Redline Draft Total Maximum Daily Loads for the Lower Columbia-Sandy Subbasin

Temperature

Changes made since advisory committee meeting 1 shown.

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State of Oregon
DEQ Department of Environmental Quality

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Table of Contents

List of Figures and Tables

1. Introduction

report adopted by reference into rule explanation

1.1. Previous TMDLs

DEQ has issued one previous TMDL action in 2005 that addressed listings for temperature and bacteria (DEQ, 2005). Once approved by EPA, the Lower Columbia-Sandy Subbasin TMDLs for temperature will replace the temperature TMDLs approved by EPA in 2005. The bacteria TMDLs approved by EPA in 2005 are still effective.

Table 1.1. Summary of previous TMDLs developed for the Lower Columbia-Sandy Subbasin.

TMDL action ID	TMDL Name	EPA Approval Date	Water Quality Impairments Addressed
11395	Sandy River Basin Total Maximum Daily Load (TMDL)	4/14/2005	Bacteria (water contact recreation), Temperature

1.2. TMDL administrative and public participation processes

Following completion of Oregon Department of Environmental Quality's drafting process, including engagement of a rule advisory committee on the fiscal impact statement and other aspects of the rule, this revised temperature TMDLs for the Lower Columbia-Sandy Subbasin TMDL will be proposed for adoption by Oregon's Environmental Quality Commission, by reference, into rule as OAR 340-042-0090(xx). Any subsequently amended or renumbered rules cited in this document are intended to apply.

DEQ convened a rule advisory committee to provide input on… [topics, number of meetings, etc.]. The committee and the xx-day public comment opportunity and public hearing (planned for May and June 2023) fulfills the public participation requirements specified in OAR 340-042-0050. DEQ considered all input received during these public participation opportunities, used input to guide the analyses and preparation of documents, and provided response to comments, which is available on DEQ's website.

2. TMDL name and location

Per Oregon Administrative Rule 340-042-0040(a), this element describes the geographic area for which the TMDL is developed.

Temperature TMDLs for the Lower Columbia-Sandy are developed for all waters determined to be waters of the state as defined under ORS 468B.005(10), including all perennial and intermittent streams, located in the Lower Columbia-Sandy Subbasin (17080001). The temperature TMDLs do not include the section of the Columbia River that flows through the Lower Columbia-Sandy Subbasin (17080001). The map in Figure 1 provides an overview of where the temperature TMDLs are applicable.

In Oregon, the Lower Columbia-Sandy Subbasin is comprised of seven smaller 10-digit watersheds as listed in Table 2.1.

Table 2.1 Watersheds within the Lower Columbia-Sandy Subbasin

HU10 code	Watershed Name
1708000101	Upper Sandy River
1708000102	Zigzag River
1708000103	Salmon River
1708000104	Middle Sandy River
1708000105	Bull Run River
1708000107	Lower Sandy River
1708000108	City of Washougal-Columbia River

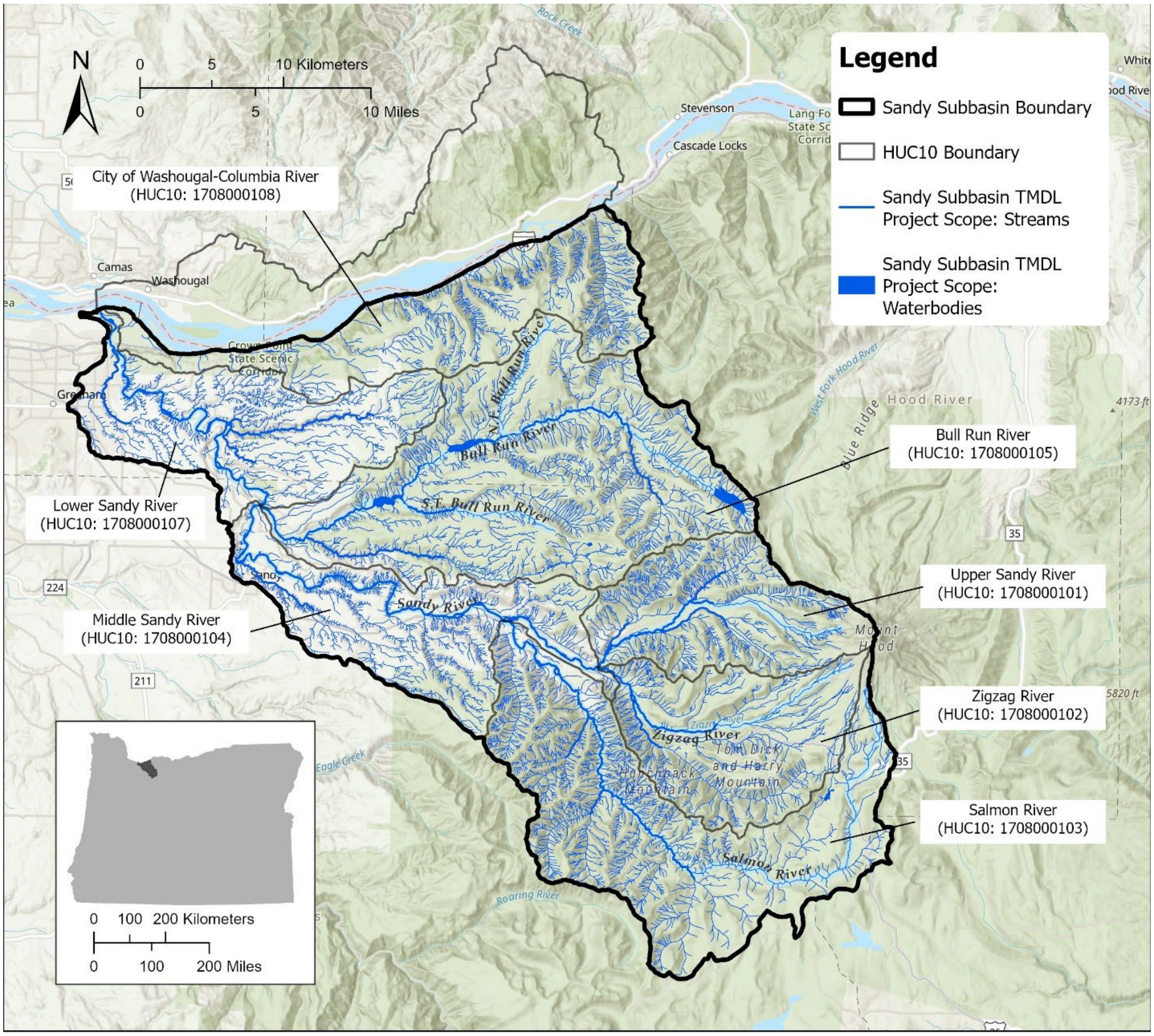


Figure 2.1 Lower Columbia-Sandy Subbasin temperature TMDLS project area overview.

3. Pollutant identification

As stated in OAR 340-042-0040(4)(b), this element identifies the pollutants causing impairment of water quality that are addressed by these TMDLs. The associated water quality standards and beneficial uses are identified in Section 4.

The pollutants addressed by this temperature TMDL are heat or thermal loads, with surrogate measures of effective shade and minimum instream flows.

Table 3.0 presents stream assessment units within the Sandy-Lower Columbia Subbasin that were listed as impaired for temperature on DEQ's 2022 Clean Water Act Section 303(d) List (as part of Oregon's Integrated Report), which was approved by the Environmental Protection

Agency on September 1, 2022. Status category designations are prescribed by Sections 305(b) and 303(d) of the Clean Water Act. Assessment units listed in Category 5 (designated use is not supported or a water quality standard is not attained) require development of a TMDL. Locations of these listed segments are depicted on Figure 2.

DEQ developed this TMDL to address Category 5 listed assessment units and to protect all other assessment units and assessment categories, including “unassessed”. The allocations, including surrogate measures, and implementation framework apply to all freshwater perennial and intermittent streams in the Lower Columbia-Sandy Subbasin, as described in Sections 2, 5, 8 and 9 of this document. The implementation framework is presented in the Lower Columbia-Sandy Subbasin TMDL Water Quality Management Plan and includes implementation activities and timeframes to improve water quality, as well as measures of success.

Surrogate measures are defined in OAR 340-042-0030(14) as “substitute methods or parameters used in a TMDL to represent pollutants.” In accordance with OAR 340-042-0040(5)(b), DEQ used effective shade and a percent consumptive use target as a surrogate measure for thermal loading caused by solar radiation and other fluxes that introduce heat. Implementation of the surrogate measures ensures achievement of necessary pollutant reductions and the nonpoint load allocations for this temperature TMDL.

Table 3.1. Lower Columbia-Sandy Subbasin Category 5 temperature impairments on the 2022 Integrated Report

Assessment Unit Name	Assessment Unit	Use Period
Beaver Creek	OR_SR_1708000107_02_103612	Year round
Beaver Creek	OR_SR_1708000107_02_103612	Spawning
Benson Lake	OR_LK_1708000108_15_100639	Year round
Bull Run River	OR_SR_1708000105_11_103611	Year round
Bull Run River	OR_SR_1708000105_11_103611	Spawning
Cedar Creek	OR_SR_1708000104_02_103607	Year round
Clear Creek	OR_SR_1708000101_02_103597	Year round
Clear Creek	OR_SR_1708000101_02_103597	Spawning
Clear Fork	OR_SR_1708000101_02_103596	Spawning
Gordon Creek	OR_SR_1708000107_02_103615	Spawning
Gordon Creek	OR_SR_1708000107_02_103617	Spawning
HUC12 Name: Beaver Creek-Sandy River	OR_WS_170800010703_02_103703	Spawning
HUC12 Name: Beaver Creek-Sandy River	OR_WS_170800010703_02_103703	Year round
HUC12 Name: Bridal Veil Creek-Columbia River	OR_WS_170800010803_15_103654	Year round
HUC12 Name: Cedar Creek-Sandy River	OR_WS_170800010402_02_103644	Year round
HUC12 Name: Headwaters Sandy River	OR_WS_170800010101_02_103635	Year round
HUC12 Name: Little Sandy River	OR_WS_170800010505_11_103669	Year round
HUC12 Name: Lower Bull Run River	OR_WS_170800010506_11_103650	Year round
HUC12 Name: Lower Salmon River	OR_WS_170800010304_02_103642	Year round
HUC12 Name: Tanner Creek-Columbia River	OR_WS_170800010801_15_103707	Spawning
HUC12 Name: Tanner Creek-Columbia River	OR_WS_170800010801_15_103707	Year round
HUC12 Name: Wildcat Creek-Sandy River	OR_WS_170800010401_02_103643	Spawning
Little Sandy River	OR_SR_1708000105_11_103609	Year round
Little Sandy River	OR_SR_1708000105_11_103609	Spawning
Lost Creek	OR_SR_1708000101_02_103598	Spawning
Salmon River	OR_SR_1708000103_02_103606	Year round
Salmon River	OR_SR_1708000103_02_103606	Spawning
Sandy River	OR_SR_1708000101_02_103595	Year round
Sandy River	OR_SR_1708000101_02_103599	Year round
Sandy River	OR_SR_1708000101_02_103599	Spawning
Sandy River	OR_SR_1708000104_02_103608	Year round

Assessment Unit Name	Assessment Unit	Use Period
Sandy River	OR_SR_1708000104_02_103608	Spawning
Sandy River	OR_SR_1708000107_02_103616	Year round
South Fork Salmon River	OR_SR_1708000103_02_103604	Spawning
Still Creek	OR_SR_1708000102_02_103601	Spawning
Zigzag River	OR_SR_1708000102_02_103600	Spawning

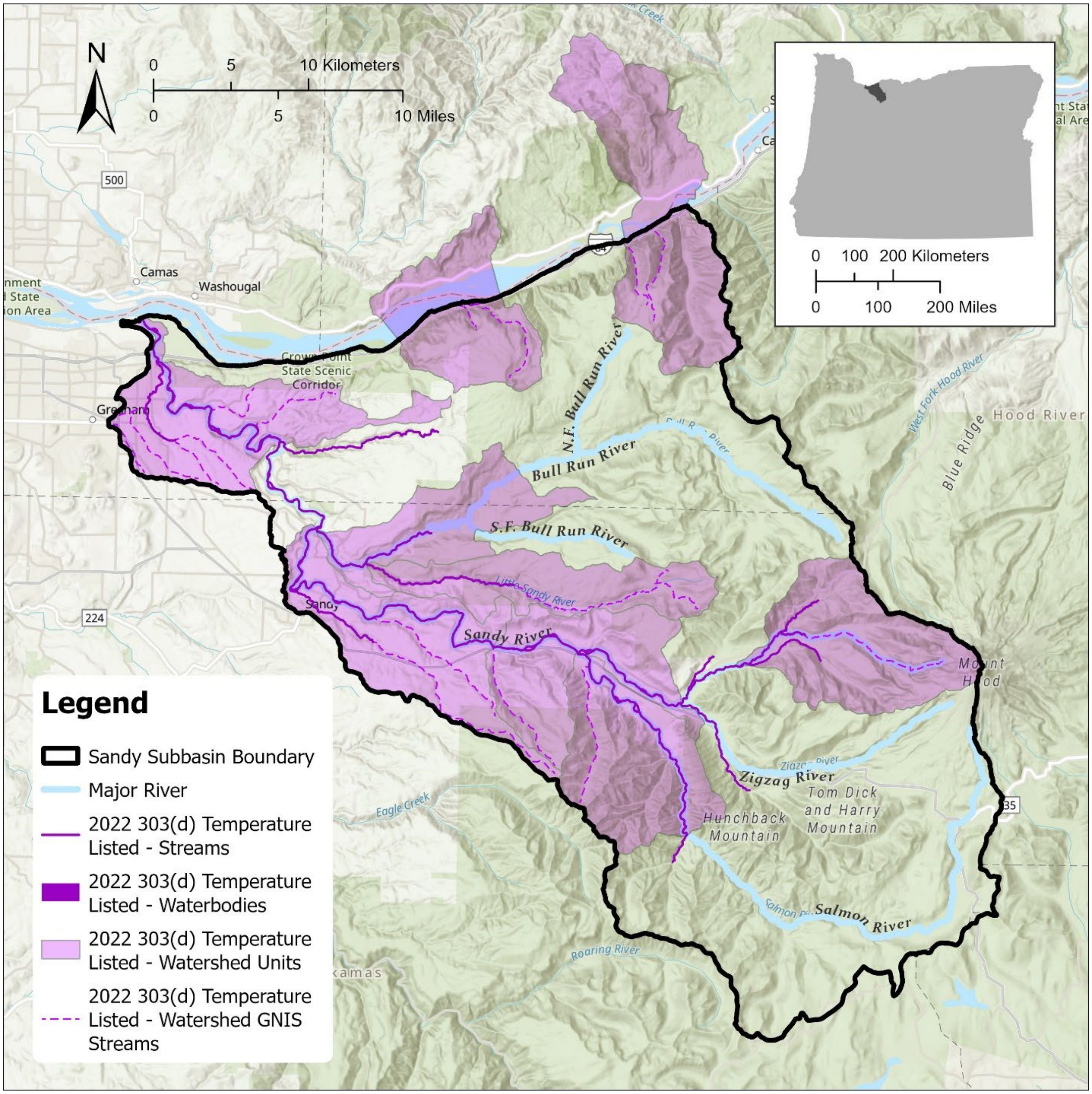


Figure 3.1. Lower Columbia-Sandy Subbasin category 5 temperature impairments on the 2022 Integrated Report.

