)*</u>: The load allocation for nonpoint sources in the Bear Creek watershed consists of the sum of the natural background heat loads from solar radiation plus 0.05ºC of the human use allowance above the criteria at the point of maximum impact in Bear Creek. The HUA has been allocated to nonpoint source activities along the mainstem Bear Creek to address anthropogenic heat loads in excess of background rates due to existing structures, or altered landscape features that are unlikely to achieve system potential shade. <u>*Load Allocations (Reservoir Operations and Irrigation Districts)*</u>: Load allocations for the reservoir and irrigation districts is based on a portion of the Human Use Allowance. Irrigation Districts are allowed a cumulative increase in temperature of not more than 0.05ºC in Bear Creek above the criteria at the point of maximum impact. Emigrant Dam is allowed no increase in natural thermal potential temperatures when the biologically-based numeric criteria are exceeded. <u>*Waste Load Allocations (NPDES Point Sources)*</u>: The City of Ashland WWTF is allowed an increase in temperature of not more than 0.1ºC in Ashland Creek above the applicable criteria at the point of maximum impact. Waste load allocations for all other NPDES point sources in the Bear Creek watershed are considered insignificant in terms of thermal load added to Bear Creek (less then 0.005ºC increase in Bear Creek at the point of maximum impact). <u>*Reserve Capacity*</u>: A portion of the human use allowance is allocated for future growth and new or expanded sources. This allowance is a total of 0.1ºC increase in Bear Creek at the point of maximum impact above natural thermal potential.
Surrogate Measures **OAR 340-042-0040(5)(b)** ***40 CFR 130.2(i)***	<u>Surrogate measures</u> are used throughout the temperature TMDL. Effective shade targets translate nonpoint source solar radiation loads into measurable stream side vegetation targets.
Margins of Safety **OAR 340-042-0040(4)(i)** ***CWA §303(d)(1)***	<u>*Margins of Safety*</u> are demonstrated in critical condition assumptions used for point source waste load allocations and are inherent to methodology for determination of nonpoint source loads.
Water Quality Management Plan **OAR 340-042-0040(4)(l)** ***CWA §303(d)(1)***	The Water Quality Management Plan (WQMP) 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 (Appendix D).

INTRODUCTION:

This TMDL Summary seeks to clearly address the elements required by EPA to meet the requirements for Total Maximum Daily Load (TMDL) development for temperature within the Bear Creek watershed (Table 5). These elements are addressed in this TMDL with references to the accompanying Water Quality Management Plan (WQMP). The TMDL and WQMP were prepared by the Oregon Department of Environmental Quality (DEQ) with assistance from state, federal, and local partners.

TMDL Extent and Subwatershed Description

This temperature TMDL applies to all perennial and intermittent fish bearing streams within the Bear Creek watershed. The subbasin is an important part of the diverse 3,300,000 acre (5,156 square miles) Rogue River Basin. The subbasin is located on the northeastern flank of the Siskiyou Mountains in southwestern Oregon. This is one of the most biologically, botanically, and geologically diverse areas in the country. It is steep and rugged, ranging in elevation from 1160 feet to 7533 feet above sea level. The 231,276 acre (361 square mile) Bear Creek watershed is located entirely within Jackson County, Oregon (more detailed information is located in Section 1 – Watershed Characterization).

BENEFICIAL USES SENSITIVE TO TEMPERATURE.

The Oregon Environmental Quality Commission (OEQC) has adopted numeric and narrative water quality standards to protect designated *beneficial uses* (Administrative Rules OAR 340–041–0271, Table 271A, November 2003). 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. Cold-water aquatic life such as salmon and trout are the most temperature sensitive *beneficial uses* occurring in the Bear Creek watershed (DEQ, 1995). The beneficial uses affected by excessive temperatures include Fish and Aquatic Life and Fishing (DEQ, 2005) (Table 6).

Table 6. Temperature Sensitive Beneficial Uses (OAR 340-041-0271, Table 271A)

Beneficial Use	***Bear Creek Mainstem***	***Bear Creek Tributaries***	***Beneficial Use***	***Bear Creek Mainstem***	***Bear Creek Tributaries***
Public Domestic Water Supply[1]	**	✓	Commercial Navigation & Trans.		
Private Domestic Water Supply[1]	✓	✓	Fish and Aquatic Life[2]	✓	✓
Industrial Water Supply	✓	✓	Wildlife and Hunting	✓	✓
Irrigation	✓	✓	Fishing	✓	✓
Livestock Watering	✓	✓	Water Contact Recreation	✓	✓
Boating	✓	✓	Hydro Power**		✓
Aesthetic Quality	✓	✓			

**Note: Designation for this use is currently under study

1. With adequate pre-treament (filtration and disinfection) and natural quality to meet drinking water standards
2. See Figures 271A and 271B for fish use designations for this watershed.

DEVIATION FROM WATER QUALITY STANDARDS; 303(d) LISTINGS

Monitoring has indicated that water temperatures in the Bear Creek watershed exceed the State of Oregon temperature criteria. Accordingly, 19 stream segments within the watershed are on the 2004/2006 303(d) list for exceeding the 64.4°F (18C) 7-day statistic for rearing salmonids and 3 stream segments are on the 2004/2006 303(d) list for exceeding the 55.4°F (16C) 7-day statistic for spawning salmonids (Table 7 and Map 3).

Table 7. 2004/2006 303(d) Listings Addressed in the Bear Creek Watershed TMDL

Waterbody Name	River Mile	Parameter	Season	List Date
Bear Creek	0 to 26.3	Temperature	Summer	1998
Butler Creek	0 to 5.2	Temperature	Summer	1998
Carter Creek	0 to 4.8	Temperature	Summer	1998
Coleman Creek	0 to 6.9	Temperature	Summer	1998
Emigrant Creek	0 to 3.6	Temperature	Summer	1998
Emigrant Creek	5.6 to 15.4	Temperature	Summer	1998
Gaerky Creek	0 to 4.6	Temperature	Summer	2002
Hobart Creek	0 to 1	Temperature	Summer	1998
Jackson Creek	0 to 12.6	Temperature	Summer	1998
Jackson Creek	0 to 12.6	Temperature	October 1 - May 31	2002
Larson Creek	0 to 6.7	Temperature	Summer	1998
Lazy Creek	0 to 4.5	Temperature	Summer	2002
Lone Pine Creek	0 to 5	Temperature	Summer	1998
Meyer Creek	0 to 5.3	Temperature	Summer	1998
Neil Creek	0 to 4.8	Temperature	October 1 - May 31	2002
Neil Creek	0 to 4.8	Temperature	Summer	1998
Payne Creek	0 to 2.1	Temperature	Summer	2002
Tyler Creek	0 to 4	Temperature	Summer	1998
Wagner Creek	6 to 7.4	Temperature	Summer	1998
Wagner Creek	0 to 6	Temperature	Summer	2002
Walker Creek	0 to 6.7	Temperature	October 1 - May 31	2002
Total number of miles listed for rearing temperature				**114.6**
Total number of miles listed for spawning temperature				**24.1**

POLLUTANT IDENTIFICATION OAR 340-042-0040(4)(B)

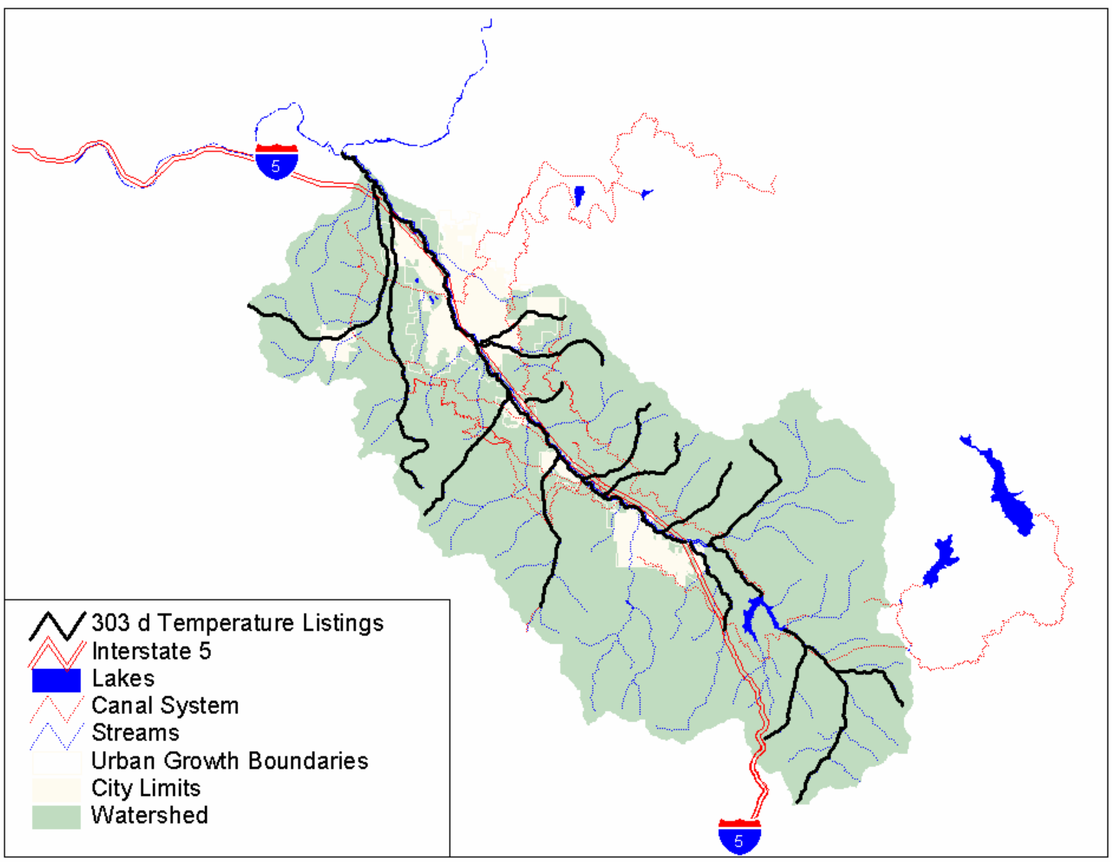
This element identifies the pollutant causing the impairment of water quality addressed in this TMDL

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 flux to waterbody:

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

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 waters 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. The pollutant targeted in this TMDL is heat from the following sources: (1) heat from warm water discharges from various point sources, (2) heat from human caused increases in solar radiation loading to the stream network, and (3) heat from reservoirs which, through their operations, increase water temperatures or otherwise modify natural thermal regimes in downstream river reaches.

Map 3: 2004/2006 303(d) Temperature Listed Stream Reaches in the Bear Creek Watershed



SALMONID STREAM TEMPERATURE REQUIREMENTS

Stream temperatures above 18.0°C (64.4°F) are considered sub-lethal and can be stressful for cold water fish species, such as salmon and trout.

Salmonids, often referred to as cold water fish, and some amphibians are highly sensitive to temperature. In particular, chinook salmon (*Oncorhynchus tshawytscha*) and coho salmon (*Oncorhynchus kisutch*) are among the most temperature sensitive of the cold water fish species in the Bear Creek watershed (DEQ, 1995). Oregon's water temperature standard employs a logic that relies on using these sensitive species as *indicator species*. If temperatures are protective of these indicator species, other species will share in protection as well.

If stream temperatures become too hot, fish 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 above 90°F (> 32°C). Such warm temperature extremes may never occur in the Bear Creek watershed. More common and widespread, however, is the occurrence of temperatures in the range of 70°F - 77°F (21°C - 25°). These temperatures, termed *incipient lethal limit*, cause death of cold water fish species during exposure times lasting a few hours to one day. The exact temperature at which a cold water fish succumbs to such a thermal stress depends on the temperature that the fish is acclimated to, and on life-stage. This cause of mortality results from the 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 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 more delayed, and occurs weeks to months after the onset of elevated temperatures of 64°F - 74°F (20°C - 23°C) (Table 8).

