Total Maximum Daily Loads for the Willamette Subbasins

Temperature

Amended to include the Willamette River and major tributaries - DRAFT

August 2024

State of Oregon
DEQ Department of Environmental Quality

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Acronyms

7DADM	7-Day Average Daily Maximum
7Q10	7-Day, 10-Year Low Flow
ADWDF	Average Dry Weather Design Flow
AU	Assessment Unit
CF	Coast Fork
CFR	Code of Federal Regulations
cfs	Cubic Feet per Second
DEQ	Oregon Department of Environmental Quality
DMA	Designated Management Agency
DMR	Discharge Monitoring Report
EPA	Environmental Protection Agency
EQC	Oregon Environmental Quality Commission
EWEB	Eugene Water and Electric Board
GNIS	USGS Geographic Names Information System
HUA	Human Use Allowance
HUC	Hydrologic Unit Code
IMD	Internal Management Directive
LA	Load Allocation
LC	Loading Capacity
MF	Middle Fork
MGD	Millions of Gallons per Day
MS4	Municipal Separate Storm Sewer System
NPDES	National Pollutant Discharge Elimination System
NPS	Nonpoint Source
OAR	Oregon Administrative Rules
ODC	Oregon Department of Corrections
ODFW	Oregon Department of Fish & Wildlife
ORS	Oregon Revised Statutes
POMI	Point of Maximum Impact
SIC	Standard Industrial Classification
STP	Sewage Treatment Plant
TMDL	Total Maximum Daily Load
TSD	Technical Support Document
USGS	United States Geological Survey
WLA	Wasteload Allocation
WQMP	Water Quality Management Plan

WTP	Water Treatment Plant
WWTP	Wastewater Treatment Plant

1 Introduction

This Total Maximum Daily Load (TMDL) project includes the following Willamette Subbasins: Coast Fork Willamette, McKenzie, Middle Fork Willamette, Upper Willamette, Middle Willamette, Molalla-Pudding, North Santiam, South Santiam, Lower Willamette, and Clackamas Subbasins. This TMDL was adopted by reference in Oregon Administrative Rules OAR 340-42-0090.

OAR 340-42-0040(3) requires the Oregon Department of Environmental Quality (DEQ) or the Oregon Environmental Quality Commission (EQC) to prioritize and schedule TMDLs for completion considering various factors outlined in the rule. Temperature TMDLs for the Willamette Subbasins were identified as a high priority on Oregon's TMDL priority ranking submitted with Oregon's 2022 Integrated Report and due to court order to Oregon and the Environmental Protection Agency (EPA) to establish TMDLs to replace the temperature TMDLs developed as part of the 2006 Willamette Basin TMDL (action ID 30674) and the 2008 Molalla-Pudding Subbasin TMDL and Water Quality Management Plan (WQMP) (action ID 35888) (**Table 1-1**).

1.1 Previous TMDLs

In 2006 and 2008 DEQ issued, and EPA approved, two TMDL actions addressing temperature impairments (**Table 1-1**) within the project area for the Willamette Subbasins temperature TMDLs. Once approved by EPA, the Willamette Subbasins TMDLs for temperature will replace the temperature TMDLs listed in **Table 1-1**. TMDLs for other water quality impaired parameters listed in **Table 1-1** are still effective.

Table 1-1: Summary of previous temperature TMDLs developed for the Willamette Subbasins.

TMDL Action ID	TMDL Name	EPA Approval Date	Water Quality Impairments Addressed
30674	Willamette Basin TMDL	9/29/2006	Ammonia, Bacteria (water contact recreation), DDT 4,4', Dieldrin, Dissolved Oxygen, Mercury, Temperature, Turbidity
35888	Molalla-Pudding Subbasin TMDL and WQMP	12/31/2008	Bacteria (water contact recreation), Chlordane, DDD 4,4', DDE 4,4', DDT 4,4', Dieldrin, Iron, Nitrates, Temperature

1.2 TMDL administrative process and public participation

Following completion of DEQ's drafting process, including engagement of a rule advisory committee on the fiscal impact statement and aspects of the rule, this revised temperature TMDL for the Willamette Subbasins was adopted by EQC, by reference, into rule section OAR 340-042-0090. Any subsequently amended or renumbered rules cited in this document are intended to apply.

DEQ convened a rule advisory committee to provide input on drafts of the TMDL, WQMP, Technical Support Document (TSD) (DEQ, 2023a and 2023b), fiscal and economic impacts, and Environmental Justice and Racial Equity. The committee met on February 23, 2023, and April 6, 2023. The agency held two informational webinars about this TMDL. A public comment period was held from January 10 through March 15, 2024. DEQ held a public hearing on February 16, 2024. DEQ considered all input received during these public participation opportunities and used input to guide the analyses and preparation of documents. DEQ developed a response to comments that is available online.

EQC adopted revisions to the Willamette Subbasins TMDL and WQMP rule on [DATE TBA]. The TMDL and WQMP were revised to add temperature TMDLs for the Willamette River, Multnomah Channel, and tributaries to the Willamette River downstream of the following dams: River Mill Dam, Detroit Dam, Foster Dam, Fern Ridge Dam, Dexter Dam, Fall Creek Dam, Dorena Dam, and Cottage Grove Dam. The name of this project area is the Willamette River mainstem and major tributaries. DEQ convened a rule advisory committee for these TMDL additions. The rule advisory committee provided input on drafts of the updated TMDL, WQMP, Technical Support Document, fiscal and economic impacts, and Environmental Justice and Racial Equity. The committee met on March 14, 2024, May 16, 2024, and July 30, 2024. A public comment period was held from [DATE1 TBA] through [DATE2 TBA]. DEQ held a public hearing on [DATE TBA]. DEQ considered all input received during these public participation opportunities and used input to guide the analyses and preparation of documents. DEQ developed a response to comments that is available online.

2 TMDL name and location

Per OAR 340-042-0040(4)(a), this element describes the geographic area for which the TMDL was developed.

The Willamette Subbasins comprise ten 8-digit hydrologic unit code (HUC) subbasins, including the Middle Fork Willamette Subbasin (HUC 17090001), Coast Fork Willamette Subbasin (HUC 17090002), Upper Willamette Subbasin (HUC 17090003), McKenzie Subbasin (HUC 17090004), North Santiam Subbasin (HUC 17090005), the South Santiam Subbasin (HUC 17090006), Middle Willamette Subbasin (HUC 17090007), Molalla-Pudding Subbasin (HUC 17090009), Clackamas Subbasin (HUC 17090011), and Lower Willamette Subbasin (HUC 17090012) (**Table 2-1**).

Temperature TMDLs for the Willamette Subbasins address all Category 5 listed assessment units (AUs) impaired for temperature on Oregon's 2022 Section 303(d) list (**Table 2-2** through **Table 2-11**) and, as applicable, any AUs identified as temperature impaired in the future. Likewise, this TMDL includes a protection plan for all other assessment categories, including AUs identified as a potential concern, attaining, or unassessed.

The loading capacity, allocations, surrogate measures, and implementation framework apply to all waters in the Willamette Subbasins determined to be waters of the state as defined under Oregon Revised Statutes ORS 468B.005(10), including all perennial and intermittent streams that have surface flow or residual pools during the TMDL allocation period.

The TMDL implementation framework is presented in the Willamette Subbasins TMDL WQMP and includes implementation activities and timeframes to improve water quality, as well as measures of success. These and other protection plan elements are further explained in Section 12.

The map in **Figure 2-1** provides an overview of where the temperature TMDLs are applicable. Appendix D of the Willamette Subbasin TSD provides a list of all AUs addressed by the TMDL.

Table 2-1: HUC8 codes and names in the Willamette Subbasins.

HUC8	Subbasin Name
17090001	Middle Fork Willamette
17090002	Coast Fork Willamette
17090003	Upper Willamette
17090004	McKenzie
17090005	North Santiam
17090006	South Santiam
17090007	Middle Willamette
17090009	Molalla-Pudding
17090011	Clackamas
17090012	Lower Willamette

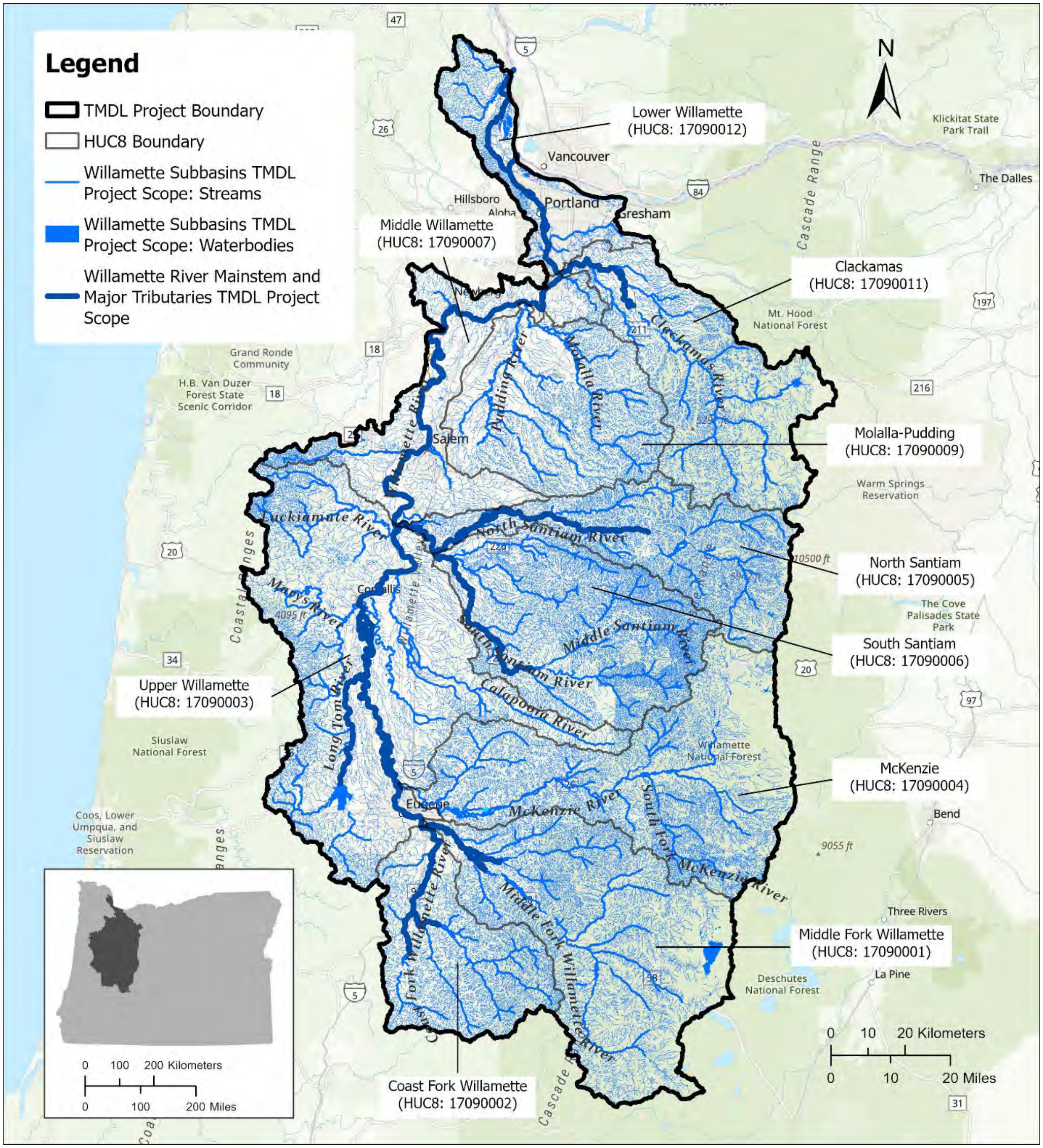

Figure 2-1: Willamette Subbasins temperature TMDLs project area overview.

Table 2-2 through **Table 2-11** present stream AUs within the Willamette Subbasins 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 EPA on September 1, 2022. Status category designations are prescribed by Sections 305(b) and 303(d) of the Clean Water Act. AUs listed in Category 5 (i.e., 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 in **Figure** 2-2.

Table 2-2: Middle Fork Willamette Subbasin (17090001) Category 5 temperature impairments on the 2022 Integrated Report.

AU ID	AU Name	Use Period
OR_SR_1709000106_02_103722	Christy Creek	Spawning
OR_SR_1709000109_02_103735	Fall Creek	Year Round
OR_SR_1709000109_02_103735	Fall Creek	Spawning
OR_SR_1709000109_02_103736	Fall Creek	Year Round
OR_SR_1709000109_02_103736	Fall Creek	Spawning
OR_SR_1709000109_02_103737	Fall Creek	Year Round
OR_SR_1709000109_02_103737	Fall Creek	Spawning
OR_SR_1709000109_02_103743	Fall Creek	Year Round
OR_SR_1709000109_02_103743	Fall Creek	Spawning
OR_LK_1709000109_02_100701	Fall Creek Lake	Year Round
OR_SR_1709000109_02_103734	Hehe Creek	Year Round
OR_SR_1709000102_02_103715	Hills Creek	Year Round
OR_SR_1709000102_02_103715	Hills Creek	Spawning
OR_SR_1709000110_02_103749	Hills Creek	Year Round
OR_WS_170900010904_02_104219	HUC12 Name: Andy Creek-Fall Creek	Year Round
OR_WS_170900010502_02_104200	HUC12 Name: Buck Creek-Middle Fork Willamette River	Year Round
OR_WS_170900010501_02_104199	HUC12 Name: Coal Creek	Year Round
OR_WS_170900010608_02_104210	HUC12 Name: Dartmouth Creek-North Fork Middle Fork Willamette River	Year Round
OR_WS_170900010701_02_104211	HUC12 Name: Deception Creek-Middle Fork Willamette River	Year Round
OR_WS_170900010901_02_104216	HUC12 Name: Delp Creek-Fall Creek	Year Round
OR_WS_170900010703_02_104213	HUC12 Name: Dexter Reservoir-Middle Fork Willamette River	Year Round
OR_WS_170900010106_02_104190	HUC12 Name: Echo Creek-Middle Fork Willamette River	Year Round
OR_WS_170900010607_02_104209	HUC12 Name: Eighth Creek-North Fork Middle Fork Willamette River	Year Round
OR_WS_170900010505_02_104202	HUC12 Name: Gray Creek-Middle Fork Willamette River	Year Round
OR_WS_170900010702_02_104212	HUC12 Name: Lost Creek	Year Round
OR_WS_170900010202_02_104192	HUC12 Name: Lower Hills Creek	Year Round
OR_WS_170900010403_02_104198	HUC12 Name: Lower Salmon Creek	Year Round
OR_WS_170900010303_02_104195	HUC12 Name: Lower Salt Creek	Year Round
OR_WS_170900010303_02_104195	HUC12 Name: Lower Salt Creek	Spawning
OR_WS_170900010302_02_104194	HUC12 Name: Middle Salt Creek	Year Round
OR_WS_170900010503_02_104201	HUC12 Name: Packard Creek-Middle Fork Willamette	Year Round
OR_WS_170900010105_02_104189	HUC12 Name: Staley Creek	Year Round
OR_WS_170900010102_02_104186	HUC12 Name: Tumblebug Creek	Year Round
OR_WS_170900010402_02_104197	HUC12 Name: Upper Salmon Creek	Year Round
OR_WS_170900010905_02_104220	HUC12 Name: Winberry Creek	Year Round
OR_SR_1709000108_02_103730	Little Fall Creek	Year Round
OR_SR_1709000108_02_103730	Little Fall Creek	Spawning
OR_SR_1709000109_02_103742	Logan Creek	Year Round
OR_SR_1709000107_02_103727	Lost Creek	Year Round
OR_SR_1709000107_02_103727	Lost Creek	Spawning
OR_SR_1709000107_02_103728	Lost Creek	Year Round
OR_SR_1709000107_02_103728	Lost Creek	Spawning
OR_SR_1709000101_02_103713	Middle Fork Willamette River	Year Round
OR_SR_1709000105_02_104579	Middle Fork Willamette River	Year Round
OR_SR_1709000105_02_104580	Middle Fork Willamette River	Year Round
OR_SR_1709000105_02_104580	Middle Fork Willamette River	Spawning
OR_SR_1709000107_02_103725	Middle Fork Willamette River	Year Round
OR_SR_1709000107_02_103725	Middle Fork Willamette River	Spawning

AU ID	AU Name	Use Period
OR_SR_1709000107_02_104583	Middle Fork Willamette River	Year Round
OR_SR_1709000107_02_104583	Middle Fork Willamette River	Spawning
OR_SR_1709000110_02_104584	Middle Fork Willamette River	Year Round
OR_SR_1709000110_02_104584	Middle Fork Willamette River	Spawning
OR_SR_1709000106_02_103721	North Fork Middle Fork Willamette River	Year Round
OR_SR_1709000106_02_103721	North Fork Middle Fork Willamette River	Spawning
OR_SR_1709000106_02_103723	North Fork Middle Fork Willamette River	Year Round
OR_SR_1709000109_02_103738	North Fork Winberry Creek	Year Round
OR_LK_1709000105_02_100684	Packard Creek	Year Round
OR_SR_1709000105_02_104578	Packard Creek	Year Round
OR_SR_1709000109_02_103741	Portland Creek	Year Round
OR_SR_1709000109_02_103744	Portland Creek	Year Round
OR_SR_1709000104_02_103719	Salmon Creek	Year Round
OR_SR_1709000104_02_103719	Salmon Creek	Spawning
OR_SR_1709000103_02_103716	Salt Creek	Year Round
OR_SR_1709000103_02_103716	Salt Creek	Spawning
OR_SR_1709000109_02_103745	South Fork Winberry Creek	Year Round
OR_SR_1709000109_02_103747	Winberry Creek	Year Round
OR_SR_1709000109_02_103747	Winberry Creek	Spawning

Table 2-3: Coast Fork Willamette Subbasin (17090002) Category 5 temperature impairments on the 2022 Integrated Report.

AU ID	AU Name	Use Period
OR_SR_1709000202_02_103771	Brice Creek	Year Round
OR_SR_1709000203_02_104585	Coast Fork Willamette River	Year Round
OR_SR_1709000203_02_104586	Coast Fork Willamette River	Year Round
OR_SR_1709000204_02_103787	Coast Fork Willamette River	Year Round
OR_LK_1709000202_02_100705	Dorena Lake	Year Round
OR_WS_170900020401_02_104238	HUC12 Name: Hill Creek-Coast Fork Willamette River	Year Round
OR_WS_170900020204_02_104230	HUC12 Name: King Creek-Row River	Year Round
OR_WS_170900020203_02_104229	HUC12 Name: Sharps Creek	Year Round
OR_SR_1709000202_02_103765	Layng Creek	Year Round
OR_SR_1709000202_02_103756	Martin Creek	Year Round
OR_SR_1709000201_02_103752	Mosby Creek	Year Round
OR_SR_1709000201_02_103752	Mosby Creek	Spawning
OR_SR_1709000202_02_103761	Row River	Year Round
OR_SR_1709000202_02_103766	Row River	Year Round
OR_SR_1709000202_02_103779	Row River	Year Round
OR_SR_1709000202_02_103755	Sharps Creek	Year Round
OR_SR_1709000202_02_103775	Sharps Creek	Year Round
OR_SR_1709000202_02_103776	Sharps Creek	Year Round

Table 2-4: Upper Willamette Subbasin (17090003) Category 5 temperature impairments on the 2022 Integrated Report.

AU ID	AU Name	Use Period
OR_SR_1709000303_02_103815	Calapooia River	Year Round
OR_SR_1709000303_02_103815	Calapooia River	Spawning
OR_SR_1709000303_02_103816	Calapooia River	Year Round
OR_SR_1709000303_02_103816	Calapooia River	Spawning
OR_SR_1709000304_02_103821	Calapooia River	Year Round
OR_SR_1709000303_02_103819	Courtney Creek	Year Round
OR_SR_1709000301_02_103796	Coyote Creek	Year Round
OR_SR_1709000301_02_103790	Ferguson Creek	Year Round
OR_WS_170900030109_02_104251	HUC12 Name: Bear Creek-Long Tom River	Year Round
OR_WS_170900030510_02_104284	HUC12 Name: Berry Creek	Year Round
OR_WS_170900030302_02_104265	HUC12 Name: Bigs Creek-Calapooia River	Year Round
OR_WS_170900030603_02_104290	HUC12 Name: Flat Creek	Year Round

AU ID	AU Name	Use Period
OR_WS_170900030204_02_104256	HUC12 Name: Greasy Creek	Year Round
OR_WS_170900030301_02_104264	HUC12 Name: Hands Creek-Calapooia River	Year Round
OR_WS_170900030301_02_104264	HUC12 Name: Hands Creek-Calapooia River	Spawning
OR_WS_170900030505_02_104279	HUC12 Name: Jont Creek-Luckiamute River	Year Round
OR_WS_170900030402_02_104273	HUC12 Name: Lower Oak Creek	Year Round
OR_WS_170900030503_02_104277	HUC12 Name: Maxfield Creek-Luckiamute River	Year Round
OR_WS_170900030504_02_104278	HUC12 Name: Pedee Creek-Luckiamute River	Year Round
OR_SR_1709000305_02_103822	Little Luckiamute River	Year Round
OR_SR_1709000301_02_103791	Long Tom River	Year Round
OR_SR_1709000305_02_103829	Luckiamute River	Year Round
OR_SR_1709000302_02_103804	Marys River	Year Round
OR_SR_1709000302_02_103812	Marys River	Year Round
OR_SR_1709000302_02_103813	Marys River	Year Round
OR_SR_1709000305_02_103825	Miller Creek	Year Round
OR_SR_1709000302_02_103806	Muddy Creek	Year Round
OR_SR_1709000306_02_103838	Muddy Creek	Year Round
OR_SR_1709000305_02_103828	North Fork Pedee Creek	Year Round
OR_SR_1709000305_02_103833	Ritner Creek	Year Round
OR_SR_1709000305_02_103832	Soap Creek	Year Round
OR_SR_1709000305_02_103824	Teal Creek	Year Round
OR_SR_1709000306_05_103854	Willamette River	Year Round
OR_SR_1709000306_05_103854	Willamette River	Spawning

Table 2-5: McKenzie Subbasin (17090004) Category 5 temperature impairments on the 2022 Integrated Report.

AU ID	AU Name	Use Period
OR_SR_1709000403_02_103865	Augusta Creek	Year Round
OR_SR_1709000407_02_103889	Camp Creek	Year Round
OR_SR_1709000407_02_103889	Camp Creek	Spawning
OR_SR_1709000406_02_103875	Cartwright Creek	Year Round
OR_SR_1709000406_02_103875	Cartwright Creek	Spawning
OR_SR_1709000407_02_103891	Cedar Creek	Year Round
OR_SR_1709000407_02_103891	Cedar Creek	Spawning
OR_SR_1709000407_02_103882	Deer Creek	Year Round
OR_SR_1709000407_02_103882	Deer Creek	Spawning
OR_SR_1709000403_02_103862	French Pete Creek	Year Round
OR_SR_1709000401_02_103855	Horse Creek	Year Round
OR_SR_1709000401_02_103856	Horse Creek	Year Round
OR_WS_170900040206_02_104310	HUC12 Name: Boulder Creek-McKenzie River	Year Round
OR_WS_170900040705_02_104336	HUC12 Name: Camp Creek	Year Round
OR_WS_170900040205_02_104309	HUC12 Name: Deer Creek	Year Round
OR_WS_170900040702_02_104333	HUC12 Name: East Fork Deer Creek-McKenzie River	Spawning
OR_WS_170900040702_02_104333	HUC12 Name: East Fork Deer Creek-McKenzie River	Year Round
OR_WS_170900040502_02_104326	HUC12 Name: Elk Creek-McKenzie River	Spawning
OR_WS_170900040502_02_104326	HUC12 Name: Elk Creek-McKenzie River	Year Round
OR_WS_170900040209_02_104313	HUC12 Name: Florence Creek-McKenzie River	Year Round
OR_WS_170900040202_02_104306	HUC12 Name: Hackleman Creek-McKenzie River	Year Round
OR_WS_170900040601_02_104327	HUC12 Name: Headwaters Mohawk River	Year Round
OR_WS_170900040204_02_104308	HUC12 Name: Kink Creek-McKenzie River	Year Round
OR_WS_170900040403_02_104324	HUC12 Name: Lower Blue River	Year Round
OR_WS_170900040105_02_104304	HUC12 Name: Lower Horse Creek	Year Round
OR_WS_170900040104_02_104303	HUC12 Name: Middle Horse Creek	Year Round
OR_WS_170900040304_02_104317	HUC12 Name: Rebel Creek-South Fork McKenzie River	Year Round
OR_WS_170900040602_02_104328	HUC12 Name: Shotgun Creek-Mohawk River	Year Round
OR_WS_170900040203_02_104307	HUC12 Name: Smith River	Year Round
OR_WS_170900040402_02_104323	HUC12 Name: Upper Blue River	Year Round

AU ID	AU Name	Use Period
OR_SR_1709000404_02_104571	Lookout Creek	Year Round
OR_SR_1709000404_02_104569	Lower Blue River	Year Round
OR_SR_1709000404_02_104569	Lower Blue River	Spawning
OR_SR_1709000406_02_103879	McGowan Creek	Year Round
OR_SR_1709000406_02_103879	McGowan Creek	Spawning
OR_SR_1709000405_02_103866	McKenzie River	Year Round
OR_SR_1709000405_02_103866	McKenzie River	Spawning
OR_SR_1709000407_02_103884	McKenzie River	Year Round
OR_SR_1709000407_02_103884	McKenzie River	Spawning
OR_SR_1709000406_02_103873	Mill Creek	Year Round
OR_SR_1709000406_02_103874	Mill Creek	Year Round
OR_SR_1709000406_02_103870	Mohawk River	Year Round
OR_SR_1709000406_02_103870	Mohawk River	Spawning
OR_SR_1709000406_02_103871	Mohawk River	Year Round
OR_SR_1709000406_02_103871	Mohawk River	Spawning
OR_SR_1709000406_02_103877	Mohawk River	Year Round
OR_SR_1709000406_02_103877	Mohawk River	Spawning
OR_SR_1709000405_02_103867	Quartz Creek	Year Round
OR_SR_1709000404_02_104576	Quentin Creek	Year Round
OR_SR_1709000406_02_103872	Shotgun Creek	Year Round
OR_SR_1709000403_02_104590	South Fork McKenzie River	Year Round
OR_SR_1709000403_02_104590	South Fork McKenzie River	Spawning
OR_SR_1709000404_02_104574	Upper Blue River	Year Round
OR_SR_1709000404_02_104577	Upper Blue River	Year Round

Table 2-6: North Santiam Subbasin (17090005) Category 5 temperature impairments on the 2022 Integrated Report.

AU ID	AU Name	Use Period
OR_SR_1709000506_02_103928	Bear Branch	Year Round
OR_SR_1709000503_02_103907	Blowout Creek	Year Round
OR_SR_1709000503_02_103909	Blowout Creek	Year Round
OR_SR_1709000502_02_103902	Boulder Creek	Year Round
OR_SR_1709000506_02_103926	Chehulpum Creek	Year Round
OR_SR_1709000505_02_103923	Elkhorn Creek	Year Round
OR_WS_170900050602_02_104360	HUC12 Name: Bear Branch-North Santiam River	Year Round
OR_WS_170900050203_02_104345	HUC12 Name: Marion Creek	Year Round
OR_WS_170900050603_02_104361	HUC12 Name: Marion Creek-North Santiam River	Year Round
OR_WS_170900050603_02_104361	HUC12 Name: Marion Creek-North Santiam River	Spawning
OR_WS_170900050504_02_104563	HUC12 Name: Middle Little North Santiam River	Year Round
OR_WS_170900050301_02_104351	HUC12 Name: Upper Blowout Creek	Year Round
OR_WS_170900050503_02_104567	HUC12 Name: Upper Little North Santiam River	Year Round
OR_SR_1709000505_02_104564	Little North Santiam River	Year Round
OR_SR_1709000505_02_104564	Little North Santiam River	Spawning
OR_SR_1709000504_02_103906	North Santiam River	Spawning
OR_SR_1709000506_02_103930	North Santiam River	Year Round
OR_SR_1709000506_02_103930	North Santiam River	Spawning
OR_SR_1709000506_02_103927	Santiam River	Year Round
OR_SR_1709000506_02_103927	Santiam River	Spawning
OR_SR_1709000506_02_103929	Stout Creek	Year Round

Table 2-7: South Santiam Subbasin (17090006) Category 5 temperature impairments on the 2022 Integrated Report.

AU ID	AU Name	Use Period
OR_SR_1709000606_02_103973	Beaver Creek	Year Round
OR_SR_1709000607_02_103986	Bilyeu Creek	Year Round
OR_SR_1709000607_02_103989	Bilyeu Creek	Year Round
OR_SR_1709000602_02_103949	Canyon Creek	Year Round

AU ID	AU Name	Use Period
OR_SR_1709000606_02_103978	Crabtree Creek	Year Round
OR_SR_1709000606_02_103978	Crabtree Creek	Spawning
OR_LK_1709000604_02_100772	Foster Lake	Year Round
OR_LK_1709000603_02_100771	Green Peter Lake	Year Round
OR_SR_1709000608_02_103993	Hamilton Creek	Year Round
OR_SR_1709000608_02_103993	Hamilton Creek	Spawning
OR_SR_1709000608_02_103996	Hamilton Creek	Year Round
OR_SR_1709000608_02_103996	Hamilton Creek	Spawning
OR_WS_170900060804_02_104398	HUC12 Name: Hamilton Creek	Year Round
OR_WS_170900060501_02_104384	HUC12 Name: Little Wiley Creek	Year Round
OR_WS_170900060705_02_104394	HUC12 Name: Lower Thomas Creek	Year Round
OR_SR_1709000602_02_103955	Latiwi Creek	Year Round
OR_SR_1709000608_02_103994	McDowell Creek	Year Round
OR_SR_1709000601_02_103934	Middle Santiam River	Year Round
OR_SR_1709000601_02_103936	Middle Santiam River	Year Round
OR_SR_1709000601_02_103938	Middle Santiam River	Year Round
OR_SR_1709000603_02_103965	Middle Santiam River	Year Round
OR_SR_1709000604_02_103969	Middle Santiam River	Spawning
OR_SR_1709000602_02_103954	Moose Creek	Year Round
OR_SR_1709000602_02_103954	Moose Creek	Spawning
OR_SR_1709000602_02_103941	Owl Creek	Year Round
OR_SR_1709000601_02_103935	Pyramid Creek	Year Round
OR_SR_1709000603_02_103957	Quartzville Creek	Year Round
OR_SR_1709000603_02_103960	Quartzville Creek	Year Round
OR_SR_1709000608_02_103997	Scott Creek	Year Round
OR_SR_1709000602_02_103953	Sheep Creek	Year Round
OR_SR_1709000602_02_103947	Soda Fork	Year Round
OR_SR_1709000607_02_103985	South Fork Neal Creek	Year Round
OR_SR_1709000602_02_103950	South Santiam River	Year Round
OR_SR_1709000602_02_103950	South Santiam River	Spawning
OR_SR_1709000604_02_103968	South Santiam River	Year Round
OR_SR_1709000604_02_103968	South Santiam River	Spawning
OR_SR_1709000608_02_103925	South Santiam River	Year Round
OR_SR_1709000608_02_103925	South Santiam River	Spawning
OR_SR_1709000607_02_103988	Thomas Creek	Year Round
OR_SR_1709000607_02_103991	Thomas Creek	Year Round
OR_SR_1709000607_02_103991	Thomas Creek	Spawning
OR_SR_1709000602_02_103942	Trout Creek	Year Round
OR_SR_1709000602_02_103948	Two Girls Creek	Year Round
OR_SR_1709000605_02_103971	Wiley Creek	Year Round
OR_SR_1709000605_02_103971	Wiley Creek	Spawning
OR_SR_1709000605_02_103972	Wiley Creek	Year Round
OR_SR_1709000605_02_103972	Wiley Creek	Spawning

Table 2-8: Middle Willamette Subbasin (17090007) Category 5 temperature impairments on the 2022 Integrated Report.

AU ID	AU Name	Use Period
OR_SR_1709000704_02_104017	Abernethy Creek	Year Round
OR_SR_1709000704_02_104594	Abernethy Creek	Year Round
OR_WS_170900070306_02_104417	HUC12 Name: Chehalem Creek	Year Round
OR_WS_170900070301_02_104413	HUC12 Name: Croisan Creek-Willamette River	Year Round
OR_WS_170900070301_02_104413	HUC12 Name: Croisan Creek-Willamette River	Spawning
OR_WS_170900070303_02_104415	HUC12 Name: Glenn Creek-Willamette River	Year Round
OR_WS_170900070304_02_104599	HUC12 Name: Lambert Slough-Willamette River	Year Round
OR_WS_170900070204_02_104412	HUC12 Name: Lower Mill Creek	Year Round
OR_WS_170900070203_02_104411	HUC12 Name: McKinney Creek	Year Round
OR_SR_1709000703_02_104007	Mill Creek	Year Round

AU ID	AU Name	Use Period
OR_SR_1709000703_02_104007	Mill Creek	Spawning
OR_SR_1709000703_02_104012	Pringle Creek	Year Round
OR_SR_1709000701_02_104591	Rickreall Creek	Year Round
OR_SR_1709000703_02_104008	Shelton Ditch	Year Round
OR_SR_1709000703_02_104008	Shelton Ditch	Spawning
OR_SR_1709000701_05_104005	Willamette River	Year Round
OR_SR_1709000701_05_104005	Willamette River	Spawning
OR_SR_1709000703_04_104013	Willamette River	Year Round
OR_SR_1709000703_04_104013	Willamette River	Spawning
OR_SR_1709000703_88_104015	Willamette River	Year Round
OR_SR_1709000704_88_104020	Willamette River	Year Round
OR_LK_1709000703_02_100792	Willamette Slough	Year Round

Table 2-9: Molalla-Pudding Subbasin (17090009) Category 5 temperature impairments on the 2022 Integrated Report.

AU ID	AU Name	Use Period
OR_SR_1709000901_02_104062	Abiqua Creek	Year Round
OR_SR_1709000902_02_104070	Butte Creek	Year Round
OR_SR_1709000902_02_104072	Butte Creek	Year Round
OR_SR_1709000901_02_104069	Drift Creek	Year Round
OR_SR_1709000901_02_104069	Drift Creek	Spawning
OR_WS_170900090303_02_104470	HUC12 Name: Bear Creek	Year Round
OR_WS_170900090204_02_104467	HUC12 Name: Brandy Creek-Pudding River	Year Round
OR_WS_170900090101_02_104454	HUC12 Name: Headwaters Pudding River	Year Round
OR_WS_170900090202_02_104465	HUC12 Name: Middle Butte Creek	Year Round
OR_WS_170900090403_02_104474	HUC12 Name: Pine Creek-Molalla River	Year Round
OR_SR_1709000904_02_104086	Molalla River	Year Round
OR_SR_1709000904_02_104086	Molalla River	Spawning
OR_SR_1709000901_02_104067	Pudding River	Year Round
OR_SR_1709000905_02_104088	Pudding River	Year Round
OR_SR_1709000901_02_104595	Silver Creek	Year Round
OR_SR_1709000901_02_104066	South Fork Silver Creek	Year Round
OR_SR_1709000904_02_104087	Table Rock Fork	Year Round
OR_SR_1709000904_02_104087	Table Rock Fork	Spawning
OR_LK_1709000902_02_100830	Zollner Creek	Year Round

Table 2-10: Clackamas Subbasin (17090011) Category 5 temperature impairments on the 2022 Integrated Report.

AU ID	AU Name	Use Period
OR_SR_1709001104_02_104154	Clackamas River	Year Round
OR_SR_1709001104_02_104154	Clackamas River	Spawning
OR_SR_1709001104_02_104155	Clackamas River	Year Round
OR_SR_1709001104_02_104155	Clackamas River	Spawning
OR_SR_1709001106_02_104597	Clackamas River	Year Round
OR_SR_1709001106_02_104597	Clackamas River	Spawning
OR_SR_1709001101_02_104142	Collawash River	Year Round
OR_SR_1709001101_02_104142	Collawash River	Spawning
OR_SR_1709001101_02_104144	Collawash River	Year Round
OR_SR_1709001105_02_104163	Eagle Creek	Year Round
OR_SR_1709001105_02_104163	Eagle Creek	Spawning
OR_SR_1709001104_02_104156	Fish Creek	Year Round
OR_SR_1709001104_02_104161	Fish Creek	Year Round
OR_SR_1709001104_02_104161	Fish Creek	Spawning
OR_WS_170900110406_02_104539	HUC12 Name: Helion Creek-Clackamas River	Year Round
OR_WS_170900110405_02_104538	HUC12 Name: North Fork Clackamas River	Year Round
OR_WS_170900110402_02_104535	HUC12 Name: Roaring River	Year Round
OR_WS_170900110607_02_104549	HUC12 Name: Rock Creek-Clackamas River	Year Round

AU ID	AU Name	Use Period
OR_WS_170900110501_02_104540	HUC12 Name: Upper Eagle Creek	Year Round
OR_SR_1709001101_02_104145	Nohorn Creek	Year Round
OR_SR_1709001101_02_104145	Nohorn Creek	Spawning
OR_SR_1709001104_02_104152	North Fork Clackamas River	Year Round
OR_SR_1709001105_02_104165	North Fork Eagle Creek	Year Round
OR_SR_1709001104_02_104160	Roaring River	Spawning
OR_SR_1709001104_02_104157	Trout Creek	Year Round

Table 2-11: Lower Willamette Subbasin (17090012) Category 5 temperature impairments on the 2022 Integrated Report.

AU ID	AU Name	Use Period
OR_WS_170900120202_02_104555	HUC12 Name: Balch Creek-Willamette River	Year Round
OR_WS_170900120201_02_104554.1	HUC12 Name: Columbia Slough (Lower)	Year Round
OR_WS_170900120201_02_104554.2	HUC12 Name: Columbia Slough (Upper)	Year Round
OR_WS_170900120103_02_104552	HUC12 Name: Lower Johnson Creek	Year Round
OR_WS_170900120103_02_104552	HUC12 Name: Lower Johnson Creek	Spawning
OR_WS_170900120305_02_104561	HUC12 Name: Multnomah Channel	Year Round
OR_WS_170900120104_02_104553	HUC12 Name: Oswego Creek-Willamette River	Year Round
OR_WS_170900120104_02_104553	HUC12 Name: Oswego Creek-Willamette River	Spawning
OR_WS_170900120301_02_104557	HUC12 Name: South Scappoose Creek	Spawning
OR_WS_170900120101_02_104550	HUC12 Name: Upper Johnson Creek	Year Round
OR_WS_170900120101_02_104550	HUC12 Name: Upper Johnson Creek	Spawning
OR_SR_1709001201_02_104170	Johnson Creek	Year Round
OR_SR_1709001201_02_104170	Johnson Creek	Spawning
OR_SR_1709001203_02_104176	Milton Creek	Year Round
OR_SR_1709001203_02_104176	Milton Creek	Spawning
OR_SR_1709001203_88_104184	Multnomah Channel	Year Round
OR_SR_1709001203_02_104179	North Scappoose Creek	Year Round
OR_SR_1709001203_02_104179	North Scappoose Creek	Spawning
OR_SR_1709001203_02_104180	South Scappoose Creek	Year Round
OR_SR_1709001203_02_104180	South Scappoose Creek	Spawning
OR_SR_1709001201_88_104019	Willamette River	Year Round
OR_SR_1709001202_88_104175	Willamette River	Year Round

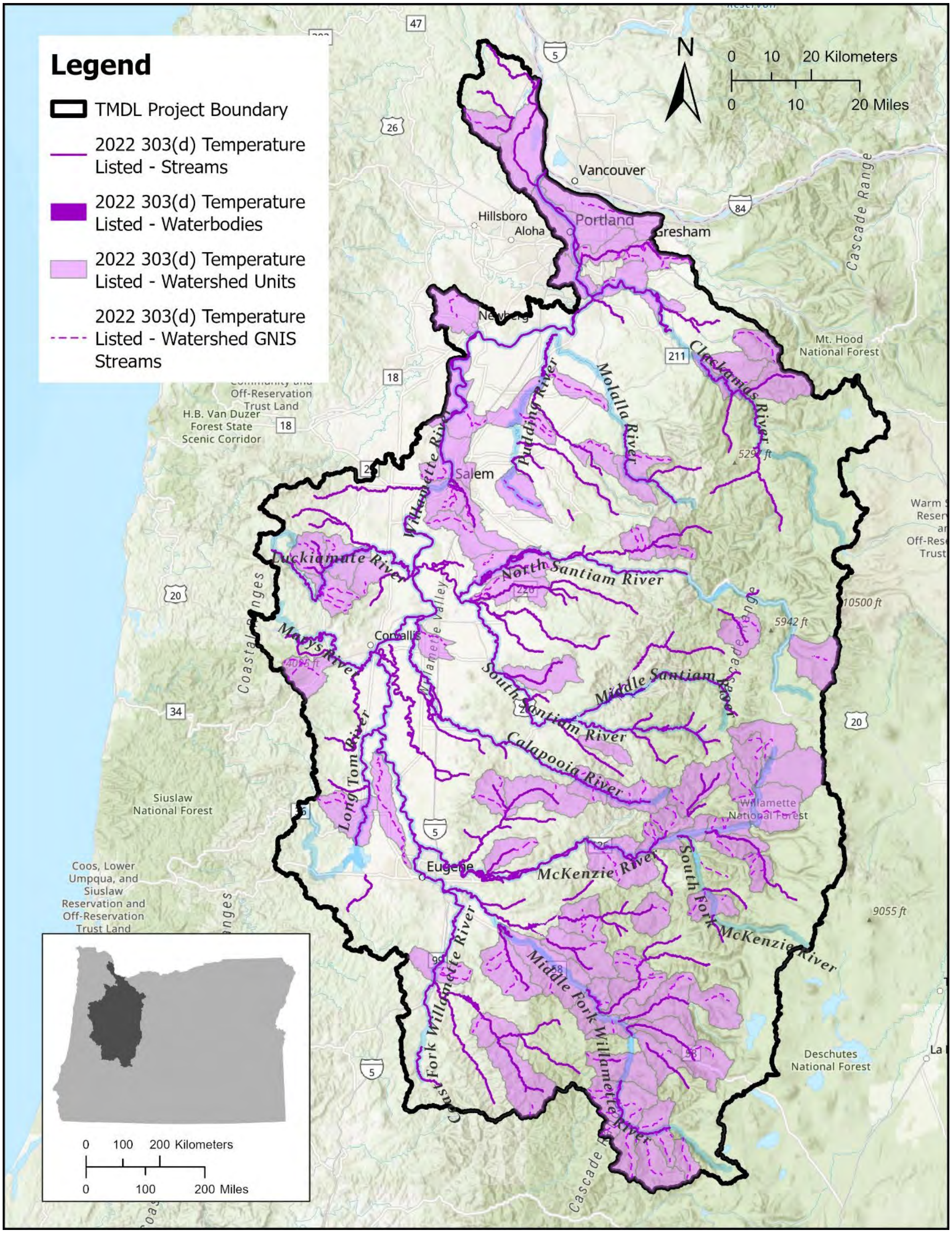

Figure 2-2: Willamette Subbasins Category 5 temperature impairments on the 2022 Integrated Report.

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.

Temperature is the water quality parameter of concern, but heat or thermal loading is the pollutant of concern causing impairment. Heat caused by human activities are of particular concern.

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). 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 as a surrogate measure for thermal loading caused by excessive solar radiation. Effective shade is the percent of the daily solar radiation flux blocked by vegetation and topography. Implementation of the surrogate measures ensures achievement of necessary pollutant reductions and the nonpoint load allocations for this temperature TMDL.

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 Willamette Subbasins surface water and the applicable numeric and narrative water quality standards and antidegradation rule and policy addressed by these TMDLs, as well as indicate 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 for that parameter.

Table 4-1: Designated beneficial uses in the Willamette Subbasins as identified in OAR 340-041-0340 Table 340A.

Beneficial Uses	All waterbodies
Public Domestic Water Supply	X
Private Domestic Water Supply	X
Industrial Water Supply	X
Irrigation	X
Livestock Watering	X
Fish and Aquatic Life	X
Wildlife and Hunting	X
Fishing	X

Beneficial Uses	All waterbodies
Boating	X
Water Contact Recreation	X
Aesthetic Quality	X
Hydro Power	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
Statewide Narrative Criteria	OAR 340-041-0007(1)	The highest and best practicable treatment and/or control of wastes, 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 <u>water temperatures</u>, 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 340-041-0340 Figures 340A and 340B	(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) (d) The 7-day average maximum temperature may not exceed 20.0˚C (68.0˚F) and cold water refugia that are sufficiently distributed. (f) The 7-day average maximum temperature may not exceed 12.0˚C (53.6 ˚F). From August 15 through May 15 there may be no more than a 0.3°C (0.5°F) increase between the water temperature immediately upstream of Carmen reservoir on the Upper McKenzie River and the water temperature immediately downstream of the spillway when the ambient seven-day-average maximum stream temperature is 9.0°C (48°F) or greater, and no more than a 1.0°C (1.8°F)	See OAR Figures 340A and 340B (**Figure 4-1** and **Figure 4-2** in this document)	Salmonid and steelhead spawning Bull Trout spawning and juvenile rearing use

Parameter	Rule Citation	Summary of applicable standards	Waters where standards are applicable	Most sensitive beneficial use
		increase when the seven-day-average stream temperature is less than 9°C.		
	OAR 340-041-0028(6)	Natural lakes may not be warmed by more than 0.3°C (0.5°F) above the natural condition unless a greater increase would not reasonably be expected to adversely affect fish or other aquatic life.	Natural Lakes	Fish and aquatic life
	OAR 340-041-0028(9)	No increase in temperature is allowed that would reasonably be expected to impair cool water species.	Cool Water	Cool water aquatic life
	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 bull trout 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 waterbody, and at the point of maximum impact.	All waters of the state	Salmonid and steelhead spawning
	Antidegradation OAR 340-041-0004 and 40 CFR 131.12(a)(2)	(3)(c) Insignificant temperature increases authorized under OAR 340-041-0028(11) and (12) are not considered a reduction in water quality.		
		(5)(a) Riparian Restoration Activities Exemption: When DEQ determines that activities to restore geomorphology or riparian vegetation have a net ecological benefit, antidegradation review is not needed.		

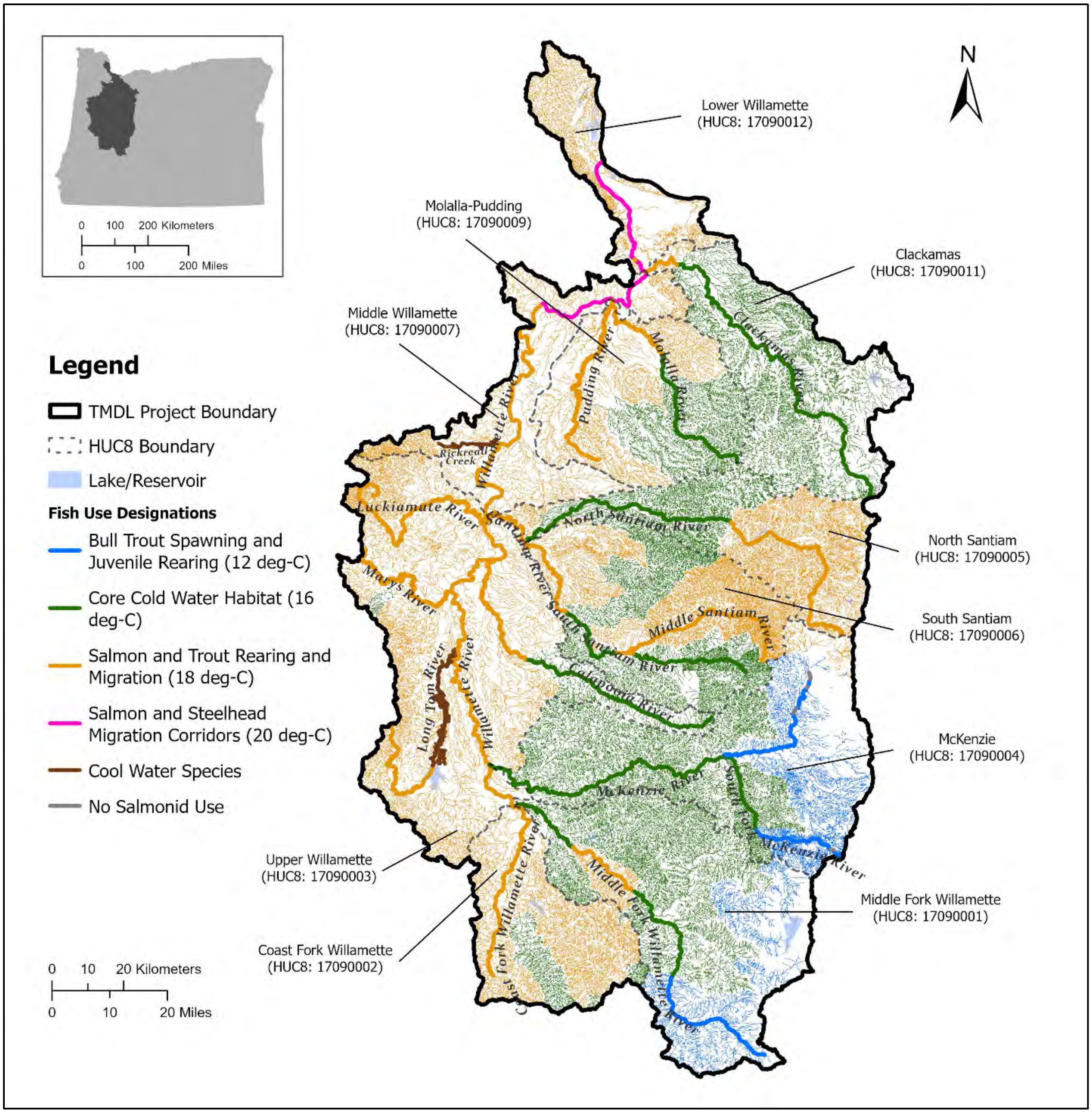

Figure 4-1: Fish use designations in the Willamette Subbasins TMDL project area.

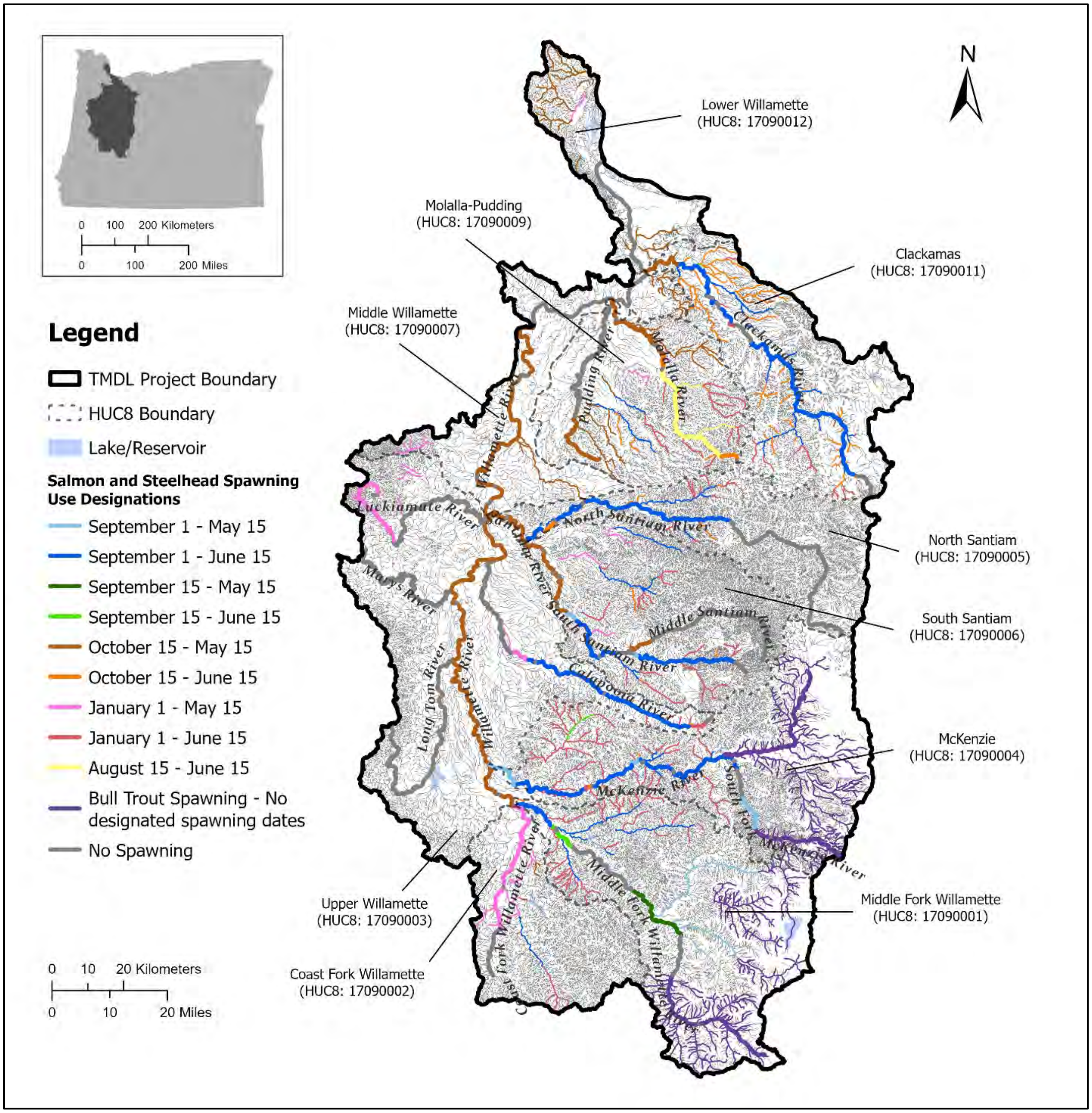

Figure 4-2: Salmon and steelhead spawning use designations in the Willamette Subbasins TMDL project area.

4.1 Human use allowance

Oregon water quality standards also have provisions for human use (OAR 340-041-0028(12)(b)). The human use allowance (HUA) is an insignificant addition of heat (0.3°C) authorized in waters that exceed the applicable temperature criteria. The applicable temperature criteria are defined in OAR 340-041-0002(4) to mean “the biologically based temperature criteria in OAR 340-041-0028(4), or the superseding cold water protection criteria in 340-041-0028(11)”. Following a temperature TMDL, or other cumulative effects analysis, wasteload and load allocations will restrict all National Pollutant Discharge Elimination System (NPDES) point sources and nonpoint sources to a cumulative increase of no greater than 0.3°C (0.5°F) above the applicable biological criterion after complete mixing in the waterbody, and at the point of maximum impact (POMI). The rationale behind selection of 0.3°C for the HUA and how DEQ implements this portion of the standard can be found in the Staff Report to the EQC (DEQ, 2003) and DEQ's Internal Management Directive (IMD) for temperature water quality standard implementation (DEQ, 2008).

4.2 Cool Water Species

The narrative cool water species criterion in rule at OAR 340-041-0028(9)(a) states that "No increase in temperature is allowed that would reasonably be expected to impair cool water species." The Long Tom River (Upper Willamette Subbasin) and Rickreall Creek (Middle Willamette Subbasin) are the only waterbodies designated for cool water species use in the Willamette Subbasins.

4.2.1 Long Tom River

The cool water species designation on the Long Tom River applies from the mouth at the confluence with the Willamette River (river mile 0) to Fern Ridge Dam (approximate river mile 24.1). In consultation with ODFW, DEQ determined what cool water species are present in the Long Tom River and translated the narrative criterion into a target temperature based on the thermal tolerance information available for those species. Redside shiner (*Richardsonius balteatus*) are the most temperature sensitive cool water species in the Long Tom River with studies showing an upper lethal temperature threshold between 22.8°C and 27.7°C (Black, 1953). DEQ also determined that Chinook Salmon (Oncorhynchus tshawytscha) are present from approximately November 1 to June 14. Spawning of Chiselmouth, Northern Pikeminnow, Peamouth, and Mountain Sucker could occur in the lower reach between April and July. These species initiate spawning when water temperatures exceed 12°C to18°C. DEQ will rely upon the 18.0°C target temperature established for protection of salmon and trout rearing and migration uses suggested by EPA guidance (EPA, 2003) and adopted in Oregon's water quality standards (OAR 340-041-0028 (4)(c)).

Based on these findings, the temperature targets (**Table 4-3**) for the Long Tom River are:
1) 24.0°C + 0.3°C human use allowance from June 15 through October 31 based thermal tolerance for Redside Shiner.
2) 18.0°C + 0.3°C human use allowance (HUA) from November 1 to June 14 based on Spring Chinook rearing and juvenile migration and spawning preferences for Mountain Sucker, Peamouth, and Chiselmouth.

Table 4-3: Summary of temperature targets implementing the cool water species narrative in lower Long Tom River.

Time period	7DADM Temperature Target (°C)	Most Temperature Sensitive Species
June 15 – October 31	24.0 + 0.3 HUA	Redside shiner (*Richardsonius balteatus*)
November 1 – June 14	18.0 + 0.3 HUA	Chinook Salmon (*Oncorhynchus tshawytscha*)

If 7DADM temperatures trend to always being cooler than temperature targets presented in Table 4 3, the protecting cold water criterion at OAR 340-041-0028 (11) shall be applied with the 0.3°C human use allowance based on an increase above the cooler ambient temperature.

Analysis and rationale for the numeric temperature targets are further described in the TMDL Technical Support Document, Section 4.8.

The mixing zone and thermal plume limitations in OAR 340-041-0053 (2)(E)(d) will provide further protections against potential migration blockages and acute impacts. This TMDL assumes assessment and application of thermal plume limitations, as necessary, will be completed during the NPDES permit renewal process.

4.2.2 Rickreall Creek

The cool water species designation on Rickreall Creek applies from the mouth at the confluence of the Willamette River (river mile 0) to the east end of Dallas City Park at approximately river mile 14. In consultation with the Oregon Department of Fish & Wildlife (ODFW), DEQ determined what cool water species are present in Rickreall Creek and translated the narrative criterion into a target temperature based on the thermal tolerance information available for those species. Prickly sculpin are the most temperature sensitive cool water species in lower Rickreall Creek with studies showing complete survival after 24 hours at 22.8°C (Black, 1953). DEQ also determined that adult winter steelhead (*Oncorhynchus mykiss*), Coho salmon, and Chinook salmon may be migrating through the lower reach of Rickreall Creek, and juvenile winter steelhead or Coastal Cutthroat trout (*Oncorhynchus clarkii*) may be rearing in lower Rickreall Creek. Based on ODFW's timing tables, steelhead may migrate through lower Rickreall Creek from February 15 through May 31. In addition, there may be resident trout present in this segment, particularly at the upper end, from October through spring. DEQ will rely upon the 18.0°C target temperature established for protection of salmon and trout rearing and migration uses suggested by EPA's guidance (EPA, 2003) and adopted in Oregon's water quality standards (OAR 340-041-0028 (4)(c)).

Based on these findings, from June 1 to September 30, where the cool water species criterion applies in Rickreall Creek, warming from anthropogenic sources shall be limited to a cumulative increase of no greater than 0.3°C above 22.8°C after complete mixing in the waterbody, and at the POMI. During the remainder of the year (October 1 – May 31), the numeric target protecting cool water fish and migrating or rearing cold water fish is an instream 7-day average daily maximum (7DADM) temperature target of 18.0°C plus an insignificant addition of heat for human use equal to 0.3°C after complete mixing in the waterbody, and at the POMI. A summary of the temperature targets are presented in **Table 4-4**.

The provisions of the protecting cold water criterion at OAR 340-41-0028(11) are also incorporated into the temperature target. If ambient 7DADM temperatures trend to always being cooler than both temperature targets presented in **Table 4-4** and all exceptions outlined in OAR 340-41-0028(11)(c) are not applicable, the protecting cold water shall be applied with the 0.3°C HUA based on an increase above the cooler ambient temperature.

Analysis and rationale for the numeric temperature targets are further described in the TMDL Technical Support Document Section 4.8.

The mixing zone and thermal plume limitations in OAR 340-041-0053 (2)(E)(d) will provide further protections against potential migration blockages and acute impacts. This TMDL assumes assessment and application of thermal plume limitations, as necessary, will be completed during the NPDES permit renewal process.

Table 4-4: Summary of temperature targets implementing the cool water species narrative in lower Rickreall Creek.

Time period	7DADM Temperature Target (°C)	Most Temperature Sensitive Species
June 1 – September 30	22.8 + 0.3 HUA	Prickly sculpin (*Cottus asper*)
October 1 – May 31	18.0 + 0.3 HUA	Winter steelhead (*Oncorhynchus mykiss*)

5 Seasonal variation and critical period for temperature

Per OAR 340-042-0040(4)(j) and 40 Code of Federal Regulation 130.7(c)(1), TMDLs must also identify any seasonal variation and the critical condition or period of each pollutant, if applicable.

Maximum 7DADM stream temperatures typically occur in July or August when stream flows are low, solar radiation fluxes are high, and ambient air temperature conditions are warmest. Maximum 7DADM temperatures downstream of some large dam and reservoir operations are shifted from July and August to September, October, and November.

The critical period is based on the frequency and period when 7DADM stream temperatures exceed the applicable temperature criteria. DEQ uses the critical period to determine when allocations apply. In setting this period, DEQ relied upon monitoring sites with the longest period of exceedance and frequency of exceedance. When downstream monitoring sites have longer exceedance periods relative to upstream waters, the longer period is used as the critical period for upstream waterbodies. This is a margin of safety to ensure warming of upstream waters does not contribute to downstream exceedances.

The critical periods for waterbodies in the Willamette Subbasins are presented in **Table 5-1**. Allocations presented in the TMDL apply during these periods. Section 5 of the TSD summarizes the critical period approach and presents plots of 7DADM temperature data used to determine seasonal variation and the critical periods.

Table 5-1: Designated critical periods for waterbodies in the Willamette Subbasins.

Subbasin	Watershed or Waterbody Name	Critical Period
Middle Fork Willamette Subbasin 17090001	All waters, except those noted	May 1 – October 31
	Middle Fork Willamette River from Hills Creek Dam to North Fork Middle Fork Willamette River OR_SR_1709000105_02_104580 OR_SR_1709000105_02_103720	May 1 – November 30
	Middle Fork Willamette River from North Fork Middle Fork Willamette River to Dexter Reservoir OR_SR_1709000107_02_103725	May 1 – November 15
	Middle Fork Willamette River downstream from Dexter Reservoir OR_SR_1709000107_02_104583 OR_SR_1709000110_02_103750 OR_SR_1709000110_02_104584	April 1 – November 15
	Fall Creek downstream from Fall Creek Dam OR_SR_1709000109_02_103735	April 1 – November 15
	Lookout Point Lake OR_LK_1709000107_02_100700 Dexter Reservoir OR_LK_1709000107_02_100699	May 1 – November 15
Coast Fork Willamette Subbasin 17090002	All waters, except those noted	May 1 – October 31
	Coast Fork Willamette River downstream from Cottage Grove Dam OR_SR_1709000203_02_104585 OR_SR_1709000204_02_103787	April 1 – November 15
	Row River downstream from Dorena Dam. OR_SR_1709000202_02_103779	April 1 – November 15
Upper Willamette Subbasin 17090003	All waters, except those noted	May 1 – October 31
	Long Tom River downstream of Fern Ridge Reservoir OR_SR_1709000301_02_10379	April 1 – November 15
	Willamette River	April 1 – November 15
McKenzie River Subbasin 17090004	All waters, except those noted	May 1 – October 31
	McKenzie River Watershed (1709000407)	April 1 – November 15
	Lower Blue River from Blue River Dam to McKenzie River AU: OR_SR_1709000404_02_104569	May 1 – November 15
	All waters, except those noted	May 1 – October 31

Subbasin	Watershed or Waterbody Name	Critical Period
North Santiam Subbasin 17090005	North Santiam River downstream from Detroit Dam OR_SR_1709000504_02_103906 OR_SR_1709000506_02_103930	April 1 – November 15
South Santiam Subbasin 17090006	All waters, except those noted	May 1 – October 31
	Middle Santiam River from Green Peter Dam to Foster Lake: OR_SR_1709000604_02_103969	May 1 – November 30
	South Santiam River downstream from Foster Dam OR_SR_1709000608_02_103925	April 1 – November 15
	Santiam River OR_SR_1709000506_02_10392	April 1 – November 15
Middle Willamette Subbasin 17090007	All waters, except those noted	May 1 – October 31
	Willamette River upstream of the Yamhill River	April 1 – November 15
	Willamette River downstream of the Yamhill River	June 1 – September 30
Molalla-Pudding Subbasin 17090009	All waters	May 1 – October 31
Clackamas Subbasin 17090011	All waters, except those noted	May 1 – October 31
	Clackamas River downstream of River Mill Dam OR_SR_1709001106_02_104597	April 1 – November 15
Lower Willamette Subbasin 17090012	All waters, except those noted	April 1 – October 31
	Johnson Creek Watershed (1709001201)	February 15 – November 15
	Willamette River downstream of the Yamhill River	June 1 – September 30
	Multnomah Channel OR_SR_1709001203_88_10418	June 1 – September 30

6 Temperature water quality data evaluation overview

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 temperature models were used in this effort and are described in the TSD model appendices.

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

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

Figure 6-1 provides an overview of the analyses completed for this TMDL.

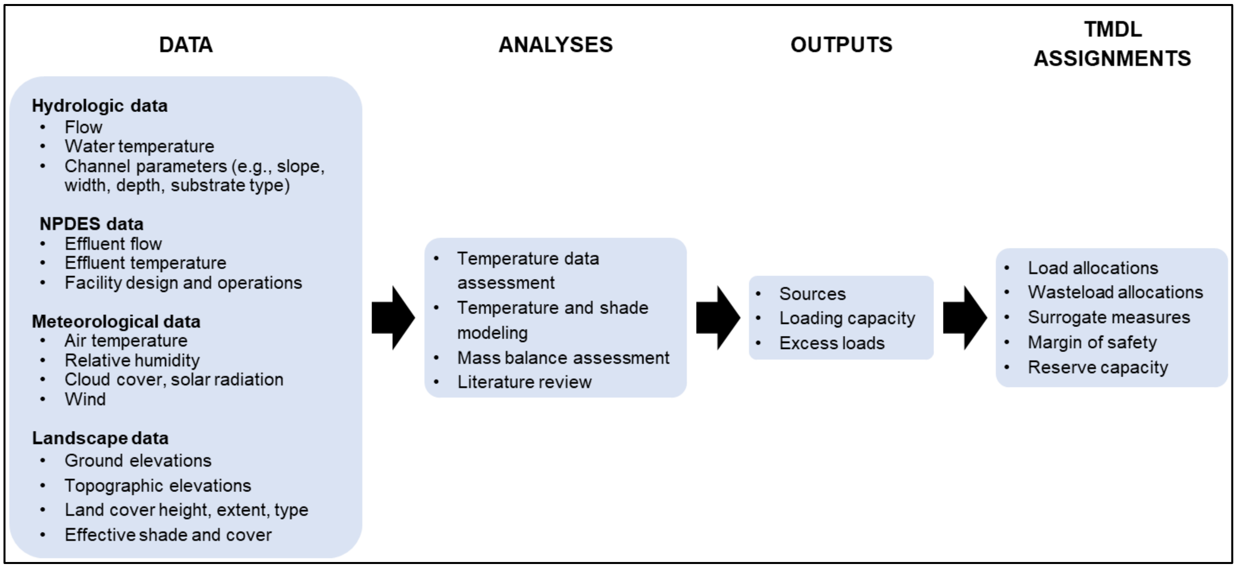

Figure 6-1: Willamette Subbasins temperature analysis overview.

7 Pollutant sources or source categories

As noted in OAR 340-042-0040(4)(f) and OAR 340-042-0030(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 nonpoint sources are sources of thermal pollution to surface waters in the Willamette Subbasins. 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 340-045-0010(17) defines a 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 121 domestic or industrial individual NPDES permitted point source discharges within the Willamette Subbasins identified as potential sources of thermal load (**Table 7-1**). There also are 21 individual Municipal Separate Storm Sewer System (MS4) NPDES permittees.

Portland International Airport is an individual NPDES permitted point source that only discharges stormwater during the TMDL allocation period. For this reason, Portland International Airport is included in **Table 7-2** as a facility where stormwater requirements apply.