4. Water quality standards and beneficial uses

As stated in OAR 340-042-0040(4)(c), this element identifies the beneficial uses in the basin, specifying the most sensitive beneficial use, and the relevant water quality standards established in OAR 340-041-0202 through 340-041-0975.

Table 4.1 and Table 4.2 specify the designated beneficial uses in the Lower Columbia-Sandy Subbasin surface water and the applicable numeric and narrative water quality standards addressed by these TMDLs, as well as indicated the most sensitive beneficial uses related to each standard. These TMDLs are designed such that meeting water quality standards for the most sensitive beneficial uses will be protective of all other uses.

Table 4.1 Designated beneficial uses in the Lower Columbia Sandy Subbasin as identified in OAR 340-041-0286 Table 286A.

Beneficial Uses	Streams Forming Waterfalls Near Columbia River Highway	Sandy River	Bull Run River and all Tributaries	All Other Tributaries to Sandy River
Public Domestic Water Supply		X	X	X
Private Domestic Water Supply		X		X
Industrial Water Supply		X		X
Irrigation		X		X
Livestock Watering		X		X
Fish and Aquatic Life	X	X	X	X
Wildlife and Hunting	X	X		X
Fishing	X	X		X
Boating		X		X
Water Contact Recreation	X	X		X
Aesthetic Quality	X	X	X	X
Hydro Power		X	X	X
Commercial Navigation & Transportation				

Table 4.2 Applicable water quality standards and most sensitive beneficial uses

Parameter	Rule Citation	Summary of applicable standards	Waters where standards are applicable	Most sensitive beneficial use
		The highest and best practicable treatment and/or control of wastes,		

Parameter	Rule Citation	Summary of applicable standards	Waters where standards are applicable	Most sensitive beneficial use
Statewide Narrative Criteria	OAR 340-041-0007(1)	activities, and flows must in every case be provided so as to maintain dissolved oxygen and overall water quality at the highest possible levels and water temperatures, coliform bacteria concentrations, dissolved chemical substances, toxic materials, radioactivity, turbidities, color, odor and other deleterious factors at the lowest possible levels.	All waters of the state	Fish and aquatic life
Temperature	OAR 340-041-0028(4) OAR 340-041-0286 Figures 286A and 286B	(a) The 7-day average maximum temperature may not exceed 13.0˚C (55˚F) at the times indicated on maps and tables (b) The 7-day average maximum temperature may not exceed 16.0˚C (60.8˚F) (c) The 7-day average maximum temperature may not exceed 18.0˚C (64.4˚F)	See OAR Figures 286A and 286B	Salmonid and steelhead spawning
	OAR 340-041-0028(11)	(a) Not warmed by more than 0.3˚C (0.5˚F) above the colder water ambient temperature, by all sources taken together at the point of maximum impact	Cold water	Salmon, steelhead or bulltrout presence
	OAR 340-041-0028(12)(b)	(B) Human Use Allowance. Following a temperature TMDL or other cumulative effects analysis, wasteload and load allocations will restrict all NPDES point sources and nonpoint sources to a cumulative increase of no greater than 0.3˚C (0.5˚F) above the applicable criteria after complete mixing in the water body, and at the point of maximum impact.	All waters of the state	Salmonid and steelhead spawning

5. Seasonal variation and critical period for Temperature

Per OAR 340-042-0040(4)(j) and 40 Code of Federal Regulation130.7(c)(1), TMDLs must also identify any seasonal variation and the critical condition or period of each pollutant, if applicable.

~~[summarize seasonality and critical periods and refer to xx Basin TMDL Technical and Policy Support Document]~~

The critical period is set based on when 7DADM stream temperature typically exceed the applicable criteria. On the Sandy River and other tributary streams the critical period is May 1 – Oct 31. On the Bull Run River, the critical period is May 1 through November 15.\
[Additional seasonality summary]

6. Temperature water quality data evaluation overview

Summarize general evaluation approach – names of models and linkage analyses, refer to a schematic

[insert figure]

Figure 6: Schematic of A critical TMDL element is water quality data evaluation and analysis to the extent that existing data allow. To understand the water quality impairment, quantify the loading capacity, identify pollutant sources, and assess various management scenarios that achieve the TMDL and applicable water quality standards, the analysis requires a predictive component. Certain models provide a means to evaluate potential stream warming sources and, to the extent existing data allow, their current and potential pollutant loads. Heat Source and CE-QUAL-W2 models were used in this effort and are described in Technical Support document model appendices.

The modeling framework needs for this project included the abilities to predict/evaluate hourly:

1. Stream temperatures spanning months at ≤500m longitudinal resolution.
2. Solar radiation fluxes and daily effective shade at ≤100m longitudinal resolution.
3. Stream temperature evaluation approach responses due to changes in:
    a. Streamside vegetation,
    b. Water withdrawals and upstream tributaries' stream flow,
    c. Channel morphology in the upstream catchment,
    d. Effluent temperature and flow discharge from NPDES permitted facilities.

provides an overview of the analyses completed for this TMDL.

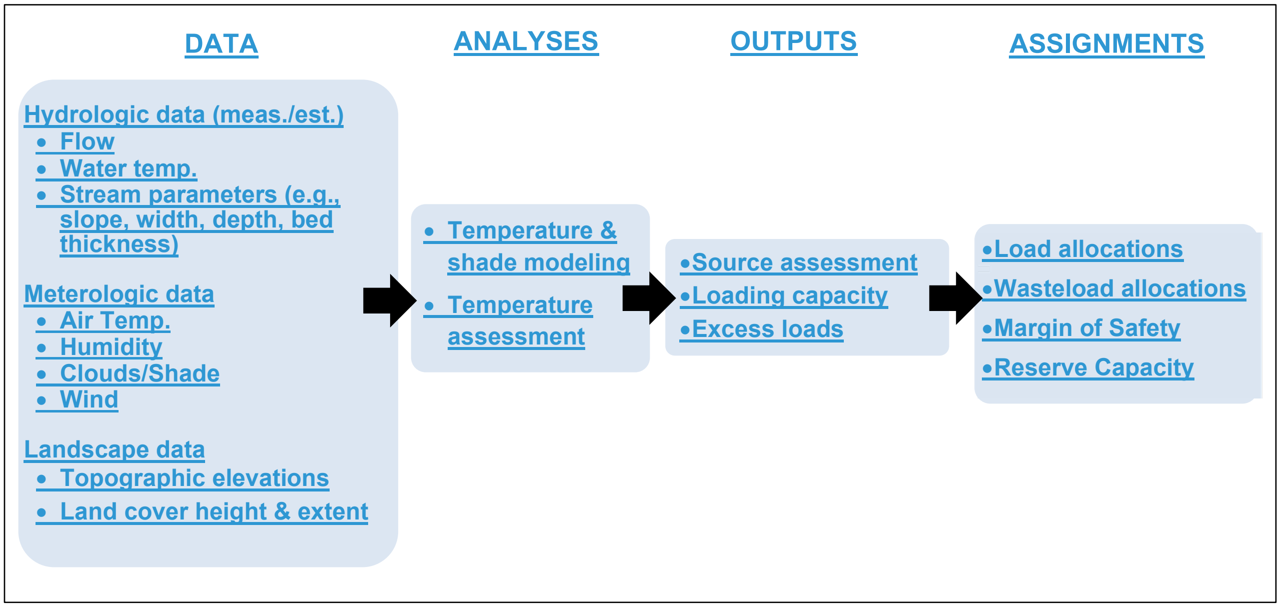


Figure 6.1 Lower Columbia-Sandy River Subbasin temperature analysis overview.

7. Pollutant sources or source categories

As noted in OAR 340-042-0040(4)(f) and OAR 340-042-030(12), a source is any process, practice, activity or resulting condition that causes or may cause pollution or the introduction of pollutants to a waterbody. This section identifies the various pollutant sources and estimates, to the extent existing data allow, the significance of pollutant loading from existing sources.

Both point and non-point sources contribute thermal pollution to surface waters in the Lower Columbia-Sandy Subbasin. Within the nonpoint source category, both background and anthropogenic nonpoint sources contribute thermal pollution. Each source's thermal loading varies in frequency and magnitude based on the flow rate and temperature of discharge, prevalence of the activities, size of the land area on which the activities occur, locations of activities in relation to surface water, and transport mechanisms.

7.1. Thermal point sources

OAR 340-045-001(17) defines point source as "any discernible, confined and discrete conveyance, including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, or vessel or other floating craft, from which pollutants are or may be discharged."

There are three individual NPDES permitted point source dischargers within the Lower Columbia-Sandy identified as significant sources of thermal load (Table 7.1).

Quantify contributions, as possible, and discuss significance relative to NPS and background.

Table 7.1 Individual NPDES permitted point source discharges that contribute thermal loads to Lower Columbia-Sandy Subbasin streams at a frequency and magnitude to cause exceedances to the temperature standard.

Permittee	Permit type	DEQ WQ File Number	EPA Number	Receiving water name	River mile
Government Camp STP	NPDES-DOM-Da	34136	OR0027791	Camp Creek	6.5
WES Hoodland STP	NPDES-DOM-Da	39750	OR0031020	Sandy River	41
City of Troutdale Water Pollution Control Facility	NPDES-DOM-C2a	89941	OR0020524	Sandy River	2.3

There are multiple categories of general NPDES permit types with registrants in the Lower Columbia-Sandy including:

- 300-J Industrial Wastewater, NPDES fish hatcheries;
- 1200-A Stormwater, NPDES sand & gravel mining;
- 1200-C Stormwater, NPDES construction more than 1 acre disturbed ground;
- 1200-Z Stormwater, NPDES specific SIC codes;
- MS4 – Phase 2 - Stormwater, NPDES Municipal Separate Storm Sewer System

There is one registrant of the 300-J permit (Table 7.2) found to be a significant source of thermal load with a temperature impact on Cedar Creek. There is one registrant to the general MS4 phase II permit (City of Troutdale), and approximately 26 registrants on the 1200-A, 1200-C, and 1200-Z permits. Based on a review of published literature and other studies related to stormwater runoff and stream temperature in Oregon, DEQ found there is not sufficient evidence to demonstrate that stormwater discharges authorized under the current municipal (MS4), construction (1200-C) and industrial (1200-A and 1200-Z) general stormwater permits contribute to exceedances of the temperature standard.

Table 7.2 General NPDES permit registrants that contribute thermal loads to Lower Columbia-Sandy Subbasin streams at a frequency and magnitude to cause exceedances to the temperature standard.

Permittee	Permit type	DEQ WQ File Number	EPA Number	Receiving water name	River mile
ODFW Sandy River Hatchery	300-J	64550	ORG130009	Cedar Creek	0.7

7.2. Thermal nonpoint sources

OAR 340-41-0002 (42) defines nonpoint sources as “diffuse or unconfined sources of pollution where wastes can either enter, or be conveyed by the movement of water, into waters of the state." Nonpoint sources of heat in the Lower Columbia-Sandy streams include activities associated with agriculture, forestry, dam and reservoir management, and development.

Sources or activities that contribute thermal load and may increase stream temperature include:

- Human caused increases in solar radiation loading to the stream network from the disturbance or removal of near-stream vegetation;
- Channel modification and widening;
- Dam and reservoir operation;
- Activities that modify flow rate or volume; and,
- Background sources, including natural sources and anthropogenic sources of warming through climate change and other factors.

Anthropogenically influenced thermal loads are targeted for reduction to attain the temperature water quality criteria. The following actions are needed to attain the TMDL allocations:

- Restoration of stream-side vegetation to reduce thermal loading from exposure to solar radiation,
- Management and operation of dams reservoirs to minimize temperature warming.
- Maintenance of minimum instream flows

7.3. Thermal background sources

By definition (OAR 340-042-0030(1)), background sources include all sources of pollution or pollutants not originating from human activities. Background sources may also include anthropogenic sources of a pollutant that the DEQ or another Oregon state agency does not have authority to regulate, such as pollutants emanating from another state, tribal lands, or sources otherwise beyond the jurisdiction of the state.

The amount of background thermal loading a stream receives is influenced by a number of landscape and meteorological characteristics, such as: substrate and channel morphology conditions; streambank and channel elevations; near stream vegetation; groundwater; hyporheic flow; tributary inflows; precipitation; cloudiness; air temperature; relative humidity and others. Many of these factors, however, are influenced by anthropogenic impacts related to the surrogate measures. Background sources of warming were explicitly quantified for ~~xx Basin~~the Sandy River, Salmon River, Little Sandy River, Bull Run River, and ~~subtracted~~the Zigzag River. In each river reductions from ~~anthropogenic loads.~~background sources will be required in order to attain the applicable temperature criteria.

8. Loading capacity and excess loads

Summarizing OAR 340-042-0040(4)(d) and 40 CFR 130.2(f), loading capacity is the amount of a pollutant or pollutants that a waterbody can receive and still meet water quality standards.

For temperature, thermal loading capacity is calculated using **Equation 1**.

$$LC = (T_C + \text{HUA}) \cdot Q_R \cdot C_F \qquad \textbf{Equation 1}$$

where,

$LC =$ Loading Capacity (kilocalories/day).

$T_C =$ The applicable river temperature criterion (°C).

$\mathrm{HUA} =$ The 0.3°C human use allowance allocated to point sources, nonpoint sources, margin of safety, or reserve capacity.

$Q_R =$ The daily mean river flow rate (cfs). When river flow is <= 7Q10, Q_R = 7Q10. When river flow > 7Q10, Q_R is equal to the daily mean river flow.

$C_F =$ Conversion factor using flow in cubic feet per second (cfs): 2,446,665

$$\cancel{\frac{1\ ft^3}{1\ sec}} \cdot \cancel{\frac{1\ m^3}{35.31\ ft^3}} \frac{1\ m^3}{35.31\ ft^3} \cdot \frac{1000\ kg}{1\ m^3} \cdot \frac{86400\ sec}{1\ day} \cdot \frac{1\ kcal}{1\ kg\ \cdot 1°C} = 2{,}446{,}665$$

Equation 1 shall be used to calculate the thermal loading capacity for any surface water location in the Lower Columbia-Sandy Subbasin. Table 8.1 presents the minimum loading capacity for select temperature impaired category 5 assessment units that have a current NPDES discharge within the assessment unit extent; or the assessment unit was modeled for the TMDL analysis. The loading capacities in Table 8.1 were calculated based on the 7Q10 low flow. **Equation 1** may be used to calculate the loading capacity when river flows are greater than 7Q10. **Equation 1** may also be used to calculate the loading capacity if in the future the applicable temperature criteria are updated and approved by EPA.

Table 8.1 Minimum thermal loading capacity for select assessment units by applicable fish use period.