Table 8. Modes of Thermally Induced Cold Water Fish Mortality

Modes of Thermally Induced Fish Mortality[1]	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 (20°C - 23°C)	Weeks to Months

1. Brett, 1952, Hokanson et al, 1977, Bell, 1986.

TEMPERATURE TARGET IDENTIFICATION: CWA 303(D) (1)

The temperature standard that applies to the Bear Creek watershed was approved by EPA on March 2, 2004 and is found in OAR 340-041-0028 (4) (a-c) (ODEQ 2004). The purpose of Oregon's stream temperature standard is to protect designated temperature-sensitive beneficial uses in waters of the State, including specific salmonid life stages. Several biologically-based numeric criteria that are specific to these life stages are used to gage whether surface waters are "water quality limited" with respect to temperature. A seven-day moving average of daily maximum temperature (7-day statistic) was adopted as the measure of the stream temperature standard. Table 9 shows the biologically-based numeric temperature criteria that are applicable to specific salmonid life stages under Oregon's standard. Oregon's standard also specifies where and when the specific salmonid life stages occur and, therefore, where and when the numeric criteria apply. A basin-wide distribution and timing map is provided in Figures 271A and 271B on the DEQ website: http://www.deq.state.or.us/wq/wqrules/wqrules.htm. The maps are summarized in Table 10 below. To develop the maps DEQ primarily relied on the Oregon Department of Fish and Wildlife (ODFW) for information on fish distribution and life stage timing. The database is the product of a multi-year effort by ODFW to develop consistent and comprehensive fish distribution data for a number of salmonid species. DEQ believes the ODFW database is scientifically sound and represents the best information readily available.

Table 10 indicates that the 18°C (64.4°F) 7-day statistic applies May 16-October 14, times of the year that are not designated salmonid spawning, egg incubation and fry emergence, during which a 13 °C (55.4°F) 7-day statistic applies. For reaches that have no spawning, the 18C criterion applies all year, though it is expected that fall winter and early spring temperatures will be cooler. This is termed the biologically-based numeric criteria under the OAR.

In addition the temperature standard contains a narrative portion describing conditions under which the numeric criteria may be superseded. Language in the standard acknowledges that in some instances the biologically-based numeric criteria may not be achieved even when waters are in their natural condition and specifies that stream temperatures achieved under natural conditions shall be deemed to be the applicable temperature criteria for that water body. In other words, a stream that does not meet one or more of the numeric temperature criteria, but is free from anthropogenic influence, is considered to be at the natural thermal potential (NTP) and therefore in compliance with the temperature standard.

Lastly, Oregon's temperature standard contains provisions that limit the cumulative anthropogenic heating of surface waters to no more than 0.3 degrees Celsius (0.5 degrees Fahrenheit) in almost all instances. Oregon chose to include a 0.3 °C human use allowance (HUA) for insignificant additions of heat in waters that exceed applicable numeric criteria. A much more extensive analysis of water temperature related to aquatic life and supporting documentation for the temperature standard can be found in the *EPA Region 10 Guidance for Pacific Northwest State and Tribal Temperature Water Quality Standards* (USEPA, 2003) and the Temperature Final Issue Paper (ODEQ, 1995).

Table 9. Biologically Based Numeric Temperature Criteria Applicable to Salmonid Uses

Use	Numeric Criteria (7-day statistic)
Salmon and Steelhead Spawning	13.0 °C / 55.4 °F
Core Cold Water Habitat	16.0 °C / 60.8 °F
Salmon and Trout Rearing and Migration	18.0 °C / 64.4 °F
Salmon and Steelhead Migration Corridors	20.0 °C / 68.0 °F
Lahontan Cutthroat or redband trout use	20.0 °C / 68.0 °F
Bull trout spawning and juvenile rearing	12.0 °C / 53.6 °F

Table 10. Biologically-based Numeric Criteria for the Bear Creek Watershed.

Criterion	7-Day Statistic (Numeric Criteria) [1]	When Criteria Applies in Bear Creek Watershed[1]
Basic Absolute Criterion: Applies year long in all streams in the watershed, with the exception of those that qualify for the salmonid spawning, egg incubation and fry emergence criterion.	**≤64.4°F (18°C)**	**May 16-October 14**
Salmon and Steelhead Spawning, Egg Incubation and Fry Emergence Criterion: Applies to all streams identified on the Salmon & Steelhead Spawning Use Map for the Rogue Basin during the specific times of the year when salmonid spawning, egg incubation and fry emergence occur[2].	**≤55.4°F (13°C)**	**October 15-May 15**

[1] Note: applies to all Perennial and intermittent fish bearing streams (as identified by ODFW, USFW or NOAA Fisheries) within the Bear Creek watershed

[2]Time of year taken from OAR 340-041-0028(4)(a) and Figure 271A. See Figure 271 B for Fish Use Maps).

EXISTING POLLUTION SOURCES

CWA §303(d)(1) and Allocations of Thermal Load 40 CFR 130.2(g) and 40 CFR 130.2(H)

Natural Background Sources

Natural or background inputs of solar radiation are by far the largest heat source in the Bear Creek system. 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 the impact of smaller tributaries has less of an impacts downstream as a stream becomes larger. Greater stream volume and mass are associated with a reduction in stream sensitivity to natural and human sources of heat.

In the absence of human disturbance, many low elevation streams were likely warmer at times than is optimal for salmon and trout. These species may not have occupied these waters during the peak heat of the summer period or they persisted in cool water environments during stressful periods. Channel complexity, cool water inflows, and hyporheic exchange 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. Flood, fire, windstorms and other natural disturbance processes 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, such disturbances are viewed as beneficial processes. In a functional riparian community, one with most of the structural components and ecological process in place, 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 natural and are part of the natural background thermal load.

Point Sources

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. ODEQ has been given authority from the U.S. Environmental Protection Agency (USEPA) to issue these permits. NPDES permits 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 or canal. 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.

Individual and General NPDES Permits

An individual NPDES permit is site-specific; it is developed to address discharges from a specific sewage or industrial wastewater treatment facility. Individual permits are usually issued for a period of five years. Individual permits often require frequent monitoring by the permittee to assure that permit limitations are being met.

A general NPDES permit is used to cover a category of similar discharges, rather than a specific site. ODEQ may issue a general permit when there are several minor sources or activities involved in similar operations that may be adequately regulated with a standard set of conditions. A general permit is issued once and expires within five years. ODEQ currently utilizes 29 different types of general permits.

Currently in the Bear Creek watershed there are 136 General permits that have been determined to have no reasonable potential to impact surface water temperatures (128 are general construction and industrial stormwater permits, 4 are general hydrocarbon cleanup permits and 4 are general washwater permits). These permits will not be discussed further in this TMDL.

There are 10 individual NPDES permits in the Bear Creek watershed with the potential to impact temperatures (Table 11). These individual sources are discussed in more detail below.

Table 11. NPDES Permits in the Bear Creek Watershed with a potential to impact temperature.

Type of Permit	Required Water Quality Controls and Monitoring	Permittee(s)
General 0100J Cooling water/heat pump discharge	• Limits on: Flow, temperature, Chlorine, pH • Monitoring: all parameters monthly	Associated Fruit Associated Fruit Bear Creek Corporation
NPDES-IW-O Non-process wastewater	• Addresses: Leachate and Stormwater • Leachate discharge only allowed Dec 1 – April 30. • Land irrigated as needed other time of year	Valley View Landfill inc.
NPDES-IW-O Non-process wastewater	• **001:** Limit: flow, pH, oil and grease, settleable solids. Monitoring: Weekly for flow, pH, settleable solids. Monthly for oil and grease. Discharge to: Elk Creek • **002**: Limit: temperature, pH, settleable solids, oil and grease. Discharge: Mingus Creek	Boise Building Solutions Manufacturing LLC Permit 100438
NPDES 0700J Recreational Suction dredging	• Limits: sedimentation, turbidity. Permits define how operations are to be conducted to ensure “no measurable increases in surface water temperature”	Individual operators may be active within the Bear Creek watershed

	• Monitoring: none required.	
General 1200A NPDES Sand and gravel mining	• Discharge of Stormwater only. All process water must be recycled.	Rogue Aggregates, inc. Rock and Ready Mix inc. Willow Creek Aggregate, inc.
NPDES-DOM-C1a	• Limits: total suspended solids, ammonia, chlorine, BOD5, pH, DO, E. coli, fecal coliform, • Monitoring: 2-7 times per week	City of Ashland

Small NPDES Point Sources
NPDES permits with a potential surface water temperature impact during the summer/fall critical periods include: 0100J Cooling Water/heat pump discharge; General 04 log ponds; and NPDES-IW-O non-process wastewater discharge. Analysis of the NPDES monitoring reports for these sources indicated that if these small individual point sources were all discharging directly into Bear Creek in the same location (Medford) under average summer river flow conditions an increase of less than 0.005°C would be expected. Using this very conservative approach the thermal impact on Bear Creek was considered insignificant from a thermal impact perspective.

0700J Suction Dredge Permits
Recreational mining using suction dredges is another NPDES permitted activity with the potential to occur in the Bear Creek watershed. All recreational suction dredging operations are required to obtain a NPDES 0700J permit from DEQ prior to beginning operations. DEQ permits define how dredging operations are to be conducted to ensure that “no measurable increases in surface water temperature” occur as a result of this activity. However DEQ permits do not require that dredging operators specify the exact location where they will be operating. As a result at the time of this writing it is uncertain if recreational mining is occurring in the Bear Creek watershed.

Ashland WWTF. NPDES-DOM-C1a permit #101609
The City of Ashland owns and operates a secondary wastewater treatment facility that discharges treated effluent into Ashland Creek about 1600 feet upstream of its confluence with Bear Creek. The plant’s discharge of domestic waste water is regulated under DEQ NPDES permit 101609. The NPDES permit for the facility was last renewed on May 27, 2004.

The Ashland WWTF was constructed in 1936 as a trickling filter facility with one primary and one secondary clarifier. Sludge was pumped directly to drying beds. Various modifications have been made over the years, including the addition of a second trickling filter. In 1974, a major upgrade was completed in which the two trickling filters were converted to activated sludge aeration basins, another secondary clarifier was added, and a new chlorine contact basin was constructed. In 1998, the City began construction of additional upgrades to the wastewater treatment plant. The upgrade initially included headworks improvements, replacement of the primary clarifier and aeration basins with two oxidation ditches, rehabilitation of the two existing secondary clarifiers, construction of a third secondary clarifier, and installation of an ultraviolet (UV) disinfection system. The purpose of these upgrades was to eliminate chlorine toxicity and provide adequate treatment during the high flow season. These upgrades were labeled Project A and were completed in 2001. To comply with the requirements of the Bear Creek Total Maximum Daily Load (1992), the City proposed to improve a 840-acre site to allow for irrigation of the treated wastewater and land application of treated biosolids. This was known as Project B. In 2001, the City decided against moving forward with Project B due to considerable public opposition. The City chose instead to install a phosphorus removal system to allow for continued discharge to public waters during the summer months. Phosphorus removal upgrades were completed and the operation initiated July 31, 2002. Additional upgrades including the replacement of the Ashland Creek pump station, construction of an alkaline stabilization facility for sludge, and installation of sludge centrifuges was completed in 2003.

Ashland WWTF Temperature impacts

Elevated instream temperatures are detrimental to cold water fish. The biologically based numeric criterion that applies to Ashland Creek is 13C (55.4F) October 15 through May 15; 18C (64.4F) May 16 through October 14)(OAR 340-0041-0028). The City has monitored temperatures both upstream and downstream of the discharge since September 2000 and installed continuous monitors in August 2002. A preliminary review of these data indicate that the temperatures of secondary effluent (7 day mean of daily maximum) frequently exceeds the biologically based numeric criterion (Figure 4) and that there is often a significant increase in temperature from below the WWTF as compared to temperatures above the plant (Figure 5).

Figure 4. Secondary Effluent Temperatures for Ashland WWTF

Source: City of Ashland WWTF September 2000 – December 2004.