Table 7-1: Individual NPDES permitted point source discharges that have the potential to contribute thermal loads to Willamette Subbasins 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 (AU ID)	River mile
Adair Village STP	NPDES-DOM-Da	500	OR0023396	Willamette River (OR_SR_1709000306_05_103854)	122
Albany Millersburg WRF	NPDES-DOM-Ba	1098	OR0028801	Willamette River (OR_SR_1709000306_05_103854)	118
Alpine Community	NPDES-DOM-Db	100101	OR0032387	Muddy Creek (OR_SR_1709000302_02_103808)	25.6
Arclin	NPDES-IW-B10	81714	OR0000892	Columbia Slough (OR_WS_170900120201_02_104554.1)	6
Arclin	NPDES-IW-B16	16037	OR0021857	Patterson Slough (OR_WS_170900030601_02_104287)	1.8
Arkema	NPDES-IW-B14	68471	OR0044695	Willamette River (OR_SR_1709001202_88_104175)	7.2
Ash Grove Cement - Rivergate Lime Plant	NPDES-IW-B16	3690	OR0001601	Willamette River (OR_SR_1709001202_88_104175)	3.3
ATI Albany Operations	NPDES-IW-B08	64300	OR0001716	Oak Creek (OR_WS_170900030402_02_104273)	1.6
ATI Millersburg	NPDES-IW-B07	87645	OR0001112	Willamette River (OR_SR_1709000306_05_103854)	2
Aumsville STP	NPDES-DOM-Db	4475	OR0022721	Beaver Creek (OR_WS_170900070202_02_104410)	2.5
Aurora STP	NPDES-DOM-Db	110020	OR0043991	Pudding River (OR_SR_1709000905_02_104088)	8.8
Bakelite Chemicals LLC	NPDES-IW-B16	32864	OR0002101	Amazon Creek (OR_WS_170900030108_02_104250)	2.7
Bakelite Chemicals LLC	NPDES-IW-B16	32650	OR0032107	Murder Creek (OR_WS_170900030610_02_104298)	0.6
Blount Oregon Cutting Systems Division	NPDES-IW-B16	63545	OR0032298	Minthorne Creek (OR_WS_170900120102_02_104551)	0.9

Permittee	Permit type	DEQ WQ File Number	EPA Number	Receiving water name (AU ID)	River mile
Boeing Of Portland – Fabrication Division	NPDES-IW-B16	9269	OR0031828	Osburn Creek (OR_WS_170900120201_02_104554.2)	1.6
Brooks STP	NPDES-DOM-Db	100077	OR0033049	Willamette River (OR_SR_1709000703_04_104013)	71.7
Brownsville STP	NPDES-DOM-Db	11770	OR0020079	Calapooia River (OR_SR_1709000303_02_103816)	31.6
Canby Regency Mobile Home Park	NPDES-DOM-Da	97612	OR0026280	Willamette River (OR_SR_1709000704_88_104020)	31.6
Canby STP	NPDES-DOM-C1a	13691	OR0020214	Willamette River (OR_SR_1709000704_88_104020)	33
Cascade Pacific Pulp, LLC	NPDES-IW-B01	36335	OR0001074	Willamette River (OR_SR_1709000306_05_103854)	147.7
Century Meadows Sanitary System (CMSS)	NPDES-DOM-Da	96010	OR0028037	Willamette River (OR_SR_1709000704_88_104020)	42.8
Coburg Wastewater Treatment Plant	NPDES-DOM-Da	115851	OR0044628	Muddy Creek (OR_WS_170900030606_02_104294)	50.7
Coffin Butte Landfill	NPDES-IW-B15	104176	OR0043630	Roadside ditch to Soap Creek tributary (OR_WS_170900030511_02_104285)	4.5
Columbia Helicopters	NPDES-IW-B16	100541	OR0033391	Unnamed Stream (tributary to Pudding River) (OR_WS_170900090502_02_104481)	2
Corvallis STP	NPDES-DOM-Ba	20151	OR0026361	Willamette River (OR_SR_1709000306_05_103854)	130.8
Cottage Grove STP	NPDES-DOM-C2a	20306	OR0020559	Coast Fork Willamette River (OR_SR_1709000203_02_104585)	20.6
Covanta Marion, Inc	NPDES-IW-B16	89638	OR0031305	Willamette River (OR_SR_1709000703_04_104013)	72
Creswell STP	NPDES-DOM-Db	20927	OR0027545	Unnamed stream (tributary to Camas Swale Creek) (OR_WS_170900020403_02_104240)	4
Dallas STP	NPDES-DOM-C1a	22546	OR0020737	Rickreall Creek (OR_SR_1709000701_02_104591)	9.3
Dundee STP	NPDES-DOM-Db	25567	OR0023388	Willamette River (OR_SR_1709000703_04_104013)	51.7
Duraflake	NPDES-IW-B20	97047	OR0000426	Murder Creek (OR_WS_170900030610_02_104298)	0.57
Estacada STP	NPDES-DOM-Da	27866	OR0020575	Clackamas River (OR_LK_1709001106_02_100850)	23.3
Evraz Oregon Steel	NPDES-IW-B08	64905	OR0000451	Willamette River (OR_SR_1709001202_88_104175)	2.4
EWEB Carmen-Smith Trail Bridge Powerhouse	NPDES-IW-B16	28393	OR0000680	McKenzie River (OR_SR_1709000402_02_104588)	76
EWEB Carmen-Smith Carmen Powerhouse	NPDES-IW-B16	28393	OR0000680	Trail Bridge Reservoir/McKenzie River (OR_LK_1709000402_02_100742)	77
Falls City STP	NPDES-DOM-Da	28830	OR0032701	Little Luckiamute River (OR_SR_1709000305_02_103822)	12

Permittee	Permit type	DEQ WQ File Number	EPA Number	Receiving water name (AU ID)	River mile
Forest Park Mobile Village	NPDES-DOM-Da	30554	OR0031267	Willamette River (OR_SR_1709000704_88_104020)	28.2
Foster Farms	NPDES-IW-B04	97246	OR0026450	Camas Swale Creek (OR_SR_1709000204_02_103786)	3.3
Frank Lumber Co. Inc.	NPDES-IW-B19	30904	OR0000124	North Santiam River (OR_SR_1709000504_02_103906)	32.5
Fujimi Corporation – SW Commerce Circle	NPDES-IW-B15	107178	OR0040339	Coffee Lake Creek (OR_WS_170900070402_02_104419)	1.8
Gervais STP	NPDES-DOM-Db	33060	OR0027391	Pudding River (OR_SR_1709000902_02_104073)	28.2
GP Halsey Mill	NPDES-IW-B01	105814	OR0033405	Willamette River (OR_SR_1709000306_05_103854)	147.7
Halsey STP	NPDES-DOM-Db	36320	OR0022390	Muddy Creek (OR_SR_1709000306_02_103838)	23
Harrisburg Lagoon Treatment Plant	NPDES-DOM-Db	105415	OR0033260	Willamette River (OR_SR_1709000306_05_103854)	158.4
Hollingsworth & Vose Fiber Co - Corvallis	NPDES-IW-B15	28476	OR0000299	Willamette River (OR_SR_1709000306_05_103854)	132.5
Hubbard STP	NPDES-DOM-Da	40494	OR0020591	Mill Creek (OR_WS_170900090502_02_104481)	5.3
Hull-Oakes Lumber Co.	NPDES-IW-B19	107228	OR0038032	Oliver Creek (OR_SR_1709000302_02_103807)	4.8
Independence STP	NPDES-DOM-Db	41513	OR0020443	Willamette River (OR_SR_1709000701_05_104005)	95.5
International Paper – Springfield Paper Mill (Outfall 1 + Outfall 2)	NPDES-IW-B01	96244	OR0000515	McKenzie River (OR_SR_1709000407_02_103884)	8
International Paper – Springfield Paper Mill (Outfall 3)	NPDES-IW-B01	96244	OR0000515	Storm Ditch to Q Street Canal (OR_WS_170900030601_02_104287)	0
J.H. Baxter & Co., Inc.	NPDES-IW-B21	6553	OR0021911	Amazon Diversion Canal (OR_WS_170900030108_02_104250)	1.5
Jasper Wood Products, LLC	NPDES-IW-B21	100097	OR0042994	Middle Fork Willamette River (OR_SR_1709000110_02_104584)	9
Jefferson STP	NPDES-DOM-Da	43129	OR0020451	Santiam River (OR_SR_1709000506_02_103927)	9.2
JLR, LLC	NPDES-IW-B05	32536	OR0001015	Pudding River (OR_SR_1709000902_02_104073)	27
Junction City STP	NPDES-DOM-Db	44509	OR0026565	Flat Creek (OR_WS_170900030603_02_104290)	9.2
Kingsford Manufacturing Company – Springfield Plant	NPDES-IW-B20	46000	OR0031330	Patterson Slough (OR_WS_170900030601_02_104287)	3.7
Knoll Terrace MHC	NPDES-DOM-Db	46990	OR0026956	Mountain View Creek (OR_WS_170900030609_02_104297)	0.4

Permittee	Permit type	DEQ WQ File Number	EPA Number	Receiving water name (AU ID)	River mile
Lakewood Utilities, Ltd	NPDES-DOM-Da	96110	OR0027570	Mill Creek (Molalla-Pudding Subbasin) (OR_WS_170900090502_02_104481 _	3.9
Lane Community College	NPDES-DOM-Db	48854	OR0026875	Russel Creek (OR_WS_170900020405_02_104242)	0.7
Lebanon WWTP	NPDES-DOM-C1a	49764	OR0020818	South Santiam River (OR_SR_1709000608_02_103925)	17.4
Lowell STP	NPDES-DOM-Da	51447	OR0020044	Dexter Reservoir 20 ft upstream of the Dexter dam penstock (OR_LK_1709000107_02_100699)	0
Mcfarland Cascade Pole & Lumber Co	NPDES-IW-B21	54370	OR0031003	Storm Ditch to Amazon Creek (OR_WS_170900030108_02_104250)	1.8
Molalla STP	NPDES-DOM-Db	57613	OR0022381	Molalla River (OR_SR_1709000906_02_104093)	8.2
Monmouth STP	NPDES-DOM-Db	57871	OR0020613	Willamette River (OR_SR_1709000701_05_104005)	95.5
Monroe STP	NPDES-DOM-Db	57951	OR0029203	Long Tom River (OR_SR_1709000301_02_103791)	6.9
Mt. Angel STP	NPDES-DOM-Da	58707	OR0028762	Pudding River (OR_SR_1709000901_02_104064)	37.5
Murphy Veneer, Foster Division	NPDES-IW-B20	97070	OR0021741	Wiley Creek (OR_SR_1709000605_02_103971)	0.9
MWMC - Eugene/Springfield STP	NPDES-DOM-A2	55999	OR0031224	Willamette River (OR_SR_1709000306_05_103854)	178
Newberg - Wynooski Road STP	NPDES-DOM-C1a	102894	OR0032352	Willamette River (OR_SR_1709000703_88_104015)	49.7
Newberg OR, LLC	NPDES-IW-B01	72615	OR0000558	Willamette River (OR_SR_1709000703_88_104015)	49.7
Norpac Foods – Brooks Plant No. 5	NPDES-IW-B04	84791	OR0021261	Fitzpatrick Creek (OR_WS_170900090109_02_104462)	1
Norpac Foods-Plant #1, Stayton	NPDES-IW-B04	84820	OR0001228	Salem Ditch (flows to Mill Creek) (OR_WS_170900070201_02_104409)	3.7
NW Natural Gas Site Remediation	NPDES-IW-B14	120589	OR0044687	Willamette River (OR_SR_1709001202_88_104175)	6.4
Oak Lodge Water Services Water Reclamation Facility	NPDES-DOM-C1a	62795	OR0026140	Willamette River (OR_SR_1709001201_88_104019)	20.1
Oakridge STP	NPDES-DOM-Da	62886	OR0022314	Middle Fork Willamette River (OR_SR_1709000105_02_103720)	39.8
ODC – Oregon State Penitentiary	NPDES-IW-B15	109727	OR0043770	Mill Creek (Middle Willamette Subbasin) (OR_SR_1709000703_02_104007)	2.5
ODFW - Clackamas River Hatchery	NPDES-IW-B17	64442	OR0034266	Clackamas River (OR_SR_1709001106_02_104597)	22.6
ODFW - Dexter Ponds	GEN 300-J	64450	ORG133514	North Santiam River (OR_SR_1709000504_02_103906)	41.1

Permittee	Permit type	DEQ WQ File Number	EPA Number	Receiving water name (AU ID)	River mile
ODFW – Leaburg Hatchery	NPDES-IW-B17	64490	OR0027642	McKenzie River (OR_SR_1709000407_02_103884)	33.7
ODFW – Marion Forks Hatchery	NPDES-IW-B17	64495	OR0027847	Horn Creek (OR_WS_170900050203_02_104345)	0.1
ODFW – McKenzie River Hatchery	NPDES-IW-B17	64500	OR0029769	McKenzie River (OR_SR_1709000407_02_103884)	31.5
ODFW - Minto Fish Facility	NPDES-IW-B17	64495	OR0027847	Middle Fork Willamette River (OR_SR_1709000107_02_104583)	41.1
ODFW - South Santiam Hatchery	GEN 300-J	64560	ORG133511	South Santiam River (OR_SR_1709000608_02_103925)	37.8
OHSU Center For Health and Healing	NPDES-IW-B16	113611	OR0034371	Willamette River (OR_SR_1709001202_88_104175)	14.5
OSU John L. Fryer Aquatic Animal Health Lab	NPDES-IW-B15	103919	OR0032573	Willamette River (OR_SR_1709000306_05_103854)	130.6
Philomath WWTP	NPDES-DOM-Db	103468	OR0032441	Marys River (OR_SR_1709000302_02_103813)	10.2
RSG Forest Products – Liberal	NPDES-IW-B19	72596	OR0021300	Unnamed ditch to Molalla River (OR_WS_170900090607_02_104488)	9.8
Salem Willow Lake STP	NPDES-DOM-A2	78140	OR0026409	Willamette River (OR_SR_1709000703_04_104013)	78.4
Sandy WWTP	NPDES-DOM-Da	78615	OR0026573	Tickle Creek (OR_WS_170900110604_02_104546)	3.1
Scappoose STP	NPDES-DOM-Da	78980	OR0022420	Multnomah Channel (OR_SR_1709001203_88_104184)	10.6
Scio STP	NPDES-DOM-Db	79633	OR0029301	Thomas Creek (OR_SR_1709000607_02_103988)	7.2
Seneca Sawmill Company	NPDES-IW-B19	80207	OR0022985	Ditch to A-1 Amazon Channel (OR_WS_170900030108_02_104250)	7.0
SFPP, L.P.	NPDES-IW-B15	103159	OR0044661	Unnamed tributary to Flat Creek (OR_WS_170900030603_02_104290)	7.9
Sherman Bros. Trucking	NPDES-DOM-Db	36646	OR0021954	Little Muddy Creek (OR_SR_1709000306_02_103838)	8
Siltronic Corporation	NPDES-IW-B14	93450	OR0030589	Willamette River (OR_SR_1709001202_88_104175)	6.6
Silverton STP	NPDES-DOM-C1a	81395	OR0020656	Silver Creek (OR_SR_1709000901_02_104595)	2.4
SLLI	NPDES-IW-B15	74995	OR0001741	Willamette River (OR_SR_1709001202_88_104175)	7
Stayton STP	NPDES-DOM-C2a	84781	OR0020427	North Santiam River (OR_SR_1709000506_02_103930)	14.9
Sunstone Circuits	NPDES-IW-B15	26788	OR0031127	Milk Creek (OR_SR_1709000906_02_104091)	5.3
Sweet Home STP	NPDES-DOM-C2a	86840	OR0020346	South Santiam River (OR_SR_1709000608_02_103925)	31.5
Tangent STP	NPDES-DOM-Db	87425	OR0031917	Calapooia River (OR_SR_1709000304_02_103821)	10.8
Timberlake STP	NPDES-DOM-Da	90948	OR0023167	Clackamas River (OR_SR_1709001104_02_104155)	51.1

Permittee	Permit type	DEQ WQ File Number	EPA Number	Receiving water name (AU ID)	River mile
Tryon Creek WWTP	NPDES-DOM-Ba	70735	OR0026891	Willamette River (OR_SR_1709001201_88_104019)	20.3
U.S. Army Corp of Engineers Big Cliff Project	NPDES-DOM-Da	126715	Not Assigned	North Santiam River (OR_SR_1709000504_02_103906)	45.2
U.S. Army Corp of Engineers Cougar Project	NPDES-DOM-Da	126712	Not Assigned	South Fork McKenzie River (OR_SR_1709000403_02_104590)	4.5
U.S. Army Corp of Engineers Detroit Project	NPDES-DOM-Da	126716	Not Assigned	Big Cliff Reservoir (OR_LK_1709000503_02_100770)	0
U.S. Army Corp of Engineers Dexter Project	NPDES-DOM-Da	126714	Not Assigned	Middle Fork Willamette River (OR_SR_1709000107_02_104583)	15.7
U.S. Army Corp of Engineers Foster Project	NPDES-DOM-Da	126713	Not Assigned	South Santiam River (OR_SR_1709000608_02_103925)	35.7
U.S. Army Corp of Engineers Green Peter Project	NPDES-DOM-Da	126717	Not Assigned	Middle Santiam River (OR_SR_1709000604_02_103969)	5.3
U.S. Army Corp of Engineers Hills Creek Project	NPDES-DOM-Da	126699	Not Assigned	Middle Fork Willamette River (OR_SR_1709000105_02_104580)	44.3
U.S. Army Corp of Engineers Lookout Point Project	NPDES-DOM-Da	126700	Not Assigned	Dexter Reservoir (OR_LK_1709000107_02_100699)	0
Univar USA Inc	NPDES-IW-B15	100517	OR0034606	Willamette River (OR_SR_1709001202_88_104175)	9
USFW – Eagle Creek National Fish Hatchery	NPDES-IW-B17	91035	OR0000710	Eagle Creek (OR_SR_1709001105_02_104162)	12.3
Veneta STP	NPDES-DOM-Db	92762	OR0020532	Long Tom River (OR_SR_1709000301_02_103789)	34.9
Vigor Industrial	NPDES-IW-B15	70596	OR0022942	Willamette River (OR_SR_1709001202_88_104175)	8.2
WES - Boring STP	NPDES-DOM-Db	16592	OR0031399	North Fork Deep Creek (OR_WS_170900110605_02_104547)	3
WES - Blue Heron Discharge	NPDES-IW-B01	72634	OR0000566	Willamette River (OR_SR_1709000704_88_104020)	27.8
WES - Kellogg Creek WWTP	NPDES-DOM-A3	16590	OR0026221	Willamette River (OR_SR_1709001201_88_104019)	18.5
WES - Tri-City WPCP	NPDES-DOM-A3	89700	OR0031259	Willamette River (OR_SR_1709000704_88_104020)	25.5
Westfir STP	NPDES-DOM-Da	94805	OR0028282	Nork Fork Middle Fork Willamette River (OR_SR_1709000106_02_103721)	1
Willamette Falls Paper Company	NPDES-IW-B01	21489	OR0000787	Willamette River (OR_SR_1709000704_88_104020)	27.5
Willamette Leadership Academy	NPDES-DOM-Db	34040	OR0027235	Wild Hog Creek (OR_WS_170900020405_02_104242)	2

Permittee	Permit type	DEQ WQ File Number	EPA Number	Receiving water name (AU ID)	River mile
Wilsonville STP	NPDES-DOM-C1a	97952	OR0022764	Willamette River (OR_SR_1709000704_88_104020)	38.5
Woodburn WWTP	NPDES-DOM-C1a	98815	OR0020001	Pudding River (OR_SR_1709000902_02_104073)	21.4

Table 7-2: Individual NPDES Municipal Separate Storm Sewer System (MS4) permittees in the Willamette Subbasins.

Permittee	Permit type	DEQ WQ File Number	EPA Number
City of Eugene	NPDES-DOM-MS4-1	107989	ORS107989
City of Fairview	NPDES-DOM-MS4-1	108013	ORS108013
City of Gresham			
City Of Portland	NPDES-DOM-MS4-1	108015	ORS108015
Port of Portland			
City of Gladstone	NPDES-DOM-MS4-1	108016	ORS108016
City of Happy Valley			
City of Johnson City			
City of Lake Oswego			
City of Milwaukie			
City of Oregon City			
City of Rivergrove			
City of West Linn			
City of Wilsonville			
Clackamas County			
Oak Lodge Water Services			
WES (Clackamas Co. Service District #1)			
City of Salem	NPDES-DOM-MS4-1	108919	ORS108919
ODOT	NPDES-DOM-MS4-1	110870	ORS110870
Multnomah County	NPDES-DOM-MS4-1	120542	ORS120542
Portland International Airport	NPDES-IW-B15	107220	OR0040291

There are multiple categories of general NPDES permit types with registrants in the Willamette Subbasins, including:

- 100-J Industrial Wastewater: NPDES cooling water
- 200-J Industrial Wastewater: NPDES filter backwash
- 300-J Industrial Wastewater: NPDES fish hatcheries
- 400-J Industrial Wastewater: NPDES log ponds
- 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
- 1500-A Industrial Wastewater: NPDES petroleum hydrocarbon cleanup
- 1700-A Industrial Wastewater: NPDES wash water
- MS4 – Phase ll – Stormwater: NPDES Municipal Separate Storm Sewer System

DEQ determined the following general permit categories have potential to discharge thermal loads that contribute to exceedances of the applicable temperature criteria:

- 100-J
- 200-J
- 300-J

There are twelve registrants of the 100-J, ten registrants of the 200-J, and four registrants of the 300-J general permits (**Table 7-3**) found to be potential significant sources of thermal load with a temperature impact. Other registrants to the industrial wastewater general permits were found to have a de minimis temperature increase based on the permit requirements, available dilution, or frequency and magnitude of discharge.

DEQ completed a review of published literature and other studies related to stormwater runoff and stream temperature in Oregon (see TSD Section 7.1.2) and concluded that stormwater discharges authorized under the current municipal (MS4), construction (1200-C) and industrial (1200-A and 1200-Z) general stormwater permits are unlikely to contribute to exceedances of the temperature standard. Therefore, no additional TMDL requirements are needed for stormwater sources to control temperature, other than those included in the current permit. More specific wasteload allocations can be considered if subsequent data and evaluation demonstrates a need and if reserve capacity is available.

Table 7-3: General NPDES permit registrants that have the potential to contribute thermal loads to Willamette Subbasins streams at a frequency and magnitude to cause exceedances to the temperature standard.

Registrant	General Permit	DEQ WQ File Number	EPA Number	Receiving water name (AU ID)	River mile
Americold Logistics, LLC	100-J	87663	ORG253544	Claggett Creek (OR_WS_170900070303_02_104415)	4.9
EWEB Leaburg	100-J	28391	ORG253525	Leaburg Canal (OR_SR_1709000407_02_103884)	34
EWEB Walterville	100-J	28395	ORG253526	Walterville Canal (OR_SR_1709000407_02_103884)	21
First Premier Properties - Spinnaker II Office Building	100-J	110603	ORG253511	Stone Quarry Lake (OR_LK_1709000703_02_100809)	0.8
Forrest Paint Co.	100-J	100684	ORG253508	Amazon Creek (OR_WS_170900030106_02_104248)	17.0
Holiday Plaza	100-J	108298	ORG253504	Stone Quarry Lake (OR_LK_1709000703_02_100809)	0.2
Malarkey Roofing	100-J	52638	ORG250024	Columbia Slough (OR_WS_170900120201_02_104554.1)	5.9
Miller Paint Company	100-J	103774	ORG250040	Columbia Slough OR_WS_170900120201_02_104554.2)	Un-known
Owens-Brockway Glass Container Plant	100-J	65610	ORG250029	Johnson Lake (OR_WS_170900120201_02_104554.2)	0

Registrant	General Permit	DEQ WQ File Number	EPA Number	Receiving water name (AU ID)	River mile
PCC Structurals, Inc.	100-J	71920	ORG250015	Mount Scott Creek (OR_WS_170900120102_02_104551)	2.3
Sundance Lumber Company, Inc.	100-J	107401	ORG253618	Ditch to Q Street Canal (OR_WS_170900030601_02_104287	14.0
Ventura Foods, LLC	100-J	103832	ORG250005	Unnamed tributary to Columbia Slough (OR_WS_170900120201_02_104554.2)	Un-known
Albany Water Treatment Plant	200-J	66584	ORG383501	Calapooia River (OR_SR_1709000304_02_103821)	0.1
City of Silverton Drinking WTP	200-J	81398	ORG383527	Unnamed tributary to Abiqua Creek (OR_WS_170900090107_02_104460	Un-known
Corvallis Rock Creek Water Treatment Plant	200-J	20160	ORG383513	Rock Creek (OR_WS_170900030204_02_104256)	13.5
Dallas Water Treatment Plant	200-J	22550	ORG383529	Rickreall Creek (OR_SR_1709000701_02_104591)	17.0
Deer Creek Estates Water Association	200-J	23650	ORG383526	Mill Creek OR_WS_170900090502_02_104481)	7.1
EWEB – Hayden Bridge Filter Plant	200-J	28385	ORG383503	McKenzie River (OR_SR_1709000407_02_103884)	11
International Paper	200-J	108921	ORG383548	Irving Slough (OR_WS_170900030601_02_104287)	Un-known
Molalla Municipal Water Treatment Plant	200-J	109846	ORG380014	Ditch to Molalla River (OR_WS_170900090607_02_104488)	Un-known
Philomath Water Treatment Plant	200-J	100048	ORG383536	Marys River (OR_SR_1709000302_02_103813)	12.2
Row River Valley Water District	200-J	100075	ORG383534	Layng Creek (OR_SR_1709000202_02_103765)	1.4
ODFW - Dexter Ponds	300-J	64450	ORG133514	Middle Fork Willamette River (OR_SR_1709000107_02_104583)	15.7
ODFW - Roaring River Hatchery	300-J	64525	ORG133506	Roaring River (OR_SR_1709000606_02_103974)	1.1
ODFW - South Santiam Hatchery	300-J	64560	ORG133511	South Santiam River (OR_SR_1709000608_02_103925)	37.8
ODFW - Willamette Fish Hatchery	300-J	64585	ORG133507	Salmon Creek (OR_SR_1709000104_02_103719)	0.4

7.2 Thermal nonpoint sources

OAR 340-041-0002(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 Willamette Subbasins streams include activities associated with agriculture, forestry, dam and reservoir management, and development.

Nonpoint 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 streamside vegetation to reduce thermal loading from exposure to solar radiation;
- Restoration of complex channel morphology and hyporheic or groundwater connection;
- Management and operation of dams and reservoirs to minimize temperature warming; and
- Maintenance of minimum instream flows.

In many of the modeled streams, thermal loading from nonpoint sources contributed to exceedances of the applicable temperature criteria and therefore were identified as significant sources of thermal loading. The maximum daily maximum or 7DADM water temperature increase from nonpoint sources ranged from 0.43°C in the Upper McKenzie River to 8.65°C in the Pudding River. See the TSD for details. Reductions from nonpoint sources will be required to attain the applicable temperature criteria.

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 DEQ or another Oregon state agency does not have the 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. As such, it was not possible to develop a model in which all human influences were controlled or accounted for. As a best estimate, background thermal sources were quantified for the modeled rivers with delineable anthropogenic influences (i.e., dams and reservoirs, vegetation alterations, point source discharges, channel modification) accounted for, thus isolating the remaining background sources.

In many of the modeled streams, thermal loading from background sources contributed to exceedances of the applicable temperature criteria and therefore were identified as significant source of thermal loading. The maximum daily maximum or 7DADM temperature standard exceedances of background sources ranged from 1.83°C in Johnson Creek to 9.16°C in the Molalla River. Background sources from seven of the nine modeled streams exceeded the applicable temperature criteria by more than 7°C. See the TSD for detailed descriptions of analysis and results. Reductions from background sources will be required 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 on AUs using **Equation 8-1**.

$$LC = (T_C + \text{HUA}) \cdot Q_R \cdot C_F \qquad \textbf{Equation 8-1}$$

where,

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

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

$\text{HUA} =$ 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 in cubic feet per second (cfs).

$C_F =$ Conversion factor using flow in cfs: 2,446,665

$$\left(\frac{1\text{ m}}{3.2808\text{ ft}}\right)^3 \cdot \frac{1000\,kg}{1\,m^3} \cdot \frac{86400\,sec}{1\,day} \cdot \frac{1\,kcal}{1\,kg\;\cdot 1°\text{C}} = 2{,}446{,}665$$

Equation 8-1 shall be used to calculate the thermal loading capacity for any surface water location in the Willamette Subbasins. **Table 8-1** presents the loading capacity for select temperature impaired Category 5 AUs modeled for the TMDL analysis at the critical 7Q10 low flow. **Equation 8-1** may be used to calculate the loading capacity when river flows are greater than 7Q10. **Equation 8-1** 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: Thermal loading capacity (LC) for select AUs by applicable fish use period at 7Q10 flow.

AU Name and AU ID	Annual 7Q10 (cfs)	Year Round Criterion + HUA (°C)	Spawning Criterion + HUA (°C)	7Q10 LC Year Round (kcal/day)	7Q10 LC Spawning (kcal/day)
Clackamas River OR_SR_1709001106_02_104597	671	16.3	13.3	26,759.91E+6	21,834.77E+6
Coast Fork Willamette River OR_SR_1709000203_02_104585	38	18.3	13.3	1,701.41E+6	1,236.54E+6
Coast Fork Willamette River OR_SR_1709000204_02_103787	132	18.3	13.3	5,910.16E+6	4,295.37E+6
Coyote Creek OR_SR_1709000301_02_103796	5.9	18.3	NA	264.17E+6	NA
Crabtree Creek OR_SR_1709000606_02_103978	25	16.3	13.3	997.02E+6	813.52E+6
Johnson Creek OR_SR_1709001201_02_104170	11	18.3	13.3	492.51E+6	357.95E+6
Little North Santiam River OR_SR_1709000505_02_104564	21	16.3	13.3	837.49E+6	683.35E+6

Long Tom River OR_SR_1709000301_02_103791	22	24.3	18.3	1,307.99E+6	985.03E+6
Luckiamute River OR_SR_1709000305_02_103829	16	18.3	13.3	716.38E+6	520.65E+6
McKenzie River OR_SR_1709000407_02_103884	1537	16.3	13.3	61,296.54E+6	50,014.97E+6
Middle Fork Willamette River OR_SR_1709000107_02_104583	1002	16.3	13.3	39,960.4E+6	32,605.73E+6
Middle Fork Willamette River OR_SR_1709000110_02_104584	1278	16.3	13.3	50,967.46E+6	41,586.94E+6
Mohawk River OR_SR_1709000406_02_103871	16	16.3	13.3	638.09E+6	520.65E+6
Molalla River OR_SR_1709000904_02_104086	38	16.3	13.3	1,515.46E+6	1,236.54E+6
Mosby Creek OR_SR_1709000201_02_103752	11	16.3	13.3	438.69E+6	357.95E+6
North Santiam River OR_SR_1709000504_02_103906	859	16.3	13.3	34,257.47E+6	27,952.41E+6
North Santiam River OR_SR_1709000506_02_103930	914	16.3	13.3	36,450.9E+6	29,742.15E+6
Pudding River OR_SR_1709000905_02_104088	10	18.3	NA	447.74E+6	NA
Santiam River OR_SR_1709000506_02_103927	1144	18.3	13.3	51,221.42E+6	37,226.5E+6
South Santiam River OR_SR_1709000608_02_103925	615	16.3	13.3	24,526.59E+6	20,012.5E+6
Thomas Creek OR_SR_1709000607_02_103988	6.9	18.3	NA	308.94E+6	NA
Willamette River OR_SR_1709000306_05_103854	3877	18.3	13.3	173,588.68E+6	126,160.08E+6
Willamette River OR_SR_1709000701_05_104005	5684	18.3	13.3	254,495.24E+6	184,961.02E+6
Willamette River OR_SR_1709000703_88_104015	5734	20.3	NA	284,792.3E+6	NA
Willamette River OR_SR_1709000704_88_104020	5988	20.3	NA	297,407.79E+6	NA
Willamette River OR_SR_1709001201_88_104019	6740	20.3	NA	334,757.6E+6	NA
Willamette River OR_SR_1709001202_88_104175	6740	20.3	NA	334,757.6E+6	NA

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 and percent load reduction were calculated for each AU where temperature data were available (**Table 8-2**). The extensive monitoring across the Willamette subbasin represents a wide range of waterbodies; however not all streams in the Willamette subbasins have monitoring data. Equation 8-2 from the TSD can be used to determine excess temperature and percent reduction for additional streams if data becomes available in the future.

The excess temperatures are the maximum difference between the monitored 7DADM river temperatures and applicable numeric criteria plus the HUA. 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.

Table 8-2: Excess temperature and percent load reduction for various AUs in the Willamette Subbasins.

AU Name	AU ID	Maximum 7DADM River Temperature (°C)	Applicable Criterion + HUA (°C)	Excess Temperature (°C)	Percent Load Reduction
Alex Creek	OR_SR_1709000202 _02_103762	16.7	18.3	0.0	0.0
Big Creek	OR_SR_1709001104 _02_104153	13.7	16.3	0.0	0.0
Blowout Creek	OR_SR_1709000503 _02_103907	21.0	18.3	2.7	12.9
Boulder Creek	OR_SR_1709000502 _02_103902	19.3	18.3	1.0	5.3
Breitenbush River	OR_SR_1709000501 _02_103892	17.5	18.3	0.0	0.0
Brice Creek	OR_SR_1709000202 _02_103771	23.1	18.3	4.8	20.6
Calapooia River	OR_SR_1709000303 _02_103815	16.0	16.3	0.0	0.0
Camp Creek	OR_SR_1709000407 _02_103889	19.3	13.3	6.0	31.1
Camp Creek	OR_SR_1709000407 _02_103889	22.4	16.3	6.1	27.2
Canyon Creek	OR_SR_1709000602 _02_103949	20.7	16.3	4.4	21.4
Cedar Creek	OR_SR_1709000407 _02_103891	20.9	13.3	7.6	36.4
Cedar Creek	OR_SR_1709000407 _02_103891	24.3	16.3	8.0	32.9
Christy Creek	OR_SR_1709000106 _02_103722	15.5	16.3	0.0	0.0
Clackamas River	OR_SR_1709000704 _02_104597	17.7	13.3	4.4	24.9
Clackamas River	OR_SR_1709000704 _02_104597	20.5	16.3	4.2	20.5
Clackamas River	OR_SR_1709000704 _02_104597	24.5	18.3	6.2	25.3
Clackamas River	OR_SR_1709001104 _02_104154	16.6	13.3	3.3	19.8
Clackamas River	OR_SR_1709001104 _02_104154	18.5	16.3	2.2	11.9
Clackamas River	OR_SR_1709001104 _02_104155	16.2	13.3	2.9	17.9
Clackamas River	OR_SR_1709001104 _02_104155	19.5	16.3	3.2	16.5
Clackamas River	OR_SR_1709001106 _02_104597	17.7	13.3	4.4	24.9
Clackamas River	OR_SR_1709001106 _02_104597	20.5	16.3	4.2	20.5
Clackamas River	OR_SR_1709001106 _02_104597	24.5	18.3	6.2	25.3
Coast Fork Willamette River	OR_SR_1709000203 _02_104585	12.5	13.3	0	0.0
Coast Fork Willamette River	OR_SR_1709000203 _02_104585	24.2	18.3	5.9	24.4
Collawash River	OR_SR_1709001101 _02_104142	17.4	13.3	4.1	23.5

AU Name	AU ID	Maximum 7DADM River Temperature (°C)	Applicable Criterion + HUA (°C)	Excess Temperature (°C)	Percent Load Reduction
Collawash River	OR_SR_1709001101_02_104142	19.8	16.3	3.5	17.8
Collawash River	OR_SR_1709001101_02_104144	16.3	13.3	3.0	18.6
Collawash River	OR_SR_1709001101_02_104144	20.5	16.3	4.2	20.4
Fall Creek	OR_SR_1709000109_02_103737	21.6	13.3	8.3	38.3
Fall Creek	OR_SR_1709000109_02_103737	24.5	16.3	8.2	33.3
Fall Creek	OR_SR_1709000109_02_103743	18.6	13.3	5.3	28.5
Fall Creek	OR_SR_1709000109_02_103743	22.4	16.3	6.1	27.3
Fall Creek	OR_SR_1709000109_02_103735	21.9	13.3	8.6	39.3
Fall Creek	OR_SR_1709000109_02_103735	20.8	16.3	4.5	21.6
Fish Creek	OR_SR_1709001104_02_104161	19.1	13.3	5.8	30.4
Fish Creek	OR_SR_1709001104_02_104161	21.2	16.3	4.9	23.0
French Pete Creek	OR_SR_1709000403_02_103862	15.7	16.3	0.0	0.0
Grass Creek	OR_SR_1709000202_02_103780	15.6	16.3	0.0	0.0
Hamilton Creek	OR_SR_1709000608_02_103996	27.3	16.3	11.0	40.3
Hehe Creek	OR_SR_1709000109_02_103734	21.0	16.3	4.7	22.5
Hills Creek	OR_SR_1709000102_02_103715	16.5	13.3	3.2	19.4
Hills Creek	OR_SR_1709000102_02_103715	18.7	16.3	2.4	12.8
Horse Creek	OR_SR_1709000401_02_103856	13.8	12.3	1.5	10.9
HUC12 Name: Andy Creek-Fall Creek	OR_WS_170900010904_02_104219	18.3	16.3	2.0	10.7
HUC12 Name: Balch Creek-Willamette River	OR_WS_170900120202_02_104555	21.8	18.3	3.5	15.9
HUC12 Name: Boulder Creek-McKenzie River	OR_WS_170900040206_02_104310	14.4	12.3	2.1	14.8
HUC12 Name: Buck Creek-Middle Fork Willamette Riv*	OR_WS_170900010502_02_104200	18.9	12.3	6.6	34.9
HUC12 Name: Canyon Creek	OR_WS_170900090601_02_104482	8.2	18.3	0.0	0.0
HUC12 Name: Columbia Slough (Lower)	OR_WS_170900120201_02_104554.1	26.8	18.3	8.5	31.8
HUC12 Name: Columbia Slough (Upper)	OR_WS_170900120201_02_104554.2	29.5	18.3	11.2	38.0

AU Name	AU ID	Maximum 7DADM River Temperature (°C)	Applicable Criterion + HUA (°C)	Excess Temperature (°C)	Percent Load Reduction
HUC12 Name: Cougar Creek-South Fork McKenzie River	OR_WS_170900040308_02_104321	15.0	16.3	0.0	0.0
HUC12 Name: Cougar Reservoir-South Fork McKenzie *	OR_WS_170900040307_02_104320	14.6	16.3	0.0	0.0
HUC12 Name: Croisan Creek-Willamette River	OR_WS_170900070301_02_104413	19.6	13.3	6.3	32.0
HUC12 Name: Croisan Creek-Willamette River	OR_WS_170900070301_02_104413	24.8	18.3	6.5	26.2
HUC12 Name: Dartmouth Creek-North Fork Middle For*	OR_WS_170900010608_02_104210	16.5	16.3	0.2	1.2
HUC12 Name: Deer Creek	OR_WS_170900040205_02_104309	20.0	12.3	7.7	38.4
HUC12 Name: Echo Creek-Middle Fork Willamette Riv*	OR_WS_170900010106_02_104190	15.6	12.3	3.3	21.1
HUC12 Name: Eighth Creek-North Fork Middle Fork W*	OR_WS_170900010607_02_104209	16.2	16.3	0.0	0.0
HUC12 Name: Elk Creek-McKenzie River	OR_WS_170900040502_02_104326	15.3	13.3	2.0	12.9
HUC12 Name: Elk Creek-McKenzie River	OR_WS_170900040502_02_104326	17.9	16.3	1.6	8.8
HUC12 Name: Elk Creek-South Fork McKenzie River	OR_WS_170900040301_02_104314	8.4	12.3	0.0	0.0
HUC12 Name: Fish Creek	OR_WS_170900110403_02_104536	16.0	16.3	0.0	0.0
HUC12 Name: Flat Creek	OR_WS_170900030603_02_104290	25.7	18.3	7.4	28.8
HUC12 Name: Glenn Creek-Willamette River	OR_WS_170900070303_02_104415	27.2	18.3	8.9	32.7
HUC12 Name: Greasy Creek	OR_WS_170900030204_02_104256	25.0	16.3	8.7	34.8
HUC12 Name: Greasy Creek	OR_WS_170900030204_02_104256	19.1	18.3	0.8	4.1
HUC12 Name: Hackleman Creek-McKenzie River	OR_WS_170900040202_02_104306	12.3			
HUC12 Name: Helion Creek-Clackamas River	OR_WS_170900110406_02_104539	16.5	16.3	0.2	1.2
HUC12 Name: Hill Creek-Coast Fork Willamette River	OR_WS_170900020401_02_104238	25.9	18.3	7.6	29.3

AU Name	AU ID	Maximum 7DADM River Temperature (°C)	Applicable Criterion + HUA (°C)	Excess Temperature (°C)	Percent Load Reduction
HUC12 Name: Kink Creek-McKenzie River	OR_WS_170900040204_02_104308	12.7	12.3	0.4	3.1
HUC12 Name: Last Creek-Pinhead Creek	OR_WS_170900110204_02_104526	10.4	16.3	0.0	0.0
HUC12 Name: Layng Creek	OR_WS_170900020201_02_104227	17.6	18.3	0.0	0.0
HUC12 Name: Lowe Creek-Clackamas River	OR_WS_170900110203_02_104525	15.6	16.3	0.0	0.0
HUC12 Name: Lower Johnson Creek	OR_WS_170900120103_02_104552	19.9	13.3	6.6	33.1
HUC12 Name: Lower Johnson Creek	OR_WS_170900120103_02_104552	23.1	18.3	4.8	20.8
HUC12 Name: Lower Mill Creek	OR_WS_170900070204_02_104412	25.9	18.3	7.6	29.3
HUC12 Name: Lower Quartzville Creek	OR_WS_170900060305_02_104379	23.7	18.3	5.4	22.8
HUC12 Name: Maxfield Creek-Luckiamute River	OR_WS_170900030503_02_104277	21.1	18.3	2.8	13.3
HUC12 Name: McKinney Creek	OR_WS_170900070203_02_104411	26.9	18.3	8.6	32.0
HUC12 Name: Middle Little Luckiamute River	OR_WS_170900030507_02_104281	17.5	18.3	0.0	0.0
HUC12 Name: Minto Creek-North Santiam River	OR_WS_170900050205_02_104347	11.4	18.3	0.0	0.0
HUC12 Name: Morgan Creek-North Santiam River	OR_WS_170900050604_02_104362	23.0	16.3	6.7	29.1
HUC12 Name: Multnomah Channel	OR_WS_170900120305_02_104561	18.5	18.3	0.2	1.2
HUC12 Name: North Fork Clackamas River	OR_WS_170900110405_02_104538	17.0	16.3	0.7	4.2
HUC12 Name: North Fork Eagle Creek	OR_WS_170900110502_02_104541	12.8	16.3	0.0	0.0
HUC12 Name: Oswego Creek-Willamette River	OR_WS_170900120104_02_104553	14.1	13.3	0.8	5.7
HUC12 Name: Oswego Creek-Willamette River	OR_WS_170900120104_02_104553	20.7	18.3	2.4	11.7
HUC12 Name: Owl Creek	OR_WS_170900060205_02_104371	15.5	16.3	0.0	0.0
HUC12 Name: Paddys Valley-Middle Fork Willamette *	OR_WS_170900010101_02_104185	10.0	12.3	0.0	0.0
HUC12 Name: Pedee Creek-Luckiamute River	OR_WS_170900030504_02_104278	19.5	18.3	1.2	6.3
HUC12 Name: Pot Creek-Clackamas River	OR_WS_170900110205_02_104527	10.1	16.3	0.0	0.0

AU Name	AU ID	Maximum 7DADM River Temperature (°C)	Applicable Criterion + HUA (°C)	Excess Temperature (°C)	Percent Load Reduction
HUC12 Name: Quartz Creek	OR_WS_170900040501_02_104325	11.7	13.3	0.0	0.0
HUC12 Name: Quartz Creek	OR_WS_170900040501_02_104325	16.3	16.3	0.0	0.2
HUC12 Name: Roaring River	OR_WS_170900110402_02_104535	24.0	16.3	7.7	32.1
HUC12 Name: Sauers Creek-North Santiam River	OR_WS_170900050208_02_104350	15.8	18.3	0.0	0.0
HUC12 Name: Sharps Creek	OR_WS_170900020203_02_104229	16.3	16.3	0.0	0.0
HUC12 Name: Smith River	OR_WS_170900040203_02_104307	23.4	12.3	11.1	47.4
HUC12 Name: Smith River	OR_WS_170900040203_02_104307	18.7			
HUC12 Name: South Fork Clackamas River	OR_WS_170900110404_02_104537	12.8	16.3	0.0	0.0
HUC12 Name: Staley Creek	OR_WS_170900010105_02_104189	16.4	12.3	4.1	25.0
HUC12 Name: Straight Creek-North Santiam River	OR_WS_170900050202_02_104344	14.2	18.3	0.0	0.0
HUC12 Name: Tumblebug Creek	OR_WS_170900010102_02_104186	15.4	12.3	3.1	20.2
HUC12 Name: Upper Canyon Creek	OR_WS_170900060204_02_104370	17.6	16.3	1.3	7.6
HUC12 Name: Upper Clear Creek	OR_WS_170900110601_02_104543	13.1	16.3	0.0	0.0
HUC12 Name: Upper Eagle Creek	OR_WS_170900110501_02_104540	17.7	16.3	1.4	8.0
HUC12 Name: Upper Johnson Creek	OR_WS_170900120101_02_104550	19.4	13.3	6.1	31.4
HUC12 Name: Upper Johnson Creek	OR_WS_170900120101_02_104550	29.3	18.3	11.0	37.5
HUC12 Name: Whitewater Creek	OR_WS_170900050206_02_104348	14.1	18.3	0.0	0.0
HUC12 Name: Winberry Creek	OR_WS_170900010905_02_104220	19.5	16.3	3.2	16.4
Johnson Creek	OR_SR_1709001201_02_104170	21.3	13.3	8.0	37.6
Johnson Creek	OR_SR_1709001201_02_104170	28.9	18.3	10.6	36.6
Junetta Creek	OR_SR_1709000202_02_103763	16.6	18.3	0.0	0.0
Layng Creek	OR_SR_1709000202_02_103765	24.3	18.3	6.0	24.8
Layng Creek	OR_SR_1709000202_02_103770	16.6	18.3	0.0	0.0
Little Fall Creek	OR_SR_1709000108_02_103730	16.1	13.3	2.8	17.2
Little Fall Creek	OR_SR_1709000108_02_103730	18.1	16.3	1.8	10.1
Little North Santiam River	OR_SR_1709000505_02_104564	23.0	13.3	9.7	42.2

AU Name	AU ID	Maximum 7DADM River Temperature (°C)	Applicable Criterion + HUA (°C)	Excess Temperature (°C)	Percent Load Reduction
Little North Santiam River	OR_SR_1709000505_02_104564	28.1	16.3	11.8	42.0
Long Tom River	OR_SR_1709000301_02_103791	24.7	24.3	0.4	1.6
Lookout Creek	OR_SR_1709000404_02_104571	20.9	16.3	4.6	22.0
Lower Blue River	OR_SR_1709000404_02_104569	21.8	13.3	8.5	39
Lower Blue River	OR_SR_1709000404_02_104569	21.6	16.3	5.3	24.5
Marion Creek	OR_SR_1709000502_02_103897	17.4	18.3	0.0	0.0
Martin Creek	OR_SR_1709000202_02_103756	19.9	18.3	1.6	8.0
McDowell Creek	OR_SR_1709000608_02_103994	21.7	18.3	3.4	15.6
McKenzie River	OR_SR_1709000402_02_104587	8.4	12.3	0.0	0.0
McKenzie River	OR_SR_1709000402_02_104588	11.8	12.3	0.0	0.0
McKenzie River	OR_SR_1709000407_02_103884	19.5	13.3	6.2	31.8
McKenzie River	OR_SR_1709000407_02_103884	21.2	16.3	4.9	23.1
Middle Fork Willamette River	OR_SR_1709000101_02_103713	13.4	12.3	1.1	8.1
Middle Fork Willamette River	OR_SR_1709000105_02_104579	21.0	12.3	8.7	41.4
Middle Fork Willamette River	OR_SR_1709000105_02_104580	17.7	13.3	4.4	24.9
Middle Fork Willamette River	OR_SR_1709000105_02_104580	18.1	16.3	1.8	9.9
Middle Fork Willamette River	OR_SR_1709000107_02_103725	17.8	13.3	4.5	25.3
Middle Fork Willamette River	OR_SR_1709000107_02_103725	19.2	16.3	2.9	15.1
Middle Fork Willamette River	OR_SR_1709000107_02_104583	21.1	13.3	7.8	37.0
Middle Fork Willamette River	OR_SR_1709000107_02_104583	21.3	16.3	5	23.5
Middle Fork Willamette River	OR_SR_1709000110_02_104584	21.1	13.3	7.8	37.0
Middle Fork Willamette River	OR_SR_1709000110_02_104584	22.3	16.3	6	26.9
Middle Santiam River	OR_SR_1709000601_02_103936	19.7	18.3	1.4	7.3
Middle Santiam River	OR_SR_1709000603_02_103965	24.0	18.3	5.7	23.8
Middle Santiam River	OR_SR_1709000604_02_103969	16.0	13.3	2.7	16.9
Middle Santiam River	OR_SR_1709000604_02_103969	14.4	18.3	0.0	0.0
Mill Creek	OR_SR_1709000702_02_104007	18.6	13.3	5.3	28.6

AU Name	AU ID	Maximum 7DADM River Temperature (°C)	Applicable Criterion + HUA (°C)	Excess Temperature (°C)	Percent Load Reduction
Mill Creek	OR_SR_1709000702_02_104007	25.3	18.3	7.0	27.8
Moose Creek	OR_SR_1709000602_02_103954	19.3	16.3	3.0	15.4
Nohorn Creek	OR_SR_1709001101_02_104145	17.1	16.3	0.8	4.7
North Fork Clackamas River	OR_SR_1709001104_02_104152	19.2	16.3	2.9	15.1
North Fork Middle Fork Willamette River	OR_SR_1709000106_02_103721	20.7	13.3	7.4	35.7
North Fork Middle Fork Willamette River	OR_SR_1709000106_02_103721	22.9	16.3	6.6	28.8
North Fork Pedee Creek	OR_SR_1709000305_02_103828	20.2	18.3	1.9	9.5
North Santiam River	OR_SR_1709000502_02_103899	17.9	18.3	0.0	0.0
North Santiam River	OR_SR_1709000503_02_103906	16.7	13.3	3.4	20.4
North Santiam River	OR_SR_1709000503_02_103906	16.7	16.3	0.4	2.4
North Santiam River	OR_SR_1709000504_02_103906	16.7	13.3	3.4	20.4
North Santiam River	OR_SR_1709000504_02_103906	16.7	16.3	0.4	2.4
North Santiam River	OR_SR_1709000506_02_103930	19.2	13.3	5.9	30.7
North Santiam River	OR_SR_1709000506_02_103930	21.1	16.3	4.8	22.7
Oak Grove Fork Clackamas River	OR_SR_1709001103_02_104149	12.2	16.3	0.0	0.0
Oak Grove Fork Clackamas River	OR_SR_1709001103_02_104150	12.6	13.3	0.0	0.0
Oak Grove Fork Clackamas River	OR_SR_1709001103_02_104150	13.8	16.3	0.0	0.0
Owl Creek	OR_SR_1709000602_02_103941	19.2	16.3	2.9	15.2
Portland Creek	OR_SR_1709000109_02_103741	22.5	16.3	6.2	27.4
Pringle Creek	OR_SR_1709000703_02_104012	25.1	18.3	6.8	27.1
Pyramid Creek	OR_SR_1709000601_02_103935	20.3	18.3	2.0	9.8
Quartz Creek	OR_SR_1709000405_02_103867	12.1	13.3	0.0	0.0
Quartz Creek	OR_SR_1709000405_02_103867	16.3	16.3	0.0	0.2
Quartzville Creek	OR_SR_1709000603_02_103957	19.3	18.3	1.0	5.2
Quartzville Creek	OR_SR_1709000603_02_103960	22.0	18.3	3.7	16.7
Rebel Creek	OR_SR_1709000403_02_103861	13.3	16.3	0.0	0.0
Ritner Creek	OR_SR_1709000305_02_103833	21.8	18.3	3.5	16.0

AU Name	AU ID	Maximum 7DADM River Temperature (°C)	Applicable Criterion + HUA (°C)	Excess Temperature (°C)	Percent Load Reduction
Roaring River	OR_SR_1709000403_02_103864	7.2	12.3	0.0	0.0
Roaring River	OR_SR_1709001104_02_104160	14.2	13.3	0.9	6.3
Roaring River	OR_SR_1709001104_02_104160	15.4	16.3	0.0	0.0
Row River	OR_SR_1709000202_02_103761	25.1	18.3	6.8	27.1
Row River	OR_SR_1709000202_02_103766	25.1	18.3	6.8	27.1
Row River	OR_SR_1709000202_02_103779	13.6	13.3	0.3	2.2
Row River	OR_SR_1709000202_02_103779	23	18.3	4.7	20.4
Salmon Creek	OR_SR_1709000104_02_103719	13.5	12.3	1.2	9.1
Salmon Creek	OR_SR_1709000104_02_103719	18.4	13.3	5.1	27.6
Salmon Creek	OR_SR_1709000104_02_103719	19.3	16.3	3.0	15.7
Salt Creek	OR_SR_1709000103_02_103716	16.1	13.3	2.8	17.1
Salt Creek	OR_SR_1709000103_02_103716	17.9	16.3	1.6	8.7
Santiam River	OR_SR_1709000506_02_103927	16.3	13.3	3	18.4
Santiam River	OR_SR_1709000506_02_103927	23.4	18.3	5.1	21.8
Separation Creek	OR_SR_1709000401_02_103857	10.0	12.3	0.0	0.0
Sharps Creek	OR_SR_1709000202_02_103755	24.0	18.3	5.7	23.8
Sharps Creek	OR_SR_1709000202_02_103775	19.2	18.3	0.9	4.6
Sheep Creek	OR_SR_1709000602_02_103953	20.9	16.3	4.6	21.9
Shelton Ditch	OR_SR_1709000703_02_104008	18.5	13.3	5.2	28.2
Shelton Ditch	OR_SR_1709000703_02_104008	23.8	18.3	5.5	23.1
Soda Fork	OR_SR_1709000602_02_103947	16.1	16.3	0.0	0.0
South Fork McKenzie River	OR_SR_1709000403_02_104589	8.7	12.3	0	0
South Fork McKenzie River	OR_SR_1709000403_02_104589	13.1	13.3	0	0
South Fork McKenzie River	OR_SR_1709000403_02_104589	14.9	16.3	0	0
South Fork McKenzie River	OR_SR_1709000403_02_104589	8.7	12.3	0.0	0.0
South Fork McKenzie River	OR_SR_1709000403_02_104589	13.1	13.3	0.0	0.0
South Fork McKenzie River	OR_SR_1709000403_02_104589	14.9	16.3	0.0	0.0

AU Name	AU ID	Maximum 7DADM River Temperature (°C)	Applicable Criterion + HUA (°C)	Excess Temperature (°C)	Percent Load Reduction
South Fork McKenzie River	OR_SR_1709000403_02_104590	16.2	13.3	2.9	17.9
South Fork McKenzie River	OR_SR_1709000403_02_104590	17.8	16.3	1.5	8.4
South Santiam River	OR_SR_1709000506_02_103925	15.0	13.3	1.7	11.3
South Santiam River	OR_SR_1709000506_02_103925	14.1	16.3	0.0	0.0
South Santiam River	OR_SR_1709000602_02_103950	18.1	13.3	4.8	26.4
South Santiam River	OR_SR_1709000602_02_103950	21.4	16.3	5.1	23.7
South Santiam River	OR_SR_1709000604_02_103968	21.8	13.3	8.5	39.0
South Santiam River	OR_SR_1709000604_02_103968	24.4	16.3	8.1	33.2
South Santiam River	OR_SR_1709000608_02_103925	15	13.3	1.7	11.3
South Santiam River	OR_SR_1709000608_02_103925	14.1	16.3	0	0.0
Teal Creek	OR_SR_1709000305_02_103824	20.3	18.3	2.0	9.9
Trout Creek	OR_SR_1709000602_02_103942	17.2	16.3	0.9	5.5
Trout Creek	OR_SR_1709001104_02_104157	16.3	16.3	0.0	0.0
Upper Blue River	OR_SR_1709000404_02_104574	20.6	16.3	4.3	20.9
Whitewater Creek	OR_SR_1709000502_02_103898	12.4	18.3	0.0	0.0
Willamette River	OR_SR_1709000306_05_103854	17.5	13.3	4.2	24.0
Willamette River	OR_SR_1709000306_05_103854	23.8	18.3	5.5	23.1
Willamette River	OR_SR_1709000703_04_104013	17.6	13.3	4.3	24.4
Willamette River	OR_SR_1709000703_04_104013	25.7	18.3	7.4	28.8
Willamette River	OR_SR_1709000703_88_104015	26.1	20.3	5.8	22.2
Willamette River	OR_SR_1709001202_88_104175	26.6	20.3	6.3	23.7
Winberry Creek	OR_SR_1709000109_02_103747	20.2	13.3	6.9	34.2
Winberry Creek	OR_SR_1709000109_02_103747	22.5	16.3	6.2	27.6

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)(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 load of a pollutant 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 allowable 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

9.1.1 Human use allowance assignments

The HUA at OAR 340-041-0028(12)(b)(B) identifies the allowed temperature increase reserved for human uses. The rule requires that wasteload and load allocations 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 waterbody, and at the POMI.

Table 9-1 through **Table 9-11** present the portions of the HUA assigned to anthropogenic source categories across different AUs and stream extents in the Willamette Subbasins.

The dam and reservoir operations source category accounts for nonpoint source temperature impacts associated with the dam impoundment and release of the impounded water back into the natural channel. Dam and reservoir discharges associated with an NPDES permit are included in the NPDES assigned HUA.

The water management activities and water withdrawals source category accounts for nonpoint source temperature impacts associated with the withdrawal of water that is intended for consumptive uses (such as irrigation) and the warming that might occur as that water moves through a canal or ditch before being returned to the natural river.

The assigned HUA for NPDES point sources is the maximum for all NPDES induvial permittees and registrants to general NPDES permits.

The assigned portion of the HUA represents the maximum cumulative warming allowed anywhere in the AU and stream extents at the POMI from all point and nonpoint source activities within each source category. Therefore, DEQ expects the amount of warming for each unique point or nonpoint source activity to be less than the values shown in **Table 9-1** through **Table 9-11**. DEQ will implement the TMDL in a manner consistent with the HUA rule by requiring all nonpoint sources to implement management strategies and reduce their warming impact such that the assigned HUA is attained. Point sources will be required to implement their wasteload allocations through their NPDES permits such that the assigned HUA is attained.

The HUA assignments in **Table 9-1** through **Table 9-11** for nonpoint source categories are achieved through the implementation of the load allocations described in Section 9.1.4 and the surrogate measures described in Section 9.1.5. Designated Management Agencies (DMAs) are responsible for implementing management activities that achieve the surrogate measure targets appropriate to their source category and location. A DMA has achieved their load allocation when surrogate measure targets are met. When all DMAs within a nonpoint source category have met their surrogate measure targets and achieved their load allocations, the HUA assigned to that nonpoint source category is achieved.

This TMDL HUA assignments and associated allocations implement EPA's Columbia and Lower Snake Rivers temperature TMDL (EPA, 2021) allocation to anthropogenic sources in Columbia River tributaries, including the Willamette River. See TSD Appendix M for additional details.

Table 9-1: HUA assignments for source or source categories on assessment units in the Middle Fork Willamette Subbasin.

AU Name	AU ID	NPDES point sources	NPS dam and reservoir operations	Consumptive use water management and water withdrawals	Solar loading from existing transportation corridors, existing buildings, and existing utility infrastructure	Solar loading from other NPS sectors	Reserve capacity	Total HUA
Dexter Reservoir	OR_LK_1709000107_02_100699	0.073	0.00	0.05	0.02	0.00	0.157	0.30
Fall Creek	OR_SR_1709000109_02_103735	0.02	0.00	0.04	0.05	0.00	0.19	0.30
Middle Fork Willamette River	OR_SR_1709000105_02_104580	0.06	0.00	0.05	0.02	0.00	0.17	0.30
Middle Fork Willamette River	OR_SR_1709000107_02_104583, OR_SR_1709000110_02_103750, OR_SR_1709000110_02_104584	0.04	0.00	0.04	0.04	0.00	0.18	0.30
Unnamed Lake Units	OR_LK_1709000110_02_100703, OR_LK_1709000110_02_100704	0.04	0.00	0.04	0.04	0.00	0.18	0.30
All other AUs	Applicable AUs are listed in TSD Appendix D	0.075	0.00	0.05	0.02	0.00	0.155	0.30

Table 9-2: HUA assignments for source or source categories on assessment units in the Coast Fork Willamette Subbasin.

AU Name	AU ID	NPDES point sources	NPS dam and reservoir operations	Consumptive use water management and water withdrawals	Solar loading from existing transportation corridors, existing buildings, and existing utility infrastructure	Solar loading from other NPS sectors	Reserve capacity	Total HUA
Camas Swale Creek	OR_SR_1709000204_02_103786	0.20	0.00	0.05	0.02	0.00	0.03	0.30
Coast Fork Willamette River	OR_SR_1709000203_02_104585	0.21	0.00	0.02	0.05	0.00	0.02	0.30
Coast Fork Willamette River	OR_SR_1709000204_02_103787	0.08	0.00	0.04	0.04	0.00	0.14	0.30
Lower Camas Swale Creek	OR_WS_170900020403_02_104240	0.20	0.00	0.05	0.02	0.00	0.03	0.30
Row River	OR_SR_1709000202_02_103779	0.02	0.00	0.04	0.05	0.00	0.19	0.30
All other AUs	Applicable AUs are listed in TSD Appendix D	0.075	0.00	0.05	0.02	0.00	0.155	0.30

Table 9-3: HUA assignments for source or source categories on assessment units in the Upper Willamette Subbasin.

AU Name	AU ID	NPDES point sources	NPS dam and reservoir operations	Consumptive use water management and water withdrawals	Solar loading from existing transportation corridors, existing buildings, and existing utility infrastructure	Solar loading from other NPS sectors	Reserve capacity	Total HUA
Amazon Creek	OR_WS_170900030106_02_104248, OR_WS_170900030108_02_104250, OR_WS_170900030109_02_104251	0.15	0.00	0.05	0.02	0.00	0.08	0.30
Calapooia River	OR_SR_1709000303_02_103816, OR_SR_1709000304_02_103821	0.21	0.00	0.05	0.02	0.00	0.02	0.30
Colorado Lake	OR_LK_1709000306_02_100720	0.20	0.00	0.05	0.02	0.00	0.03	0.30
Fern Ridge Lake	OR_LK_1709000301_02_100708	0.20	0.00	0.05	0.02	0.00	0.03	0.30
Greasy Creek	OR_SR_1709000302_02_103810	0.20	0.00	0.05	0.02	0.00	0.03	0.30
Greasy Creek and Rock Creek tributaries	OR_WS_170900030204_02_104256	0.20	0.00	0.05	0.02	0.00	0.03	0.30
Long Tom River	OR_SR_1709000301_02_103791	0.07	0.00	0.04	0.05	0.00	0.14	0.30
Long Tom River and tributaries in 170900030107	OR_SR_1709000301_02_103789 OR_WS_170900030107_02_104249	0.20	0.00	0.05	0.02	0.00	0.03	0.30
Mary’s River	OR_SR_1709000302_02_103813	0.20	0.00	0.05	0.02	0.00	0.03	0.30
Muddy Creek	OR_SR_1709000306_02_103838	0.20	0.00	0.05	0.02	0.00	0.03	0.30
Muddy Creek tributaries	OR_WS_170900030606_02_104294	0.20	0.00	0.05	0.02	0.00	0.03	0.30
Murder Creek and other streams	OR_WS_170900030610_02_104298	0.20	0.00	0.05	0.02	0.00	0.03	0.30
Oak Creek	OR_WS_170900030402_02_104273	0.21	0.00	0.05	0.02	0.00	0.02	0.30
Spring Creek – Willamette River	OR_WS_170900030601_02_104287	0.30[a] 0.225[b]	0.00	0.05	0.02	0.00	0.00[a] 0.075[b]	0.30
All other AUs	Applicable AUs are listed in TSD Appendix D	0.075	0.00	0.05	0.02	0.00	0.155	0.30
a. May 1 – May 31 b. June 1 – Oct 31								

Table 9-4: HUA assignments for source or source categories on assessment units in the McKenzie Subbasin.

AU Name	AU ID	NPDES point sources	Dam and reservoir operations	Consumptive use water management and water withdrawals	Solar loading from existing transportation corridors, existing buildings, and existing utility infrastructure	Solar loading from other NPS sectors	Reserve capacity	Tota l HUA
McKenzie River from Trail Bridge Dam to Leaburg Diversion	OR_SR_1709000402_02_104588, OR_SR_1709000402_02_103858, OR_SR_1709000405_02_103868, OR_SR_1709000405_02_103869, OR_SR_1709000405_02_103866, OR_SR_1709000407_02_103884 from Ennis Creek to Leaburg Diversion (McKenzie River Miles 35.7 – 48.2)	0.03	0.00	0.03	0.02	0.00	0.22	0.30
McKenzie River from Leaburg Diversion to International Paper Springfield outfall	OR_SR_1709000407_02_103884 from McKenzie River Mile 12.4 – 35.7	0.08	0.00[a] 0.16[b] 0.00[c]	0.03	0.02	0.00	0.02	0.30
McKenzie River from International Paper Springfield's outfall to the mouth	OR_SR_1709000407_02_103884 from McKenzie River Mile 0 – 12.4	0.20[d] 0.22[e] 0.23[f]	0.00[a] 0.02[b] 0.00[c]	0.02	0.02	0.00	0.04[d] 0.02[e] 0.01[f]	0.30
South Fork McKenzie	OR_SR_1709000403_02_104590	0.01	0.00	0.05	0.02	0.00	0.22	0.30
All other AUs	Applicable AUs are listed in TSD Appendix D	0.075	0.00	0.05	0.02	0.00	0.155	0.30

a: NPS dam and reservoir operations
b: EWEB Walterville NPS and NPDES increases
c: EWEB Leaburg project NPS increases
d: Spring spawning period
e: Summer non spawning period
f: Fall spawning period

Table 9-5: HUA assignments for source or source categories on assessment units in the North Santiam Subbasin.

AU Name	AU ID	NPDES point sources	NPS dam and reservoir operations	Consumptive use water management and water withdrawals	Solar loading from existing transportation corridors, existing buildings, and existing utility infrastructure	Solar loading from other NPS sectors	Reserve capacity	Total HUA
Big Cliff Reservoir	OR_LK_1709000503_02_100770	0.10	0.00	0.05	0.02	0.00	0.13	0.30
North Santiam River	OR_SR_1709000504_02_103906, OR_SR_1709000506_02_103930	0.07	0.00	0.04	0.05	0.00	0.14	0.30
Santiam River	OR_SR_1709000506_02_103927	0.04	0.00	0.04	0.04	0.00	0.18	0.30
All other AUs	Applicable AUs are listed in TSD Appendix D	0.075	0.00	0.05	0.02	0.00	0.155	0.30

Table 9-6: HUA assignments for source or source categories on assessment units in the South Santiam Subbasin.

AU Name	AU ID	NPDES point sources	NPS dam and reservoir operations	Consumptive use water management and water withdrawals	Solar loading from existing transportation corridors, existing buildings, and existing utility infrastructure	Solar loading from other NPS sectors	Reserve capacity	Total HUA
Crabtree Creek	OR_SR_1709000606_02_103978	0.10	0.00	0.05	0.02	0.00	0.13	0.30
Foster Lake	OR_LK_1709000604_02_100772	0.10	0.00	0.05	0.02	0.00	0.13	0.30
Middle Santiam River	OR_SR_1709000604_02_103969	0.10	0.00	0.05	0.02	0.00	0.13	0.30
Roaring River	OR_SR_1709000606_02_103974	0.10	0.00	0.05	0.02	0.00	0.13	0.30
South Santiam River	OR_SR_1709000608_02_103925	0.13	0.00	0.04	0.05	0.00	0.08	0.30
Wiley Creek	OR_SR_1709000605_02_103971	0.20	0.00	0.05	0.02	0.00	0.03	0.30
All other AUs	Applicable AUs are listed in TSD Appendix D	0.075	0.00	0.05	0.02	0.00	0.155	0.30

Table 9-7: HUA assignments for source or source categories on assessment units in the Middle Willamette Subbasin.

AU Name	AU ID	NPDES point sources	NPS dam and reservoir operations	Consumptive use water management and water withdrawals	Solar loading from existing transportation corridors, existing buildings, and existing utility infrastructure	Solar loading from other NPS sectors	Reserve capacity	Tota l HUA
Coffee Lake Creek-Willamette River	OR_WS_170900070402_02_104419	0.20	0.00	0.05	0.02	0.00	0.03	0.30
Rickreall Creek	OR_SR_1709000701_02_104591	0.22	0.00	0.05	0.02	0.00	0.01	0.30
Stone Quarry Lake	OR_LK_1709000703_02_100809	0.15	0.00	0.05	0.02	0.00	0.08	0.30
Upper Mill Creek	OR_WS_170900070201_02_104409	0.20	0.00	0.05	0.02	0.00	0.03	0.30
All other AUs	Applicable AUs are listed in TSD Appendix D	0.075	0.00	0.05	0.02	0.00	0.155	0.30

Table 9-8: HUA assignments for source or source categories on assessment units in the Molalla-Pudding Subbasin.

AU Name	AU ID	NPDES point sources	NPS dam and reservoir operations	Consumptive use water management and water withdrawals	Solar loading from existing transportation corridors, existing buildings, and existing utility infrastructure	Solar loading from other NPS sectors	Reserve capacity	Total HUA
Abiqua Creek	OR_SR_1709000901_02_104062	0.20	0.00	0.05	0.02	0.00	0.03	0.30
Lower Abiqua Creek	OR_WS_170900090107_02_104460	0.20	0.00	0.05	0.02	0.00	0.03	0.30
Mill Creek	OR_WS_170900090502_02_104481	0.20	0.00	0.05	0.02	0.00	0.03	0.30
Molalla River	OR_SR_1709000906_02_104093, OR_SR_1709000906_02_104094, OR_LK_1709000906_02_100834, OR_WS_170900090607_02_104488	0.20	0.00	0.05	0.02	0.00	0.03	0.30
Pudding River	OR_SR_1709000902_02_104073, OR_SR_1709000905_02_104088, OR_SR_1709000901_02_104064	0.20	0.00	0.05	0.02	0.00	0.03	0.30
Silver Creek	OR_SR_1709000901_02_104595	0.20	0.00	0.05	0.02	0.00	0.03	0.30
All other AUs	Applicable AUs are listed in TSD Appendix D	0.075	0.00	0.05	0.02	0.00	0.155	0.30

Table 9-9: HUA assignments for source or source categories on assessment units in the Clackamas Subbasin.

AU Name	AU ID	NPDES point sources	NPS dam and reservoir operations	Consumptive use water management and water withdrawals	Solar loading from existing transportation corridors, existing buildings, and existing utility infrastructure	Solar loading from other NPS sectors	Reserve capacity	Total HUA
Clackamas Cove	OR_LK_1709001106_02_100259	0.04	0.00	0.05	0.05	0.00	0.16	0.30
Clackamas River	OR_SR_1709001106_02_104597	0.04	0.00	0.05	0.05	0.00	0.16	0.30
Deep Creek	OR_SR_1709001106_02_104166	0.20	0.00	0.05	0.02	0.00	0.03	0.30
Eagle Creek	OR_SR_1709001105_02_104162, OR_SR_1709001105_02_104163	0.20	0.00	0.05	0.02	0.00	0.03	0.30
North Fork Deep Creek	OR_WS_170900110605_02_104547	0.20	0.00	0.05	0.02	0.00	0.03	0.30
Unnamed Lake Unit	OR_LK_1709001106_02_100852	0.04	0.00	0.05	0.05	0.00	0.16	0.30
All other AUs	Applicable AUs are listed in TSD Appendix D	0.075	0.00	0.05	0.02	0.00	0.155	0.30

Table 9-10: HUA assignments for source or source categories on assessment units in the Lower Willamette Subbasin.

AU Name	AU ID	NPDES point sources	NPS dam and reservoir operations	Consumptive use water management and water withdrawals	Solar loading from existing transportation corridors, existing buildings, and existing utility infrastructure	Solar loading from other NPS sectors	Reserve capacity	Total HUA
Columbia Slough	OR_WS_170900120201_02_104554.1, OR_WS_170900120201_02_104554.2	0.225	0.00	0.05	0.02	0.00	0.005	0.30
Mount Scott Creek	OR_SR_1709001201_02_104171, OR_WS_170900120102_02_104551	0.15	0.00	0.05	0.02	0.00	0.08	0.30
Multnomah Channel	OR_SR_1709001203_88_104184	0.09	0.00	0.05	0.05	0.00	0.11	0.30
All other AUs	Applicable AUs are listed in TSD Appendix D	0.075	0.00	0.05	0.02	0.00	0.155	0.30

Table 9-11: HUA assignments for source or source categories on the Willamette River or Willamette River side channel assessment units.

AU Name	AU ID	NPDES point sources	NPS dam and reservoir operations	Consumptive use water management and water withdrawals	Solar loading from existing transportation corridors, existing buildings, and existing utility infrastructure	Solar loading from other NPS sectors	Reserve capacity	Total HUA
Willamette River RM 187-107.5 Confluence of MF Willamette River and CF Willamette River to Santiam River	OR_SR_1709000306_05_103854	0.23	0.00	0.03	0.03	0.00	0.01	0.30
Willamette River RM 107.5 – 84.5 Luckiamute River to Willamette Slough	OR_SR_1709000701_05_104005, OR_SR_1709000703_05_104014	0.16	0.00	0.03	0.03	0.00	0.08	0.30
Willamette River RM 84.5 - 51 Willamette Slough to Chehalem Creek	OR_SR_1709000703_04_104013	0.20	0.00	0.03	0.03	0.00	0.04	0.30
Willamette River RM 51 – 45 Chehalem Creek to Champoeg Creek	OR_SR_1709000703_88_104015	0.13	0.00	0.02	0.02	0.00	0.13	0.30
Willamette River RM 45 - 0 Champoeg Creek to Confluence with Columbia River	OR_SR_1709000704_88_104020, OR_SR_1709001201_88_104019, OR_SR_1709001202_88_104175	0.12	0.10	0.02	0.02	0.00	0.04	0.30
Albany Channel	OR_SR_1709000306_02_103849	0.23	0.00	0.03	0.03	0.00	0.01	0.30
Booneville Channel	OR_SR_1709000306_02_103842	0.23	0.00	0.03	0.03	0.00	0.01	0.30
Curtis Slough	OR_SR_1709000306_02_103848	0.23	0.00	0.03	0.03	0.00	0.01	0.30
Long Tom River (Norwood Island side channel)	OR_SR_1709000306_02_103844	0.23	0.00	0.03	0.03	0.00	0.01	0.30

AU Name	AU ID	NPDES point sources	NPS dam and reservoir operations	Consumptive use water management and water withdrawals	Solar loading from existing transportation corridors, existing buildings, and existing utility infrastructure	Solar loading from other NPS sectors	Reserve capacity	Total HUA
Marshall Slough	OR_SR_1709000306_02_103850	0.23	0.00	0.03	0.03	0.00	0.01	0.30
Mill Race	OR_SR_1709000306_02_103846	0.23	0.00	0.03	0.03	0.00	0.01	0.30
Spring Creek	OR_SR_1709000306_02_103851	0.23	0.00	0.03	0.03	0.00	0.01	0.30
Lambert Slough	OR_LK_1709000703_02_100794	0.20	0.00	0.03	0.03	0.00	0.04	0.30
Mission Lake	OR_LK_1709000703_02_100795	0.20	0.00	0.03	0.03	0.00	0.04	0.30
Unnamed side channel	OR_SR_1709000703_02_104010	0.20	0.00	0.03	0.03	0.00	0.04	0.30
Willamette Slough	OR_LK_1709000703_02_100792	0.20	0.00	0.03	0.03	0.00	0.04	0.30
Third Slough	OR_SR_1709000306_02_103845	0.23	0.00	0.03	0.03	0.00	0.01	0.30
Unnamed side channels	OR_SR_1709000306_02_103840, OR_SR_1709000306_02_103841, OR_SR_1709000306_02_103843, OR_SR_1709000306_02_103847, OR_SR_1709000306_02_103852, OR_SR_1709000306_02_103853	0.23	0.00	0.03	0.03	0.00	0.01	0.30
Willamette River West channel between Dodson Slough and McKenzie River	OR_SR_1709000306_02_103839	0.23	0.00	0.03	0.03	0.00	0.01	0.30

9.1.2 Thermal wasteload allocations for point sources

Wasteload allocations are assigned to NPDES permitted point sources listed in **Table 9-12**. The wasteload allocation for the Phase I individual MS4 stormwater permits and registrants under the general stormwater permits (MS4 phase II, 1200-A, 1200-C and 1200-Z), and registrants under the 400-J, 1500-A, and 1700-A general permits are set equal to loads permitted by these NPDES permits. This means that individual permittees and registrants must follow their permit conditions to meet the narrative wasteload allocation. Beyond current permit limits, no additional TMDL requirements are needed for these sources to control temperature. For all general wastewater and stormwater NPDES permits, more precise wasteload allocations may be considered if subsequent data analysis indicates a need and capacity is available.