AU ID and Extent	Annual 7Q10 (cfs)	Non-Spawning Criterion + HUA (deg-C)	Spawning Criterion + HUA (deg-C)	Minimum Loading Capacity Non-Spawning (kilocalories/day)	Minimum Loading Capacity Spawning (kilocalories/day)
Bull Run River - Bull Run Reservoir Number Two to confluence with Sandy River OR_SR_1708000105_11_103611	3.6	16.3	13.3	143,570,302	117,146,320
Cedar Creek - Beaver Creek to confluence with Sandy River OR_SR_1708000104_02_103607	4.9	18.3	NA	219,392,451	NA
Salmon River - South Fork Salmon River to confluence with Sandy River OR_SR_1708000103_02_103606	174	16.3	13.3	6,939,231,273	5,662,072,143
Sandy River - Bull Run River to confluence with Columbia River OR_SR_1708000107_02_103616	277.3	18.3	13.3	12,415,821,742	9,023,520,720
Sandy River - Clear Fork to Zigzag River OR_SR_1708000101_02_103599	50.3	18.3	13.3	2,252,130,666	1,636,794,418
Sandy River - Zigzag River to Bull Run River OR_SR_1708000104_02_103608	216.9	16.3	13.3	8,650,110,708	7,058,065,792

In accordance with OAR 340-042-0040(4)(e), the excess load calculation evaluates, to the extent existing data allow, the difference between the actual pollutant load in a waterbody and the loading capacity of that waterbody.

Because flow monitoring data were not available at most temperature monitoring locations, it was not possible to calculate the excess load. Instead, the excess ~~temperatures~~temperature and percent load reduction were calculated for each assessment unit where temperature data were available (Table 8.2). The excess ~~temperatures are~~temperature is the maximum difference between the monitored ~~7dadm~~7DADM river ~~temperatures~~temperature and sum of the applicable numeric ~~criteria~~criterion plus the human use allowance. The percent load reduction represents the portion of the actual thermal loading that must be reduced to attain the TMDL loading capacity. The percent load reduction can be calculated from the excess temperature and is mathematically equal to the percent load reduction calculated from the excess load. This is because the river flow rate used to calculate a thermal load is the same number in the numerator and denominator and is cancelled out when calculating the percent reduction. The percent load reductions (Table 8.2) were calculated from temperatures ~~measured~~ in degrees Celsius~~ with reduction to thermal loading that is should also be measured and~~. Load reductions calculated from future monitoring should also be derived from temperatures ~~measured~~ in degrees Celsius ~~(rather than Fahrenheit or Kelvin).~~if making comparisons to the values in Table 8.2.

Table 8.2 Excess temperature and percent load reduction for various assessment units in the Lower Columbia-Sandy Subbasin.

Assessment Unit Name	Assessment Unit ID	Maximum 7DADM River Temperature (°C)	Applicable Criterion + HUA (°C)	Excess Temperature (°C)	Percent Load Reduction
Clear Fork	OR_SR_1708000101_02_103596	14.7	13.3	1.4	9.2
Clear Fork	OR_SR_1708000101_02_103596	14.9	16.3	0.0	0.0
Clear Creek	OR_SR_1708000101_02_103597	17.4	13.3	4.1	23.5
Clear Creek	OR_SR_1708000101_02_103597	17.8	16.3	1.5	8.2
Lost Creek	OR_SR_1708000101_02_103598	13.6	13.3	0.3	2.1
Lost Creek	OR_SR_1708000101_02_103598	15.2	16.3	0.0	0.0
Sandy River	OR_SR_1708000101_02_103599	19.4	13.3	6.1	31.5
Sandy River	OR_SR_1708000101_02_103599	20.1	16.3	3.8	19.0
Zigzag River	OR_SR_1708000102_02_103600	13.9	13.3	0.6	4.3
Zigzag River	OR_SR_1708000102_02_103600	15.7	16.3	0.0	0.0
Still Creek	OR_SR_1708000102_02_103601	16.0	13.3	2.7	16.8
Still Creek	OR_SR_1708000102_02_103601	16.3	16.3	0.0	0.2
Zigzag River	OR_SR_1708000102_02_103602	12.1	13.3	0.0	0.0
Zigzag River	OR_SR_1708000102_02_103602	12.5	16.3	0.0	0.0
Salmon River	OR_SR_1708000103_02_103605	11.4	16.3	0.0	0.0
Salmon River	OR_SR_1708000103_02_103606	19.7	13.3	6.4	32.6
Salmon River	OR_SR_1708000103_02_103606	21.0	16.3	4.7	22.3
Cedar Creek	OR_SR_1708000104_02_103607	19.7	18.3	1.4	6.9
Sandy River	OR_SR_1708000104_02_103608	19.3	13.3	6.0	31.2
Sandy River	OR_SR_1708000104_02_103608	19.5	16.3	3.2	16.3
Little Sandy River	OR_SR_1708000105_11_103609	19.1	13.3	5.8	30.3
Little Sandy River	OR_SR_1708000105_11_103609	22.2	16.3	5.9	26.6

South Fork Bull Run River	OR_SR_1708000105_11_103610	18.3	16.3	2.0	10.9
Bull Run River	OR_SR_1708000105_11_103611	20.6	13.3	7.3	35.4
Bull Run River	OR_SR_1708000105_11_103611	21.1	16.3	4.8	22.6
Bull Run River	OR_SR_1708000105_11_103688	17.8	16.3	1.5	8.4
Beaver Creek	OR_SR_1708000107_02_103612	20.1	13.3	6.8	33.8
Beaver Creek	OR_SR_1708000107_02_103612	27.8	18.3	9.5	34.2
Gordon Creek	OR_SR_1708000107_02_103615	13.3	13.3	0.0	0.0
Gordon Creek	OR_SR_1708000107_02_103615	19.2	18.3	0.9	4.5
Sandy River	OR_SR_1708000107_02_103616	14.5	13.3	1.2	8.2
Sandy River	OR_SR_1708000107_02_103616	23.2	18.3	4.9	21.2
Columbia River (upstream from Multnomah Creek)	OR_SR_1708000108_88_100673	23.1	20.3	2.8	12.1
HUC12 Name: Upper Salmon River	OR_WS_170800010302_02_103640	15.7	16.3	0.0	0.0
HUC12 Name: Wildcat Creek-Sandy River	OR_WS_170800010401_02_103643	16.5	13.3	3.2	19.3
HUC12 Name: Wildcat Creek-Sandy River	OR_WS_170800010401_02_103643	15.5	16.3	0.0	0.0
HUC12 Name: Upper Bull Run River	OR_WS_170800010502_11_103647	7.0	16.3	0.0	0.0
HUC12 Name: Middle Bull Run River	OR_WS_170800010503_11_103648	16.9	16.3	0.6	3.6
HUC12 Name: Little Sandy River	OR_WS_170800010505_11_103669	24.2	16.3	7.9	32.5
HUC12 Name: Lower Bull Run River	OR_WS_170800010506_11_103650	17.6	16.3	1.3	7.5
HUC12 Name: Gordon Creek	OR_WS_170800010701_02_103651	13.0	16.3	0.0	0.0
HUC12 Name: Beaver Creek-Sandy River	OR_WS_170800010703_02_103703	21.4	13.3	8.1	37.8
HUC12 Name: Beaver Creek-Sandy River	OR_WS_170800010703_02_103703	26.2	18.3	7.9	30.0
HUC12 Name: Tanner Creek-Columbia River	OR_WS_170800010801_15_103707	18.1	13.3	4.8	26.3
HUC12 Name: Tanner Creek-Columbia River	OR_WS_170800010801_15_103707	18.9	16.3	2.6	13.9
HUC12 Name: Woodard Creek-Columbia River	OR_WS_170800010802_15_103653	17.5	18.3	0.0	0.0
HUC12 Name: Bridal Veil Creek-Columbia River	OR_WS_170800010803_15_103654	19.9	18.3	1.6	8.1

9. Allocations, reserve capacity, and margin of safety

OAR 340-042-0040(4)(g),(h),(i) and (k) [and 40 CFR 130.2(h) and (g) and 130.7(c)() (1) and (2)] respectively define the required TMDL elements of apportionment of the allowable pollutant load: point source wasteload allocations; nonpoint source load allocations (including background); margin of safety; and, reserve capacity. Collectively, these elements add up to the maximum pollutant load that still allows a waterbody to meet water quality standards. OAR 304-042-0040(5) and (6) describe the potential factors of consideration for determining and distributing these allocations of the pollutant loading capacities. Water quality data analysis must be conducted to determine allocations, potentially including statistical analysis and mathematical modeling. Factors to consider in allocation distribution may include: source contributions; costs of implementing management measures; ease of implementation; timelines for attaining water quality standards; environmental impacts of allocations; unintended consequences; reasonable assurance of implementation; and, any other relevant factor.

9.1. Thermal Allocations

~~[Add discussion of allocation scenarios, with reference to TPSD, relevant factors considered in distribution and surrogate measures… Include assumptions and requirements, as needed]~~

~~[Add a section on seasonal variation and critical conditions if this is not a section earlier in the document because it influenced modeling decisions]~~

~~[Include discussion of HUA and how applied in the allocation tables.]~~

Table 9.1 Sandy River human use allowance allocations

Portion of Human Use Allowance (°C)	Source or source category
0.13*	NPDES point sources
0.05	Dam and reservoirs
0.05	Water management activities and water withdrawals
0.02	Solar loading from existing transportation corridors, existing buildings, and existing utility infrastructure
0.00	Solar loading from other NPS sectors
0.05	Reserve capacity
0.30	**Total**
Note: * NPDES permitted point sources discharging to the Sandy River are each allowed up to 0.07°C at the point of discharge and 0.13°C cumulatively at the point of maximum impact.	

Table 9.2 Bull Run River human use allowance allocations

Portion of Human Use Allowance (°C)	Source or source category
0.00	NPDES point sources
0.30	City of Portland Bull Run dam and reservoir operations
0.00	Other anthropogenic nonpoint sources
0.00	Reserve capacity
0.30	**Total**

Table 9.3 Cedar Creek Human Use Allowance allocations

Portion of Human Use Allowance (°C)	Source or source category
0.30	ODFW Sandy River Fish Hatchery
0.00	Anthropogenic Nonpoint sources
0.00	Reserve capacity
0.30	**Total**

Table 9.4 Camp Creek Human Use Allowance allocations

Portion of Human Use Allowance (°C)	Source or source category
0.20	Government Camp STP
0.05	Water management activities and water withdrawals
0.02	Solar loading from existing transportation corridors, existing buildings, and existing utility infrastructure
0.00	Other anthropogenic nonpoint source sectors
0.03	Reserve capacity
0.30	**Total**

Table 9.5 Human Use Allowance allocations for all other waterbodies in the Lower Columbia-Sandy Subbasin

Portion of Human Use Allowance (°C)	Source or source category
0.00	NPDES point sources
0.05	Water management activities and water withdrawals
0.02	Solar loading from existing transportation corridors, existing buildings, and existing utility infrastructure
0.00	Solar loading from other nonpoint sectors
0.23	Reserve capacity
0.30	**Total**

9.1.1. Thermal wasteload allocations for point sources

Waste load allocations for the NPDES permitted point sources listed in Table 9.6 were calculated using **Equation 2**.

The wasteload allocation for registrants under the general stormwater permits (MS4, 1200-A, 1200-C and 1200-Z) is equal to any existing thermal load authorized under the current permit.

For all general wastewater and stormwater NPDES permits, more specific wasteload allocations can be considered, if subsequent data and evaluation demonstrates a need and if capacity is available.

$$WLA = (\Delta T) \cdot (Q_E + Q_R) \cdot C_F \qquad \textbf{Equation 2}$$

where,

$WLA =$ Waste load allocation (kilocalories/day).

$\Delta T =$ The maximum temperature increase (°C) above the applicable river temperature criterion using 100% of river flow not to be exceeded by each individual source from all outfalls combined.

$Q_E =$ The daily mean effluent flow (cfs).
When effluent flow is in million gallons per day (MGD) covertconvert to cfs: 1.5472

$$\cancel{\frac{1\ million\ gallons}{1\ day} \cdot \frac{1.5472\ ft^3}{1\ million\ gallons} = 1.5472}\ \frac{1{,}000{,}000\ gallons}{1\ day} \cdot \frac{0.13368 ft^3}{1\ gallon} \cdot \frac{1\ day}{86{,}400\ sec} = 1.5472$$

$Q_R =$ The daily mean river flow rate, upstream (cfs).
When river flow is <= 7Q10, Q_R = 7Q10. When river flow > 7Q10, Q_R is equal to the daily mean river flow, upstream.

$C_F =$ Conversion factor using flow in cubic feet per second (cfs): 2,446,665

$$\cancel{\frac{1\ ft^3}{1\ sec} \cdot \frac{1\ m^3}{35.31\ ft^3}}\ \frac{1\ m^3}{35.31\ ft^3} \cdot \frac{1000\ kg}{1\ m^3} \cdot \frac{86400\ sec}{1\ day} \cdot \frac{1\ kcal}{1\ kg \cdot 1°C} = 2{,}446{,}665$$

Table 9.6 Thermal waste load allocations for point sources

NPDES Permittee WQ File# : EPA Number	Allocated Human Use Allowance (°C)	Applicable Criterion (°C)	WLA period start	WLA period end	Annual 7Q10 River flow (cfs)	Effluent discharge (cfs)	Minimum WLA (kcals/day)
Government Camp STP 34136 : OR0027791	0.20	16.0 13.0	~~6~~5/1	10/31	5.6	0.4	2,935,998
Hoodland STP (WES) 89941 : OR0031020	0.07	16.0 13.0	~~6~~5/1	10/31	80.3	1.4	13,992,477
City of Troutdale WPCF 39750 : OR0020524	0.07	18.0 13.0	~~6~~5/1	10/31	277.3	4.6	48,280,040
City of Sandy WWTP 78615 : OR0026573	0.07	18.0 13.0	~~6~~5/1	10/31	~~56.5~~215.9	1.9	~~10,001,967~~ 37,301,855
ODFW Sandy River Fish Hatchery 64550 : ORG130009	0.30*	18.0 13.0	~~6~~5/1	10/31	4.9	3.5	6,165,596

Notes: Applicable criterion = Biologically-based numeric criteria WLA = waste load allocation; kcals/day = kilocalories/day
* When the minimum duties provision at OAR 340-041-0028(12)(a) applies, ODFW Sandy River Fish Hatchery ΔT = 0.0 and the WLA = 0 kilocalories/day.

The effluent discharge used to calculate the waste load allocations presented in Table 9.6 are based on the average dry weather facility design flow for all facilities except the ODFW Sandy River Fish Hatchery. The effluent discharge flow for the ODFW Sandy River Fish Hatchery is the maximum effluent discharge characterized from discharge data provided by ODFW. Average dry weather facility design flows were obtained from the current NPDES permit or permit evaluation report.

Wasteload allocations in Table 9.6 may be implemented in NPDES permits in any of the following ways: 1) incorporating the minimum wasteload allocation as a static numeric limit. Permit writers may recalculate the limit using ~~using~~ different values for 7Q10 (Q_R), and effluent flow (Q_E), if better estimates are available. 2) incorporating **Equation 2** directly into the permit with effluent flow (Q_E), river flow (Q_R), and the wasteload allocation (WLA) being dynamic and calculated on a daily basis.