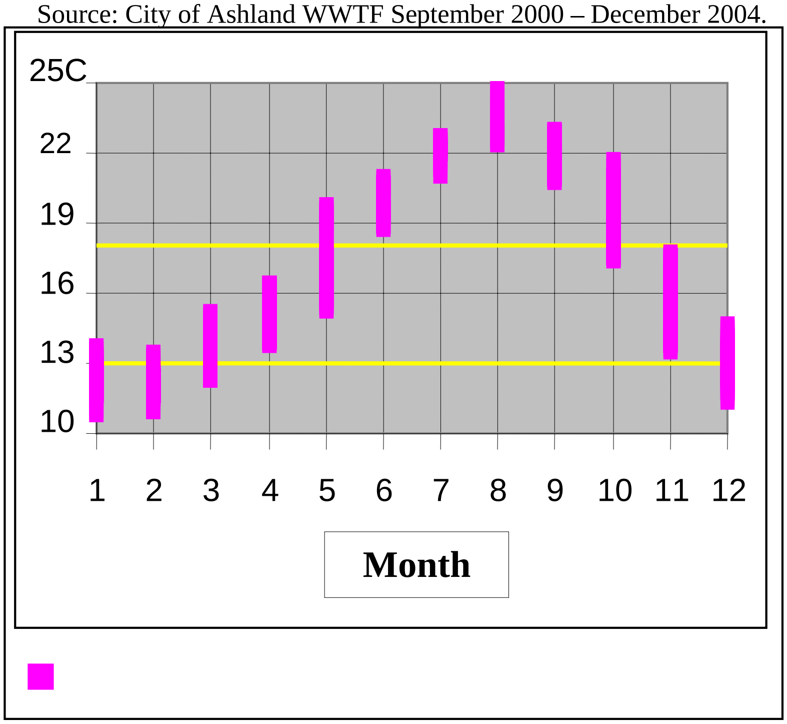
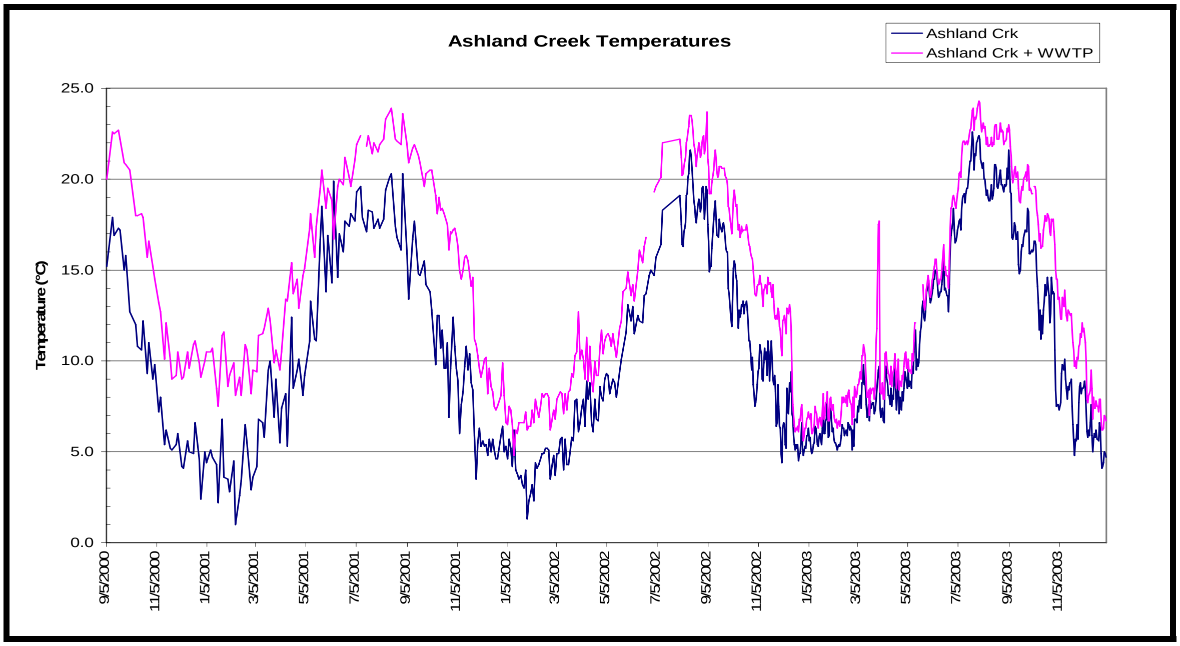


Figure 5: Daily High Temperatures in Ashland Creek Above and Below the WWTF



Note: Graphic taken from NPDES Permit evaluation fact sheet. March 8, 2004

Nonpoint Sources

The term "Nonpoint Sources" applies to a diffuse or unconfined source of pollution where wastes can either enter into or be conveyed by the movement of water to waters of the state (OAR 340-41-0002 (40). For the purposes of the Bear Creek Temperature TMDL nonpoint sources are *past or present human activities that contribute to a greater heat load to surface waters than that which would occur naturally*. Nonpoint source activities may include urban and rural development, agricultural practices, forest management, and associated developments such as transportation systems that cause or contribute to the removal of streamside vegetation or detrimental changes in stream channel form. Dam, irrigation, and reservoir management activities are also identified as nonpoint sources which, through the alteration of flow and timing may have substantial impact on stream temperatures throughout the Bear Creek watershed. Riparian vegetation, stream morphology, hydrology, climate, and geographic location influence stream temperature. For the Bear Creek watershed temperature TMDL five nonpoint source categories are discussed below:

1. ***Near stream vegetation disturbance/removal***
2. ***Channel modifications and widening***
3. ***Dams, Diversions, and Irrigation Districts***
4. ***Hydromodification – Water Rights.***
5. ***Other Anthropogenic sources***

1. Near-stream vegetation disturbance/removal

Near-stream vegetation disturbance/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[1]). Riparian vegetation also plays an important role in shaping channel morphology, resisting erosive high flows, and maintaining floodplain roughness.

In the Bear Creek watershed, as the floodplain and streamside areas have been converted to urban and rural developments, agricultural fields, roadsides, and other uses, much of the original vegetation has been modified or removed. In many cases stream channels have been confined or rerouted. As a result of these activities, riparian areas in the watershed today cover less area and contain fewer species than in the past. Trees tend to be younger in age and dominated by hardwoods. Large fir, pine, and cedar that existed along streams historically are often absent. Woodland stands are fragmented, creating a patchy, poorly connected landscape of simpler and less biologically productive habitat. These changes have resulted in less shade on the stream's surface and an increase in stream water temperatures (DEQ, 2000; BCWC, 2005). Figure 6 shows the potential for improvement in shade for the Bear Creek mainstem as the difference between current and site potential effective shade. The site potential condition as defined in this TMDL is the near-stream vegetative community that can grow on a site at a given elevation, and aspect in the absence of human disturbance.

Site potential is an estimate of a condition without anthropogenic activities that disturb or remove near stream vegetation.

- Vegetation is mature and undisturbed;
- Vegetation height and density is at or near the potential expected for the given plant community;
- Vegetation buffer is sufficiently wide to maximize solar attenuation (Note: Buffer widths required to meet the site potential target will vary given potential vegetation, topography, stream width, and aspect.);
- Vegetation width accommodates channel migrations.

Site potential is not an estimate of pre-settlement conditions. In many areas changes in stream location and hydrology (channel armoring and wetland draining) have occurred and reversing these changes is not a part of the establishing a target value. In addition, site potential does not account for potential major disturbances resulting from floods, drought, fires, insect damage, disease or other factors that could impact riparian areas.

Site potential targets for the Bear Creek watershed were developed using growth curves for the various tree species within southwest Oregon. These growth curves were developed by DEQ in consultation with BLM, ODF and NRCS professionals to project growth rates and maximum height for the dominant riparian tree species. Riparian corridors are assumed to be managed to reach their full system potential condition. Shade densities for system potential conditions were set at 70% for a conifer dominant, mixed old growth stand and 80% for a mature hardwood dominant stand. Current and modeled site potential shade heights, widths and densities as well a vegetation overhang are defined in Appendix A : Bear Creek watershed Temperature Modeling Appendix. Buffer widths, defined as the width of riparian vegetation measured out from the top of stream bank, were set at a value to achieve maximum shade. From a management perspective, buffer widths required to meet the shade targets will vary given potential vegetation, topography, stream width, and aspect. The increase in shade calculated as vegetation approaches a site potential condition will vary considerably from site to site along a stream. The figures below illustrate current percent-effective shade and site potential percent-effective shade for the Bear Creek mainstem (Figure 6) and its primary tributaries (Table 12). The current average percent-effective shade on the Bear Creek mainstem, from mouth to RM 27.5 the confluence of Walker and Emigrant Creeks, is 15%, expected to increase to an average of 54% when all vegetation reaches site potential conditions.

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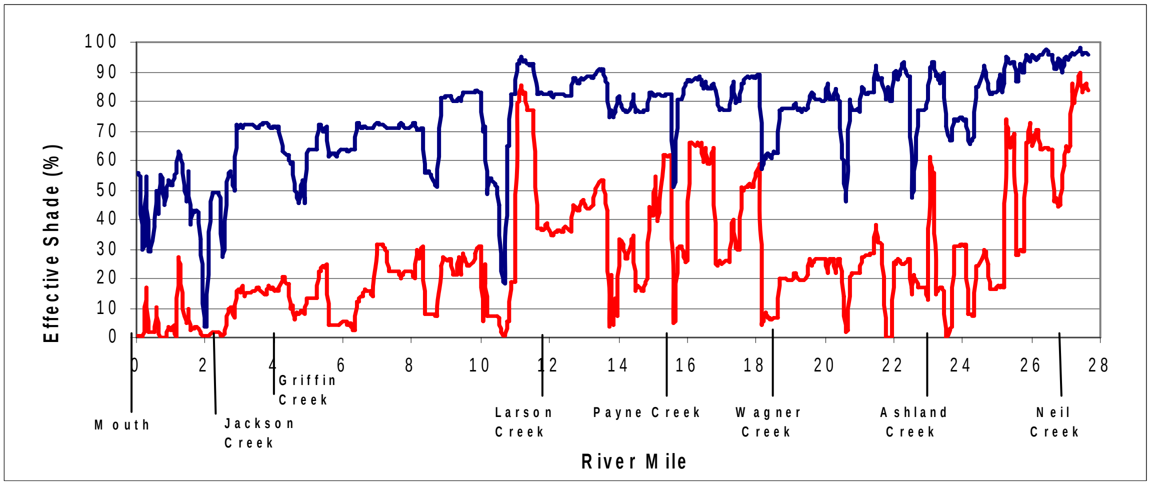
[1] Percent-effective shade is defined as ((total solar radiation – total solar radiation reaching the stream)/total radiation) x 100

Figure 6. Current and Site Potential Percent-Effective Shade along the Bear Creek Mainstem.



Note: Current percent-effective shade shown as red line, percent-effective shade at site potential shown as blue line)

Note 2: Figure 6 represents the longitudinal shading of the Bear Creek mainstem as calculated by the HeatSource model. Table 12 below represents the same reaches calculated using a slightly different method and as such the results from the two methods are not necessarily comparable. HeatSource measures shade within the wetted width while the method in Table 12 reflects that of Appendix D, measuring shade within the zone of disturbance.

Table 12. Average Current Percent Effective Shade Targets

	Current Shade[1,4]	Site Potential Shade[1,2,4]	% Change
Bear Creek Mainstem	15	54	39
Jackson Creek	46	88	42
Griffin Creek	47	85	38
Lazy Creek	26	82	56
Coleman Creek	67	89	21
Wagner Creek	70	91	21
Myer Creek	40	83	42
Butler Creek	21	84	63
Ashland Creek[3]	66	82	16
Neil Creek	71	88	17
Walker Creek	41	86	37
Emigrant Creek	54	85	31

1. Current Shade and Site Potential Shade refer to percent-effective shade defined as the percent reduction of solar radiation load delivered to the water surface. The role of effective shade in this TMDL is to prevent or reduce heating by solar radiation and serve as a linear translator to the solar loading capacities (MW-hr/m^2).