Wasteload allocations were calculated using **Equation 9-1**.

$$WLA = (\Delta T) \cdot (Q_E + Q_R) \cdot C_F$$ **Equation 9-1**

where,

$WLA =$ Wasteload allocation (kilocalories/day), expressed as a rolling seven-day average.

$\Delta T =$ The assigned portion of the HUA from **Table 9-12**. It is 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. When the minimum duties provision at OAR 340-041-0028(12)(a) applies, ΔT = 0.0. See **Table 9-13** for list of NPDES permittees where minimum duties provision may apply.

$Q_E =$ The daily mean effluent flow (cfs).

When effluent flow is in million gallons per day (MGD) convert to cfs:

$$\frac{1 \text{ million } gallons}{1 \; day} \cdot \frac{1.5472 \; ft^3}{1 \text{ million gallons}} = 1.5472$$

$Q_R =$ 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 cfs: 2,446,665

$$\left(\frac{1 \text{ m}}{3.2808 \text{ ft}}\right)^3 \cdot \frac{1000 \; kg}{1 \; m^3} \cdot \frac{86400 \; sec}{1 \; day} \cdot \frac{1 \; kcal}{1 \; kg \; \cdot 1^{\circ}\text{C}} = 2{,}446{,}665$$

The effluent discharge used to calculate the wasteload allocations presented in **Table 9-12** are based on the average dry weather facility design, a maximum discharge authorized by an NPDES permit, or an effluent discharge characterized from discharge data. More information on the specific source of the effluent discharge flow and the rationale behind the assigned HUA is described in the TSD Section 9.2.

Wasteload allocations may be implemented in NPDES permits in any of the following ways:

(1) Incorporate the 7Q10 wasteload allocation in **Table 9-12** as a static numeric limit. Permit writers may recalculate the static limit using different values for 7Q10 (Q_R) and effluent discharge (Q_E), if better estimates are available (including the use of seasonal values, as appropriate).
(2) Incorporate **Equation 9-1** 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. The assigned portion of the HUA (ΔT) is static and based on the value in **Table 9-12**. Permit writers may recalculate the 7Q10 using seasonal or annual values, as appropriate, if better estimates are available.

The wasteload allocation period for each facility is consistent with the critical period of the receiving waterbody, which is presented in Section 5: Seasonal variation and critical period for temperature.

Table 9-12: Thermal wasteload allocations (WLA) for point sources.

NPDES Permittee WQ File Number : EPA Number	Assigned HUA ΔT (°C)	WLA period start	WLA period end	7Q10 River flow (cfs)	Effluent discharge (cfs)	7Q10 WLA[1] (kcals/day)
Adair Village STP 500 : OR0023396	0.001	4/1	5/15	6308	1.3	15.437E+6
	0.001	5/16	10/14	3877	0.2	9.486E+6
	0.002	10/15	11/30	4443	1.3	21.747E+6
Albany Millersburg WRF [2] 1098 : OR0028801	0.010	4/1	5/15	6308	14.3	154.686E+6
	0.017	5/16	10/14	3877	13.7	161.827E+6
	0.037	10/15	11/30	4443	25.1	404.482E+6
Albany Water Treatment Plant 66584 : ORG383501	0.20	5/1	10/31	24	1.30	12.38E+6
Alpine Community 100101 : OR0032387	0.00	5/1	10/31	0.4	0.03	0
Arclin 16037 : OR0021857	0.075	5/1	10/31	0	1.55	0.284E+6
Arclin 81714 : OR0000892	0.075	4/1	10/31	30	0.93	5.675E+6
Arkema 68471 : OR0044695	0.001	6/1	9/30	6740	0.14	16.491E+6
Ash Grove Cement - Rivergate Lime Plant 3690 : OR0001601	0.00	6/1	9/30	5934	0	0
ATI Albany Operations 64300 : OR0001716	0.01	5/1	10/31	1.4	3.52	0.12E+6
ATI Millersburg [2] 87645 : OR0001112	0.010	4/1	5/15	6308	5.2	154.463E+6
	0.011	5/16	10/14	3877	5.2	104.483E+6
	0.012	10/15	11/15	4443	5.4	130.605E+6
Aumsville STP 4475 : OR0022721	0.00	5/1	10/31	0.7	0.52	0

NPDES Permittee WQ File Number : EPA Number	Assigned HUA ΔT (°C)	WLA period start	WLA period end	7Q10 River flow (cfs)	Effluent discharge (cfs)	7Q10 WLA[1] (kcals/day)
Aurora STP 110020 : OR0043991	0.00	5/1	10/31	10	0.1	0
Bakelite Chemicals LLC 32650 : OR0032107	0.00	5/1	10/31	0	0.0	0
Bakelite Chemicals LLC 32864 : OR0002101	0.075	5/1	5/31	0	0.0	0
	0.00	6/1	10/31	0	0.0	0
Blount Oregon Cutting Systems Division 63545 : OR0032298	0.075	2/15	11/15	0	0.19	0.034E+6
Boeing Of Portland - Fabrication Division 9269 : OR0031828	0.075	4/1	10/31	0	0.46	0.085E+6
Brooks STP 100077 : OR0033049	0.001	4/1	5/15	11955	1.6	29.254E+6
	0.001	5/16	10/14	5684	0.4	13.908E+6
	0.002	10/15	11/15	7133	1.6	34.912E+6
Brownsville STP 11770 : OR0020079	0.00	5/1	10/31	14	0.0	0
Canby Regency Mobile Home Park 97612 : OR0026280	0.001	6/1	9/30	5790	0.06	14.166E+6
Canby STP 13691 : OR0020214	0.004	6/1	9/30	5790	3.1	56.695E+6
Cascade Pacific Pulp, LLC 36335 : OR0001074	0.024	4/1	5/15	5330	16.5	313.946E+6
	0.049	5/16	10/14	3609	17.3	434.745E+6
	0.037	10/15	11/15	4280	14.5	388.767E+6
Century Meadows Sanitary System (CMSS) 96010 : OR0028037	0.001	6/1	9/30	5734	0.6	14.031E+6
City of Silverton Drinking WTP 81398 : ORG383527	0.20	5/1	10/31	0	0.08	0.038E+6
Coburg Wastewater Treatment Plant 115851 : OR0044628	0.20	5/1	10/31	0	0.68	0.333E+6
Coffin Butte Landfill 104176 : OR0043630	0.075	5/1	10/31	0	0.0	0
Columbia Helicopters 100541 : OR0033391	0.075	5/1	10/31	0	0.01	0.002E+6
Corvallis Rock Creek WTP 20160 : ORG383513	0.20	5/1	10/31	0	0.37	0.182E+6
Corvallis STP 20151 : OR0026361	0.015	4/1	5/15	5800	15.3	213.421E+6
	0.015	5/16	10/14	3683	11.7	135.595E+6
	0.031	10/15	11/15	4149	24.0	316.508E+6
Cottage Grove STP 20306 : OR0020559	0.154	4/1	5/15	61	2.1	23.775E+6
	0.206	5/16	11/15	38	2.8	20.564E+6
Covanta Marion, Inc	0.001	4/1	5/15	10688	0.2	26.15E+6

NPDES Permittee WQ File Number : EPA Number	Assigned HUA ΔT (°C)	WLA period start	WLA period end	7Q10 River flow (cfs)	Effluent discharge (cfs)	7Q10 WLA[1] (kcals/day)
89638 : OR0031305	0.002	5/16	10/14	5684	0.3	27.815E+6
	0.001	10/15	11/15	7133	0.2	17.453E+6
Creswell STP 20927 : OR0027545	0.20	5/1	5/31	0	5.09	2.491E+6
	0.00	6/1	10/31	0	0.31	0
Dallas STP 22546 : OR0020737	0.11	5/1	10/31	4.2	3.09	1.963E+6
Dallas WTP 22550 : ORG383529	0.11	5/1	10/31	3.3	0.17	0.934E+6
Deer Creek Estates Water Association 23650 : ORG383526	0.20	5/1	10/31	0.7	0.004	0.344E+6
Dundee STP 25567 : OR0023388	0.002	6/1	9/30	5734	1.1	28.064E+6
Duraflake 97047 : OR0000426	0.20	5/1	10/31	0	0.55	0.270E+6
Estacada STP 27866 : OR0020575	0.075	5/1	10/31	317	0.84	58.323E+6
Evraz Oregon Steel 64905 : OR0000451	0.002	6/1	9/30	6740	1.2	32.987E+6
EWEB Carmen Powerhouse (Outfalls 001A and 001B) 28393 : OR0000680	0.075	5/1	10/31	146	2.68	27.282E+6
EWEB Trail Bridge Powerhouse (Outfalls 002A and 002B) 28393 : OR0000680	0.030	5/1	10/31	496	0.93	36.475E+6
EWEB Hayden Bridge Filter Plant 28385 : ORG383503	0.011	4/1	11/15	1538	2.09	41.449E+6
Falls City STP 28830 : OR0032701	0.00	5/1	10/31	5.3	0.0	0
Forest Park Mobile Village 30554 : OR0031267	0.001	6/1	9/30	5988	0.02	14.651E+6
Foster Farms 97246 : OR0026450	0.00	5/1	10/31	0	0.0	0
Frank Lumber Co. Inc. 30904 : OR0000124	0.04	4/1	6/15	987	3	96.888E+6
	0.04	6/16	8/31	859	3	84.361E+6
	0.04	9/1	11/15	957	4.4	94.089E+6
Fujimi Corporation - SW Commerce Circle 107178 : OR0040339	0.20	5/1	10/31	0	0.2	0.094E+6
Gervais STP 33060 : OR0027391	0.00	5/1	10/31	6.6	0.34	0
GP Halsey Mill 105814 : OR0033405	0.010	4/1	5/15	5330	5.3	130.537E+6
	0.016	5/16	10/14	3609	4.9	141.472E+6
	0.011	10/15	11/15	4280	4.0	115.297E+6

NPDES Permittee WQ File Number : EPA Number	Assigned HUA ΔT (°C)	WLA period start	WLA period end	7Q10 River flow (cfs)	Effluent discharge (cfs)	7Q10 WLA[1] (kcals/day)
Halsey STP 36320 : OR0022390	0.00	5/1	10/31	5.0	0.30	0
Harrisburg Lagoon Treatment Plant 105415 : OR0033260	0.002	4/1	4/30	5204	1.9	25.474E+6
	0.004	5/1	10/31	3480	1.6	34.073E+6
	0.003	11/1	11/15	3853	1.9	28.295E+6
Hollingsworth & Vose Fiber Co – Corvallis 28476 : OR0000299	0.001	4/1	5/15	5800	0.1	14.191E+6
	0.001	5/16	10/14	3683	0.2	9.012E+6
	0.001	10/15	11/15	4149	0.1	10.151E+6
Hubbard STP 40494 : OR0020591	0.20	5/1	10/31	0	0.35	0.169E+6
Hull-Oakes Lumber Co. 107228 : OR0038032	0.075	5/1	10/31	0	0.08	0.014E+6
Independence STP 41513 : OR0020443	0.005	4/1	5/15	10688	3.9	130.797E+6
	0.005	5/16	10/14	5684	3.8	69.581E+6
	0.003	10/15	11/15	7133	6.2	52.402E+6
International Paper - Springfield 108921 : ORG383548 (200-J discharge)	0.075	5/1	10/31	0	0.01	0.001E+6
International Paper - Springfield (Outfall 001 + Outfall 002) 96244 : OR0000515	0.12	4/1	6/15	2,442	28.9	725.456E+6
	0.20	6/16	8/31	1,537	28.9	766.247E+6
	0.19	9/1	11/15	1,630	28.9	771.167E+6
International Paper - Springfield (Outfall 003) 96244 : OR0000515	0.075	5/1	10/31	0	3.09	0.568E+6
J.H. Baxter & Co 6553 : OR0021911	0.075	5/1	10/31	0.6	0.12	0.132E+6
Jasper Wood Products 100097 : OR0042994	0.00	6/1	9/30	6691	0	0
Jefferson STP 43129 : OR0020451	0.002	4/1	5/15	3275	0.6	16.029E+6
	0.006	5/16	10/14	1144	0.8	16.806E+6
	0.003	10/15	11/15	2278	0.6	16.725E+6
JLR 32536 : OR0001015	0.01	5/1	10/31	6.9	0.5	0.181E+6
Junction City STP 44509 : OR0026565	0.00	5/1	10/31	0	0.0	0
Kingsford Manufacturing Company - Springfield Plant 46000 : OR0031330	0.075	5/1	5/31	0	0.08	0.015E+6
	0.00	6/1	10/31	0	0	0
Knoll Terrace Mhc 46990 : OR0026956	0.00	5/1	10/31	0	0.09	0
Lakewood Utilities, Ltd 96110 : OR0027570	0.00	5/1	10/31	0	0.0	0
Lane Community College 48854 : OR0026875	0.00	5/1	10/31	0	0.22	0

NPDES Permittee WQ File Number : EPA Number	Assigned HUA ΔT (°C)	WLA period start	WLA period end	7Q10 River flow (cfs)	Effluent discharge (cfs)	7Q10 WLA[1] (kcals/day)
Lebanon WWTP 49764 : OR0020818	0.03	4/1	5/15	1043	4.1	76.857E+6
	0.05	5/16	10/14	506	4.9	62.50E+6
	0.08	10/15	11/15	726	12.3	144.51E+6
Lowell STP 51447 : OR0020044	0.013	5/1	11/15	1,002	1.22	31.909E+6
Mcfarland Cascade Pole & Lumber Co 54370 : OR0031003	0.00	5/1	10/31	0	0.0	0
Molalla Municipal Drinking WTP 109846 : ORG380014	0.20	5/1	10/31	0	0.16	0.078E+6
Molalla STP 57613 : OR0022381	0.10	5/1	10/31	56	3.46	14.547E+6
Monmouth STP 57871 : OR0020613	0.004	4/1	5/15	10688	5.8	104.657E+6
	0.005	5/16	10/14	5684	4.3	69.587E+6
	0.003	10/15	11/15	7133	5.8	52.399E+6
Monroe STP 57951 : OR0029203	0.08	4/1	4/30	55	1.2	11.00E+6
	0.03	5/1	10/31	22	0.2	1.629E+6
	0.03	11/1	11/15	55	1.2	4.125E+6
Mt. Angel STP 58707 : OR0028762	0.00	5/1	10/31	6.6	0.87	0
Murphy Veneer, Foster Division 97070 : OR0021741	0.20	5/1	10/31	4.2	1.11	2.598E+6
MWMC - Eugene/Springfield STP 55999 : OR0031224	0.118	4/1	5/15	1906	42.6	562.573E+6
	0.093	5/16	10/14	1508	55.0	355.645E+6
	0.188	10/15	11/15	1925	86.3	925.144E+6
Newberg - Wynooski Road STP 102894 : OR0032352	0.006	6/1	9/30	5734	6.2	84.266E+6
Newberg OR, LLC 72615 : OR0000558	0.00	6/1	9/30	5934	0	0
Norpac Foods- Plant #1, Stayton 84820 : OR0001228	0.20	5/1	10/31	0	6.19	3.028E+6
NW Natural Gas Site Remediation 120589 : OR0044687	0.001	6/1	9/30	6740	0.7	16.492E+6
Oak Lodge Water Services Water Reclamation Facility 62795 : OR0026140	0.003	6/1	9/30	6740	4	49.501E+6
Oakridge STP 62886 : OR0022314	0.075	5/1	11/30	514	0.73	94.452E+6
ODC - Oregon State Penitentiary 109727 : OR0043770	0.075	5/1	10/31	6.5	2.48	1.647E+6
ODFW - Clackamas River Hatchery 64442 : OR0034266	0.072*	4/1	6/15	1186	42.1	216.342E+6*
	0.261*	6/16	8/31	627	41.0	426.571E+6*
	0.283*	9/1	11/15	645	42.0	475.683E+6*

NPDES Permittee WQ File Number : EPA Number	Assigned HUA ΔT (°C)	WLA period start	WLA period end	7Q10 River flow (cfs)	Effluent discharge (cfs)	7Q10 WLA[1] (kcals/day)
ODFW - Dexter Ponds 64450 : ORG133514	0.036*	4/1	6/15	986	48.0	91.075E+6*
	0.189*	6/16	9/14	1002	48.0	485.541E+6*
	0.255*	9/15	11/15	1301	48.0	841.641E+6*
ODFW - Leaburg Hatchery 64490 : OR0027642	0.074*	4/1	6/15	2,442	92.4	458.861E+6*
	0.012*	6/16	8/31	1,537	39.1	46.274E+6*
	0.026*	9/1	11/15	1,630	78.3	108.671E+6*
ODFW - Marion Forks Hatchery 64495 : OR0027847	0.075*	5/1	10/31	6.3	18.6	4.562E+6*
ODFW - McKenzie River Hatchery 64500 : OR0029769	0.002	4/1	6/15	2442	12.7	12.012E+6
	0.033	6/16	8/31	1537	11.8	125.05E+6
	0.002	9/1	11/15	1,630	1.0	7.981E+6
ODFW - Minto Fish Facility 64495 : OR0027847	0.03*	4/1	6/15	987	30	74.648E+6*
	0.03*	6/16	8/31	859	36	65.693E+6*
	0.03*	9/1	11/15	957	41	73.253E+6*
ODFW - Roaring River Hatchery 64525 : ORG133506	0.10*	5/1	10/31	0.5	14.2	3.597E+6*
ODFW - South Santiam Hatchery 64560 : ORG133511	0.02*	4/1	6/15	841	10.6	41.672E+6*
	0.02*	6/16	8/31	621	25.9	31.655E+6*
	0.02*	9/1	11/15	677	28.5	34.522E+6*
ODFW - Willamette Fish Hatchery 64585 : ORG133507	0.075*	5/1	10/31	110	79.0	34.681E+6*
OHSU Center For Health and Healing 113611 : OR0034371	0.001	6/1	9/30	6740	0.06	16.491E+6
OSU John L. Fryer Aquatic Animal Health Lab 103919 : OR0032573	0.001	4/1	5/15	5800	0.9	14.193E+6
	0.001	5/16	10/14	3683	1.2	9.014E+6
	0.001	10/15	11/15	4149	0.9	10.153E+6
Philomath WTP 100048 : ORG383536	0.20	5/1	10/31	6.7	0.32	3.435E+6
Philomath WWTP 103468 : OR0032441	0.00	5/1	10/31	6.7	0.0	0
PNW Veg Co DBA Norpac Foods No. 5 84791 : OR0021261	0.00	5/1	10/31	0	0.0	0
Row River Valley Water District 100075 : ORG383534	0.075	5/1	10/31	12	0.04	2.210E+6
RSG Forest Products - Liberal 72596 : OR0021300	0.20	5/1	10/31	0	1.24	0.606E+6
Philomath WTP 100048 : ORG383536	0.20	5/1	10/31	6.7	0.32	3.435E+6
Salem Willow Lake STP 78140 : OR0026409	0.024	4/1	5/15	10688	52.9	630.705E+6
	0.036	5/16	10/14	5684	38.3	504.02E+6
	0.058	10/15	11/15	7133	80.2	1,023.60E+6

NPDES Permittee WQ File Number : EPA Number	Assigned HUA ΔT (°C)	WLA period start	WLA period end	7Q10 River flow (cfs)	Effluent discharge (cfs)	7Q10 WLA[1] (kcals/day)
Sandy WWTP 78615 : OR0026573	0.00	5/1	10/31	0.2	0.00	0
Scappoose STP 78980 : OR0022420	NA	6/1	9/30	NA	0.9	21.00E+6
Scio STP 79633 : OR0029301	0.00	5/1	10/31	6.9	0.14	0
Seneca Sawmill Company 80207 : OR0022985	0.00	5/1	10/31	0	1.19	0
SFPP 103159 : OR0044661	0.075	5/1	10/31	0	0.02	0.004E+6
Sherman Bros. Trucking 36646 : OR0021954	0.00	5/1	10/31	0.2	0.02	0
Siltronic Corporation 93450 : OR0030589	0.007	6/1	9/30	6740	4.2	115.506E+6
Silverton STP 81395 : OR0020656	0.20	5/1	10/31	14	3.87	8.743E+6
SLLI 74995 : OR0001741	0.001	6/1	9/30	6740	0.04	16.491E+6
Stayton STP 84781 : OR0020427	0.02	4/1	6/15	1482	1.8	72.607E+6
	0.02	6/16	8/31	914	1.9	44.818E+6
	0.02	9/1	11/15	1018	1.8	49.902E+6
Sunstone Circuits 26788 : OR0031127	0.04	5/1	10/31	10.5	0.065	1.034E+6
Sweet Home STP 86840 : OR0020346	0.02	4/1	6/15	841	2.6	41.28E+6
	0.03	6/16	8/31	621	2.1	45.736E+6
	0.04	9/1	11/15	667	3.5	65.62E+6
Tangent STP 87425 : OR0031917	0.00	5/1	10/31	20	0.17	0
Timberlake STP 90948 : OR0023167	0.00	5/1	10/31	254	0.22	0
Tryon Creek WWTP 70735 : OR0026891	0.004	6/1	9/30	6740	12.8	66.087E+6
Univar USA Inc 100517 : OR0034606	0.001	6/1	9/30	6740	0.04	16.491E+6
USFW - Eagle Creek National Fish Hatchery 91035 : OR0000710	0.20*	5/1	10/31	0	52.6	25.739E+6*
Veneta STP 92762 : OR0020532	0.20	5/1	5/31	6.4	0.98	3.611E+6
	0.00	6/1	9/30	6.4	0.00	0
	0.20	10/1	10/31	6.4	0.98	3.611E+6
U.S Army Corp of Engineers Big Cliff Project 126715 : Not assigned	0.004	4/1	11/15	859	1.1	8.418E+6

NPDES Permittee WQ File Number : EPA Number	Assigned HUA ΔT (°C)	WLA period start	WLA period end	7Q10 River flow (cfs)	Effluent discharge (cfs)	7Q10 WLA[1] (kcals/day)
U.S. Army Corp of Engineers Cougar Project 126712: Not Assigned	0.01	5/1	10/31	236**	0.21	5.779E+6
U.S. Army Corp of Engineers Detroit Project 126716: Not Assigned	0.10	5/1	10/31	743**	7.94	183.729E+6
U.S Army Corp of Engineers Dexter Project 126714 : Not assigned	0.001	4/1	11/15	1002	0.7	2.453E+6
U.S Army Corp of Engineers Foster Project 126713 : Not assigned	0.003	4/1	11/15	621	1.4	4.568E+6
U.S. Army Corp of Engineers Green Peter Project 126717 : Not Assigned	0.10	5/1	11/30	33**	2.12	8.592E+6
U.S. Army Corp of Engineers Hills Creek Project 126699 : Not Assigned	0.06	5/1	11/30	309**	2.85	45.78E+6
U.S. Army Corp of Engineers Lookout Point Project 126700 : Not Assigned	0.06	5/1	11/15	1145**	2.82	168.50E+6
Vigor Industrial 70596 : OR0022942	0.005	6/1	9/30	6740	2.4	82.482E+6
WES - Blue Heron Discharge 72634 : OR0000566	0.00	6/1	9/30	5988	0	0
WES - Boring STP 16592 : OR0031399	0.20	5/1	10/31	0.24	0.06	0.145E+6
WES - Kellogg Creek WWTP 16590 : OR0026221	0.007	6/1	9/30	6740	15.5	115.699E+6
WES - Tri-City WPCP 89700 : OR0031259	0.015	6/1	9/30	5988	18.4	220.435E+6
Westfir STP 94805 : OR0028282	0.075	5/1	10/31	174	0.05	31.937E+6
Willamette Falls Paper Company 21489 : OR0000787	0.007	6/1	9/30	5988	6.5	102.666E+6
Willamette Leadership Academy 34040 : OR0027235	0.00	5/1	10/31	0	0.01	0
Wilsonville STP 97952 : OR0022764	0.005	6/1	9/30	5734	4.2	70.197E+6
Woodburn WWTP 98815 : OR0020001	0.20	5/1	10/31	6.7	7.79	7.092E+6

[1] Listed WLAs were calculated based on the 7Q10 flow.

[2] ATI Millersburg and Albany-Millersburg Water Reclamation Facility discharge to the same outfall, but each holds an individual NPDES permit and is assigned its own thermal wasteload allocation

Notes:

WLA = wasteload allocation; kcals/day = kilocalories/day

* When the minimum duties provision at OAR 340-041-0028(12)(a) applies, ΔT = 0.0 and the WLA = 0 kilocalories/day.

** Listed 7Q10s calculated based on a seasonal period corresponding to WLA period.

The minimum duties provision at OAR 340-041-0028(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 point sources, DEQ is implementing the minimum duties provision if a facility operation meets acceptable operation and design requirements. The facility must be operated as a “flow through” facility where intake water moves through the facility and is not processed as part of an industrial or wastewater treatment operation. If a facility mixes the intake water with other wastewater or as a method to cool equipment DEQ considers the thermal effects of this operation to be part of the facility’s own activity and the minimum duties provision does not apply. The intake water must also be returned to the same stream where the intake is located. If the water is not returned to the same stream the thermal effects do not originate from the receiving stream and therefore are considered as part of the facilities own discharge.

When the minimum duties provision applies, the facility cannot add any additional thermal loading to the intake temperatures when the intake temperatures are warmer than the maximum effluent discharge temperatures allowed by the wasteload allocation. The purpose is to ensure the facility controls for thermal effects resulting from passing the water through and not from upstream sources. The specific equations to implement this approach in NPDES permits are included in the TSD Section 9.2.2 through Section 9.2.9. DEQ determined the minimum duties provision is applicable to the facilities listed in **Table 9-13**.

Table 9-13: NPDES permittees where the minimum duties provision may be implemented as part of the TMDL wasteload allocation.

NPDES Permittee	WQ File Number : EPA Number	Intake and Receiving Stream	AU
ODFW - Clackamas River Hatchery	64442 : OR0034266	Clackamas River	OR_SR_1709001106_02_104597
ODFW - Dexter Ponds	64450 : ORG133514	Middle Fork Willamette River	OR_SR_1709000107_02_104583
ODFW - Leaburg Fish Hatchery	64490 : OR0027642	McKenzie River	OR_SR_1709000407_02_103884
ODFW - Marion Forks Fish Hatchery	64495 : OR0027847	Horn Creek	OR_WS_170900050203_02_104345
ODFW - Minto Fish Facility	64495 : OR0027847	North Santiam River	OR_SR_1709000504_02_103906
ODFW - Roaring River Fish Hatchery	64525 : ORG133506	Roaring River	OR_SR_1709000606_02_103974
ODFW - South Santiam Hatchery	64560 : ORG133511	South Santiam River	OR_SR_1709000608_02_103925
ODFW - Willamette Fish Hatchery	64585 : ORG133507	Salmon Creek	OR_SR_1709000104_02_103719
USFW - Eagle Creek National Fish Hatchery	91035 : OR0000710	Eagle Creek	OR_SR_1709001105_02_104162

9.1.3 Thermal wasteload allocations for 100-J general permit registrants

The TMDL includes narrative wasteload allocation requirements for registrants to the 100-J general permit. The wasteload allocation for current and future registrants to the 100-J general permit is equal to loads permitted by the 100-J general permit and the TMDL requirements identified in **Table 9-14** and **Table 9-15**.

With some exceptions, 100-J registrants have been assigned a cumulative HUA of 0.075°C (**Table 9-14**). In addition, each AU has a maximum number of registrants that may discharge based on the 7Q10 stream flow at the discharge location. With some exceptions noted in **Table 9-14**, watershed (WS) AUs may only have one registrant due to low flows. The maximum number of registrants ensures the assigned HUA is attained based on DEQ’s estimated temperature impacts. Additional registrants above the maximum require reserve capacity. The flow categories in **Table 9-14** are set up so the combined sum of warming from each registrant at the point of discharge does not exceed the maximum warming allowed for that AU. As the river flow increases and provides increased dilution, the maximum number of registrants allowed also increases. On select AUs (Columbia Slough, McKenzie River, and Stone Quarry Lake) the maximum number of registrants and assigned HUA reflect the current number of 100-J registrants. Some AUs do not have sufficient loading capacity for new 100-J registrants. On these AUs the capacity has been assigned to other NPDES permittees. **Table 9-15** identifies the AUs with insufficient loading capacity. On these AUs, the assigned HUA is zero and new 100-J registrants cannot increase stream temperature above the applicable temperature criteria. A maximum number of registrants is not needed on these AUs as there is no temperature increase allowed.

Table 9-14: TMDL requirements for 100-J registrants in the Willamette Subbasins.

AU 7Q10 stream flow (cfs)	Assigned HUA (°C)*	Maximum number of registrants per AU
<= 149	0.075	1
> 149 and <= 297	0.075	2
> 297 and <= 521	0.075	3
> 521 and <= 652	0.075	4
> 652 and <= 990	0.075	5
> 990 and <= 1154	0.075	6
> 1154 and <= 1319	0.075	7
> 1319 and <= 1484	0.075	8
> 1484	0.075	9
McKenzie River OR_SR_1709000407_02_103884	0.02	2
Columbia Slough OR_WS_170900120201_02_104554.2	0.225	3
Other Watershed AUs	0.075	1
Stone Quarry Lake OR_LK_1709000703_02_100809	0.15	2
Other natural lakes or ponds where the Natural Lakes temperature criterion apply (OAR 340-041-0028(6))	0.075	1

*Assigned HUA is zero for AUs listed in **Table 9-15**.

Table 9-15: AUs where new 100-J general permit registrants may not increase temperature above the applicable criteria.

AU ID	AU or GNIS Name	Assigned HUA (°C)
OR_LK_1709000107_02_100699	Dexter Reservoir	0.00
OR_LK_1709000402_02_100742	Trail Bridge Reservoir	0.00
OR_LK_1709000503_02_100770	Big Cliff Reservoir	0.00
OR_LK_1709001106_02_100850	Estacada Lake	0.00
OR_LK_1709001202_02_100858	Fairview Lake	0.00
OR_SR_1709000104_02_103719	Salmon Creek	0.00
OR_SR_1709000105_02_103720	Middle Fork Willamette River	0.00
OR_SR_1709000106_02_103721	North Fork Middle Fork Willamette River	0.00
OR_SR_1709000202_02_103765	Layng Creek	0.00
OR_SR_1709000301_02_103789	Long Tom River	0.00
OR_SR_1709000302_02_103807	Oliver Creek	0.00
OR_SR_1709000302_02_103813	Marys River	0.00
OR_SR_1709000402_02_103858	McKenzie River	0.00
OR_SR_1709000105_02_104580	Middle Fork Willamette River	0.00
OR_SR_1709000402_02_104587	McKenzie River	0.00
OR_SR_1709000402_02_104588	McKenzie River	0.00
OR_SR_1709000403_02_104590	South Fork McKenzie River	0.00
OR_SR_1709000405_02_103866	McKenzie River	0.00
OR_SR_1709000405_02_103868	McKenzie River	0.00
OR_SR_1709000405_02_103869	McKenzie River	0.00
OR_SR_1709000605_02_103971	Wiley Creek	0.00
OR_SR_1709000606_02_103974	Roaring River	0.00
OR_SR_1709000701_02_104591	Rickreall Creek	0.00
OR_SR_1709000703_02_104007	Mill Creek	0.00
OR_SR_1709000901_02_104595	Silver Creek	0.00
OR_SR_1709000902_02_104073	Pudding River	0.00
OR_SR_1709001105_02_104162	Eagle Creek	0.00
OR_WS_170900020403_02_104240	Unnamed tributary to Camas Swale Creek	0.00
OR_WS_170900030108_02_104250	Amazon Creek, Amazon Diversion Canal	0.00
OR_WS_170900030204_02_104256	Rock Creek	0.00
OR_WS_170900030511_02_104285	Ditch to Soap Creek tributary	0.00
OR_WS_170900030603_02_104290	Unnamed tributary to Flat Creek	0.00
OR_WS_170900030606_02_104294	Muddy Creek	0.00
OR_WS_170900030610_02_104298	Murder Creek	0.00
OR_WS_170900050203_02_104345	Horn Creek	0.00
OR_WS_170900070201_02_104409	Salem Ditch	0.00
OR_WS_170900070402_02_104419	Coffee Lake Creek	0.00
OR_WS_170900090107_02_104460	Unnamed tributary to Abiqua Creek	0.00
OR_WS_170900090502_02_104481	Mill Creek	0.00
OR_WS_170900090607_02_104488	Unnamed tributary to Molalla River	0.00
OR_WS_170900110605_02_104547	North Fork Deep Creek	0.00

9.1.4 Thermal load allocations for nonpoint sources

Load allocations are assigned to background sources and anthropogenic nonpoint sources on all waters, as defined in Section 2, in the Willamette Subbasins.

The allocation period is consistent with the critical period of each waterbody, which is presented in Section 5: Seasonal variation and critical period for temperature.

Load allocations for background sources are calculated using **Equation 9-2**.

$LA_{BG} = (T_C) \cdot (Q_R) \cdot C_F$ **Equation 9-2**

where,

$LA_{BG} =$ Load allocation to background sources (kilocalories/day), expressed as a rolling seven-day average.

$T_C =$ The applicable temperature criteria, not including the HUA. When there are two year-round applicable temperature criteria that apply to the same AU, the more stringent criteria shall be used.

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

$C_F =$ Conversion factor using flow in cfs: 2,446,665

$$\left(\frac{1\text{ m}}{3.2808\text{ ft}}\right)^3 \cdot \frac{1\ m^3}{35.31\ ft^3} \cdot \frac{1000\ kg}{1\ m^3} \cdot \frac{86400\ sec}{1\ day} \cdot \frac{1\ kcal}{1\ kg\ \cdot 1℃} = 2{,}446{,}665$$

Table 9-16 presents the load allocations assigned to background sources on temperature impaired Category 5 AUs that were modeled for the TMDL analysis. The load allocations are based on the 7Q10 low river flows and the minimum applicable criterion in the respective AUs. **Equation 9-2** shall be used to calculate the load allocations assigned to background sources on all other AUs or stream location in the Willamette Subbasins not identified in **Table 9-16**; or for any AUs identified in **Table 9-16** when river flows are greater than 7Q10.

If the applicable temperature criteria are updated and approved by EPA, the background load allocations assigned to any AU or stream location where the temperature criterion changed shall be recalculated using the updated criterion and **Equation 9-2**.

Table 9-16: Thermal load allocations (LA) for background sources.

AU Name and AU ID	Annual 7Q10 (cfs)	Year Round Criterion (°C)	Spawning Criterion (°C)	LA period start	LA period end	7Q10 LA Year Round (kcal/day)	7Q10 LA Spawning (kcal/day)
Clackamas River OR_SR_1709001106_02_104597	671	16	13	4/1	11/15	26,267.4E+6	21,342.26E+6
Coast Fork Willamette River OR_SR_1709000203_02_104585	38	18	13	4/1	11/15	1,673.52E+6	1,208.65E+6
Coast Fork Willamette River OR_SR_1709000204_02_103787	132	18	13	4/1	11/15	5,813.28E+6	4,198.48E+6
Coyote Creek OR_SR_1709000301_02_103796	5.9	18	NA	5/1	10/31	259.84E+6	NA
Crabtree Creek OR_SR_1709000606_02_103978	25	16	13	5/1	11/30	978.67E+6	795.17E+6
Johnson Creek OR_SR_1709001201_02_104170	11	18	13	2/15	11/15	484.44E+6	349.87E+6
Little North Santiam River OR_SR_1709000505_02_104564	21	16	13	5/1	10/31	822.08E+6	667.94E+6
Long Tom River OR_SR_1709000301_02_103791	22	24	18	4/1	11/15	1,291.84E+6	968.88E+6
Luckiamute River OR_SR_1709000305_02_103829	16	18	13	5/1	10/31	704.64E+6	508.91E+6
McKenzie River	1537	16	13	4/1	11/15	60,168.39E+6	48,886.81E+6

AU Name and AU ID	Annual 7Q10 (cfs)	Year Round Criterion (°C)	Spawning Criterion (°C)	LA period start	LA period end	7Q10 LA Year Round (kcal/day)	7Q10 LA Spawning (kcal/day)
OR_SR_1709000407_02_103884							
Middle Fork Willamette River OR_SR_1709000107_02_104583	1002	16	13	4/1	11/15	39,224.93E+6	31,870.26E+6
Middle Fork Willamette River OR_SR_1709000110_02_104584	1278	16	13	4/1	11/15	50,029.41E+6	40,648.89E+6
Mohawk River OR_SR_1709000406_02_103871	16	16	13	3/15	11/15	626.35E+6	508.91E+6
Molalla River OR_SR_1709000904_02_104086	38	16	13	5/1	10/31	1,487.57E+6	1,208.65E+6
Mosby Creek OR_SR_1709000201_02_103752	11	16	13	5/1	10/31	430.61E+6	349.87E+6
North Santiam River OR_SR_1709000504_02_103906	859	16	13	4/1	11/15	33,626.96E+6	27,321.91E+6
North Santiam River OR_SR_1709000506_02_103930	914	16	13	4/1	11/15	35,780.03E+6	29,071.27E+6
Pudding River OR_SR_1709000905_02_104088	10	18	NA	5/1	10/31	440.4E+6	NA
Santiam River OR_SR_1709000506_02_103927	1144	18	13	4/1	11/15	50,381.73E+6	36,386.8E+6
South Santiam River OR_SR_1709000608_02_103925	615	16	13	4/1	11/15	24,075.18E+6	19,561.09E+6
Thomas Creek OR_SR_1709000607_02_103988	6.9	18	NA	5/1	11/30	303.88E+6	NA
Willamette River OR_SR_1709000306_05_103854	3877	18	13	4/1	11/15	170,742.96E+6	123,314.36E+6
Willamette River OR_SR_1709000701_05_104005	5684	18	13	4/1	11/15	250,323.19E+6	180,788.97E+6
Willamette River OR_SR_1709000703_88_104015	5734	20	NA	6/1	9/30	280,583.54E+6	NA
Willamette River OR_SR_1709000704_88_104020	5988	20	NA	6/1	9/30	293,012.6E+6	NA
Willamette River OR_SR_1709001201_88_104019	6740	20	NA	6/1	9/30	329,810.44E+6	NA
Willamette River OR_SR_1709001202_88_104175	6740	20	NA	6/1	9/30	329,810.44E+6	NA

Load allocations assigned to anthropogenic nonpoint sources on any AU or stream location in the Willamette Subbasins are calculated using **Equation 9-3**. The portions of the HUA (ΔT) assigned to nonpoint sources or source categories are presented in Section 9.1.1. When all of the load allocations assigned to a nonpoint source or source category have been achieved, the HUA allocation to that nonpoint source or source category is achieved.

$LA_{NPS} = (\Delta T) \cdot (Q_R) \cdot C_F$ **Equation 9-3**

where,

$LA_{NPS} =$ Load allocation to anthropogenic nonpoint sources (kilocalories/day), expressed as a rolling seven-day average.

$\Delta T =$ The portion of the HUA assigned to each nonpoint source category representing the maximum cumulative temperature increase (°C) from all source activity in the nonpoint source category. When the minimum duties provision at OAR 340-041-0028(12)(a) applies, ΔT = 0.0.

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

$C_F =$ Conversion factor using flow in cfs: 2,446,665

$$\left(\frac{1\ \mathrm{m}}{3.2808\ \mathrm{ft}}\right)^3 \cdot \frac{1\ m^3}{35.31\ ft^3} \cdot \frac{1000\ kg}{1\ m^3} \cdot \frac{86400\ sec}{1\ day} \cdot \frac{1\ kcal}{1\ kg\ \cdot 1°\mathrm{C}} = 2{,}446{,}665$$

9.1.5 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 allocations.

9.1.5.1 Dam and reservoir operations

Dam and reservoir operations have been assigned 0.00 °C of the HUA, except for the PGE Willamette Falls Hydroelectric Project (Section 9.1.1), and the equivalent load allocation as calculated using **Equation 9-3**. Monitoring stream temperature, rather than a thermal load, is easier and a more meaningful approach for reservoir management. Temperature is mathematically related to excess thermal loading and directly linked to the temperature water quality standard. For these reasons, DEQ is using a surrogate measure to implement the load allocation for dam and reservoir operations.

DEQ has developed the following surrogate measure temperature approach to implement the load allocation. The surrogate measure compliance point is located just downstream of the dam or just downstream of where impounded water is returned to the free-flowing stream. The surrogate measure is:

a) The 7DADM temperatures immediately upstream of the reservoirs. If multiple streams flow into the reservoir, 7DADM temperatures upstream of the reservoirs may be calculated as a flow weighted mean of temperatures from each inflowing tributary. The estimated free flowing (no dam) temperatures may be calculated using a mechanistic or empirical model to account for any warming or cooling that would occur through the reservoir reaches absent the dam and reservoir operations. The results may be applied as the temperature surrogate measure or to adjust the 7DADM temperatures monitored immediately upstream of the reservoirs. Use of the model approach for the surrogate measure must be approved by DEQ.

b) Additional adjustments to the surrogate temperature target calculated or measured under item a) may be allowed when all the following are true:

i. Monitoring data shows 7DADM temperatures do not exceed the applicable temperature criteria plus assigned HUA in the AU downstream of the dam;

ii. The protecting cold water criterion at OAR 340-041-0028(11) does not apply. DEQ has evaluated which dams the protecting cold water criterion likely apply in the TSD Section 9.4.1.1;

iii. A cumulative effects analysis, approved by DEQ, demonstrates that dam release water temperatures warmer than the surrogate measure calculated or measured under item a) will result in attainment of the dam and reservoir assigned HUA above the applicable criteria in downstream waters.

For implementation of the low flow conditions provision at OAR 340-041-0028(12)(d), the 7Q10 shall be calculated at a monitoring gage upstream of the reservoir or at nearby gage that isn't influenced by the dam's operations.

9.1.5.2 Site specific effective shade surrogate measure

Effective shade surrogate measure targets shown in **Table 9-17** and **Table 9-18** represent a surrogate for the amount of solar loading that will attain the HUA and load allocations for nonpoint sources managing streamside vegetation. The surrogate measure is the arithmetic mean of the effective shade values at all model nodes assigned to each DMA (**Equation 9-4**). **Equation 9-4** may be used to recalculate the mean effective shade targets if DMA boundaries change or the DMA boundary needs to be corrected. **Equation 9-4** may also be used to recalculate the mean effective shade targets based on an updated shade gap assessment following the process and methods outlined in the WQMP.

Changes in the target effective shade from the values presented in **Table 9-17** and **Table 9-18** 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, HUA, or the load allocations. They remain the same as presented in this TMDL.

$$\overline{ES} = \frac{\sum ES_{n_i}}{n_i}$$ **Equation 9-4**

Where,

$\overline{ES} =$ The mean effective shade for DMA *i.*

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

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

Table 9-17: Site specific effective shade surrogate measure targets to meet nonpoint source load allocations for specific model extents.

Model Stream	Total Kilometers Assessed	Assessed Effective Shade (%)	TMDL Target Effective Shade (%)	Shade Gap
Clackamas River	36.5	13	37	24
Coast Fork Willamette River	46.7	35	54	19
Fall Creek	11.5	29	47	18
Long Tom River	38.2	25	57	32

Middle Fork Willamette River	26.6	16	26	10
Molalla River	75.36	27	41	14
North Santiam River	79.6	19	34	15
Pudding River	85.55	44	52	8
Row River	12.2	24	54	30
Santiam River	19.5	11	19	8
South Santiam River	58.4	7	21	14
Willamette River	257.8	11	20	9

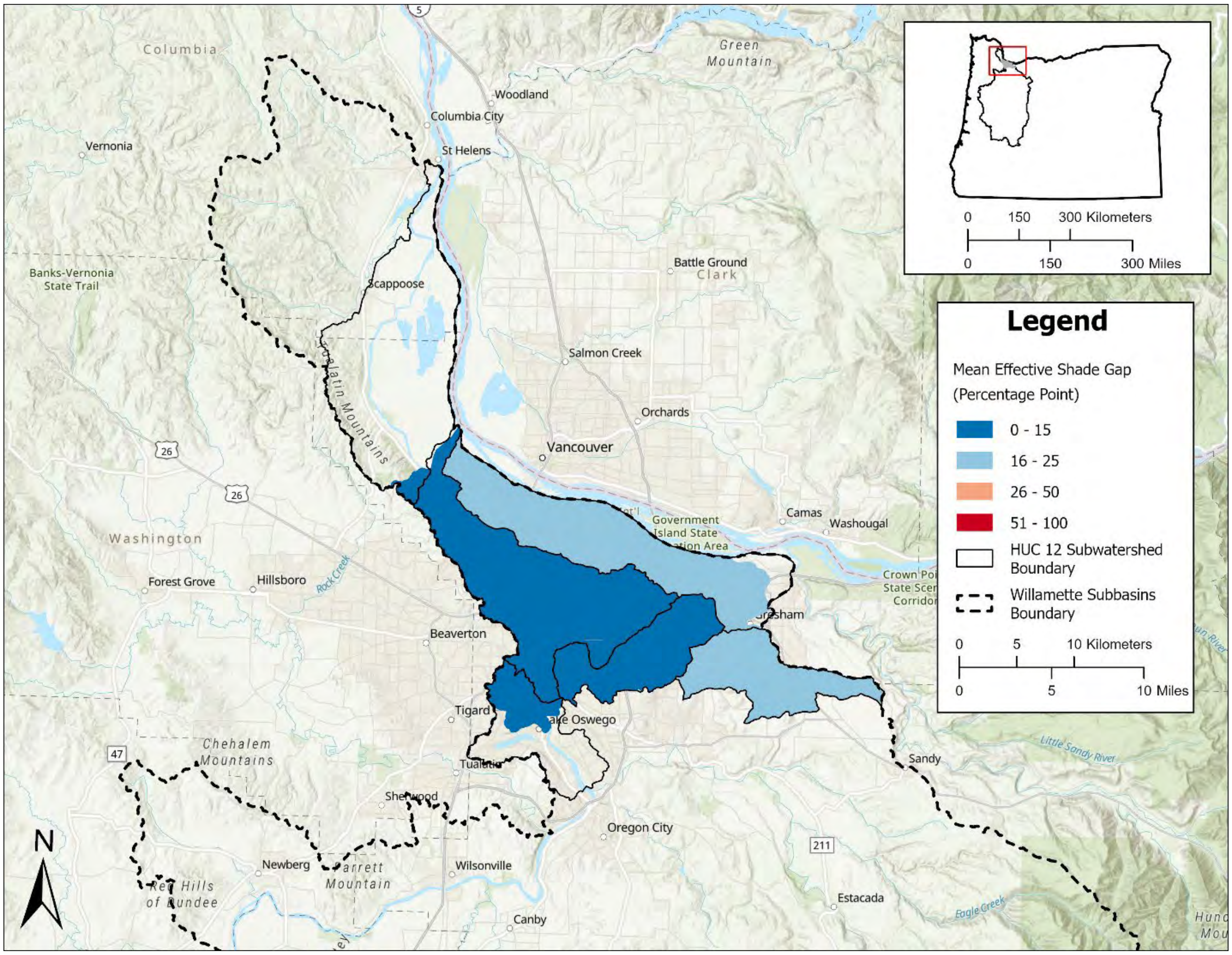

Figure 9-1: Lower Willamette Subbasin model area and mean effective shade gap for each HUC12 subwatershed within the model extent.

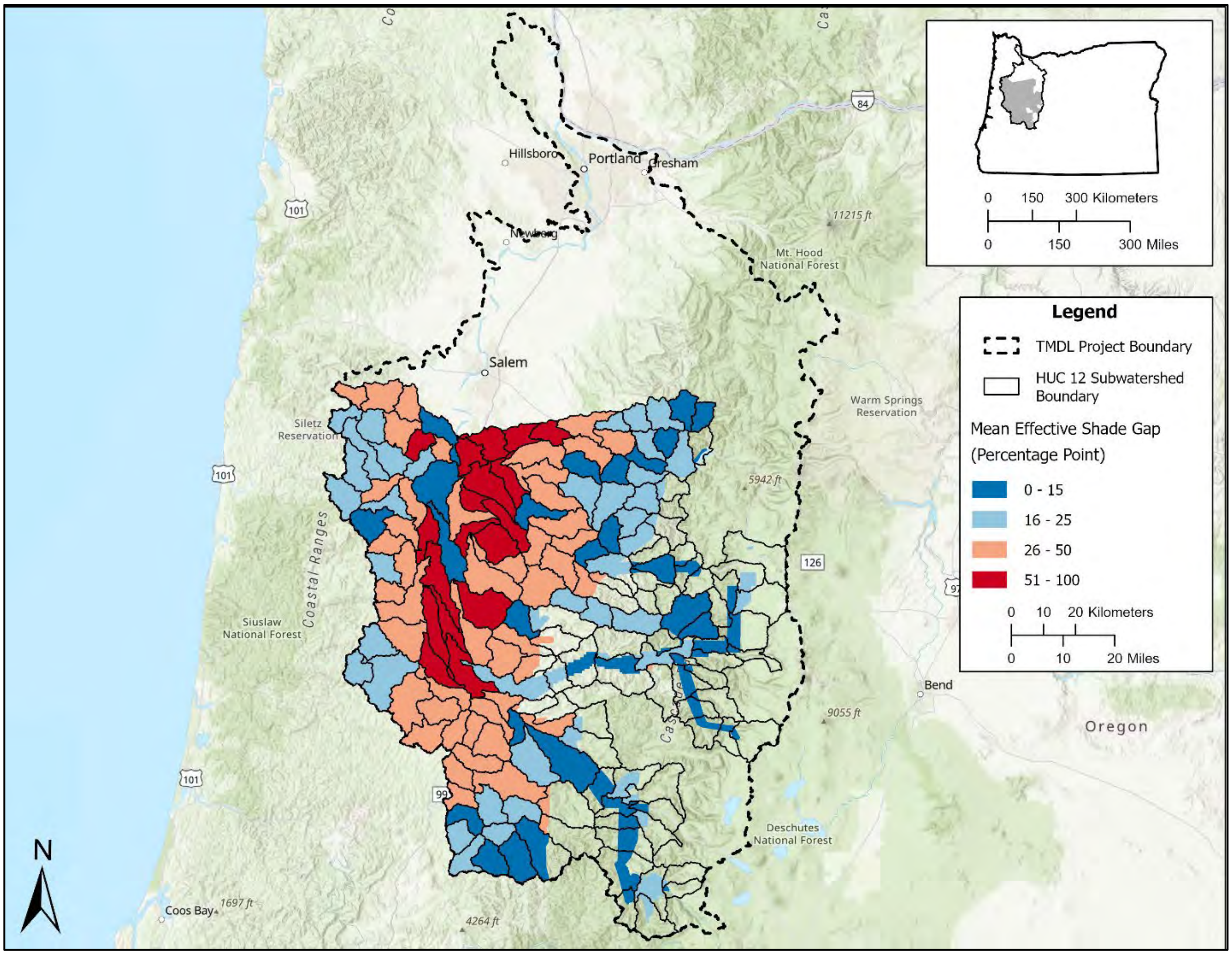

Figure 9-2: Southern Willamette model area and mean effective shade gap for each HUC12 subwatershed within the model extent.

Table 9-18: Site specific effective shade surrogate measure targets to meet nonpoint source load allocations for DMAs in all model areas in the Willamette Subbasins.

DMA	Total Kilometers Assessed	Assessed Effective Shade (%)	TMDL Target Effective Shade (%)	Shade Gap
Albany & Eastern Railroad	0.3	71	74	3
BNSF	0.1	35	42	7
Benton County	122.3	54	85	31
Bonneville Power Administration	2.3	34	94	60
Central Oregon & Pacific Railroad	0.2	32	75	43
City of Adair Village	2	27	93	66
City of Albany	54.4	27	55	28
City of Aurora	0.2	28	33	5
City of Brownsville	4	28	67	39
City of Canby	3.9	23	38	15
City of Coburg	2.8	22	91	69
City of Corvallis	76.4	40	63	23
City of Cottage Grove	19.1	40	67	27
City of Creswell	5.3	19	77	58
City of Dundee	0.1	19	16	-3
City of Eugene	161.7	21	62	41

DMA	Total Kilometers Assessed	Assessed Effective Shade (%)	TMDL Target Effective Shade (%)	Shade Gap
City of Fairview	0.1	21	54	33
City of Falls City	9	56	96	40
City of Gates	8.2	30	60	30
City of Gladstone	3.8	11	35	24
City of Gresham	16	63	81	18
City of Halsey	1.6	8	87	79
City of Happy Valley	2.7	36	58	22
City of Harrisburg	4.1	10	27	17
City of Independence	2.4	14	22	8
City of Jefferson	5.9	22	40	18
City of Junction City	11.6	9	85	76
City of Keizer	3.1	12	18	6
City of Lake Oswego	5.8	83	90	7
City of Lebanon	18.8	25	61	36
City of Lowell	2.7	33	90	57
City of Lyons	4.4	21	43	22
City of McMinnville	0.1	15	20	5
City of Mill City	8	20	53	33
City of Millersburg	19.5	21	59	38
City of Milwaukie	2.9	62	80	18
City of Molalla	0.1	5	29	24
City of Monmouth	0.5	82	89	7
City of Monroe	3.5	27	50	23
City of Newberg	0.7	5	19	14
City of Oakridge	9.2	28	75	47
City of Oregon City	0.7	2	12	10
City of Philomath	7.6	37	88	51
City of Portland	127.4	61	73	12
City of Salem	14.5	12	24	12
City of Scio	1.7	51	59	8
City of Springfield	55.4	21	59	38
City of Stayton	10.2	24	43	19
City of Sweet Home	34.3	17	50	33
City of Tangent	10.9	48	82	34
City of Veneta	8.7	50	95	45
City of Waterloo	0.5	27	46	19
City of West Linn	2.1	4	11	7
City of Westfir	3.1	29	80	51
City of Wilsonville	4.3	10	13	3
Clackamas County	27.8	42	62	20
Lane County	879.7	41	71	30
Lincoln County	0.2	9	96	87
Linn County	224.9	30	62	32
Marion County	60.8	30	53	23
Multnomah County	9.7	75	90	15
Oregon Department of Agriculture	5505.7	28	69	41
Oregon Department of Aviation	0.2	4	66	62
Oregon Department of Fish and Wildlife	21.8	24	58	34
Oregon Department of Forestry - Private	8684.7	69	94	25
Oregon Department of Forestry - Public	530.1	84	96	12
Oregon Department of Geology and Mineral Industries	8.2	27	57	30
Oregon Department of State Lands	7	25	40	15
Oregon Department of Transportation	81.6	26	55	29
Oregon Military Department	0.2	0	86	86

DMA	Total Kilometers Assessed	Assessed Effective Shade (%)	TMDL Target Effective Shade (%)	Shade Gap
Oregon Parks and Recreation Department	95.7	19	30	11
Polk County	65.9	47	87	40
Port of Coos Bay	1.9	56	93	37
Port of Portland	2.1	29	45	16
Portland & Western Railroad	2.6	37	52	15
State of Oregon	12.5	14	25	11
U.S. Army Corps of Engineers	83.5	46	70	24
U.S. Bureau of Land Management	2607.9	87	95	8
U.S. Department of Agriculture	1.2	29	49	20
U.S. Department of Defense	1.5	47	85	38
U.S. Fish and Wildlife Service	43.5	36	62	26
U.S. Forest Service	2985.4	84	95	11
U.S. Government	15.8	33	53	20
Union Pacific Railroad	7.5	35	52	17
Yamhill County	2.1	11	12	1

9.1.5.3 Effective shade curve surrogate measure

Effective shade surrogate measure targets represent a surrogate for the amount of solar loading that will attain the HUA and load allocations for nonpoint sources managing streamside vegetation. Effective shade curves are applicable to any stream that does not have site specific shade targets (Section 9.1.5.2). Effective shade curves represent the maximum possible effective shade for a given vegetation type. The values presented within the effective shade curves (**Figure 9-5** to **Figure 9-26**) represent the mean effective shade target for different mapping units, stream aspects, and active channel widths. The vegetation height, density, overhang, and buffer widths used for each mapping unit is summarized in **Table 9-19**. See the TSD Appendix A: Heat Source Model Report and Appendix C: Potential Near-Stream Land Cover for additional details on the model approach for shade curves and the methodologies used to determine the mapping units and vegetation characteristics. Section 14 of this TMDL document provides tables of the plotted shade curve values. A map of all mapping units in the Willamette Basin can be found in the TSD Appendix H: Willamette Subbasins Interactive TMDL Map. This is an interactive HTML map that can be opened in an internet browser.

Local geology, geography, soils, climate, legacy impacts, natural disturbance rates, and other 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. Where natural disturbances prevent achievement of the target effective shade, DEQ will work with the DMAs to develop plans to restore riparian vegetation.

Table 9-19: Vegetation height, density, overhang, and horizontal distance buffer widths used to derive generalized effective shade curve targets for each mapping unit.

Mapping Unit	Height (m)	Height (ft)	Density (%)	Overhang (m)	Buffer Width (m)
Qff1	40.7	134	70	4.9	36.8
Qfc	37.7	124	64	4.5	36.8
Qalc	26.9	88	71	3.2	36.8
Qg1	21.6	71	64	2.6	36.8
Qau	22.6	74	69	2.7	36.8
Qalf	17.5	57	68	2.1	36.8

Mapping Unit	Height (m)	Height (ft)	Density (%)	Overhang (m)	Buffer Width (m)
Qff2	21.5	71	66	2.6	36.8
Qbf	22.0	72	68	2.6	36.8
Tvc	27.8	91	65	3.3	36.8
Qtg	40.5	133	72	4.9	36.8
Tvw	35.1	115	65	4.2	36.8
Tcr	36.9	121	68	4.4	36.8
Tm	29.7	97	68	3.6	36.8
QTt	25.2	83	66	3.0	36.8
QTb	35.2	115	64	4.2	36.8
Qls	44.0	144	65	5.3	36.8
OW	1.9	6	74	0.2	36.8
Upland Forest	40.9	134	75	4.9	36.8
1d/1f - Coast Range - Volcanics and Willapa Hills	36.0	118.1	75	3.9	36.8
3a -Willamette Valley - Portland/Vancouver Basin	26.0	85.3	75	1.9	36.8
3c -Willamette Valley - Prairie Terraces	33.2	108.9	75	1.9	36.8
3d - Willamette Valley - Valley Foothills	31.0	101.7	75	1.9	36.8

How to use a shade curve:

1. Determine the applicable mapping unit for the stream location you are applying a shade curve to.

   Example: Your site of interest is in the Rickreall Creek watershed, in the City of Independence, along the west bank of a tributary to the Willamette River. Open the Willamette Subbasins Interactive TMDL Map (TSD Appendix H) and select the Shade Curve Mapping Units Layer in the Map Legend to add it to the map. You may also want to select the City Boundaries Layer and the Stream Names Layer to help identify your site of interest. Once you have identified your site of interest, click that point on the map and you will see a pop-up box that identifies the Shade Curve Mapping Unit for that point. In this example, you identify the mapping unit at your site to be Qalc (Quaternary alluvium floodplain deposits) (**Figure 9-3**).

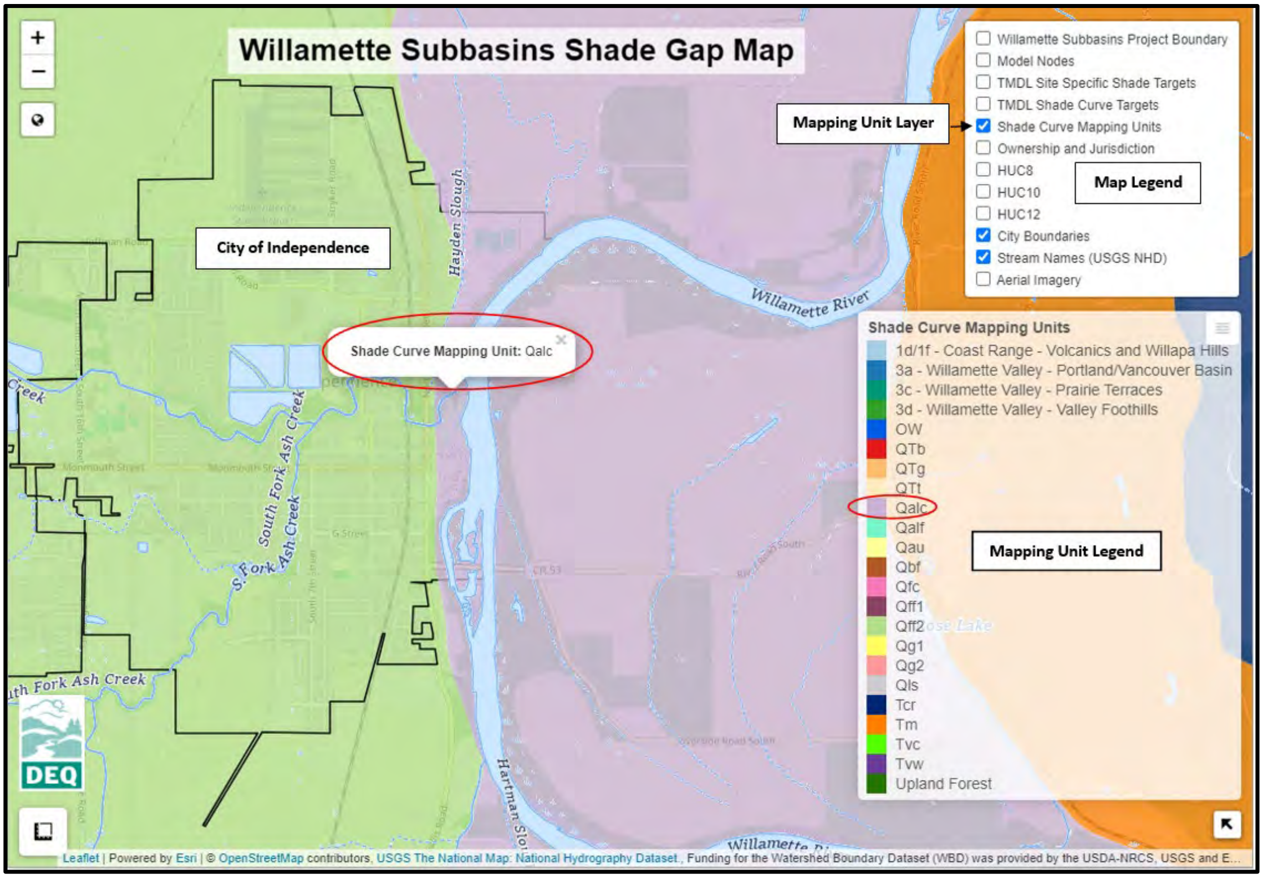

Figure 9-3: Mapping units in the example area of interest from the Willamette Subbasins Interactive TMDL Map.

2. Determine the stream aspect from north.

   Example: Standing in-stream mid-channel, facing north you determine the river's aspect as 0º or 180º from north (this means the river reach runs south to north).

3. Determine the active channel width of the stream reach.

   Example: At your location you measure the active channel width using a tape measure or laser range finder and determine that it is 25 ft.

4. Use the appropriate mapping unit shade curve, stream aspect line, and active channel width (x-axis), to determine the percent effective shade of your site (y-axis). This is the surrogate measure effective shade target of that stream reach location.

   Example: You have determined that the appropriate shade curve mapping unit for your site is Qalc (**Figure 9-4**). Since you are located on a tributary with an East-West stream aspect and an active channel width of 25 ft, you use the dotted line to determine the effective shade. By reading the y-axes, you determine that the effective shade to be ~83% when system potential vegetation is applied to the left and right bank of the stream reach. System potential vegetation defines the average riparian vegetation height as 88.2 ft (26.9 m), and the stand density (canopy density) as 71%.

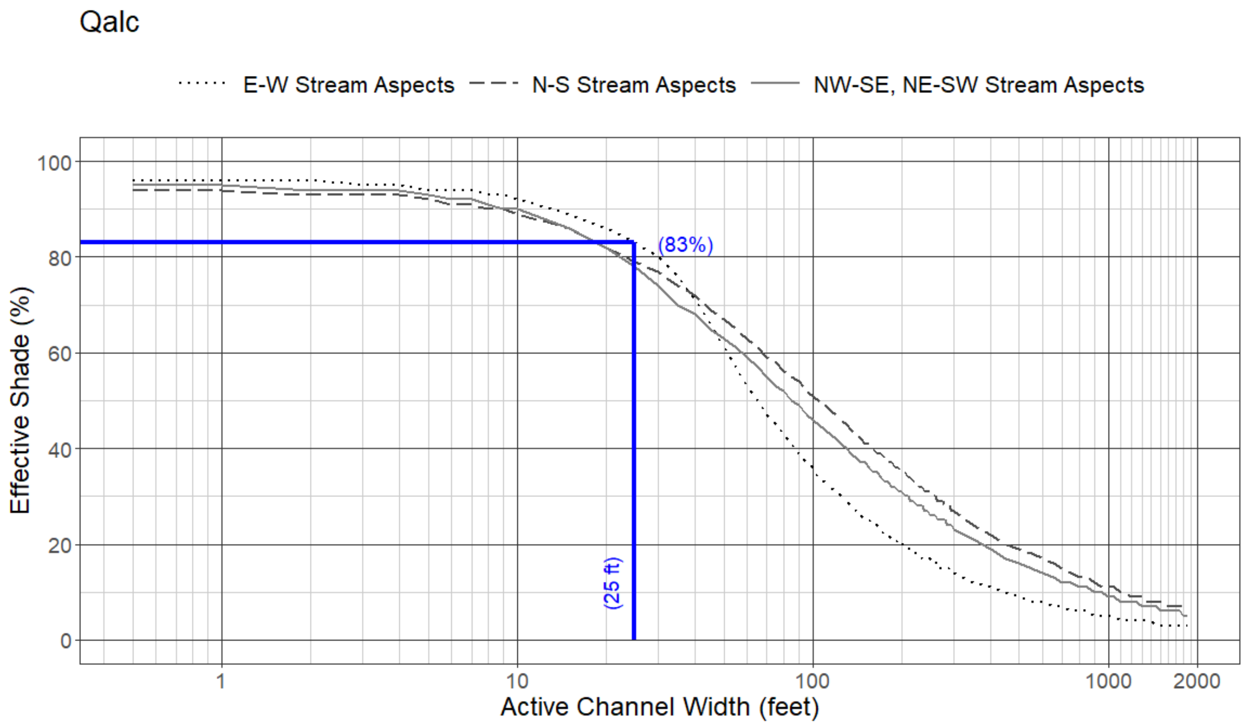

Figure 9-4: Example illustrating use of the shade curve for the Qalc mapping unit based on an east to west aspect and an active channel width of 25 ft.

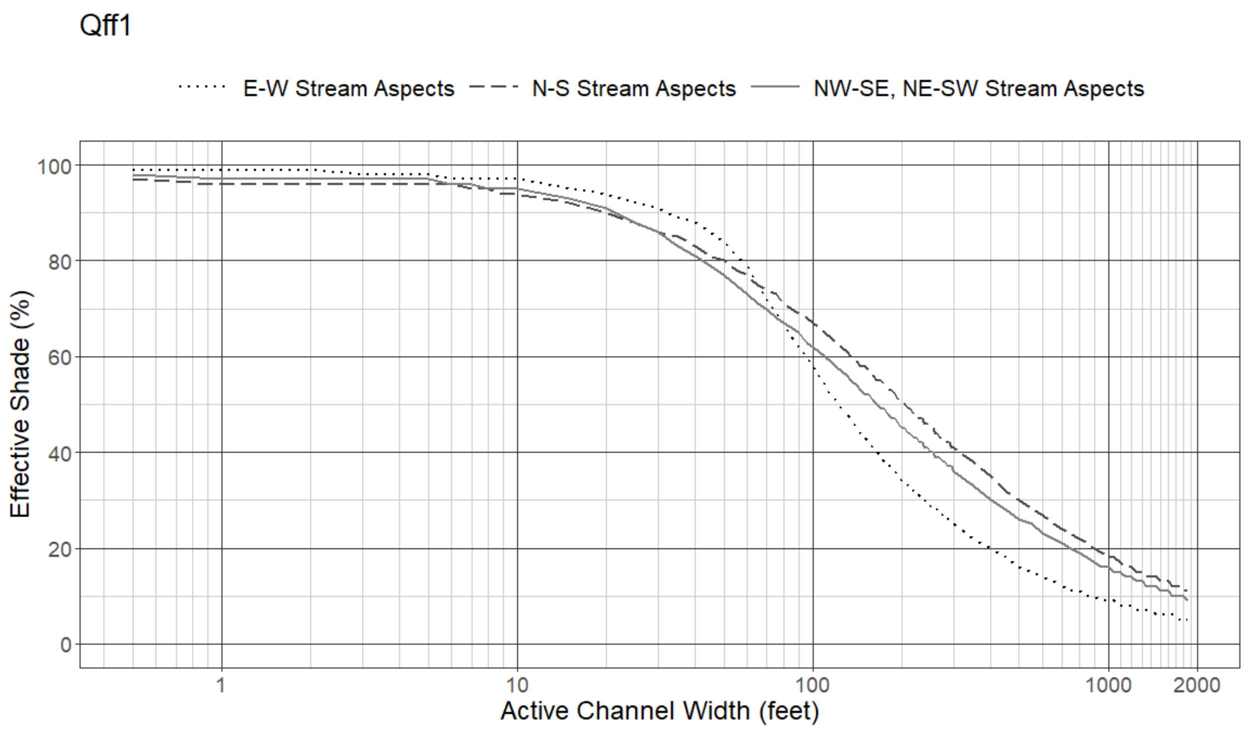

Figure 9-5: Effective shade targets for stream sites in the Qff1 mapping unit.

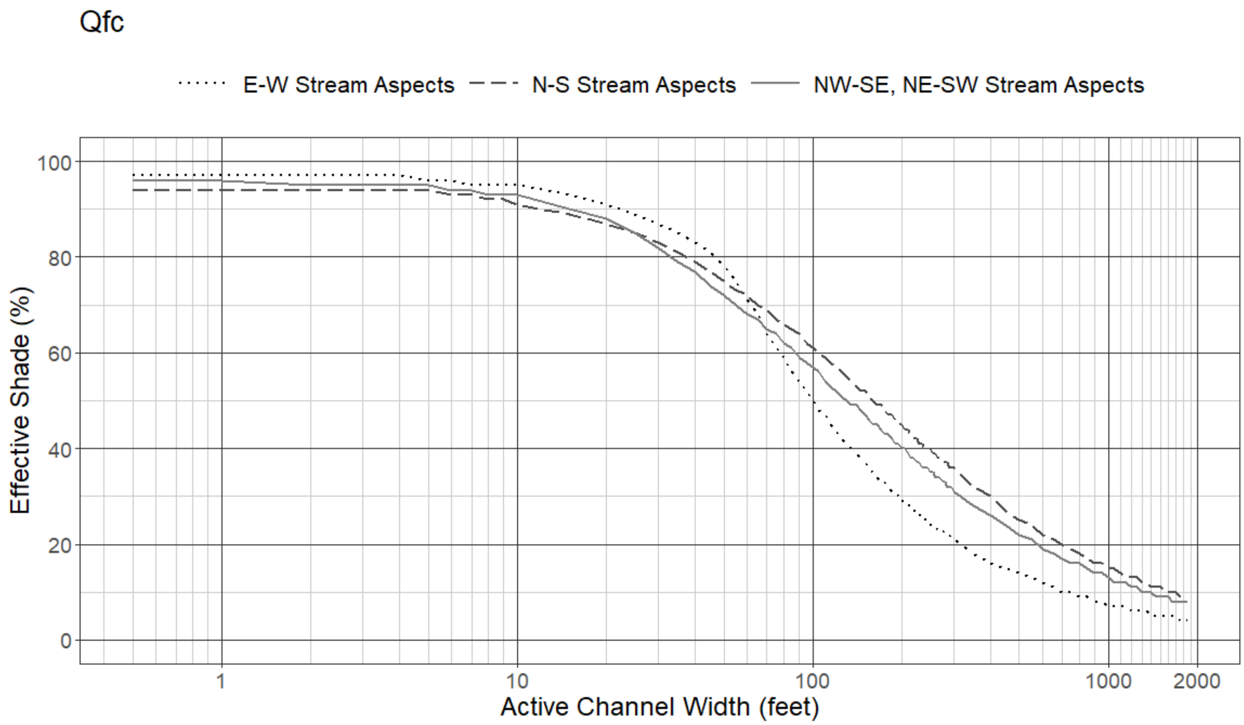

Figure 9-6: Effective shade targets for stream sites in the Qfc mapping unit.