9.1.2. Thermal load allocations for nonpoint sources

Load allocations for nonpoint sources were calculated using Equation 3.

$$LA = (\Delta T) \cdot (Q_R) \cdot C_F$$ **Equation 3**

where,

$LA =$ Load allocation (kilocalories/day).

$\Delta T =$ The maximum allowed temperature increase (°C). When the minimum duties provision at OAR 340-041-0028(12)(a) applies, ΔT = 0.0. For background nonpoint sources, ΔT = applicable temperature criteria.

$Q_R =$ The daily average river flow rate (cfs).

$C_F =$ Conversion factor using flow in cubic feet per second (cfs): 2,446,665

$$\cancel{\frac{1\,ft^3}{1\,sec}} \cdot \cancel{\frac{1\,m^3}{35.31\,ft^3}} \frac{1\,m^3}{35.31\,ft^3} \cdot \frac{1000\,kg}{1\,m^3} \cdot \frac{86400\,sec}{1\,day} \cdot \frac{1\,kcal}{1\,kg \cdot 1°C} = 2{,}446{,}665$$

The load allocations presented in Table 9.7 through Table 9.11 were calculated based on the 7Q10 low river flows. Equation 3 may be used to calculate the load allocations when river flows are greater than 7Q10. Equation 3 may also be used to calculate the load allocations for background nonpoint sources if in the future the applicable temperature criteria are updated and approved by EPA.

Table 9.7 presents the minimum load allocation for background sources on temperature impaired category 5 assessment units that have a current NPDES discharge within the assessment unit extent; or the assessment unit was modeled for the TMDL analysis.

Table 9.7 Thermal load allocations for background sources.

Assessment Unit	Annual 7Q10 flow (cfs)	Applicable criterion (°C)	LA period start	LA period end	Minimum Load Allocation – Non Spawning (kilocalories/day)	Minimum Load Allocation – Spawning (kilocalories/day)
Bull Run River - Bull Run Reservoir Number Two to confluence with Sandy River OR_SR_1708000105_11_103611	3.6	16.0 13.0	5/1	11/15	140,927,904	114,503,922
Cedar Creek - Beaver Creek to confluence with Sandy River OR_SR_1708000104_02_103607	4.9	18.0	~~6~~5/1	10/31	215,795,853	NA
Salmon River - South Fork Salmon River to confluence with Sandy River OR_SR_1708000103_02_103606	174	16.0 13.0	~~6~~5/1	10/31	6,811,515,360	5,534,356,230
Sandy River - Bull Run River to confluence with Columbia River OR_SR_1708000107_02_103616	277.3	18.0 13.0	~~6~~5/1	10/31	12,212,283,681	8,819,982,659
Sandy River - Clear Fork to Zigzag River OR_SR_1708000101_02_103599	50.3	18.0 13.0	~~6~~5/1	10/31	2,215,210,491	1,599,874,244
Sandy River - Zigzag River to Bull Run River OR_SR_1708000104_02_103608	216.9	16.0 13.0	~~6~~5/1	10/31	8,490,906,216	6,898,861,301
Notes: Applicable criterion = Biologically-based numeric criteria (to protect cold water fish); LA = load allocation; kcals/day = kilocalories/day						

Table 9.8 through Table 9.10 presents the minimum load allocation for anthropogenic nonpoint sources on the Sandy River, Bull Run River, and Cedar Creek. The allocated portion of the human use allowance (ΔT) presented in Table 9.1 through Table 9.3 were used in Equation 3 to calculate the load allocation for each nonpoint source or source category. Other nonpoint sources with thermal loads to waters not listed in Table 9.8 through Table 9.10 shall use

Equation 3 and the allocated portion of the human use allowance presented in Table 9.4 and Table 9.5 to calculate the load allocation.

Table 9.8 Thermal load allocations for anthropogenic nonpoint sources on the Sandy River.

Nonpoint source or source category	Annual 7Q10 (cfs)	Allocated HUA (deg-C)	Load Allocation Period Start	Load Allocation Period End	Minimum Load Allocation (kilocalories/day)
City of Portland Bull Run Dam and Reservoir operations	277.3	0.05	~~6~~5/1	10/31	33,923,010
Diversions and water withdrawal activities	277.3	0.05	~~6~~5/1	10/31	33,923,010
Anthropogenic solar loading from existing buildings and existing transportation or utility corridors	277.3	0.02	~~6~~5/1	10/31	13,569,204
Other anthropogenic nonpoint sectors	277.3	0.00	~~6~~5/1	10/31	0.0

Table 9.9 Thermal load allocations for anthropogenic nonpoint sources on the Bull Run River.

Nonpoint source or source category	Annual 7Q10 (cfs)	Allocated HUA (deg-C)	Load Allocation Period Start	Load Allocation Period End	Minimum Load Allocation (kilocalories/day)
City of Portland Bull Run Dam and Reservoir Operations	3.6	0.30	5/1	11/15	2,642,398
Other anthropogenic nonpoint sources	3.6	0.00	5/1	11/15	0

Table 9.10 Thermal load allocations for anthropogenic nonpoint sources on Cedar Creek.

Nonpoint source or source category	Annual 7Q10 (cfs)	Allocated HUA (deg-C)	Load Allocation Period Start	Load Allocation Period End	Minimum Load Allocation (kilocalories/day)
All anthropogenic nonpoint sources	4.8	0.00	5/1	10/31	0

9.1.2.1. Surrogate Measures

EPA regulations (40 CFR 130.2(i)) and OAR 340-042-0040(O)(5)(b) allow for TMDLs to utilize other appropriate measures (or surrogate measures). This section presents surrogate measures that implement the load allocatons.

~~DEQ Effective shade is a combination of topographic and vegetative shading that blocks direct exposure of the stream to the sun. Effective shade was estimated…[~~

9.1.2.1.1. City of Portland Bull Run Drinking Water and Hydroelectric Project

The City of Portland Bull Run drinking water and hydroelectric project has been allocated 0.3 °C of the human use allowance (Table 9.2) and the equivalent load allocation on the Bull Run River (Table 9.9). Monitoring stream temperature, rather than a thermal load, is often a more useful and meaningful approach for reservoir management. For this reason, DEQ is using a surrogate measure to implement the load allocation. OAR 340-042-0028(12)(a) states that anthropogenic sources are only responsible for controlling the thermal effects of their own discharge or activity in accordance with its overall heat contribution. For dam and reservoir operations, the minimum duties provision means that when 7-day average daily maximum temperatures upstream of the reservoirs exceed the applicable criteria plus the human use allowance the dam and reservoir operations must not contribute any additional warming above and beyond those upstream temperatures entering the reservoir. DEQ has developed a surrogate measure temperature target that implements this approach. The compliance point is at the lamprey barrier just downstream Reservoir #2.

The surrogate measure temperature target is the higher of either:

a) The estimated free flowing (no dam) ~~7dadm~~7DADM temperatures at the lamprey barrier; or

b) ~~The~~ The allocated portion of the human use allowance (0.3 deg-C) plus the most restrictive applicable temperature criteria in the Bull Run River ~~downstream of~~between Reservoir #2 ~~plus the allocated portion of the human use allowance (0.3 deg-C).~~ and the confluence of the Bull Run River and Sandy River. If the applicable temperature criteria in this reach are updated and approved by EPA, the updated criteria and period when they apply shall be used instead.

I. 16.3 °C June 16 - August 14
II. 13.3 °C May 1 through June 15 and August 15 through November 15.

The transition to the 13 deg-C spawning use varies spatially and temporally in the Bull Run River. To be protective of these downstream spawning uses DEQ used the most restrictive temporal period to determine when to apply the spawning criterion for the surrogate measure target.

DEQ developed a regression equation (**Equation 4**) to predict the free flowing (no dam) daily maximum temperatures at the lamprey barrier. The methodology and data for development of the regression is documented in the Lower Columbia-Sandy technical support document. With DEQ approval, an alternative approach may be used to calculate the surrogate measure if that approach demonstrates improved goodness of fit relative to **Equation 4**. The CE-QUAL-W2 model may also be used.

$$T_{Max} = 0.1405173 + 1.1572642\overline{T_{LS}} + -0.3588068 \log \overline{Q_{LS}} + \left(\frac{3.7557135 + 1.1668769T_{dLS} + -0.5969993 \log \overline{Q_{LS}}}{2}\right)$$ **Equation 4**

Where,

$T_{Max} =$ The no dam daily maximum stream temperature at the lamprey barrier downstream of Reservoir #2.

$\overline{T_{LS}} =$ The daily mean temperature (ºC) at USGS Gage 14141500 Little Sandy River Near Bull Run.

$\overline{Q_{LS}} =$ The mean daily discharge (cfs) at USGS Gage 14141500 Little Sandy River Near Bull Run.

$T_{dLS} =$ The daily temperature range (ºC) calculated as the daily maximum minus the daily minimum at USGS Gage 14141500 Little Sandy River Near Bull Run.

9.1.2.1.2. Site specific effective shade surrogate measure

Effective shade surrogate measure targets shown in Table 9.11 represent the arithmetic mean of the shade values at all model nodes assigned to each designated management agency (**Equation 5**). Following the process and methods outlined in the water quality management plan, current or target site specific shade values shall be calculated using **Equation 5**. Changes in the target effective shade may result in redistribution of the sector or source responsible for excess load reduction. If the shade target increases, the equivalent portion of the excess load is reassigned from background sources to nonpoint sources. If the shade target decreases, the portion of the excess load is reassigned from nonpoint sources to background sources. The exact portion reassigned can only be determined in locations where temperature models have been developed. In locations without temperature models, the reassignment remains unquantified. Changes to the target effective shade do not impact the loading capacity, human use allowance, or the load allocations. They remain the same as presented in this TMDL.

$$\overline{ES} = \frac{\sum ES_{n_i}}{n_i}$$ **Equation 5**

Where,

$\overline{ES} =$ The mean effective shade for designated management agency *i.*

$\sum ES_{n_i} =$ The sum of effective shade from all model nodes or measurement points assigned to designated management agency *i.*

$n_i =$ Total number of model nodes or measurement points assigned to designated management agency *i.*

Table 9.11 Shade surrogate measure targets to meet nonpoint source load allocations on model stream extents

~~Designated Management Agency~~	~~Stream Name~~	~~Current Shade~~	~~TMDL Target~~	~~Shade Gap~~
~~Clackamas County~~	~~Salmon River~~	~~24~~	~~37~~	~~13~~
~~Oregon Department of Forestry - Private~~	~~Salmon River~~	~~26~~	~~40~~	~~14~~
~~Oregon Department of Transportation~~	~~Salmon River~~	~~10~~	~~48~~	~~38~~

~~U.S. Bureau of Land Management~~	~~Salmon River~~	~~26~~	~~35~~	~~9~~
~~U.S. Forest Service~~	~~Salmon River~~	~~49~~	~~59~~	~~10~~
~~Water~~	~~Salmon River~~	~~26~~	~~40~~	~~14~~
~~City of Portland~~	~~Sandy River~~	~~8~~	~~12~~	~~4~~
~~City of Sandy~~	~~Sandy River~~	~~23~~	~~25~~	~~2~~
~~City of Troutdale~~	~~Sandy River~~	~~13~~	~~18~~	~~5~~
~~Clackamas County~~	~~Sandy River~~	~~18~~	~~27~~	~~9~~
~~Multnomah County~~	~~Sandy River~~	~~16~~	~~19~~	~~3~~
~~Oregon Department of Agriculture~~	~~Sandy River~~	~~24~~	~~28~~	~~4~~
~~Oregon Department of Fish and Wildlife~~	~~Sandy River~~	~~22~~	~~26~~	~~4~~
~~Oregon Department of Forestry - Private~~	~~Sandy River~~	~~19~~	~~23~~	~~4~~
~~Oregon Parks and Recreation Department~~	~~Sandy River~~	~~6~~	~~7~~	~~1~~
~~Port of Portland~~	~~Sandy River~~	~~3~~	~~9~~	~~6~~
~~State of Oregon~~	~~Sandy River~~	~~13~~	~~17~~	~~4~~
~~U.S. Bureau of Land Management~~	~~Sandy River~~	~~25~~	~~29~~	~~4~~
~~U.S. Forest Service~~	~~Sandy River~~	~~3~~	~~6~~	~~3~~
~~U.S. Government~~	~~Sandy River~~	~~16~~	~~18~~	~~2~~

Designated Management Agency	**Stream Name**	**Current Shade**	**TMDL Target**	**Shade Gap**
Multiple	Little Sandy River	64	69	5
Multiple	Zigzag River	46	60	14
Clackamas County	Salmon River	24	37	13
Oregon Department of Forestry - Private	Salmon River	26	40	14
Oregon Department of Transportation	Salmon River	10	48	38
U.S. Bureau of Land Management	Salmon River	26	35	9
U.S. Forest Service	Salmon River	49	59	10
City of Portland	Sandy River	8	12	4
City of Sandy	Sandy River	23	25	2
City of Troutdale	Sandy River	13	18	5
Clackamas County	Sandy River	18	27	9

Multnomah County	Sandy River	16	19	3
Oregon Department of Agriculture	Sandy River	24	28	4
Oregon Department of Fish and Wildlife	Sandy River	22	26	4
Oregon Department of Forestry - Private	Sandy River	19	23	4
Oregon Parks and Recreation Department	Sandy River	6	7	1
Port of Portland	Sandy River	3	9	6
State of Oregon	Sandy River	13	17	4
U.S. Bureau of Land Management	Sandy River	25	29	4
U.S. Forest Service	Sandy River	3	6	3
U.S. Government	Sandy River	16	18	2

9.1.2.1.1. General effective shade curve surrogate measure

Effective shade curves are applicable to any stream that does not have site specific shade targets (Section 9.1.2.1.2). Effective shade curves represent the maximum possible effective shade for a given vegetation type. The values presented in Figure 9.1 to Figure 9.4 and ~~Table 9.12 to Table 9.15~~Table 13.1 to Table 13.5 represent the mean effective shade target for different composite vegetation types, stream aspects, and active channel widths. The vegetation height, density, overhang, and buffer width used for each vegetation type is summarized in Table 9.12. See the technical support document, Appendix B for the methodology used to determine restored vegetation heights and densities and their distribution.

Local geology, geography, soils, climate, legacy impacts, natural disturbance rates, and other natural factors may prevent effective shade from reaching the target effective shade. No enforcement action will be taken by DEQ for reductions in effective shade caused by natural disturbances.

Table 9.12. Vegetation height, density, overhang, and horizontal distance buffer widths used to derive generalized effective shade curve targets.