2. It is important to note that any increase in shade over 80% effective shade is considered a margin of safety. At 80% further reduction in stream temperature as a function of vegetation may not be measurable for all stream flows (Boyd, 1996). At values of >80% effective shade stream is considered recovered and the stream should not be a candidate for active restoration. Additional shade should come from passive management of the riparian area.

3. Ashland Creek as shown represents the average shade from the base of Hosler Dam to the mouth (mouth to river mile 4.9). If all of Ashland Creek is included in the average (both East and West Forks), average percent effective shade from the mouth to the head waters currently is 91%, site potential shade is 94%.

4. All values shown are taken from the shade calculations shown in Appendix D. Shade values are determined within the zone of disturbance.

2. Channel modifications and widening

The Bear Creek basin is a narrow watershed, about twice as long as it is wide. Most of the tributary creeks pass down onto the narrow valley floor off the steep-sided, mountainous areas that surround the watershed on three sides. When tributaries flow down the steep slopes they have a great amount of energy that must be dissipated once the flows reach the relatively flat valley floor. Historically this energy was absorbed by Bear Creek meandering wildly across the valley, leaving behind oxbow lakes, braided streams, side channels, isolated wetlands, and an extensive, hummocky ground. A testament to Bear Creek's wild meandering behavior is seen in the records of the Southern Oregon Historical Society. One newspaper editorial written in the early 1950s refers to Bear Creek "as unpredictable and cantankerous as the ornery critter it's named after." The editorial went on to describe the creek as having “several channels, none of them very permanent, coursing through a morass of trees, brush and swamp-grass 'so thick a dog could scarce penetrate...'." The article also mentioned that "Fording Bear Creek and other valley streams was ever risky, especially during winter rains and spring freshets. Saddle and harness horses, wagons, as well as human life was lost” (Bear Creek Watershed Council, 1995).

The importance of this behavior is that the once wildly meandering Bear Creek naturally created areas of temporary water storage. These off-channel areas stored water during high flows and slowly released it through the floodplain soils later during periods of dryer weather. The question is debatable over how significant the watershed's natural water storage capabilities were, but there is no doubt that there were some benefits gained from the cooler, spring-fed pools and off-channel areas. This natural water storage characteristic was recognized in the area between Medford, Jacksonville and Central Point, being referred to locally as the “wet triangle.” This wet area no longer exists due to the extensive insertion of drainage tiles across the valley floor (Bear Creek Watershed Council, 1995).

Over 100 years of river management for irrigation & flood control has resulted in a greatly simplified Bear Creek mainstem. Figure 7 shows the channel straightening that has occurred on Bear Creek in the area of North Medford near river mile 7 by comparing the channel in 1939, 1960, 1994 on 2001 air photos. A consequence of this channel simplification is the probable loss of diversity in the spatial distribution of temperatures throughout the Bear Creek watershed. The current wetted channel widths on the Bear Creek mainstem vary from 30 to 50 feet during the summer (DEQ, 2002 Appendix D). Efforts to simulate historical channel complexity and its effects on water temperature patterns in the basin were not undertaken in this TMDL. This explicit omission is due to the limitations in understanding processes such as hyporheic exchange and the ability to satisfactorily simulate these processes through physical, watershed-scale models at this time. Given the highly variable nature of stream widths in the system, current stream widths where used to model the natural thermal potential of the watershed. Since some narrowing of the active channel is expected, this may lead to more stream cooling than predicted.

Figure 7: Air Photo Composite of Bear Creek: 1939, 1960, 1994.

3. Hydromodification: Reservoirs & Dams

Dams and reservoirs may contribute to stream warming. Reservoirs increase the surface area of water exposed to solar radiation and may delay the movement of water through the river system. Throughout the summer months reservoirs store solar radiation as heat in the warm surface waters pooled behind the dam. These reservoirs may become strongly thermally stratified in late summer. Accumulated heat is discharged with the stored water from each reservoir into downstream river reaches during annual draw down which occurs in early summer and continues into late fall.

Emigrant Dam and Stored Water

Emigrant Dam and Lake, located 7.5 miles southeast of Ashland, Oregon, has a total capacity is 40,500 acre-feet (active 39,000 acre-feet) (USBOR 2002). As authorized by Congress over half a century ago, water for irrigation is the highest priority of Emigrant Dam and the USBOR Rogue Basin Project Talent Division. Other purposes include flood control, irrigation, power production, fisheries and water quality (USBOR 2002). The reservoir also re-regulates the Green Springs Powerplant discharge which is capable of producing 17290 kW of electric power (53,400,000 kWh FY2004).

Under current operations for Emigrant Dam, water can be impounded in the flood control reserved space only when inflow from Emigrant Creek is greater than 600 cfs or flow in Bear Creek at Medford Gage (USGS: 14357500) is forecasted to be greater than 3,000 cfs. Any flood control reserved space filled under the foregoing conditions must be evacuated as soon as possible. The lake reaches its highest level after April 1. It is drawn down during the irrigation season and reaches its lowest level in mid-October. The outlet gates at Emigrant Dam are normally completely shut at the end of the irrigation season to accommodate refill of the lake (Figure 8). At the end of the irrigation season releases from Emigrant Lake are made only if required by the flood control management plan. Tributaries, and for a time irrigation return flows, provide most of the flow in the mainstem unless flood control releases are made (USBOR website: http://www.usbr.gov/dataweb/dams/or00581.htm).

As currently constructed and operated, the release of water from Emigrant Dam modifies the flow and natural temperature patterns downstream. The reservoir has been constructed with regulating outlets near the bottom. Cool waters are released from the bottom of the thermally stratified Emigrant Lake during the summer months. Thus during the peak of summer, flows are higher and water temperatures cooler in portions of Bear Creek than those estimated under natural conditions (Figure 9). By late summer and into early autumn the reservoir has been drawn down to provide irrigation waters to the 3 downstream irrigation districts. During this time it is likely that the thermal stratification in the reservoir has broken down but that water temperatures in the lake remain warmer than the temperatures in the streams flowing into the reservoir.

Figure 8. Average Daily Emigrant Dam Discharge in Cubic Feet per Second (CFS) Water Year 2000-2001.

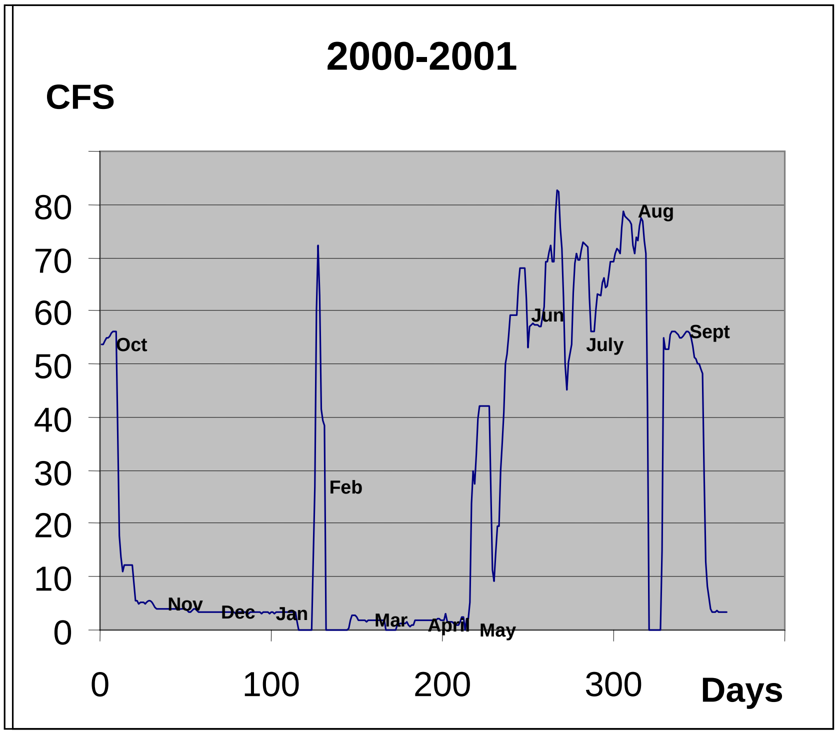
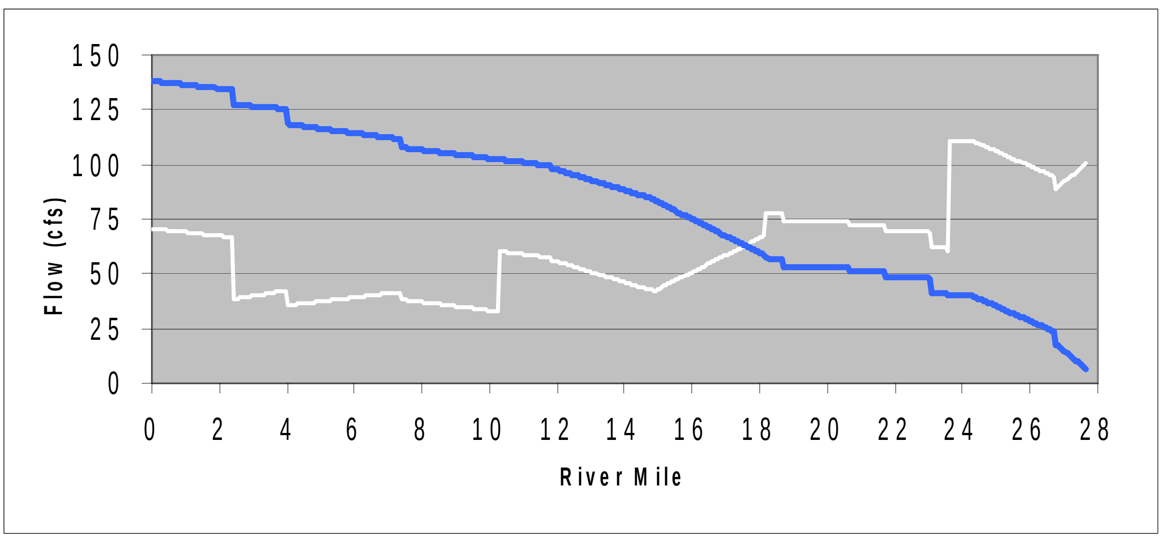


Figure 9: Bear Creek Current Flows (White Line) and Estimated Natural Flows (Blue Line).



Note: Current Conditions (white line) as measured August 3, 1999. Blue line predicted flow under natural conditions. Source USBOR and DEQ. See Appendix A for a more complete discussion of thermal modeling and flow.

3. Hydromodification: Irrigation Districts

Three large irrigation districts operate within the Bear Creek watershed. They are Talent Irrigation District (TID), Medford Irrigation District (MID), and Rogue River Irrigation District (RRVID) which are intricately tied to each other in a complex system of reservoirs and canals that include 7 storage dams, 20 diversion dams, and over 250 miles of canal (USBOR, 2002). All three districts obtain water from Howard Prairie Lake, Hyatt Reservoir, Emigrant Lake, Keene Creek Reservoir, and Bear Creek and its tributaries. Fourmile Lake and Fish Lake provide a partial water supply to RRVID and MID and Agate Reservoir provides water to RRVID (Figure 2, Page 7 of this TMDL). Return flows from irrigation that are not diverted for reuse return to Bear Creek and into the Rogue River (USBOR, 2002). In addition to the 3 large districts, there are private irrigation rights and ditch associations operating on Bear Creek and some of its major tributaries which cumulatively may take up to 15-20 CFS from the system (RVCOG, 1999). Potential thermal impacts from irrigation operations within the Bear Creek watershed include:

- Diversion dams are used to divert water from a stream to an irrigation ditch or canal. Diversion dams affect stream temperature by dewatering the downstream reach of the river. Reductions in stream flow in a natural channel slows the movement of water and generally increases the amount of time the water is exposed to solar radiation. Stream temperatures downstream of diversion dams can be substantially warmer than those above.
- Canals and other unpiped water conveyance systems generally are open ditches. These ditches are usually unshaded and increase the surface area of water exposed to solar radiation. Canal waters are allowed to mix with natural stream flows at diversion dams and at places where natural stream channels are used to convey irrigation water to downstream users.
- Irrigation return flows are those waters that flow off of fields or pastures as a part of irrigation. These excess waters may end up in a stream or the irrigation ditch to be used by the next water right holder. These waters are generally warm and may be nutrient rich as well.
- Operational spills are places in the irrigation delivery system where excess unused irrigation water in the canals is discharged back into either a downslope canal or lateral or a natural stream channel without being delivered to or used on an individual field. These waters may be picked up by the next water right holder.