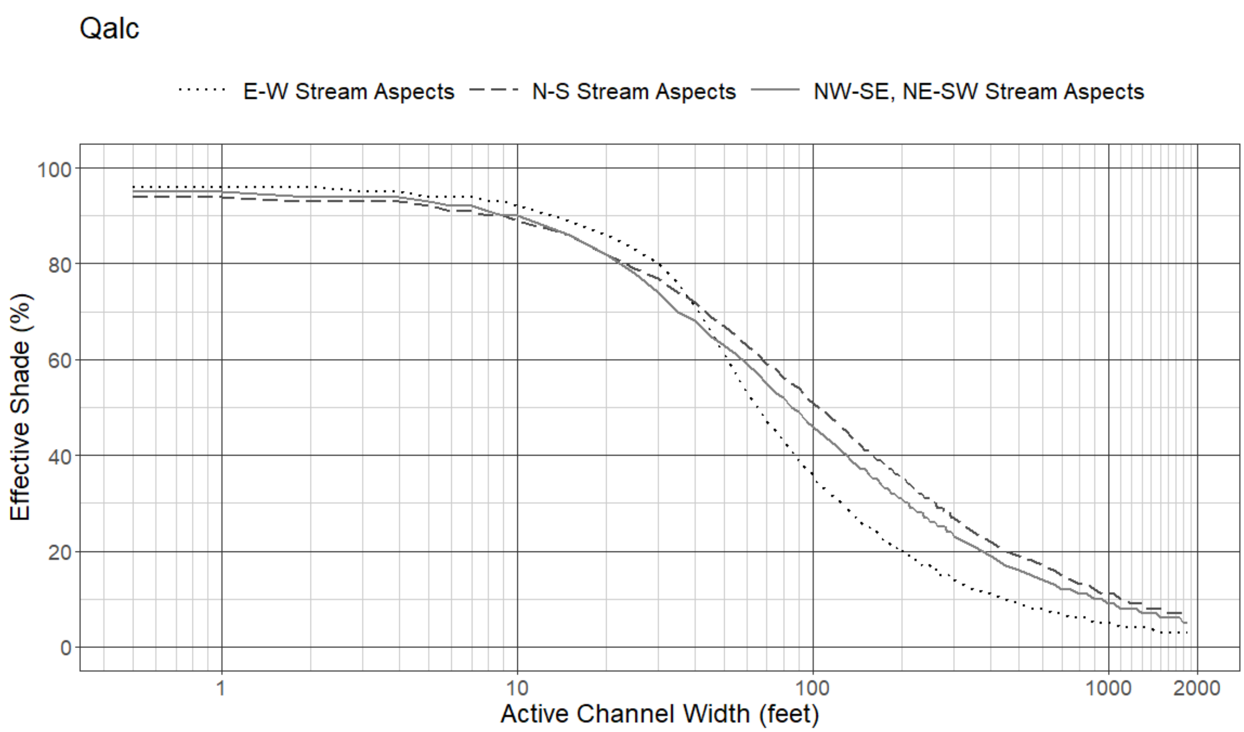

Figure 9-7: Effective shade targets for stream sites in the Qalc mapping unit.

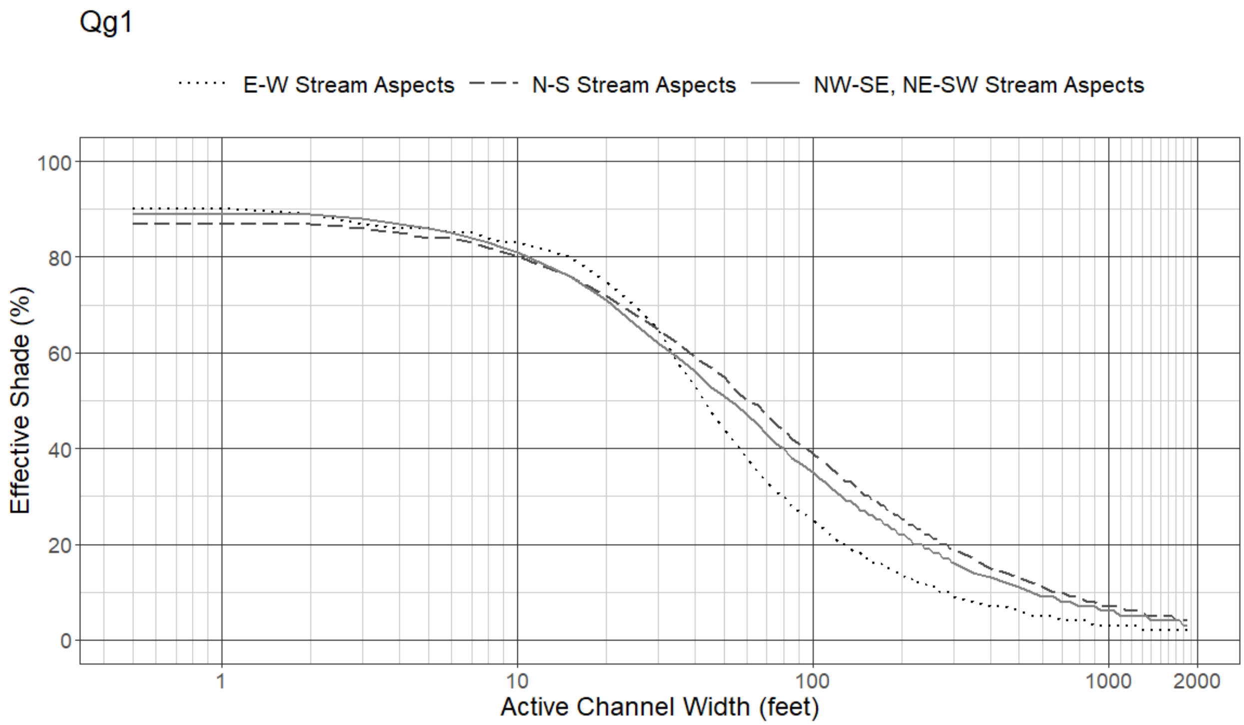

Figure 9-8: Effective shade targets for stream sites in the Qg1 mapping unit.

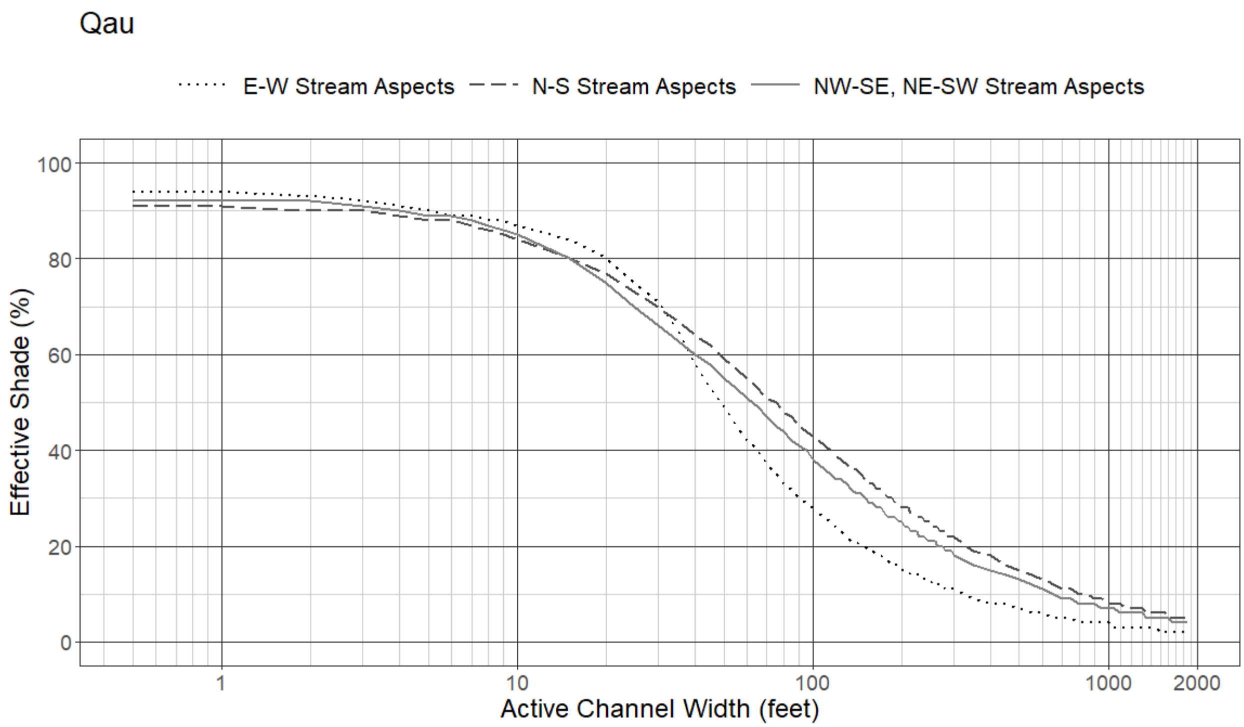

Figure 9-9: Effective shade targets for stream sites in the Qau mapping unit.

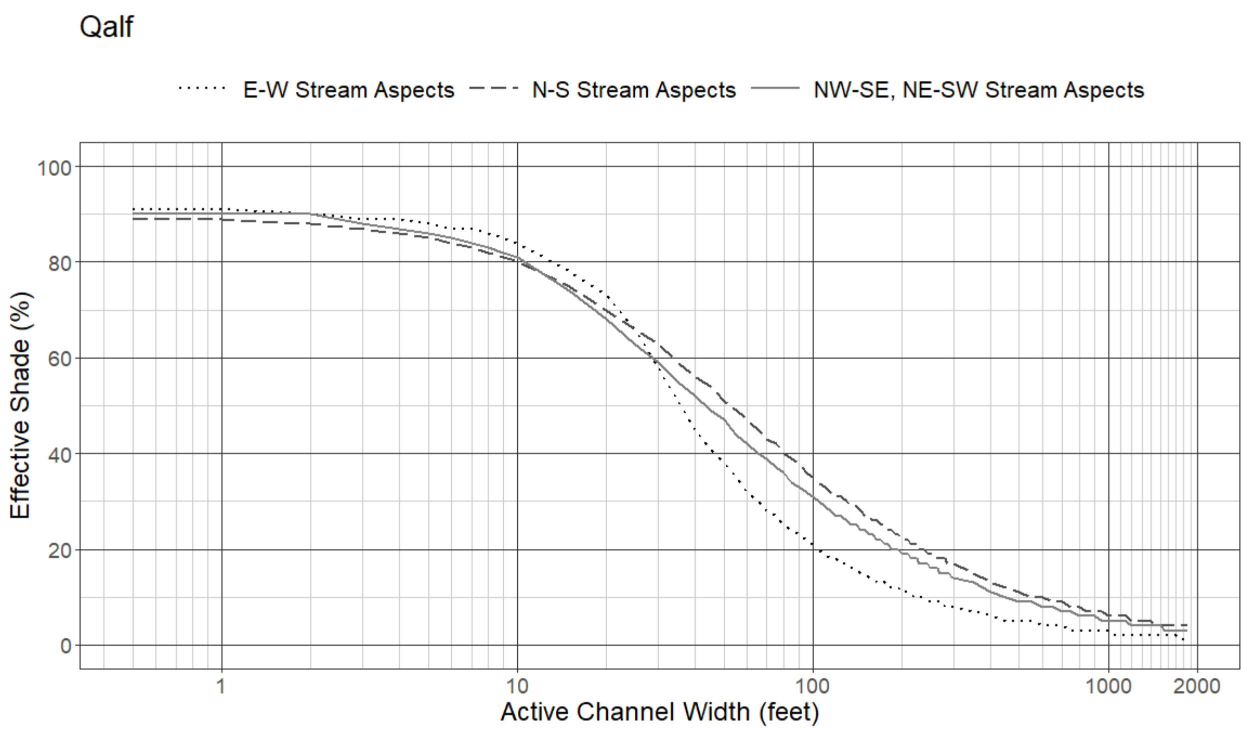

Figure 9-10: Effective shade targets for stream sites in the Qalf mapping unit.

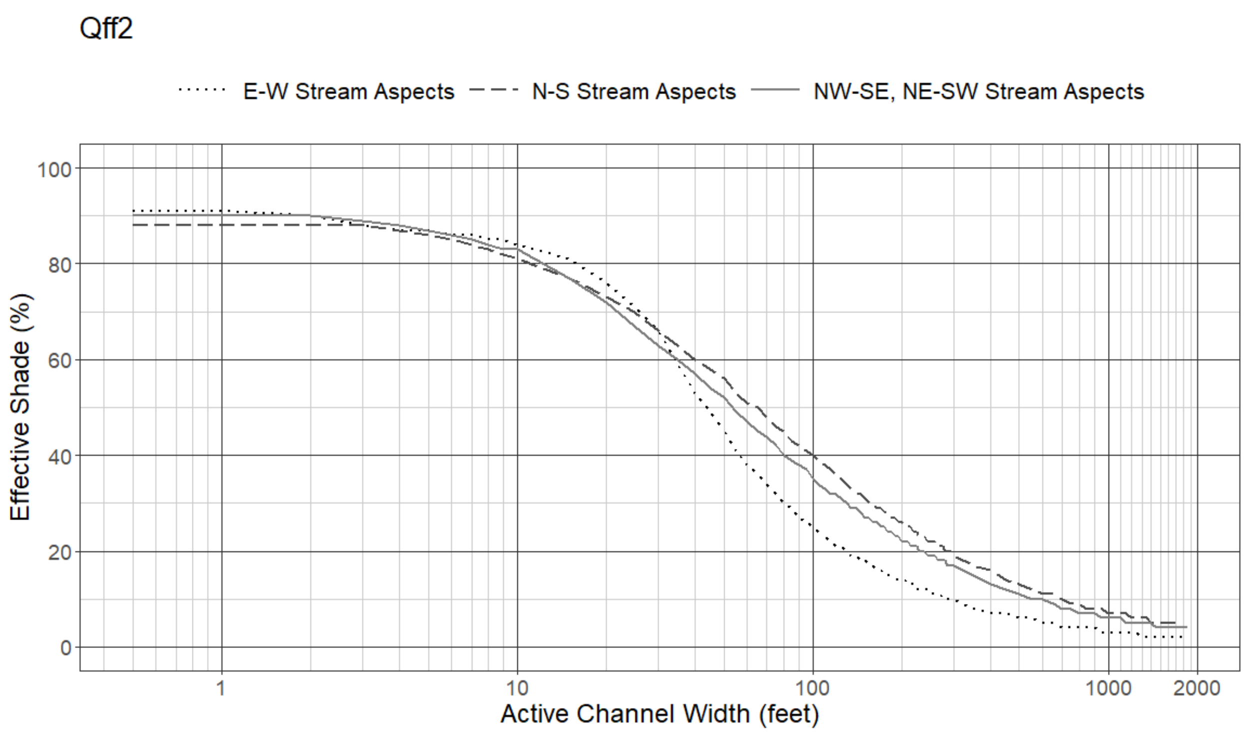

Figure 9-11: Effective shade targets for stream sites in the Qff2 mapping unit.

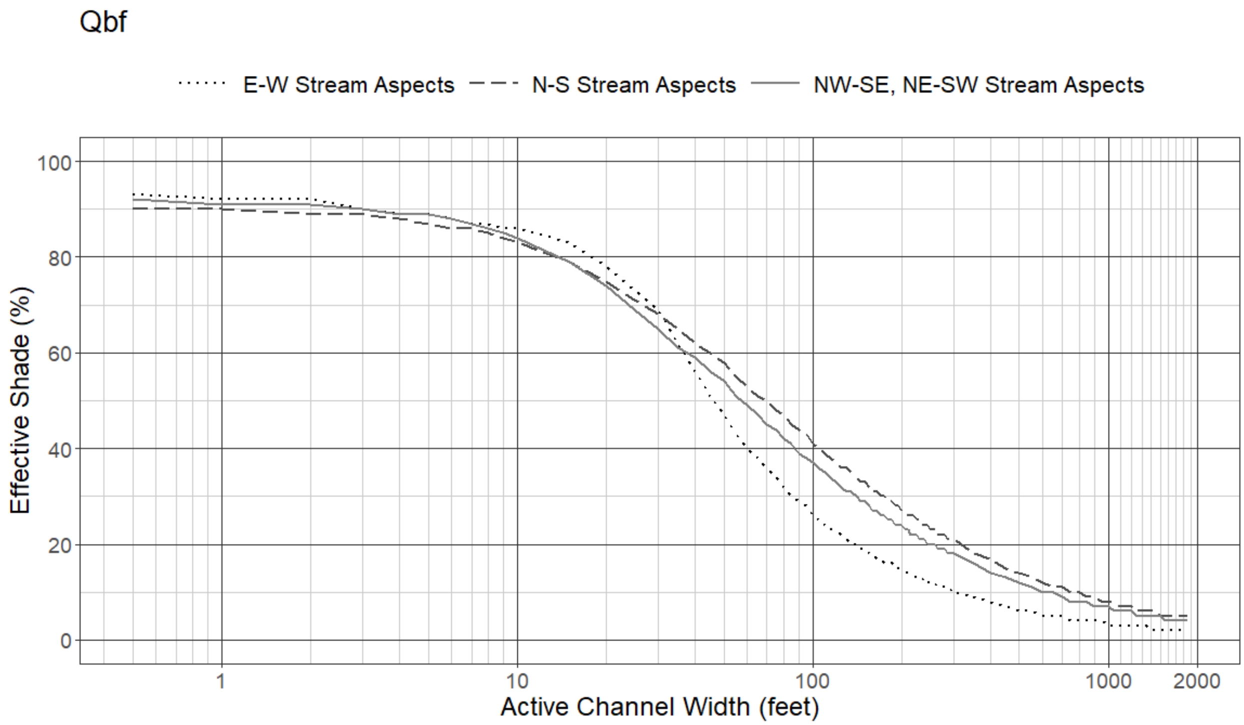

Figure 9-12: Effective shade targets for stream sites in the Qbf mapping unit.

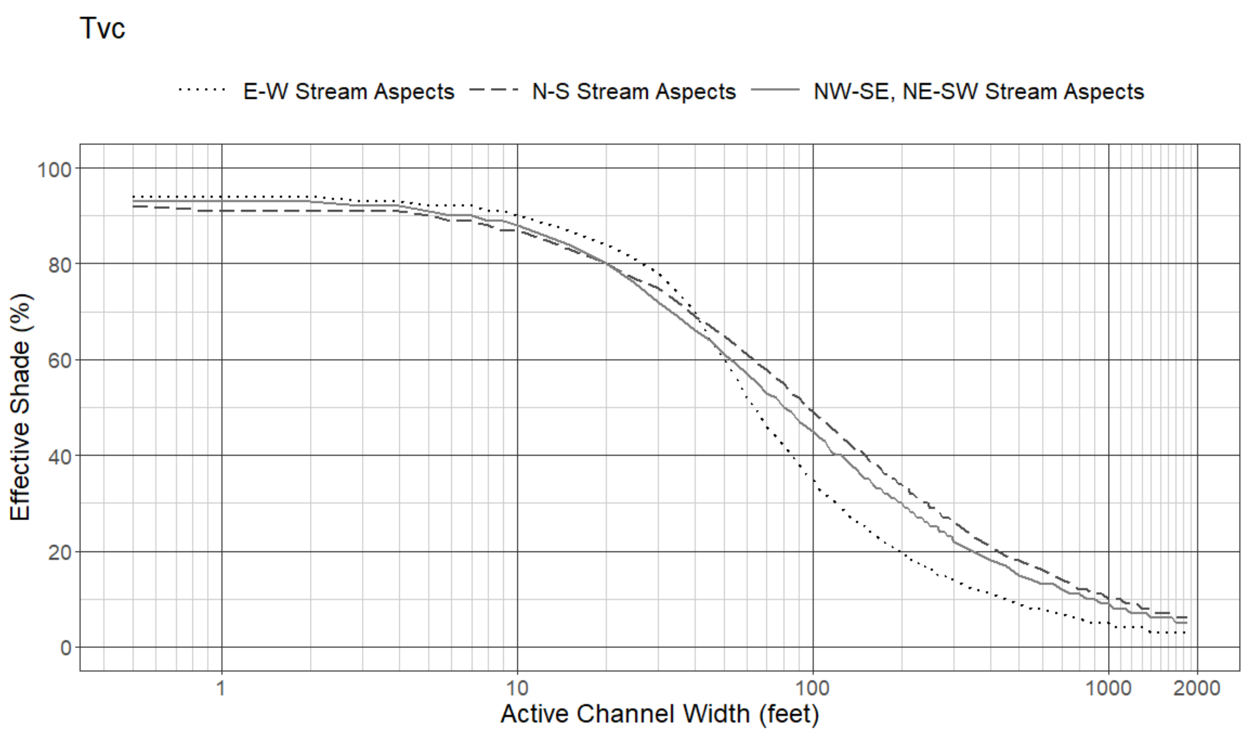

Figure 9-13: Effective shade targets for stream sites in the Tvc mapping unit.

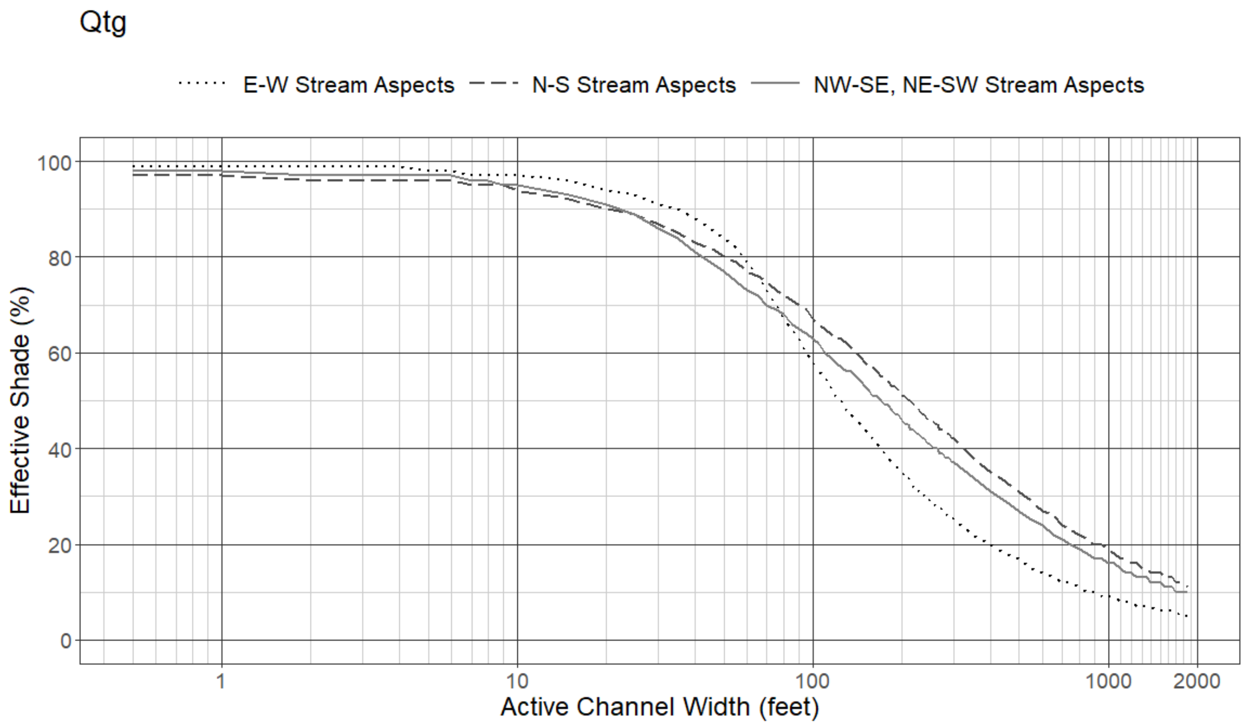

Figure 9-14: Effective shade targets for stream sites in the Qtg mapping unit.

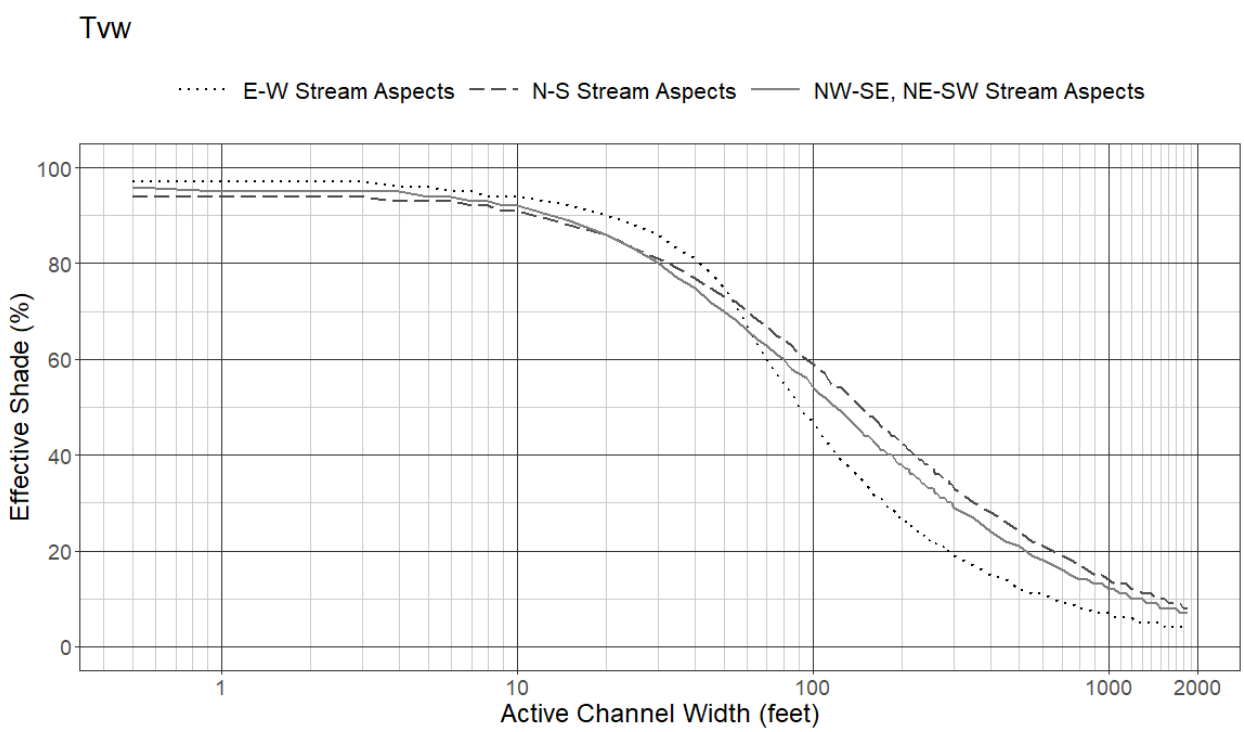

Figure 9-15: Effective shade targets for stream sites in the Tvw mapping unit.

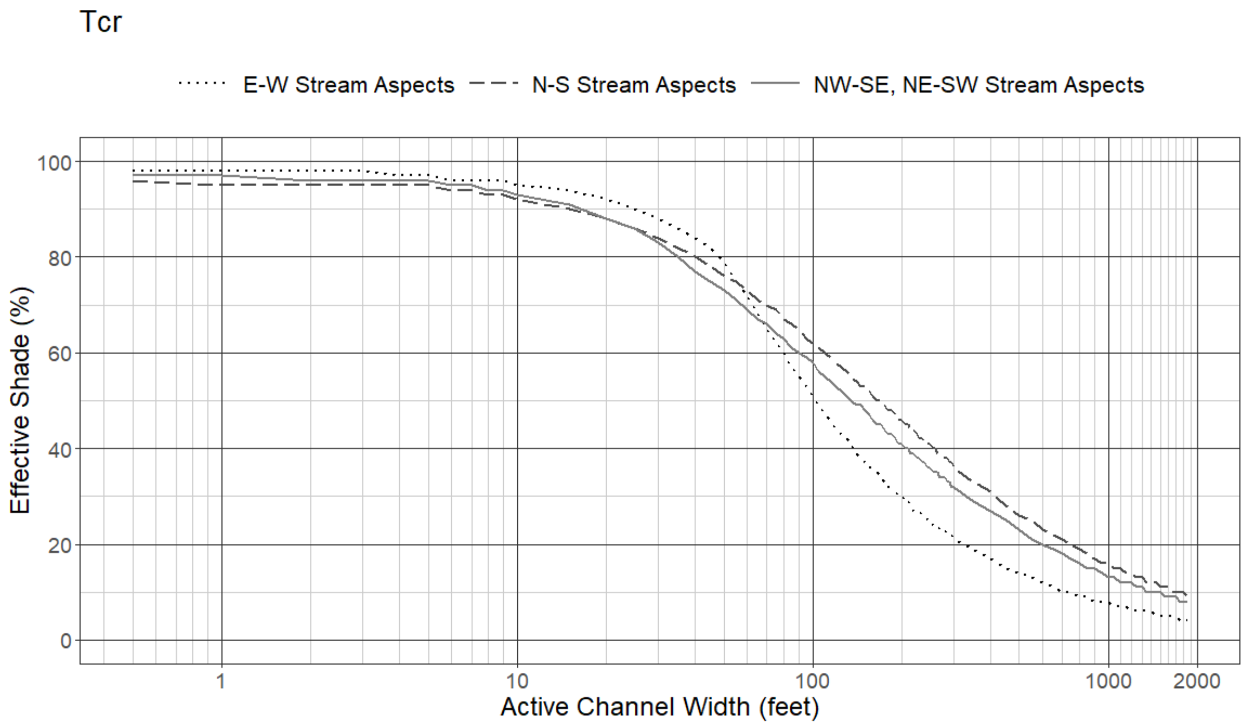

Figure 9-16: Effective shade targets for stream sites in the Tcr mapping unit.

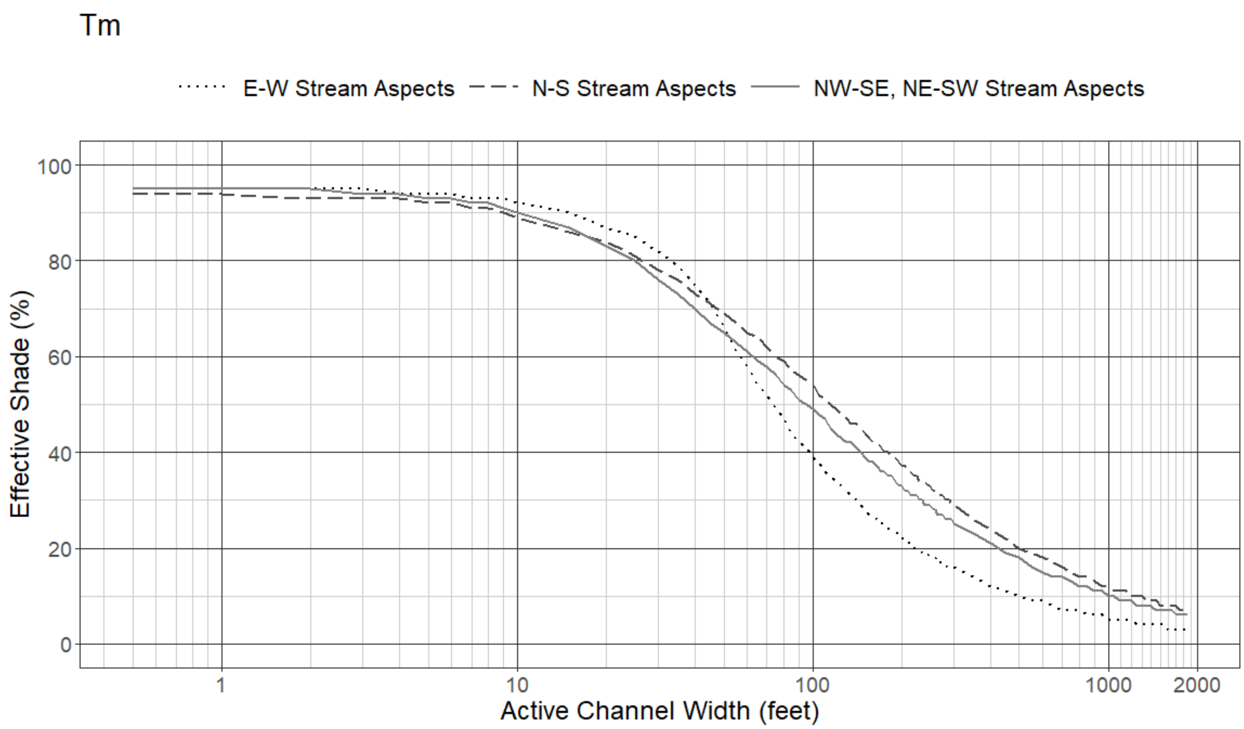

Figure 9-17: Effective shade targets for stream sites in the Tm mapping unit.

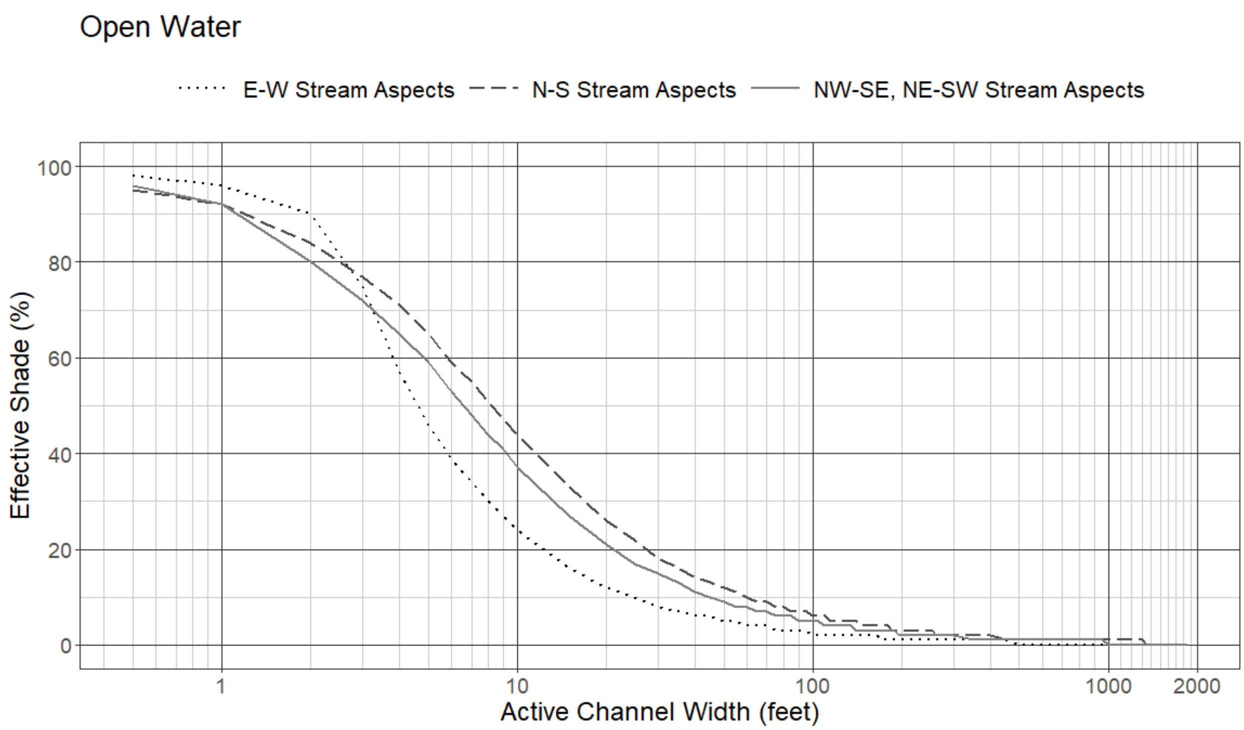

Figure 9-18: Effective shade targets for stream sites in the Open Water (OW) mapping unit.

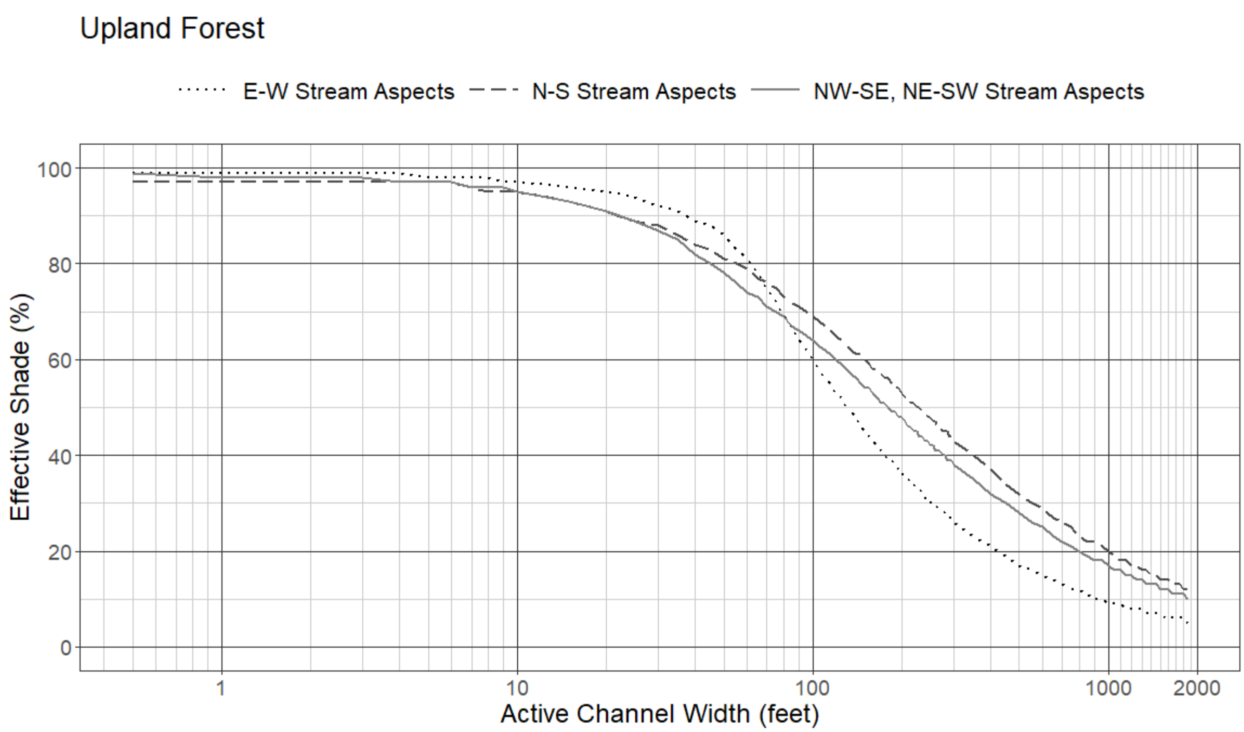

Figure 9-19: Effective shade targets for stream sites in the Upland Forest mapping unit.

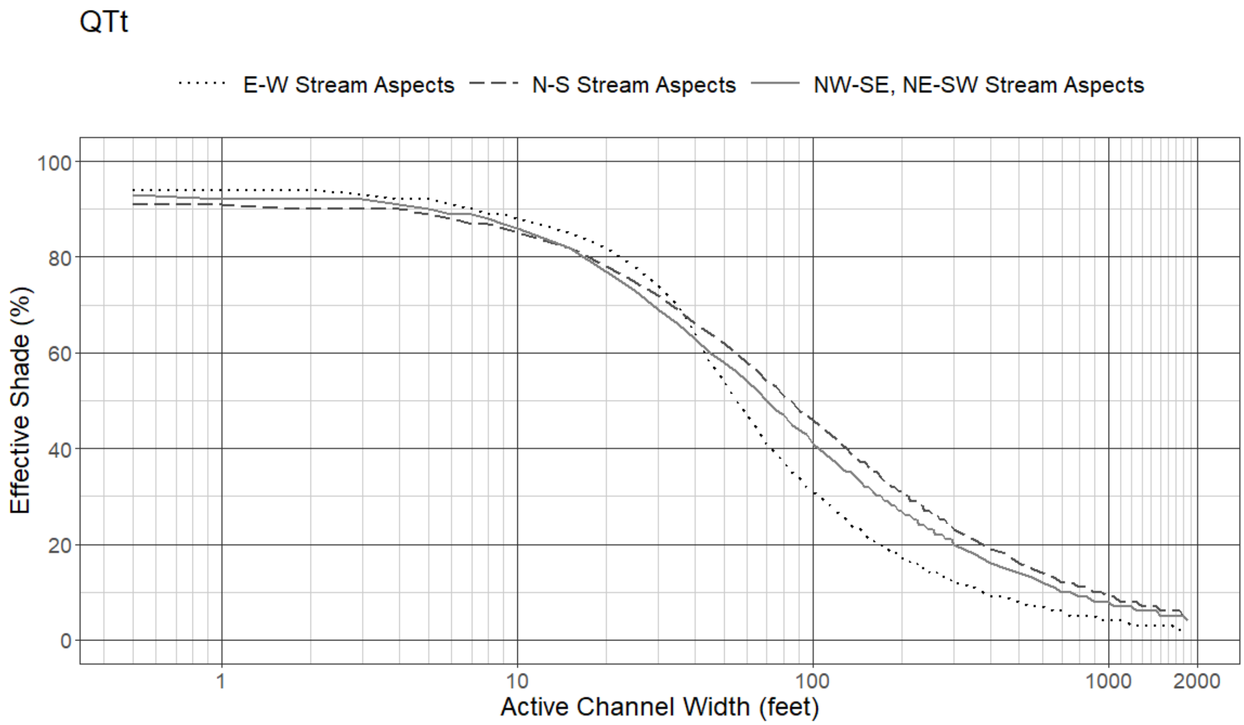

Figure 9-20: Effective shade targets for stream sites in the QTt mapping unit.

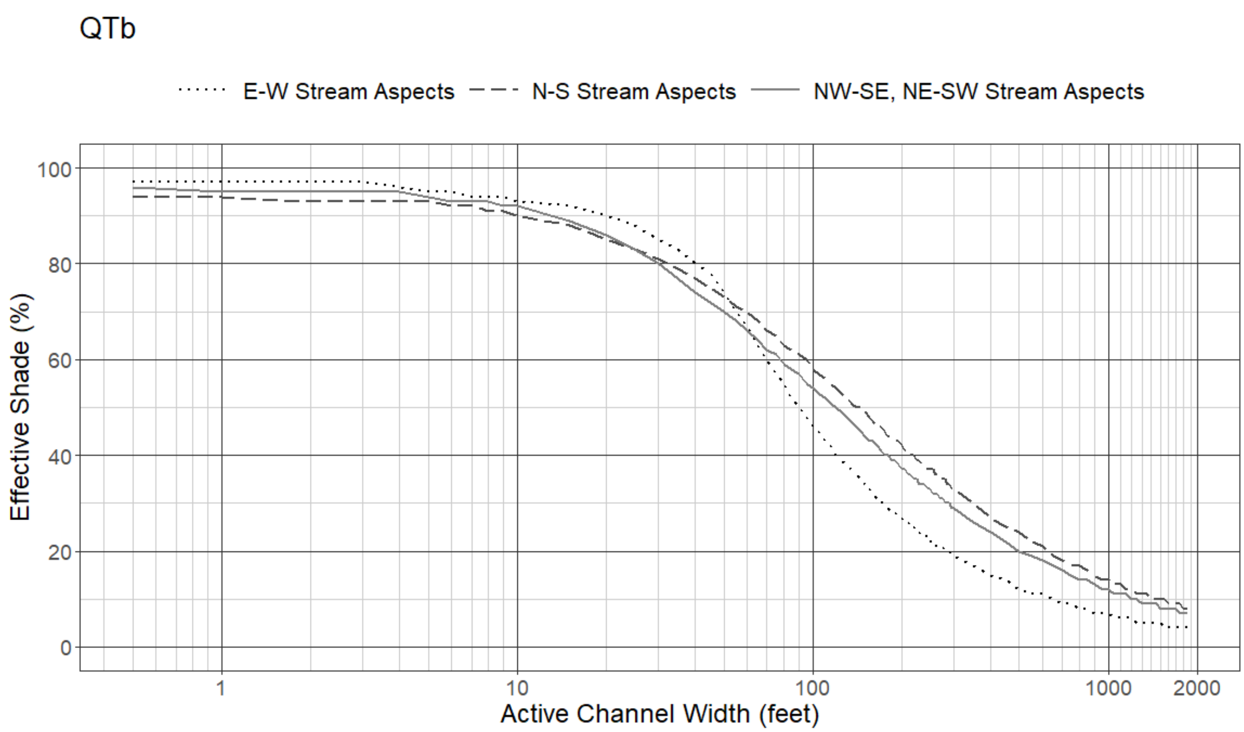

Figure 9-21: Effective shade targets for stream sites in the QTb mapping unit.

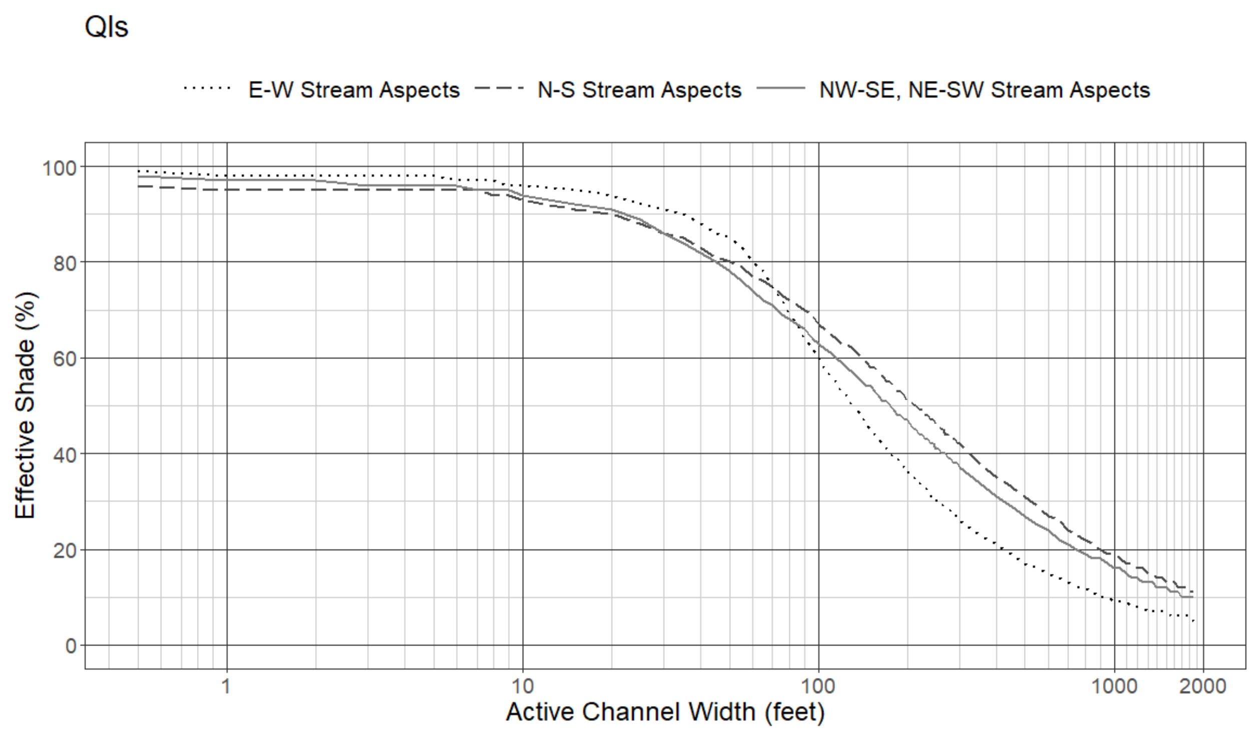

Figure 9-22: Effective shade targets for stream sites in the Qls mapping unit.

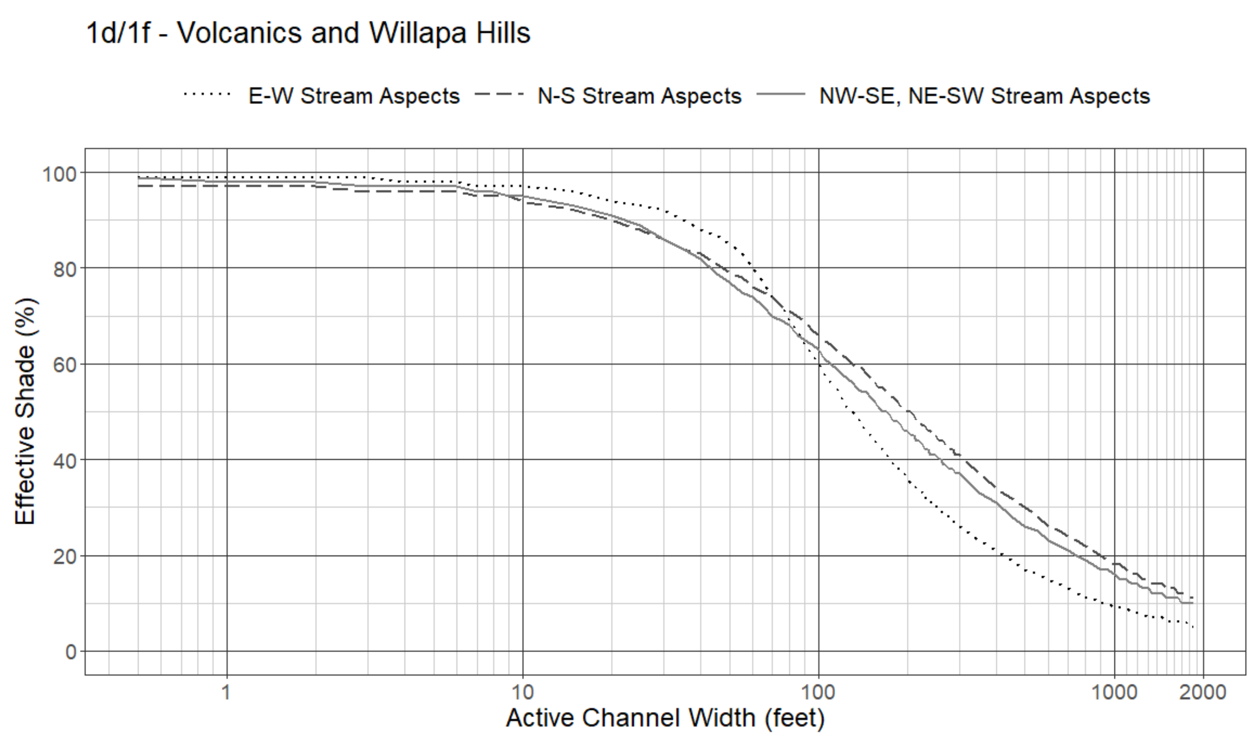

Figure 9-23: Effective shade targets for stream sites in Ecoregion 1d/1f - Volcanics and Willapa Hills.

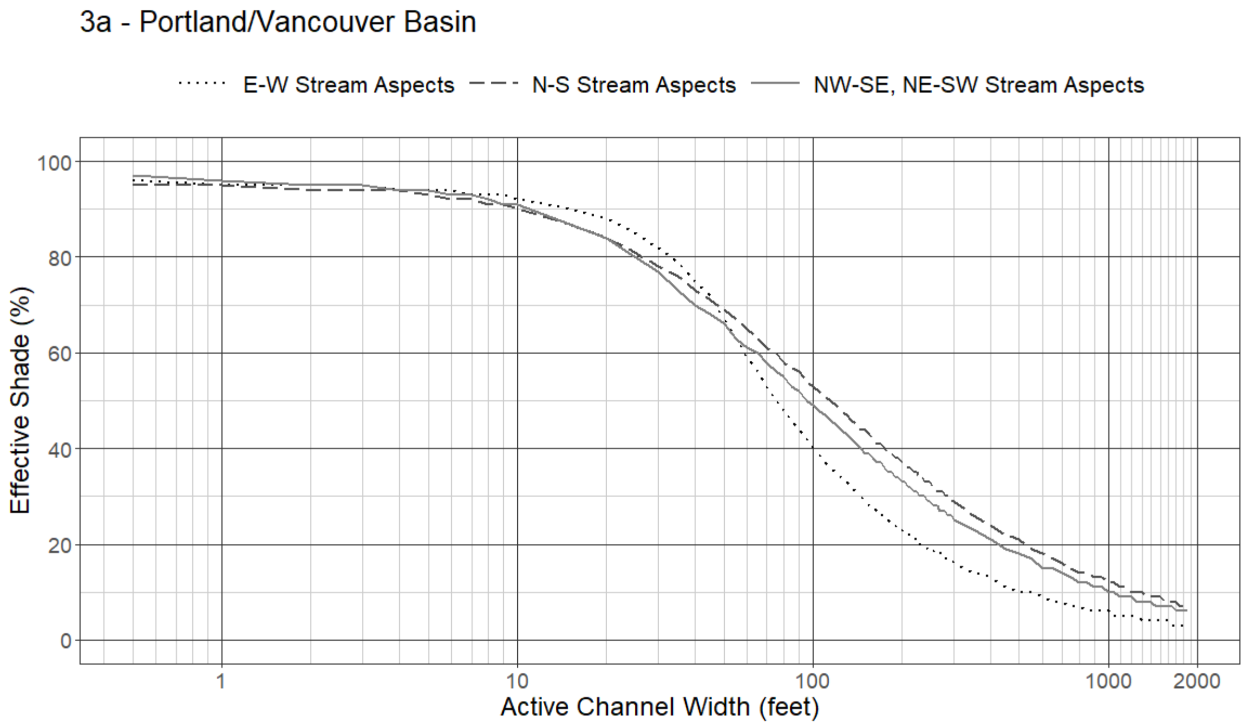

Figure 9-24: Effective shade targets for stream sites in Ecoregion 3a - Portland/Vancouver Basin.

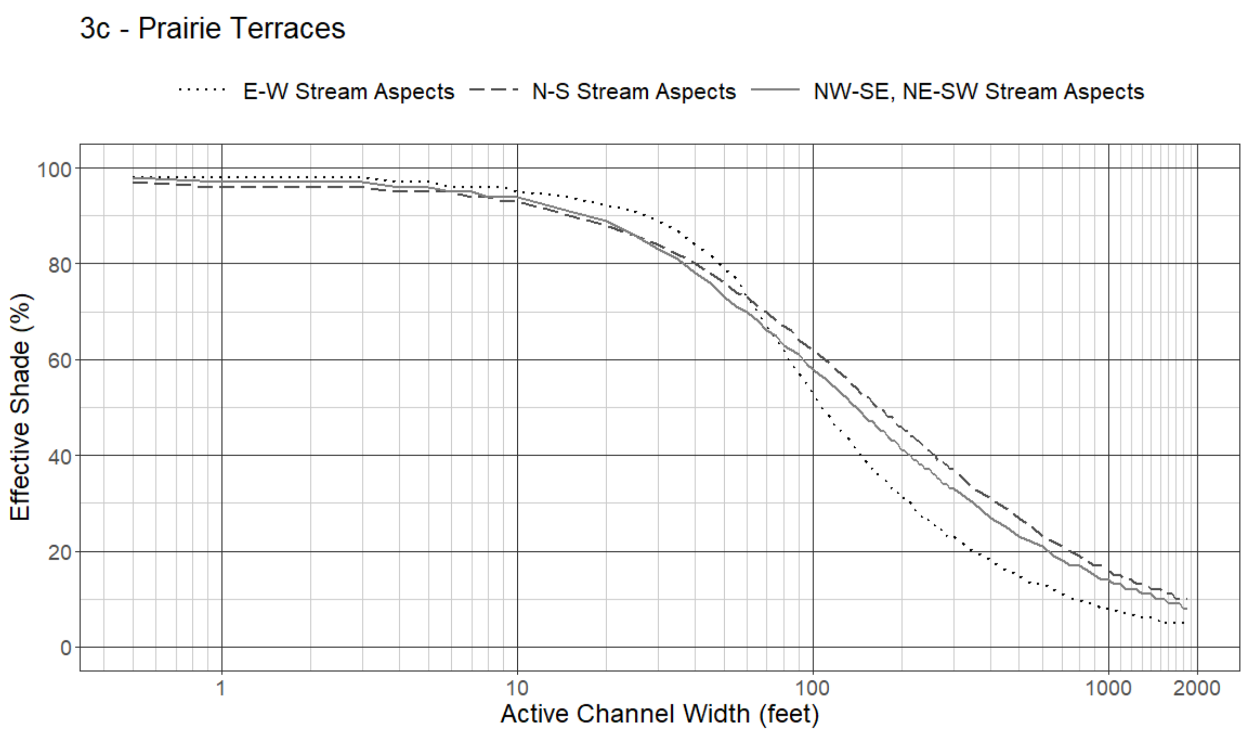

Figure 9-25: Effective shade targets for stream sites in Ecoregion 3c - Prairie Terraces.

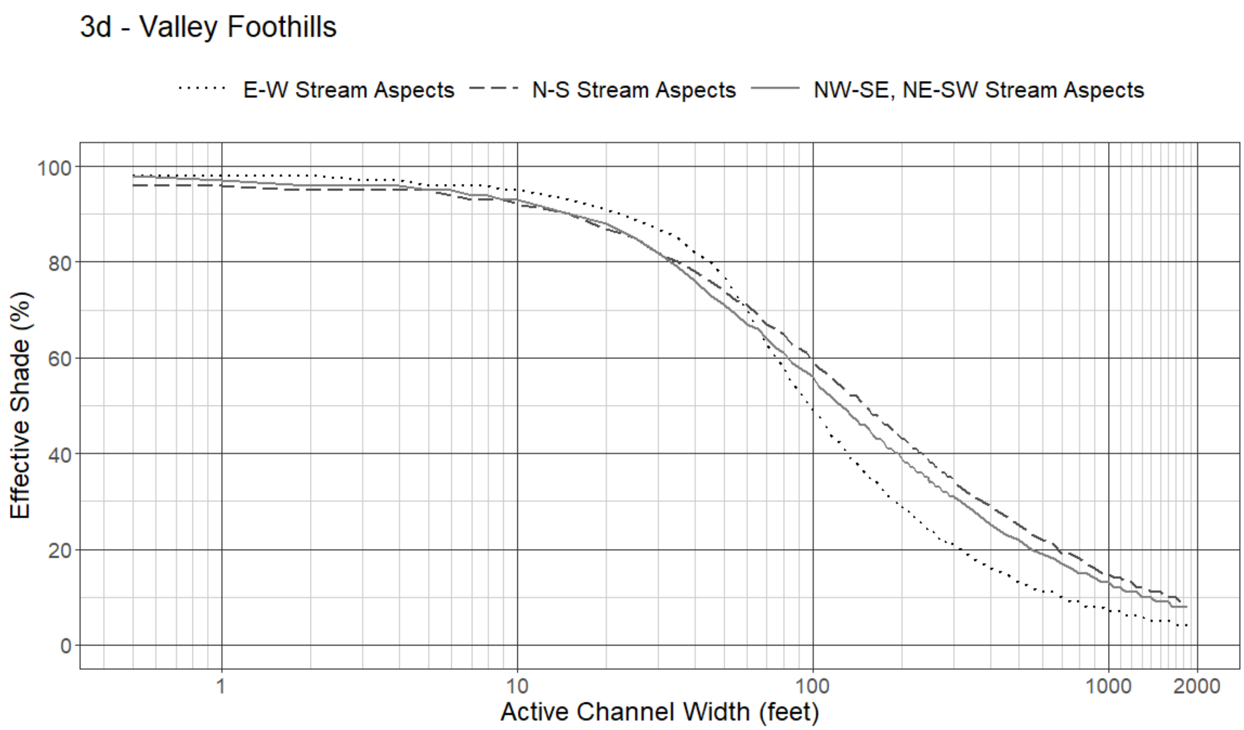

Figure 9-26: Effective shade targets for stream sites in Ecoregion 3d - Valley Foothills.

9.1.6 Reserve capacity

DEQ set aside explicit allocations for reserve capacity for providing either point or nonpoint source allocation(s) to new or increased thermal loads, or to assign corrected allocations to any existing source(s) that were assigned an erroneous allocation or may not have been identified during the development of this TMDL. The portion of the HUA associated with the reserve capacity is described Section 9.1.1.

If DEQ determines the cumulative warming from all NPDES point sources is less than the assigned portion of the HUA, the remainder may be considered as reserve capacity for point sources.

DEQ will consider requests for allocation of reserve capacity submitted in writing on a case-by-case basis. Except when DEQ is correcting an error or omission, DEQ may require requesters to demonstrate that there are no reasonable alternatives to an increased load and to prepare modeling or similar analysis to ensure that loading capacity is available at the discharge location(s) or in downstream waters. The HUA assigned to reserve capacity may not be available for allocation due to cumulative warming and points of maximum impact downstream. DEQ will use its discretion in making determinations on requests, based on the information available and priorities appropriate at the time of the request. DEQ will track allocation of reserve capacity over time and will not approve requests once reserve capacity is depleted. Allocations of reserve capacity must be approved by DEQ's Director or designee.

9.2 Margin of safety

CFR 130.7(c)(1) and OAR 340-042-0040(4)(i) require a TMDL to 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 Willamette Subbasins, 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 (ADWDF) or a maximum flow obtained from discharge monitoring reports (DMRs) for the model scenario assessing the wasteload allocations and for assessments of current thermal loading. It is rare that actual discharges from point sources will reach design flows and sustain that discharge for long periods of time.
- Setting effluent temperatures as high as 32°C for the model scenario assessing the wasteload allocations. On days when the current thermal load was less than the wasteload allocation, the maximum effluent temperatures were increased above the actual temperatures up to either 32°C or the effluent temperature that would fully utilize the wasteload allocation. Actual maximum effluent temperatures are unlikely to get this warm or be sustained over multiple days or weeks.
- The cumulative effects analysis applied the maximum assigned HUA to each source category to assess cumulative allocation attainment. The modeling shows the maximum allowed temperature increase is limited to one or two days and is generally less than 5% of the time. Additionally, the maximum temperature increase is geographically limited and focused to distinct locations. This means that a portion of the loading capacity reserved for human use will go unutilized most of the time. The cumulative effects analysis was performed for modeled reaches and is described in the modeling reports (TSD Appendix A, Appendix J and Appendix K).
- Groundwater inflows were assumed to be zero in most models. Because groundwater directly cools stream temperatures via mixing, this means that actual instream temperatures would be lower than modeled temperatures anywhere that groundwater influences exist.
- DEQ uses the critical period to determine when allocations apply. In setting this period, DEQ relied upon monitoring sites with the longest period of exceedance. When downstream monitoring sites have longer exceedance periods relative to upstream waters, the longer period is used as the critical period for upstream waterbodies. This is a margin of safety to ensure warming of upstream waters does not contribute to downstream exceedances.
- The sum of individual human use allocations was used to assess cumulative attainment across the entirety of a given AU. This method does not account for longitudinal instream heat dissipation downstream from each thermal source. Thus, the total thermal load and corresponding temperature increase is likely to result in a maximum temperature increase of less than 0.3°C.
- The nonpoint source HUA allocation will be implemented by assessing the cumulative warming of a waterbody by all nonpoint sources. This is a margin of safety that ensures cumulative warming from all nonpoint sources will not exceed the portion of the HUA allocated to nonpoint sources.

10 Water quality management plan

As described in OAR 340-042-0040(4)(l)(A)-(O), an associated WQMP is a 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 DMAs, 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 Willamette Subbasins WQMP as a stand-alone document. DEQ intends to propose the draft WQMP as an element of Temperature TMDLs for the Willamette Subbasins for adoption as rule by the EQC.

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.” EPA’s TMDL guidance describes that when a TMDL is developed for waters impaired by both point and nonpoint sources and WLAs are based on an assumption that NPS load reductions will occur, the TMDL must provide “reasonable assurances” that NPS control measures will achieve expected load reductions (EPA, 1991). Comprehensive explanations of reasonable assurances of implementation are provided in Section 7 of the Willamette Subbasins WQMP.

12 Protection plan

The scope of these temperature TMDLs includes all waters of the state, including freshwater perennial and intermittent streams in the Willamette Subbasins. As such, these TMDLs also serve as a “protection plan” to prevent impairment in waters currently attaining the applicable water quality standards or for unassessed waters. The protection of these unimpaired waters has watershed-wide benefits such as:

- Clarity and consistency for implementation of management strategies throughout the watershed;
- Proactively applying management strategies and protections to waters where data are not available for establishing listing status;
- Improving TMDL outcomes by maintaining or improving water quality in streams that are tributary to listed streams;
- Creating efficiencies between TMDL and protection plan implementation (including monitoring, evaluating progress, adaptive management, enforcement, and leveraging partner entities' efforts); and
- Assisting with funding opportunities for implementation when grants require projects to be part of a larger watershed plan.

Protection plan core elements, as described in materials available on EPA's webpage (EPA, 2023a, 2023b), are fulfilled by the statements and references to specific sections of the TMDLs, WQMP, and TSD in the subsections that follow. A full list of AUs where the protection plan applies is in the TSD Appendix D.

12.1 Identification of specific waters to be protected and risks to their condition

Appendix D of the TMDL TSD lists all the assessments units within the Willamette Subbasins and their 2022 Integrated Report assessment status. Those AUs with the status of Category 2 or Category 3 are included in the protection plan, along with any unassessed waters that may be found to be unimpaired for temperature in the future. The same sources and processes described in Section 7 that have caused temperature impairments to some reaches in the watershed also pose a risk to unimpaired waters.

12.2 Quantification of loads and activities expected to resist degradation

Monitoring stations that provided data used in the TMDLs analyses are shown in the TSD Appendix A, Section 2.1. Water temperature data, along with flow measurements were used to calculate loading capacities of the pollutants and surrogates within the watershed. Applicable loading capacities for any unimpaired stream can be calculated using **Equation 8-1**.

Similar to loading capacities, relevant HUA assignments for anthropogenic sources are shown in **Table 9-1** through **Table 9-11**. Loads for nonpoint sources are calculated using **Equation 9-2**.

The implementation of management practices specified in Sections 2 and 5 of the WQMP also protect against risks to unimpaired waters.

12.3 Timeframes for protection

Timelines for watershed-wide implementation of the TMDLs are described in Section 5 of the WQMP and estimated timelines for attainment of water quality standards in the impaired stream reaches are provided in Section 4 of the WQMP. DEQ's watershed-wide approach ensures that the TMDLs and the protection plan will be implemented in a prioritized manner over the same timeframe that will be required to demonstrate effectiveness of management strategies in reducing excess pollutant loads.

12.4 Measures of success

The WQMP describes in detail DEQ's approach to quantitative and qualitative measures of progress in attaining and maintaining water quality standards, which is applied watershed-wide. Section 6 of the WQMP discusses quantitative and qualitative evaluation of implementation of management strategies, development of a plan for periodic monitoring and an approach to adaptive management. Section 7 of the WQMP details the interconnected framework for accountability of implementation, including: engaging with sources; setting measurable objectives; evaluating progress; conducting enforcement; and tracking status and trends.

13 References

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14 Appendix of effective shade curve tables

14.1 Qff1 mapping unit

Table 14-1: Effective shade targets for stream sites in the Qff1 mapping unit.

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
0.2	0.5	97	98	99
0.3	1	96	97	99
0.6	2	96	97	99
0.9	3	96	97	98
1.2	4	96	97	98
1.5	5	96	97	98
1.8	6	96	96	97
2.1	7	95	96	97
2.4	8	95	95	97
2.7	9	94	95	97
3	10	94	95	97
4.6	15	92	93	95
6.1	20	90	91	94
7.6	25	88	88	92
9.1	30	86	86	91
10.7	35	85	83	89
12.2	40	83	81	88
13.7	45	81	79	86
15.2	50	80	77	84
16.8	55	78	75	81
18.3	60	77	73	79
19.8	65	75	71	75
21.3	70	74	70	72
22.9	75	73	68	69
24.4	80	71	67	67
25.9	85	70	66	64
27.4	90	69	65	62
29	95	68	63	60
30.5	100	67	62	58
32	105	66	61	56
33.5	110	65	60	54
35.1	115	64	59	52

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
36.6	120	63	58	51
38.1	125	62	57	49
39.6	130	61	56	48
41.1	135	60	55	47
42.7	140	59	54	45
44.2	145	58	53	44
45.7	150	58	52	43
47.2	155	57	52	42
48.8	160	56	51	41
50.3	165	55	50	40
51.8	170	55	49	39
53.3	175	54	49	38
54.9	180	53	48	37
56.4	185	53	47	37
57.9	190	52	47	36
59.4	195	51	46	35
61	200	51	45	34
62.5	205	50	45	34
64	210	49	44	33
65.5	215	49	44	33
67.1	220	48	43	32
68.6	225	48	43	31
70.1	230	47	42	31
71.6	235	47	42	30
73.2	240	46	41	30
74.7	245	46	41	29
76.2	250	45	40	29
77.7	255	45	40	28
79.2	260	44	39	28
80.8	265	44	39	28
82.3	270	43	39	27
83.8	275	43	38	27
85.3	280	43	38	26
86.9	285	42	37	26
88.4	290	42	37	26
89.9	295	41	37	25
91.4	300	41	36	25
106.7	350	38	33	22
121.9	400	35	30	20
137.2	450	32	28	18
152.4	500	30	26	16
167.6	550	28	25	15

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
182.9	600	27	23	14
198.1	650	25	22	13
213.4	700	24	21	12
228.6	750	23	20	11
243.8	800	22	19	11
259.1	850	21	18	10
274.3	900	20	17	10
289.6	950	19	16	9
304.8	1000	18	16	9
320	1050	18	15	9
335.3	1100	17	15	8
350.5	1150	16	14	8
365.8	1200	16	14	8
381	1250	15	13	7
396.2	1300	15	13	7
411.5	1350	14	12	7
426.7	1400	14	12	7
442	1450	14	12	6
457.2	1500	13	11	6
472.4	1550	13	11	6
487.7	1600	13	11	6
502.9	1650	12	10	6
518.2	1700	12	10	6
533.4	1750	12	10	5
548.6	1800	11	10	5
563.9	1850	11	9	5

14.2 Qfc mapping unit

Table 14-2: Effective shade targets for stream sites in the Qfc Quaternary geologic unit.

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
0.2	0.5	94	96	97
0.3	1	94	96	97
0.6	2	94	95	97
0.9	3	94	95	97
1.2	4	94	95	97
1.5	5	94	95	96
1.8	6	93	94	96
2.1	7	93	94	95

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
2.4	8	92	93	95
2.7	9	92	93	95
3	10	91	93	95
4.6	15	89	90	93
6.1	20	87	88	91
7.6	25	85	85	89
9.1	30	83	82	87
10.7	35	81	79	85
12.2	40	79	77	83
13.7	45	77	74	81
15.2	50	75	72	78
16.8	55	73	70	75
18.3	60	72	68	71
19.8	65	70	67	68
21.3	70	69	65	64
22.9	75	67	64	61
24.4	80	66	62	59
25.9	85	65	61	56
27.4	90	64	59	54
29	95	62	58	52
30.5	100	61	57	50
32	105	60	56	48
33.5	110	59	54	47
35.1	115	58	53	45
36.6	120	57	52	44
38.1	125	56	51	42
39.6	130	55	50	41
41.1	135	54	49	40
42.7	140	53	49	39
44.2	145	52	48	38
45.7	150	52	47	37
47.2	155	51	46	36
48.8	160	50	45	35
50.3	165	49	45	34
51.8	170	49	44	33
53.3	175	48	43	33
54.9	180	47	43	32
56.4	185	47	42	31
57.9	190	46	41	31
59.4	195	45	41	30
61	200	45	40	29
62.5	205	44	40	29

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
64	210	44	39	28
65.5	215	43	38	28
67.1	220	42	38	27
68.6	225	42	37	27
70.1	230	41	37	26
71.6	235	41	36	26
73.2	240	40	36	25
74.7	245	40	36	25
76.2	250	40	35	24
77.7	255	39	35	24
79.2	260	39	34	24
80.8	265	38	34	23
82.3	270	38	34	23
83.8	275	37	33	23
85.3	280	37	33	22
86.9	285	37	32	22
88.4	290	36	32	22
89.9	295	36	32	21
91.4	300	36	31	21
106.7	350	32	28	18
121.9	400	30	26	16
137.2	450	27	24	15
152.4	500	25	22	14
167.6	550	24	21	13
182.9	600	22	19	12
198.1	650	21	18	11
213.4	700	20	17	10
228.6	750	19	16	10
243.8	800	18	16	9
259.1	850	17	15	9
274.3	900	16	14	8
289.6	950	16	14	8
304.8	1000	15	13	7
320	1050	15	12	7
335.3	1100	14	12	7
350.5	1150	13	12	7
365.8	1200	13	11	6
381	1250	13	11	6
396.2	1300	12	10	6
411.5	1350	12	10	6
426.7	1400	11	10	5
442	1450	11	9	5

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
457.2	1500	11	9	5
472.4	1550	10	9	5
487.7	1600	10	9	5
502.9	1650	10	8	5
518.2	1700	10	8	5
533.4	1750	9	8	4
548.6	1800	9	8	4
563.9	1850	9	8	4

14.3 Qalc mapping unit

Table 14-3: Effective shade targets for stream sites in the Qalc geomorphic region.