Landcover Code	Vegetation Type	Height (m)	Height (feet)	Density (%)	Overhang (m)	Buffer Width (m)
348	Mixed Conifer/Hardwood - High Density	26.7	87.6	60%	3.3	36.8
550	Mixed Conifer/Hardwood - Medium Density	26.7	87.6	30%	3.3	36.8
600	Hardwood - High Density	20.1	65.9	75%	3.0	36.8
700	Conifer - High Density	35.1	115.2	60%	3.5	36.8

750	Conifer - Low Density	35.1	115.2	30%	3.5	36.8

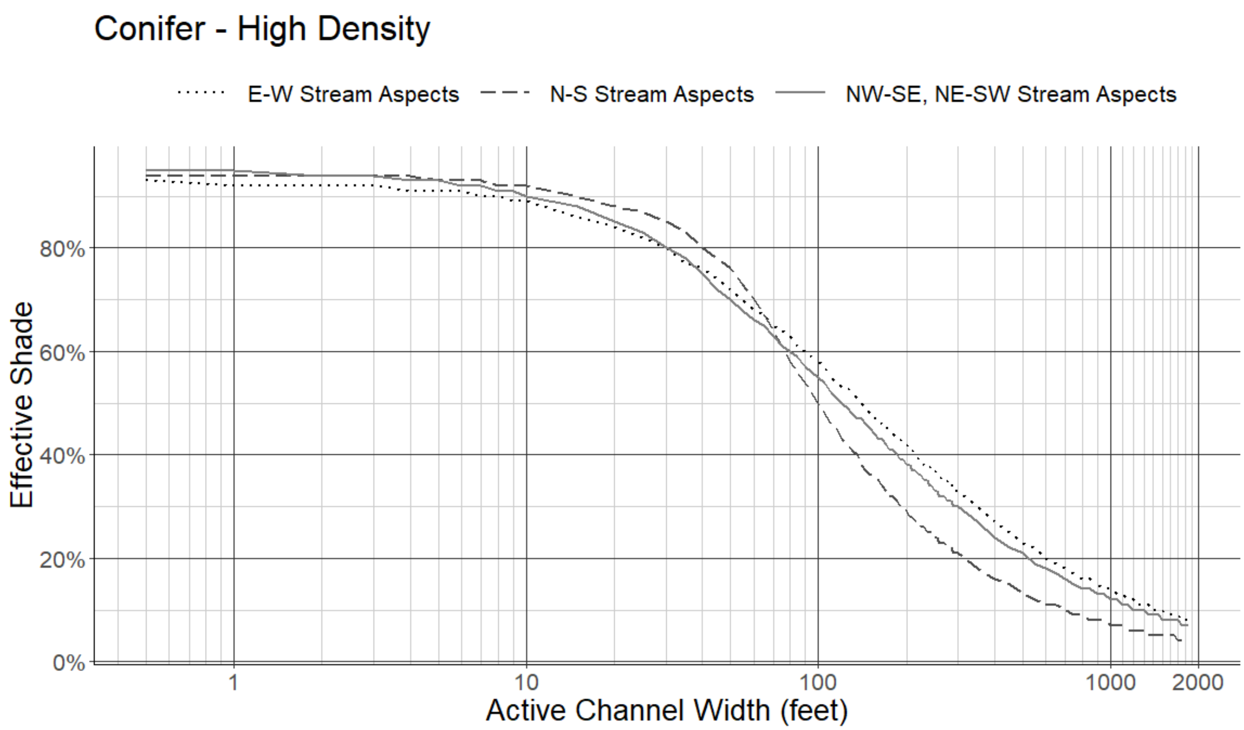


Figure 9.1. Effective shade targets for high density conifer dominated stream sites.

~~Table~~

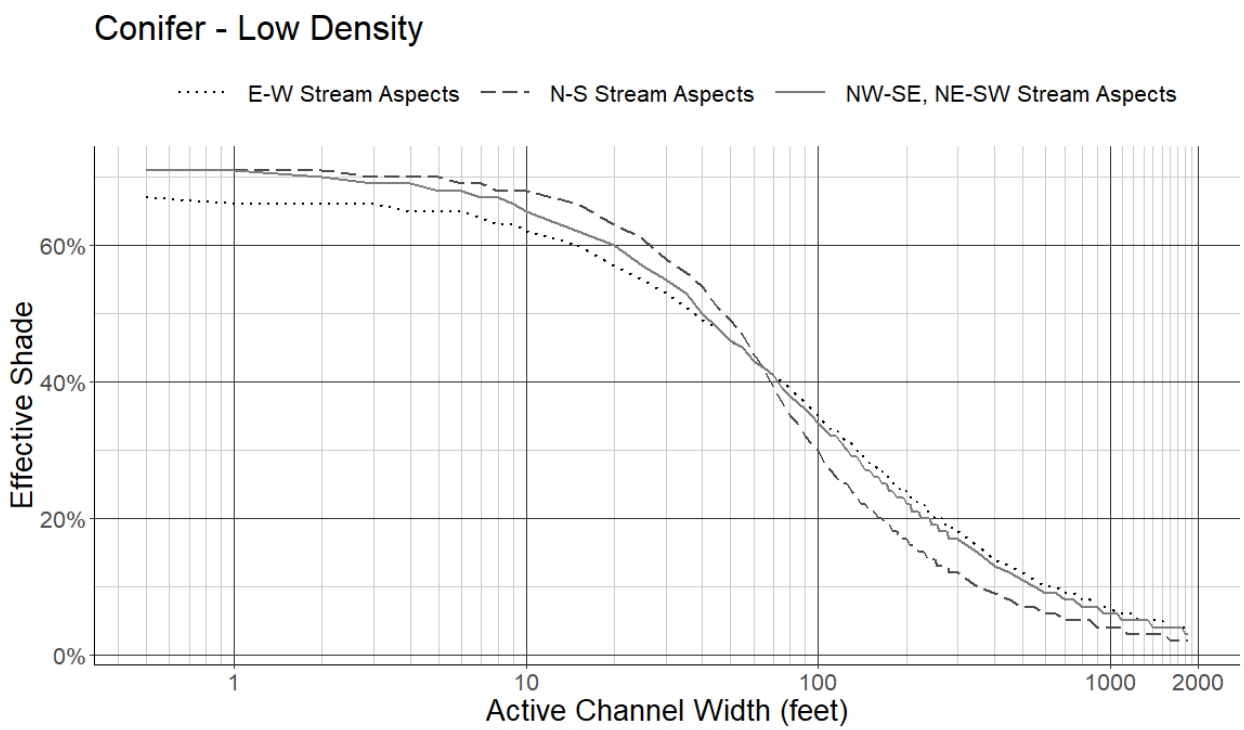


Figure 9.2. Effective shade targets for low density conifer dominated stream sites.

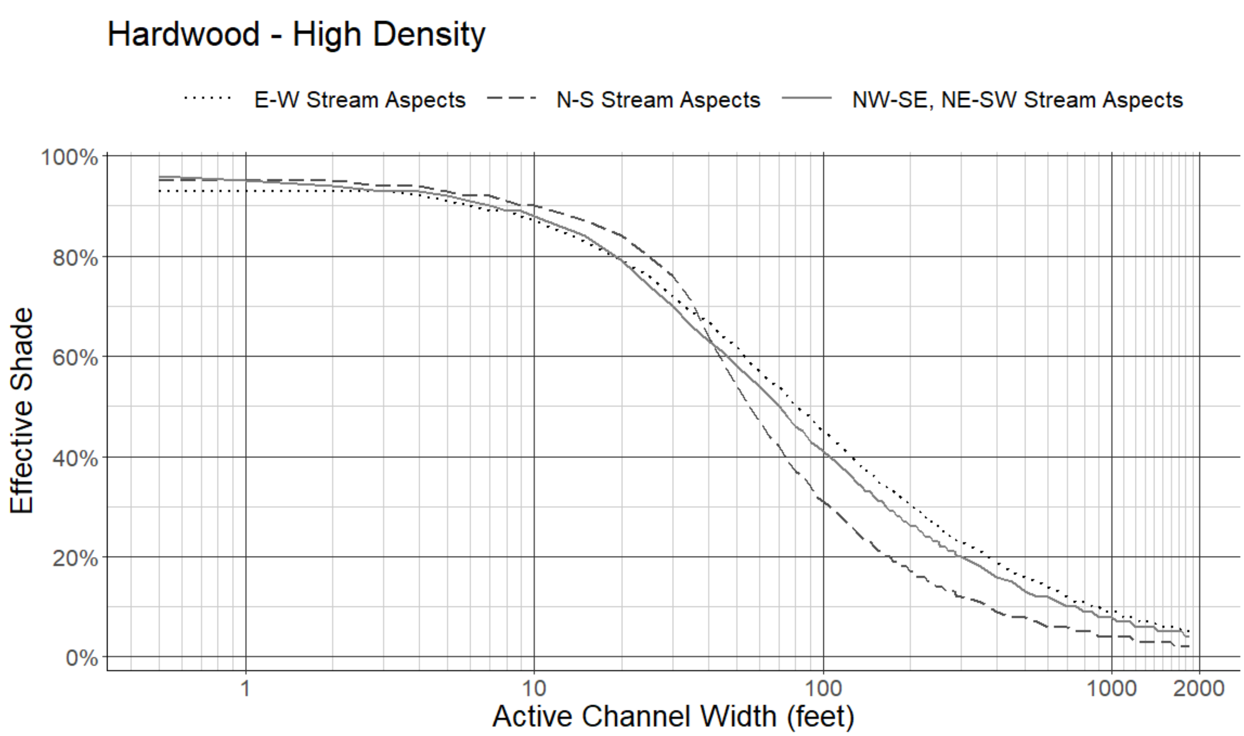


Figure 9.3. Effective shade targets for high density hardwood dominated stream sites.

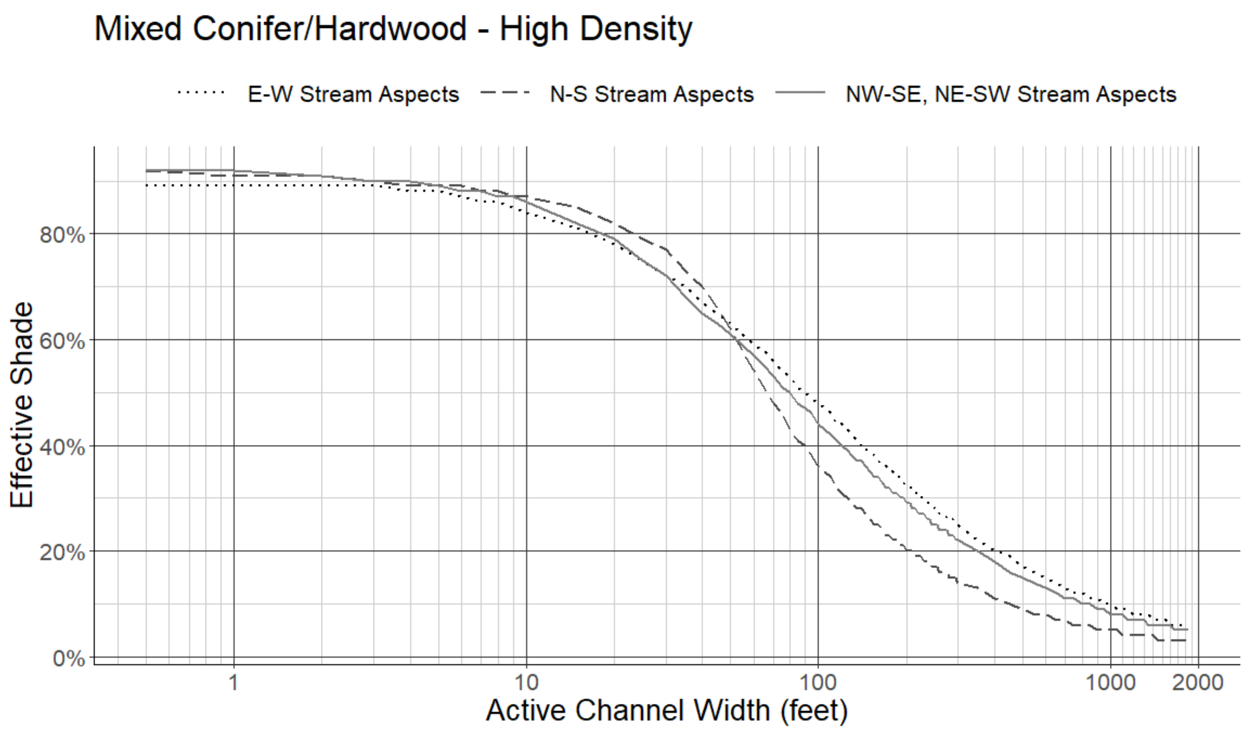


Figure 9.4. Effective shade targets for high density mixed conifer and hardwood stream sites.

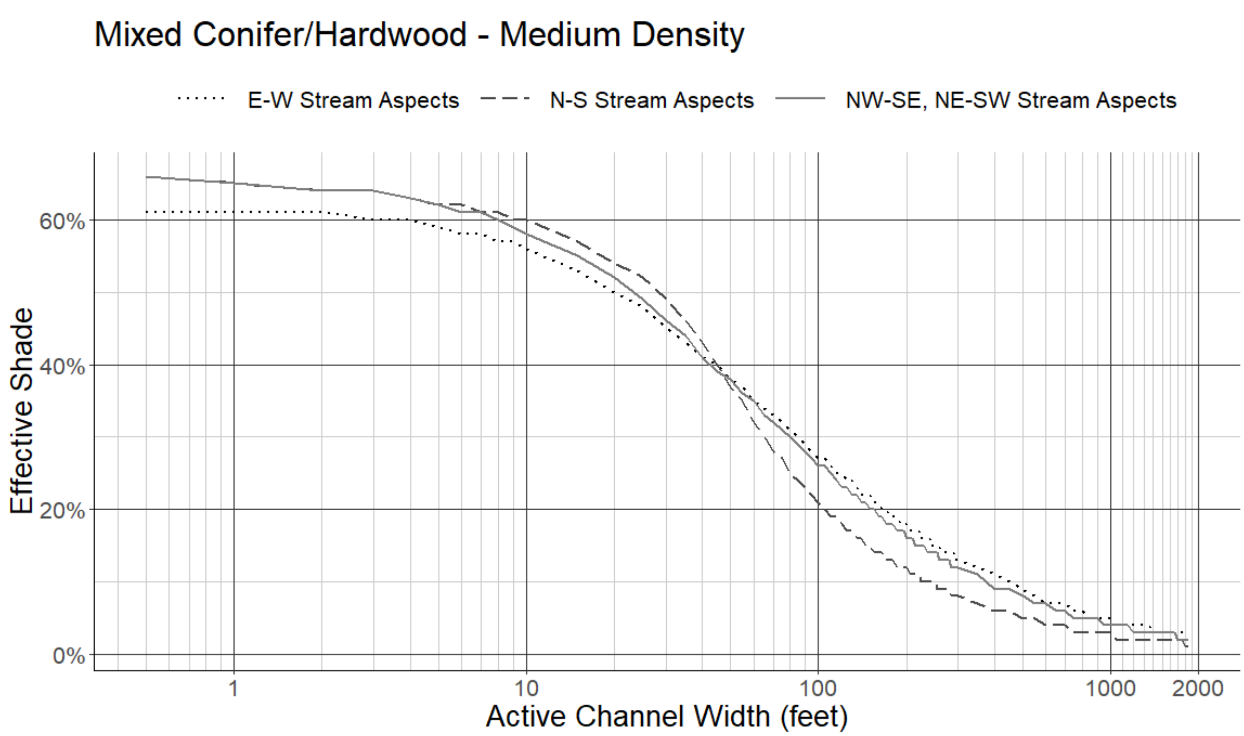


Figure 9.5. Effective shade targets for medium density mixed conifer and hardwood stream sites.