Due to the complexity of irrigation systems, the total thermal impact of irrigation activities on Bear Creek temperatures has not been not been adequately measured or estimated through modeling. However in 2003 the USBOR completed a flow study which estimated the impact of all irrigation activities on the flow within Bear Creek (USBOR, Leslie Stillwater pers. Com. 2005). These estimates, while not used to estimate the thermal impacts of irrigation activities, have been used as the basis for estimating the un-regulated flows used to model the natural thermal potential of Bear Creek (Appendix A). Note that the USBOR model used is still under refinement and due to a lack of sufficient date is based on numerous assumptions.

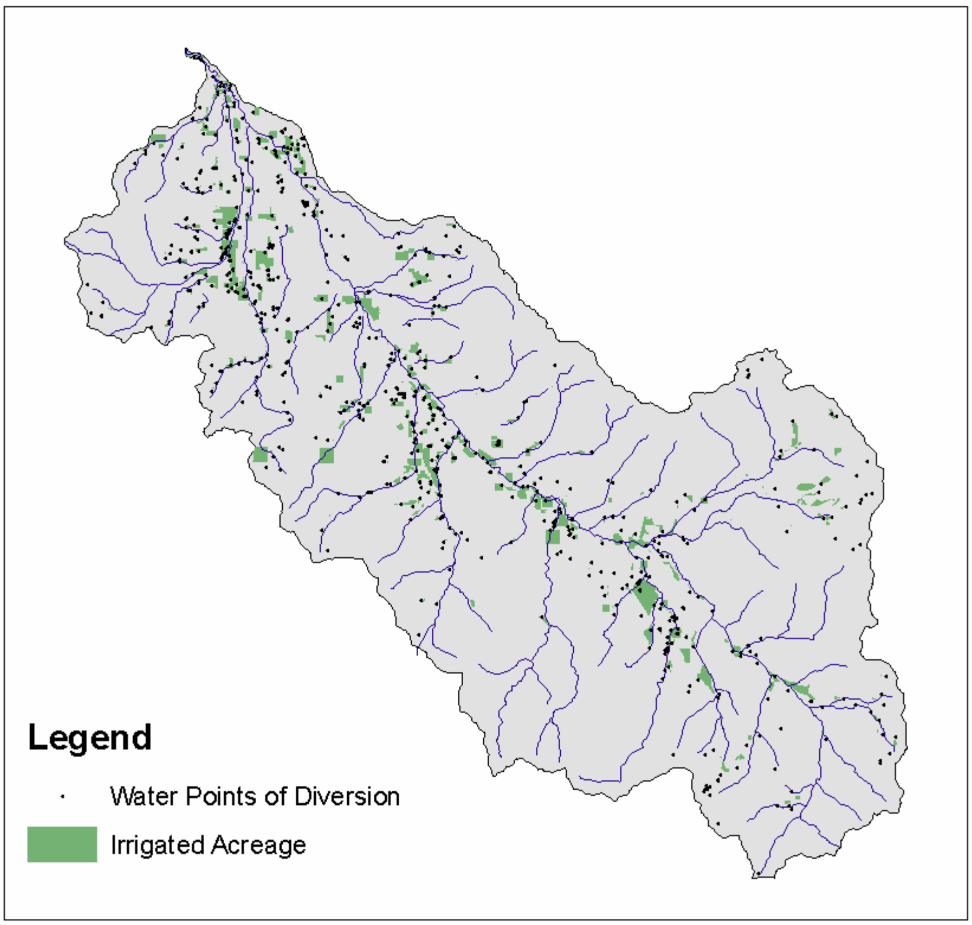
Early in the 1990s discussions took place between the Oregon Department of Fish and Wildlife (ODFW), Oregon Department of Environmental Quality (ODEQ), Oregon Water Resources Department (OWRD), Governor's Office, City of Ashland, Medford Water Commission, and the three Irrigation Districts in the Bear Creek Basin (TID, MID, RRVID) to determine a realistic flow target to maintain throughout the year in Bear Creek. A minimum flow of 10 cubic feet per second (cfs) was discussed but could not be agreed upon. With the failure of consensus on what a minimum flow target should be, no agreement was ever reached.

4. Hydromodification-Water Rights

Currently there are over 421 approved surface water withdrawal rights on Bear Creek, many of them are very senior rights (Over 50 water rights pre-date Oregon statehood in 1859). Bear Creek has been closed to further appropriation since 1959 when it was determined that natural flow amounts were not adequate to satisfy all water rights. Stream flows in the Bear Creek watershed are allocated for irrigation, mining and domestic use (Map 4). As stream flows recede, those users with junior rights are the first required to curtail their water use. Senior water right holders are allowed to continue using water, even in dry years and low flow conditions, as long as water is available to meet the demand under their priority date.

Water withdrawals have the potential to greatly impact surface water temperatures within the Bear Creek watershed. However, the management of water withdrawals fall under the jurisdiction of the Oregon Water Resources Department and as such DEQ has no authority in this area. No flow targets will be set or changes in water use required as part of this TMDL. However the HeatSource 6.0 model established for Bear Creek can be used to examine the effect of changes in flows on stream temperature if water rights do become available in the future.

Map 4: Water Diversion Points



Instream Rights

With passage of the Instream Water Rights Act In 1987, Oregon legally recognized that instream flows were a beneficial use of water. In 1990 ODFW petitioned OWRD for instream water rights in Bear Creek (Table 13). The instream flow, calculated using the *Oregon Method*, was developed to protect the uses of the stream for: "migration, spawning, egg incubation, fry emergence, and juvenile rearing for coho, fall chinook salmon, summer steelhead and cutthroat trout." Because ODFW's instream water rights are so junior to other rights in Bear Creek these instream rights are not met year-round. Flow records for Medford and Ashland demonstrate that ODFW instream rights are not met from May 15 through December at the Medford gage (mile 11.0), and are only met at the Ashland gage (mile 22.9) in January and the first half of May (Table 13).

Table 13. ODFW Instream Water Rights on Bear Creek

Flow in CFS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
[(a)]**ODFW Instream Water Right (1991 priority)**	170 170	170 170	170 170	170 170	170 100	100 100	67 67	67 170	170 170	170 170	170 170	170 170
[(b)]**Medford Gage**	221	223	202	197	134	73	29	29	31	33	59	147
[(c)]**Ashland Gage**	236	139	127	124	147	77	50	47	28	16	27	163

[(a)]ODFW recommendations for minimum flows in Bear Creek to protect salmonids. Flows in cfs determined using the Oregon Method for Bear Creek from Walker Creek (mile 27.0) to the Mouth (mile 0.0). Flows are presented for first 15 days of month and second 15 days of the month.
[(b)]Average Monthly Discharge in cfs. Bear Creek at Medford (Mile 11.0). Period of record 1921-1981 Station 14357500
[(c)]Average Monthly Discharge in cfs. Bear Creek Below Ashland Creek at Ashland. Bear Creek Mile 22.9. Period of record 1990-1998 Station 14354200

In addition to the ODFW instream water rights, Oregon Water Trust (OWT) manages 2 instream rights in the watershed (as of June 2005, Table 13). OWT allows private parties to create instream rights by purchasing**,** leasing**,** or accepting a donation of existing water rights for conversion to instream rights, with the same priority date as the original right. The OWT process of converting existing out-of-stream water rights to instream flows using the instream water rights act involves negotiating a private agreement with a water right holder, and then applying to Oregon Water Resources Department for approval to transfer the water right to instream use.

Table 14. Instream water rights in the Bear Creek watershed Managed by Oregon Water Trust:

Stream	Location	Year	Rate (CFS)	Duty (AcFt)	Priority Date
Ashland Creek	River Mile 0.5	2002 - lease	0.05	10.6	1886
Bear Creek	River Mile 3	2003 - lease	0.086	31.049	2/27/1950

**Source Oregon Water Trust, June 2005.

5. *Other Human Activities That Contribute to Stream Warming*

Upland and floodplain development has resulted in high percentages of impervious surfaces in some areas of the watershed. Increased impervious area results in greater stormwater runoff and diminished groundwater recharge. Studies have shown that base flows in small streams with substantial impervious area may be lower as a result of a loss of groundwater contribution during dry periods. Warmer stream temperatures and poorer water quality are associated with these diminished flows.

TMDL - LOADING CAPACITIES 40 CFR 130.2(f)

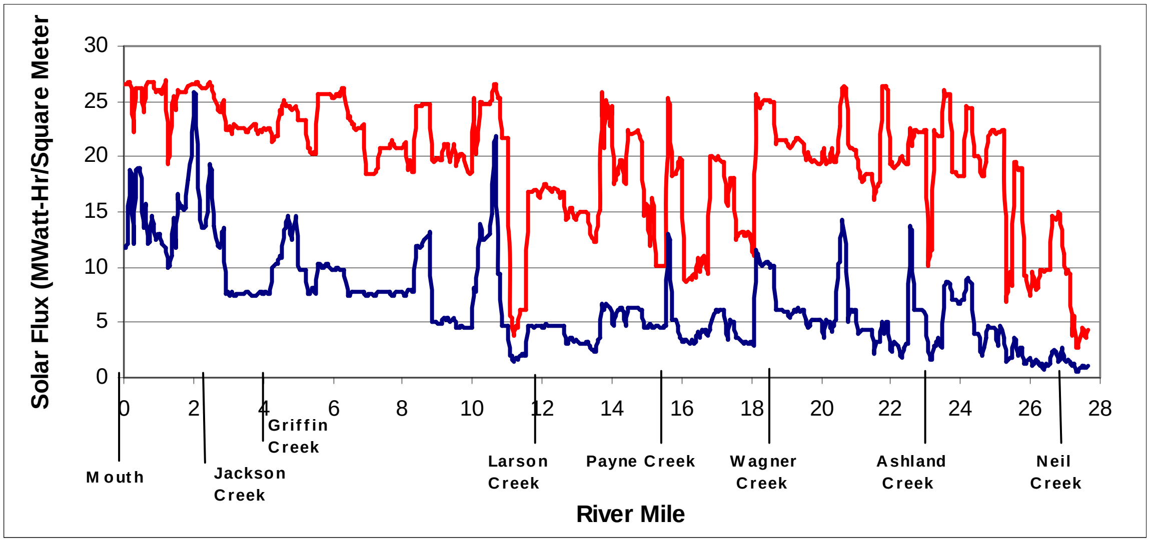
Loading Capacity: This element specifies the amount of a pollutant or pollutants that Bear Creek can receive and still meet water quality standards. For the Bear Creek watershed, the loading capacity will be met when: (1) all NPDES permitted point source effluent discharges meet the TMDL assigned WLA, 2.) Emigrant Dam and the three Irrigation Districts meet their assigned TMDL targets, (3) solar loading is reduced to that of site potential.

Loading Capacity – 40 CFR 130.2(f)

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 standards.

Simulations were performed using HeatSource 6.0 to calculate the thermal loading in Bear Creek under a Natural Thermal Potential scenario during the period of maximum solar input (August 03, 1999, See Appendix A for more details on the analysis). The established load capacity ensures that water quality standards are met regardless of seasonal variation and foreseeable increases in pollutant loads from point or nonpoint source activities. The determination of loading capacity is based on the achievement of a watershed condition termed natural thermal potential. Natural thermal potential is defined as "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 (OAR 341-041-0002 (35). The current total thermal load on Bear Creek is approximately 8680 MW-hr/m^2. The total thermal load that the creek would receive under natural thermal potential conditions is considered the loading capacity and has been calculated as 3059 MW-hr/m^2. The difference between current load and the loading capacity is 6059 MW-hr/m^2, a load reduction of 64% (Figure 10).