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
0.2	0.5	94	95	96
0.3	1	94	95	96
0.6	2	93	94	96
0.9	3	93	94	95
1.2	4	93	94	95
1.5	5	92	93	94
1.8	6	91	92	94
2.1	7	91	92	94
2.4	8	90	91	93
2.7	9	90	90	93
3	10	89	90	92
4.6	15	86	86	89
6.1	20	82	82	86
7.6	25	79	78	83
9.1	30	77	74	80
10.7	35	74	70	76
12.2	40	72	68	71
13.7	45	69	65	66
15.2	50	67	63	61
16.8	55	65	61	57
18.3	60	63	59	53
19.8	65	61	57	50
21.3	70	59	55	47
22.9	75	58	53	45
24.4	80	56	52	43
25.9	85	55	50	41

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
27.4	90	54	49	39
29	95	52	47	37
30.5	100	51	46	36
32	105	50	45	34
33.5	110	49	44	33
35.1	115	48	43	32
36.6	120	47	42	31
38.1	125	46	41	30
39.6	130	45	40	29
41.1	135	44	39	28
42.7	140	43	38	27
44.2	145	42	37	26
45.7	150	41	37	25
47.2	155	41	36	25
48.8	160	40	35	24
50.3	165	39	35	24
51.8	170	39	34	23
53.3	175	38	33	22
54.9	180	37	33	22
56.4	185	37	32	21
57.9	190	36	32	21
59.4	195	36	31	20
61	200	35	31	20
62.5	205	35	30	20
64	210	34	30	19
65.5	215	34	29	19
67.1	220	33	29	18
68.6	225	33	28	18
70.1	230	32	28	18
71.6	235	32	28	17
73.2	240	31	27	17
74.7	245	31	27	17
76.2	250	31	26	17
77.7	255	30	26	16
79.2	260	30	26	16
80.8	265	29	25	16
82.3	270	29	25	15
83.8	275	29	25	15
85.3	280	28	25	15
86.9	285	28	24	15
88.4	290	28	24	15
89.9	295	27	24	14

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
91.4	300	27	23	14
106.7	350	24	21	12
121.9	400	22	19	11
137.2	450	20	17	10
152.4	500	19	16	9
167.6	550	18	15	8
182.9	600	17	14	8
198.1	650	16	13	7
213.4	700	15	12	7
228.6	750	14	12	6
243.8	800	13	11	6
259.1	850	13	11	6
274.3	900	12	10	5
289.6	950	11	10	5
304.8	1000	11	9	5
320	1050	11	9	5
335.3	1100	10	8	4
350.5	1150	10	8	4
365.8	1200	9	8	4
381	1250	9	8	4
396.2	1300	9	7	4
411.5	1350	8	7	4
426.7	1400	8	7	4
442	1450	8	7	3
457.2	1500	8	6	3
472.4	1550	8	6	3
487.7	1600	7	6	3
502.9	1650	7	6	3
518.2	1700	7	6	3
533.4	1750	7	6	3
548.6	1800	7	5	3
563.9	1850	6	5	3

14.4 Qg1 mapping unit

Table 14-4: Effective shade targets for stream sites in the Qg1 mapping unit.

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
0.2	0.5	87	89	90
0.3	1	87	89	90

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
0.6	2	87	89	89
0.9	3	86	88	87
1.2	4	85	87	86
1.5	5	84	86	86
1.8	6	84	85	85
2.1	7	83	84	85
2.4	8	82	83	84
2.7	9	81	82	83
3	10	80	81	83
4.6	15	76	76	80
6.1	20	72	71	75
7.6	25	68	66	70
9.1	30	65	62	65
10.7	35	62	59	58
12.2	40	59	56	53
13.7	45	57	53	48
15.2	50	55	51	44
16.8	55	52	49	41
18.3	60	50	47	38
19.8	65	49	45	35
21.3	70	47	43	33
22.9	75	45	41	31
24.4	80	44	40	30
25.9	85	42	38	28
27.4	90	41	37	27
29	95	40	36	26
30.5	100	39	35	25
32	105	38	34	24
33.5	110	37	33	23
35.1	115	36	32	22
36.6	120	35	31	21
38.1	125	34	30	20
39.6	130	33	29	20
41.1	135	33	29	19
42.7	140	32	28	18
44.2	145	31	27	18
45.7	150	30	27	17
47.2	155	30	26	17
48.8	160	29	26	16
50.3	165	29	25	16
51.8	170	28	25	16
53.3	175	28	24	15

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
54.9	180	27	24	15
56.4	185	27	23	15
57.9	190	26	23	14
59.4	195	26	22	14
61	200	25	22	14
62.5	205	25	22	13
64	210	24	21	13
65.5	215	24	21	13
67.1	220	24	20	12
68.6	225	23	20	12
70.1	230	23	20	12
71.6	235	23	20	12
73.2	240	22	19	12
74.7	245	22	19	11
76.2	250	22	19	11
77.7	255	21	18	11
79.2	260	21	18	11
80.8	265	21	18	11
82.3	270	20	18	10
83.8	275	20	17	10
85.3	280	20	17	10
86.9	285	20	17	10
88.4	290	19	17	10
89.9	295	19	16	10
91.4	300	19	16	9
106.7	350	17	14	8
121.9	400	15	13	7
137.2	450	14	12	7
152.4	500	13	11	6
167.6	550	12	10	5
182.9	600	11	9	5
198.1	650	10	9	5
213.4	700	10	8	4
228.6	750	9	8	4
243.8	800	9	7	4
259.1	850	8	7	4
274.3	900	8	7	3
289.6	950	7	6	3
304.8	1000	7	6	3
320	1050	7	6	3
335.3	1100	7	5	3
350.5	1150	6	5	3

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
365.8	1200	6	5	3
381	1250	6	5	3
396.2	1300	6	5	2
411.5	1350	5	5	2
426.7	1400	5	4	2
442	1450	5	4	2
457.2	1500	5	4	2
472.4	1550	5	4	2
487.7	1600	5	4	2
502.9	1650	5	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

14.5 Qau mapping unit

Table 14-5: Effective shade targets for stream sites in the Qau mapping unit.

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
0.2	0.5	91	92	94
0.3	1	91	92	94
0.6	2	90	92	93
0.9	3	90	91	92
1.2	4	89	90	91
1.5	5	88	89	90
1.8	6	88	89	89
2.1	7	87	88	89
2.4	8	86	87	88
2.7	9	85	86	88
3	10	84	85	87
4.6	15	80	80	84
6.1	20	77	75	80
7.6	25	73	70	75
9.1	30	70	66	71
10.7	35	67	63	65
12.2	40	64	60	58
13.7	45	62	58	53
15.2	50	59	55	49
16.8	55	57	53	45

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
18.3	60	55	51	42
19.8	65	53	49	40
21.3	70	51	47	37
22.9	75	50	45	35
24.4	80	48	44	33
25.9	85	47	42	32
27.4	90	45	41	30
29	95	44	40	29
30.5	100	43	38	28
32	105	42	37	27
33.5	110	41	36	26
35.1	115	40	35	25
36.6	120	39	34	24
38.1	125	38	34	23
39.6	130	37	33	22
41.1	135	36	32	21
42.7	140	36	31	21
44.2	145	35	31	20
45.7	150	34	30	20
47.2	155	33	29	19
48.8	160	33	29	19
50.3	165	32	28	18
51.8	170	32	28	18
53.3	175	31	27	17
54.9	180	30	26	17
56.4	185	30	26	16
57.9	190	29	26	16
59.4	195	29	25	16
61	200	28	25	15
62.5	205	28	24	15
64	210	28	24	15
65.5	215	27	23	14
67.1	220	27	23	14
68.6	225	26	23	14
70.1	230	26	22	14
71.6	235	26	22	13
73.2	240	25	22	13
74.7	245	25	21	13
76.2	250	25	21	13
77.7	255	24	21	12
79.2	260	24	21	12
80.8	265	24	20	12

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
82.3	270	23	20	12
83.8	275	23	20	12
85.3	280	23	19	11
86.9	285	22	19	11
88.4	290	22	19	11
89.9	295	22	19	11
91.4	300	22	18	11
106.7	350	19	16	9
121.9	400	18	15	8
137.2	450	16	14	8
152.4	500	15	13	7
167.6	550	14	12	6
182.9	600	13	11	6
198.1	650	12	10	5
213.4	700	11	9	5
228.6	750	11	9	5
243.8	800	10	8	4
259.1	850	10	8	4
274.3	900	9	8	4
289.6	950	9	7	4
304.8	1000	8	7	4
320	1050	8	7	3
335.3	1100	8	6	3
350.5	1150	7	6	3
365.8	1200	7	6	3
381	1250	7	6	3
396.2	1300	7	6	3
411.5	1350	6	5	3
426.7	1400	6	5	3
442	1450	6	5	3
457.2	1500	6	5	2
472.4	1550	6	5	2
487.7	1600	5	5	2
502.9	1650	5	4	2
518.2	1700	5	4	2
533.4	1750	5	4	2
548.6	1800	5	4	2
563.9	1850	5	4	2

14.6 Qalf mapping unit

Table 14-6: Effective shade targets for stream sites in the Qalf mapping unit.

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
0.2	0.5	89	90	91
0.3	1	89	90	91
0.6	2	88	90	90
0.9	3	87	88	89
1.2	4	86	87	89
1.5	5	85	86	88
1.8	6	84	85	87
2.1	7	83	84	87
2.4	8	82	83	86
2.7	9	81	82	85
3	10	80	81	84
4.6	15	75	74	78
6.1	20	70	68	73
7.6	25	66	63	66
9.1	30	63	59	58
10.7	35	59	55	51
12.2	40	56	52	45
13.7	45	54	49	41
15.2	50	51	47	38
16.8	55	49	44	35
18.3	60	47	42	32
19.8	65	45	40	30
21.3	70	43	39	28
22.9	75	42	37	27
24.4	80	40	36	25
25.9	85	39	34	24
27.4	90	38	33	23
29	95	36	32	22
30.5	100	35	31	21
32	105	34	30	20
33.5	110	33	29	19
35.1	115	32	28	18
36.6	120	31	27	18
38.1	125	31	27	17
39.6	130	30	26	17
41.1	135	29	25	16
42.7	140	29	25	16
44.2	145	28	24	15
45.7	150	27	24	15
47.2	155	27	23	14

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
48.8	160	26	23	14
50.3	165	26	22	13
51.8	170	25	22	13
53.3	175	25	21	13
54.9	180	24	21	12
56.4	185	24	20	12
57.9	190	23	20	12
59.4	195	23	20	12
61	200	22	19	11
62.5	205	22	19	11
64	210	22	19	11
65.5	215	21	18	11
67.1	220	21	18	10
68.6	225	21	18	10
70.1	230	20	17	10
71.6	235	20	17	10
73.2	240	20	17	10
74.7	245	19	17	9
76.2	250	19	16	9
77.7	255	19	16	9
79.2	260	19	16	9
80.8	265	18	16	9
82.3	270	18	15	9
83.8	275	18	15	9
85.3	280	18	15	8
86.9	285	17	15	8
88.4	290	17	15	8
89.9	295	17	14	8
91.4	300	17	14	8
106.7	350	15	13	7
121.9	400	13	11	6
137.2	450	12	10	5
152.4	500	11	9	5
167.6	550	10	9	5
182.9	600	10	8	4
198.1	650	9	8	4
213.4	700	9	7	4
228.6	750	8	7	3
243.8	800	8	6	3
259.1	850	7	6	3
274.3	900	7	6	3
289.6	950	7	5	3

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
304.8	1000	6	5	3
320	1050	6	5	2
335.3	1100	6	5	2
350.5	1150	6	5	2
365.8	1200	5	4	2
381	1250	5	4	2
396.2	1300	5	4	2
411.5	1350	5	4	2
426.7	1400	5	4	2
442	1450	4	4	2
457.2	1500	4	4	2
472.4	1550	4	3	2
487.7	1600	4	3	2
502.9	1650	4	3	2
518.2	1700	4	3	2
533.4	1750	4	3	1
548.6	1800	4	3	1
563.9	1850	4	3	1

14.7 Qff2 mapping unit

Table 14-7: Effective shade targets for stream sites in the Qff2 mapping unit.

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
0.2	0.5	88	90	91
0.3	1	88	90	91
0.6	2	88	90	90
0.9	3	88	89	88
1.2	4	87	88	87
1.5	5	86	87	87
1.8	6	85	86	86
2.1	7	84	85	86
2.4	8	83	84	85
2.7	9	82	83	85
3	10	81	83	84
4.6	15	77	77	81
6.1	20	73	72	76
7.6	25	70	67	71
9.1	30	66	63	66
10.7	35	63	60	59

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
12.2	40	60	57	53
13.7	45	58	54	49
15.2	50	56	52	45
16.8	55	53	49	41
18.3	60	51	47	38
19.8	65	50	45	36
21.3	70	48	44	34
22.9	75	46	42	32
24.4	80	45	40	30
25.9	85	43	39	29
27.4	90	42	38	27
29	95	41	37	26
30.5	100	40	35	25
32	105	39	34	24
33.5	110	38	33	23
35.1	115	37	32	22
36.6	120	36	32	21
38.1	125	35	31	21
39.6	130	34	30	20
41.1	135	33	29	19
42.7	140	32	29	19
44.2	145	32	28	18
45.7	150	31	27	18
47.2	155	30	27	17
48.8	160	30	26	17
50.3	165	29	26	16
51.8	170	29	25	16
53.3	175	28	25	15
54.9	180	28	24	15
56.4	185	27	24	15
57.9	190	27	23	14
59.4	195	26	23	14
61	200	26	22	14
62.5	205	25	22	14
64	210	25	22	13
65.5	215	25	21	13
67.1	220	24	21	13
68.6	225	24	21	12
70.1	230	23	20	12
71.6	235	23	20	12
73.2	240	23	20	12
74.7	245	22	19	12

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
76.2	250	22	19	11
77.7	255	22	19	11
79.2	260	22	19	11
80.8	265	21	18	11
82.3	270	21	18	11
83.8	275	21	18	10
85.3	280	20	18	10
86.9	285	20	17	10
88.4	290	20	17	10
89.9	295	20	17	10
91.4	300	19	17	10
106.7	350	17	15	8
121.9	400	16	13	7
137.2	450	14	12	7
152.4	500	13	11	6
167.6	550	12	10	6
182.9	600	11	10	5
198.1	650	11	9	5
213.4	700	10	8	4
228.6	750	9	8	4
243.8	800	9	7	4
259.1	850	8	7	4
274.3	900	8	7	4
289.6	950	8	6	3
304.8	1000	7	6	3
320	1050	7	6	3
335.3	1100	7	6	3
350.5	1150	7	5	3
365.8	1200	6	5	3
381	1250	6	5	3
396.2	1300	6	5	2
411.5	1350	6	5	2
426.7	1400	5	5	2
442	1450	5	4	2
457.2	1500	5	4	2
472.4	1550	5	4	2
487.7	1600	5	4	2
502.9	1650	5	4	2
518.2	1700	5	4	2
533.4	1750	4	4	2
548.6	1800	4	4	2
563.9	1850	4	4	2

14.8 Qbf mapping unit

Table 14-8: Effective shade targets for stream sites in the Qbf mapping unit.

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
0.2	0.5	90	92	93
0.3	1	90	91	92
0.6	2	89	91	92
0.9	3	89	90	90
1.2	4	88	89	89
1.5	5	87	89	89
1.8	6	86	88	88
2.1	7	86	87	87
2.4	8	85	86	87
2.7	9	84	85	86
3	10	83	84	86
4.6	15	79	79	83
6.1	20	75	74	78
7.6	25	71	69	73
9.1	30	68	65	69
10.7	35	65	61	62
12.2	40	62	59	56
13.7	45	60	56	51
15.2	50	58	54	47
16.8	55	55	51	43
18.3	60	53	49	40
19.8	65	51	47	38
21.3	70	50	45	36
22.9	75	48	44	34
24.4	80	47	42	32
25.9	85	45	41	30
27.4	90	44	39	29
29	95	43	38	28
30.5	100	41	37	26
32	105	40	36	25
33.5	110	39	35	24
35.1	115	38	34	23
36.6	120	37	33	23
38.1	125	36	32	22
39.6	130	36	31	21
41.1	135	35	31	20

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
42.7	140	34	30	20
44.2	145	33	29	19
45.7	150	33	29	19
47.2	155	32	28	18
48.8	160	31	27	18
50.3	165	31	27	17
51.8	170	30	26	17
53.3	175	30	26	16
54.9	180	29	25	16
56.4	185	29	25	16
57.9	190	28	24	15
59.4	195	28	24	15
61	200	27	24	15
62.5	205	27	23	14
64	210	26	23	14
65.5	215	26	22	14
67.1	220	26	22	13
68.6	225	25	22	13
70.1	230	25	21	13
71.6	235	24	21	13
73.2	240	24	21	12
74.7	245	24	20	12
76.2	250	23	20	12
77.7	255	23	20	12
79.2	260	23	20	12
80.8	265	22	19	11
82.3	270	22	19	11
83.8	275	22	19	11
85.3	280	22	19	11
86.9	285	21	18	11
88.4	290	21	18	11
89.9	295	21	18	10
91.4	300	21	18	10
106.7	350	18	16	9
121.9	400	17	14	8
137.2	450	15	13	7
152.4	500	14	12	6
167.6	550	13	11	6
182.9	600	12	10	5
198.1	650	11	10	5
213.4	700	11	9	5
228.6	750	10	8	4

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
243.8	800	10	8	4
259.1	850	9	8	4
274.3	900	9	7	4
289.6	950	8	7	4
304.8	1000	8	7	3
320	1050	8	6	3
335.3	1100	7	6	3
350.5	1150	7	6	3
365.8	1200	7	6	3
381	1250	6	5	3
396.2	1300	6	5	3
411.5	1350	6	5	3
426.7	1400	6	5	2
442	1450	6	5	2
457.2	1500	5	5	2
472.4	1550	5	4	2
487.7	1600	5	4	2
502.9	1650	5	4	2
518.2	1700	5	4	2
533.4	1750	5	4	2
548.6	1800	5	4	2
563.9	1850	5	4	2

14.9 Tvc mapping unit

Table 14-9: Effective shade targets for stream sites in the Tvc mapping unit.

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
0.2	0.5	92	93	94
0.3	1	91	93	94
0.6	2	91	93	94
0.9	3	91	92	93
1.2	4	91	92	93
1.5	5	90	91	92
1.8	6	89	90	92
2.1	7	89	90	92
2.4	8	88	89	91
2.7	9	87	89	91
3	10	87	88	90
4.6	15	83	84	87

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
6.1	20	80	80	84
7.6	25	77	76	81
9.1	30	75	72	78
10.7	35	72	69	74
12.2	40	69	66	70
13.7	45	67	64	64
15.2	50	65	61	60
16.8	55	63	59	56
18.3	60	61	57	52
19.8	65	59	55	49
21.3	70	58	53	46
22.9	75	56	52	44
24.4	80	55	50	42
25.9	85	53	49	40
27.4	90	52	47	38
29	95	50	46	36
30.5	100	49	45	35
32	105	48	44	33
33.5	110	47	43	32
35.1	115	46	41	31
36.6	120	45	40	30
38.1	125	44	40	29
39.6	130	43	39	28
41.1	135	42	38	27
42.7	140	41	37	26
44.2	145	41	36	26
45.7	150	40	35	25
47.2	155	39	35	24
48.8	160	38	34	24
50.3	165	38	33	23
51.8	170	37	33	22
53.3	175	36	32	22
54.9	180	36	32	21
56.4	185	35	31	21
57.9	190	35	31	20
59.4	195	34	30	20
61	200	34	30	20
62.5	205	33	29	19
64	210	33	29	19
65.5	215	32	28	18
67.1	220	32	28	18
68.6	225	31	27	18

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
70.1	230	31	27	17
71.6	235	30	27	17
73.2	240	30	26	17
74.7	245	30	26	16
76.2	250	29	25	16
77.7	255	29	25	16
79.2	260	29	25	16
80.8	265	28	25	15
82.3	270	28	24	15
83.8	275	27	24	15
85.3	280	27	24	15
86.9	285	27	23	14
88.4	290	27	23	14
89.9	295	26	23	14
91.4	300	26	22	14
106.7	350	23	20	12
121.9	400	21	18	11
137.2	450	19	17	10
152.4	500	18	15	9
167.6	550	17	14	8
182.9	600	16	13	8
198.1	650	15	13	7
213.4	700	14	12	7
228.6	750	13	11	6
243.8	800	12	11	6
259.1	850	12	10	5
274.3	900	11	10	5
289.6	950	11	9	5
304.8	1000	10	9	5
320	1050	10	8	4
335.3	1100	10	8	4
350.5	1150	9	8	4
365.8	1200	9	7	4
381	1250	9	7	4
396.2	1300	8	7	4
411.5	1350	8	7	4
426.7	1400	8	6	3
442	1450	7	6	3
457.2	1500	7	6	3
472.4	1550	7	6	3
487.7	1600	7	6	3
502.9	1650	7	6	3

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
518.2	1700	6	5	3
533.4	1750	6	5	3
548.6	1800	6	5	3
563.9	1850	6	5	%

14.10 Qtg mapping unit

Table 14-10: Effective shade targets for stream sites in the Qtg mapping unit.

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
0.2	0.5	97	98	99
0.3	1	97	98	99
0.6	2	96	97	99
0.9	3	96	97	99
1.2	4	96	97	99
1.5	5	96	97	98
1.8	6	96	97	98
2.1	7	95	96	97
2.4	8	95	96	97
2.7	9	95	95	97
3	10	94	95	97
4.6	15	92	93	96
6.1	20	90	91	94
7.6	25	89	89	93
9.1	30	87	86	91
10.7	35	85	84	90
12.2	40	83	81	88
13.7	45	82	79	86
15.2	50	80	77	84
16.8	55	79	75	82
18.3	60	77	73	79
19.8	65	76	72	76
21.3	70	75	70	73
22.9	75	73	69	70
24.4	80	72	68	67
25.9	85	71	66	65
27.4	90	70	65	63
29	95	69	64	60
30.5	100	67	63	58
32	105	66	62	56

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
33.5	110	65	60	55
35.1	115	64	59	53
36.6	120	63	58	51
38.1	125	63	57	50
39.6	130	62	56	48
41.1	135	61	56	47
42.7	140	60	55	46
44.2	145	59	54	45
45.7	150	58	53	44
47.2	155	57	52	43
48.8	160	57	51	42
50.3	165	56	51	41
51.8	170	55	50	40
53.3	175	55	49	39
54.9	180	54	49	38
56.4	185	53	48	37
57.9	190	53	47	36
59.4	195	52	47	36
61	200	51	46	35
62.5	205	51	45	34
64	210	50	45	34
65.5	215	50	44	33
67.1	220	49	44	32
68.6	225	49	43	32
70.1	230	48	43	31
71.6	235	47	42	31
73.2	240	47	42	30
74.7	245	46	41	30
76.2	250	46	41	29
77.7	255	46	40	29
79.2	260	45	40	28
80.8	265	45	40	28
82.3	270	44	39	28
83.8	275	44	39	27
85.3	280	43	38	27
86.9	285	43	38	26
88.4	290	43	38	26
89.9	295	42	37	26
91.4	300	42	37	25
106.7	350	38	34	22
121.9	400	35	31	20
137.2	450	33	29	18

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
152.4	500	31	27	17
167.6	550	29	25	15
182.9	600	27	24	14
198.1	650	26	22	13
213.4	700	24	21	12
228.6	750	23	20	12
243.8	800	22	19	11
259.1	850	21	18	10
274.3	900	20	17	10
289.6	950	20	17	9
304.8	1000	19	16	9
320	1050	18	16	9
335.3	1100	17	15	8
350.5	1150	17	14	8
365.8	1200	16	14	8
381	1250	16	13	7
396.2	1300	15	13	7
411.5	1350	15	13	7
426.7	1400	14	12	7
442	1450	14	12	6
457.2	1500	14	12	6
472.4	1550	13	11	6
487.7	1600	13	11	6
502.9	1650	13	11	6
518.2	1700	12	10	6
533.4	1750	12	10	5
548.6	1800	12	10	5
563.9	1850	11	10	5

14.11 Tvw mapping unit

Table 14-11: Effective shade targets for stream sites in the Tvw mapping unit.

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
0.2	0.5	94	96	97
0.3	1	94	95	97
0.6	2	94	95	97
0.9	3	94	95	97
1.2	4	93	95	96
1.5	5	93	94	96

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
1.8	6	93	94	95
2.1	7	92	93	95
2.4	8	92	93	94
2.7	9	91	92	94
3	10	91	92	94
4.6	15	88	89	92
6.1	20	86	86	90
7.6	25	83	83	88
9.1	30	81	80	86
10.7	35	79	77	83
12.2	40	77	75	81
13.7	45	75	72	78
15.2	50	73	70	75
16.8	55	72	68	71
18.3	60	70	66	67
19.8	65	68	64	63
21.3	70	67	63	60
22.9	75	65	61	57
24.4	80	64	60	55
25.9	85	63	58	53
27.4	90	61	57	50
29	95	60	56	48
30.5	100	59	54	47
32	105	58	53	45
33.5	110	57	52	43
35.1	115	55	51	42
36.6	120	54	50	40
38.1	125	54	49	39
39.6	130	53	48	38
41.1	135	52	47	37
42.7	140	51	46	36
44.2	145	50	45	35
45.7	150	49	44	34
47.2	155	48	44	33
48.8	160	48	43	32
50.3	165	47	42	31
51.8	170	46	41	31
53.3	175	45	41	30
54.9	180	45	40	29
56.4	185	44	40	29
57.9	190	44	39	28
59.4	195	43	38	27

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
61	200	42	38	27
62.5	205	42	37	26
64	210	41	37	26
65.5	215	41	36	25
67.1	220	40	36	25
68.6	225	40	35	24
70.1	230	39	35	24
71.6	235	39	34	24
73.2	240	38	34	23
74.7	245	38	33	23
76.2	250	37	33	22
77.7	255	37	33	22
79.2	260	36	32	22
80.8	265	36	32	21
82.3	270	36	31	21
83.8	275	35	31	21
85.3	280	35	31	20
86.9	285	35	30	20
88.4	290	34	30	20
89.9	295	34	30	19
91.4	300	33	29	19
106.7	350	30	27	17
121.9	400	28	24	15
137.2	450	26	22	14
152.4	500	24	21	12
167.6	550	22	19	11
182.9	600	21	18	11
198.1	650	20	17	10
213.4	700	19	16	9
228.6	750	18	15	9
243.8	800	17	14	8
259.1	850	16	14	8
274.3	900	15	13	7
289.6	950	15	13	7
304.8	1000	14	12	7
320	1050	13	12	6
335.3	1100	13	11	6
350.5	1150	13	11	6
365.8	1200	12	10	6
381	1250	12	10	5
396.2	1300	11	10	5
411.5	1350	11	9	5

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

14.12 Tcr mapping unit

Table 14-12: Effective shade targets for stream sites in the Tcr mapping unit.

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
0.2	0.5	96	97	98
0.3	1	95	97	98
0.6	2	95	96	98
0.9	3	95	96	98
1.2	4	95	96	97
1.5	5	95	96	97
1.8	6	94	95	96
2.1	7	94	95	96
2.4	8	93	94	96
2.7	9	93	94	96
3	10	92	93	95
4.6	15	90	91	94
6.1	20	88	88	92
7.6	25	86	86	90
9.1	30	84	83	88
10.7	35	82	80	86
12.2	40	80	77	84
13.7	45	78	75	82
15.2	50	76	73	79
16.8	55	75	71	75
18.3	60	73	69	72
19.8	65	71	67	68
21.3	70	70	66	65
22.9	75	69	64	62

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
24.4	80	67	63	60
25.9	85	66	61	57
27.4	90	65	60	55
29	95	63	59	53
30.5	100	62	58	51
32	105	61	56	49
33.5	110	60	55	47
35.1	115	59	54	46
36.6	120	58	53	44
38.1	125	57	52	43
39.6	130	56	51	42
41.1	135	55	50	41
42.7	140	54	49	39
44.2	145	53	49	38
45.7	150	53	48	37
47.2	155	52	47	36
48.8	160	51	46	36
50.3	165	50	45	35
51.8	170	50	45	34
53.3	175	49	44	33
54.9	180	48	43	32
56.4	185	48	43	32
57.9	190	47	42	31
59.4	195	46	41	30
61	200	46	41	30
62.5	205	45	40	29
64	210	45	40	29
65.5	215	44	39	28
67.1	220	44	39	27
68.6	225	43	38	27
70.1	230	42	38	27
71.6	235	42	37	26
73.2	240	41	37	26
74.7	245	41	36	25
76.2	250	41	36	25
77.7	255	40	35	24
79.2	260	40	35	24
80.8	265	39	35	24
82.3	270	39	34	23
83.8	275	38	34	23
85.3	280	38	34	23
86.9	285	38	33	22

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
88.4	290	37	33	22
89.9	295	37	32	22
91.4	300	36	32	21
106.7	350	33	29	19
121.9	400	31	27	17
137.2	450	28	25	15
152.4	500	26	23	14
167.6	550	25	21	13
182.9	600	23	20	12
198.1	650	22	19	11
213.4	700	21	18	10
228.6	750	20	17	10
243.8	800	19	16	9
259.1	850	18	15	9
274.3	900	17	15	8
289.6	950	16	14	8
304.8	1000	16	13	8
320	1050	15	13	7
335.3	1100	15	12	7
350.5	1150	14	12	7
365.8	1200	14	12	6
381	1250	13	11	6
396.2	1300	13	11	6
411.5	1350	12	10	6
426.7	1400	12	10	6
442	1450	12	10	5
457.2	1500	11	10	5
472.4	1550	11	9	5
487.7	1600	11	9	5
502.9	1650	10	9	5
518.2	1700	10	9	5
533.4	1750	10	8	4
548.6	1800	10	8	4
563.9	1850	9	8	4

14.13 Tm mapping unit

Table 14-13: Effective shade targets for stream sites in the Tm mapping unit.

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
0.2	0.5	94	95	95
0.3	1	94	95	95
0.6	2	93	95	95
0.9	3	93	94	95
1.2	4	93	94	94
1.5	5	92	93	94
1.8	6	92	93	94
2.1	7	91	92	93
2.4	8	91	92	93
2.7	9	90	91	93
3	10	89	90	92
4.6	15	86	87	90
6.1	20	84	83	87
7.6	25	81	80	85
9.1	30	78	76	82
10.7	35	76	73	79
12.2	40	73	70	75
13.7	45	71	67	71
15.2	50	69	65	66
16.8	55	67	63	61
18.3	60	65	61	58
19.8	65	64	59	54
21.3	70	62	58	52
22.9	75	60	56	49
24.4	80	59	54	47
25.9	85	57	53	44
27.4	90	56	51	42
29	95	55	50	41
30.5	100	54	49	39
32	105	52	48	38
33.5	110	51	47	36
35.1	115	50	45	35
36.6	120	49	44	34
38.1	125	48	43	33
39.6	130	47	42	32
41.1	135	46	42	31
42.7	140	46	41	30
44.2	145	45	40	29
45.7	150	44	39	28
47.2	155	43	38	27
48.8	160	42	38	27
50.3	165	42	37	26

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
51.8	170	41	36	25
53.3	175	40	36	25
54.9	180	40	35	24
56.4	185	39	35	24
57.9	190	39	34	23
59.4	195	38	33	23
61	200	37	33	22
62.5	205	37	32	22
64	210	36	32	21
65.5	215	36	31	21
67.1	220	35	31	20
68.6	225	35	31	20
70.1	230	34	30	20
71.6	235	34	30	19
73.2	240	34	29	19
74.7	245	33	29	19
76.2	250	33	29	18
77.7	255	32	28	18
79.2	260	32	28	18
80.8	265	32	27	17
82.3	270	31	27	17
83.8	275	31	27	17
85.3	280	30	26	17
86.9	285	30	26	16
88.4	290	30	26	16
89.9	295	29	26	16
91.4	300	29	25	16
106.7	350	26	23	14
121.9	400	24	21	12
137.2	450	22	19	11
152.4	500	20	18	10
167.6	550	19	16	9
182.9	600	18	15	9
198.1	650	17	14	8
213.4	700	16	14	7
228.6	750	15	13	7
243.8	800	14	12	7
259.1	850	14	12	6
274.3	900	13	11	6
289.6	950	12	11	6
304.8	1000	12	10	5
320	1050	11	10	5

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
335.3	1100	11	9	5
350.5	1150	11	9	5
365.8	1200	10	9	5
381	1250	10	8	4
396.2	1300	10	8	4
411.5	1350	9	8	4
426.7	1400	9	8	4
442	1450	9	7	4
457.2	1500	8	7	4
472.4	1550	8	7	4
487.7	1600	8	7	3
502.9	1650	8	7	3
518.2	1700	8	6	3
533.4	1750	7	6	3
548.6	1800	7	6	3
563.9	1850	7	6	3

14.14 QTt mapping unit

Table 14-14: Effective shade targets for stream sites in the QTt mapping unit.

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
0.2	0.5	91	93	94
0.3	1	91	92	94
0.6	2	90	92	94
0.9	3	90	92	93
1.2	4	90	91	92
1.5	5	89	90	92
1.8	6	88	89	91
2.1	7	87	89	90
2.4	8	87	88	89
2.7	9	86	87	89
3	10	85	86	88
4.6	15	82	82	85
6.1	20	78	77	82
7.6	25	75	73	78
9.1	30	72	69	74
10.7	35	69	66	70
12.2	40	66	63	64
13.7	45	64	60	58

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
15.2	50	62	58	54
16.8	55	60	56	50
18.3	60	58	54	47
19.8	65	56	52	44
21.3	70	54	50	41
22.9	75	53	48	39
24.4	80	51	47	37
25.9	85	50	45	35
27.4	90	48	44	34
29	95	47	43	32
30.5	100	46	41	31
32	105	45	40	30
33.5	110	44	39	29
35.1	115	43	38	28
36.6	120	42	37	27
38.1	125	41	36	26
39.6	130	40	35	25
41.1	135	39	35	24
42.7	140	38	34	23
44.2	145	37	33	23
45.7	150	37	32	22
47.2	155	36	32	21
48.8	160	35	31	21
50.3	165	35	30	20
51.8	170	34	30	20
53.3	175	33	29	19
54.9	180	33	29	19
56.4	185	32	28	18
57.9	190	32	28	18
59.4	195	31	27	18
61	200	31	27	17
62.5	205	30	26	17
64	210	30	26	17
65.5	215	29	26	16
67.1	220	29	25	16
68.6	225	29	25	16
70.1	230	28	24	15
71.6	235	28	24	15
73.2	240	27	24	15
74.7	245	27	23	15
76.2	250	27	23	14
77.7	255	26	23	14

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
79.2	260	26	22	14
80.8	265	26	22	14
82.3	270	25	22	13
83.8	275	25	22	13
85.3	280	25	21	13
86.9	285	24	21	13
88.4	290	24	21	13
89.9	295	24	21	12
91.4	300	23	20	12
106.7	350	21	18	11
121.9	400	19	16	9
137.2	450	18	15	9
152.4	500	16	14	8
167.6	550	15	13	7
182.9	600	14	12	7
198.1	650	13	11	6
213.4	700	12	10	6
228.6	750	12	10	5
243.8	800	11	9	5
259.1	850	11	9	5
274.3	900	10	8	5
289.6	950	10	8	4
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	7	3
381	1250	8	6	3
396.2	1300	7	6	3
411.5	1350	7	6	3
426.7	1400	7	6	3
442	1450	7	6	3
457.2	1500	6	5	3
472.4	1550	6	5	3
487.7	1600	6	5	3
502.9	1650	6	5	3
518.2	1700	6	5	2
533.4	1750	6	5	2
548.6	1800	5	5	2
563.9	1850	5	4	2

14.15 QTb mapping unit

Table 14-15: Effective shade targets for stream sites in the QTb mapping unit.

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
0.2	0.5	94	96	97
0.3	1	94	95	97
0.6	2	93	95	97
0.9	3	93	95	97
1.2	4	93	95	96
1.5	5	93	94	95
1.8	6	92	93	95
2.1	7	92	93	94
2.4	8	91	93	94
2.7	9	91	92	94
3	10	90	92	93
4.6	15	88	89	92
6.1	20	85	86	90
7.6	25	83	83	88
9.1	30	81	80	85
10.7	35	79	77	83
12.2	40	77	74	80
13.7	45	75	72	78
15.2	50	73	70	74
16.8	55	71	68	70
18.3	60	70	66	67
19.8	65	68	64	63
21.3	70	66	62	60
22.9	75	65	61	57
24.4	80	63	59	55
25.9	85	62	58	52
27.4	90	61	57	50
29	95	60	55	48
30.5	100	58	54	46
32	105	57	53	45
33.5	110	56	52	43
35.1	115	55	51	42
36.6	120	54	50	40
38.1	125	53	49	39
39.6	130	52	48	38
41.1	135	51	47	37
42.7	140	50	46	36
44.2	145	50	45	35

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
45.7	150	49	44	34
47.2	155	48	43	33
48.8	160	47	43	32
50.3	165	46	42	31
51.8	170	46	41	30
53.3	175	45	40	30
54.9	180	44	40	29
56.4	185	44	39	28
57.9	190	43	39	28
59.4	195	43	38	27
61	200	42	37	27
62.5	205	41	37	26
64	210	41	36	26
65.5	215	40	36	25
67.1	220	40	35	25
68.6	225	39	35	24
70.1	230	39	34	24
71.6	235	38	34	23
73.2	240	38	34	23
74.7	245	37	33	23
76.2	250	37	33	22
77.7	255	37	32	22
79.2	260	36	32	21
80.8	265	36	32	21
82.3	270	35	31	21
83.8	275	35	31	21
85.3	280	35	30	20
86.9	285	34	30	20
88.4	290	34	30	20
89.9	295	33	29	19
91.4	300	33	29	19
106.7	350	30	26	17
121.9	400	27	24	15
137.2	450	25	22	14
152.4	500	24	20	12
167.6	550	22	19	11
182.9	600	21	18	11
198.1	650	19	17	10
213.4	700	18	16	9
228.6	750	17	15	9
243.8	800	17	14	8
259.1	850	16	14	8

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
274.3	900	15	13	7
289.6	950	14	12	7
304.8	1000	14	12	7
320	1050	13	11	6
335.3	1100	13	11	6
350.5	1150	12	11	6
365.8	1200	12	10	6
381	1250	11	10	5
396.2	1300	11	9	5
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	10	8	4
487.7	1600	9	8	4
502.9	1650	9	8	4
518.2	1700	9	8	4
533.4	1750	9	7	4
548.6	1800	8	7	4
563.9	1850	8	7	4

14.16 Qls mapping unit

Table 14-16: Effective shade targets for stream sites in the Qls mapping unit.

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
0.2	0.5	96	98	99
0.3	1	95	97	98
0.6	2	95	97	98
0.9	3	95	96	98
1.2	4	95	96	98
1.5	5	95	96	98
1.8	6	95	96	97
2.1	7	95	95	97
2.4	8	94	95	97
2.7	9	94	95	96
3	10	93	94	96
4.6	15	91	92	95
6.1	20	90	91	94
7.6	25	88	89	92

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
9.1	30	86	86	91
10.7	35	85	84	90
12.2	40	83	82	88
13.7	45	81	80	86
15.2	50	80	78	85
16.8	55	79	76	83
18.3	60	77	74	80
19.8	65	76	72	78
21.3	70	75	71	75
22.9	75	73	69	72
24.4	80	72	68	69
25.9	85	71	67	67
27.4	90	70	66	64
29	95	69	64	62
30.5	100	67	63	60
32	105	66	62	58
33.5	110	65	61	56
35.1	115	64	60	55
36.6	120	63	59	53
38.1	125	63	58	52
39.6	130	62	57	50
41.1	135	61	56	49
42.7	140	60	55	48
44.2	145	59	54	46
45.7	150	58	54	45
47.2	155	58	53	44
48.8	160	57	52	43
50.3	165	56	51	42
51.8	170	55	51	41
53.3	175	55	50	40
54.9	180	54	49	39
56.4	185	53	48	39
57.9	190	53	48	38
59.4	195	52	47	37
61	200	51	47	36
62.5	205	51	46	36
64	210	50	45	35
65.5	215	50	45	34
67.1	220	49	44	34
68.6	225	49	44	33
70.1	230	48	43	33
71.6	235	48	43	32

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
73.2	240	47	42	31
74.7	245	47	42	31
76.2	250	46	41	30
77.7	255	46	41	30
79.2	260	45	40	30
80.8	265	45	40	29
82.3	270	44	40	29
83.8	275	44	39	28
85.3	280	43	39	28
86.9	285	43	38	27
88.4	290	43	38	27
89.9	295	42	38	27
91.4	300	42	37	26
106.7	350	38	34	23
121.9	400	35	31	21
137.2	450	33	29	19
152.4	500	31	27	17
167.6	550	29	25	16
182.9	600	27	24	15
198.1	650	26	22	14
213.4	700	24	21	13
228.6	750	23	20	12
243.8	800	22	19	12
259.1	850	21	18	11
274.3	900	20	18	10
289.6	950	19	17	10
304.8	1000	19	16	9
320	1050	18	16	9
335.3	1100	17	15	9
350.5	1150	17	14	8
365.8	1200	16	14	8
381	1250	16	13	8
396.2	1300	15	13	7
411.5	1350	15	13	7
426.7	1400	14	12	7
442	1450	14	12	7
457.2	1500	13	12	7
472.4	1550	13	11	6
487.7	1600	13	11	6
502.9	1650	12	11	6
518.2	1700	12	10	6
533.4	1750	12	10	6

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
548.6	1800	11	10	6
563.9	1850	11	10	5

14.17 Open Water (OW)

Table 14-17: Effective shade targets for stream sites classified as Open Water (OW).

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
0.2	0.5	95	96	98
0.3	1	92	92	96
0.6	2	84	80	90
0.9	3	77	72	75
1.2	4	71	65	57
1.5	5	65	59	46
1.8	6	59	53	39
2.1	7	55	48	34
2.4	8	51	44	30
2.7	9	47	41	27
3	10	44	37	24
4.6	15	33	27	16
6.1	20	26	21	12
7.6	25	22	17	10
9.1	30	18	15	8
10.7	35	16	13	7
12.2	40	14	11	6
13.7	45	13	10	6
15.2	50	12	9	5
16.8	55	11	8	5
18.3	60	10	8	4
19.8	65	9	7	4
21.3	70	9	7	4
22.9	75	8	6	3
24.4	80	8	6	3
25.9	85	7	6	3
27.4	90	7	5	3
29	95	7	5	3
30.5	100	6	5	2
32	105	6	5	2

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
33.5	110	6	4	2
35.1	115	5	4	2
36.6	120	5	4	2
38.1	125	5	4	2
39.6	130	5	4	2
41.1	135	5	4	2
42.7	140	5	3	2
44.2	145	4	3	2
45.7	150	4	3	2
47.2	155	4	3	2
48.8	160	4	3	2
50.3	165	4	3	2
51.8	170	4	3	1
53.3	175	4	3	1
54.9	180	4	3	1
56.4	185	3	3	1
57.9	190	3	3	1
59.4	195	3	2	1
61	200	3	2	1
62.5	205	3	2	1
64	210	3	2	1
65.5	215	3	2	1
67.1	220	3	2	1
68.6	225	3	2	1
70.1	230	3	2	1
71.6	235	3	2	1
73.2	240	3	2	1
74.7	245	3	2	1
76.2	250	3	2	1
77.7	255	3	2	1
79.2	260	2	2	1
80.8	265	2	2	1
82.3	270	2	2	1
83.8	275	2	2	1
85.3	280	2	2	1
86.9	285	2	2	1
88.4	290	2	2	1
89.9	295	2	2	1
91.4	300	2	2	1
106.7	350	2	1	1
121.9	400	2	1	1
137.2	450	1	1	1

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
152.4	500	1	1	0
167.6	550	1	1	0
182.9	600	1	1	0
198.1	650	1	1	0
213.4	700	1	1	0
228.6	750	1	1	0
243.8	800	1	1	0
259.1	850	1	1	0
274.3	900	1	1	0
289.6	950	1	1	0
304.8	1000	1	0	0
320	1050	1	0	0
335.3	1100	1	0	0
350.5	1150	1	0	0
365.8	1200	1	0	0
381	1250	1	0	0
396.2	1300	1	0	0
411.5	1350	0	0	0
426.7	1400	0	0	0
442	1450	0	0	0
457.2	1500	0	0	0
472.4	1550	0	0	0
487.7	1600	0	0	0
502.9	1650	0	0	0
518.2	1700	0	0	0
533.4	1750	0	0	0
548.6	1800	0	0	0
563.9	1850	0	0	0

14.18 Upland Forest

Table 14-18: Effective shade targets for stream sites in the Upland Forest mapping unit.

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
0.2	0.5	97	99	99
0.3	1	97	98	99
0.6	2	97	98	99
0.9	3	97	98	99

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
1.2	4	97	97	99
1.5	5	97	97	98
1.8	6	97	97	98
2.1	7	96	96	98
2.4	8	95	96	98
2.7	9	95	96	97
3	10	95	95	97
4.6	15	93	93	96
6.1	20	91	91	95
7.6	25	89	89	94
9.1	30	88	87	92
10.7	35	86	85	91
12.2	40	84	82	89
13.7	45	83	80	88
15.2	50	81	78	86
16.8	55	80	76	83
18.3	60	79	74	81
19.8	65	77	73	78
21.3	70	76	71	75
22.9	75	75	70	72
24.4	80	73	69	69
25.9	85	72	67	67
27.4	90	71	66	64
29	95	70	65	62
30.5	100	69	64	60
32	105	68	63	58
33.5	110	67	62	56
35.1	115	66	61	55
36.6	120	65	60	53
38.1	125	64	59	52
39.6	130	63	58	50
41.1	135	62	57	49
42.7	140	61	56	48
44.2	145	61	55	46
45.7	150	60	54	45
47.2	155	59	54	44
48.8	160	58	53	43
50.3	165	58	52	42
51.8	170	57	51	41
53.3	175	56	51	40
54.9	180	56	50	39
56.4	185	55	49	39

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
57.9	190	54	49	38
59.4	195	54	48	37
61	200	53	48	36
62.5	205	52	47	36
64	210	52	46	35
65.5	215	51	46	34
67.1	220	51	45	34
68.6	225	50	45	33
70.1	230	50	44	33
71.6	235	49	44	32
73.2	240	49	43	31
74.7	245	48	43	31
76.2	250	48	42	30
77.7	255	47	42	30
79.2	260	47	41	30
80.8	265	46	41	29
82.3	270	46	41	29
83.8	275	45	40	28
85.3	280	45	40	28
86.9	285	45	39	27
88.4	290	44	39	27
89.9	295	44	39	27
91.4	300	43	38	26
106.7	350	40	35	23
121.9	400	37	32	21
137.2	450	34	30	19
152.4	500	32	28	17
167.6	550	30	26	16
182.9	600	29	25	15
198.1	650	27	23	14
213.4	700	26	22	13
228.6	750	25	21	12
243.8	800	23	20	12
259.1	850	22	19	11
274.3	900	22	18	10
289.6	950	21	18	10
304.8	1000	20	17	9
320	1050	19	16	9
335.3	1100	18	16	9
350.5	1150	18	15	8
365.8	1200	17	15	8
381	1250	17	14	8

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
396.2	1300	16	14	8
411.5	1350	16	13	7
426.7	1400	15	13	7
442	1450	15	13	7
457.2	1500	14	12	7
472.4	1550	14	12	6
487.7	1600	14	12	6
502.9	1650	13	11	6
518.2	1700	13	11	6
533.4	1750	13	11	6
548.6	1800	12	11	6
563.9	1850	12	10	5

14.19 1d/1f - Volcanics and Willapa Hills

Table 14-19: Effective shade targets for stream sites in Ecoregion 1d/1f - Volcanics and Willapa Hills.

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
0.2	0.5	97	99	99
0.3	1	97	98	99
0.6	2	97	98	99
0.9	3	96	97	99
1.2	4	96	97	98
1.5	5	96	97	98
1.8	6	96	97	98
2.1	7	95	96	97
2.4	8	95	96	97
2.7	9	95	95	97
3	10	94	95	97
4.6	15	92	93	96
6.1	20	90	91	94
7.6	25	88	89	93
9.1	30	86	86	92
10.7	35	84	84	90
12.2	40	83	82	88
13.7	45	81	79	87
15.2	50	79	77	85
16.8	55	78	75	83

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
18.3	60	76	74	80
19.8	65	75	72	77
21.3	70	74	70	74
22.9	75	72	69	72
24.4	80	71	68	69
25.9	85	70	66	67
27.4	90	69	65	64
29	95	67	64	62
30.5	100	66	63	60
32	105	65	61	58
33.5	110	64	60	56
35.1	115	63	59	55
36.6	120	62	58	53
38.1	125	61	57	51
39.6	130	60	56	50
41.1	135	59	55	49
42.7	140	59	54	47
44.2	145	58	54	46
45.7	150	57	53	45
47.2	155	56	52	44
48.8	160	55	51	43
50.3	165	55	50	42
51.8	170	54	50	41
53.3	175	53	49	40
54.9	180	53	48	39
56.4	185	52	48	38
57.9	190	51	47	38
59.4	195	51	46	37
61	200	50	46	36
62.5	205	50	45	35
64	210	49	45	35
65.5	215	48	44	34
67.1	220	48	44	34
68.6	225	47	43	33
70.1	230	47	42	32
71.6	235	46	42	32
73.2	240	46	41	31
74.7	245	45	41	31
76.2	250	45	41	30
77.7	255	44	40	30
79.2	260	44	40	29
80.8	265	44	39	29

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
82.3	270	43	39	28
83.8	275	43	38	28
85.3	280	42	38	28
86.9	285	42	38	27
88.4	290	41	37	27
89.9	295	41	37	27
91.4	300	41	37	26
106.7	350	37	33	23
121.9	400	34	31	21
137.2	450	32	28	19
152.4	500	30	26	17
167.6	550	28	25	16
182.9	600	26	23	15
198.1	650	25	22	14
213.4	700	24	21	13
228.6	750	23	20	12
243.8	800	22	19	11
259.1	850	21	18	11
274.3	900	20	17	10
289.6	950	19	17	10
304.8	1000	18	16	9
320	1050	18	15	9
335.3	1100	17	15	9
350.5	1150	16	14	8
365.8	1200	16	14	8
381	1250	15	13	8
396.2	1300	15	13	7
411.5	1350	14	12	7
426.7	1400	14	12	7
442	1450	14	12	7
457.2	1500	13	11	6
472.4	1550	13	11	6
487.7	1600	13	11	6
502.9	1650	12	11	6
518.2	1700	12	10	6
533.4	1750	12	10	6
548.6	1800	11	10	5
563.9	1850	11	10	5

14.20 3a - Portland/Vancouver Basin

Table 14-20: Effective shade targets for stream sites in Ecoregion 3a - Portland/Vancouver Basin.

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
0.2	0.5	95	97	96
0.3	1	95	96	95
0.6	2	94	95	95
0.9	3	94	95	95
1.2	4	94	94	94
1.5	5	93	94	94
1.8	6	92	93	94
2.1	7	92	93	93
2.4	8	91	92	93
2.7	9	91	91	93
3	10	90	91	92
4.6	15	87	87	90
6.1	20	84	84	88
7.6	25	81	80	85
9.1	30	78	77	82
10.7	35	76	73	79
12.2	40	73	70	75
13.7	45	71	68	72
15.2	50	69	66	67
16.8	55	67	63	63
18.3	60	65	61	59
19.8	65	63	60	56
21.3	70	61	58	53
22.9	75	60	56	50
24.4	80	58	55	48
25.9	85	57	53	46
27.4	90	56	52	44
29	95	54	50	42
30.5	100	53	49	40
32	105	52	48	39
33.5	110	51	47	37
35.1	115	50	46	36
36.6	120	49	45	35
38.1	125	48	44	34
39.6	130	47	43	33
41.1	135	46	42	32
42.7	140	45	41	31
44.2	145	44	40	30
45.7	150	44	39	29
47.2	155	43	39	28

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
48.8	160	42	38	28
50.3	165	41	37	27
51.8	170	41	37	26
53.3	175	40	36	26
54.9	180	39	35	25
56.4	185	39	35	24
57.9	190	38	34	24
59.4	195	38	34	23
61	200	37	33	23
62.5	205	37	33	22
64	210	36	32	22
65.5	215	36	32	22
67.1	220	35	31	21
68.6	225	35	31	21
70.1	230	34	30	20
71.6	235	34	30	20
73.2	240	33	30	20
74.7	245	33	29	19
76.2	250	33	29	19
77.7	255	32	28	19
79.2	260	32	28	18
80.8	265	31	28	18
82.3	270	31	27	18
83.8	275	31	27	18
85.3	280	30	27	17
86.9	285	30	26	17
88.4	290	30	26	17
89.9	295	29	26	17
91.4	300	29	25	16
106.7	350	26	23	14
121.9	400	24	21	13
137.2	450	22	19	11
152.4	500	21	18	10
167.6	550	19	17	10
182.9	600	18	15	9
198.1	650	17	15	8
213.4	700	16	14	8
228.6	750	15	13	7
243.8	800	14	12	7
259.1	850	14	12	6
274.3	900	13	11	6
289.6	950	13	11	6

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
304.8	1000	12	10	6
320	1050	12	10	5
335.3	1100	11	9	5
350.5	1150	11	9	5
365.8	1200	10	9	5
381	1250	10	8	5
396.2	1300	10	8	4
411.5	1350	9	8	4
426.7	1400	9	8	4
442	1450	9	7	4
457.2	1500	9	7	4
472.4	1550	8	7	4
487.7	1600	8	7	4
502.9	1650	8	7	3
518.2	1700	8	6	3
533.4	1750	7	6	3
548.6	1800	7	6	3
563.9	1850	7	6	3

14.21 3c - Prairie Terraces

Table 14-21: Effective shade targets for stream sites in Ecoregion 3c - Prairie Terraces.

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
0.2	0.5	97	98	98
0.3	1	96	97	98
0.6	2	96	97	98
0.9	3	96	97	98
1.2	4	95	96	97
1.5	5	95	96	97
1.8	6	95	95	96
2.1	7	94	95	96
2.4	8	94	94	96
2.7	9	93	94	96
3	10	93	94	95
4.6	15	90	91	94
6.1	20	88	89	92
7.6	25	86	86	91

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
9.1	30	84	83	89
10.7	35	82	81	87
12.2	40	80	78	84
13.7	45	78	76	82
15.2	50	76	73	79
16.8	55	74	71	77
18.3	60	73	70	73
19.8	65	71	68	70
21.3	70	70	66	67
22.9	75	68	65	64
24.4	80	67	63	62
25.9	85	66	62	59
27.4	90	64	61	57
29	95	63	59	55
30.5	100	62	58	53
32	105	61	57	51
33.5	110	60	56	49
35.1	115	59	55	48
36.6	120	58	54	46
38.1	125	57	53	45
39.6	130	56	52	44
41.1	135	55	51	43
42.7	140	54	50	41
44.2	145	53	49	40
45.7	150	52	48	39
47.2	155	52	47	38
48.8	160	51	47	37
50.3	165	50	46	36
51.8	170	50	45	36
53.3	175	49	45	35
54.9	180	48	44	34
56.4	185	48	43	33
57.9	190	47	43	33
59.4	195	46	42	32
61	200	46	41	31
62.5	205	45	41	31
64	210	45	40	30
65.5	215	44	40	30
67.1	220	44	39	29
68.6	225	43	39	28
70.1	230	43	38	28
71.6	235	42	38	27

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
73.2	240	42	37	27
74.7	245	41	37	27
76.2	250	41	37	26
77.7	255	40	36	26
79.2	260	40	36	25
80.8	265	39	35	25
82.3	270	39	35	25
83.8	275	39	34	24
85.3	280	38	34	24
86.9	285	38	34	23
88.4	290	37	33	23
89.9	295	37	33	23
91.4	300	37	33	23
106.7	350	33	30	20
121.9	400	31	27	18
137.2	450	29	25	16
152.4	500	27	23	15
167.6	550	25	22	13
182.9	600	23	21	13
198.1	650	22	19	12
213.4	700	21	18	11
228.6	750	20	17	10
243.8	800	19	17	10
259.1	850	18	16	9
274.3	900	17	15	9
289.6	950	17	14	8
304.8	1000	16	14	8
320	1050	15	13	8
335.3	1100	15	13	7
350.5	1150	14	12	7
365.8	1200	14	12	7
381	1250	13	12	6
396.2	1300	13	11	6
411.5	1350	13	11	6
426.7	1400	12	11	6
442	1450	12	10	6
457.2	1500	12	10	5
472.4	1550	11	10	5
487.7	1600	11	9	5
502.9	1650	11	9	5
518.2	1700	10	9	5
533.4	1750	10	9	5

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
548.6	1800	10	8	5
563.9	1850	10	8	5

14.22 3d - Valley Foothills

Table 14-22: Effective shade targets for stream sites in Ecoregion 3d - Valley Foothills.

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
0.2	0.5	96	98	98
0.3	1	96	97	98
0.6	2	95	96	98
0.9	3	95	96	97
1.2	4	95	96	97
1.5	5	95	95	96
1.8	6	94	95	96
2.1	7	93	94	96
2.4	8	93	94	96
2.7	9	93	93	95
3	10	92	93	95
4.6	15	90	90	93
6.1	20	87	88	91
7.6	25	85	85	89
9.1	30	82	82	87
10.7	35	80	79	85
12.2	40	78	76	82
13.7	45	76	73	80
15.2	50	74	71	77
16.8	55	72	69	73
18.3	60	71	67	70
19.8	65	69	66	66
21.3	70	67	64	63
22.9	75	66	62	60
24.4	80	65	61	58
25.9	85	63	59	55
27.4	90	62	58	53
29	95	61	57	51
30.5	100	59	56	49
32	105	58	54	48

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
33.5	110	57	53	46
35.1	115	56	52	44
36.6	120	55	51	43
38.1	125	54	50	42
39.6	130	53	49	40
41.1	135	52	48	39
42.7	140	52	47	38
44.2	145	51	46	37
45.7	150	50	46	36
47.2	155	49	45	35
48.8	160	48	44	34
50.3	165	48	43	34
51.8	170	47	43	33
53.3	175	46	42	32
54.9	180	46	41	31
56.4	185	45	41	31
57.9	190	44	40	30
59.4	195	44	40	29
61	200	43	39	29
62.5	205	43	38	28
64	210	42	38	28
65.5	215	42	37	27
67.1	220	41	37	27
68.6	225	41	36	26
70.1	230	40	36	26
71.6	235	40	36	25
73.2	240	39	35	25
74.7	245	39	35	24
76.2	250	38	34	24
77.7	255	38	34	24
79.2	260	37	33	23
80.8	265	37	33	23
82.3	270	37	33	22
83.8	275	36	32	22
85.3	280	36	32	22
86.9	285	35	32	21
88.4	290	35	31	21
89.9	295	35	31	21
91.4	300	34	31	21
106.7	350	31	28	18
121.9	400	29	25	16
137.2	450	27	23	15

Active Channel Width (m)	Active Channel Width (ft)	Effective Shade Target for N-S Stream Aspects (%)	Effective Shade Target for NW-SE, NE-SW Stream Aspects (%)	Effective Shade Target for E-W Stream Aspects (%)
152.4	500	25	22	13
167.6	550	23	20	12
182.9	600	22	19	11
198.1	650	21	18	11
213.4	700	19	17	10
228.6	750	19	16	9
243.8	800	18	15	9
259.1	850	17	15	8
274.3	900	16	14	8
289.6	950	15	13	8
304.8	1000	15	13	7
320	1050	14	12	7
335.3	1100	14	12	7
350.5	1150	13	11	6
365.8	1200	13	11	6
381	1250	12	11	6
396.2	1300	12	10	6
411.5	1350	12	10	5
426.7	1400	11	10	5
442	1450	11	9	5
457.2	1500	11	9	5
472.4	1550	10	9	5
487.7	1600	10	9	5
502.9	1650	10	8	5
518.2	1700	10	8	4
533.4	1750	9	8	4
548.6	1800	9	8	4
563.9	1850	9	8	4

Total Maximum Daily Loads for the Willamette Subbasins

Water Quality Management Plan

Temperature

Amended to include the Willamette River and major tributaries - DRAFT

August 2024

State of Oregon
DEQ Department of Environmental Quality

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1. Introduction

DEQ provides this Water Quality Management Plan to guide implementation of the temperature Total Maximum Daily Load developed for 10 subbasins of the Willamette River Basin and the mainstem Willamette River(Figure 1, TMDL Figure 2-1). A WQMP is an element of a TMDL, as described by Oregon Administrative Rule 340-042-0040(4)(l), to guide implementation of management strategies to attain and maintain water quality standards. Each WQMP will guide the preparation of detailed TMDL implementation plans prepared by responsible persons including Designated Management Agencies.

This temperature WQMP will be proposed for adoption by Oregon's Environmental Quality Commission, by reference, into rule as OAR 340-042-0090(c)(B). This WQMP is intended to provide comprehensive information for implementation of the temperature TMDL, and will be amended, as needed, upon issuance of any future TMDLs within the Willamette Basin. Any subsequently amended or renumbered rules cited in this document are intended to apply.

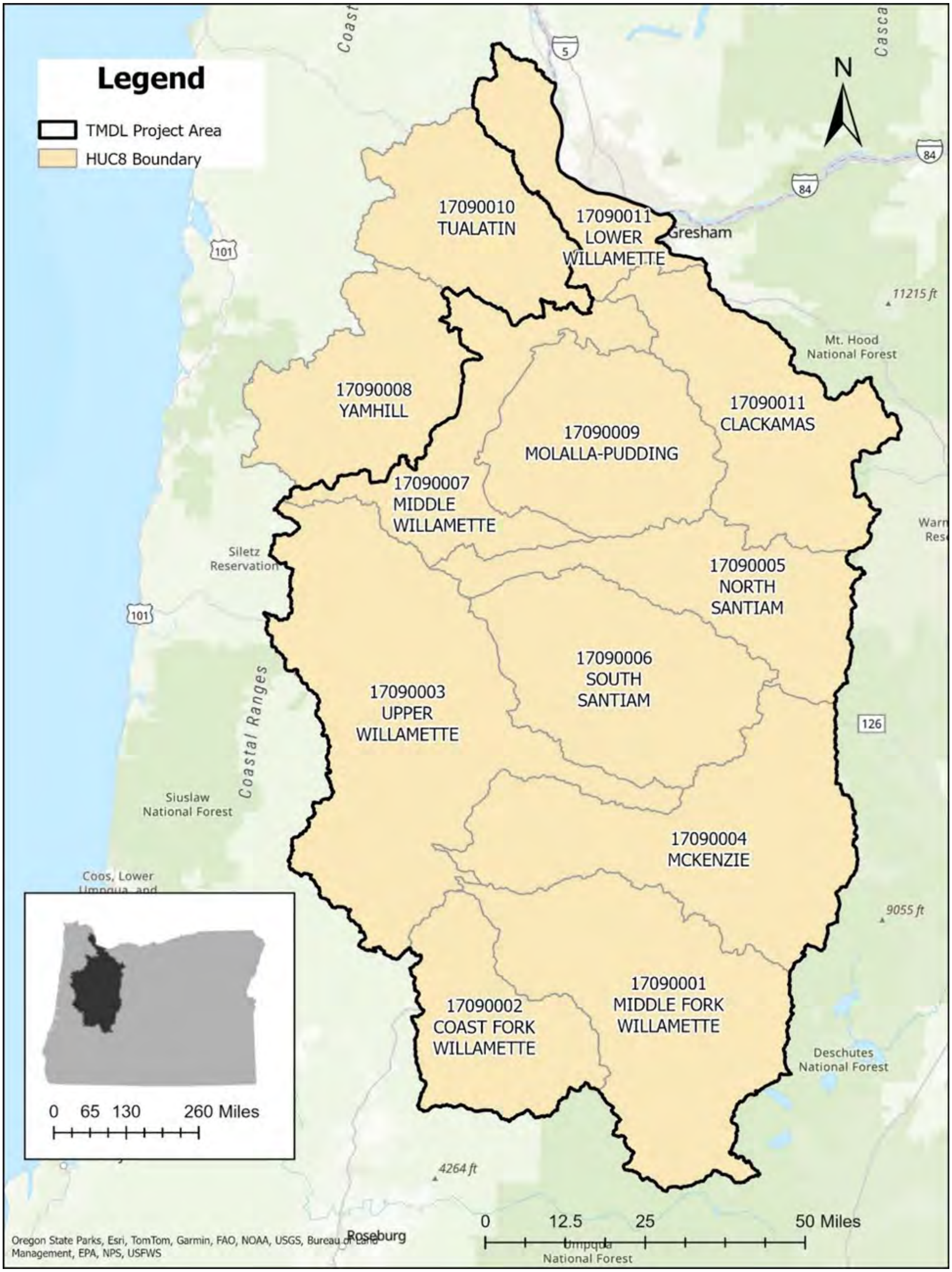

Figure 1 Map of Willamette HUC8 Subbasins.

The Willamette River Basin encompasses twelve subbasins. EPA previously approved three of DEQ's temperature TMDLs covering eleven of the twelve subbasins, as listed below in order of the issuance year. However, in 2013, EPA disapproved the Natural Conditions Criterion contained in Oregon's water quality standard for temperature due to the 2012 U.S. District Court decision for Northwest Environmental Advocates v. EPA. On October 4, 2019, the U.S. District Court issued a judgment in the lawsuit requiring EPA and DEQ to reissue 15 Oregon temperature TMDLs that were based on the Natural Conditions Criterion, including the Lower Columbia-Sandy Subbasin.

1. Molalla-Pudding Subbasin TMDL (2008)
2. Willamette Basin TMDL (2006)
    - Clackamas Subbasin
    - Coast Fork Willamette Subbasin
    - Lower Willamette Subbasin
    - McKenzie Subbasin
    - Middle Fork Willamette Subbasin
    - Middle Willamette Subbasin
    - North Santiam Subbasin
    - South Santiam Subbasin
    - Upper Willamette Subbasin
3. Tualatin Subbasin TMDL (2001)

This TMDL replaces the listed temperature TMDLs except for the Tualatin Subbasin TMDL, which remains in effect for temperature and other pollutants. The Tualatin TMDL did not use the natural conditions criteria to develop TMDL allocations and therefore is not required to be replaced as part of the federal court order to replace the 2006 and 2008 Willamette Basin and Molalla-Pudding temperature TMDLs. The Yamhill subbasin is the 12th subbasin and is not included in this TMDL because it was not included in the 2006 temperature TMDLs and is not under court order to be developed.

This TMDL applies to all waters of the state in the subbasins listed in Table 1. The subbasins and associated waterbodies listed in Table 1 will hereafter be referred to as the "Willamette Subbasins."

Table 1: Waterbodies included in Willamette Subbasins TMDL.

Subbasin	Waterbodies Included
1. Clackamas	All waters of the state in the Clackamas Subbasin
2. Coast Fork	All waters of the state in the Coast Fork Willamette Subbasin
3. Lower Willamette	All waters of the state in the Lower Willamette Subbasin
4. McKenzie	All waters of the state
5. Middle Fork	All waters of the state in the Middle Fork Willamette Subbasin
6. Middle Willamette	All waters of the state in the Middle Willamette Subbasin
7. Molalla-Pudding	All waters of the state
8. North Santiam	All waters of the state in the North Santiam Subbasin
9. South Santiam	All waters of the state in the South Santiam Subbasin
10. Upper Willamette	All waters of the state in the Upper Willamette Subbasin

11. Mainstem Willamette River	From the confluence of the Columbia River upstream to the confluence of the Coast Fork Willamette River and the Middle Fork Willamette River

Section 2 of the Willamette Subbasins Temperature TMDL Rule contains a listing of all Category 5 temperature impairments from the 2022 Integrated Report (DEQ, 2024). The TMDL Technical Support Document (TSD) contains a complete listing of all the Assessment Units included in this rulemaking (DEQ, 2024a).

1.1 Condition assessment and problem description

The first element of the WQMP according to OAR 340-042-0040(4)(l)(A) is an assessment of water quality conditions in the Willamette Subbasins with a problem description. There are assessment units in the Willamette Subbasins listed as impaired (category 5 or 4A) for temperature in Oregon's 2022 Integrated Report, which was approved by the U.S. Environmental Protection Agency on September 1, 2022.

DEQ must develop TMDLs for pollutants causing temperature impairments of waters within the Willamette Subbasins, as required by Section 303(d) of the federal Clean Water Act. These pollutants are solar radiation and heat from various sources and conditions that cause water temperatures to exceed criteria established to support aquatic life beneficial uses.

1.2 Goals and objectives

OAR 340-042-0040(4)(l)(B) requires identification of the goals and objectives of the WQMP. The goal of this WQMP is to provide an implementation framework for this Willamette Subbasins temperature TMDL. Implementing the TMDL is designed to achieve and maintain the temperature water quality criteria, including narrative criteria, and meet antidegradation requirements in streams within the Willamette Subbasins. The primary objectives of this WQMP are to describe responsibilities for implementing TMDL management strategies and actions necessary to reduce excess pollutant loads to meet all TMDL allocations, and to provide a strategy to evaluate progress towards attaining water quality standards throughout the Willamette Subbasins.

2. Proposed Management Strategies

The following section presents proposed management strategies, by pollutant source and activity, that are designed to meet the load and wasteload allocations required by the Willamette Subbasins temperature TMDL, as required by OAR 340-042-0040(4)(l)(C).

OAR 340-042-0030(6) defines management strategies as "measures to control the addition of pollutants to waters of the state and includes application of pollutant control practices, technologies, processes, siting criteria, operating methods, best management practices or other alternatives."

2.1 Streamside vegetation management strategies

DEQ's water quality analysis and modeling show that streamside vegetation planting and management are the strategies necessary to meet water quality standards in the temperature impaired sections of streams in the Willamette Subbasins. Streamside overstory vegetation reduces solar radiation loads to streams by providing shade. Protecting and restoring streamside overstory vegetation is essential to achieving the TMDL surrogate measure of effective shade. More information about the physical and ecological factors affecting effective shade can be found in Section 9.3 of the TMDL Technical Support Document.

The primary streamside vegetation planting and management strategies are summarized as follows:

1. **Vegetation planting and establishment**
   This strategy restores locations that have little or no shade producing overstory vegetation. These locations are important for streamside tree and shrub planting projects. These sites may currently be dominated by invasive species.

2. **Vegetation protection (enhancement, maintenance and growth)**
   This strategy addresses streamside areas that have existing vegetation that needs to be protected from removal to maintain current shade levels. In some cases, protection is needed because effective shade can only be achieved with additional growth. Protecting and maintaining existing vegetation ensures that it can grow and mature, enhances vegetation success and survival, and provides for optimal ecological conditions.

3. **Vegetation thinning and management**
   This strategy addresses streamside areas that might need vegetation density reduction to achieve optimal benefits of shade in the long term. Current site conditions at some riparian areas have been shown to be overly dense with trees or dominated by invasive species that inhibit a healthy streamside community, and thinning may be an option to promote development of a healthy mature streamside forest. However, it must be ensured that riparian thinning and management actions will result in limited (i.e., quantity, duration, and spatial extent) stream shade loss. TSD Appendix I presents material describing potential shade and temperature impacts resulting from riparian buffer management and actions to limit these effects.

2.2 Flow management strategies

DEQ's modeling and evaluation of water quality data and research (DEQ, 2024a) found that water withdrawals decrease the capacity of streams to assimilate pollutant loads. Because temperature is a flow-related parameter, water withdrawals can result in increased pollutant concentrations and warmer stream temperatures. In waterbodies where temperatures are already known to exceed standards, further withdrawals from the stream will reduce the stream's assimilative capacity and cause greater fluctuation in daytime and nighttime stream temperatures.

Water conservation is a best management practice that directly links the relationship between water quantity and water quality. Leaving water instream functions as a method to protect water quality from flow-related parameters of concern, such as temperature. Under state law, the first person to file for and obtain a water right on a stream is the last person to be denied water in times of low stream flows. Therefore, restoration of stream flows may require establishing instream water rights. One way this can be accomplished is by donating or purchasing out-of-stream rights and converting these rights to instream uses.

2.3 Hydromodification management strategies

Hydromodification refers to alterations of natural hydrological processes which affect characteristics of a waterbody and impact water quality. Examples of hydromodification in streams include human activities such as modifying stream channel morphologic attributes such as width, depth and course, construction and operation of dams and impoundments for flood control, drinking water, recreation, irrigation, and other uses, as well as activities meant to restore and protect streams. These activities can change the loading, timing, and delivery of nonpoint source pollutants, including thermal pollution (EPA, 2007).

Hydromodification activities that alter channel morphology can impact stream temperature (Galli and Dubose, 1990), e.g., wide, shallow streams allow solar radiation to increase stream temperature compared to narrower and deeper channels (Larson and Larson,1996). Activities that make streams more prone to erosion, such as uncontrolled livestock access, can also result in shallower streams and increased stream temperatures. As streambanks erode and slough, sediments can accumulate on the bottom of the stream, which reduces stream depth. Established riparian vegetation is frequently lost, reducing the shade provided to a stream (EPA, 2007). Channelization is another hydromodification activity that impacts channel morphology. Channelization disconnects streams from their floodplains through activities such as urban development or road construction. Streams that have been disconnected from floodplains are not able to slow and store floodwaters during the rainy season or recharge groundwater to support summer flows, factors that increase summer stream temperatures (EPA, 2017).