9.1.2.1.2. Percent flow rate reduction surrogate measure

Table 9.13 Target maximum percent flow rate reduction relative to the median natural flow at the stated reference flow monitoring site.

Maximum percent flow rate reduction	Reference Monitoring Site
1.75	USGS 14142500 – Sandy River below Bull Run

9.1.3. Reserve capacity

Explicit allocations for reserve capacity have been set aside for use by either point or nonpoint sources to provide an allocation to new or increased thermal loads, or to any existing source that may not have been identified during the development of this TMDL. The portion of the human use allowance associated with the reserve capacity is described in Table 9.1 through Table 9.5.

9.2. Margin of safety

CFR 130.7(c)(1), and OAR 340-042-0040(4)(i). require a TMDL include a margin of safety. The margin of safety accounts for lack of knowledge or uncertainty. This may result from limited data; an incomplete understanding of the exact magnitude or quantity of thermal loading from various sources; or the actual effect controls will have on loading reductions and receiving. The margin of safety is intended to account for such uncertainties in a manner that is conservative and will result in environmental protection. A margin of safety can be achieved through two approaches: (1) implicitly using conservative analytical assumptions to develop allocations, or (2) explicitly specifying a portion of the TMDL loading capacity as a margin of safety.

In the Lower Columbia-Sandy, an implicit margin of safety was used in derivation of the allocations. The primary conservative assumptions include:

- Setting effluent flow rates at average dry weather design flow or a maximum flow obtained from discharge monitoring reports for the model scenario assessing the waste load allocations. It is rare that actual discharges from point sources will reach design flows and sustain that discharge for long periods of time all at the same time.
- Setting effluent temperatures as high as 32 degrees Celsius for the model scenario assessing the waste load allocations. On days when the current thermal load was less than the waste load allocation, the maximum effluent temperatures were increased above the actual temperatures up to either 32 or the effluent temperature that would full utilize the waste load allocation. Actual maximum effluent temperatures are unlikely to get this warm or be sustained over multiple days or weeks.

- The cumulative effects analysis used the maximum increase as the basis for determining attainment of allocations. The maximum increase does not happen more than 5% of the time and the median increase is less. This means that a portion of the loading capacity reserved for human use will go unutilized most of the time.

10. Water quality management plan

As described in OAR 340-042-0040(4)(l)(A)-(O), an associated WQMP is an required element of a TMDL and must include the following components: (A) Condition assessment and problem description; (B) Goals and objectives; (C) Proposed management strategies design to meet the TMDL allocations; (D) Timeline for implementing management strategies; (E) Explanation of how TMDL implementation will attain water quality standards; (F) Timeline for attaining water quality standards; (G) Identification of persons, including Designated Management Agencies, responsible for TMDL implementation; (H) Identification of existing implementation plans; (I) Schedule for submittal of implementation plans and revision triggers; (J) Description of reasonable assurance of TMDL implementation; (K) Plan to monitor and evaluate progress toward achieving TMDL allocations and water quality standards; (L) Plan for public involvement in TMDL implementation; (M) Description of planned efforts to maintain management strategies over time; (N) General discussion of costs and funding for TMDL implementation; and, (O) citation of legal authorities relating to TMDL implementation.

DEQ sought and considered input from various persons, including DMAs, responsible for TMDL implementation and other interested public and prepared the Lower Columbia-Sandy Subbasin WQMP as a stand-alone document. DEQ intends to propose the draft WQMP as an element of Temperature TMDLs for the Lower Columbia-Sandy Subbasin for adoption as rule by the Oregon Environmental Quality Commission.

11. Reasonable assurance

OAR 340-042-0030(9) defines Reasonable Assurance as “a demonstration that a TMDL will be implemented by federal, state or local governments or individuals through regulatory or voluntary actions including management strategies or other controls.” OAR 340-042-0040(4)(l)(J) requires a description of reasonable assurance that management strategies and sector-specific or source-specific implementation plans will be carried out through regulatory or voluntary actions. And as a factor in consideration of allocation distribution among sources, OAR 340-042-0040(6)(g) states that “to establish reasonable assurance that the TMDL’s load allocations will be achieved requires determination that practices capable of reducing the specified pollutant load: (1) exist; (2) are technically feasible at a level required to meet allocations; and (3) have a high likelihood of implementation.” This three point test is consistent with EPA past practice and guidance on determining reasonable assurance and supports federal antidegradation rules and Oregon’s antidegradation policy (OAR 340-041-0004).

Temperature TMDLs for the Lower Columbia-Sandy Subbasin were developed for waters impaired by both point and nonpoint sources, with allocations distributed to sources of thermal loading. It is the state's (and, with TMDL approval, EPA's) best professional judgment as to a reasonable assurance determination that the TMDL's load allocations will be achieved. DEQ employs a six-point accountability framework for reasonable assurance of implementation, as detailed in DEQ's Water Quality Management Plan.

Pollutant reduction strategies are identified in DEQ's Water Quality Management Plan, and more specific strategies will be detailed in each required implementation plan, to be submitted per the timelines in the Water Quality Management Plan. These strategies and actions are comprehensively implemented through a variety of regulatory and non-regulatory programs. Many of these are existing strategies and actions that are already being implemented within the subbasin and demonstrate reduced pollutant loading. These strategies are technically feasible at an appropriate scale in order to meet the allocations. A high likelihood of implementation is demonstrated because DEQ reviews the individual implementation plans and proposed actions for adequacy and establishes a monitoring and reporting system to track implementation and respond to any inadequacies.

The rationale described in this TMDL Rule, TMDL Technical Support Document and Water Quality Management Plan stems from robust evaluations, implements an accountability framework and provides opportunities for adaptive management to maximize pollutant reductions. Together this approach provides reasonable assurance to meet state and federal requirements and attain the goals of the TMDL.

12. References

DEQ (Oregon Department of Environmental Quality). 2005. "Sandy River Basin Total Maximum Daily Load (TMDL)."

DEQ (Oregon Department of Environmental Quality). 2023a. "Draft Lower Columbia-Sandy River Subbasin TMDL Technical Support Document."

DEQ (Oregon Department of Environmental Quality). 2023b. "Draft Lower Columbia-Sandy River Subbasin TMDL Water Quality Management Plan."

~~13~~

13. Appendix of long tables

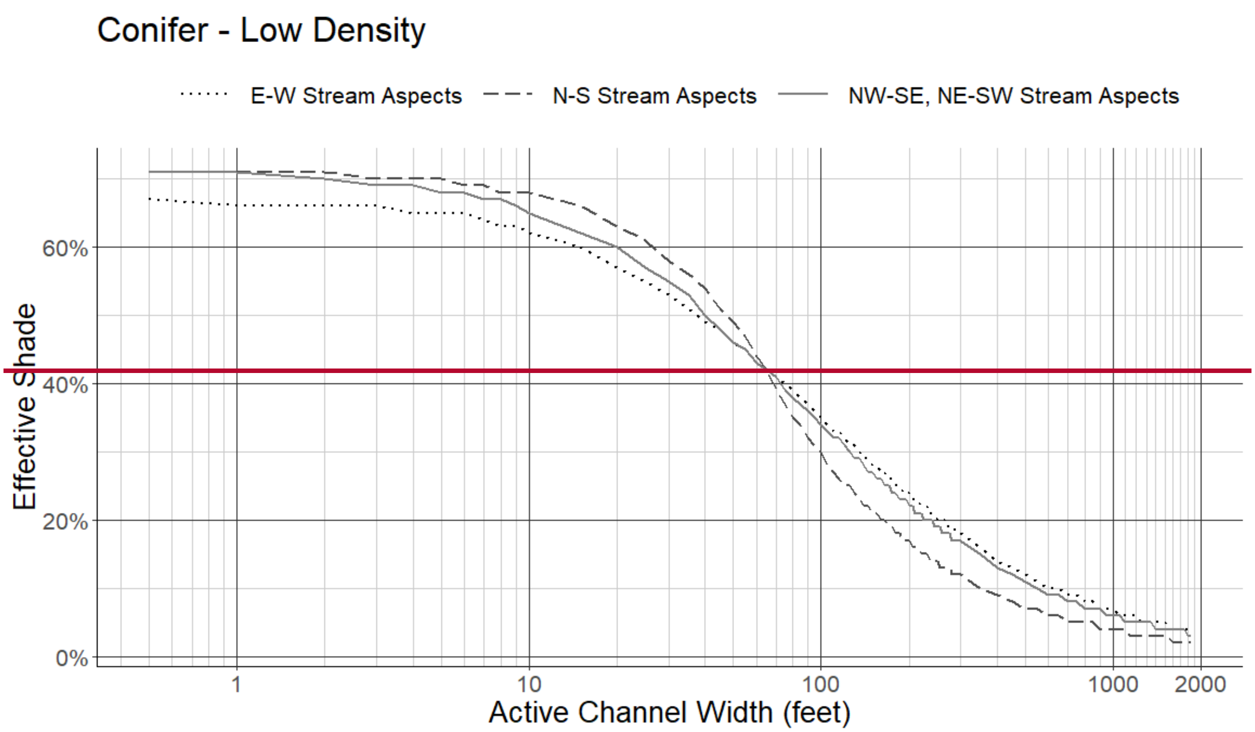
Table 13.1. Effective shade targets for high density conifer dominated stream sites.

Active Channel Width (m)	Active Channel Width (feet)	Effective Shade Target for E-W Stream Aspects	Effective Shade Target for NW-SE, NE-SW Stream Aspects	Effective Shade Target for N-S Stream Aspects
0.2	0.5	93%	95%	94%
0.3	1	92%	95%	94%

Active Channel Width (m)	Active Channel Width (feet)	Effective Shade Target for E-W Stream Aspects	Effective Shade Target for NW-SE, NE-SW Stream Aspects	Effective Shade Target for N-S Stream Aspects
0.6	2	92%	94%	94%
0.9	3	92%	94%	94%
1.2	4	91%	93%	94%
1.5	5	91%	93%	93%
1.8	6	91%	92%	93%
2.1	7	90%	92%	93%
2.4	8	90%	91%	92%
2.7	9	89%	91%	92%
3	10	89%	90%	92%
4.6	15	86%	88%	90%
6.1	20	84%	85%	88%
7.6	25	82%	83%	87%
9.1	30	80%	80%	85%
10.7	35	77%	78%	83%
12.2	40	76%	75%	80%
13.7	45	74%	72%	78%
15.2	50	72%	70%	76%
16.8	55	70%	68%	73%
18.3	60	68%	66%	70%
19.8	65	67%	65%	67%
21.3	70	65%	63%	64%
22.9	75	64%	61%	61%
24.4	80	63%	60%	58%
25.9	85	61%	59%	56%
27.4	90	60%	57%	54%
29	95	59%	56%	52%
30.5	100	58%	55%	50%
32	105	57%	54%	48%
33.5	110	55%	52%	46%
35.1	115	54%	51%	45%
36.6	120	53%	50%	43%
38.1	125	53%	49%	42%
39.6	130	52%	48%	41%
41.1	135	51%	47%	40%
42.7	140	50%	47%	38%
44.2	145	49%	46%	37%
45.7	150	48%	45%	36%
47.2	155	47%	44%	36%
48.8	160	47%	43%	35%
50.3	165	46%	43%	34%
51.8	170	45%	42%	33%
53.3	175	45%	41%	32%

Active Channel Width (m)	Active Channel Width (feet)	Effective Shade Target for E-W Stream Aspects	Effective Shade Target for NW-SE, NE-SW Stream Aspects	Effective Shade Target for N-S Stream Aspects
54.9	180	44%	41%	32%
56.4	185	43%	40%	31%
57.9	190	43%	39%	30%
59.4	195	42%	39%	30%
61	200	42%	38%	29%
62.5	205	41%	38%	28%
64	210	41%	37%	28%
65.5	215	40%	37%	27%
67.1	220	39%	36%	27%
68.6	225	39%	36%	26%
70.1	230	38%	35%	26%
71.6	235	38%	35%	25%
73.2	240	38%	34%	25%
74.7	245	37%	34%	25%
76.2	250	37%	33%	24%
77.7	255	36%	33%	24%
79.2	260	36%	32%	23%
80.8	265	35%	32%	23%
82.3	270	35%	32%	23%
83.8	275	35%	31%	22%
85.3	280	34%	31%	22%
86.9	285	34%	31%	22%
88.4	290	34%	30%	21%
89.9	295	33%	30%	21%
91.4	300	33%	30%	21%
106.7	350	30%	27%	18%
121.9	400	27%	24%	16%
137.2	450	25%	22%	15%
152.4	500	23%	21%	13%
167.6	550	22%	19%	12%
182.9	600	20%	18%	11%
198.1	650	19%	17%	11%
213.4	700	18%	16%	10%
228.6	750	17%	15%	9%
243.8	800	16%	14%	9%
259.1	850	16%	14%	8%
274.3	900	15%	13%	8%
289.6	950	14%	13%	8%
304.8	1000	14%	12%	7%
320	1050	13%	12%	7%
335.3	1100	13%	11%	7%
350.5	1150	12%	11%	6%

Active Channel Width (m)	Active Channel Width (feet)	Effective Shade Target for E-W Stream Aspects	Effective Shade Target for NW-SE, NE-SW Stream Aspects	Effective Shade Target for N-S Stream Aspects
365.8	1200	12%	10%	6%
381	1250	11%	10%	6%
396.2	1300	11%	10%	6%
411.5	1350	11%	9%	5%
426.7	1400	10%	9%	5%
442	1450	10%	9%	5%
457.2	1500	10%	8%	5%
472.4	1550	9%	8%	5%
487.7	1600	9%	8%	5%
502.9	1650	9%	8%	5%
518.2	1700	9%	8%	4%
533.4	1750	8%	7%	4%
548.6	1800	8%	7%	4%
563.9	1850	8%	7%	4%