Figure 10. Longitudinal Thermal Load in Bear Creek



Note: red line is current conditions thermal load, blue line is predicted thermal load under a natural thermal potential scenario.

Water Quality Standard Attainment Analysis – CWA §303(d)(1)

Attainment Analysis: *This analysis is used to determine if assimilative capacity is available for Bear Creek when loading capacity is achieved.*

The Heat Source 6.0 Model was used to simulate stream temperatures on Bear Creek under natural thermal potential conditions. The resulting simulated stream temperatures were used to determine if there was assimilative capacity available for point or nonpoint sources.

Assimilative capacity is the amount of pollutant above the background level that a waterbody can receive without exceeding water quality standards. The Heatsource model at natural thermal potential is a model of background conditions.

The Bear Creek model was calibrated using data collected on August 2nd and 3rd, 1999. The model used field measurements and model-derived parameters as inputs to simulate how stream temperatures respond to changed conditions within the watershed. The Bear Creek model begins at the confluence of Walker and Emigrant Creeks and extends to the confluence of Bear Creek and the Rogue River, a distance of 27.5 miles. It is broken up into four hundred and forty five 100 meter segments. Twelve tributaries had temperature data and flow volume measured at their confluence with Bear Creek. The Bear Creek mainstem had 11 sites where both temperature and flow were measured. A more in depth discussion of the modeling effort is provided in Appendix A.

Once calibrated to current conditions the model was set to estimate stream temperatures under the natural thermal potential scenario. The model simulation used the following assumptions:

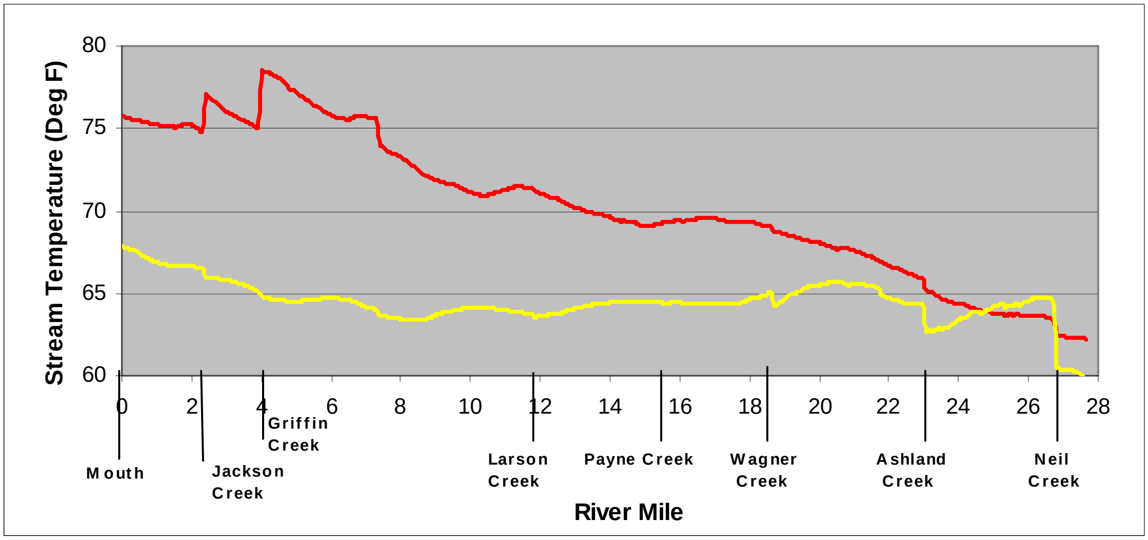
- Site potential vegetation heights and densities for Bear Creek and tributaries.
- Natural flow conditions – no dams, no irrigation withdrawals, no point sources, no water imported into the watershed.
- Tributary temperatures and flows were adjusted to reflect an estimate of natural thermal potential conditions.

Results

Figure 11 shows the natural thermal potential temperature profile (in yellow) along with current conditions (in red) for Bear Creek from the confluence with Walker Creek down to the mouth. All data simulates temperatures at 4:00PM in early August. The simulations indicate that temperatures in Bear Creek under the natural thermal potential scenario are mostly cooler than current conditions. The difference in degrees Fahrenheit (Delta T°) between current conditions and natural thermal potential is shown in Figure 12. Natural thermal potential conditions are warmer by approximately 1°F in a small section of Bear Creek below Neil Creek (river mile 25-27) due to the lower flows in the natural thermal potential scenario than are currently in the creek. The natural thermal potential temperatures in the rest of Bear Creek are cooler by up to 14°F. The biologically based numeric criteria that applies to Bear Creek is 64.4°F (18°C: May 16-October 14) OAR 340-041-0028(4). Under the natural conditions criteria language of OAR 340-041-0028(8) if the natural thermal potential of the water body exceeds the biologically-based criteria, the natural thermal potential temperatures supersede the biologically based criteria. Generally, the warmer of the two criteria apply to the waterbody.

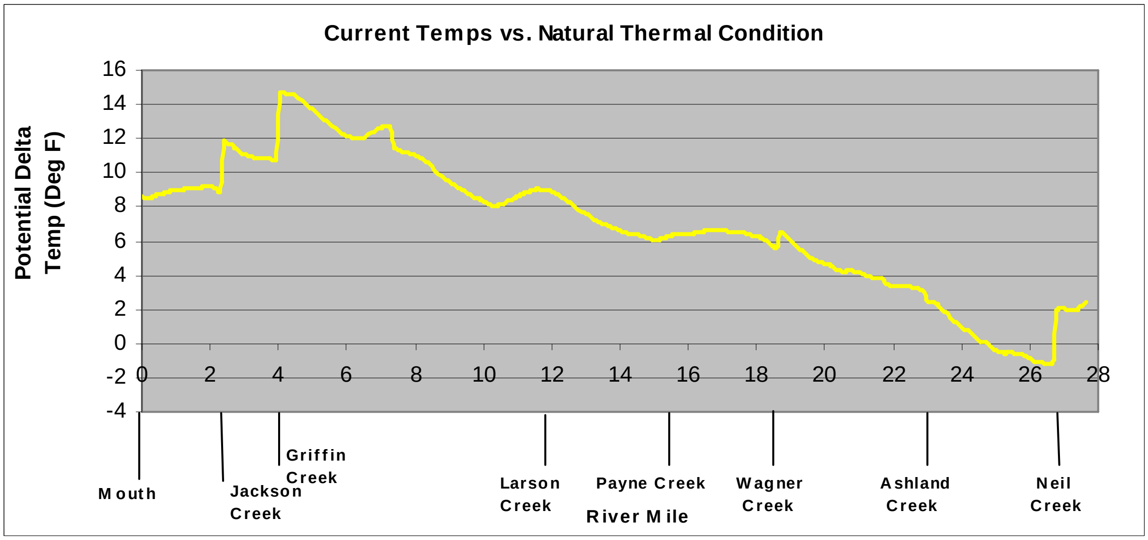
In this simulation the natural thermal potential temperature exceeds the biologically based numeric criterion, indicating that there is no assimilative capacity available in Bear Creek. Besides the human use allowance, all sources are allocated zero heat loads above background.

Figure 11: Bear Creek Natural Thermal Potential Temperatures



Note: Red line is current conditions stream temperatures, yellow line is predicted temperature profile under the natural thermal potential scenario.

Figure 12. Change in Temperature (Delta T): Current Conditions vs. Natural Thermal Potential



TMDL - LOAD ALLOCATIONS AND WASTE LOAD ALLOCATIONS 40 CFR 130.2(G) AND 40 CFR 130.2(H)

This element divides the loading capacity between individual point and nonpoint sources and sets the thermal load targets that when reached will result in achieving the TMDL loading capacity of 3059 MW-hr/m^2.

Allowable heat loads are divided among the potential sources and are termed Waste Load Allocations (WLA) for point sources and Load Allocations (LA) for nonpoint sources. The loading capacity as defined previously can be split into the sum of natural background heat load plus WLA plus LA plus a reserve capacity. In the sections that follow the allocations are explained and surrogate targets, where appropriate, are designated for each source. Allocations are assigned to each designated management agency (DMA). As per OAR 340-042-0030(2), DMA means "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".

Current Rules define the loading capacity as being met if a cumulative increase of no greater than 0.3^{0}C above the applicable criteria after complete mixing in the waterbody and at the point of maximum impact (OAR 340-041-0028 12(b)(B)). The 0.3^{0}C cumulative increase is termed the human use allowance (HUA) and is distributed between point and nonpoint sources and reserve capacity (Table 14).

Table 15. Allocations and Distribution of HUA.

Point Sources: Waste Load Allocations (WLA)[1]	
Ashland WWTF	No greater than 0.1^{0}C increase above the applicable criteria (18^{0}C May 16-Oct 14, 13^{0}C Oct. 15-May 15) in Ashland Creek at point of maximum impact.
Individual and General NPDES Permittees	No significant cumulative increase above the applicable criteria (Significant is defined as 0.005C).
Nonpoint sources; Load Allocations (LA)[1]	
Nonpoint Sources: (DMA authority: Ashland, Talent, Phoenix, Medford, Central Point, Jacksonville, Jackson County, ODA, ODF, USFS, BLM, ODOT).	Cumulative impact no greater than 0.05^{0}C above the applicable criteria at the point of maximum impact.
Emigrant Dam: (DMA authority: USBOR and TID)	No increase in natural thermal potential temperatures when the biologically-based numeric criteria are exceeded.
Irrigation Districts: (DMA authority: TID, MID, RRVID)	No greater than 0.05^{0}C increase above the applicable criteria due to management of waters by TID, MID, RRVID in Bear Creek at the point of maximum impact.
Reserve Capacity	
	No greater than 0.1^{0}C increase above the applicable criteria in Bear Creek at the point of maximum impact.

[1]Note: Current Rules define the loading capacity as being met if a cumulative increase of no greater than 0.3^{0}C above the applicable criteria after complete mixing in the waterbody and at the point of maximum impact OAR 340-041-0028 12(b)(B). This 0.3^{0}C increase is distributed between point and nonpoint sources and reserve capacity.

PERMITTED POINT SOURCES OAR 340-042-0040(4)(G), 40 CFR 130.2(G)

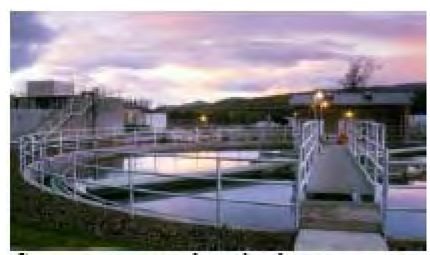
Point source effects were assessed individually and cumulatively to ensure compliance with the human use allowance (OAR 340-0041-0028(b)). This element explains the waste load allocations for all point source discharges regulated under the NPDES permit process.

In the Bear Creek watershed there are 146 NPDES permitted point source discharges (as of 5/15/05)(Table 11). Some point source allocations are narrative in nature and will be quantified in the permitting process while others have been quantified in the TMDL analysis. Waste load allocations for general NPDES sources including stormwater sources (municipal separate storm sewer (MS4) permits, and combined sewage overflows (CSO)) were not given allocations in this TMDL because they have been determined not to be a significant contributor to heat over the seven day period specified in the water quality standard. Assignment of individual waste load allocations to all heat sources is not necessary to demonstrate attainment of water quality standards (USEPA, 1999). However, it is the intent of this TMDL that all point sources in the Bear Creek watershed will be in compliance with the assigned waste load allocations and associated human use allowances.