Management of hydromodification activities to prevent stream temperature increases can include BMPs for point and nonpoint source discharges like riparian restoration, livestock fencing, flow augmentation, reservoir operations, and projects including instream channel restoration. Note that permits are often needed to conduct stream restoration work involving removal and fill activities, and to ensure activities occur during the in-water work period to avoid harming fish. In addition, responsible persons including DMAs need to conduct site-specific evaluations of streams to determine what specific channel modifications are appropriate to meet the desired future condition. For more information about hydromodification sources and impacts, see EPA's *National Management Measures to Control Nonpoint Source Pollution from Hydromodification* (EPA, 2007), as well as a DEQ study, *Water Temperature Impacts from In-Channel Ponds in Portland Metro and Northwest Region* (DEQ, 2023b).

2.3.1 Large dam owners and reservoir management

There are approximately 206 reservoirs located within the Willamette Subbasins temperature TMDL project area that are large enough to require evaluation for dam safety. DEQ compiled this basic list of 206 dams from the U.S. Army Corps of Engineers (USACE) National Inventory of Dams (NID) database and a similar database maintained by the Oregon Water Resources Department (OWRD), dam safety program (see Appendix E). The OWRD prescribes dam safety rules that apply to dams 10 feet or higher, or store 9.2 acre-feet or more (OAR 690-020-0000). "Dam" means a hydraulic structure built above the natural ground line that is used to impound water. Dams include all appurtenant structures, and together are sometimes referred to as "the works". Dams include wastewater lagoons and other hydraulic structures that store water, attenuate floods, and divert water into canals. Where possible, DEQ removed reservoirs from this list that were not relevant to the TMDL, such as treatment lagoons or reservoirs not connected to a waterbody.

Dams of all sizes can increase stream temperatures, depending on factors that include dam and stream characteristics, location, and density of dams in a watershed. For these reasons, DEQ expects all dam owners to manage their reservoirs to meet water quality standards, including standards for temperature. For details on reservoir operator implementation requirements, see Section 5.3.7.

2.4 Summary of nonpoint source priority management strategies

Table 2 includes proven strategies (and practices within the strategies) summarized by pollutant source. These strategies and practices are adapted from published sources. DEQ used the categories and terminology from Oregon Watershed Enhancement Board's Oregon Aquatic Habitat Restoration and Enhancement Guide and Oregon Watershed Restoration Inventory Online List of Treatments. Additional strategies included in Table 2 are supported by Oregon Department of Agriculture, the U.S. Department of Agriculture Natural Resources Conservation Service, Oregon State University Extension Service, Oregon Plan for Salmon and Watersheds, and other available published sources. DEQ identified the strategies in Table 2 as appropriate for the conditions and sources within the subbasins. These are considered priority strategies and practices that should receive special focus during TMDL implementation plan development.

DEQ expects that entities identified in Section 5.1 will include strategies and practices listed in Table 2 that are applicable to their jurisdiction in their implementation plans. Implementation plans must include specifics on where and when priority and other strategies and practices will be applied. Implementation plans must also include measurable objectives and milestones to document efficacy of each strategy and practice. See Section 5.3.4.1 for methods for determining where land conditions require restoration, protection, and enhancement.

Although not specifically detailed in this WQMP, climate change is another important factor affecting stream temperature. Potential climate change impacts to waterbodies in Oregon may include:

- higher air temperature;
- decreased snowpack leading to less water in reservoirs, streams and groundwater; and
- large-scale wildfires, which can reduce effective shade in streamside areas.

Table 2: Priority temperature management strategies by source.

Pollutant	Source or Activity	Management Strategies
Heat or thermal loading	Insufficient riparian vegetation height, density or width	The primary goal is to increase site effective shade (combination of vegetation height, buffer width and canopy density) through streamside vegetation management strategies using regulatory programs and voluntary activities, including incentive-based projects. Streamside tree planting (conifer and hardwood); streamside vegetation planting (shrub or herbaceous cover); streamside vegetation management (invasive thinning, removal or other treatment); voluntary streamside tree retention; streamside invasive plant

		control; streamside fencing or other livestock streamside exclusion methods; identify and protect cold water refuges Maintain plants until free to grow; monitor survival rates. Develop, update and/or enforce streamside code/ordinance to ensure streamside native vegetation and intact bank conditions are protected or restored following site development; purchase, acquire, designate conservation easements along streamside areas.
	Water withdrawals, flow alteration	Pursue instream water right transfers and leases; water right application reviews; irrigation conservation and management; repair or replace leaking pipes and infrastructure; provide incentives for water conservation; implement water consumption restrictions during the summer months, such as lawn watering
	Channel modification and hydromodification	Conduct whole channel restorations (e.g., enhance channel, wetlands, and floodplain interactions, reduce width-to-depth channel ratios, bank stabilization, large wood placement, create/connect side channels, etc.); streamside road re-construction/obliteration activities; streamside fencing or other livestock exclusion methods; protect and enhance cold water refuges; remove in-channel ponds or modify pond structures to reduce temperature increases downstream; and protect areas that don't require restoration actions
	Dam and reservoir management	Modifications to the quantity and nature of water releases to meet water quality standards for temperature

2.5 Point source priority management strategies

Point sources may be assigned wasteload allocations and/or other requirements under the TMDL. These point sources are required to have National Pollutant Discharge Elimination System (NPDES) permits for any wastewater discharges. Under federal rules, effluent limits within NPDES permits are required to be consistent with the assumptions and requirements of any available wasteload allocation.

The primary way DEQ addresses numeric wasteload allocations is by including effluent limits in permits (though different mechanisms may be used if they are consistent with the TMDL). There are many ways to achieve compliance with these limits and requirements, which can be incorporated into NPDES permits during renewal or issuance. These include, but are not limited to, immediate compliance with the limits, the use of compliance schedules, water quality trading, and other pathways allowed under state and federal rules.

2.6 Water Quality Trading Opportunities

DEQ encourages Willamette Basin DMAs to develop water quality credit trading plans that meet the TMDL allocations for the Willamette Subbasins. Water quality trading is a well-established feature of TMDL implementation in Oregon that is designed to achieve water quality goals more efficiently and with enhanced outcomes. Trading is allowed statewide so long as the requirements of OAR 340-039 are met. Trading is based on a more holistic understanding that pollutant sources are distributed throughout a watershed, and that eliminating these pollutant sources benefits the entire watershed. Trading programs allow facilities to meet their regulatory obligations by exchanging environmentally equivalent (or greater) pollution reductions from sources elsewhere in a watershed. Trading in Oregon includes the use of green infrastructure, which has the additional benefits of enhancing the resilience of natural systems to the effects of climate change. Many trading plans can achieve the higher levels of heat load reduction at a lower cost. For more information, please refer to DEQ's web page on water quality credit trading at http://www.deq.state.or.us/wq/trading/faqs.htm.

3. Timelines for Implementing Strategies

OAR 340-042-0040(4)(l)(D) requires schedules for implementing management strategies including permit revisions, achieving appropriate incremental and measurable water quality targets, implementing control actions and completing measurable milestones. DEQ's water quality permitting program has responsibility for revising permits to comply with TMDLs. Timelines for implementation of management strategies by responsible persons including DMAs is discussed separately.

3.1 DEQ permit revisions

NPDES permits have five-year terms. Appendix D includes a list of permit holders located within the project area that have NPDES permits, as well as the next expected permit renewal date. DEQ incorporates any required TMDL wasteload allocations into NPDES permits when the permit is renewed.

3.2 Management strategies implemented 2007- 2021 by responsible persons including DMAs

DEQ uses multiple sources to establish current conditions and track implementation progress in the Willamette Subbasins project area. One of these sources is the Oregon Watershed Enhancement Board's Oregon Watershed Restoration Inventory which is a repository for watershed restoration activities. OWRI contains project level information from watershed councils, landowners and other groups who have implemented restoration projects to improve aquatic habitat and water quality conditions. Stream temperature projects in OWRI that have been implemented in the Willamette Basin include riparian fencing, channel modification, voluntary riparian tree retention, dam management and others. The OWRI database reflects 183 total miles of riparian area planted in the Willamette Basin between 2007 and 2021 including 161.6 miles of conifer and hardwood, 13.9 miles of hardwood and 7.4 miles of conifer.

Another resource to track implementation progress is the Willamette Basin Year Five Report, which summarizes data and information submitted to DEQ by DMAs. DMA reporting during for the 2013-2018 period documented 17.3 total linear miles of streamside trees planted in the Willamette Basin. There were also 0.7 miles planted in the Molalla-Pudding Subbasin from 2016-2021, which had a separate Year Five Report completed. DEQ did not collect total linear miles of streamside trees planted by DMAs in the 2013 Year Five Report. Additionally, DEQ did not collect information from DMAs on linear feet or acres of streamside land acquisitions, which is an important strategy in protecting water quality. Some of the data reported in the Year Five Reviews may have also been included in the OWRI data.

Note that the number of miles of streamside trees planted reported above in the Willamette Basin Year Five Report includes the Tualatin Basin, which is not included in the Willamette Subbasins TMDL.

DEQ also utilized effective shade gap modelling to assess current conditions within the project area. Where DEQ completed modeling for this TMDL, effective shade targets were calculated at 25-meter node intervals (Lower Willamette model area) and 200-meter node intervals (Southern Willamette model area) for each waterbody. A mean effective shade was then calculated for DMAs where this modeling occurred, and a shade gap assessment was completed. The shade gap results for the modeled areas include shade conditions that may have been impacted by streamside planting projects that were completed following the approval of the 2006 Willamette Basin Temperature TMDL.

While DEQ was not able to directly quantify the impact that planting projects documented in OWRI and the DEQ Willamette Basin Year Five Report had on modeled streamside shade gaps, available data indicate that the pace and scale of streamside planting will need to increase to meet the shade target timelines in Table 3.

3.3 Timeline for implementation of management strategies

This section of the WQMP includes an estimate of the timeline for implementation of management strategies that will be sufficient to attain water quality standards.

For solar radiation, excess pollutant load is quantified in kilocalories/day units (kcal/day), whereas effective shade percent is the primary surrogate measure used in this TMDL. DEQ developed timelines to meet water quality standards based on the assumptions that responsible persons including DMAs will consistently implement the three primary streamside vegetation strategies in Section 2.1 until the streamside vegetation class reaches a mid-seral stage conifer-deciduous mix or equivalent characteristics. For this timeline, DEQ also assumed:

- No measurable existing overstory vegetation is removed, thereby reducing the current shade condition;
- Overstory vegetation continues to grow, consistent with average conifer and deciduous growth curves for this portion of the Willamette Basin; and
- Associated effective shade is produced at a rate commensurate with tree growth without significant disturbance (Means and Helm, 1985).

Significant uncertainty exists in meeting timelines for establishing shade. DEQ completed a shade gap assessment covering approximately 21,483 stream kilometers of the Willamette

Subbasins project area. This assessment showed that 9,607 stream kilometers currently have an effective shade gap between 15 and 100 percent. For this analysis, DEQ assumes that both current effective shade gaps and future implementation rates will be consistent across assessed and non-assessed areas of the Willamette Subbasins.

Estimating timeframes for meeting the percent effective shade targets across the project area is influenced by several factors:

- The project area is large and the percent effective shade targets to be met are developed at a small scale (i.e., 25- and 200-meter increments) or through shade curves.
- A shade gap analysis is unavailable for all streams in the Willamette Basin to gauge what percent of streamside areas across the Willamette Subbasins area are not currently meeting effective shade targets.
- DEQ is unable to determine whether the rate of planting that has occurred over the past 16 years would be similar to planting efforts following the adoption of this TMDL.
- DMAs that have a large percentage of private property within their jurisdiction will have challenges in meeting effective shade targets. It will likely take additional time to develop more protective streamside ordinances or regulations, work with landowners, or partner with other organizations to conduct streamside planting and restoration projects in these areas.
- It is unclear how much future planting will be targeted in priority shade gap areas given that some planting projects are opportunistic in nature.
- The scale of implementation, location, and water quality benefits from future in-stream restoration and flow augmentation projects are unknown.
- The effects of climate change and invasive species on streamside tree assemblages is unknown. For example, the emerald ash borer, which is now present in Oregon, could result in fewer ash species found in streamside areas.
- Frequency and magnitude of natural disturbances such as wildfires.

DEQ expects responsible persons including DMAs to consider the timeline projections and interim targets presented in Table 3 in establishing commitments for streamside planting and protection in TMDL implementation plans. Based on DEQ analysis of the number of stream miles that will need restoration, and the pace of restoration logged in OWRI over the previous years of implementation, restoration rates will need to accelerate to meet the targets below. Timelines for attainment of percent cumulative effective shade were estimated based on time for trees to grow to heights sufficient to provide effective shade, and considers the factors and assumptions described above. This equates to meeting 10 percent of shade targets across the basin every 10 years beginning in 2030 and meeting all shade targets in 90 years. Meeting shade targets on all waterbodies may not be possible due to various factors, for example natural disturbances, the built environment, and private streamside ownership.

Table 3: Timelines to meet percent shade targets in the Willamette Subbasins TMDL in 10-year increments.

Assessment Year	Percent Cumulative Shade Targets Met in Willamette Subbasins TMDL
2030	10%
2040	20%
2050	30%

2060	40%
2070	50%
2080	60%
2090	70%
2100	80%
2110	90%
2120	100%

4. Attaining Water Quality Standards

Based on TMDL analyses, achieving the excess load reductions identified will result in attainment of water quality standards. Each management strategy identified in this WQMP, and in implementation plans provided by responsible persons including DMAs, represents part of a system of measures and practices that collectively reduce pollutant loads and improve water quality.

4.1 How management strategies support attainment of water quality standards

OAR 340-042-0040(4)(l)(E) requires an explanation of how implementing the management strategies will result in attainment of water quality standards.

DEQ identified priority implementation management strategies and specific practices in Table 2 and Section 2.1. DEQ expects these strategies and practices to increase site effective shade and address the excess solar radiation and shade deficits calculated along streams within the Willamette Subbasins (see Section 8 of the TMDL Rule). DEQ focused on the three vegetation strategies described in Section 2.1 to identify timelines for achieving surrogate effective shade targets in Table 3, and by extension solar radiation load reductions to meet temperature water quality standards.

DEQ developed site-specific effective shade targets and effective shade curves to meet temperature load allocations in the TMDL Rule (Section 9 in the TMDL Rule). Shade curves identify the relationship between stream width, orientation, and effective shade for specific streamside vegetation types. Effective shade curves are applicable to any stream that does not have site specific shade targets. Effective shade curves represent the maximum possible effective shade for a given vegetation type.

Landowners, foresters, restoration professionals and horticulturists have expertise and experience needed to develop site-specific planting prescriptions that will ensure that the best combination of streamside species are planted. These site-specific planting prescriptions will typically contain a higher diversity of shrub and overstory species than the vegetation types used in developing the shade curves. The overall goal is to establish and protect streamside vegetation to meet effective shade targets established for that site. Maintenance activities, such as removal of invasive species and watering newly established trees and shrubs will be important for trees to become fully established (free to grow).

In addition to streamside shading strategies, significant water quality benefits will be achieved through implementation of stream restoration and flow augmentation management strategies.

4.2 Timelines for attaining temperature water quality standards

OAR 340-042-0040(4)(l)(F) requires an estimated timeline for attaining water quality standards through implementation of the TMDL, WQMP and associated TMDL implementation plans. Based on DEQ's source assessment and TMDL analyses (Section 7.2 in the TSD), nonpoint sources contribute nearly all of the excess solar radiation pollutant loading associated with temperature impairments in the Willamette Subbasins TMDL. Therefore, it is critical for nonpoint sources to make timely progress toward reducing anthropogenic pollutant loads to meet the TMDL load allocations.

The TMDL calculates NPS load allocations using a percent effective shade surrogate. Therefore, estimated timelines to meet water quality standards are primarily based on streamside planting activities, although stream channel restoration and increasing instream flows would also improve stream temperature conditions. Based on the timeline to meet effective shade targets shown in Table 3, temperature water quality standards for the Willamette Subbasins will be met by 2120. Any uncertainty associated with this date stems from unknowns related to current conditions, the potential for natural disturbances and the pace of future restoration activities. Achieving the identified timelines for cumulative effective shade and resulting water quality benefits will require active participation from all responsible persons including DMAs within the basin.

5. Implementation Responsibilities and Schedule

5.1 Identification of implementation responsibility

OARs 340-042-0040(4)(I)(G) and 340-042-0080(1) require identification of persons, including Designated Management Agencies, responsible for implementing management strategies and preparing and revising implementation plans.

OAR 340-042-0030(2) defines Designated Management Agency as a federal, state or local governmental agency that has legal authority over a sector or source contributing pollutants and is identified as such by DEQ in a TMDL.

The TMDL rule provides numerous mentions of the term 'responsible person' with associated requirements. OAR 340-042-0025(2) indicates that responsible sources must meet TMDL load allocations through strategies developed in implementation plans. OAR 340-042-0030(9) defines ‘reasonable assurance’ as a demonstration of TMDL implementation by governments or individuals. OARs 340-042-0040(4)(l)(G) requires identification of persons, including DMAs, responsible for developing and revising implementation plans. OAR 340-042-0040(4)(l)(I) requires a schedule for submittal and revision of implementation plans by responsible persons including DMAs. OAR 340-042-0080(4) reiterates the requirement for persons, including DMAs, responsible for development, submittal and revision of implementation plans, along with the required elements of those plans. For purposes of this Willamette Subbasins WQMP, for implementation of the temperature TMDLs, ‘responsible person’ is defined as any entity responsible for any source of pollution addressed by the TMDL.

Responsible persons including DMAs are organized by DMA type in the following subsections. These persons are responsible for developing or revising implementation plans and implementing management strategies to achieve the TMDL allocations. A complete list of responsible persons including DMAs for the Willamette Subbasins Temperature TMDL is in Appendix A. There are 135 responsible persons including DMAs such as cities, counties, federal and state agencies, and other entities.

Appendix A is not an exhaustive list of every individual that bears responsibility for improving water quality in the Willamette Subbasins. It may be necessary for all people that live, work, and recreate in the basin to take steps to reduce pollution and protect or restore water quality to attain standards and protect the designated beneficial uses.

As shown in Figure 2 and Figure 3 four DMAs manage or own the bulk of the land area referenced in the Willamette Subbasins Temperature TMDL. Figure 2 illustrates the estimated land area owned or managed by these entities, and Figure 3 shows the percentage of estimated acres that are within 150 feet of a stream for these DMAs. Appendix A contains jurisdictional acres associated with many DMAs, however, that information was not available for all responsible persons including DMAs. Appendix B and Appendix C contain further information divided by subbasin and show jurisdictional area of each DMA by subbasin and within 150 feet of a stream.

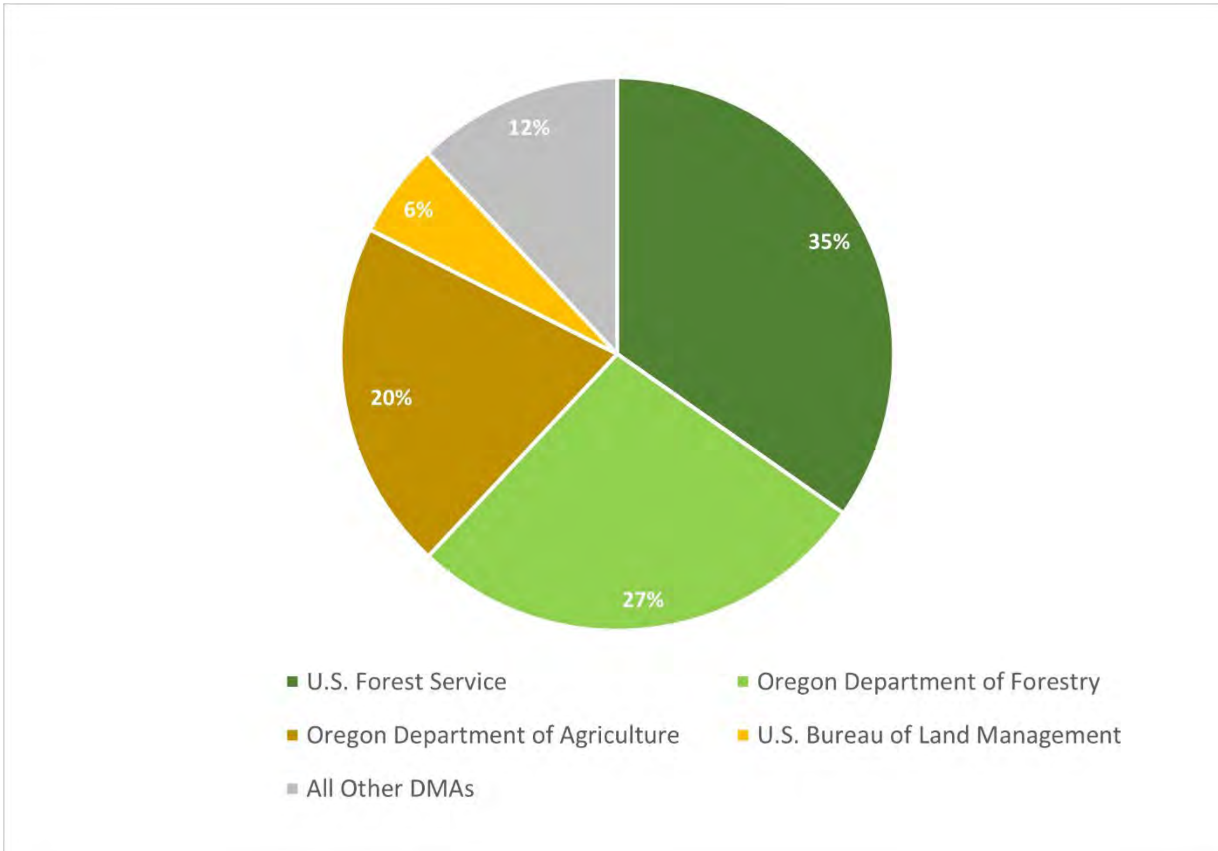

Figure 2: Percent estimated acres owned or managed by responsible persons including DMAs in Willamette Subbasins TMDL.

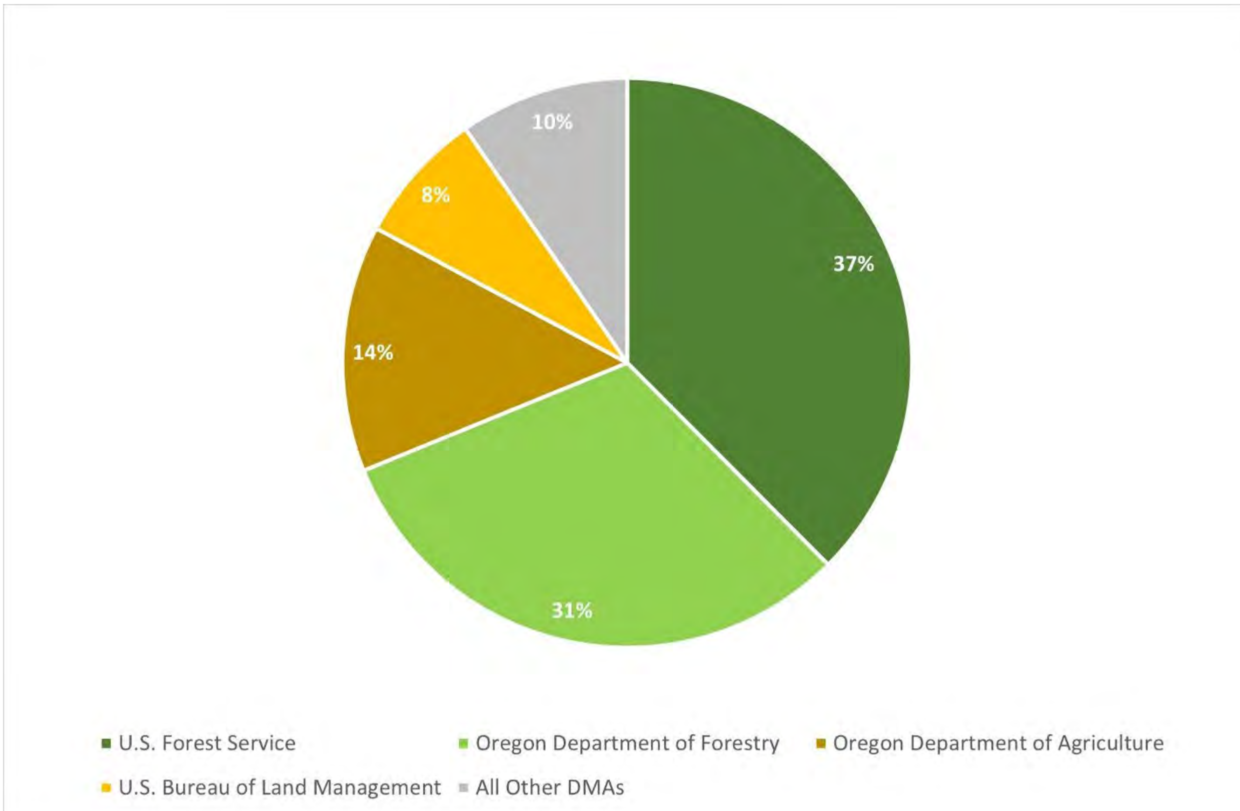

Figure 3: Percent estimated acres owned or managed by responsible persons including DMAs 150 feet from stream centerline.

5.1.1 Responsible persons including DMAs not required to develop a TMDL implementation plan

Some responsible persons including DMAs will not be required to submit implementation plans at this time for the following reasons:

1) Responsibilities are covered under the Tualatin Temperature TMDL.
2) Does not have ownership or jurisdiction over land management activities within the streamside area, so they are unable to implement actions identified in
3) Table 2 in this WQMP.
4) Other implementation pathway:
    a. Area is managed by other authorities already required to develop a plan.
    b. Water protection actions are implemented through permits (e.g., DOGAMI).
5) Has limited ability or opportunity to conduct stream restoration activities (e.g., railroads).
6) Has limited streamside area under its jurisdiction (generally less than 7 acres within 150 feet of a stream in the entire project area).

Table 4 identifies the entities that are named as responsible persons including DMAs in this TMDL that are not required to develop and submit an implementation plan at this time. DEQ may require implementation plans from these entities in the future if ownership or jurisdiction of streamside areas increases, or other data or information indicates a TMDL implementation plan is needed to achieve temperature allocations and shade targets identified in this TMDL. DEQ may revise the WQMP or issue individual orders to notify them of the required schedule for submitting an implementation plan.

Table 4: List of Responsible Persons including Designated Management Agencies for which no TMDL implementation plan is required at this time.

No.	Responsible Persons including Designated Management Agencies	DMA Type
1	Tualatin	City
2	McMinnville	City
3	Curry County	County
4	Lincoln County	County
5	Washington County	County
6	Bonneville Power Administration	Federal
7	Pacific Power and Light	Private Utility
8	Portland Terminal Railroad Company	Railroad
9	Vennel Farms Railroad Company	Railroad
10	Willamette Shore Trolley	Railroad
11	Oregon Pacific Railroad	Railroad
12	BNSF Railway	Railroad
13	Central Oregon & Pacific Railroad	Railroad
14	TriMet	Railroad
15	Willamette Valley Railway	Railroad
16	Albany & Eastern Railroad	Railroad
17	Port of Coos Bay	Railroad
18	Portland & Western Railroad	Railroad
19	Union Pacific Railroad	Railroad
20	Ash Creek Water Control District	Responsible Person
21	East Valley Water District	Responsible Person
22	Santiam Water Control District	Responsible Person
23	West Labish Water Control District	Responsible Person
24	Palmer Creek Water District Improvement Co.	Responsible Person
25	G A Miller Drainage District No 1	Responsible Person
26	Sidney Irrigation District	Responsible Person
27	Hawn Creek District Improvement Co.	Responsible Person
28	Creswell Water Control District	Responsible Person
29	Creswell Irrigation District	Responsible Person
30	East Valley Water District	Responsible Person
31	Fertile Improvement District	Responsible Person
32	Grand Prairie Water Control District	Responsible Person
33	Junction City Water Control District	Responsible Person
34	Lacomb Irrigation District	Responsible Person
35	Lake Labish Water Control District	Responsible Person
36	Muddy Creeks Irrigation Project	Responsible Person
37	Multnomah County Drainage District	Responsible Person
38	North Lebanon Water Control District	Responsible Person
39	Peninsula Drainage District #1	Responsible Person
40	Peninsula Drainage District #2	Responsible Person
41	Sauvie Island Drainage Improvement Company	Responsible Person
42	Scappoose Drainage Improvement Company	Responsible Person
43	Oregon Department of Environmental Quality	State
44	Oregon Department of State Lands	State

45	Oregon Department of Geology and Mineral Industries	State

5.2 Existing implementation plans

OAR 340-042-0040(4)(l)(H) requires identification of any source or sector-specific implementation plans available at the time of TMDL issuance. Following the issuance of the 2006 Willamette Basin and 2008 Molalla-Pudding TMDLs and WQMPs, DEQ required responsible persons including DMAs to develop implementation plans that included specific management strategies and best management practices to meet load allocations for temperature. Reporting requirements for many of these entities included an annual progress report and a comprehensive assessment of activities every five years. For information on each DMA, including which DMAs are existing DMAs, see Appendix A. DEQ notes that not all existing DMAs have DEQ-approved TMDL implementation plans. Existing DMAs will need to update their current implementation plans for temperature to ensure any new requirements in this WQMP are met.

In addition, certain statewide rules, programs and management plans for forestry and agriculture are intended, in part, to reduce or control nonpoint sources of pollution. The programs described in OAR 340-042-0080(2) and (3), respectively, represent existing implementation plans for non-federal forest and agricultural lands, and their sufficiency is discussed below.

5.2.1 Oregon Department of Forestry: Adequacy of Forest Practices Act to meet TMDL load allocations

Waterway protection measures were established in 1994 for state and private forest practices in Oregon, as codified in Oregon Revised Statutes 527.610 through 527.992, Oregon's Forest Practices Act (OAR 629-600 through 629-665) and Oregon's Plan for Salmon and Watersheds (Executive Order 99-01). As provided in ORS 527.770, forest operations conducted in accordance with the Forest Practices Act and other voluntary measures are generally considered to be in compliance with water quality standards. However, as provided in OAR 340-042-0080(2), revisions to the Forest Practices Act rules may be required when DEQ determines that these rules are not adequate to implement load allocations in an approved TMDL.

Periodic revisions to the Forest Practices Act rules occurred between the 1990s through 2022. With the publication of the Private Forest Accord Report and subsequent passage of Senate Bill 1501, 1502 and HB 4055, Forest Practices Act rule revisions were adopted by the Board of Forestry in October 2022 and additional amendments are anticipated through 2025. Implementation of these rules, including increased riparian widths and additional tree retention, may be effective at meeting shade allocations. The streamside vegetation retention and riparian management area distances in the current Forest Practices Act are summarized in Table 5 below. There are multiple other requirements or exceptions found in the forest practice rules not included in the table.

Table 5: Summary streamside vegetation retention riparian management area distances in Forest Practices Act rules OAR 629-643.

ODF Stream Type*	Standard Practice Vegetation Retention (Feet)	Small Forestland Option Vegetation Retention (Feet)
Large Type SSBT	110	100

Medium Type SSBT	110	80
Small Type SSBT	100	60
Large Type F	110	100
Medium Type F	110	70
Small Type F	100	50
Large Type N	75	70
Medium Type N	75	50
Small Type N	See Type Np	See Type Np
Small Type Np flows into to Type SSBT	75 feet vegetation retention for 500 feet upstream from the confluence with the Type SSBT, then 50 feet buffer retention for 650 feet upstream. Retention distance is the shorter of 1,150 feet (RH Max+) or the uppermost flow feature.	35 feet vegetation retention from the confluence with the Type SSBT to the upper most flow feature or 1,150 feet upstream (RH Max), whichever is shorter.
Small Type Np flows into to Type F	75 feet vegetation retention from the confluence with the Type F to the upper most flow feature or 600 feet upstream (RH Max), whichever is shorter.	35 feet vegetation retention from the confluence with the Type F to the upper most flow feature or 600 feet upstream (RH Max), whichever is shorter.
Small Type Ns	35' Equipment Limitation Zone (ELZ)	

***ODF Stream Type Definitions:**
SSBT—salmon, steelhead, or bull trout
F—fish-bearing (non-SSBT)
N—non-fish-bearing, non-domestic
Np—perennial, Type-N
Ns—seasonal, Type-N

+ "RH Max" means the maximum distance described for any particular small Type Np stream.

DEQ finds the no-harvest vegetation retention buffers of 100-110 feet (e.g. large SSBT, Large F, small and medium SSBT/F standard practice) may be sufficient to meet some shade targets, depending on density of residual trees, stream orientation, topography, and other site-specific factors (see TSD Appendix I). However, based on the findings in Appendix I, it is probable that in some cases these buffers will not provide shade equivalent to 120-foot no-harvest buffer. Smaller no-harvest buffers are progressively less likely to meet shade targets and more likely to result in temperature increases beyond the assigned TMDL human use allowance of (0.0°C) and equivalent load allocation for all fish-bearing and perennial non-fish-bearing streams. This is more pronounced for the Small Forestland Option. Adoption of forest conservation tax credits on small forestlands to align protections with standard practice will increase the effectiveness. Overall, required riparian protections under the Forest Practices Act are unlikely to consistently meet shade targets and load allocations. For these reasons, ODF is required to develop a TMDL implementation plan to be submitted to DEQ for review and approval. See Table 8 for the schedule.

As agreed, in the 2021 Memorandum of Understanding between DEQ and ODF, DEQ will work with ODF to identify additional regulatory or non-regulatory measures that could be implemented by rule revisions, stewardship agreements, incentive programs or other means to provide reasonable assurance of achieving TMDL solar radiation load allocations. Collaboration on these additional measures may occur during development of ODF's implementation plan.

5.2.2 Oregon Department of Agriculture: Adequacy of agricultural water quality management programs in attaining TMDL load allocations and effective shade surrogate measures

The Oregon Legislature passed the Agricultural Water Quality Management Act in 1993, which directed Oregon Department of Agriculture to adopt rules as necessary and to develop plans to prevent water pollution from agricultural activities (ORS 568.900 to 568.933 and ORS 561.191 and OAR chapter 603, divisions 90 and 95). Subsequently, ODA worked with Local Advisory Committees and Soil and Water Conservation Districts to develop Agricultural Water Quality Area Rules and Area Plans for 38 watershed-based management areas across the state.

The Willamette Subbasins TMDL includes eight ODA Agricultural Water Quality Management Areas that each have an Area Plan (TSD, Section 11). DEQ participates in ODA's Area Plan review process by providing water quality status and trends for each management area, as well as assessments of land conditions, agricultural activities and implementation gaps that likely contribute to water quality impairments. The Area Plans for the eight management areas included in this TMDL were reviewed by DEQ within the last three years, however not all reviews resulted in Area Plan revisions.

Willamette Basin streams continue to be identified as impaired on Oregon's Section 303(d) list for temperature in part due to the lack of adequate streamside vegetation in agriculturally influenced streamside areas (Section 9.1.2.1.1). DEQ's assessments of Area Plans identified protecting, maintaining and establishing streamside vegetation as a high priority to achieve TMDL load allocations. However, ODA's Area Plans lack specific measurable goals related to streamside conditions that will achieve TMDL shade measures.

The agricultural Area Rules and Area Plans that regulate and guide streamside management in the Willamette Subbasins TMDL project area do not identify quantitative targets for effective shade based on site specific factors, including stream width or orientation. DEQ also notes the disparity between ODA's implementation of their Area Rules for "site capable vegetation" in streamside areas and the streamside conditions needed to meet effective shade targets in this TMDL. ODA has not demonstrated that voluntary landowner implementation of Area Plans will bridge the gap between current conditions and what is needed to meet TMDL allocations.

DEQ concluded that current ODA WQ program Area Rules combined with implementation of Area Plans' voluntary measures are not adequate in all locations to meet the streamside vegetation requirements necessary to achieve TMDL effective shade targets, load allocations, and temperature water quality standards. Therefore, ODA is required to develop a TMDL implementation plan to be submitted to DEQ for review and approval. See Table 8 for schedule.

5.2.3 U.S. Bureau of Land Management: Adequacy of streamside management strategies in attaining TMDL load allocations and effective shade surrogate measures

Streamside vegetation on BLM managed lands in the Willamette Subbasins are currently managed based on BLM's Northwestern and Coastal Oregon Resources Management Plan (BLM, 2016).

BLM defines riparian management areas called ‘riparian reserves’ using slope distance from the ordinary high water line on each side of a stream. Slope distance is specific to different types of waterbodies as summarized in Table 6. The slope distance or *riparian reserve distance* is defined based on site-potential tree height. Site-potential tree height is the average maximum height of the tallest dominant trees (200 years or older) for a given site’s class. BLM states that site-potential tree heights generally range from 140 feet to 240 feet, depending on site productivity.

Management practices in riparian reserves varies, however, clearcut harvesting within the riparian reserve is prohibited. Some tree removal or thinning activities are allowed based on certain circumstances such as to protect public safety, or to keep roads and other infrastructure clear of debris. Tree removal for yarding corridors, skid trails, road construction, stream crossings and road maintenance or improvement are allowed where there is no operationally feasible and economically viable alternative. On fish bearing streams and perennial streams between 0- and 120-feet slope distance, there is no thinning except in cases of sudden oak death or for individual tree cutting or tipping that achieve restoration or habitat enhancement objectives. On intermittent, non-fish bearing streams, the same management strategy is applied but only from 0 to 50 feet.

Table 6: Summary of BLM riparian reserve buffer distance for different waterbody features.

Feature	Riparian Reserve Distance measured as slope distance
Fish-bearing streams and perennial streams	One site-potential tree height distance from the ordinary high water line or from the outer edge of the channel migration zone for low-gradient alluvial shifting channels, whichever is greatest, on each side of the stream
Intermittent, non fish-bearing streams	Class I and II subwatersheds: One site-potential tree height distance from the ordinary high water line on each side of the stream
	Class III subwatersheds: 50 feet from the ordinary high water line on each side of a stream
Unstable areas that are above or adjacent to stream channels and are likely to deliver material such as sediment and logs to the stream if the unstable area fails	The extent of the unstable area; where there is stable area between such unstable areas and a stream, and the unstable area has the potential to deliver material such as sediment and logs to the stream, extend the Riparian Reserve from the stream to include the intervening stable area as well as the unstable area
Lakes, natural ponds and reservoirs > 1 acres, and wetland > 1 acres	100 feet extending from the ordinary high water line
Natural ponds < 1 acres, wetlands < 1 acres (including seeps and springs), and constructed water impoundments (e.g. canal ditches and pump chances) of any size	25 feet extending from the ordinary high water line

DEQ finds that BLM’s streamside vegetation management strategies on fish-bearing streams and perennial streams are adequate and will likely lead to achievement of the TMDL load allocation and effective shade targets. Riparian reserves located on intermittent, non-fish bearing streams may not be adequate to achieve the load allocation or effective shade targets. Streamside management on intermittent streams is a concern because they may contain residual pools that support aquatic life; or be flowing during periods when the TMDL allocations apply. The classification and mapping of intermittent streams often do not account for these situations. See TSD Section 2.4 for additional details. In locations where an intermittent stream has surface flow in Class III subwatersheds, a riparian reserve distance of 50 feet is unlikely to provide sufficient shade and will result in stream warming. In Class I and Class II subwatersheds, thinning is authorized between 50- and 120-feet slope distance and must maintain at least 30 percent canopy cover and 60 trees per acre expressed as an average. Thinning at these levels within 120-foot slope-distance from the stream may reduce effective shade and contribute to stream warming (see summary in TSD Appendix I). The amount of effective shade reduction and temperature response will depend on the thinning intensity and spacing of thinning treatments (Roon et. al., 2021).

For these reasons, BLM is required to develop a TMDL implementation plan to be submitted to DEQ for review and approval. See Table 8 for schedule.

5.2.4 U.S. Forest Service: Adequacy of streamside management strategies in attaining TMDL load allocations and effective shade surrogate measures

Streamside vegetation on USFS lands in the Willamette Subbasins currently managed based on Northwest Forest Plan (USFS and BLM 1994). As part of the plan, the Aquatic Conservation Strategy was developed to restore and maintain the ecological health of watersheds and aquatic ecosystems, including salmon and steelhead habitat on federal lands managed by USFS. Maintaining and restoring water quality is one of the stated objectives of the Aquatic Conservation Strategy. These aquatic ecosystems and the streamside adjacent areas are called *riparian reserves.* Like BLM, USFS defines many of the reserve distances using site-potential tree height. The Northwest Forest Plan states a site-potential tree height is the average maximum height of the tallest dominant trees (200 years or older) for a given site class and is consistent with the BLM definition. The following text is a description of the riparian buffer distance for different types of waterbodies. The text was extracted from USFS and BLM (1994), Attachment A, Standards and Guidelines, Section C, pages C-3- through C-31.

> ***Fish-bearing streams*** *- Riparian Reserves consist of the stream and the area on each side of the stream extending from the edges of the active stream channel to the top of the inner gorge, or to the outer edges of the 100-year floodplain, or to the outer edges of riparian vegetation, or to a distance equal to the height of two site-potential trees, or 300 feet slope distance (600 feet total, including both sides of the stream channel), whichever is greatest.*
>
> ***Permanently flowing nonfish-bearing streams*** *- Riparian Reserves consist of the stream and the area on each side of the stream extending from the edges of the active stream channel to the top of the inner gorge, or to the outer edges of the 100-year floodplain, or to the outer edges of riparian vegetation, or to a distance equal to the height of one site-potential tree, or 150 feet slope distance (300 feet total, including both sides of the stream channel), whichever is greatest.*
>
> ***Constructed ponds and reservoirs, and wetlands greater than 1 acre*** *- Riparian Reserves consist of the body of water or wetland and: the area to the outer edges of the riparian vegetation, or to the extent of seasonally saturated soil, or the extent of unstable and potentially unstable areas, or to a distance equal to the height of one site-potential tree, or 150 feet slope distance from the edge of the wetland greater than 1 acre or the maximum pool elevation of constructed ponds and reservoirs, whichever is greatest.*

Lakes and natural ponds *- Riparian Reserves consist of the body of water and: the area to the outer edges of the riparian vegetation, or to the extent of seasonally saturated soil, or to the extent of unstable and potentially unstable areas, or to a distance equal to the height of two site-potential trees, or 300 feet slope distance, whichever is greatest.*

Seasonally flowing or intermittent streams, wetlands less than 1 acre, and unstable and potentially unstable areas *- This category applies to features with high variability in size and site-specific characteristics. At a minimum, the Riparian Reserves must include:*

- *The extent of unstable and potentially unstable areas (including earthflows),*
- *The stream channel and extend to the top of the inner gorge,*
- *The stream channel or wetland and the area from the edges of the stream channel or wetland to the outer edges of the riparian vegetation, and*
- *Extension from the edges of the stream channel to a distance equal to the height of one site-potential tree, or 100 feet slope distance, whichever is greatest.*

DEQ finds that USFS's streamside vegetation management strategies on fish-bearing streams, perennial streams, non-fish bearing streams, constructed ponds and reservoirs, lakes and natural ponds, and wetlands greater than 1-acre are adequate and will likely lead to achievement of the TMDL load allocation and effective shade targets. Vegetation management strategies on intermittent streams, and wetlands less than 1-acre may not be adequate to achieve the load allocation or effective shade targets (see summary in TSD Appendix I). Streamside management on intermittent streams is a concern because they may contain residual pools that support aquatic life; or be flowing during periods when the TMDL allocations apply. The classification and mapping of intermittent streams often do not account for these situations. See TSD Section 2.4 for additional details.

For these reasons, USFS is required to develop a TMDL implementation plan to be submitted to DEQ for review and approval. See Table 8 for schedule.

5.3 Implementation plan requirements

Appendix A lists the responsible persons including DMAs that are required to submit an implementation plan. As required in OAR 340-042-0080(4)(a), implementation plans must include:

- Management strategies that the entity will use to achieve load allocations and reduce pollutant loading;
- Timeline for strategy implementation and a schedule for completing measurable milestones;
- Performance monitoring and a plan for periodic review and revision of implementation plans;
- To the extent required by ORS 197.180 and OAR chapter 340, division 18, provide evidence of compliance with applicable statewide land use requirements; and,
- Any other analyses or information specified in this WQMP.

The following subsections provide detail on each component required by this WQMP that must be included in implementation plans. Some implementation plan requirements vary depending on the responsible person including DMAs.

TMDL implementation plans and annual reports must be posted to each DMA’s website for public transparency. If a DMA does not have a website, these documents must be made available to the public in another manner.

Figure 4 is provided to help responsible persons including DMAs determine the information and analyses they are responsible for submitting to DEQ. DEQ will work with each entity required to develop a TMDL implementation plan to ensure that all required elements are included with sufficient detail for their plan to be approved on the schedule required in Section 5.3.8 (Table 8)

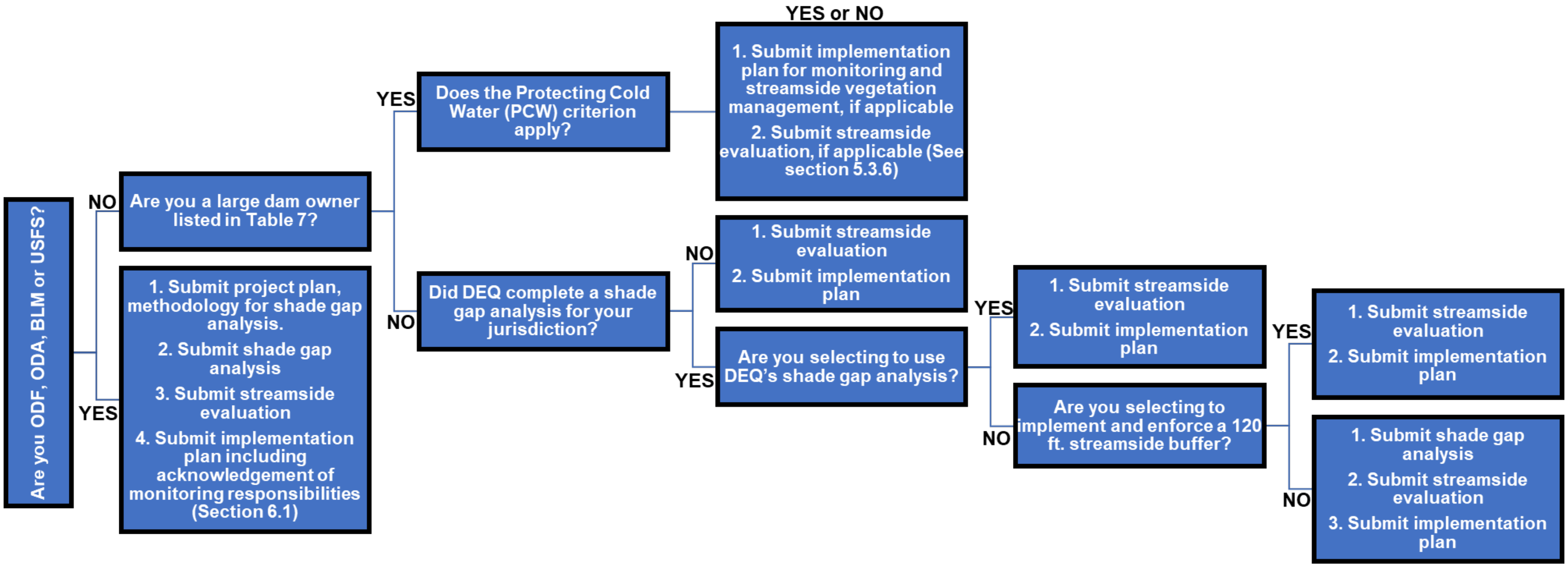

Figure 4: Decision support tree to help identify information and analyses requirements for different responsible persons including DMAs.

5.3.1 Management strategies

Responsible persons including DMAs in Appendix A that are required to develop a TMDL implementation plan must include applicable priority management strategies from Table 2. Other practices and actions appropriate for activities and landscape conditions specific to their pollutant sources or source sectors should also be included. Implementation plans must identify all streamside areas or streamside activities within a responsible person's including DMA's jurisdiction or responsibility.

5.3.2 Streamside evaluation

Responsible persons including DMAs that are required to submit an implementation plan must complete a streamside evaluation. The streamside evaluation will use a review of current conditions to support implementation measurable objectives and milestones. The streamside evaluation must be included in the TMDL implementation plan.

Entities that have a DEQ shade gap analysis, and entities that must complete a shade gap analysis (see Section 5.3.4), must include the shade gap analysis results in their streamside evaluation. The streamside evaluation must also include the following data and information:

- **a.** Quantify the streamside area in acres that needs enhancement (e.g., areas that do not currently meet shade targets, are comprised of non-native vegetation, need additional planting)
- **b.** Quantify the streamside area in acres that may not need action beyond protection.
- **c.** Quantify the streamside area in acres where physical constraints exist (e.g., buildings) that preclude implementation of vegetation management strategies that provide stream shade.
- **d.** Quantify the streamside area in acres where jurisdictional constraints (e.g., private ownership) limit implementation of vegetation management strategies that provide stream shade.
- **e.** Opportunities that may exist to address constraints to implementing vegetation management strategies that provide stream shade.
- **f.** Any areas within your jurisdiction where there is the potential to implement best management practices such as in-stream restoration, flow augmentation projects, experimental temperature management techniques, as well as enhancing and protecting cold water refuges where identified.
- **g.** An evaluation of the data from **a - f** to prioritize implementation. This evaluation must include a description of the rationale utilized to prioritize implementation in addition to a description of the data and analysis methods used to estimate quantities **a - d** and the reasoning specific areas will or will not be prioritized for implementation actions. It is expected that DMAs prioritize areas with the greatest shade gaps for implementation of riparian restoration, unless physical, jurisdictional, or other identified constraints exist.
    - i. Entities that have a DEQ shade gap analysis, and entities that must complete a shade gap analysis (i.e. ODA, ODF, USFS and BLM), must include the shade gap analysis results in their streamside evaluation.
    - ii. DEQ expects entities that do not have a DEQ shade gap analysis to use other available data to estimate the quantities outlined in items **a - d** and address these data in their streamside evaluation.

DEQ acknowledges that factors such as climate change and local geology, geography, soils, climate, legacy impacts, wildfires and floods may hinder achieving the target effective shade. No enforcement action will be taken by DEQ for reductions in effective shade caused by natural disturbances. Where natural disturbances have occurred, DEQ expects responsible persons including DMAs to assess and prioritize these areas for streamside restoration following an event.

The streamside evaluation must be completed according to the timeline assigned in Table 8. The streamside evaluation will be utilized during the year five review (see Section 5.3.9.2) to help assess progress in meeting implementation timelines, milestones, and measurable goals in subsequent five-year implementation cycles.

5.3.3 120-foot slope streamside buffer as an alternative to a streamside shade gap analysis

The responsible persons including DMAs that are required to complete a shade gap analysis and those that choose not to use DEQ's shade gap analysis (where available) for their streamside evaluation (Section 5.3.4) may instead choose to establish and protect overstory, woody vegetation within a 120-foot slope buffer, as measured up-slope along the ground's contour from top of bank (TSD Appendix I Section 1.1). The streamside buffer must be established through development of enforceable ordinances or regulations. The literature review presented in TSD Appendix I indicates that potential stream shade loss associated with a 120-foot buffer will not cause stream temperature increases for most waterbodies. For this option, responsible persons including DMAs must ensure that any activity occurring within this 120-foot slope buffer would result in limited stream shade reduction and ensure that stream shade targets are still achieved at that location following management actions. Entities that choose this option must also complete a streamside evaluation but do not have to complete a shade gap analysis. (Sec. 5.3.2).

5.3.4 Streamside shade gap analysis

DEQ conducted a vegetation height and shade gap analysis within approximately 150 feet of modeled waterbodies in the Lower Willamette (partial analysis completed) and Southern Willamette Subbasins, as detailed in Tables 9.5 and 9.6 in the TMDL Rule. DEQ did not complete a shade gap analysis for all responsible persons including DMAs.

The shade gap analysis calculates the difference between current effective shade (i.e., assessed) versus the target effective shade. Where DEQ calculated a shade gap, DEQ averaged the percent shade gap across all waterbodies within a DMA's jurisdiction. DEQ will provide the site-specific shade gap results upon request.

5.3.4.1 Streamside shade gap analysis methods for responsible persons including DMAs

If DEQ did not provide a shade gap analysis for a jurisdiction then that DMA is not required to complete a shade gap analysis unless they are named in Section 5.3.4.2. If DEQ has provided a shade gap analysis for a jurisdiction, then DMAs must either use DEQ's analysis to inform their streamside evaluation (Sec. 5.3.2), or other methods, for example on the ground measurements and remote sensing, to assess the current effective shade within their jurisdiction and whether effective shade allocations along Willamette Subbasins assessment units are met. These methods are described below.

1. Measure current effective shade at the stream surface using monitoring equipment, such as the Solar Pathfinder™, or using a hemispherical camera system and imagery analysis software.
   a. Determine general vegetation category, canopy density, stream width and stream orientation.
   b. Compare current effective shade results to either target effective shade from DEQ's shade gap analysis, or to the target percent effective shade values derived from the shade curves in the TMDL to assess the percent effective shade gap.
   c. Entities choosing to use this methodology must submit their assessment strategy to DEQ for approval. Assessments should conform to guidelines outlined in OWEB's Addendum to Water Quality Monitoring Technical Guide Book, Ch. 14: https://www.oregon.gov/oweb/Documents/Stream-Shade-Canopy-Cover-WQ-Monitoring-Guidebook-addendum-ch14.pdf (OWEB, 1999).
2. Conduct modeling using the Heat Source model (as used in this TMDL).
3. Another method approved by DEQ through the TMDL implementation plan approval process.

A project plan which includes a description of the assessment methodology must be submitted to DEQ for review and approval according to the timeline assigned in Table 8. Method documentation for Solar Pathfinder™ can be accessed at https://www.solarpathfinder.com/pdf/pathfinder-manual.pdf.

5.3.4.2 Shade gap analysis requirements for ODF, ODA, BLM and USFS

Together, the ODF, ODA, BLM, and USFS either manage or regulate approximately 93 percent of the land area within 150 feet of streams within the Willamette Subbasins project area (Figure 3). Increasing shade on streams within the extensive areas within their jurisdictions is important to achieving the surrogate shade measures of this TMDL. Therefore, ODF, ODA, BLM, and USFS must complete a streamside evaluation (Section 5.3.2) as well as a shade assessment for streamside areas within their jurisdiction. The assessment must use methods outlined in Section 5.3.4.1 for determining whether effective shade allocations along the Willamette Subbasins assessment units are met. A shade assessment is not needed for those streamside areas where DEQ has completed a shade gap analysis, or for streamside areas where DEQ has determined the streamside buffers are sufficient (Section 5.2). The shade gap analysis requirement includes intermittent streams as defined in the TMDL. For more information on intermittent streams and which are included in temperature TMDLs see TSD Section 2.4. A project plan, which includes a description of the shade gap assessment methodology including any methodology that proposes target effective shade values different from shade curves developed by DEQ, must be submitted to DEQ for review and approval according to the timeline assigned in Table 8.

5.3.5 Target Effective Shade Values and Shade Curves

Shade curves, which are charts that represent the mean effective shade target for different mapping units, stream aspects, and active channel widths (TMDL Section 9.1.5.2), were developed (Figures 9-5 – 9-27 in the TMDL Rule) to allow users to find target percent effective shade values for streams based on several stream characteristics. Unlike the site-specific shade targets and shade gap analysis (TMDL Section 9.1.5.2), shade curves do not calculate current effective shade. Any responsible person including DMAs can use DEQ shade curves, site-specific shade targets or other DEQ- approved method to assess and recommend an effective shade target for their jurisdiction.

TMDL implementation plans must include the mean effective shade targets calculated by DEQ, if available, (Table 9-28 through Table 9-32 in the TMDL Rule document), or any updated effective shade target assessment approved or performed by DEQ in the future.

5.3.6 Cold Water Refuge Requirements

Responsible persons, including DMAs who have jurisdiction along the lower 50 river miles of the Willamette River must include actions in their TMDL implementation plans to identify, enhance and protect cold water refuges. This reach extends from the mouth of the Willamette River at the confluence with the Columbia River to the confluence of the Willamette River and Chehalem Creek in the area of the Newberg pool. This reach of the river has been designated as a migration corridor in OAR 340-041-0028(4)(d):*The seven-day-average maximum temperature of a stream identified as having a migration corridor use on subbasin maps and tables OAR 340-041-0101 to 340-041-0340: Tables 101B, and 121B, and Figures 151A, 170A, 300A, and 340A, may not exceed 20.0 degrees Celsius (68.0 degrees Fahrenheit). In addition, these water bodies must have cold water refugia that are sufficiently distributed so as to allow salmon and steelhead migration without significant adverse effects from higher water temperatures elsewhere in the water body. Finally, the seasonal thermal pattern in Columbia and Snake Rivers must reflect the natural seasonal thermal pattern.*

According to OAR 340-041-0002(10) “Cold Water Refugia” means those portions of a water body where, or times during the day when, the water temperature is at least 2 degrees Celsius colder than the daily maximum temperature of the adjacent well-mixed flow of the water body.

DEQ expects DMAs with jurisdiction along these lower 50 river miles of the Willamette River to reference DEQ’s *Lower Willamette River Cold-Water Refuge Narrative Criterion Interpretation Study,* or other cold water refuge studies, as a resource for protecting cold water refuges that have already been identified. This study identified a total of 48 cold water refuge locations within the migration corridor.

DMAs along this reach may protect existing refuges by:

1. Maintaining or enhancing vegetation for shade
2. Protecting the watersheds of cold tributaries
3. Protecting channel features that create cold water flows from physical alteration
4. Protecting sources of groundwater inflows
5. Removing or prohibiting barriers to fish access in areas of cold water

Potential cold-water refuges may also be restored by improving access or enhancing characteristics that form cold-water refuge where they have been altered by human activity.

DMAs not along this 50 river mile reach should also consider including best management practices in their implementation plans that support identifying, enhancing and protecting cold water refuges, which are important to fish seeking escape from warm stream temperatures, in other waterbodies within the Willamette Basin.

5.3.7 TMDL implementation plan requirements for dam owners

DEQ is using a surrogate measure to implement the load allocation for dam and reservoir operations. This means that reservoir operations must not contribute any additional warming above and beyond upstream water temperatures entering the reservoir. See Section 9.1.4.1 dam and reservoir operations in the TMDL Rule for more information.

All dam and reservoir operators named in Table 7 must submit an implementation plan that addresses the monitoring and assessment requirements described in Section 5.3.7.1. If monitoring and assessment show that dam operations contribute additional warming above upstream temperatures entering the reservoir, then the operator can choose to either:

1. Complete a cumulative effects analysis which demonstrates that releasing waters warmer than the surrogate measure would not contribute to downstream exceedances of water quality standards, or
2. Update their TMDL implementation plan to include structural and operational strategies for mitigating temperature increases.

If a cumulative effects analysis demonstrates that dam operations will contribute to additional downstream warming, then the operator must update their implementation plan to include specific mitigation strategies for temperature. If DEQ determines sufficient data are available to demonstrate that stream temperature does not increase between a reservoir's inflow and outflow, then the reservoir operator may not be required to update their implementation plan for structural and operational management strategies.

Dam and reservoir operators that have jurisdiction over streamside areas must also develop a TMDL implementation plan to implement streamside management strategies even if a future updated TMDL implementation plan is not required for dam and reservoir management. See Sections 5.3.2 through 5.3.4 for additional information regarding streamside management implementation plan requirements.

Given the large number of dams within the Willamette Basin, DEQ is not focusing implementation requirements on dams owned and operated by individuals or businesses (See Appendix E for the entire list of dams in the Willamette Subbasins project area). Additionally, DEQ is not requiring reservoir management plans for dams that are operated to manage seasonal flow to sustain ecological benefits associated with wetlands and marshes. These individual, business, and ecological entities comprise only about 1.2 percent of the large reservoir storage capacity in the Willamette Basin. DEQ encourages partnerships between responsible persons including DMAs and individual dam operators within their jurisdictions to evaluate ways in which these dams could be managed to reduce temperature impacts.

Table 7: Large dam and reservoir owners responsible for monitoring. Owners may be required to submit an implementation plan that includes reservoir management strategies.

No.	Dam Name	Owner	Reservoir Storage (ac-ft)
1	Plywood Products Reservoir	City of Adair Village	39
2	North Fork	City of Corvallis	305
3	Mercer	City of Dallas	1,550
4	Binford Dam	City of Gresham	30
5	Silver Creek	City of Silverton	2,500
6	Salmonberry Reservoir	City of St. Helens	61

7	Carmen Diversion	Eugene Water and Electric Board	260
8	Leaburg	Eugene Water and Electric Board	345
9	Leaburg Canal and Forebay	Eugene Water and Electric Board	459
10	Smith	Eugene Water and Electric Board	17,530
11	Trail Bridge	Eugene Water and Electric Board	2,263
12	Walterville Forebay	Eugene Water and Electric Board	275
13	Walterville Storage Pond	Eugene Water and Electric Board	345
14	Faraday Diversion	Portland General Electric Company	1,200
15	Faraday Forebay	Portland General Electric Company	550
16	Harriet Lake	Portland General Electric Company	400
17	North Fork	Portland General Electric Company	18,630
18	River Mill	Portland General Electric Company	2,300
19	Timothy Lake	Portland General Electric Company	69,000
20	Big Cliff Dam	USACE - Portland District	5,930
21	Blue River Dam	USACE - Portland District	89,000
22	Cottage Grove Dam	USACE - Portland District	50,000
23	Cougar Dam	USACE - Portland District	220,000
24	Detroit Dam	USACE - Portland District	455,000
25	Dexter Dam	USACE - Portland District	29,900
26	Dorena Dam	USACE - Portland District	131,000
27	Fall Creek Dam	USACE - Portland District	125,000
28	Fern Ridge Dam	USACE - Portland District	121,000
29	Foster Dam	USACE - Portland District	61,000
30	Green Peter Dam	USACE - Portland District	430,000
31	Hills Creek Dam	USACE - Portland District	356,000
32	Lookout Point Dam	USACE - Portland District	477,700
33	Lebanon Dam	City of Albany	149

5.3.7.1 Monitoring and assessment requirements for dam owners

Dams and reservoirs alter solar radiation flux and seasonally increase surface temperatures compared to free-flowing stream segments. Increased temperatures may lead to violations of water quality temperature standards and impact aquatic life. Water released from the hypolimnion of stratified reservoirs may cool downstream reaches during the summer leading to attainment of water quality standards. In the fall, a reservoir may become isothermal and warm stream reaches below a reservoir.

Section 9.1.4.1 of the TMDL rule identifies a temperature surrogate measure target for dam and reservoir operations. Attainment of this target requires assessment of temperatures up and downstream of the dam and reservoir based on the seven-day average of the daily maximum temperature (7DADM).

Large dam and reservoir owners in Table 7 will collect temperature data and assess temperature dynamics associated with their dam and reservoir operations using a mechanistic model, empirical model, and/or analysis of continuous temperature data collected upstream, downstream, and in the reservoir. The assessment shall include:

1. Collection of continuous temperature data to characterize reservoir inflow and outflow temperatures. If multiple streams flow into the reservoir, 7DADM

temperatures upstream of the reservoirs may be calculated as a flow weighted mean of temperatures from each inflowing tributary. The estimated free flowing (no dam) temperatures may be calculated using a mechanistic or empirical model to account for any warming or cooling that would occur through the reservoir reaches absent the dam and reservoir operations.

   a. Continuous temperature data must be collected for four consecutive years and must be collected during the critical period as defined in the TMDL document. Previously collected data can be used as long as it meets DEQ QA/QC protocols and has been collected within the last five years.

2. Reservoir temperature profiles to sufficiently characterize timing and extent of thermal stratification, and

3. Measurement of reservoir water level fluctuations and outflow rates

Temperature data must be submitted to DEQ and uploaded to the Ambient Water Quality Monitoring System, or through another online publicly accessible database approved by DEQ. These data will be used for the following purposes:

1. establishing baseline conditions,
2. adaptive management, and
3. evaluation of site-specific approaches to reduce temperature impacts.

DEQ recommends dam owners develop a mechanistic or empirical model to predict and compare inflow and outflow temperatures. This model will be used to develop effective management strategies to reduce temperature impacts.

For reservoirs on reaches where DEQ has determined that the protecting cold water criterion does not apply, operators are required to select one of the two following options. The first option is to ensure that discharges meet the temperature target surrogate measure (TMDL Rule Section 9.1.4.1). The second option is to prepare a cumulative effects analysis to demonstrate that water releases that periodically exceed the ambient temperature criteria would not contribute to cumulative warming above water quality standards at downstream locations. Reservoir operators who choose this second option will be required to submit a Quality Assurance Project Plan (QAPP) to DEQ for review and approval. Required elements of the QAPP include descriptions of the dataset and cumulative effects approach that will be used to assess downstream temperature impacts.

5.3.7.2 Protecting Cold Water Criterion

The “protecting cold water” criterion in OAR 340-041-0028(11) applies to waters of the state that have summer seven-day-average maximum ambient temperatures that are colder than the biologically based criteria. With some exceptions, these waters may not be warmed cumulatively by anthropogenic point and nonpoint sources by more than 0.3 degrees Celsius (0.5 degrees Fahrenheit) above the colder water ambient temperature. Reservoir operators on reaches where protecting cold water apply must meet the cold water criterion. DEQ’s current assessment shows that the protecting cold water criterion likely applies at the following three dams:

1. Carmen Diversion (McKenzie River)
2. Harriet Lake (Oak Grove River)

3. Trail Bridge and Trail Bridge Saddle Dike (McKenzie River)

Water flowing above these dams is likely to have cooler ambient temperatures than the temperature criteria. To meet the cold-water criterion, these dams cannot warm up ambient temperature to the applicable temperature criteria. Additional information on protecting cold water is found in the TMDL Rule (Section 9.1.4.1). This list could change given updated assessments.

If DEQ determines sufficient data are available to demonstrate that stream temperature does not increase from upstream of dam to downstream of dam, then the reservoir operator may not be required to develop a TMDL implementation plan for dam management.

5.3.8 Timeline and schedule

Each implementation plan must include a commitment to enact specific management strategies on a reasonable timeline, including a schedule for meeting measurable milestones to demonstrate progress. To meet the intent of this requirement and be useful for the requirement to track and report progress, entities should develop management strategies using the SMART elements: Specific, Measurable, Achievable, Relevant, Time-bound (Doran, 1981).

Timelines and milestone schedules should be informed by the Streamside Evaluation, as described in Section 5.3.2 above, and each entity should consider all factors relevant to their situation. The due dates and timelines for specific information and analyses discussed in Sections 5.3.2 and 5.3.4 are shown in Table 8 below. DMA timelines in TMDL implementation plans that differ from timelines stated below must be approved by DEQ.

Table 8: Due dates for implementation plans, information, and analyses. See sections 5.3.1 through 5.3.7 for more details.

Requirement	Due Date / Timeframe
TMDL implementation plan (Appendix A)	18 months after EQC adoption of amendment to Willamette Subbasins TMDL
Streamside Evaluation (Sec. 5.3.2)	Three years after EQC adoption of amendment to Willamette Subbasins TMDL
Project plan and description of the assessment methodology to be used to complete a shade gap analysis (Sec. 5.3.4)	18 months after EQC adoption of amendment to Willamette TMDL
Streamside shade gap analysis (Sec. 5.3.4) and updated streamside evaluation OR 120 ft. streamside buffer that establishes and protects overstory, woody vegetation (sec. 5.3.3)	Four years after implementation plan submission deadline

Large dam and reservoir owners named in Table 7 (Sec. 5.3.7): TMDL implementation plan for temperature monitoring and assessment requirements for each reservoir	18 months after EQC adoption of amendment to Willamette Subbasins TMDL. Following the temperature assessment, the DMA will consult with DEQ on a timeframe for submitting a cumulative effects analysis, or updated TMDL implementation plan as needed. Some reservoir operators must also submit a streamside evaluation and implementation plan for streamside management. See section 5.3.2 for details.
ODA, ODF, USFS, BLM: Quality Assurance Project Plans or project-specific Sampling and Analysis Plans for temperature (Sec. 6.1)	As directed by DEQ following development of a Willamette Basin wide monitoring strategy.

5.3.9 Reporting of performance monitoring and plan review and revision

5.3.9.1 Reporting on performance monitoring

Each implementation plan must include a commitment to prepare annual reports on performance monitoring and specify a day of the year they will be submitted to DEQ. These reports must include implementation tracking for each of the identified management strategies, progress toward timelines and measurable milestones specified in the implementation plan, and evaluation of the effectiveness of each strategy.

DMAs should track and report implementation actions including the number, type and location of projects, best management practices, education activities, or other actions taken to improve or protect water quality. Most DMAs will track implementation actions they are directly responsible for completing, and some may need to track and report on actions that they implement through their support of other land managers, e.g., private landowners.

Oregon Watershed Restoration Inventory Reporting Requirement

Projects designed to control thermal pollution that use practices listed in OWEB's Oregon Watershed Restoration Inventory (OWRI) Online List of Treatments must be reported by responsible persons including DMAs to the OWRI database (OWEB 2023, OWEB 2023a) upon project completion. DEQ utilizes OWRI's database to track implementation activities statewide and within watersheds for various reporting metrics. Responsible persons including DMAs must also report BMP implementation annually to DEQ to document progress and track actions over time.

Other publicly accessible databases may be used to document restoration activities when approved by DEQ.

Adaptive Management

Implementation plans must include a commitment to use adaptive management to evaluate the effectiveness of implementation activities in improving streamside conditions including stream shade. Annual reports must summarize the status and results of these evaluations on the relevant time scale. At a minimum, reports in year five must summarize implementation and effectiveness over the preceding four years.

5.3.9.2 Implementation plan review and revision

Implementation plans must be reviewed by each responsible person including DMAs, revised to incorporate lessons learned, and approved by DEQ every five years. At a minimum, plans must be revised to reflect updated timelines for the continuation of implementation activities for the next five years. DEQ will use implementation and effectiveness evaluations from annual reports for this review. If implementation plan revisions are needed to correct deficiencies or otherwise ensure the plan is effective following the year five review, DEQ will identify a date for submission of the revised plan for DEQ approval.

5.3.10 Public involvement

As required in OAR 340-042-0040(4)(l)(L), implementation plans prepared by designated management agencies must include a plan to involve the public in implementation of management strategies. Public engagement and education must be included to meet this requirement.

5.3.11 Maintenance of strategies over time

As required in OAR 340-042-0040(4)(l)(M), implementation plans prepared by responsible persons including DMAs should include discussion of planned efforts to maintain management strategies over time.

5.3.12 Implementation costs and funding

As required in OAR 340-042-0040(4)(l)(N), this section provides a general discussion of costs and funding for implementing management strategies. Implementation of management strategies to reduce or prevent pollution into waters of the state may incur financial capital or operating costs. These costs vary in relation to pollutant sources and loading, proximity to waterways and type or extent of preventative controls already in place. Certain management practices, such as preventative infrastructure maintenance, may result in long-term cost savings to responsible persons including DMAs, or landowners.

OAR 340-042-0040(4)(l)(N) also indicates that sector-specific or source-specific implementation plans may provide more detailed analyses of costs and funding for specific management strategies in the plan. DEQ requires each DMA to provide a fiscal analysis of the resources needed to develop, execute and maintain the programs and projects described in implementation plans to the extent that these costs can be accounted for or estimated. DEQ recommends that all responsible persons including DMAs prepare the following level of economic analysis:

- Staff salaries, supplies, volunteer coordination and regulatory fees
- Installation, operation and maintenance of management measures
- Monitoring, data analysis and plan revisions
- Public education and outreach efforts
- Ordinance development (if needed to implement a management strategy)

This analysis should be in five-year increments to estimate costs, demonstrate sufficient funding is available to begin implementation and identify potential future funding sources to sustain management strategy implementation. DMAs may include actual costs spent on implementation activities as part of annual TMDL reporting. This information may help DEQ estimate actual costs associated with implementing current and future temperature TMDLs.

There are multiple sources of local, state, and federal funds available for implementation of pollutant management strategies and control practices. Table 9 provides a partial list of financial incentives, technical assistance programs, grant funding and low interest loans for public entities and with principal forgiveness available in Oregon that may be used to support implementation of assessment, pollution controls and watershed restoration actions or land condition improvements that improve water quality in the Willamette Basin. Soil and water conservation districts and watershed councils are additional resources that may support responsible persons including DMAs in implementation of pollutant management strategies and control practices through the programs listed in Table 9.

Table 9: Partial list of funding programs available in the Willamette Subbasins.