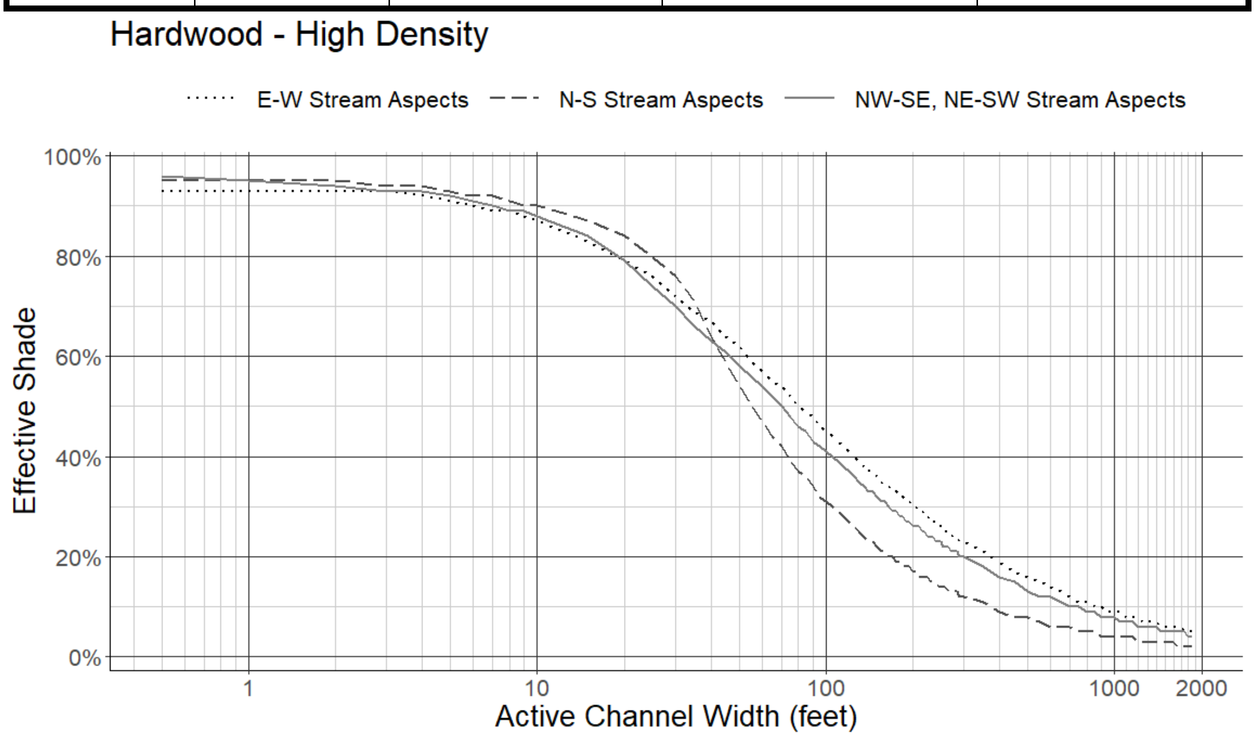
~~Figure~~Table ~~9~~13.~~1~~.2.~~. Effective shade targets for low density conifer dominated stream sites.~~

~~Table 9.14.~~ **Effective shade targets for low density conifer dominated stream sites.**

Active Channel Width (m)	Active Channel Width (feet)	Effective Shade Target for E-W Stream Aspects	Effective Shade Target for NW-SE, NE-SW Stream Aspects	Effective Shade Target for N-S Stream Aspects
0.2	0.5	67%	71%	71%
0.3	1	66%	71%	71%
0.6	2	66%	70%	71%
0.9	3	66%	69%	70%
1.2	4	65%	69%	70%
1.5	5	65%	68%	70%
1.8	6	65%	68%	69%
2.1	7	64%	67%	69%
2.4	8	63%	67%	68%
2.7	9	63%	66%	68%
3	10	62%	65%	68%
4.6	15	60%	62%	66%
6.1	20	57%	60%	63%
7.6	25	55%	57%	61%
9.1	30	53%	55%	58%
10.7	35	51%	53%	56%
12.2	40	49%	50%	54%
13.7	45	48%	48%	51%
15.2	50	46%	46%	49%
16.8	55	45%	45%	47%
18.3	60	43%	43%	44%
19.8	65	42%	42%	42%
21.3	70	41%	41%	39%
22.9	75	40%	39%	37%
24.4	80	39%	38%	35%
25.9	85	38%	37%	34%
27.4	90	37%	36%	32%
29	95	36%	35%	31%
30.5	100	35%	34%	30%
32	105	34%	33%	28%
33.5	110	33%	32%	27%
35.1	115	33%	32%	26%
36.6	120	32%	31%	25%
38.1	125	31%	30%	25%
39.6	130	31%	29%	24%
41.1	135	30%	29%	23%
42.7	140	29%	28%	22%
44.2	145	29%	27%	22%
45.7	150	28%	27%	21%
47.2	155	28%	26%	21%

Active Channel Width (m)	Active Channel Width (feet)	Effective Shade Target for E-W Stream Aspects	Effective Shade Target for NW-SE, NE-SW Stream Aspects	Effective Shade Target for N-S Stream Aspects
48.8	160	27%	26%	20%
50.3	165	27%	25%	20%
51.8	170	26%	25%	19%
53.3	175	26%	24%	19%
54.9	180	25%	24%	18%
56.4	185	25%	23%	18%
57.9	190	24%	23%	17%
59.4	195	24%	23%	17%
61	200	24%	22%	17%
62.5	205	23%	22%	16%
64	210	23%	21%	16%
65.5	215	23%	21%	16%
67.1	220	22%	21%	15%
68.6	225	22%	20%	15%
70.1	230	22%	20%	15%
71.6	235	21%	20%	14%
73.2	240	21%	20%	14%
74.7	245	21%	19%	14%
76.2	250	20%	19%	14%
77.7	255	20%	19%	13%
79.2	260	20%	18%	13%
80.8	265	20%	18%	13%
82.3	270	19%	18%	13%
83.8	275	19%	18%	13%
85.3	280	19%	17%	12%
86.9	285	19%	17%	12%
88.4	290	18%	17%	12%
89.9	295	18%	17%	12%
91.4	300	18%	17%	12%
106.7	350	16%	15%	10%
121.9	400	14%	13%	9%
137.2	450	13%	12%	8%
152.4	500	12%	11%	7%
167.6	550	11%	10%	7%
182.9	600	10%	9%	6%
198.1	650	10%	9%	6%
213.4	700	9%	8%	5%
228.6	750	9%	8%	5%
243.8	800	8%	7%	5%
259.1	850	8%	7%	5%
274.3	900	7%	7%	4%
289.6	950	7%	6%	4%

Active Channel Width (m)	Active Channel Width (feet)	Effective Shade Target for E-W Stream Aspects	Effective Shade Target for NW-SE, NE-SW Stream Aspects	Effective Shade Target for N-S Stream Aspects
304.8	1000	7%	6%	4%
320	1050	6%	6%	4%
335.3	1100	6%	5%	4%
350.5	1150	6%	5%	3%
365.8	1200	6%	5%	3%
381	1250	5%	5%	3%
396.2	1300	5%	5%	3%
411.5	1350	5%	5%	3%
426.7	1400	5%	4%	3%
442	1450	5%	4%	3%
457.2	1500	5%	4%	3%
472.4	1550	4%	4%	3%
487.7	1600	4%	4%	2%
502.9	1650	4%	4%	2%
518.2	1700	4%	4%	2%
533.4	1750	4%	4%	2%
548.6	1800	4%	3%	2%
563.9	1850	4%	3%	2%



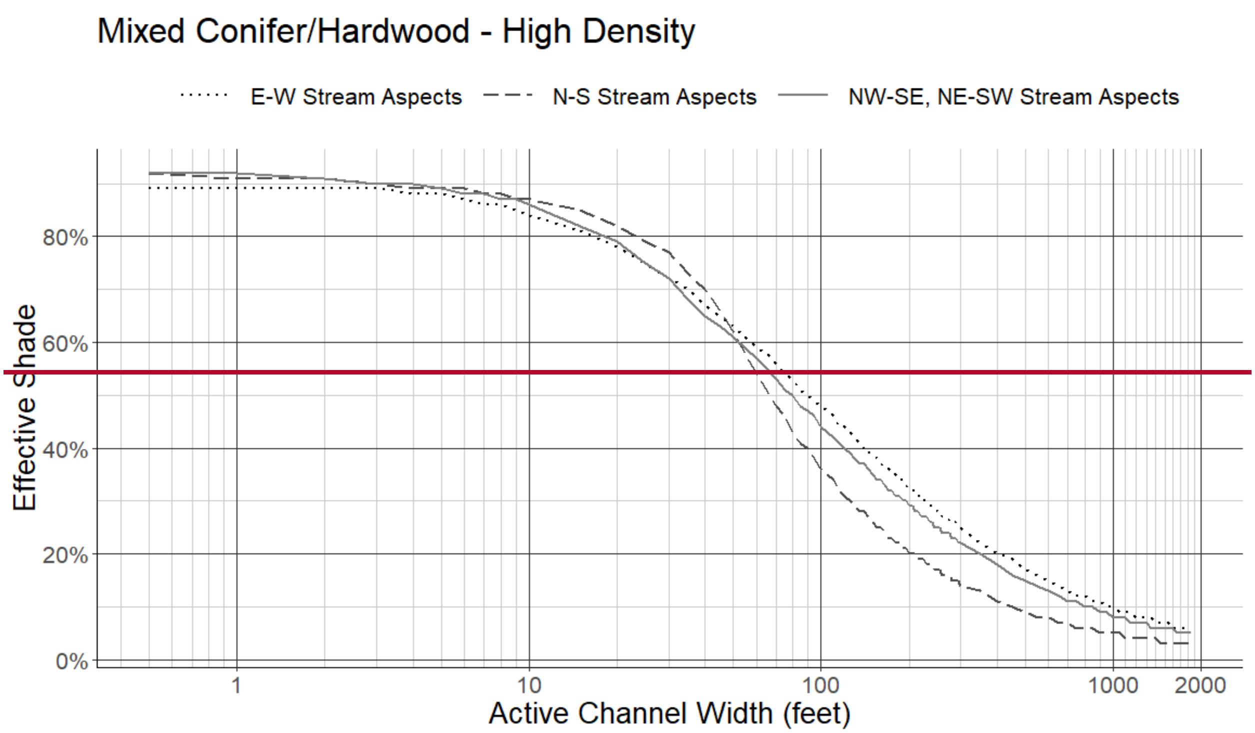
~~**Figure 9.3. Effective shade targets for high density hardwood dominated stream sites.**~~

Table ~~9~~13.3. Effective shade targets for high density hardwood dominated stream sites.

Active Channel Width (m)	Active Channel Width (feet)	Effective Shade Target for E-W Stream Aspects	Effective Shade Target for NW-SE, NE-SW Stream Aspects	Effective Shade Target for N-S Stream Aspects
0.2	0.5	93%	96%	95%
0.3	1	93%	95%	95%
0.6	2	93%	94%	95%
0.9	3	93%	93%	94%
1.2	4	92%	93%	94%
1.5	5	91%	92%	93%
1.8	6	90%	91%	92%
2.1	7	89%	90%	92%
2.4	8	89%	89%	91%
2.7	9	88%	89%	90%
3	10	87%	88%	90%
4.6	15	83%	84%	87%
6.1	20	79%	79%	84%
7.6	25	76%	74%	80%
9.1	30	72%	70%	76%
10.7	35	69%	66%	71%
12.2	40	67%	63%	64%
13.7	45	64%	61%	59%
15.2	50	62%	58%	54%
16.8	55	59%	56%	50%
18.3	60	57%	54%	47%
19.8	65	55%	52%	44%
21.3	70	54%	50%	42%
22.9	75	52%	48%	39%
24.4	80	50%	46%	37%
25.9	85	49%	45%	36%
27.4	90	48%	43%	34%
29	95	46%	42%	32%
30.5	100	45%	41%	31%
32	105	44%	40%	30%
33.5	110	43%	39%	29%
35.1	115	42%	38%	28%
36.6	120	41%	37%	27%
38.1	125	40%	36%	26%
39.6	130	39%	35%	25%
41.1	135	38%	34%	24%
42.7	140	37%	33%	23%
44.2	145	37%	33%	23%
45.7	150	36%	32%	22%
47.2	155	35%	31%	21%

Active Channel Width (m)	Active Channel Width (feet)	Effective Shade Target for E-W Stream Aspects	Effective Shade Target for NW-SE, NE-SW Stream Aspects	Effective Shade Target for N-S Stream Aspects
48.8	160	34%	31%	21%
50.3	165	34%	30%	20%
51.8	170	33%	29%	20%
53.3	175	33%	29%	19%
54.9	180	32%	28%	19%
56.4	185	32%	28%	18%
57.9	190	31%	27%	18%
59.4	195	31%	27%	18%
61	200	30%	26%	17%
62.5	205	30%	26%	17%
64	210	29%	26%	16%
65.5	215	29%	25%	16%
67.1	220	28%	25%	16%
68.6	225	28%	24%	16%
70.1	230	27%	24%	15%
71.6	235	27%	24%	15%
73.2	240	27%	23%	15%
74.7	245	26%	23%	14%
76.2	250	26%	23%	14%
77.7	255	26%	22%	14%
79.2	260	25%	22%	14%
80.8	265	25%	22%	13%
82.3	270	25%	21%	13%
83.8	275	24%	21%	13%
85.3	280	24%	21%	13%
86.9	285	24%	21%	13%
88.4	290	23%	20%	12%
89.9	295	23%	20%	12%
91.4	300	23%	20%	12%
106.7	350	21%	18%	11%
121.9	400	19%	16%	9%
137.2	450	17%	15%	8%
152.4	500	16%	13%	8%
167.6	550	15%	12%	7%
182.9	600	14%	12%	6%
198.1	650	13%	11%	6%
213.4	700	12%	10%	6%
228.6	750	11%	10%	5%
243.8	800	11%	9%	5%
259.1	850	10%	9%	5%
274.3	900	10%	8%	4%
289.6	950	9%	8%	4%

Active Channel Width (m)	Active Channel Width (feet)	Effective Shade Target for E-W Stream Aspects	Effective Shade Target for NW-SE, NE-SW Stream Aspects	Effective Shade Target for N-S Stream Aspects
304.8	1000	9%	8%	4%
320	1050	9%	7%	4%
335.3	1100	8%	7%	4%
350.5	1150	8%	7%	4%
365.8	1200	8%	6%	3%
381	1250	7%	6%	3%
396.2	1300	7%	6%	3%
411.5	1350	7%	6%	3%
426.7	1400	7%	6%	3%
442	1450	6%	5%	3%
457.2	1500	6%	5%	3%
472.4	1550	6%	5%	3%
487.7	1600	6%	5%	3%
502.9	1650	6%	5%	2%
518.2	1700	6%	5%	2%
533.4	1750	5%	5%	2%
548.6	1800	5%	4%	2%
563.9	1850	5%	4%	2%



~~Figure 9.4. Effective shade targets for high density mixed conifer and hardwood stream sites.~~

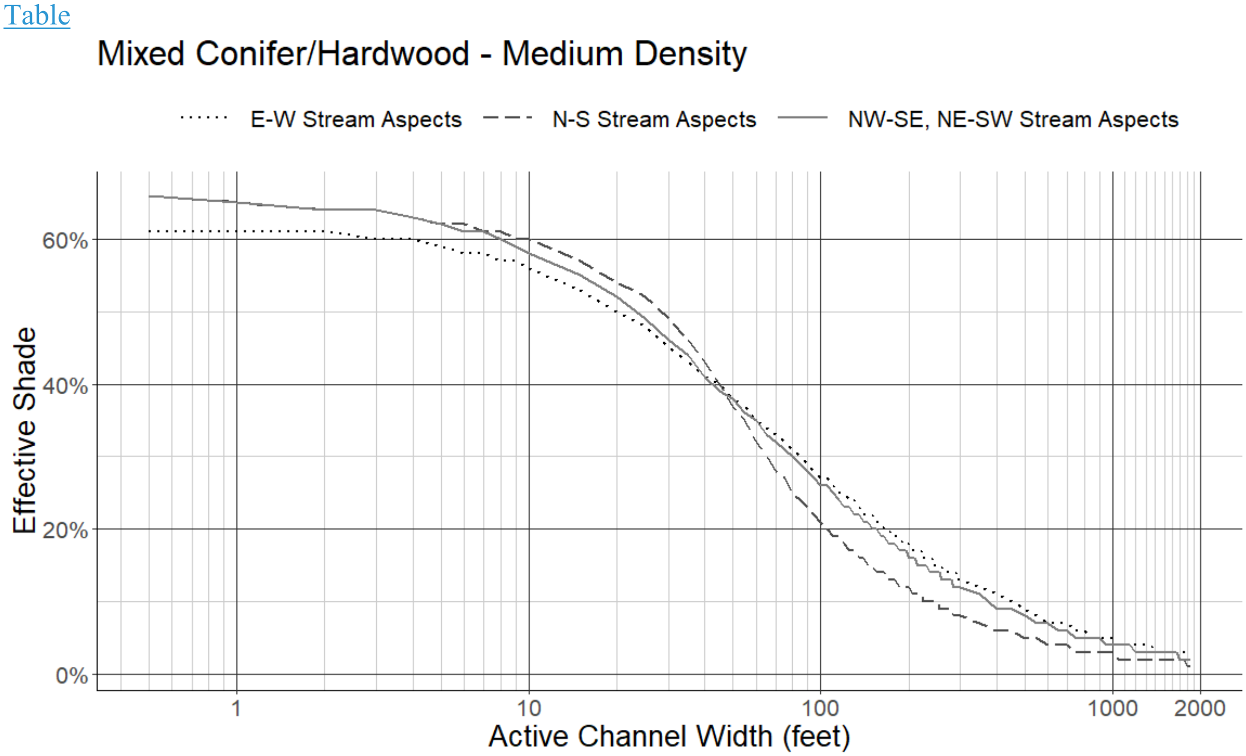
Table ~~9~~13.4. Effective shade targets for high density mixed conifer and hardwood dominated stream sites.