Of the existing NPDES permits those with a potential surface water temperature impact during the summer/fall critical periods include: 0100J Cooling Water/heat pump discharge; General 04 log ponds; and NPDES-IW-O non-process wastewater discharge. Analysis of the NPDES monitoring reports for these sources indicated that if these small individual point sources were all discharging directly into Bear Creek under a summer 7Q10 flow condition, an increase of less than 0.005°C would be expected. Using this very conservative approach the thermal impact on Bear Creek was considered insignificant from a thermal impact perspective.

For these sources, as part of the permit review process, the department will develop permit limits as appropriate, taking into account potential local adverse thermal effects as specified in the temperature thermal plume limitations standard (OAR 340-041-0053 2(d)). ODEQ will specify thermal limits for these point sources based on whichever of the following methods is most protective: 1.) allocations will be quantified to reflect heat limits consistent with current effluent design capacity and effluent temperatures, or 2.) allocations will be quantified to allow for a cumulative temperature increase above the applicable temperature criteria that is no greater then 0.005°C at 100% of the 7Q10 flow at the point of maximum impact.

Ashland WWTF NPDES-DOM-C1a permit #101609



The Ashland WWTF discharges into Ashland Creek approximately 1600 ft (490m) from its confluence with Bear Creek. Although Ashland Creek is not currently on the 2004/2006 303(d) list for temperature, a review of temperature logger data from Ashland Creek above the WWTF discharge point indicates that the stream should be listed year-round for an exceedance of the applicable temperature criteria (Table 16). Ashland Creek was not Heat Source modeled by DEQ as part of the temperature TMDL. In the absence of modeling the temperature criteria that applies to Ashland Creek is 13^0C (55.4F) October 15 through May 15; 18^0C (64.4F) May 16 through October 14 (Biologically Based Numeric Criteria OAR 340-0041-0028).

Table 16. Ashland Creek Temperatures above WWTF (7 day maximum)[1].

	Total[2]	Number Above 13^{0}C	% Exceedance
Oct (15-31)	**51**	**15**	**29.4**
Nov	**87**	**0**	**0**
Dec	**62**	**0**	**0**
Jan	**62**	**0**	**0**
Feb	**47**	**0**	**0**
Mar	**31**	**0**	**0**
Apr	**30**	**0**	**0**
May (1-15)	**21**	**0**	**0**
Sum	**391**	**15**	**3.8**

	Total[2]	Number Above 18^{0}C	% Exceedance
May (16-31)	**34**	**0**	**0**
Jun	**60**	**1**	**1.7**
Jul	**62**	**55**	**88.7**
Aug	**90**	**86**	**95.6**
Sep	**90**	**13**	**14.4**
Oct (1-14)	**42**	**0**	**0**
Sum	**378**	**155**	**41.0**

[1] Ashland Creek upstream of WWTF outfall, 7 day mean of daily maximum temperatures. Period of record 8/1/2002 to 2/29/2004 and 5/5/2004 to 11/30/2004. Source: City of Ashland.
[2] Total number of 7 day maximum temperature data points.

Thermal waste load allocations are calculated to ensure that a point source will not increase stream temperatures beyond the applicable criterion by more than the allowable Human Use Allowance (HUA) cumulatively at the stream's point of maximum impact. Points of maximum impact are locations where the greatest thermal change due to the point source is observed in a stream and include impacts at the point of discharge as well as downstream where the cumulative impacts of multiple sources are the greatest. These locations vary spatially and temporally.

In accordance with the human use allowance provision OAR 340-0041-0028(b), the Ashland WWTF is allocated a 0.1^{0}C increase (HUA) above the applicable criterion in Ashland Creek as well as at the point of maximum impact. The allocations apply at the point of discharge where an individual source has its maximum impact on river temperature as well as downstream where the cumulative impacts of multiple sources may be the greatest. Impacts on Ashland Creek were determined using mass balance calculations (Eq 2.1). Downstream impacts on Bear Creek were determined using the Heat Source model. Stream flows for all scenarios were set to 7Q10[2] low flow conditions with shade and riparian vegetation at site potential for Bear Creek and all tributaries. The 7Q10 low flow conditions were used because these conservative flows are the lowest conditions to which the temperature criteria apply. Exceedance of the criteria under less than 7Q10 flow conditions is not considered a permit violation 340-041-0028 (12)(b)(D)(d). Ashland Creek 7Q10 flows during the low flow season are 1 CFS and the critical flows during the high flow season are 3 CFS as determined in DEQ 2004. Far-field temperature modeling of Bear Creek was only performed for the summertime critical period in August. In order to simulate a conservative worst case

[2] 7Q10 refers to the streamflow that occurs over 7 consecutive days and has a 10-year recurrence interval period, or a 1 in 10 chance of occurring in any one year. Daily streamflows in the 7Q10 range are general indicators of drought or lowflow conditions. 7Q10 values are also frequently used to regulate water withdrawals and discharges into streams.

scenario, facility dry weather design flows (2.3 MGD (3.65 CFS)) were used both scenarios. Simulations assume 100% of the river is used for mixing.

The amount of heat energy a point source can add to a receiving stream is dependant upon the flow of the receiving water, the discharge flow from the plant, and the human use allowance. The allowable heat energy is determined by the following mass balance equation:

EQ. 2.1 $H_{WLA}=(HUA)(Q_{PS}+Q_R)(c)/1{,}000{,}000$

Where:
H_{WLA} = Waste Load Allocation Heat Load (MW)
Q_{PS} = Point Source Effluent Flow (cms)
Q_R = Upstream River Flow (cms)
HUA = Human Use Allowance (^oC)
c = Specific Heat of Water = 1.0 cal/g*C = 4.1868 x 10^6 J/m3*C
1,000,000 = conversion factor from J/sec to MW

In order to translate the thermal waste load allocation into an effluent temperature useful for managing the plant, the applicable temperature criterion must also be accounted for. For the case of the Ashland WWTF the applicable criterion is 13^0C (55.4F) October 15 through May 15; 18^0C (64.4F) May 16 through October 14 (Biologically Based Numeric Criteria OAR 340-0041-0028(4). The following equation is used to calculate the effluent temperature limit for any given effluent flow and river flow:

EQ. 2.2 $T_{WLA}=((T_R + HUA)(Q_{PS}+Q_R) - (Q_R)(T_R))/Q_{PS}$

Where:
T_{WLA} = Waste Load Allocation Temperature
Q_{PS} = Point Source Effluent Flow (cms)
Q_R = Upstream River Flow (cms)
T_R = Applicable Temperature Criterion
HUA = Human Use Allowance (^oC)

Providing the Ashland WWTF a human use allowance of 0.1C above the applicable criteria did not result in near-field impacts on Ashland Creek or far field impacts on Bear Creek in exceedance of 0.1C HUA. The resulting waste load allocations are summarized in Table 17. The city of Ashland has expressed an interest in potentially moving the WWTF outfall to Bear Creek. This scenario was examined using Heatsource modeling with the facility outfall placed directly into Bear Creek above the confluence with Ashland Creek and given a HUA of 0.1C. The waste load allocations associated with this scenario are shown in Appendix A, Table 6.

Near-field and far field impacts from the Ashland WWTF greater than the 0.1C HUA were not observed in the Heat Source model. For this reason, the point of maximum impact is considered to be the mixing zone during both the summertime and fall critical periods as shown in Table 17.

Table 17 provides the waste the waste load allocations and permit limits that account for seasonal variability and future attainment of the applicable standard under the worst case conditions as represented by 7Q10 flows and the WWTF discharging at design flows. As part of the NPDES permit renewal process, the city of Ashland may wish to compute daily or monthly thermal waste load allocations based on the applicable standard, actual receiving water flows, and actual WWTF discharges.

Table 17. Ashland WWTF Waste Load Allocation – Current Outfall into Ashland Creek

Month	Applicable Criterion °C	Dry Weather Design Flows CFS Q_{PS}	Receiving Water 7Q10 CFS[1] Q_R	Human Use Allowance °C HUA	WLA (MW)[2] H_{WLA}	Effluent Temp Limit °C T_{WLA}
May 16 – Oct 14	18C	3.65	1	0.1C	.055	18.13
Oct 15 – May 15	13C	3.65	3	0.1C	.079	13.18

[1] Seasonal 7Q10 flows are taken from DEQ, 2004.
[2] Note: 1 MW-hr = 859845.2 Kcal-hr

NONPOINT SOURCES: LOAD ALLOCATIONS OAR 340-042-0040(4)(H), 40 CFR 130.2(H)

This element determines the portions of the receiving water's loading capacity that are allocated to existing nonpoint sources of pollution or to background sources. Load allocations are a best estimate of loading, and may range from reasonably accurate estimates to gross allotments depending on the availability of data and appropriate techniques for predicting loading.

With the exception of irrigation diversions and returns and reservoir and dam operations, this temperature TMDL will target site potential effective shade as the surrogate target to meet the TMDL load allocation for nonpoint sources. Because allocating heat above background levels to nonpoint sources is a new policy (implementation of the HUA), the department will be developing guidance to assist in its implementation. It is envisioned that such allocations will be used for such things as the placement of roads, highways and bridges and the uncertainty that vegetation management will be completed successfully in all locations through time. The nonpoint source HUA allocation may be used by any of the nonpoint sources located in the Bear Creek watershed, including agriculture, forestry, urban areas, irrigation, dam operations, or for heat trading.

Nonpoint Sources: Urban, Transportation, Agriculture, Forestry.

The nonpoint source load allocation for the Urban DMAs, Agriculture, Forestry and Transportation is defined as the amount of solar radiation that reaches a stream surface when riparian vegetation and stream channels have achieved site potential and applies to all perennial and intermittent fish bearing streams in the watershed. Site potential shade targets are the TMDL implementation targets for urban, transportation, agriculture and forestry (ODF, BLM, USFS). The TMDL targets for selected tributaries are provided in Table 18. Targets for additional surface waters in the watershed are shown in Appendix D.

Note that in Table 18, current shade and site potential shade refer to percent-effective shade defined as the percent reduction of solar radiation load delivered to the water surface. The role of effective shade in this TMDL is to prevent or reduce heating by solar radiation and serve as a linear translator to the solar loading capacities in MW-hr/m^2. From an implementation standpoint it is important to note that any increase in shade over 80% effective shade is considered a margin of safety. At 80% further reduction in stream temperature as a function of vegetation may not be measurable for all stream flows (Boyd, 1996). At values of >80% effective shade, the stream is considered recovered and should not be a candidate for active restoration. Additional shade should come from passive management of the riparian area.

Table 18. TMDL Shade Targets for Bear Creek and Selected Tributaries

Creek	Current (Percent Effective Shade)	TMDL Shade Target. [1] (Percent Effective Shade)	% Change
Bear Creek Mainstem	15	54	39
Jackson Creek	46	88	42
Griffin Creek	47	85	38
Lazy Creek	26	82	56
Coleman Creek	67	89	21
Wagner Creek	70	91	21
Myer Creek	40	83	42
Butler Creek	21	84	63
Ashland Creek[2]	66	82	16
Neil Creek	71	88	17
Walker Creek	41	86	37
Emigrant Creek	54	85	31

1: TMDL shade target is the calculated percent effective shade provided when riparian vegetation reaches site potential.

2: Ashland Creek as shown represents the average shade from the base of Hosler Dam to the mouth (mouth to river mile 4.9). If all of Ashland Creek is included in the average (both East and West Forks), average percent effective shade from the mouth to the head waters currently is 91%, site potential shade is 94%.

Load Allocations have been further refined for the Urban DMAs that have management authority for lands that border Bear Creek. Table 19 presents the Thermal Load Allocations by jurisdiction for each urban DMA on the Bear Creek mainstem. These calculations are based on the condition of Bear Creek within the Urban Growth Boundary (UGB) of each DMA. Note that Table 19 is for Bear Creek only and was developed to provide an idea of the increase in shade that is needed to meet the TMDL for each urban jurisdiction. Tributaries are also required to meet site potential effective shade targets as shown in Table 19 and in Appendix D, but percent reduction targets have not been calculated for each DMA.