Program	General Description	Contact
Clean Water State Revolving Fund	Loan program for below-market rate loans for planning, design, and construction of various water pollution control activities.	DEQ
Conservation Reserve Enhancement Program (CREP)	Provides annual rent to landowners who enroll agricultural lands along streams. Also cost-shares conservation practices such as riparian tree planting, livestock watering facilities, and riparian fencing.	NRCS
Conservation Reserve Program (CRP)	Competitive CRP provides annual rent to landowners who enroll highly erodible lands. Continuous CRP provides annual rent to landowners who enroll agricultural lands along seasonal or perennial streams. Also cost-shares conservation practices such as riparian plantings.	NRCS
Conservation Stewardship Program (CSP)	Provides cost-share and incentive payments to landowners who have attained a certain level of stewardship and are willing to implement additional conservation practices.	NRCS
Drinking Water Source Protection Fund	These funds allow states to provide loans for certain source water assessment implementation activities, including source water protection land acquisition and other types of incentive-based source water quality protection measures.	OHA
Emergency Watershed Protection Program (EWP)	Available through the USDA-Natural Resources Conservation Service. Provides federal funds for emergency protection measures to safeguard lives and property from floods and the products of erosion created by natural disasters that cause a sudden impairment to a watershed.	NRCS
Emergency Forest Restoration Program (EFRP)	Available through the USDA-Natural Resources Conservation Service. Helps owners of non-industrial private forests restore forest health damaged by natural disasters.	USDA

Oregon 319 Nonpoint Source Implementation Grants	Fund projects that reduce nonpoint source pollution, improve watershed functions and protect the quality of surface and groundwater, including restoration and education projects.	DEQ
Environmental Quality Incentives Program (EQIP)	Cost-shares water quality and wildlife habitat improvement activities, including conservation tillage, nutrient and manure management, fish habitat improvements, and riparian plantings.	NRCS
Agriculture Water Quality Support Grant	Provides capacity to support voluntary agricultural water quality work in small watersheds and to meet the goals of the Agricultural Water Quality Management Area Plans and the SIA initiative.	ODA
Agricultural Conservation Easement Program (ACEP)	Provides financial and technical assistance to help conserve agricultural lands and wetlands and their related benefits.	NRCS
Farm and Ranchland Protection Program (FRPP)	Cost-shares purchases of agricultural conservation easements to protect agricultural land from development.	NRCS, SWCDs, ODF
Federal Reforestation Tax Credit	Provides federal tax credit as incentive to plant trees.	Internal Revenue Service
Grassland Reserve Program (GRP)	Provides incentives to landowners to protect and restore pastureland, rangeland, and certain other grasslands.	NRCS
Landowner Incentive Program (LIP)	Provides funds to enhance existing incentive programs for fish and wildlife habitat improvements.	U.S. Fish and Wildlife Service
Oregon Watershed Enhancement Board (OWEB)	Provides grants for a variety of restoration, assessment, monitoring, and education projects, as well as watershed council staff support. 25 percent local match requirement on all grants.	OWEB
Oregon Watershed Enhancement Board Small Grant Program	Provides grants up to $10,000 for priority watershed enhancement projects identified by local focus group.	OWEB
Partners for Wildlife Program	Provides financial and technical assistance to private and non-federal landowners to restore and improve wetlands, riparian areas, and upland habitats in partnership with the U.S. Fish and Wildlife Service and other cooperating groups.	U.S. Fish and Wildlife Service
Public Law 566 Watershed Program	Program available to state agencies and other eligible organizations for planning and implementing watershed improvement and management projects. Projects should reduce erosion, siltation, and flooding; provide for agricultural water management; or improve fish and wildlife resources.	NRCS
Resource Conservation & Development (RC & D) Grants	Provides assistance to organizations within RC & D areas in accessing and managing grants.	Resource Conservation and Development
ODF Small Forestland Investment in Stream Habitat (SFISH) Grants	Provides funding for Small Forestland Owners (SFO's) to improve road conditions and stream crossings as part of forest operations.	ODF
State Forestation Tax Credit	Provides for reforestation of under-productive forestland not covered under the Oregon Forest Practices Act.	ODF

	Situations include brush and pasture conversions, fire damage areas, and insect and disease areas.	
Forest Stewardship Program	Provides cost share dollars through USFS funds to family forest landowners to have management plans developed.	ODF
Western Bark Beetle Mitigation	ODF administers a cost share program for forest management practices pertaining to bark beetle mitigation for forest health and is funded through the USFS.	ODF
State Tax Credit for Fish Habitat Improvements	Provides tax credit for part of the costs of voluntary fish habitat improvements and required fish screening devices.	ODFW
Wetlands Reserve Program (WRP)	Provides cost-sharing to landowners who restore wetlands on agricultural lands.	NRCS
Wildlife Habitat Tax Deferral Program	Maintains farm or forestry deferral for landowners who develop a wildlife management plan with the approval of the Oregon Department of Fish and Wildlife.	ODFW
Funding Resources for Watershed Protection and Restoration	EPA's Funding Resources for Watershed Protection and Restoration (EPA, 2023) contains links to multiple funding sources	Various

5.4 Schedule for implementation plan submittal

OAR 340-042-0040(4)(l)(I) specifies that the WQMP contain a schedule for submittal of implementation plans. As stated in OAR 340-042-0080(4)(a), entities identified in the WQMP with responsibility for developing implementation plans are required to prepare and submit an implementation plan for DEQ approval according to the schedule in the WQMP.

Within 18 months of EQC adoption of the Willamette Basin Subbasins TMDL amendment (planned for February 2025), persons, including DMAs, responsible for developing implementation plans must submit implementation plans to DEQ for review and approval (See Table 8).

OAR 340-012-0055(2)(e) identifies failure to timely submit or implement a TMDL implementation plan, as required by DEQ order or rule, as a Class II violation. OAR 340-012-0053(1) identifies failure to report by the reporting deadline, as required by DEQ order or rule, as a Class I violation.

Should a sector or sector-wide DMA fail to submit an approvable TMDL implementation plan or fail to timely implement the plan, DEQ may pursue enforcement under OAR 340-012-0055(2)(e) or identify individual sources (landowners/operators) as persons responsible for developing and implementing TMDL implementation plans to address the load allocations relevant for the sector. DEQ may revise the WQMP or issue individual orders to identify additional responsible persons including DMAs and notify them of the required schedule for submitting source-specific implementation plans.

Following the issuance of this TMDL and WQMP, DEQ may determine that nonpoint source implementation plans are not necessary for certain entities identified in the WQMP based on available information or new information provided by those entities. For these entities, DEQ will provide a written determination for why a plan is not required. This determination could be based on a variety of factors, such as inaccurate identification within the geographic scope of the TMDLs, or documentation that an entity is not a source of pollution or does not discharge pollutants to a waterbody within the geographic scope of a TMDL.

Once approved, DEQ expects implementation plans to be fully implemented according to the timelines and schedules for achieving measurable milestones specified within the plans. Implementation plans must be reviewed and revised as appropriate for DEQ approval every five years and submitted on the date specified in DEQ's approval letter for an implementation plan.

6. Monitoring and Evaluation of Progress

OAR 340-042-0040(4)(l)(K) requires that the WQMP include a plan to monitor and evaluate progress toward achieving the TMDL allocations and associated water quality standards for the impairments addressed in the TMDL. Additional objectives of monitoring efforts are to assess progress towards reducing excess pollutant loads and to better understand variability associated with environmental or anthropogenic factors. This section summarizes DEQ's approach, including the required elements of identification of monitoring responsibilities and the plan and schedule for reviewing monitoring information to make TMDL revisions, as appropriate.

There are two fundamental components to DEQ's approach to monitoring and evaluating TMDL progress:

1. Tracking the implementation and effectiveness of activities committed to by responsible persons including DMAs in DEQ-approved implementation plans, and
2. Periodically monitoring the physical, chemical and biological parameters necessary to assess water quality status and trends for the impairments that constitute the basis for this TMDL.

All responsible persons including DMAs are responsible for tracking the implementation and effectiveness of their actions and meeting milestones where established. The streamside evaluation (Section 5.3.2) will provide a baseline for DMA implementation plans against which DMA progress will be assessed. DEQ acknowledges that it will take decades for restored streamside areas to provide mature, overstory woody vegetation that shades streams, so DEQ will rely on tracking implementation compliance through DEQ approved implementation plans, annual reports, and comprehensive year five reviews (Sections 5.3.9 and 5.3.10) in the coming years.

DEQ effective shade targets are regulatory and can be used to assess implementation progress in the future. In areas where stream temperature criteria are not met, DEQ will assess the status of current conditions and effective shade targets as part of the adaptive management process (Section 6). DEQ will also evaluate other restoration efforts that have been implemented to improve stream temperature, for example channel morphology and stream flow restoration, protection and enhancement of cold water refuges, etc. In cases where DEQ determines implementation actions are not making sufficient progress, DEQ will rely on the adaptive management process and our enforcement authority to assess compliance with the load allocations.

With input from partners, DEQ will develop overarching water column sampling and analysis plans to finalize the first iteration of the Willamette Basin Temperature Monitoring Strategy after the issuance of the Willamette Subbasins Temperature TMDL and WQMP amendment. DEQ will continue to work with partners to implement the sampling and analysis plan and periodically refine the strategy as needed. Although DEQ encourages responsible persons including DMAs to conduct physical, chemical or biological monitoring to better evaluate how implementation actions may impact water quality conditions, DEQ is only requiring the DMAs listed under section 6.1 to conduct water column monitoring associated with this TMDL.

6.1 Persons responsible for water quality monitoring

Section 5.1 identifies responsible persons including DMAs that are responsible for developing TMDL implementation plans and implementing the management strategies described on the timelines committed to in approved plans. Section 5.3 details the content required in implementation plans and annual reports, as well as the schedules for their submittal.

DEQ is requiring ODA, ODF, BLM, and USFS to undertake monitoring actions in areas within their jurisdiction or ownership to help determine the status of instream water quality and landscape conditions associated with water quality. These four agencies have jurisdiction over approximately 93 percent of streamside areas in the Willamette Subbasins TMDL. For this reason, DEQ considers it appropriate for these large agencies to collaborate with DEQ on the Monitoring Strategy. DEQ encourages and invites other DMAs to collaborate with DEQ on collecting water quality data, especially DMAs that have been collecting temperature data as part of TMDL implementation or other related programs.

This effort will be iterative, beginning with review of existing data and monitoring locations, then adjusted as needed to improve understanding of current water quality status and develop a temperature trend monitoring network. DEQ expects to refine this monitoring strategy over time and modify as necessary.

The objectives for monitoring and assessment will be described in DMA implementation plans and will include, but are not limited to:

1. Provide information necessary to determine locations for applying management strategies or to assess the effectiveness of those strategies.
2. Refine information on source-specific or sector-specific pollutant loading.
3. Provide information necessary to demonstrate progress towards meeting load allocations.
4. Provide information used to identify roles and participate in collaborative effort among responsible persons including DMAs to characterize water quality status and trends.
5. Provide information integral to an adaptive management approach to inform and adjust management strategies over time.

Environmental media and water column monitoring activities conducted by ODA, ODF, BLM, USFS, or other DMAs to meet TMDL objectives, data collection and management must be performed in adherence to Quality Control procedures and Quality Assurance protocols established by DEQ, U.S. EPA or other appropriate organizations. This requirement will be met through developing or adapting Quality Assurance Project Plans or project-specific Sampling and Analysis Plans, and submitting to DEQ for review and approval based on a schedule determined by DEQ once development of the Monitoring Strategy has been initiated. ODA, ODF, BLM, USFS or other DMAs can also agree to participate in a collaborative monitoring plan under an umbrella QAPP. DEQ staff will coordinate QAPP development with ODA, ODF, BLM, and USFS upon request in advance of submission. Resources for developing quality assurance project plans and sampling and analysis plans are available on DEQ's water quality monitoring website (DEQ, 2023a).

At a minimum, ODA, ODF, BLM, and USFS must acknowledge in their implementation plans their responsibility in collaborating with DEQ to develop the Willamette Basin Temperature Monitoring Strategy. DEQ encourages these agencies to begin evaluating their existing temperature monitoring networks, if any, and explore opportunities to establish future long-term monitoring sites. Data collected by DMAs participating in the monitoring strategy must be in a format accessible to DEQ.

6.2 Plan and schedule for reviewing monitoring information and revising the TMDL

DEQ recognizes that it will take time before management practices identified in a WQMP are fully implemented and effective in reducing and controlling pollution. DEQ also recognizes that despite best efforts, natural events beyond the control of humans may interfere with or delay attainment of the TMDL. Such events include, but are not limited to, floods, fire, insect infestations and drought. In addition, DEQ recognizes that technology and practices for controlling nonpoint source pollution will continue to develop and improve over time. DEQ will use adaptive management to refine implementation as technology, and knowledge about these approaches progress.

Adaptive management is a process that acknowledges and incorporates improved technologies and practices over time to refine implementation. A conceptual representation of the TMDL adaptive management process is presented in Figure 5.

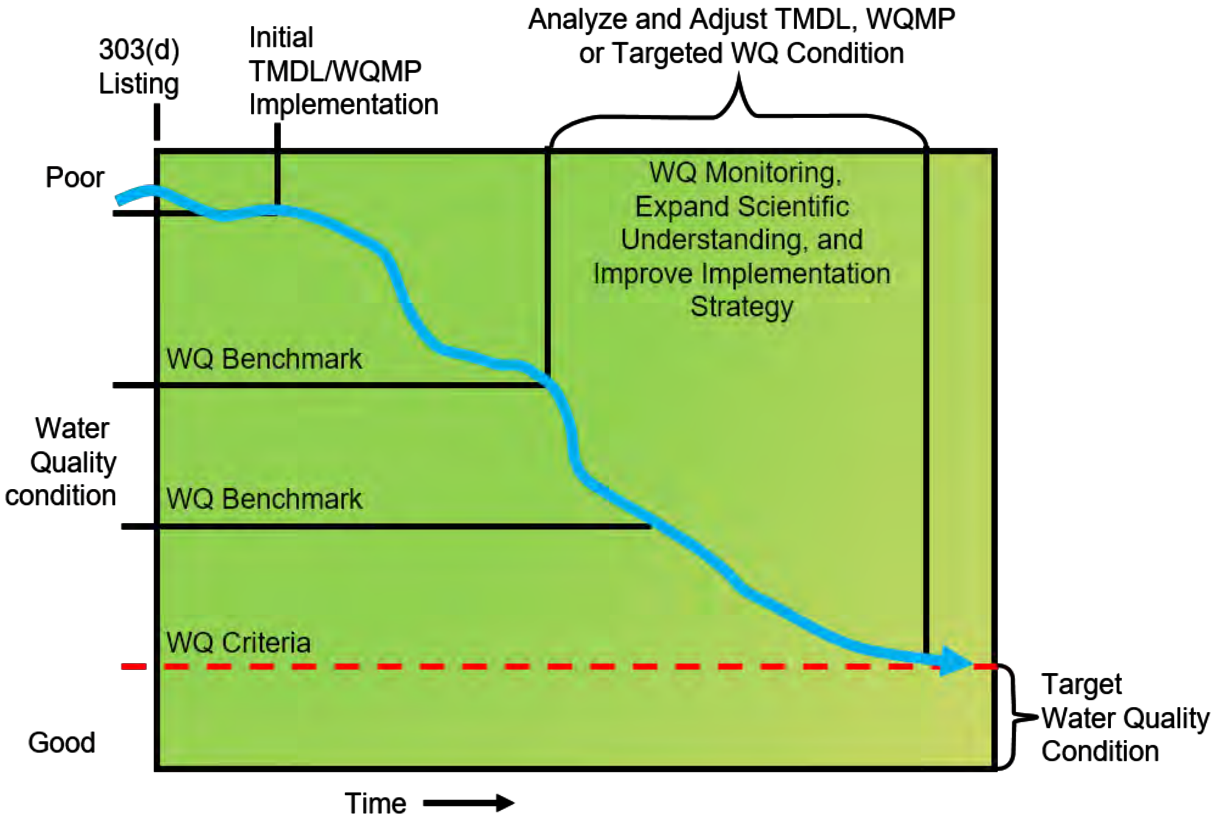

Figure 5: Conceptual representation of adaptive management.

DEQ considers entities complying with DEQ-approved TMDL implementation plans to be in compliance with their respective requirements contained in the TMDLs. The annual reports and Year Five Reviews submitted to DEQ by each of the responsible persons including DMAs in the Willamette Basin will be evaluated individually and collectively. DEQ will use this information to determine whether management actions are supporting progress towards TMDL objectives, or if changes in management actions and/or TMDLs are needed.

DEQ will review annual reports, participate with responsible persons including DMAs in review of monitoring information, and participate in implementing the Willamette Basin Monitoring Strategy.

Every five years, DEQ will collectively evaluate annual reports and all available monitoring data and information to assess progress on meeting the goals of the TMDLs and WQMP.

- DEQ will require responsible persons including DMAs to revise their implementation plans to address deficiencies where DEQ determines that implementation plans or effectiveness of management strategies are inadequate.
- DEQ and partners will revise sampling and analysis plans or other aspects of the Monitoring Strategy where progress toward meeting Monitoring Strategy objectives is not being made.
- DEQ will consider TMDL revisions if DEQ's evaluation of water monitoring data and supporting information indicate that the TMDL load allocations for a given pollutant-impairment are insufficient to meet state numeric criteria or narrative criteria, or insufficient to protect the designated beneficial uses.

- DEQ will follow all public participation requirements, including convening a local technical or rulemaking advisory committee to provide input on TMDL revisions per OAR 340-042-0040(7).

7. Reasonable Assurance of Implementation

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. 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 on determining reasonable assurance in the Chesapeake Bay TMDL (EPA, 2010) and supports federal antidegradation rules and Oregon’s antidegradation policy (OAR 340-041-0004).

The Clean Water Act section 303(d) requires that a TMDL be “established at a level necessary to implement the applicable water quality standard.” Federal regulations define a TMDL as “the sum of the individual wasteload allocations for point sources and load allocations for nonpoint sources and natural background” [40 CFR 130.2(i)]. For TMDL approval, EPA guidance documents and memos on the TMDL process requires determinations that allocations are appropriate to implement water quality standards and reasonable assurance that nonpoint source controls will achieve load reductions, when WLAs are based on an assumption that nonpoint source load reductions will occur (EPA, 1991, 2002 and 2012).

Although TMDL implementation is anticipated to improve rather than lower water quality, federal antidegradation rules at 40 CFR 131.12(a)(2), require states to “assure that there shall be achieved the highest statutory and regulatory requirements for all new and existing point sources and cost-effective and reasonable best management practices for nonpoint source control,” when allowing any lowering of water quality.

When a TMDL is developed for waters impaired by point sources only, the existence of the NPDES regulatory program and the issuance of NPDES permits provide the reasonable assurance that the wasteload allocations in the TMDL will be achieved. That is because federal regulations implementing the Clean Water Act require that water quality-based effluent limits in permits be consistent with “the assumptions and requirements of any available wasteload allocation” in an approved TMDL [40 CFR 122.44(d)(1)(vii)(B)].

Where a TMDL is developed for waters impaired by both point and nonpoint sources, it is the state’s best professional judgment as to the three-point test in OAR 340-042-0040(6)(g) on reasonable assurance that the TMDL’s load allocations will be achieved.

Where there is a demonstration that nonpoint source load reductions can and will be achieved; a determination that reasonable assurance exists and allocation of greater loads to point sources is appropriate. Without a demonstration of reasonable assurance that relied-upon nonpoint source reductions will occur, reductions to point sources wasteload allocations are needed.

The Willamette Basin TMDLs were developed to address both point and nonpoint sources with load reduction allocations proportional to estimated source contributions and in consideration of opportunities for effective measures to reduce those contributions. There are several elements that combine to provide the reasonable assurance to meet federal and state requirements, including for antidegradation. Education, outreach, technical and financial assistance, permit administration, permit enforcement, responsible persons' including DMAs' implementation and DEQ enforcement of TMDL implementation plans will all be used to ensure that the goals of this TMDL are met.

7.1 Accountability framework

Reasonable assurance that needed load reductions will be achieved for nonpoint sources and antidegradation requirements and narrative water quality criteria will be met is based primarily on an accountability framework incorporated into the WQMP, together with the implementation plans of persons responsible for implementation. This approach is similar to the accountability framework adopted by EPA for the Chesapeake Bay TMDL, which was adopted in 2010 (EPA, 2010). Figure 6 presents the accountability framework elements, which are intended to work in concert to demonstrate reasonable assurance of implementation.

Figure 6: Representation of the reasonable assurance accountability framework led by DEQ.

Pollutant reduction strategies are identified in Section 2 and more specific strategies, practices and actions will be detailed in each required implementation plan, to be submitted per the timelines in Section 5.4. 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 watershed and demonstrate reduced pollutant loading. These strategies are technically feasible at an appropriate scale 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.

In Oregon, forestry and agricultural related nonpoint source best management strategies are implemented through the state Forest Practices Act and agricultural Water Quality Management Area Plans and Rules. In Sections 5.2.1 and 5.2.2 DEQ determined that ODF and ODA must also develop and implement TMDL implementation plans that describe strategies specific to the Willamette River Subbasins. This adds to the accountability for implementation of cost-effective and reasonable best management and further assures that antidegradation requirements and narrative criteria will be met.

Approximately 134 responsible persons including DMAs in Appendix A are responsible for implementation of pollutant reduction strategies. General timelines, milestones and measurable objectives are identified in Sections 3 and 4.2, respectively. More specific timelines, milestones and measurable objectives will be specified in each required implementation plan. Attaining the relevant water quality criteria are provided in Sections 3 and 4.2, respectively. These elements support timely action by both DEQ and other entities responsible for implementation so that enforcement and adaptive management actions can be triggered and evaluation of attainment of TMDL goals occurs.

DEQ periodically reviews reporting by persons and agencies responsible for implementing pollutant reduction strategies to track the management strategies being implemented and evaluate achievements against established timelines and milestones.

Following up on reviews to track progress of implementation plans, DEQ will take appropriate action if responsible persons including DMAs fail to develop or effectively implement their implementation plan or fulfill milestones. DEQ's actions can include enforcement or engagement in voluntary initiatives. DEQ uses both, as appropriate within the process, to achieve optimal pollutant reductions. In some cases, DEQ will also take enforcement actions where necessary based on authorities listed in Section 8 or raise the issue to the Environmental Quality Commission as provided in OAR 340-042-0080.

DEQ tracks water quality status and trends concurrently with implementation of management strategies. DEQ relies on a system of interconnected evaluations, which include DMAs meeting measurable objectives, effectiveness demonstration of pollutant management strategies, accountability of implementation, periodically assessing progress on Oregon's Nonpoint Source Program Five-Year Plan Goals (approved by EPA), discharge monitoring and instream monitoring. DEQ also periodically evaluates water quality data collected through ambient and specific monitoring programs, including monitoring plans developed specifically for the Willamette Basin, as presented in Section 6. The *Assessment and Monitoring Strategy to Support Implementation of Mercury Total Maximum Daily Loads for the Willamette Basin* is one such plan, which was developed in partnership with EPA. DEQ regularly prepares Status and Trends reports and conducts water quality assessments on status of all waterways in Oregon every two years, as required by the Clean Water Act for submittal to EPA for approval as DEQ's Integrated Report. Together, these data and evaluations allow refinement of focus on specific geographic areas or discharges and appropriate implementation of adaptive management actions to attain, over time, the objectives of the TMDL.

7.2 Reasonable assurance conclusions

DEQ's implementation approach is multi-faceted and requires many targeted management practices across the entire basin to reduce anthropogenic pollutants, regardless of source origination.

The management strategies and practices that must be employed to reduce excess solar radiation loading are spatially distributed and involve multiple responsible persons including DMAs. Also, highly variable lag times are anticipated following the establishment of shade-producing vegetation to decrease solar radiation reaching streams. For these reasons, there is some uncertainty about the pace of achieving the needed reductions necessary in the Willamette Subbasins to attain water quality criteria. DEQ's WQMP addresses this uncertainty by including an extensive monitoring, reporting, and adaptive component that is designed to match the accountability framework used by EPA in its Chesapeake Bay TMDL (2010).

The rationale described in this document stems from robust evaluations, implements an accountability framework and provides opportunities for adaptive management to maximize pollutant reductions. In addition, DMAs and other groups have been continuing to implement on-the-ground actions since the establishment of the 2006 Willamette Basin Temperature TMDL. Together this approach provides reasonable assurance to meet state and federal requirements, including for antidegradation, and attain the goals of the TMDL.

8. Legal Authorities

As required in Oregon Administrative Rule 340-042-0040(4)(l)(O), this section cites legal authorities relating to implementation of management strategies.

Clean Water Act, Section 303(d)

The DEQ is the Oregon state agency responsible for implementing the Clean Water Act in Oregon. Section 303(d) of the 1972 Federal Clean Water Act as amended requires states to develop a list of rivers, streams and lakes that cannot meet water quality standards without application of additional pollution controls beyond the existing requirements on industrial sources and sewage treatment plants. These waters are referred to as “water quality limited.” Water quality limited waterbodies must be identified by the EPA or by a state agency which has this authority. In Oregon, the responsibility to delegate water quality limited waterbodies rests with DEQ and DEQ’s list of water quality limited waters is updated every two years. The list is referred to as the 303(d) list. Section 303 of the Clean Water Act further requires that TMDLs be developed for all waters on the 303(d) list. The Oregon Environmental Quality Commission granted DEQ authority to implement TMDLs through OAR 340-042, with special provisions for agricultural lands and nonfederal forestland as governed by the Agriculture Water Quality Management Act and the Forest Practices Act, respectively. The EPA has the authority under the Clean Water Act to approve or disapprove TMDLs that states submit. When a TMDL is officially submitted by a state to EPA, EPA has 30 days to take action on the TMDL. In the case where EPA disapproves a TMDL, EPA must issue a TMDL within 30 days. A TMDL defines the amount of pollution that can be present in the waterbody without causing water quality standards to be violated. A WQMP is developed to describe a strategy for reducing water pollution to the level of the load allocations and waste load allocations prescribed in the TMDL, which is designed to restore the water quality and result in compliance with the water quality standards. In this way, the designated beneficial uses of the water will be protected for all users.

Endangered Species Act, Section 6

Section 6 of the 1973 federal Endangered Species Act, as amended, encourages states to develop and maintain conservation programs for federally listed threatened and endangered species. In addition, Section 4(d) of the ESA requires the National Marine Fisheries Service to list the activities that could result in a “take” of species they are charged with protecting. With regard to this TMDL, NMFS’ protected species are salmonid fish. NMFS also described certain precautions that, if followed, would preclude prosecution for take even if a listed species were harmed inadvertently. Such a provision is called a limit on the take prohibition. The intent is to provide local governments and other entities greater certainty regarding their liability for take.

NMFS published their rule in response to Section 4(d) in July of 2000 (see 65 FR 42421, July 10, 2000). The NMFS 4(d) rule lists 12 criteria that will be used to determine whether a local program incorporates sufficient precautionary measures to adequately conserve fish. The rule provides for local jurisdictions to submit development ordinances for review by NMFS under one, several or all of the criteria. The criteria for the Municipal, Residential, Commercial and Industrial Development and Redevelopment limit are listed below:

1. Avoid inappropriate areas such as unstable slopes, wetlands, and areas of high habitat value;
2. Prevent stormwater discharge impacts on water quality;
3. Protect riparian areas;
4. Avoid stream crossings – whether by roads, utilities, or other linear development;
5. Protect historic stream meander patterns;
6. Protect wetlands, wetland buffers, and wetland function;
7. Preserve the ability of permanent and intermittent streams to pass peak flows (hydrologic capacity);
8. Stress landscaping with native vegetation;
9. Prevent erosion and sediment run-off during and after construction;
10. Ensure water supply demand can be met without affecting salmon needs;
11. Provide mechanisms for monitoring, enforcing, funding and implementing; and
12. Comply with all other state and federal environmental laws and permits.

Oregon Revised Statute Chapter 468B

DEQ is authorized by law to prevent and abate water pollution within the State of Oregon. Particularly relevant provisions of this chapter include:

ORS 468B.020 Prevention of pollution

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

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

   a) Fostering and encouraging the cooperation of the people, industry, cities and counties, in order to prevent, control and reduce pollution of the waters of the state; and

   b) Requiring the use of all available and reasonable methods necessary to achieve the purposes of ORS 468B.015 and to conform to the standards of water quality and purity established under ORS 468B.048.

ORS 468B.110 provides DEQ and the EQC with authority to take actions necessary to achieve and maintain water quality standards, including issuing TMDLs and establishing wasteload allocations and load allocations.

NPDES and WPCF Permits

DEQ administers two different types of wastewater permits in implementing Oregon Revised Statute (ORS) 468B.050. These are: the NPDES permits for waste discharge into waters of the United States; and Water Pollution Control Facilities permits for waste disposal on land. The NPDES permit is also a federal permit and is required under the Clean Water Act. The WPCF permit is a state program.

401 Water Quality Certification

Section 401 of the CWA requires that any applicant for a federal license or permit to conduct any activity that may result in a discharge to waters of the state must provide the licensing or permitting agency a certificate from DEQ that the activity complies with water quality requirements and standards. These include certifications for hydroelectric projects and for ‘dredge and fill’ projects. The legal citations are: 33 U.S.C. 1341; ORS 468B.035 – 468B.047; and OAR 340-048-0005 – 340-048-0040.

USACE Dam Operation and Management

In association with other federal statues, including House Document No. 531 Volume V, the River and Harbor Act, the Flood Control Act, and the Water Resources Development Act, the USACE is charged with operating its projects in compliance with the federal Clean Water Act, and in accordance with all federal, State, interstate and local requirements, administrative authority, and process and sanctions respecting the control and abatement of water quality pollution as per Title 1 Section 313 (33 U.S.C. 1323).

Oregon Forest Practices Act

The Oregon Department of Forestry is the designated management agency for regulating land management actions on non-federal forestry lands that impact water quality (ORS 527.610 to 527.992, and OAR 629 Divisions 600 through 665). The Board of Forestry has adopted water protection rules, including but not limited to OAR Chapter 629, Divisions 625, 630, and 635-660, which describe best management practices for forest operations. The Oregon Environmental Quality Commission, Board of Forestry, DEQ, and ODF have agreed that these pollution control measures will primarily be relied upon to result in achievement of state water quality standards. Statutes and rules also include provisions for adaptive management that provide for revisions to FPA practices where necessary to meet water quality standards. These provisions are described in ORS 527.710, ORS 527.765, OAR 629-035-0100, and OAR 340-042-0080.

Agricultural Water Quality Management Act

The Oregon Department of Agriculture is responsible for the prevention and control of water pollution from agricultural activities as directed and authorized through the Agricultural Water Quality Management Act, adopted by the Oregon legislature in 1993 (ORS 568.900 to ORS 568.933). It is the lead state agency for regulating agriculture for water quality (ORS 561.191). The Agricultural Water Quality Management Plan Act directs the ODA to work with local communities to develop water quality management plans for specific watersheds that have been identified as violating water quality standards and have agriculture water pollution contributions. The agriculture water quality management plans are expected to identify problems in the watershed that need to be addressed and outline ways to correct the problems. Water Quality area rules for areas within the Willamette Basin include OAR 603-095-2100 to 1160, OAR 603-095-2300 to 2360, OAR 603-095-2600 to 2660, and OAR 603-095-3700 to 3760.

Local Ordinances

Local governments are expected to describe in their implementation plans their specific legal authorities to carry out the management strategies necessary to meet the TMDL allocations. If new or modified local codes or ordinances are required to implement the plan, the DMA will identify code development as a management strategy. Legal authority to enforce the provisions of a city's NPDES permit would be a specific example of legal authority to carry out specific management strategies.

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Appendix A: List of responsible persons including designated management agencies

No.	Designated Management Agencies/Responsible Persons	DMA Type	Total Acres in Subbasins	Acres 150ft from stream	DMA/RP Status	TMDL Plan Needed?
1	Adair Village	City	483	55	existing	yes
2	Albany	City	11,237	1,139	existing	yes
3	Aumsville	City	788	103	existing	yes
4	Aurora	City	315	45	existing	yes
5	Brownsville	City	834	96	existing	yes
6	Canby	City	3,185	123	existing	yes
7	Coburg	City	653	68	existing	yes
8	Corvallis	City	14,020	1,695	existing	yes
9	Cottage Grove	City	2,403	408	existing	yes
10	Creswell	City	1,432	123	existing	yes
11	Dallas	City	3,998	757	existing	yes
12	Detroit	City	661	132	existing	yes
13	Donald	City	283	18	existing	yes
14	Dundee	City	848	51	existing	yes
15	Estacada	City	1,434	207	existing	yes
16	Eugene	City	31,614	3,606	existing	yes
17	Fairview	City	1,773	343	existing	yes
18	Falls City	City	787	241	existing	yes
19	Gates	City	399	175	existing	yes
20	Gervais	City	308	19	existing	yes
21	Gladstone	City	1,578	163	existing	yes
22	Gresham	City	11,952	1,594	existing	yes
23	Halsey	City	259	36	existing	yes
24	Happy Valley	City	7,402	1,569	existing	yes
25	Harrisburg	City	826	129	existing	yes
26	Hubbard	City	444	29	existing	yes
27	Idanha	City	530	147	existing	yes
28	Independence	City	1,908	263	existing	yes
29	Jefferson	City	529	118	existing	yes
30	Junction City	City	1,992	280	existing	yes
31	Keizer	City	4,298	257	existing	yes

32	Lake Oswego	City	5,807	990	existing	yes
33	Lebanon	City	4,306	431	existing	yes
34	Lowell	City	534	76	existing	yes
35	Lyons	City	544	83	existing	yes
36	McMinnville	City	9.1	3	new	no
37	Mill City	City	526	158	existing	yes
38	Millersburg	City	2,804	423	existing	yes
39	Milwaukie	City	3,241	330	existing	yes
40	Molalla	City	1,642	74	existing	yes
41	Monmouth	City	1,462	135	existing	yes
42	Monroe	City	342	78	existing	yes
43	Mt. Angel	City	677	18	existing	yes
44	Newberg	City	3,692	318	existing	yes
45	Oakridge	City	1,241	153	existing	yes
46	Oregon City	City	6,437	597	existing	yes
47	Philomath	City	1,597	165	existing	yes
48	Portland	City	73,674	10,876	existing	yes
49	Salem	City	31,373	3,576	existing	yes
50	Sandy	City	1,768	197	existing	yes
51	Scappoose	City	2,098	212	new	yes
52	Scio	City	262	40	existing	yes
53	Scotts Mills	City	225	46	existing	yes
54	Silverton	City	2,455	597	existing	yes
55	Springfield	City	10,323	1,154	existing	yes
56	St. Helens	City	1,973	368	new	yes
57	St. Paul	City	184	6	existing	yes
58	Stayton	City	1,923	439	existing	yes
59	Sublimity	City	595	25	existing	yes
60	Sweet Home	City	3,441	753	existing	yes
61	Tangent	City	2,230	252	existing	yes
62	Tualatin	City	401	7	existing	no
63	Turner	City	911	124	existing	yes
64	Veneta	City	1,658	207	existing	yes
65	West Linn	City	4,335	933	existing	yes
66	Westfir	City	192	68	existing	yes
67	Wilsonville	City	4,869	549	existing	yes
68	Woodburn	City	3,596	276	existing	yes
69	Benton County	County	27,798	3,456	existing	yes
70	Clackamas County	County	79,838	13,994	existing	yes
71	Columbia County	County	15,374	3,499	new	yes
72	Curry County	County	3	0.5	new	no
73	Lane County	County	121,090	21,545	existing	yes
74	Lincoln County	County	89	43	new	no

75	Linn County	County	35,141	6,781	existing	yes
76	Marion County	County	43,290	6,267	existing	yes
77	Multnomah County	County	4,089	1,172	existing	yes
78	Polk County	County	20,855	4,102	existing	yes
79	Washington County	County	2,130	156	new	no
80	Yamhill County	County	10,131	1,401	new	yes
81	Bonneville Power Administration	Federal	1,018	270	new	no
82	U.S. Bureau of Land Management	Federal	351,837	110,432	existing	yes
83	U.S. Fish and Wildlife Service	Federal	10,912	1,604	existing	yes
84	U.S. Forest Service	Federal	2,201,208	549,814	existing	yes
85	U.S. Army Corps of Engineers	Federal	29,289	5,980	existing	yes
86	Pacific Power and Light	Private Utility	35	1	new	no
87	Eugene Water and Electric Board	Public Utility	not assessed	not assessed	existing	yes
88	Portland General Electric	Public Utility	not assessed	not assessed	new	yes
89	Albany & Eastern Railroad	Railroad	304	61	new	no
90	BNSF Railway	Railroad	148	9	new	no
91	Central Oregon & Pacific Railroad	Railroad	182	51	new	no
92	Oregon Pacific Railroad	Railroad	44	2	new	no
93	Port of Coos Bay	Transportation	315	57	new	no
94	Portland & Western Railroad	Railroad	1,898	279	new	no
95	Portland Terminal Railroad Company	Railroad	0.1	0.1	new	no
96	TriMet	Railroad	102	38	new	no
97	Union Pacific Railroad	Railroad	3,788	677	new	no
98	Vennel Farms Railroad Company	Railroad	2	0.2	new	no
99	Willamette Shore Trolley	Railroad	6	1	new	no
100	Willamette Valley Railway	Railroad	255	51	new	no
101	Ash Creek Water Control District	Responsible Person	not assessed	not assessed	new	no
102	Creswell Water Control District	Responsible Person	not assessed	not assessed	new	no
103	Creswell Irrigation District	Responsible Person	not assessed	not assessed	new	no
104	East Valley Water District	Responsible Person	not assessed	not assessed	new	no
105	Fertile Improvement District	Responsible Person	not assessed	not assessed	new	no

106	G A Miller Drainage District No 1	Responsible Person	not assessed	not assessed	new	no
107	Grand Prairie Water Control District	Responsible Person	not assessed	not assessed	new	no
108	Hawn Creek District Improvement Co.	Responsible Person	not assessed	not assessed	new	no
109	Junction City Water Control District	Responsible Person	not assessed	not assessed	new	no
110	Lacomb Irrigation District	Responsible Person	not assessed	not assessed	new	no
111	Lake Labish Water Control District	Responsible Person	not assessed	not assessed	new	no
112	Muddy Creeks Irrigation Project	Responsible Person	not assessed	not assessed	new	no
113	Multnomah County Drainage District	Responsible Person	not assessed	not assessed	new	no
114	North Lebanon Water Control District	Responsible Person	not assessed	not assessed	new	no
115	Palmer Creek Water District Improvement Co.	Responsible Person	not assessed	not assessed	new	no
116	Peninsula Drainage District #1	Responsible Person	not assessed	not assessed	new	no
117	Peninsula Drainage District #2	Responsible Person	not assessed	not assessed	new	no
118	Santiam Water Control District	Responsible Person	not assessed	not assessed	new	no
119	Sauvie Island Drainage Improvement Company	Responsible Person	not assessed	not assessed	new	no
120	Scappoose Drainage Improvement Company	Responsible Person	not assessed	not assessed	new	no
121	Sidney Irrigation District	Responsible Person	not assessed	not assessed	new	no
122	West Labish Water Control District	Responsible Person	not assessed	not assessed	new	no
123	Metro (Portland Metropolitan Government)	Special District	not assessed	not assessed	existing	yes
124	Water Environment Services	Special District	not assessed	not assessed	existing	yes
125	Oak Lodge Water Services	Special District	not assessed	not assessed	existing	yes
126	Department of Geology and Mineral Industries	State	2,055	357	existing	no
127	Oregon Department of Agriculture	State	1,296,224	205,135	existing	yes
128	Oregon Department of Environmental Quality	State	0	0	existing	no
129	Oregon Department of Fish & Wildlife	State	10,080	1,588	new	yes
130	Oregon Department of Forestry	State	1,721,090	458,257	existing	yes
131	Oregon Department of State Lands	State	336	124	existing	no

132	Oregon Department of Transportation	State	31,007	5,525	existing	yes
133	Oregon Parks and Recreation Department	State	19,440	4,692	existing	yes
134	Port of Columbia County	Transportation	619	71	new	yes
135	Port of Portland	Transportation	5,497	558	existing	yes

Appendix B: Acres of jurisdiction, by HUC, within 150 feet of stream centerline for each entity

Landowner or Jurisdiction	Classification	Acres in HUC8 subbasin	Acres in HUC8 subbasin 150 feet from a stream centerline
Molalla-Pudding Subbasin - HUC 17090009			
Oregon Department of Forestry	State Agency	207,747	56,523
Oregon Department of Agriculture	State Agency	237,200	35,970
U.S. Bureau of Land Management	Federal Agency	54,013	16,403
Marion County	County	19,780	2,733
Clackamas County	County	11,823	2,594
Oregon Parks and Recreation Department	State Agency	9,197	2,073
U.S. Forest Service	Federal Agency	2,796	762
Water	Water	819	738
City of Silverton	Municipality	2,455	597
City of Salem	Municipality	3,245	388
City of Woodburn	Municipality	3,596	276
Oregon Department of Transportation	State Agency	2,255	252
U.S. Government	Federal Agency	315	108
State of Oregon	State Agency	569	85
City of Molalla	Municipality	1,642	74
City of Canby	Municipality	1,081	65
City of Scotts Mills	Municipality	225	46
City of Aurora	Municipality	315	45
City of Hubbard	Municipality	444	29
Willamette Valley Railway	Private	196	25
City of Gervais	Municipality	308	19
City of Mt. Angel	Municipality	677	18
Union Pacific Railroad	Private	276	18
Portland & Western Railroad	Private	51	2
Oregon Pacific Railroad	Private	41	2
City of Barlow	Municipality	33	0
City of Donald	Municipality	70	0

Oregon Department of Fish and Wildlife	State Agency	215	0
Middle Willamette Subbasin - HUC 17090007			
Oregon Department of Agriculture	State Agency	265,372	29,797
Oregon Department of Forestry	State Agency	40,322	12,687
Water	Water	6,007	5,346
Clackamas County	County	20,406	3,695
City of Salem	Municipality	27,830	3,023
Polk County	County	11,325	2,054
Marion County	County	18,823	1,910
U.S. Bureau of Land Management	Federal Agency	3,787	1,413
Yamhill County	County	10,131	1,401
City of Dallas	Municipality	3,998	757
Oregon Parks and Recreation Department	State Agency	3,699	591
Oregon Department of Transportation	State Agency	4,810	590
U.S. Fish and Wildlife Service	Federal Agency	5,092	549
City of Wilsonville	Municipality	4,869	549
City of Oregon City	Municipality	5,559	487
U.S. Forest Service	Federal Agency	1,033	363
City of West Linn	Municipality	2,191	362
City of Newberg	Municipality	3,692	318
City of Independence	Municipality	1,908	263
City of Keizer	Municipality	4,298	257
Washington County	County	2,094	152
City of Stayton	Municipality	1,200	146
State of Oregon	State Agency	306	145
City of Turner	Municipality	911	124
City of Monmouth	Municipality	1,433	120
City of Aumsville	Municipality	788	103
Union Pacific Railroad	Private	251	73
Portland & Western Railroad	Private	524	59
City of Canby	Municipality	2,102	57
City of Dundee	Municipality	848	51
U.S. Government	Federal Agency	91	29
Oregon Department of Geology and Mineral Industries	State Agency	329	26
Willamette Valley Railway	Private	59	26
City of Sublimity	Municipality	595	25
Oregon Department of Fish and Wildlife	State Agency	357	22
City of Donald	Municipality	213	18
City of Gladstone	Municipality	20	14
City of Tualatin	Municipality	327	7

City of St. Paul	Municipality	184	6
Bonneville Power Administration	Special District	22	5
City of McMinnville	Municipality	9	3
Oregon Military Department	State Agency	14	2
TriMet	Special District	10	1
City of Tigard	Municipality	15	0
Oregon Department of Aviation	State Agency	15	0
SP Fiber Technologies Railway	Private	1	0
North Santiam Subbasin - HUC 17090005			
U.S. Forest Service	Federal Agency	293,610	92,924
Oregon Department of Forestry	State Agency	94,279	33,850
Oregon Department of Agriculture	State Agency	57,498	15,423
U.S. Bureau of Land Management	Federal Agency	20,455	7,967
Marion County	County	4,648	1,618
U.S. Army Corps of Engineers	Federal Agency	4,060	1,223
Linn County	County	3,607	999
Water	Water	911	848
Oregon Department of Transportation	State Agency	1,877	693
City of Stayton	Municipality	723	293
Oregon Department of Fish and Wildlife	State Agency	419	222
City of Gates	Municipality	399	175
City of Salem	Municipality	298	165
Oregon Department of Geology and Mineral Industries	State Agency	420	159
City of Mill City	Municipality	526	158
City of Idanha	Municipality	530	147
City of Detroit	Municipality	661	132
City of Jefferson	Municipality	529	118
State of Oregon	State Agency	237	101
City of Lyons	Municipality	544	83
Oregon Parks and Recreation Department	State Agency	183	78
Bonneville Power Administration	Special District	153	42
U.S. Government	Federal Agency	98	33
Union Pacific Railroad	Private	61	31
Albany & Eastern Railroad	Private	94	25
Portland & Western Railroad	Private	12	5
Pacific Power and Light	Private	1	0
Confederated Tribes of Warm Springs	Tribal	717	0
Jefferson County	County	0	0
South Santiam Subbasin - HUC 17090006			
Oregon Department of Forestry	State Agency	310,035	98,467

U.S. Forest Service	Federal Agency	155,242	69,455
Oregon Department of Agriculture	State Agency	113,371	27,567
U.S. Bureau of Land Management	Federal Agency	59,501	21,585
Linn County	County	13,621	3,586
Water	Water	5,254	1,923
City of Sweet Home	Municipality	3,441	753
Oregon Department of Transportation	State Agency	1,519	492
City of Lebanon	Municipality	1,762	279
U.S. Army Corps of Engineers	Federal Agency	1,068	257
Oregon Parks and Recreation Department	State Agency	254	77
City of Scio	Municipality	262	40
State of Oregon	State Agency	49	37
Albany & Eastern Railroad	Private	164	30
Oregon Department of Geology and Mineral Industries	State Agency	107	25
Oregon Department of Fish and Wildlife	State Agency	41	19
City of Waterloo	Municipality	81	16
U.S. Government	Federal Agency	81	14
Pacific Power and Light	Private	1	0
Bonneville Power Administration	Special District	0	0
City of Sodaville	Municipality	7	0
Upper Willamette Subbasin - HUC 17090003			
Oregon Department of Forestry	State Agency	419,332	84,994
Oregon Department of Agriculture	State Agency	497,249	74,131
U.S. Bureau of Land Management	Federal Agency	48,530	14,570
Lane County	County	50,389	7,618
U.S. Forest Service	Federal Agency	14,684	4,164
Benton County	County	27,798	3,524
City of Eugene	Municipality	30,202	3,459
Water	Water	3,511	2,453
Linn County	County	17,912	2,196
Polk County	County	9,530	2,048
City of Corvallis	Municipality	14,020	1,695
U.S. Army Corps of Engineers	Federal Agency	11,988	1,423
Oregon Department of Transportation	State Agency	7,953	1,206
City of Albany	Municipality	11,237	1,139
U.S. Fish and Wildlife Service	Federal Agency	5,696	993
Oregon Parks and Recreation Department	State Agency	3,247	954
City of Springfield	Municipality	5,302	437
City of Millersburg	Municipality	2,804	423
Oregon Department of Fish and Wildlife	State Agency	2,551	292

City of Junction City	Municipality	1,992	280
City of Tangent	Municipality	2,230	252
City of Falls City	Municipality	787	241
City of Veneta	Municipality	1,658	207
City of Philomath	Municipality	1,597	165
City of Lebanon	Municipality	2,545	153
Portland & Western Railroad	Private	989	137
City of Harrisburg	Municipality	826	129
City of Brownsville	Municipality	834	96
Oregon Department of State Lands	State Agency	222	88
City of Monroe	Municipality	342	78
City of Coburg	Municipality	653	68
U.S. Government	Federal Agency	404	60
Union Pacific Railroad	Private	719	60
Port of Coos Bay	Special District	315	57
City of Adair Village	Municipality	483	55
Lincoln County	County	89	43
City of Halsey	Municipality	259	36
Bonneville Power Administration	Special District	118	35
U.S. Department of Defense	Federal Agency	601	35
State of Oregon	State Agency	219	26
City of Monmouth	Municipality	29	15
Oregon Department of Geology and Mineral Industries	State Agency	231	13
Albany & Eastern Railroad	Private	46	7
Oregon Military Department	State Agency	34	4
Central Oregon & Pacific Railroad	Private	22	3
Oregon Department of Aviation	State Agency	18	3
Pacific Power and Light	Private	24	0
Vennel Farms Railroad Company	Private	2	0
City of Sodaville	Municipality	182	0
Coos Bay Rail Link	Private	3	0
U.S. Department of Agriculture	Federal Agency	43	0
Clackamas Subbasin - HUC 17090011			
U.S. Forest Service	Federal Agency	413,482	87,423
Oregon Department of Forestry	State Agency	74,558	19,446
Oregon Department of Agriculture	State Agency	37,321	6,157
Clackamas County	County	33,208	5,790
U.S. Bureau of Land Management	Federal Agency	14,103	3,854
City of Happy Valley	Municipality	4,214	857
Water	Water	605	588

Oregon Department of Transportation	State Agency	1,630	392
Oregon Parks and Recreation Department	State Agency	1,179	374
City of Estacada	Municipality	1,434	207
City of Sandy	Municipality	1,768	197
U.S. Government	Federal Agency	518	152
City of Gladstone	Municipality	878	111
City of Oregon City	Municipality	878	110
U.S. Fish and Wildlife Service	Federal Agency	124	62
State of Oregon	State Agency	165	51
Union Pacific Railroad	Private	28	14
Confederated Tribes of Warm Springs	Tribal	17,168	11
Marion County	County	40	7
Bonneville Power Administration	Special District	209	6
City of Portland	Municipality	6	0
Wasco County	County	247	0
Coast Fork Willamette Subbasin - HUC 17090002			
Oregon Department of Forestry	State Agency	198,134	49,201
U.S. Forest Service	Federal Agency	86,827	27,997
U.S. Bureau of Land Management	Federal Agency	67,685	18,130
Lane County	County	31,815	5,976
Oregon Department of Agriculture	State Agency	32,053	5,438
Water	Water	3,194	1,052
City of Cottage Grove	Municipality	2,403	408
Oregon Department of Transportation	State Agency	1,535	310
Oregon Parks and Recreation Department	State Agency	523	251
U.S. Government	Federal Agency	486	128
City of Creswell	Municipality	1,432	123
City of Eugene	Municipality	811	52
Central Oregon & Pacific Railroad	Private	160	48
State of Oregon	State Agency	54	35
Bonneville Power Administration	Special District	42	26
Oregon Department of Aviation	State Agency	19	5
Oregon Department of Fish and Wildlife	State Agency	3	3
Oregon Department of State Lands	State Agency	3	3
Pacific Power and Light	Private	2	0
U.S. Army Corps of Engineers	Federal Agency	2	0
U.S. Department of Agriculture	Federal Agency	1	0
McKenzie Subbasin - HUC 17090004			
U.S. Forest Service	Federal Agency	545,195	123,717
Oregon Department of Forestry	State Agency	210,320	58,662

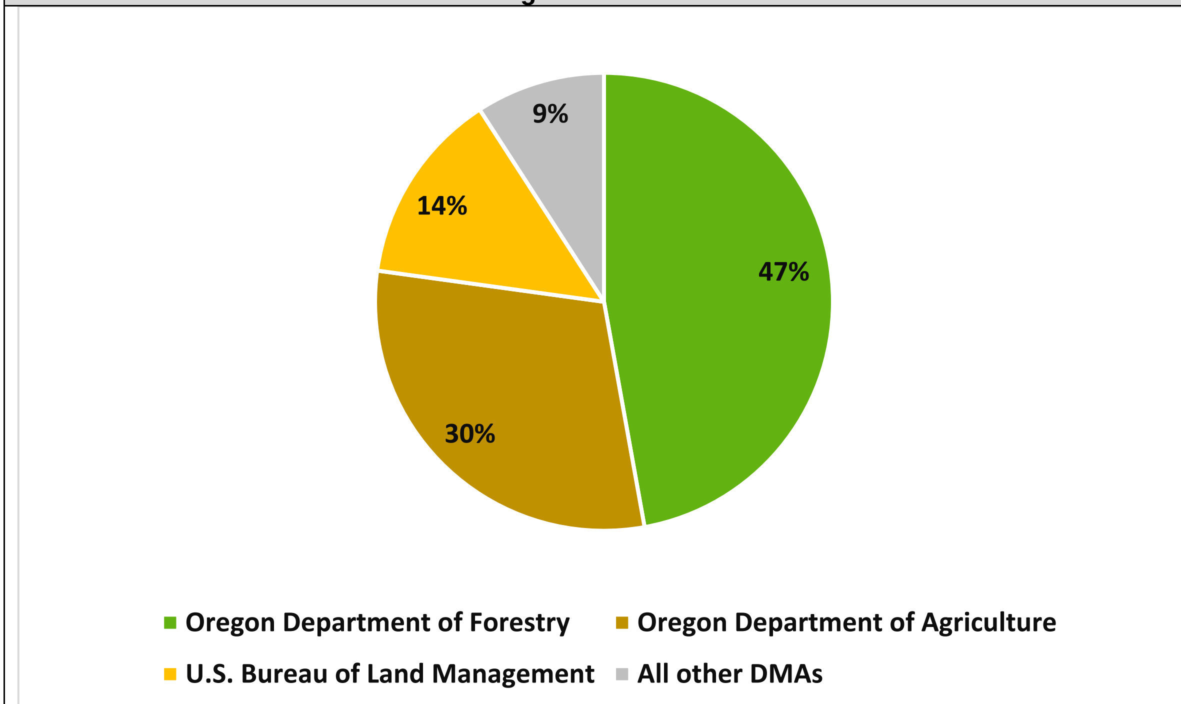
U.S. Bureau of Land Management	Federal Agency	52,470	16,244
Lane County	County	20,905	3,677
Oregon Department of Agriculture	State Agency	16,823	3,272
U.S. Army Corps of Engineers	Federal Agency	2,356	717
Water	Water	2,140	509
City of Springfield	Municipality	3,809	456
Oregon Department of Transportation	State Agency	1,864	281
City of Eugene	Municipality	601	94
U.S. Government	Federal Agency	315	68
Oregon Parks and Recreation Department	State Agency	86	29
Oregon Department of State Lands	State Agency	66	9
Bonneville Power Administration	Special District	22	6
Oregon Department of Fish and Wildlife	State Agency	5	1
Linn County	County	1	0
U.S. Department of Agriculture	Federal Agency	19	0
Union Pacific Railroad	Private	2	0
Lower Willamette Subbasin - HUC 17090012			
Oregon Department of Forestry	State Agency	57,427	16,392
City of Portland	Municipality	73,669	10,876
Oregon Department of Agriculture	State Agency	27,227	5,217
Columbia County	County	15,374	3,499
Clackamas County	County	14,401	1,915
U.S. Bureau of Land Management	Federal Agency	6,432	1,636
City of Gresham	Municipality	11,952	1,594
Water	Water	2,867	1,305
Multnomah County	County	4,089	1,172
Oregon Department of Fish and Wildlife	State Agency	6,491	1,029
City of Lake Oswego	Municipality	5,807	990
City of Happy Valley	Municipality	3,188	712
Oregon Department of Transportation	State Agency	5,141	678
City of West Linn	Municipality	2,144	571
Port of Portland	Special District	5,536	558
City of St. Helens	Municipality	1,973	368
City of Fairview	Municipality	1,773	343
City of Milwaukie	Municipality	3,241	330
City of Scappoose	Municipality	2,098	212
City of Troutdale	Municipality	1,230	166
Bonneville Power Administration	Special District	427	143
Oregon Department of Geology and Mineral Industries	State Agency	967	134
Portland & Western Railroad	Private	323	75

Union Pacific Railroad	Private	560	72
Port of St. Helens	Special District	619	71
Oregon Parks and Recreation Department	State Agency	495	52
City of Gladstone	Municipality	679	38
TriMet	Special District	92	36
City of Wood Village	Municipality	563	18
City of Johnson City	Municipality	43	13
State of Oregon	State Agency	99	11
BNSF Railway	Private	148	9
Washington County	County	35	4
U.S. Government	Federal Agency	11	3
Willamette Shore Trolley	Private	6	1
City of Canby	Municipality	2	1
Curry County	County	3	0
Pacific Power and Light	Private	7	0
Oregon Pacific Railroad	Private	3	0
Portland Terminal Railroad Company	Private	0	0
City of Clatskanie	Municipality	1	0
City of Maywood Park	Municipality	83	0
City of Tualatin	Municipality	74	0
Peninsula Terminal Company	Private	13	0
Middle Fork Willamette Subbasin - HUC 17090001			
U.S. Forest Service	Federal Agency	688,782	143,011
Oregon Department of Forestry	State Agency	108,936	28,037
U.S. Bureau of Land Management	Federal Agency	24,864	8,631
Lane County	County	17,982	4,273
U.S. Army Corps of Engineers	Federal Agency	9,815	2,360
Oregon Department of Agriculture	State Agency	12,110	2,163
Water	Water	3,695	1,638
Oregon Department of Transportation	State Agency	2,422	631
Union Pacific Railroad	Private	1,891	410
City of Springfield	Municipality	1,212	261
Oregon Parks and Recreation Department	State Agency	577	213
City of Oakridge	Municipality	1,241	153
City of Lowell	Municipality	534	76
City of Westfir	Municipality	192	68
U.S. Government	Federal Agency	102	40
State of Oregon	State Agency	69	40
Oregon Department of State Lands	State Agency	45	23
U.S. Department of Agriculture	Federal Agency	36	16

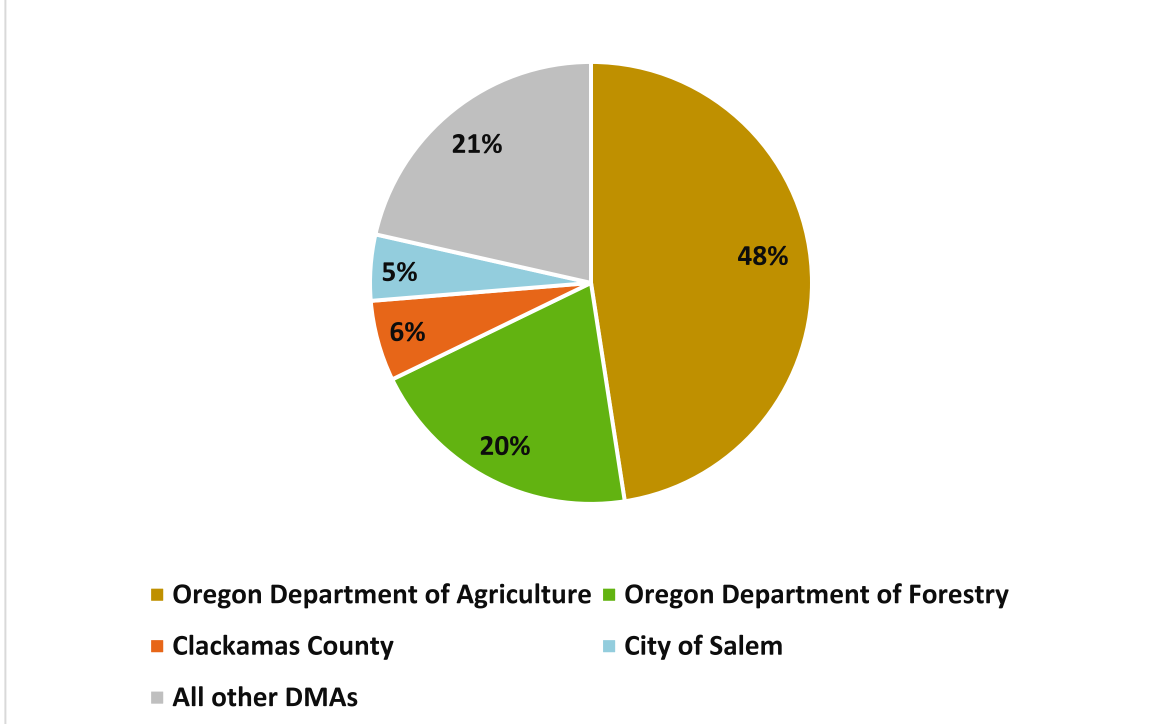
Bonneville Power Administration	Special District	25	8
Oregon Department of Aviation	State Agency	18	0

Appendix C: Percent of acres by HUC, within 150 feet of stream centerline

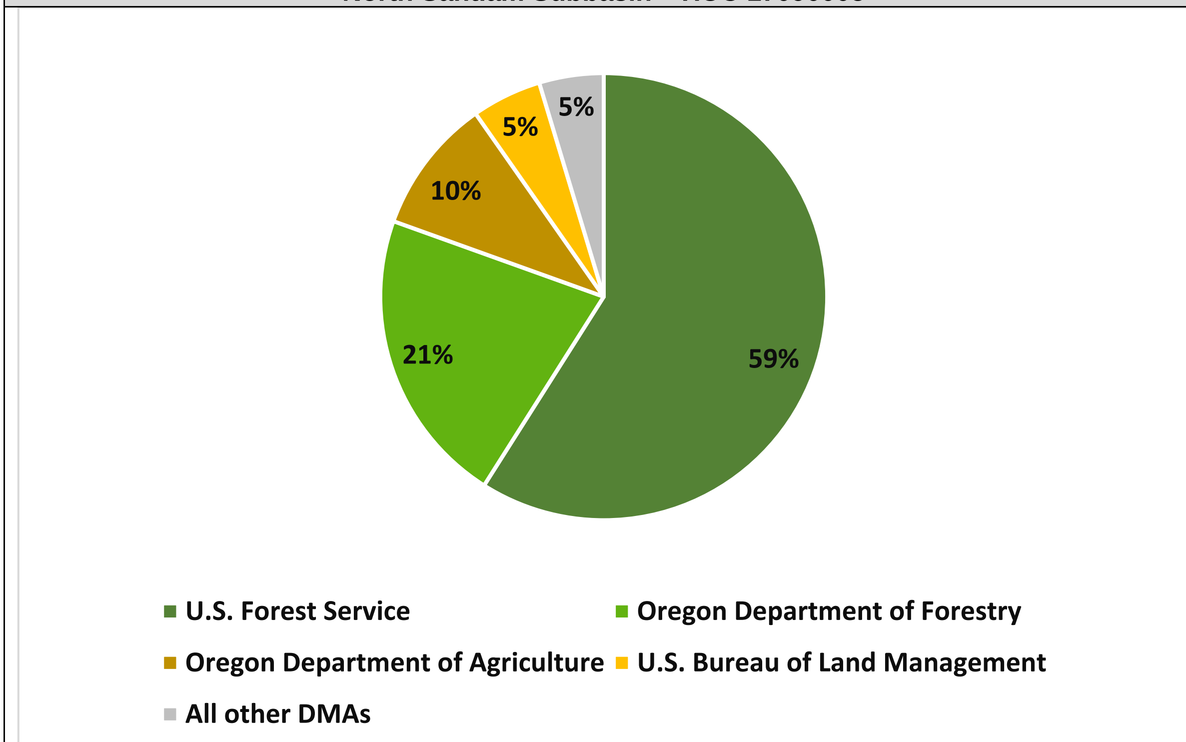
Molalla-Pudding Subbasin – HUC 17090010



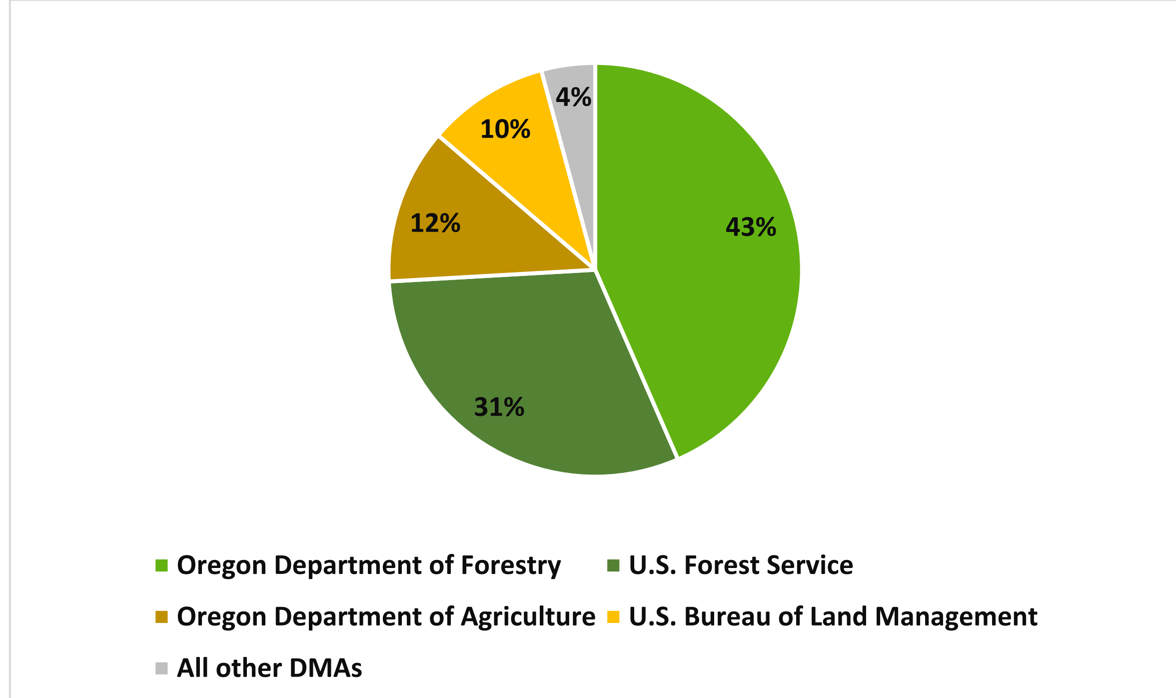
Middle Willamette Subbasin – HUC 17090007



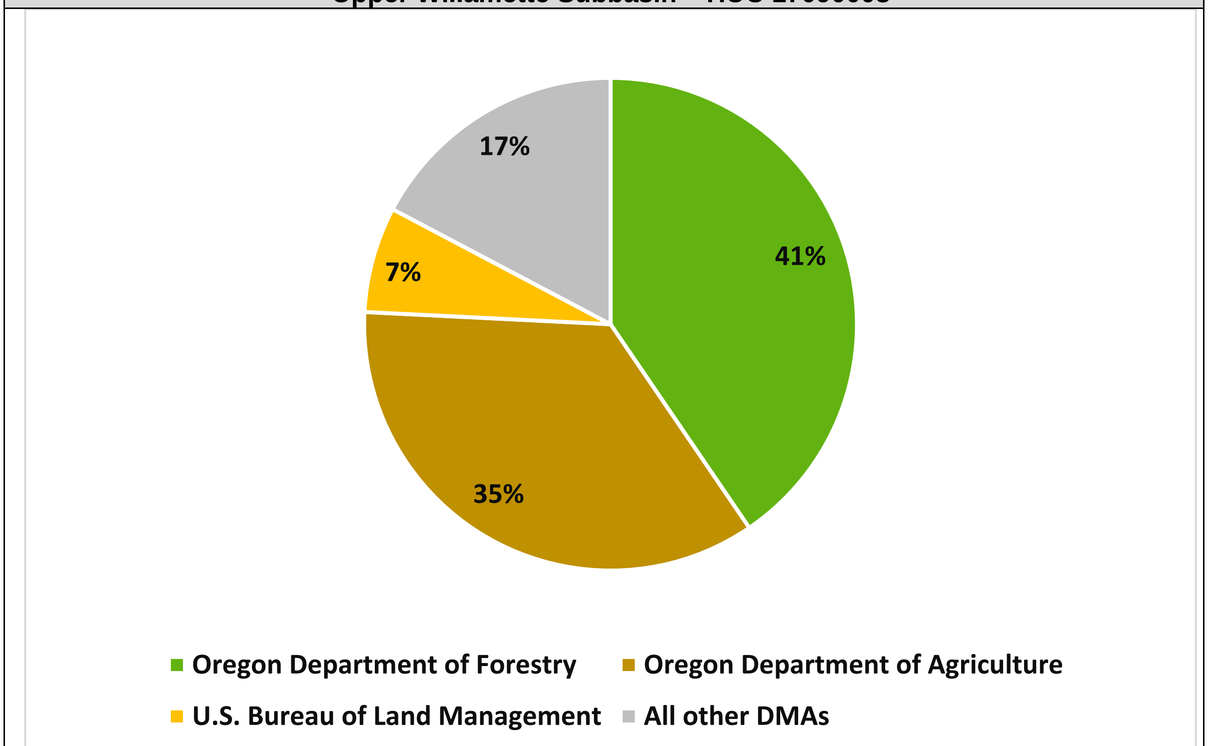
North Santiam Subbasin – HUC 17090005



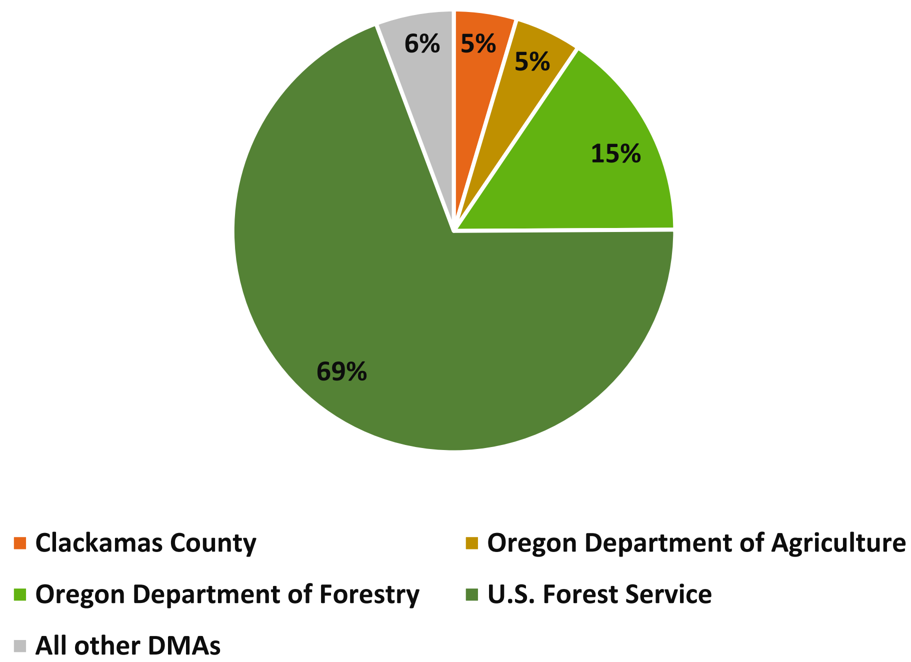
South Santiam Subbasin – HUC 17090006



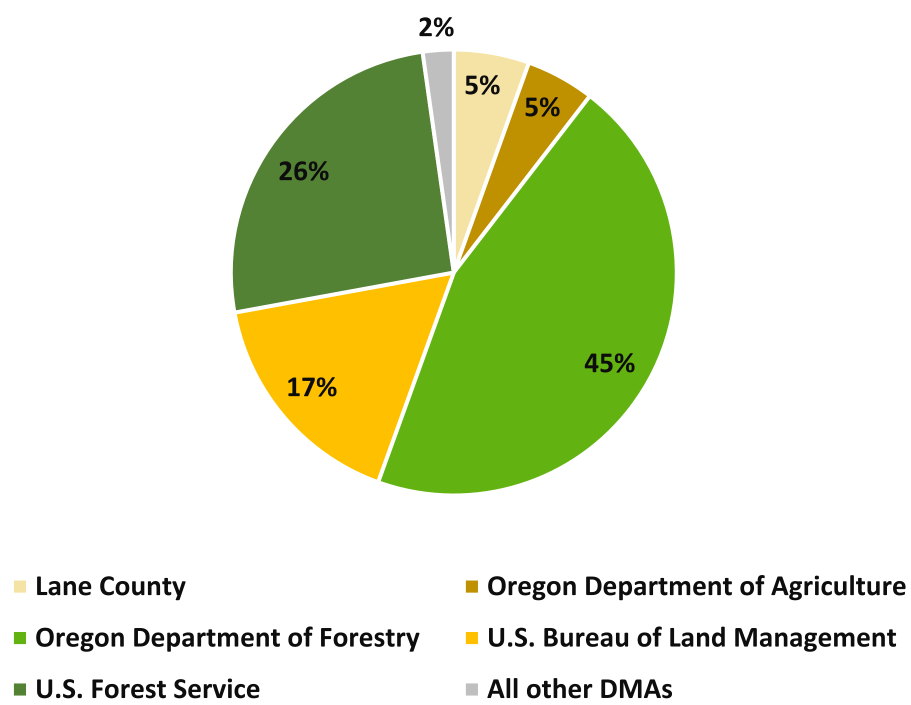
Upper Willamette Subbasin – HUC 17090003