Active Channel Width (m)	Active Channel Width (feet)	Effective Shade Target for E-W Stream Aspects	Effective Shade Target for NW-SE, NE-SW Stream Aspects	Effective Shade Target for N-S Stream Aspects
0.2	0.5	89%	92%	92%
0.3	1	89%	92%	91%
0.6	2	89%	91%	91%
0.9	3	89%	90%	90%
1.2	4	88%	90%	89%
1.5	5	88%	89%	89%
1.8	6	87%	88%	89%
2.1	7	86%	88%	88%
2.4	8	86%	87%	88%
2.7	9	85%	87%	87%
3	10	84%	86%	87%
4.6	15	81%	82%	85%
6.1	20	78%	79%	82%
7.6	25	75%	75%	79%
9.1	30	72%	72%	77%
10.7	35	70%	68%	73%
12.2	40	67%	65%	70%
13.7	45	65%	63%	66%
15.2	50	63%	61%	62%
16.8	55	61%	59%	58%
18.3	60	59%	57%	54%
19.8	65	58%	55%	51%
21.3	70	56%	53%	48%
22.9	75	54%	51%	46%
24.4	80	53%	50%	43%
25.9	85	51%	48%	41%
27.4	90	50%	47%	40%
29	95	49%	46%	38%
30.5	100	48%	44%	36%
32	105	47%	43%	35%
33.5	110	46%	42%	34%
35.1	115	44%	41%	32%
36.6	120	44%	40%	31%
38.1	125	43%	39%	30%
39.6	130	42%	38%	29%
41.1	135	41%	37%	28%
42.7	140	40%	37%	28%
44.2	145	39%	36%	27%
45.7	150	39%	35%	26%
47.2	155	38%	34%	25%

Active Channel Width (m)	Active Channel Width (feet)	Effective Shade Target for E-W Stream Aspects	Effective Shade Target for NW-SE, NE-SW Stream Aspects	Effective Shade Target for N-S Stream Aspects
48.8	160	37%	34%	25%
50.3	165	36%	33%	24%
51.8	170	36%	32%	23%
53.3	175	35%	32%	23%
54.9	180	35%	31%	22%
56.4	185	34%	31%	22%
57.9	190	34%	30%	21%
59.4	195	33%	30%	21%
61	200	32%	29%	20%
62.5	205	32%	29%	20%
64	210	32%	28%	20%
65.5	215	31%	28%	19%
67.1	220	31%	27%	19%
68.6	225	30%	27%	19%
70.1	230	30%	27%	18%
71.6	235	29%	26%	18%
73.2	240	29%	26%	18%
74.7	245	29%	25%	17%
76.2	250	28%	25%	17%
77.7	255	28%	25%	17%
79.2	260	27%	24%	16%
80.8	265	27%	24%	16%
82.3	270	27%	24%	16%
83.8	275	26%	24%	16%
85.3	280	26%	23%	15%
86.9	285	26%	23%	15%
88.4	290	26%	23%	15%
89.9	295	25%	22%	15%
91.4	300	25%	22%	14%
106.7	350	22%	20%	13%
121.9	400	20%	18%	11%
137.2	450	19%	16%	10%
152.4	500	17%	15%	9%
167.6	550	16%	14%	8%
182.9	600	15%	13%	8%
198.1	650	14%	12%	7%
213.4	700	13%	11%	7%
228.6	750	12%	11%	6%
243.8	800	12%	10%	6%
259.1	850	11%	10%	6%
274.3	900	11%	9%	5%
289.6	950	10%	9%	5%

Active Channel Width (m)	Active Channel Width (feet)	Effective Shade Target for E-W Stream Aspects	Effective Shade Target for NW-SE, NE-SW Stream Aspects	Effective Shade Target for N-S Stream Aspects
304.8	1000	10%	8%	5%
320	1050	9%	8%	5%
335.3	1100	9%	8%	4%
350.5	1150	9%	7%	4%
365.8	1200	8%	7%	4%
381	1250	8%	7%	4%
396.2	1300	8%	7%	4%
411.5	1350	8%	6%	4%
426.7	1400	7%	6%	4%
442	1450	7%	6%	3%
457.2	1500	7%	6%	3%
472.4	1550	7%	6%	3%
487.7	1600	6%	6%	3%
502.9	1650	6%	5%	3%
518.2	1700	6%	5%	3%
533.4	1750	6%	5%	3%
548.6	1800	6%	5%	3%
563.9	1850	6%	5%	3%

Table



~~Figure 9~~13~~.4. Effective shade targets for medium density mixed conifer and hardwood stream sites.~~

~~Table 9.17.~~ 5. Effective shade targets for medium density mixed conifer and hardwood dominated stream sites.

Active Channel Width (m)	Active Channel Width (feet)	Effective Shade Target for E-W Stream Aspects	Effective Shade Target for NW-SE, NE-SW Stream Aspects	Effective Shade Target for N-S Stream Aspects
0.2	0.5	61%	66%	66%
0.3	1	61%	65%	65%
0.6	2	61%	64%	64%
0.9	3	60%	64%	64%
1.2	4	60%	63%	63%
1.5	5	59%	62%	62%
1.8	6	58%	61%	62%
2.1	7	58%	61%	61%
2.4	8	57%	60%	61%
2.7	9	57%	59%	60%
3	10	56%	58%	60%
4.6	15	53%	55%	57%
6.1	20	50%	52%	54%
7.6	25	48%	49%	52%
9.1	30	45%	46%	49%
10.7	35	43%	44%	46%
12.2	40	41%	41%	43%
13.7	45	40%	39%	40%
15.2	50	38%	38%	37%
16.8	55	37%	36%	35%
18.3	60	35%	35%	32%
19.8	65	34%	33%	30%
21.3	70	33%	32%	28%
22.9	75	32%	31%	27%
24.4	80	31%	30%	25%
25.9	85	30%	29%	24%
27.4	90	29%	28%	23%
29	95	28%	27%	22%
30.5	100	27%	26%	21%
32	105	27%	26%	20%
33.5	110	26%	25%	19%
35.1	115	25%	24%	19%
36.6	120	25%	23%	18%
38.1	125	24%	23%	17%
39.6	130	24%	22%	17%
41.1	135	23%	22%	16%
42.7	140	22%	21%	16%
44.2	145	22%	21%	15%

Active Channel Width (m)	Active Channel Width (feet)	Effective Shade Target for E-W Stream Aspects	Effective Shade Target for NW-SE, NE-SW Stream Aspects	Effective Shade Target for N-S Stream Aspects
45.7	150	22%	20%	15%
47.2	155	21%	20%	14%
48.8	160	21%	19%	14%
50.3	165	20%	19%	14%
51.8	170	20%	18%	13%
53.3	175	19%	18%	13%
54.9	180	19%	18%	13%
56.4	185	19%	17%	12%
57.9	190	18%	17%	12%
59.4	195	18%	17%	12%
61	200	18%	16%	12%
62.5	205	17%	16%	11%
64	210	17%	16%	11%
65.5	215	17%	15%	11%
67.1	220	17%	15%	11%
68.6	225	16%	15%	10%
70.1	230	16%	15%	10%
71.6	235	16%	14%	10%
73.2	240	16%	14%	10%
74.7	245	15%	14%	10%
76.2	250	15%	14%	10%
77.7	255	15%	14%	9%
79.2	260	15%	13%	9%
80.8	265	14%	13%	9%
82.3	270	14%	13%	9%
83.8	275	14%	13%	9%
85.3	280	14%	13%	9%
86.9	285	14%	12%	8%
88.4	290	14%	12%	8%
89.9	295	13%	12%	8%
91.4	300	13%	12%	8%
106.7	350	12%	11%	7%
121.9	400	11%	9%	6%
137.2	450	10%	9%	6%
152.4	500	9%	8%	5%
167.6	550	8%	7%	5%
182.9	600	7%	7%	4%
198.1	650	7%	6%	4%
213.4	700	7%	6%	4%
228.6	750	6%	5%	3%
243.8	800	6%	5%	3%
259.1	850	5%	5%	3%

Active Channel Width (m)	Active Channel Width (feet)	Effective Shade Target for E-W Stream Aspects	Effective Shade Target for NW-SE, NE-SW Stream Aspects	Effective Shade Target for N-S Stream Aspects
274.3	900	5%	5%	3%
289.6	950	5%	4%	3%
304.8	1000	5%	4%	3%
320	1050	4%	4%	2%
335.3	1100	4%	4%	2%
350.5	1150	4%	4%	2%
365.8	1200	4%	3%	2%
381	1250	4%	3%	2%
396.2	1300	4%	3%	2%
411.5	1350	4%	3%	2%
426.7	1400	3%	3%	2%
442	1450	3%	3%	2%
457.2	1500	3%	3%	2%
472.4	1550	3%	3%	2%
487.7	1600	3%	3%	2%
502.9	1650	3%	3%	2%
518.2	1700	3%	2%	2%
533.4	1750	3%	2%	2%
548.6	1800	3%	2%	1%
563.9	1850	3%	2%	1%

9.1.2.1.2.1.1.1.1.1. Percent flow rate reduction surrogate measure

Table 9.18 Target maximum percent flow rate reduction relative to the median natural flow at the stated reference flow monitoring site.

Maximum percent flow rate reduction	Reference Monitoring Site
1.75	USGS 14142500 – Sandy River below Bull Run

9.1.3.1.1.1. Reserve capacity

Explicit allocations for reserve capacity have been set aside for use by either point or nonpoint sources to provide an allocation to new or increased thermal loads, or to any existing source that may not have been identified during the development of this TMDL. The portion of the human use allowance associated with the reserve capacity is described in Table 9.1 through Table 9.5.

9.2.1.1. Margin of safety

This TMDL used an implicit margin of safety.

10.1. Water quality management plan

As described in OAR 340-042-0040(4)(l)(A)-(O), an associated WQMP is an required element of a TMDL and must include the following components: (A) Condition assessment and problem description; (B) Goals and objectives; (C) Proposed management strategies design to meet the TMDL allocations; (D) Timeline for implementing management strategies; (E) Explanation of how TMDL implementation will attain water quality standards; (F) Timeline for attaining water quality standards; (G) Identification of persons, including Designated Management Agencies, responsible for TMDL implementation; (H) Identification of existing implementation plans; (I) Schedule for submittal of implementation plans and revision triggers; (J) Description of reasonable assurance of TMDL implementation; (K) Plan to monitor and evaluate progress toward achieving TMDL allocations and water quality standards; (L) Plan for public involvement in TMDL implementation; (M) Description of planned efforts to maintain management strategies over time; (N) General discussion of costs and funding for TMDL implementation; and, (O) citation of legal authorities relating to TMDL implementation.

DEQ sought and considered input from various persons, including DMAs, responsible for TMDL implementation and other interested public and prepared the Lower Columbia-Sandy Subbasin WQMP as a stand-alone document. DEQ intends to propose the draft WQMP as an element of Temperature TMDLs for the Lower Columbia-Sandy Subbasin for adoption as rule by the Oregon Environmental Quality Commission.

11.1. Reasonable assurance

OAR 340-042-0030(9) defines Reasonable Assurance as "a demonstration that a TMDL will be implemented by federal, state or local governments or individuals through regulatory or voluntary actions including management strategies or other controls." OAR 340-042-0040(4)(l)(J) requires a description of reasonable assurance that management strategies and sector-specific or source-specific implementation plans will be carried out through regulatory or voluntary actions. And as a factor in consideration of allocation distribution among sources, OAR 340-042-0040(6)(g) states that "to establish reasonable assurance that the TMDL's load allocations will be achieved requires determination that practices capable of reducing the specified pollutant load: (1) exist; (2) are technically feasible at a level required to meet allocations; and (3) have a high likelihood of implementation." This three point test is consistent with EPA past practice and guidance on determining reasonable assurance and supports federal antidegradation rules and Oregon's antidegradation policy (OAR 340-041-0004).

Temperature TMDLs for the Lower Columbia-Sandy Subbasin were developed for waters impaired by both point and nonpoint sources, with allocations distributed to sources of thermal loading. It is the state's (and, with TMDL approval, EPA's) best professional judgment as to a reasonable assurance determination that the TMDL's load allocations will be achieved. DEQ employs a six-point accountability framework for reasonable assurance of implementation, as detailed in DEQ's Water Quality Management Plan.

Pollutant reduction strategies are identified in DEQ's Water Quality Management Plan, and more specific strategies will be detailed in each required implementation plan, to be submitted per the timelines in the Water Quality Management Plan. These strategies and actions are comprehensively implemented through a variety of regulatory and non-regulatory programs. Many of these are existing strategies and actions that are already being implemented within the subbasin and demonstrate reduced pollutant loading. These strategies are technically feasible at an appropriate scale in order to meet the allocations. A high likelihood of implementation is demonstrated because DEQ reviews the individual implementation plans and proposed actions for adequacy and establishes a monitoring and reporting system to track implementation and respond to any inadequacies.

The rationale described in this TMDL Rule, TMDL Technical Support Document and Water Quality Management Plan stems from robust evaluations, implements an accountability framework and provides opportunities for adaptive management to maximize pollutant reductions. Together this approach provides reasonable assurance to meet state and federal requirements and attain the goals of the TMDL.

12.1. References

DEQ (Oregon Department of Environmental Quality). 2005. "Sandy River Basin Total Maximum Daily Load (TMDL)."

DEQ (Oregon Department of Environmental Quality). 2023a. "Draft Lower Columbia-Sandy River Subbasin TMDL Technical Support Document."

DEQ (Oregon Department of Environmental Quality). 2023b. "Draft Lower Columbia-Sandy River Subbasin TMDL Water Quality Management Plan."