Table 19. Thermal Load Allocations for Urban DMAs : Bear Creek within UGB

Urban DMA bordering Bear Creek[1]	Miles of Bear Creek within UGB	Current Percent Effective Shade	TMDL Target Shade[2]	Current Thermal Load $MW\text{-}hr/m^2$	TMDL Target Load $MW\text{-}hr/m^2$	Percent Reduction to meet TMDL
Ashland	1.9	43.4	86.8	449	103	76%
Talent	2.1	18.6	74.6	631	196	69%
Phoenix	1.8	47.0	81.5	378	132	65%
Medford	6.9	15.6	65.3	655	268	59%
Central Point	0.7	30.6	76.5	2075	702	66%
Jackson County	14.1[3]	22.9	71.4	4489	1664	63%

[1] Although Jacksonville receives no LA for Bear Creek, the city must work to achieve site potential shade for all perennial and fish bearing streams within city limits. System potential shade targets for all perennial and intermittent fish bearing streams is shown in Appendix D.

[2] TMDL Target Shade is the percent effective shade on Bear Creek within the Urban Growth Boundary of each jurisdiction at site potential vegetation. Note: 1 MW-hr/m2 = 859845.2 Kcal-hr/m2

[3] The value shown for Jackson County is only for the modeled section of Bear Creek, from the mouth to the confluence of Walker and Emigrant Creeks, a distance of 27.5 miles. In reality Jackson Creek is responsible for meeting water quality standards for all lands under its jurisdiction including Bear Creek above the modeled reach.

Emigrant Dam

Emigrant reservoir is owned by USBOR and operated by Talent Irrigation District. Unlike point sources that discharge heat loads into a receiving water body, a large reservoir, such as Emigrant Lake, greatly impacts the temperature and flow of the entire creek. The load allocation that applies to Emigrant Dam is no increase in natural thermal potential temperatures when the biologically-based numeric criteria are exceeded. The biologically based numeric criteria that apply are 13^0C (55.4F) October 15 through May 15; 18^0C (64.4F) May 16 through October 14 (Biologically Based Numeric Criteria OAR 340-0041-0028).

Additional monitoring and modeling are needed to establish estimates of natural thermal potential that can be used to establish the target temperatures for reservoir operations. However in the absence of such data heat load allocations equivalent to natural background loads apply to Emigrant Dam.

Stream models are needed of currently impounded reaches to determine the heating that would occur in these reaches in the absence of the reservoir. Stream models and temperature data for the primary streams above the reservoir are also needed to determine the natural thermal potential of the streams where they flow into Emigrant Lake. Because heat load is a function of temperature and flow, reservoir effects on stream temperature are better expressed as water temperature targets rather than as a heat load expressed as units of energy such as calories (DEQ, 2006; Willamette TMDL). Reservoir models, currently being developed by US Army Corp of Engineers (USACE) and others, may be employed to optimize reservoir operations and evaluate the potential for achieving target temperatures. With these tools, a cost-benefit analyses can be performed and load allocations greater than background may be provided at some time in the future.

Temperature Management Plan – Emigrant Dam

DEQ will assist the USBOR and the Talent Irrigation District in developing a formal temperature management plan for Emigrant Dam and Lake. As stated in Rule OAR 340-041-0028(h): "Other Nonpoint Sources. The department may, on a case-by-case basis, require nonpoint sources (other than forestry and agriculture), including private hydropower facilities regulated by a 401 water quality certification, that may contribute to warming of State waters beyond 0.3 degrees Celsius (0.5 degrees Fahrenheit), and are therefore designated as water-quality limited, to develop and implement a temperature management plan to achieve compliance with applicable temperature criteria or an applicable load allocation in a TMDL pursuant to OAR 340-042-0080".

A plan must include a description of best management practices, measures, effluent trading, and control technologies (including eliminating the heat impact on the stream) that the nonpoint source intends to use to reduce its temperature effect, a monitoring plan, and a compliance schedule for undertaking each measure. The Department may periodically require a nonpoint source to revise its temperature management plan to ensure that all practical steps have been taken to mitigate or eliminate the temperature effect of the source on the water body. Once approved, a nonpoint source complying with its temperature management plan is deemed in compliance with this rule.

Irrigation Districts: TID, RRVID, MID

The 3 irrigation districts in the Bear Creek watershed, Talent, Medford and Rogue River Valley, are allowed a cumulative impact of 0.05^oC above natural thermal potential temperatures in Bear Creek. Because of the complexity and size of the irrigation systems (>250 miles of canals), it was impossible at the time of data collection to quantify the thermal impact of irrigation withdrawals, delivery, and return into the Bear Creek system.

Under the current TMDL, the irrigation districts are not given individual load allocations but the 3 districts combined are allowed a 0.05ºC increase in Bear Creek, above the applicable criteria at the point of maximum impact.

Temperature Management Plan – irrigation districts

DEQ requests that the 3 districts work with the Department to submit a formal temperature management plan to address irrigation district operations. As stated in Rule OAR 340-041-0028(h): "Other Nonpoint Sources. The department may, on a case-by-case basis, require nonpoint sources (other than forestry and agriculture), including private hydropower facilities regulated by a 401 water quality certification, that may contribute to warming of State waters beyond 0.3 degrees Celsius (0.5 degrees Fahrenheit), and are therefore designated as water-quality limited, to develop and implement a temperature management plan to achieve compliance with applicable temperature criteria or an applicable load allocation in a TMDL pursuant to OAR 340-042-0080".

To date, the districts have been undertaken numerous improvements in operations, infrastructure and management which will continue to lead to improvements in the delivery and use of irrigation water and lessen the negative impacts of irrigation water on surface water quality:

- The districts have been active supporters of the Waters for Irrigation, Streams and Economy (WISE) project which advocates for increased conservation measures including canal piping and the use of reclaimed wastewater for irrigation.
- The districts have worked with state and federal partners to install and maintain real-time flow gage stations through out the watershed
- There is an aggressive piping project underway at all 3 districts
- Providing gravity pressure systems to encourage the shift from flood irrigation to sprinkler use.
- Actively installing inverted siphon systems to separate canal systems from the natural stream system
- Participated in studies to assess water quality in the canals
- Cooperating with the Oregon Water Trust and willing land owners to convert idle lands water rights to instream leases
- The district recently installed a re-regulating reservoir to more efficiently control runoff and control operational spills
- The districts have installed or upgraded flow measuring devices to better manage the water within the canal system.

The efforts listed above can all be incorporated into an implementation plan for the irrigation districts. However, as per rule OAR 340-041-0028(h)(A-D), each plan must also include a description of best management practices, measures, effluent trading, and control technologies (including eliminating the heat impact on the stream) that the nonpoint source intends to use to reduce its temperature effect, a monitoring plan, and a compliance schedule for undertaking each measure. The Department may periodically require a nonpoint source to revise its temperature management plan to ensure that all practical steps have been taken to mitigate or eliminate the temperature effect of the source on the water body. Once approved, a nonpoint source complying with its temperature management plan is deemed in compliance with this rule.

BEAR CREEK RESERVE CAPACITY OAR 340-042-0040(4)(K)

This element provides an allocation for increases in pollutant loads due to future growth and new and expanded sources. The Bear Creek TMDL allocates a reserve capacity of 0.1ºC on Bear Creek at the point of maximum impact.

There is an explicit allocation for reserve capacity throughout the mainstem Bear Creek and its tributaries. The general framework of the TMDL allocates 0.1°C or 1/3rd of the human use allowance to reserve capacity. 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.

There are currently questions centering on when the reserve capacity will be available for use. There are uncertainties as to when significant reductions in thermal load will occur. This coupled with the uncertainties over the impact of dams and irrigation, have resulted in a recommendation to distribute the reserve capacity only after it is demonstrated that a significant reduction in thermal loads will be achieved within a specified timeframe. The issues relating to when the reserve capacity will become available are currently under discussion and will be determined at a later date.

MAINSTEM BEAR SEASONAL VARIATION AND CRITICAL CONDITIONS

OAR 340-042-0040(4)(j), CWA §303(d)(1)

This element accounts for seasonal variation and critical conditions in stream flow, sensitive beneficial uses, pollutant loading and water quality parameters so that water quality standards will be attained and maintained during all seasons of the year.

Warmest water temperatures in the Bear Basin typically occur during summer months when natural levels of solar radiation input to the system are greatest. This also corresponds to the period when stream flows may be low or inconsistent due to irrigation water inputs. Salmon migration and rearing and other beneficial uses including resident fish and aquatic life may be adversely affected or impaired when temperatures exceed the biologically based numeric criteria for extended periods of time. This is the period of year when nonpoint source activities that decrease effective shade levels along the stream are of greatest concern.

Late summer and early autumn is another period when biological criteria are exceeded. Ambient water temperatures begin to cool, but streamflow levels remain low (due to both reservoir management and natural conditions) and susceptible to point source heat loads. This is also at a time when salmon begin to spawn in many streams. Applicable numeric criteria during this time reflects this increase in beneficial use sensitivity and the target temperature for the seven-day average of the daily maximum decreases from 18°C to 13°C on October 15. It is during this time that reservoir releases have their greatest effect on ambient stream temperatures.

The mainstem Bear temperature TMDL addressed the period spanning the months of May through October. Load allocations and monthly waste loads and were developed for the time period when stream temperatures exceed the biological based numeric criteria (18C, 64.4F) to ensure anthropogenic heat loads meet the human use allowance and other elements of Oregon temperature criteria.

MAINSTEM BEAR MARGIN OF SAFETY OAR 340-042-0040(4)(I), CWA §303(D)(1)

This element accounts for the uncertainty related to the TMDL and, where feasible, quantifies uncertainties associated with estimating pollutant loads, modeling water quality and monitoring water quality.

A margin of safety 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 margin of safety 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) Table 20.

Table 20. Approaches for Incorporating a Margin of Safety into a TMDL

Type of Margin of Safety	*Available Approaches*
Explicit	1. Set numeric targets at more conservative levels than analytical results indicate. 2. Add a safety factor to pollutant loading estimates. 3. Do not allocate a portion of available loading capacity; reserve for margin of safety.
Implicit	4. Conservative assumptions in derivation of numeric targets. 5 Conservative assumptions when developing numeric model applications. 6 Conservative assumptions when analyzing prospective feasibility of practices and restoration activities.

Explicit Margins of Safety

Specific heat load allocations are provided to point sources, nonpoint sources and reserve capacity, but no portion of the human use allowance is set aside as margin of safety. However, there are implicit margins of safety included in the TMDL through conservative assumptions during analysis and interpretation and application of temperature criteria.

Implicit Margins of Safety

The Bear Creek watershed temperature TMDL relies upon implicit assumptions used in the temperature TMDL assessment methodology.

- Groundwater inflow was assumed to be zero and its cooling influence on stream temperatures via mass transfer/mixing was not accounted for. Further, cooler microclimates associated with late seral conifer riparian zones were not accounted for in the simulation methodology.

- The Heat Source model (Appendix A) did not change current vegetative shade overhang values as part of its site potential scenario. The present overhang values are very low and are likely to increase in the future. This will provide a MOS as vegetative overhang will add additional effective shade to Bear Creek .

- In modeling Bear Creek natural thermal potential conditions, tributary temperatures inputs were lowered. The improvements were very conservative and it is expected that improvements in effective shade will have a more profound effect on tributaries then the temperatures input into the model. This additional cooling is considered a MOS.

- Individual waste load allocations were based on critical conditions that are unlikely to occur. For example, it is unlikely that maximum effluent flows and maximum effluent temperatures are likely to occur simultaneously for NDPES sources, however these values were used to determine the cumulative impact of these sources.

- Modeling was conducted using summer low flow and seasonal maximum air temperatures.

- The Heat Source 6.0 model simulation was used to determine if assimilative capacity was available for Bear Creek.). Heatsource outputs of a one-day maximum temperatures was used against the 64.4°F biologically based numeric criteria (a 7-day moving average of the daily maximum temperatures) to determine if an assimilative was available. One-day maximum temperatures can be expected to be higher than a 7-day moving average of maximum temperatures resulting in a conservative assimilative capacity and an additional margin of safety.

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