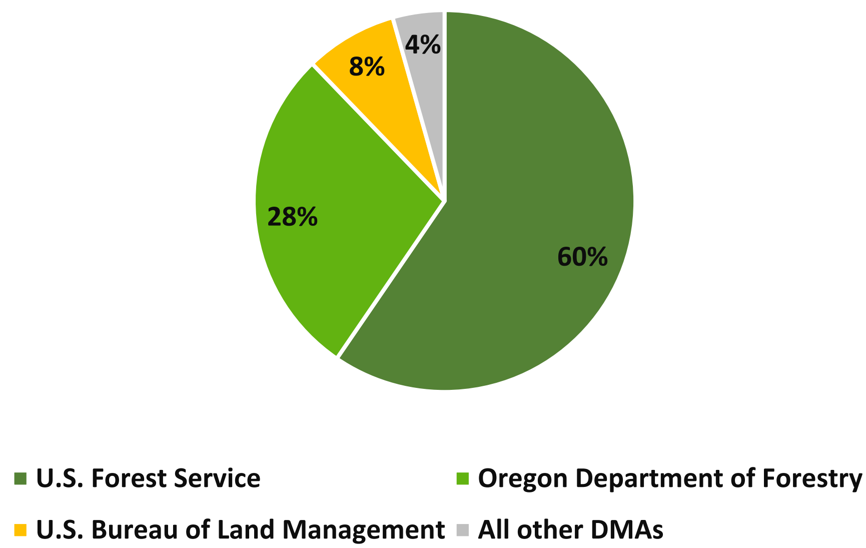
Clackamas Subbasin – HUC 17090011



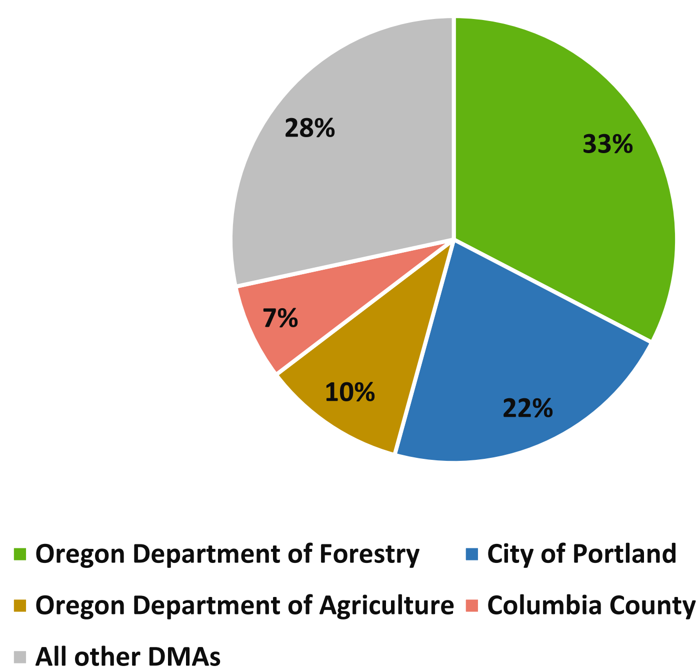
Coast Fork Willamette Subbasin -HUC 17090002



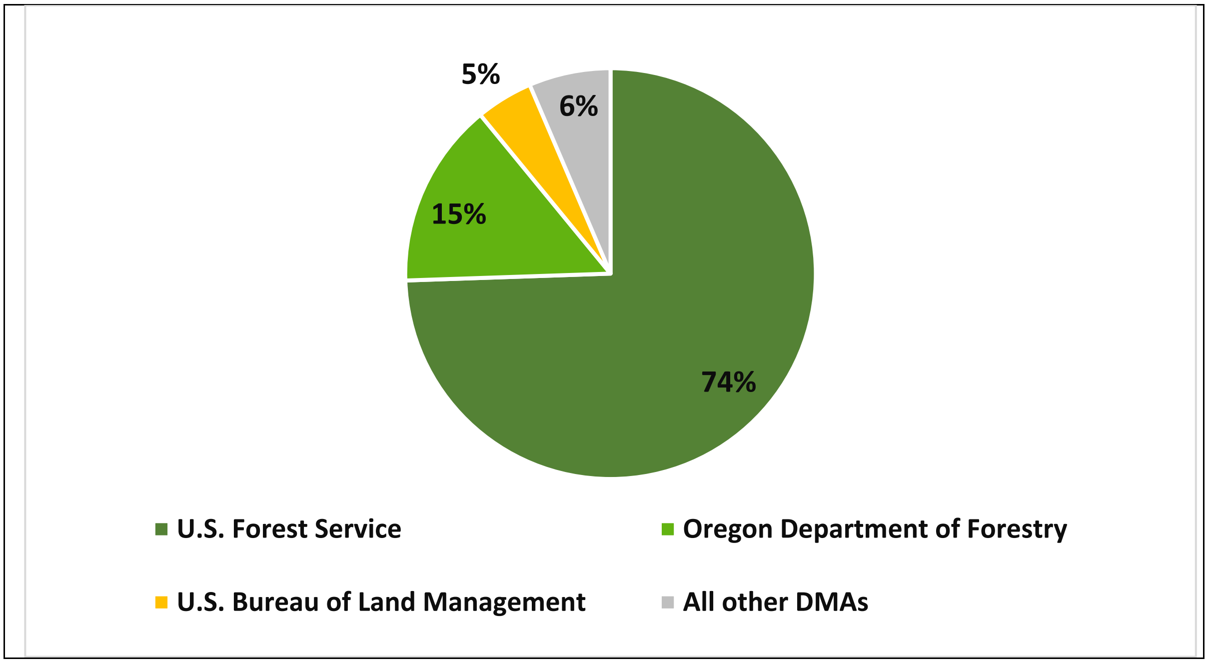
Mckenzie Subbasin – HUC 17090004



Lower Willamette Subbasin – HUC 17090012



Middle Fork Willamette Subbasin – HUC 17090001


5%
6%
15%
74%
U.S. Forest Service
Oregon Department of Forestry
U.S. Bureau of Land Management
All other DMAs

Appendix C: NPDES Permit Issuance Dates

Note: This appendix does not currently include general permittees within the Willamette Mainstem project area who may receive updated WLAs

Permit Type	Planned Issuance Date	Legal Name	Common Name	WQ File No.	Permit No.	EPA No.
NPDES-IW-B21	2026	J.H. Baxter & Co., Inc.	J.H. Baxter & Co., Inc.	6553	102432	OR0021911
NPDES-IW-B21	2026	Mcfarland Cascade Pole & Lumber Company	Mcfarland Cascade Pole & Lumber Co	54370	102392	OR0031003
NPDES-IW-B20	2024	Arauco North America, Inc	Duraflake	97047	100668	OR0000426
NPDES-IW-B20	2025	Kingsford Manufacturing Company	Kingsford Manufacturing Company - Springfield Plant	46000	102153	OR0031330
NPDES-IW-B20	2026	Murphy Company	Murphy Veneer, Foster Division	97070	101777	OR0021741
NPDES-IW-B19	2024	Hull-Oakes Lumber Co.	Hull-Oakes Lumber Co.	107228	101466	OR0038032
NPDES-IW-B19	2025	Sanders Wood Products, Inc.	RSG Forest Products - Liberal	72596	100929	OR0021300
NPDES-IW-B19	2027	Seneca Sawmill Company	Seneca Sawmill Company	80207	101893	OR0022985
NPDES-IW-B17	2027	Oregon Department of Fish & Wildlife	ODFW - Marion Forks Hatchery	64495	101917	OR0027847
NPDES-IW-B17	2023	USDOI; Fish & Wildlife Service	USFW - Eagle Creek National Fish Hatchery	91035	101522	OR0000710
NPDES-IW-B17	2026	Oregon Department of Fish & Wildlife	ODFW - Clackamas River Hatchery	64442	102663	OR0034266
NPDES-IW-B17	2026	Oregon Department of Fish & Wildlife	ODFW - Leaburg Hatchery	64500	101914	OR0027642
NPDES-IW-B17	2026	Oregon Department of Fish & Wildlife	ODFW - Mckenzie River Hatchery	64490	101918	OR0029769
NPDES-IW-B16	2024	Arclin U.S.A. LLC	Arclin	16037	101235	OR0021857

NPDES-IW-B16	2025	Blount, Inc.	Blount Oregon Cutting Systems Division	63545	101162	OR0032298
NPDES-IW-B16	2025	Boeing Company, The	Boeing of Portland - Fabrication Division	9269	101761	OR0031828
NPDES-IW-B16	2026	Columbia Helicopters, Inc.	Columbia Helicopters	100541	101906	OR0033391
NPDES-IW-B16	2027	Eugene Water & Electric Board	EWEB Carmen-Smith	28393	101329	OR0000680
NPDES-IW-B16	2024	Georgia-Pacific Chemicals LLC	Georgia-Pacific Chemicals LLC	32864	101474	OR0002101
NPDES-IW-B16	2025	Georgia-Pacific Chemicals LLC	GP Millersburg Resin Plant	32650	102603	OR0032107
NPDES-IW-B16	2027	Covanta Marion, Inc	Covanta Marion County Solid Waste-To-Energy Facility	89638	101240	OR0031305
NPDES-IW-B15	2027	Fujimi Corporation	Fujimi Corporation - SW Commerce Circle	107178	103033	OR0040339
NPDES-IW-B15	2025	Oregon Department of Corrections	ODC - Oregon State Penitentiary	109727	101619	OR0043770
NPDES-IW-B15	2024	Port of Portland & Co-Applicants	Portland International Airport	107220	101647	OR0040291
NPDES-IW-B15	2027	SFPP, L.P.	SFPP, L.P.	103159	103042	OR0044661
NPDES-IW-B15	2023	Sunstone Circuits, LLC	Sunstone Circuits	26788	101015	OR0031127
NPDES-IW-B15	2027	Valley Landfills, Inc.	Coffin Butte Landfill	104176	101545	OR0043630
NPDES-IW-B15	2025	Starlink Logistics Inc.	Slli	74995	101180	OR0001741
NPDES-IW-B14	2025	Arkema, Inc	Arkema	68471	103075	OR0044695
NPDES-IW-B14	2024	Siltronic Corporation	Siltronic Corporation	93450	101128	OR0030589
NPDES-IW-B14	2028	Northwest Natural	NW Natural Gas Site Remediation	120589	103061	OR0044687
NPDES-IW-B10	2027	Arclin Surfaces, Inc.	Arclin	81714	101544	OR0000892
NPDES-IW-B08	2026	Oregon Metallurgical, LLC	ATI Albany Operations	64300	102223	OR0001716
NPDES-IW-B08	2026	Evraz Inc. Na	Evraz Oregon Steel	64905	101007	OR0000451
NPDES-IW-B07	2024	TDY Industries, LLC	Teledyne Wah Chang Albany	87645	100522	
NPDES-IW-B05	2026	JLR, LLC	JLR, LLC	32536	101253	OR0001015

NPDES-IW-B04	2023	Foster Poultry Farms, Inc.	Foster Farms	97246	101590	OR0026450
NPDES-IW-B04	2023	Norpac Foods, Inc.	Norpac Foods - Brooks Plant No. 5	84791	100907	OR0021261
NPDES-IW-B04	2024	Norpac Foods, Inc.	Norpac Foods-Plant #1, Stayton	84820	101265	OR0001228
NPDES-IW-B01	2024	West Linn Paper Company	West Linn Paper Company	21489	100976	OR0000787
NPDES-DOM-Db	2025	Alpine County Service District	Alpine Community	100101	101923	OR0032387
NPDES-DOM-Db	2026	Aumsville, City of	Aumsville STP	4475	101784	OR0022721
NPDES-DOM-Db	2027	Aurora, City of	Aurora STP	110020	101772	OR0043991
NPDES-DOM-Db	2027	Brownsville, City of	Brownsville STP	11770	102206	OR0020079
NPDES-DOM-Db	2025	Corvallis MHC LLC	Knoll Terrace MHC	46990	102611	OR0026956
NPDES-DOM-Db	2027	Creswell, City of	Creswell STP	20927	101639	OR0027545
NPDES-DOM-Db	2027	Diamond Hill L.L.C.	Sherman Bros. Trucking	36646	101557	OR0021954
NPDES-DOM-Db	2026	Gervais, City of	Gervais STP	33060	101665	OR0027391
NPDES-DOM-Db	2025	Halsey, City of	Halsey STP	36320	101297	OR0022390
NPDES-DOM-Db	2027	Junction City, City of	Junction City STP	44509	102396	OR0026565
NPDES-DOM-Db	2026	Lane Community College	Lane Community College	48854	102116	OR0026875
NPDES-DOM-Db	2023	Molalla, City of	Molalla STP	57613	101514	OR0022381
NPDES-DOM-Db	2027	Philomath, City of	Philomath WWTP	103468	102060	OR0032441
NPDES-DOM-Db	2026	Scio, City Of	Scio STP	79633	101503	OR0029301
NPDES-DOM-Db	2027	Tangent, City of	Tangent STP	87425	102247	OR0031917
NPDES-DOM-Db	2025	Veneta, City of	Veneta STP	92762	102480	OR0020532
NPDES-DOM-Db	2024	Water Environment Services	Wes (Boring STP)	16592	100968	OR0031399
NPDES-DOM-Db	2025	Willamette Leadership Academy	Willamette Leadership Academy	34040	101441	OR0027235
NPDES-DOM-Db	2027	Monroe, City of	Monroe STP	57951	101692	OR0029203
NPDES-DOM-Db	2027	Independence, City of	Independence STP	41513	101217	OR0020443
NPDES-DOM-Db	2025	Monmouth, City of	Monmouth STP	57871	101919	OR0020613
NPDES-DOM-Db	2026	Marion County and Brooks Community Sewer District	Brooks Sewage Treatment Plant	100077	101397	OR0033049

NPDES-DOM-Db	2027	Dundee, City of	Dundee STP	25567	101722	OR0023388
NPDES-DOM-Da	2025	Coburg, City of	Coburg Wastewater Treatment Plant	115851	102979	OR0044628
NPDES-DOM-Da	2026	Estacada, City of	Estacada STP	27866	101542	OR0020575
NPDES-DOM-Da	2025	Falls City, City of	Falls City STP	28830	101808	OR0032701
NPDES-DOM-Da	2027	Hubbard, City of	Hubbard STP	40494	101640	OR0020591
NPDES-DOM-Da	2025	Lakewood Homeowners, Inc.	Lakewood Utilities, Ltd	96110	101781	OR0027570
NPDES-DOM-Da	2027	Mt. Angel, City of	Mt. Angel STP	58707	101802	OR0028762
NPDES-DOM-Da	2027	Oakridge, City of	Oakridge STP	62886	102443	OR0022314
NPDES-DOM-Da	2023	Sandy, City of	Sandy WWTP	78615	102492	OR0026573
NPDES-DOM-Da	2026	US Forest Service	Timberlake STP	90948	101498	OR0023167
NPDES-DOM-Da	2027	Westfir, City of	Westfir STP	94805	100811	OR0028282
NPDES-DOM-Da	2028	Lowell, City of	Lowell STP	51447	101384	OR0020044
NPDES-DOM-Da	2027	Jefferson, City of	Jefferson STP	43129	101780	OR0020451
NPDES-DOM-Da	2025	Adair Village, City of	Adair Village STP	500	101701	OR0023396
NPDES-DOM-Da	2025	Century Meadows Sanitary System, Inc.	Century Meadows Sanitary System (CMSS)	96010	101721	OR0028037
NPDES-DOM-Da	2027	Regency of Oregon, Inc.	Canby Regency Mobile Home Park	97612	101644	OR0026280
NPDES-DOM-Da	2024	Forest Park Mhp, Llc	Forest Park Mobile Village	30554	102323	OR0031267
NPDES-DOM-Da	2028	Scappoose, City of	Scappoose STP	78980	100677	OR0022420
NPDES-DOM-C2a	2026	Cottage Grove, City of	Cottage Grove STP	20306	101300	OR0020559
NPDES-DOM-C2a	2026	Stayton, City of	Stayton STP	84781	101601	OR0020427
NPDES-DOM-C2a	2025	Sweet Home, City of	Sweet Home STP	86840	101657	OR0020346
NPDES-DOM-C1a	2023	Dallas, City of	Dallas STP	22546	101518	OR0020737
NPDES-DOM-C1a	2026	Silverton, City of	Silverton STP	81395	101720	OR0020656
NPDES-DOM-C1a	2025	Woodburn, City of	Woodburn WWTP	98815	101558	OR0020001
NPDES-DOM-C1a	2025	Lebanon, City of	Lebanon WWTP	49764	101771	OR0020818
NPDES-DOM-C1a	2026	Newberg, City of	Newberg - Wynooski Road STP	102894	100988	OR0032352

NPDES-DOM-C1a	2025	Wilsonville, City of	Wilsonville STP	97952	101888	OR0022764
NPDES-DOM-C1a	2028	Canby, City of	Canby STP	13691	101063	OR0020214
NPDES-DOM-C1a	2027	Oak Lodge Water Services District	Oak Lodge Water Services Water Reclamation Facility	62795	100986	OR0026140
NPDES-DOM-Ba	2028	Corvallis, City of	Corvallis STP	20151	101714	OR0026361
NPDES-DOM-Ba	2024	Albany-Millersburg Water Reclamation Facility	AM WRF - Albany-Millersburg Water Reclamation Facility	1098	102024	OR0028801
NPDES-DOM-Ba	2026	Portland, City of	Tryon Creek WWTP	70735	101614	OR0026891
NPDES-DOM-A3	2024	Water Environment Services	Wes Tri-City WPCP	89700	101168	OR0031259
NPDES-DOM-A3	2024	Water Environment Services	Wes Kellogg Creek WWTP	16590	100983	OR0026221
NPDES-DOM-A2	2027	Metropolitan Wastewater Management Commission	MWMC - Eugene/Springfield STP	55999	102486	OR0031224
NPDES-DOM-A2	2026	Salem, City of	Salem Willow Lake STP	78140	101145	OR0026409
GEN03	2024	Oregon Department of Fish & Wildlife	ODFW - Roaring River Hatchery	64525		
GEN03	2024	Oregon Department of Fish & Wildlife	ODFW - Willamette Fish Hatchery	64585		
GEN01	2023	Americold Logistics, LLC	Americold Logistics, LLC	87663		
GEN01	2023	First Premier Properties	Spinnaker Ii Office Building	110603		
GEN01	2023	Forrest Paint Co.	Forrest Paint Co.	100684		
GEN01	2023	Herbert Malarkey Roofing Company	Malarkey Roofing	52638		
GEN01	2023	Holiday Retirement Corp	Holiday Plaza	108298		
GEN01	2023	Hydro Extrusion Portland, Inc.	Hydro Main Plant	3060		

GEN01	2023	Miller Paint Co Inc	Miller Paint Company	103774		
GEN01	2023	Owens-Brockway Glass Container Inc.	Owens-Brockway Glass Container Plant	65610		
GEN01	2023	PCC Structurals, Inc.	PCC Structurals, Inc. - (SSB) Small Structurals Bus. Ops.	71920		
GEN01	2023	Sundance Lumber Company, Inc.	Sundance Lumber Company, Inc.	107401		
GEN01	2023	Ventura Foods, LLC	Ventura Foods, LLC	103832		

Appendix D: List of Large Reservoirs in the Willamette Subbasins TMDL Project Area

DEQ compiled this list of 206 dams located within the Willamette Subbasins temperature TMDL project area from the U.S. Army Corps of Engineers National Inventory of Dams (NID) database and a similar database maintained by the Oregon Water Resources Department, dam safety program (i.e. large dams 10 feet or higher, or store 9.2 acre-feet or more (OAR 690-020-0000)). DEQ requires the 33 **bolded** dams in the table below to conduct monitoring related to temperature. Depending on analytical or modeling results, reservoir owners or operators may be required to develop a TMDL plan for temperature.

No.	Reservoir Name	NID/DAM ID	Owner Names	Owner Types	Primary Purpose	NID Reservoir Storage (Acre-Ft)
1	**Big Cliff Dam**	OR00003	U.S. Army Corps of Engineers	Federal	Hydroelectric	5930
2	**Blue River Dam**	OR00013	U.S. Army Corps of Engineers	Federal	Flood Risk Reduction	89000
3	**Cottage Grove Dam**	OR00005	U.S. Army Corps of Engineers	Federal	Flood Risk Reduction	50000
4	**Cougar Dam**	OR00015	U.S. Army Corps of Engineers	Federal	Flood Risk Reduction	220000
5	**Detroit Dam**	OR00004	U.S. Army Corps of Engineers	Federal	Flood Risk Reduction	455000
6	**Dexter Dam**	OR00006	U.S. Army Corps of Engineers	Federal	Flood Risk Reduction	29900
7	**Dorena Dam**	OR00008	U.S. Army Corps of Engineers	Federal	Flood Risk Reduction	131000
8	**Fall Creek Dam**	OR00007	U.S. Army Corps of Engineers	Federal	Flood Risk Reduction	125000
9	**Fern Ridge Dam**	OR00016	U.S. Army Corps of Engineers	Federal	Flood Risk Reduction	121000

10	Fern Ridge Dam - Dike 1	OR00016	U.S. Army Corps of Engineers	Federal	unknown	9774
11	Fern Ridge Dam - Dike 2	OR00016	U.S. Army Corps of Engineers	Federal	unknown	56647
12	**Foster Dam**	OR00012	U.S. Army Corps of Engineers	Federal	Flood Risk Reduction	61000
13	**Green Peter Dam**	OR00010	U.S. Army Corps of Engineers	Federal	Flood Risk Reduction	430000
14	**Hills Creek Dam**	OR00014	U.S. Army Corps of Engineers	Federal	Flood Risk Reduction	356000
15	**Lookout Point Dam**	OR00009	U.S. Army Corps of Engineers	Federal	Flood Risk Reduction	477700
16	Cackler Marsh Dam/Basket Slough - South	OR03834	U.S. Fish & Wildlife Service	Federal	Fish and Wildlife Pond	964
17	Dusky Marsh Dam	OR03835	U.S. Fish & Wildlife Service	Federal	Fish and Wildlife Pond	299
18	Moffitti Marsh Dam	OR04062	U.S. Fish & Wildlife Service	Federal	Fish and Wildlife Pond	184
19	Morgan Brothers Dam	OR00576	U.S. Fish & Wildlife Service	Federal	Fish and Wildlife Pond	720
20	Parvipes Marsh Dam	OR04063	U.S. Fish & Wildlife Service	Federal	Fish and Wildlife Pond	250
21	Taverner Marsh Dam	OR03852	U.S. Fish & Wildlife Service	Federal	Fish and Wildlife Pond	287
22	Upper Display Pond	OR03774	U.S. Fish & Wildlife Service	Federal	unknown	17.3
23	Findlay Reservoir-Ankeny Natl. Wildlife Refuge	OR00971	U.S. Fish & Wildlife Service	Federal	unknown	9.5
24	Timber Lake	OR00281	U.S. Forest Service	Federal	Recreation	390
25	**Plywood Products Reservoir**	OR02700	City of Adair Village	Local Government	unknown	39
26	**North Fork**	OR00348	City of Corvallis	Local Government	Water Supply	305
27	**Mercer**	OR00524	City of Dallas	Local Government	Water Supply	1550
28	**Binford Dam**	OR00725	City of Gresham	Local Government	Irrigation	30

29	Gresham Stormwater Retention Basin (Lagoon)	OR04021	City of Gresham	Local Government	Stormwater Treatment	38
30	Oakridge Mill Log Pond	OR00168	City of Oakridge	Local Government	Other	380
31	Smith-Bybee Lakes	OR00680	City of Portland	Local Government	Fish and Wildlife Pond	4100
32	**Silver Creek**	OR00622	City of Silverton	Local Government	Water Supply	2500
33	**Salmonberry Reservoir**	OR02958	City of St. Helens	Local Government	Water Supply	61.22
34	Three Creeks Natural Area	OR04083	Clackamas Water Environment Services	Local Government	unknown	57
35	Sullivan Pond 3	OR04077	A & D Sullivan Enterprises Inc.	Private	unknown	65
36	Spada Reservoir #1 (Champoeg)	OR00462	A&R Spada Nursery and Farms	Private	Irrigation	329
37	Fisher, James O Reservoir	OR00515	A.F. Grabhorn	Private	Irrigation	36
38	Aamodt Flashboard Dam	OR00645	Aamodt Dairy Inc.	Private	Irrigation	120
39	Stevens	OR03191	Allen E. Stevens	Private	unknown	11
40	Siegmund Parcel No. 1	OR03058	Andrew Seigmund	Private	unknown	25
41	Qualey Reservoir 1	OR02750	Arthur Qualey	Private	unknown	14
42	Zehner	OR03369	Arthur R. Zehner	Private	unknown	14.3
43	Funrue	OR00519	Aurora; Dan Funrue	Private	Irrigation	126
44	Walker (Bryan Creek)	OR00289	Bailey Nurseries, Inc.	Private	Irrigation	209
45	Baker West Nursery Dam	OR03789	Baker West, Inc.	Private	Fish and Wildlife Pond	16.8
46	Barkdoll Dam	OR03803	Barkdol, Inc.	Private	unknown	9.917
47	Sherman Stock Reservoir #2	OR03041	Bart Grabhorn	Private	unknown	14
48	Mompano	OR00500	Beaverlake Owners Assoc.	Private	Other	780
49	Elmer Farms Dam	OR03367	Ben Elmer Farms	Private	unknown	28.4
50	Polehn Dam	OR03377	Bernard Vancil	Private	unknown	9.5
51	Beyer Reservoir	OR00476	Beyer Lake, Inc	Private	Irrigation	280
52	Rose Reservoir	OR00708	Bill Rose	Private	Irrigation	550

53	Carroll Reservoir	OR01340	Black Berry Hills Ranch LLC	Private	Irrigation	355
54	Herring Reservoir	OR00821	Bland Herring	Private	unknown	12
55	Robert Kuenzi	OR03998	Bob Simmons	Private	unknown	22
56	Stadeli	OR03394	Brooke Craeger-Stadeli	Private	Irrigation	167
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58	Baker, Er	OR00507	Camp Tillicum	Private	Irrigation	250
59	Orchard Heights	OR03165	Carl R. Staats	Private	unknown	12
60	Hills Reservoir (Polk)	OR01925	Chuck & Maxime Dehn	Private	Irrigation	73
61	Koinenia Lake Dam	OR00621	Cindy Jerger	Private	Irrigation	125
62	Bentz Bros. Pond 3	OR01157	Clint Bentz	Private	unknown	31.7
63	S-M-S No. 1	OR00417	Cody & Barbara Duerst	Private	Recreation	57
64	Meridian Reservoir	OR03725	Columbia Trust Co.	Private	Irrigation	95
65	Eola Hills Reservoir	OR01657	Contact Allen Holstein	Private	Irrigation	37
66	Cooper Creek Vineyards	OR04065	Cooper Creek LLC	Private	unknown	100
67	Porter Cc Reservoir (Clackamas)	OR00644	Dan Myrick	Private	Recreation	80
68	Hays Reservoir	OR01894	Daniel & Stacee Hurst	Private	unknown	25
69	Mt. Pisgah	OR03964	David And Bette Mckibben Trust	Private	unknown	45
70	Neil Creek Reservoir	OR00266	Dean Yeager	Private	Irrigation	81
71	P.M. Delaubenfelds Dam	OR00494	Delaubenfeld And Osu Found	Private	Recreation	130
72	Bottem Reservoir #5	OR03779	Dennis & Judy Bottem	Private	unknown	19.9
73	Murry Pond #3	OR03860	Dennis Bottem	Private	unknown	35.7
74	Hickory Hill Farm	OR00231	Dick Day	Private	Irrigation	65
75	Stewart Reservoir #2	OR03799	Don & Alberta Stewart	Private	unknown	16.6
76	Teasel Creek	OR00489	Don Deardorff	Private	Other	90
77	Henderer Reservoir	OR01905	Dorothy Fairchild	Private	unknown	13.9
78	Deardorff, Betty Jane	OR00497	Doubletrees Farms	Private	Other	1300
79	Case Creek Dam 1	OR00504	Douglas & Patricia Krahmer	Private	Irrigation	352
80	Duck Pond Dam	OR03816	Douglas Fries	Private	Recreation	94.6
81	Schewnke	OR00939	Dr. Glenn Schwenke	Private	unknown	10

82	Pettit Reservoir	OR00396	Dr. Virgil E. Pettit	Private	Other	290
83	Abe Ediger Reservoir	OR01009	Dudley And Lauri Walters	Private	Irrigation	85
84	Neil Reservoir	OR02514	E.R. Neil	Private	unknown	9.5
85	Kennel Reservoir	OR00617	Earl Kennel	Private	Irrigation	160
86	Eder	OR03967	Eder Farms Inc	Private	unknown	30.1
87	Kronke	OR03961	Elke Kronke	Private	unknown	14.5
88	Barnes Bros. Reservoir	OR00392	Eric And Pamela Barnes	Private	Irrigation	100
89	Thompson (Benton)	OR00294	Eric Thompson	Private	Recreation	450
90	Peterson, Floyd	OR02665	Erik Rodgers	Private	Recreation	19
91	Fairview Lake	OR03713	Fairview Lake Property Owners Association (FLPOA)	Private	unknown	411
92	Tangen-A. L. Irig Reservoir	OR03256	Flying Feather Orchards, Inc.	Private	unknown	25
93	Ford Farms Reservoir	OR00251	Ford Farms, Inc.	Private	Irrigation	60
94	Silver Falls Log Pond (Marion)	OR00273	Gelco Investment LLC	Private	Irrigation	68
95	Gibson and Gibson Waste Lagoon	OR01793	Gibson & Gibson	Private	unknown	36
96	Whispering Winds	OR00527	Girls Scouts of Oregon & SW Washington	Private	Recreation	100
97	Marcott Reservoir	OR02331	Goldie Marcott	Private	unknown	24.3
98	Circle S Reservoir	OR01383	Gordon and Catherine Tibbitts	Private	unknown	16
99	Lorence Lake	OR00384	Greg & Kara Pilcher	Private	Other	160
100	Skylane Farms Reservoir 3	OR03079	Gregory R & Deborah D Cochell	Private	unknown	13.5
101	Mulkey, Gryland Reservoir	OR02485	Gylan Mulkey	Private	Irrigation	50
102	Bryant Dam (Marion)	OR03786	H. Richard Bryant	Private	unknown	27.7
103	Winters (Lower)	OR03764	H.E. Winters Sanders Family Farm LLC	Private	unknown	9.4
104	Kuehne Dam	OR00216	Harold Kuehne	Private	Irrigation	110
105	Golliday, Paul	OR00954	Harold Schipporeit	Private	unknown	13
106	Buche (Clackamas)	OR00766	Harvey Buche	Private	Recreation	81
107	Deep Creek Reservoir	OR01518	Hays/Shainsky and Judas Crop	Private	unknown	10
108	Schindler Reservoir	OR02980	Henry & Albert Schindler	Private	unknown	15

109	Kyllo Reservoir	OR02124	Henry Kyllo	Private	unknown	44
110	Berger Lake	OR01158	Hidden Lakes Recreation Association Attn: Dan Schlottmann	Private	Irrigation	45
111	Hull-Oakes Lumber Company Reservoir	OR01986	Hull-Oakes Lumber Company	Private	unknown	
112	Kreder Reservoir	OR00478	Jack Platt	Private	Irrigation	162
113	Maple Grove	OR03773	Jackson Family Wines	Private	Irrigation	210
114	Payne Lake No. 1	OR02137	James L. Payne	Private	unknown	30
115	River Bend No. 2	OR00434	James L. Payne	Private	Irrigation	50
116	Heater Reservoir #2	OR00729	James M. Heater	Private	Irrigation	42.5
117	Borris Reservoir	OR01234	James Swanek	Private	unknown	22
118	Sherman Stock Reservoir #1	OR03040	Jeff Heller	Private	Irrigation	36
119	Moore-Emory	OR00382	Jerald and Carol Bush	Private	Irrigation	166
120	Isakson Reservoir	OR00674	Jerry Isakson	Private	Recreation	29
121	Mission Creek Dam and Reservoir Company	OR00520	Jerry Mullen	Private	Irrigation	1590
122	Heater Dam	OR01899	Jim Heater	Private	Irrigation	32
123	Evans Pro. Company Sawmill Reservoir	OR00927	Jimmy W. Evans	Private	unknown	11
124	Drescher Reservoir	OR01574	John Drescher	Private	Irrigation	21
125	Schwartz Reservoir	OR02978	John Inda	Private	Irrigation	20
126	Jyn Dam	OR03807	Jyn Inc	Private	unknown	13.8
127	Adkins "B" Reservoir	OR03749	Kathryn J Adkins	Private	unknown	12
128	Tribbett Reservoir	OR00687	Kelly Farms	Private	Recreation	31
129	Knudsen Reservoir #2	OR03775	Knudson Vineyards	Private	unknown	11.5
130	Kraemer Farms Dam	OR03781	Kraemer Farms, Inc.	Private	Irrigation	125
131	Waldo Lake	OR00349	Krautmann Family Nursery, LLC	Private	Irrigation	56
132	Westbrook Dam	OR03805	Krautmann Family Nursery, LLC	Private	Fish and Wildlife Pond	141.2
133	Youngblood Dam	OR00811	Kyle R & Lori J Sherman	Private	unknown	30
134	Little Pudding	OR04073	Lake Labish Water Control Dist	Private	unknown	

135	Oswego Lake Dam	OR00237	Lake Oswego Corporation	Private	Hydroelectric	9800
136	Lakewood Estates	OR03731	Lakewood Homeowners, Inc.	Private	unknown	78
137	Lakewood Estates Sewage Lagoon	OR03918	Lakewood Utilities, Ltd.	Private	unknown	17
138	O.E.Loe Dam 2 Porter Place	OR02721	Larie Loe	Private	Irrigation	25
139	Kuenzi, Lee A.	OR03392	Lee A. Kuenzi	Private	unknown	15
140	Ed Zach A	OR01635	Lee Wallace	Private	unknown	33.5
141	Veterans Reservoir	OR00102	Lincoln Memorial Cemetery	Private	Irrigation	18
142	Griffith Reservoir	OR01832	LSH Investments	Private	unknown	45
143	Manton Carl Dam	OR03987	Manton Carl	Private	unknown	11.5
144	Fredericks Pond	OR00620	Maple Leaf Lake Homeowners Association	Private	Irrigation	48
145	Johnson Creek Reservoir (Linn)	OR02051	Marion Cota	Private	unknown	10.5
146	Gehring Reservoir (Towery Dam)	OR00314	Mark Gehring	Private	Irrigation	50
147	Mueller	OR04018	Mark Herkamp	Private	unknown	12.7
148	Mckay Acres Dam	OR00484	Mark Mckay	Private	Irrigation	510
149	Peyralans Reservoir	OR02671	Marpol Ridge HOA	Private	esthetics	12
150	Anderson - Roy Reservoir	OR00710	MBK 35803 LLC	Private	Recreation	32
151	Powell Reservoir (Lane)	OR00829	Michael Fix	Private	unknown	24
152	Rogers - Joseph Reservoir	OR00492	Michael P. Warn	Private	Irrigation	40
153	Marx Reservoir #1	OR00389	Mike Sweeney, Cherry Hill Winery	Private	Irrigation	85
154	Helms Reservoir	OR00455	Miller Forests, Inc.	Private	Irrigation	120
155	Marx, Emil #2	OR02340	Mountain Spring Farms, LLC	Private	unknown	35
156	Foster Log Pond	OR00159	Murphy Company Foster Veneer	Private	Other	375
157	Neal Miller	OR03395	Neal Miller	Private	unknown	31.3
158	Haberlach Dam	OR00880	Old North State Trust, LLC	Private	Irrigation	15
159	Fleshman Reservoir 2	OR01722	Orval & Margaret Fleshman	Private	unknown	10.6
160	Forcia and Larsen Log Pond	OR00099	Peggy Kraft, Don Merkle	Private	Other	90
161	Bye Reservoir	OR01317	Perl Bye	Private	unknown	13
162	Zenczak Reservoir	OR03637	Piotr Zenczak	Private	unknown	13

163	**Faraday Diversion**	OR00551	Portland General Electric Company	Private	Hydroelectric	1200
164	**Faraday Forebay**	OR00245	Portland General Electric Company	Private	Hydroelectric	550
165	**Harriet Lake**	OR00546	Portland General Electric Company	Private	Hydroelectric	400
166	**North Fork**	OR00550	Portland General Electric Company	Private	Hydroelectric	18630
167	**River Mill**	OR00552	Portland General Electric Company	Private	Hydroelectric	2300
168	**Timothy Lake**	OR00545	Portland General Electric Company	Private	Hydroelectric	69000
169	Bull Frog Lake	OR01296	Ray Derby, President	Private	unknown	21.5
170	Schaefer, Ray Reservoir	OR03380	Ray Schaefer	Private	Irrigation	18
171	Mitchell - Stanley Reservoir	OR00706	Richard Satnick	Private	Irrigation	42
172	Vandecoevering	OR03863	Ron Vandecoevering	Private	Irrigation	87
173	Vaughn Log Gibson Reservoir Pond	OR00198	Rosboro, LLC	Private	Other	132
174		OR00672	Roserock West 2, LLC	Private	unknown	32
175	Cedar Grove Lake	OR01351	Ryan J Dissen	Private	Irrigation	14.2
176	Sandy Farms No. 1-A	OR00709	Sandy Farms, C/O Bob Underwood	Private	Irrigation	49
177	Spring Lake Estates	OR00532	Spring Lake Estates	Private	Recreation	120
178	Delaubenfels	OR03944	Starker Forests, Inc	Private	Irrigation	84
179	Tadmore Lake Dam	OR03252	Steve Ellingboe	Private	unknown	29
180	Alderwood	OR01020	Swanson Bros. Lumber Company	Private	unknown	12
181	Willards Pool	OR00179	Terry Caster	Private	Recreation	680
182	Devers Reservoir 1	OR01538	Todd Bartlem	Private	unknown	9.7
183	FOX NO. 2	OR01756	Tom Fox	Private	unknown	21
184	Fox Reservoir	OR00236	Tom Fox	Private	Irrigation	120
185	Croft	OR00415	Waldensee LLC	Private	Irrigation	137
186	Zielinski Farm Reservoir	OR00711	Wally Zelinski	Private	Irrigation	41

187	Bremer Reservoir	OR01253	Warren W. Bremer	Private	unknown	27
188	Bohemia Pond C	OR02715	Weyerhaeuser Company	Private	unknown	47
189	Day Reservoir	OR03411	William Day	Private	Irrigation	12.2
190	Fry Reservoir	OR01775	William Fry	Private	unknown	15.7
191	Woodburn Nursery	OR03862	Woodburn Nursery And Azaleas, Inc.	Private	Other	40
192	Serres Reservoir	OR03010	Woodburn Organic Farms, LLC	Private	unknown	10
193	**Carmen Diversion**	OR00539	Eugene Water and Electric Board	Public Utility	Hydroelectric	260
194	**Leaburg**	OR00553	Eugene Water and Electric Board	Public Utility	Hydroelectric	345
195	**Leaburg Canal and Forebay**	OR00553	Eugene Water and Electric Board	Public Utility	Hydroelectric	459
196	**Smith**	OR00541	Eugene Water and Electric Board	Public Utility	Hydroelectric	17530
197	**Trail Bridge**	OR00540	Eugene Water and Electric Board	Public Utility	Hydroelectric	2263
198	Trail Bridge Saddle Dike	OR00540	Eugene Water and Electric Board	Public Utility	Hydroelectric	2263
199	**Walterville Forebay**	OR00600	Eugene Water and Electric Board	Public Utility	Hydroelectric	275
200	**Walterville Storage Pond**	OR00267	Eugene Water and Electric Board	Public Utility	Hydroelectric	345
201	Adair Pond	OR01012	Oregon Dept. of Fish & Wildlife	State	unknown	43
202	Petes Slough	OR00643	Oregon Dept. of Fish & Wildlife	State	Recreation	2000
203	**Lebanon Dam**	OR04067	City of Albany	Local Government	Water Supply	149
204	Multnomanh Channel Dam #2	OR03823	Metro Parks & Greenspaces	Private	Fish and Wildlife Pond	240
205	Willamette Falls	OR00596	Portland General Electric Company	Private	Hydroelectric	17000
206	Willamette Falls Locks	OR00596	USACE - Portland District	Federal	Navigation	17000

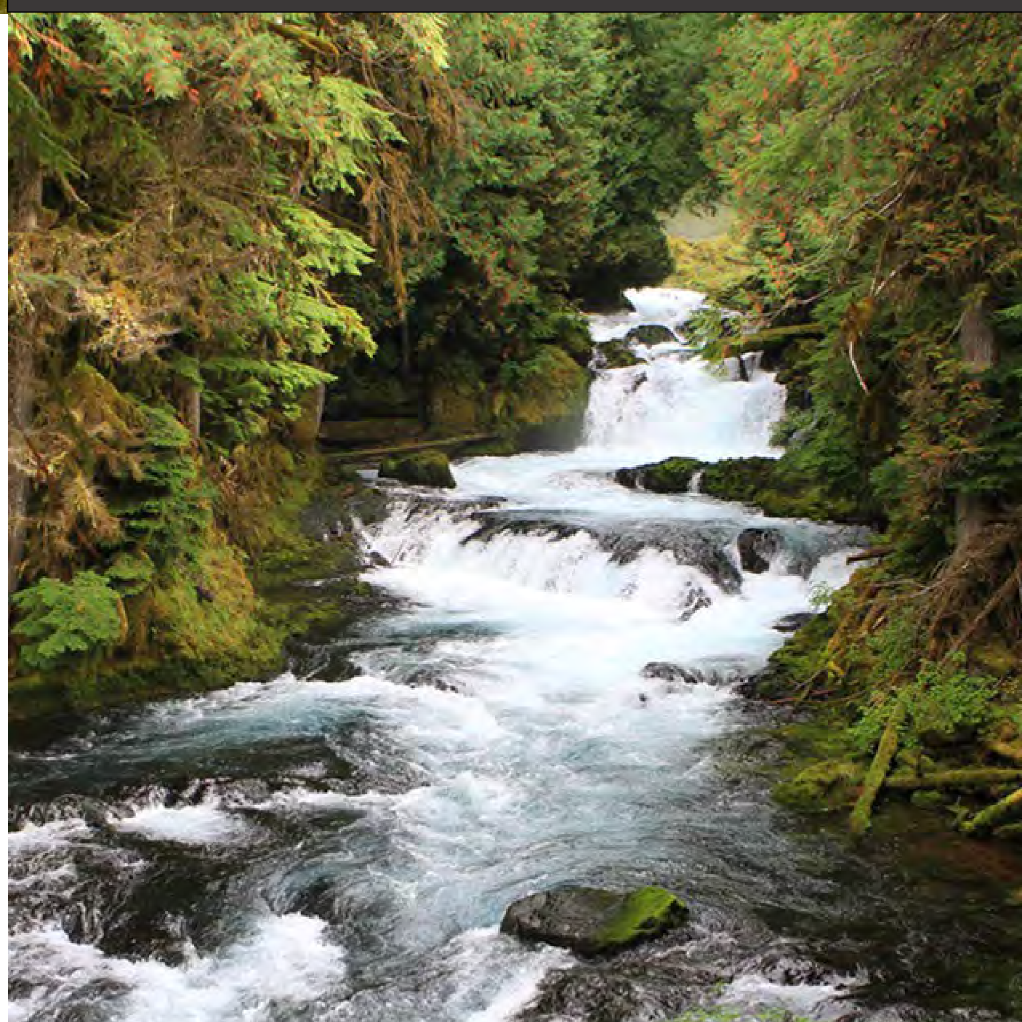
Total Maximum Daily Loads for the Willamette Subbasins

Technical Support Document

Temperature

Amended to include the Willamette River and major tributaries - DRAFT

August 2024



State of Oregon
DEQ Department of Environmental Quality

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Acronyms

Listed acronyms apply to this document and its appendices.

7DADM	7-Day Average Daily Maximum
7Q10	7-Day, 10-Year Low Flow
ADWDF	Average Dry Weather Design Flow
AU	Assessment Unit
AWQMS	Ambient Water Quality Monitoring System
BG	Background Source
BLM	U.S. Bureau of Land Management
CFR	Code of Federal Regulations
cfs	Cubic Feet per Second
DEM	Digital Elevation Model
DEQ	Oregon Department of Environmental Quality
DMA	Designated Management Agency
DMR	Discharge Monitoring Report
DOGAMI	Oregon Department of Geology and Mineral Industries
DOQ	Digital Orthophoto Quad
DQL	Data Quality Level
DSM	Digital Surface Model
EPA	Environmental Protection Agency
EQC	Oregon Environmental Quality Commission
ETL	Excess Thermal Load
EWEB	Eugene Water and Electric Board
GIS	Geographic Information System
GLO	General Land Office
GNIS	USGS Geographic Names Information System
HTML	Hyper Text Markup Language
HUA	Human Use Allowance
HUC	Hydrologic Unit Code
IMD	Internal Management Directive
LA	Load Allocation
LAC	Local Advisory Committee
LC	Loading Capacity
LiDAR	Light Detection and Ranging
LT50	Lethal Time 50
MF	Middle Fork
MGD	Millions of Gallons per Day
MOS	Margin of Safety
MS4	Municipal Separate Storm Sewer System
MWMT	Maximum Weekly Maximum Temperature
NA	Not Applicable

NHD	National Hydrography Dataset
NID	National Inventory of Dams
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NPS	Nonpoint Source
NWI	National Wetland Inventory
OAR	Oregon Administrative Rules
ODA	Oregon Department of Agriculture
ODC	Oregon Department of Corrections
ODF	Oregon Department of Forestry
ODFW	Oregon Department of Fish & Wildlife
ORS	Oregon Revised Statutes
OWRD	Oregon Water Resources Department
PCW	Protecting Cold Water
PGE	Portland General Electric
POD	Points of Diversion
POMI	Point of Maximum Impact
PRISM	Parameter-elevation Regressions on Independent Slopes Model
RC	Reserve Capacity
SCS	Soil Conservation Service
SF	South Fork
SIA	Strategic Implementation Area
SIC	Standard Industrial Classification
STP	Sewage Treatment Plant
SWCD	Soil and Water Conservation District
TIR	Thermal Infrared Radiometry
TMDL	Total Maximum Daily Load
TSD	Technical Support Document
USACE	U.S. Army Corps of Engineers
USFS	U.S. Department of Agriculture Forest Service
USGS	United States Geological Survey
WDOE	Washington Department of Ecology
WLA	Wasteload Allocation
WQMP	Water Quality Management Plan
WTP	Water Treatment Plant
WWTP	Wastewater Treatment Plant

1 Introduction

1.1 Document purpose and organization

This document provides comprehensive supporting information on technical analyses completed for the Total Maximum Daily Load (TMDL) and Water Quality Management Plan (WQMP) for addressing temperature impairments in the waters of the Willamette Subbasins. This document provides explanations of TMDL concepts and analysis and support for conclusions and requirements included in the Willamette Subbasins TMDL and WQMP, which have been adopted by Oregon's Environmental Quality Commission (EQC), by reference, in Oregon Administrative Rules (OAR) 340-42-0090. EQC adopted revisions to the Willamette Subbasins TMDL and WQMP rule on [DATE TBA]. The TMDL and WQMP were revised to add temperature TMDLs for the Willamette River, Multnomah Channel, and tributaries to the Willamette River downstream of the following dams: River Mill Dam, Detroit Dam, Foster Dam, Fern Ridge Dam, Dexter Dam, Fall Creek Dam, Dorena Dam, and Cottage Grove Dam. The name of this project area is the Willamette River mainstem and major tributaries.

This document is organized into sections with titles reflective of the TMDL elements required by Oregon Administrative Rule OAR 340-042-0040(4) in the Willamette Subbasins TMDL for temperature. This organization is intended to assist readers in readily accessing the information relied on for TMDL element-specific determinations.

1.2 Overview of TMDL elements

According to OAR 340-042-0030(15) Definitions: Total Maximum Daily Load means a written quantitative plan and analysis for attaining and maintaining water quality standards and includes the elements described in OAR 340-042-0040. Determinations on each element are presented in the Willamette Subbasins TMDL for temperature. Technical and policy information supporting those determinations are presented in this report at the section headings that correspond to the TMDL elements for which complex analysis was undertaken.

In plain language, a TMDL is a water quality budget plan to ensure that the receiving waterbody can attain water quality standards that protect beneficial uses of the water. This budget calculates and assigns pollutant loads for discharges of point (end of pipe) and nonpoint (landscape) sources, in consideration of natural background levels, along with determination of a margin of safety and reserve capacity.

A margin of safety (MOS) accounts for the uncertainty in predicting how well pollutant reductions will result in meeting water quality standards and can be expressed either explicitly, as a portion of the allocations, or implicitly, by incorporating conservative assumptions into the analyses.

Reserve capacity (RC) sets aside some portion of the loading capacity for pollutant discharges that may result from future growth and new or expanded sources.

A key element of analysis is the amount of pollutant that a waterbody can receive and still meet the applicable water quality standard, and is referred to as the "loading capacity" (LC) of a waterbody. Because the loading capacity must not be exceeded by pollutant loads from all existing sources, plus the margin of safety and reserve capacity, it can be considered the maximum load. Hence, the loading capacity is often referred to as the TMDL. A loading capacity, or TMDL, is calculated on each assessment unit (AU) for each applicable temperature criteria in the TMDL project area. An AU is a partition (segment) of the state's waterbodies (streams, river, lakes, estuaries, etc.) into manageable units. The Integrated Report makes assessment conclusions for each AU.

Another key element of analysis is allocating portions of the loading capacity or TMDL to known sources. Allocations are quantified measures that assure water quality standards will be met and may distribute the pollutant loads between nonpoint and point sources. "Load allocations" are portions of the loading capacity that are attributed to: 1) nonpoint sources such as urban, agriculture, rural residential or forestry activities; and 2) natural background sources such as soils or wildlife. "Wasteload allocations" (WLAs) are portions of the total load that are allotted to point sources of pollution, such as permitted discharges from sewage treatment plants, industrial wastewater or stormwater. As noted above, allocations can also be reserved for future uses, termed "reserve capacity."

This general TMDL concept is represented by the following equation:

$$\text{TMDL} = \sum \text{Wasteload Allocations} + \sum \text{Load Allocations} + \text{Reserve Capacity} + \text{Margin of Safety}$$

Together, these elements establish the pollutant loads necessary to meet the applicable water quality standards for impaired pollutants and protect beneficial uses.

2 TMDL location and scope

The Willamette Subbasins comprise ten 8-digit hydrologic unit code (HUC) subbasins, including the Middle Fork Willamette Subbasin (HUC 17090001), Coast Fork Willamette Subbasin (HUC 17090002), Upper Willamette Subbasin (HUC 17090003), McKenzie Subbasin (HUC 17090004), North Santiam Subbasin (HUC 17090005), the South Santiam Subbasin (HUC 17090006), Middle Willamette Subbasin (HUC 17090007), Molalla-Pudding Subbasin (HUC 17090009), Clackamas Subbasin (HUC 17090011), and Lower Willamette Subbasin (HUC 17090012) (**Table 2-1**).

Temperature TMDLs for the Willamette Subbasins address all Category 5 listed assessment units (AUs) impaired for temperature on Oregon's 2022 Section 303(d) list (identified in Section 2.1) and, as applicable, any AUs identified as temperature impaired in the future. Likewise, this TMDL includes a protection plan for all other assessment categories including AUs identified as a potential concern, attaining, or unassessed. The map in **Figure 2-1** provides an overview of where the temperature TMDLs are applicable. In total, the TMDL applies to 958 AUs. Appendix D of the Willamette Subbasin Technical Support Document (TSD) provides a list of all AUs addressed by the TMDL.

The loading capacity, allocations, surrogate measures, and implementation framework apply to all waters in the Willamette Subbasins determined to be waters of the state as defined under Oregon Revised Statutes ORS 468B.005(10), including all perennial and intermittent streams that have surface flow or residual pools during the TMDL allocation period. The rationale for applying TMDL allocations to intermittent streams (and potential exceptions) is summarized in Section 2.4.

Table 2-1: HUC8 codes and names in the Willamette Subbasins.

HUC8	Subbasin Name
17090001	Middle Fork Willamette
17090002	Coast Fork Willamette
17090003	Upper Willamette
17090004	McKenzie
17090005	North Santiam
17090006	South Santiam
17090007	Middle Willamette
17090009	Molalla-Pudding
17090011	Clackamas
17090012	Lower Willamette

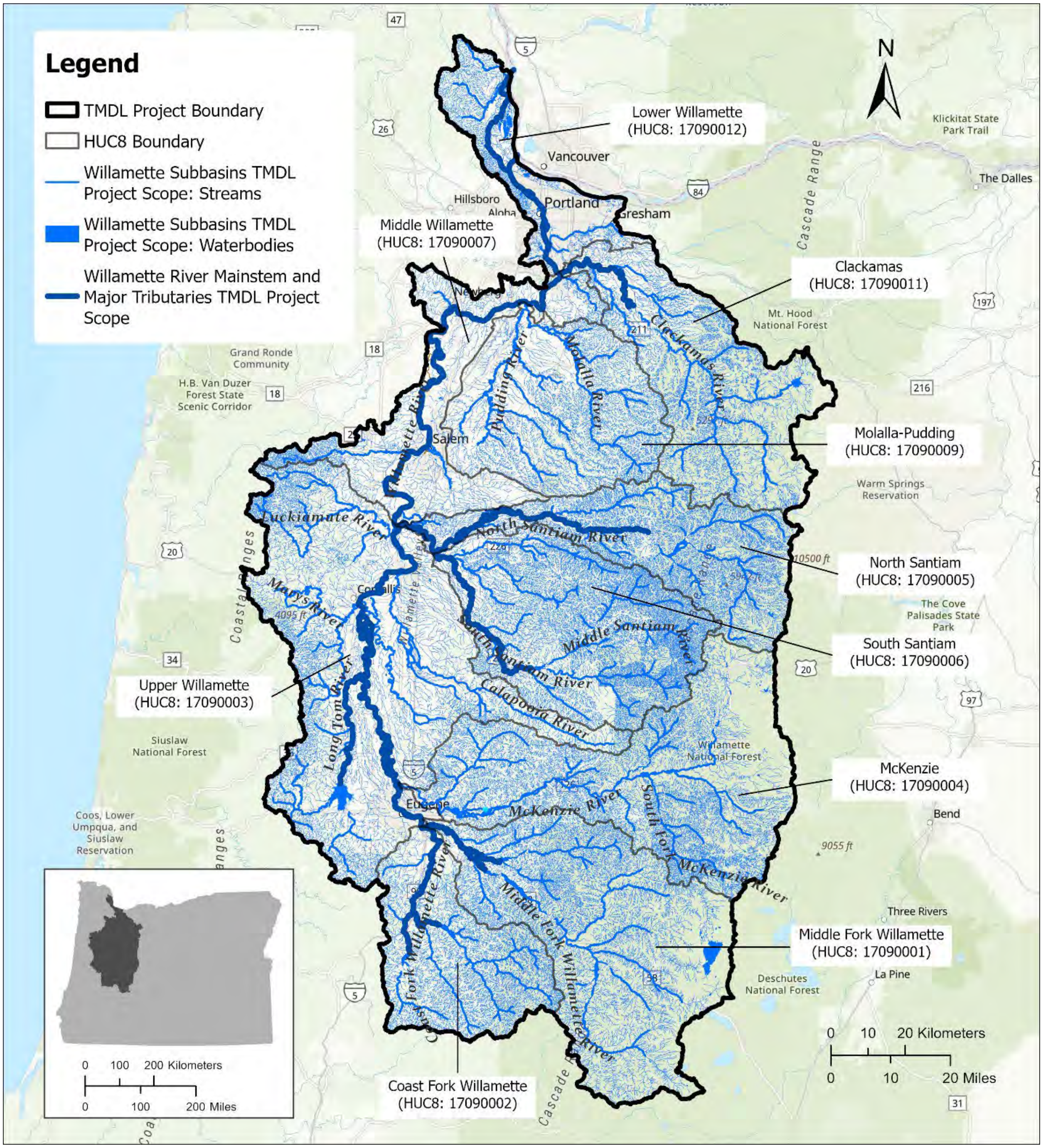


Figure 2-1: Willamette Subbasins temperature TMDLs project area overview.

2.1 Impaired waters

Table 2-2 through **Table 2-11** present stream AUs within the Willamette Subbasins 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 EPA on September 1, 2022. Status category designations are prescribed by Sections 305(b) and 303(d) of the Clean Water Act. AUs 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 AUs are depicted in **Figure 2-2**.

In total, the 2022 Integrated Report identifies 321 Category 5 temperature impairments in the Willamette Subbasins. Some of these AUs have both year-round and spawning use designations impaired. If both use designations are impaired, it is considered two listings. Counting only AUs, there are 253 unique AUs with Category 5 temperature impairments.

Table 2-2: Middle Fork Willamette Subbasin (17090001) Category 5 temperature impairments on the 2022 Integrated Report.

AU ID	AU Name	Use Period
OR_SR_1709000106_02_103722	Christy Creek	Spawning
OR_SR_1709000109_02_103735	Fall Creek	Year Round
OR_SR_1709000109_02_103735	Fall Creek	Spawning
OR_SR_1709000109_02_103736	Fall Creek	Year Round
OR_SR_1709000109_02_103736	Fall Creek	Spawning
OR_SR_1709000109_02_103737	Fall Creek	Year Round
OR_SR_1709000109_02_103737	Fall Creek	Spawning
OR_SR_1709000109_02_103743	Fall Creek	Year Round
OR_SR_1709000109_02_103743	Fall Creek	Spawning
OR_LK_1709000109_02_100701	Fall Creek Lake	Year Round
OR_SR_1709000109_02_103734	Hehe Creek	Year Round
OR_SR_1709000102_02_103715	Hills Creek	Year Round
OR_SR_1709000102_02_103715	Hills Creek	Spawning
OR_SR_1709000110_02_103749	Hills Creek	Year Round
OR_WS_170900010904_02_104219	HUC12 Name: Andy Creek-Fall Creek	Year Round
OR_WS_170900010502_02_104200	HUC12 Name: Buck Creek-Middle Fork Willamette River	Year Round
OR_WS_170900010501_02_104199	HUC12 Name: Coal Creek	Year Round
OR_WS_170900010608_02_104210	HUC12 Name: Dartmouth Creek-North Fork Middle Fork Willamette River	Year Round
OR_WS_170900010701_02_104211	HUC12 Name: Deception Creek-Middle Fork Willamette River	Year Round
OR_WS_170900010901_02_104216	HUC12 Name: Delp Creek-Fall Creek	Year Round
OR_WS_170900010703_02_104213	HUC12 Name: Dexter Reservoir-Middle Fork Willamette River	Year Round
OR_WS_170900010106_02_104190	HUC12 Name: Echo Creek-Middle Fork Willamette River	Year Round
OR_WS_170900010607_02_104209	HUC12 Name: Eighth Creek-North Fork Middle Fork Willamette River	Year Round
OR_WS_170900010505_02_104202	HUC12 Name: Gray Creek-Middle Fork Willamette River	Year Round
OR_WS_170900010702_02_104212	HUC12 Name: Lost Creek	Year Round
OR_WS_170900010202_02_104192	HUC12 Name: Lower Hills Creek	Year Round
OR_WS_170900010403_02_104198	HUC12 Name: Lower Salmon Creek	Year Round
OR_WS_170900010303_02_104195	HUC12 Name: Lower Salt Creek	Year Round
OR_WS_170900010303_02_104195	HUC12 Name: Lower Salt Creek	Spawning
OR_WS_170900010302_02_104194	HUC12 Name: Middle Salt Creek	Year Round
OR_WS_170900010503_02_104201	HUC12 Name: Packard Creek-Middle Fork Willamette	Year Round
OR_WS_170900010105_02_104189	HUC12 Name: Staley Creek	Year Round
OR_WS_170900010102_02_104186	HUC12 Name: Tumblebug Creek	Year Round
OR_WS_170900010402_02_104197	HUC12 Name: Upper Salmon Creek	Year Round
OR_WS_170900010905_02_104220	HUC12 Name: Winberry Creek	Year Round
OR_SR_1709000108_02_103730	Little Fall Creek	Year Round
OR_SR_1709000108_02_103730	Little Fall Creek	Spawning
OR_SR_1709000109_02_103742	Logan Creek	Year Round
OR_SR_1709000107_02_103727	Lost Creek	Year Round

AU ID	AU Name	Use Period
OR_SR_1709000107_02_103727	Lost Creek	Spawning
OR_SR_1709000107_02_103728	Lost Creek	Year Round
OR_SR_1709000107_02_103728	Lost Creek	Spawning
OR_SR_1709000101_02_103713	Middle Fork Willamette River	Year Round
OR_SR_1709000105_02_104579	Middle Fork Willamette River	Year Round
OR_SR_1709000105_02_104580	Middle Fork Willamette River	Year Round
OR_SR_1709000105_02_104580	Middle Fork Willamette River	Spawning
OR_SR_1709000107_02_103725	Middle Fork Willamette River	Year Round
OR_SR_1709000107_02_103725	Middle Fork Willamette River	Spawning
OR_SR_1709000107_02_104583	Middle Fork Willamette River	Year Round
OR_SR_1709000107_02_104583	Middle Fork Willamette River	Spawning
OR_SR_1709000110_02_104584	Middle Fork Willamette River	Year Round
OR_SR_1709000110_02_104584	Middle Fork Willamette River	Spawning
OR_SR_1709000106_02_103721	North Fork Middle Fork Willamette River	Year Round
OR_SR_1709000106_02_103721	North Fork Middle Fork Willamette River	Spawning
OR_SR_1709000106_02_103723	North Fork Middle Fork Willamette River	Year Round
OR_SR_1709000109_02_103738	North Fork Winberry Creek	Year Round
OR_LK_1709000105_02_100684	Packard Creek	Year Round
OR_SR_1709000105_02_104578	Packard Creek	Year Round
OR_SR_1709000109_02_103741	Portland Creek	Year Round
OR_SR_1709000109_02_103744	Portland Creek	Year Round
OR_SR_1709000104_02_103719	Salmon Creek	Year Round
OR_SR_1709000104_02_103719	Salmon Creek	Spawning
OR_SR_1709000103_02_103716	Salt Creek	Year Round
OR_SR_1709000103_02_103716	Salt Creek	Spawning
OR_SR_1709000109_02_103745	South Fork Winberry Creek	Year Round
OR_SR_1709000109_02_103747	Winberry Creek	Year Round
OR_SR_1709000109_02_103747	Winberry Creek	Spawning

Table 2-3: Coast Fork Willamette Subbasin (17090002) Category 5 temperature impairments on the 2022 Integrated Report.

AU ID	AU Name	Use Period
OR_SR_1709000202_02_103771	Brice Creek	Year Round
OR_SR_1709000203_02_104585	Coast Fork Willamette River	Year Round
OR_SR_1709000203_02_104586	Coast Fork Willamette River	Year Round
OR_SR_1709000204_02_103787	Coast Fork Willamette River	Year Round
OR_LK_1709000202_02_100705	Dorena Lake	Year Round
OR_WS_170900020401_02_104238	HUC12 Name: Hill Creek-Coast Fork Willamette River	Year Round
OR_WS_170900020204_02_104230	HUC12 Name: King Creek-Row River	Year Round
OR_WS_170900020203_02_104229	HUC12 Name: Sharps Creek	Year Round
OR_SR_1709000202_02_103765	Layng Creek	Year Round
OR_SR_1709000202_02_103756	Martin Creek	Year Round
OR_SR_1709000201_02_103752	Mosby Creek	Year Round
OR_SR_1709000201_02_103752	Mosby Creek	Spawning
OR_SR_1709000202_02_103761	Row River	Year Round
OR_SR_1709000202_02_103766	Row River	Year Round
OR_SR_1709000202_02_103779	Row River	Year Round
OR_SR_1709000202_02_103755	Sharps Creek	Year Round
OR_SR_1709000202_02_103775	Sharps Creek	Year Round
OR_SR_1709000202_02_103776	Sharps Creek	Year Round

Table 2-4: Upper Willamette Subbasin (17090003) Category 5 temperature impairments on the 2022 Integrated Report.

AU ID	AU Name	Use Period
OR_SR_1709000303_02_103815	Calapooia River	Year Round
OR_SR_1709000303_02_103815	Calapooia River	Spawning

AU ID	AU Name	Use Period
OR_SR_1709000303_02_103816	Calapooia River	Year Round
OR_SR_1709000303_02_103816	Calapooia River	Spawning
OR_SR_1709000304_02_103821	Calapooia River	Year Round
OR_SR_1709000303_02_103819	Courtney Creek	Year Round
OR_SR_1709000301_02_103796	Coyote Creek	Year Round
OR_SR_1709000301_02_103790	Ferguson Creek	Year Round
OR_WS_170900030109_02_104251	HUC12 Name: Bear Creek-Long Tom River	Year Round
OR_WS_170900030510_02_104284	HUC12 Name: Berry Creek	Year Round
OR_WS_170900030302_02_104265	HUC12 Name: Bigs Creek-Calapooia River	Year Round
OR_WS_170900030603_02_104290	HUC12 Name: Flat Creek	Year Round
OR_WS_170900030204_02_104256	HUC12 Name: Greasy Creek	Year Round
OR_WS_170900030301_02_104264	HUC12 Name: Hands Creek-Calapooia River	Year Round
OR_WS_170900030301_02_104264	HUC12 Name: Hands Creek-Calapooia River	Spawning
OR_WS_170900030505_02_104279	HUC12 Name: Jont Creek-Luckiamute River	Year Round
OR_WS_170900030402_02_104273	HUC12 Name: Lower Oak Creek	Year Round
OR_WS_170900030503_02_104277	HUC12 Name: Maxfield Creek-Luckiamute River	Year Round
OR_WS_170900030504_02_104278	HUC12 Name: Pedee Creek-Luckiamute River	Year Round
OR_SR_1709000305_02_103822	Little Luckiamute River	Year Round
OR_SR_1709000301_02_103791	Long Tom River	Year Round
OR_SR_1709000305_02_103829	Luckiamute River	Year Round
OR_SR_1709000302_02_103804	Marys River	Year Round
OR_SR_1709000302_02_103812	Marys River	Year Round
OR_SR_1709000302_02_103813	Marys River	Year Round
OR_SR_1709000305_02_103825	Miller Creek	Year Round
OR_SR_1709000302_02_103806	Muddy Creek	Year Round
OR_SR_1709000306_02_103838	Muddy Creek	Year Round
OR_SR_1709000305_02_103828	North Fork Pedee Creek	Year Round
OR_SR_1709000305_02_103833	Ritner Creek	Year Round
OR_SR_1709000305_02_103832	Soap Creek	Year Round
OR_SR_1709000305_02_103824	Teal Creek	Year Round
OR_SR_1709000306_05_103854	Willamette River	Year Round
OR_SR_1709000306_05_103854	Willamette River	Spawning

Table 2-5: McKenzie Subbasin (17090004) Category 5 temperature impairments on the 2022 Integrated Report.

AU ID	AU Name	Use Period
OR_SR_1709000403_02_103865	Augusta Creek	Year Round
OR_SR_1709000407_02_103889	Camp Creek	Year Round
OR_SR_1709000407_02_103889	Camp Creek	Spawning
OR_SR_1709000406_02_103875	Cartwright Creek	Year Round
OR_SR_1709000406_02_103875	Cartwright Creek	Spawning
OR_SR_1709000407_02_103891	Cedar Creek	Year Round
OR_SR_1709000407_02_103891	Cedar Creek	Spawning
OR_SR_1709000407_02_103882	Deer Creek	Year Round
OR_SR_1709000407_02_103882	Deer Creek	Spawning
OR_SR_1709000403_02_103862	French Pete Creek	Year Round
OR_SR_1709000401_02_103855	Horse Creek	Year Round
OR_SR_1709000401_02_103856	Horse Creek	Year Round
OR_WS_170900040206_02_104310	HUC12 Name: Boulder Creek-McKenzie River	Year Round
OR_WS_170900040705_02_104336	HUC12 Name: Camp Creek	Year Round
OR_WS_170900040205_02_104309	HUC12 Name: Deer Creek	Year Round
OR_WS_170900040702_02_104333	HUC12 Name: East Fork Deer Creek-McKenzie River	Year Round
OR_WS_170900040702_02_104333	HUC12 Name: East Fork Deer Creek-McKenzie River	Spawning
OR_WS_170900040502_02_104326	HUC12 Name: Elk Creek-McKenzie River	Year Round
OR_WS_170900040502_02_104326	HUC12 Name: Elk Creek-McKenzie River	Spawning
OR_WS_170900040209_02_104313	HUC12 Name: Florence Creek-McKenzie River	Year Round
OR_WS_170900040202_02_104306	HUC12 Name: Hackleman Creek-McKenzie River	Year Round

AU ID	AU Name	Use Period
OR_WS_170900040601_02_104327	HUC12 Name: Headwaters Mohawk River	Year Round
OR_WS_170900040204_02_104308	HUC12 Name: Kink Creek-McKenzie River	Year Round
OR_WS_170900040403_02_104324	HUC12 Name: Lower Blue River	Year Round
OR_WS_170900040105_02_104304	HUC12 Name: Lower Horse Creek	Year Round
OR_WS_170900040104_02_104303	HUC12 Name: Middle Horse Creek	Year Round
OR_WS_170900040304_02_104317	HUC12 Name: Rebel Creek-South Fork McKenzie River	Year Round
OR_WS_170900040602_02_104328	HUC12 Name: Shotgun Creek-Mohawk River	Year Round
OR_WS_170900040203_02_104307	HUC12 Name: Smith River	Year Round
OR_WS_170900040402_02_104323	HUC12 Name: Upper Blue River	Year Round
OR_SR_1709000404_02_104571	Lookout Creek	Year Round
OR_SR_1709000404_02_104569	Lower Blue River	Year Round
OR_SR_1709000404_02_104569	Lower Blue River	Spawning
OR_SR_1709000406_02_103879	McGowan Creek	Year Round
OR_SR_1709000406_02_103879	McGowan Creek	Spawning
OR_SR_1709000405_02_103866	McKenzie River	Year Round
OR_SR_1709000405_02_103866	McKenzie River	Spawning
OR_SR_1709000407_02_103884	McKenzie River	Year Round
OR_SR_1709000407_02_103884	McKenzie River	Spawning
OR_SR_1709000406_02_103873	Mill Creek	Year Round
OR_SR_1709000406_02_103874	Mill Creek	Year Round
OR_SR_1709000406_02_103870	Mohawk River	Year Round
OR_SR_1709000406_02_103870	Mohawk River	Spawning
OR_SR_1709000406_02_103871	Mohawk River	Year Round
OR_SR_1709000406_02_103871	Mohawk River	Spawning
OR_SR_1709000406_02_103877	Mohawk River	Year Round
OR_SR_1709000406_02_103877	Mohawk River	Spawning
OR_SR_1709000405_02_103867	Quartz Creek	Year Round
OR_SR_1709000404_02_104576	Quentin Creek	Year Round
OR_SR_1709000406_02_103872	Shotgun Creek	Year Round
OR_SR_1709000403_02_104590	South Fork McKenzie River	Year Round
OR_SR_1709000403_02_104590	South Fork McKenzie River	Spawning
OR_SR_1709000404_02_104574	Upper Blue River	Year Round
OR_SR_1709000404_02_104577	Upper Blue River	Year Round

Table 2-6: North Santiam Subbasin (17090005) Category 5 temperature impairments on the 2022 Integrated Report.

AU ID	AU Name	Use Period
OR_SR_1709000506_02_103928	Bear Branch	Year Round
OR_SR_1709000503_02_103907	Blowout Creek	Year Round
OR_SR_1709000503_02_103909	Blowout Creek	Year Round
OR_SR_1709000502_02_103902	Boulder Creek	Year Round
OR_SR_1709000506_02_103926	Chehulpum Creek	Year Round
OR_SR_1709000505_02_103923	Elkhorn Creek	Year Round
OR_WS_170900050602_02_104360	HUC12 Name: Bear Branch-North Santiam River	Year Round
OR_WS_170900050203_02_104345	HUC12 Name: Marion Creek	Year Round
OR_WS_170900050603_02_104361	HUC12 Name: Marion Creek-North Santiam River	Year Round
OR_WS_170900050603_02_104361	HUC12 Name: Marion Creek-North Santiam River	Spawning
OR_WS_170900050504_02_104563	HUC12 Name: Middle Little North Santiam River	Year Round
OR_WS_170900050301_02_104351	HUC12 Name: Upper Blowout Creek	Year Round
OR_WS_170900050503_02_104567	HUC12 Name: Upper Little North Santiam River	Year Round
OR_SR_1709000505_02_104564	Little North Santiam River	Year Round
OR_SR_1709000505_02_104564	Little North Santiam River	Spawning
OR_SR_1709000504_02_103906	North Santiam River	Spawning
OR_SR_1709000506_02_103930	North Santiam River	Year Round
OR_SR_1709000506_02_103930	North Santiam River	Spawning
OR_SR_1709000506_02_103927	Santiam River	Year Round

AU ID	AU Name	Use Period
OR_SR_1709000506_02_103927	Santiam River	Spawning
OR_SR_1709000506_02_103929	Stout Creek	Year Round

Table 2-7: South Santiam Subbasin (17090006) Category 5 temperature impairments on the 2022 Integrated Report.

AU ID	AU Name	Use Period
OR_SR_1709000606_02_103973	Beaver Creek	Year Round
OR_SR_1709000607_02_103986	Bilyeu Creek	Year Round
OR_SR_1709000607_02_103989	Bilyeu Creek	Year Round
OR_SR_1709000602_02_103949	Canyon Creek	Year Round
OR_SR_1709000606_02_103978	Crabtree Creek	Year Round
OR_SR_1709000606_02_103978	Crabtree Creek	Spawning
OR_LK_1709000604_02_100772	Foster Lake	Year Round
OR_LK_1709000603_02_100771	Green Peter Lake	Year Round
OR_SR_1709000608_02_103993	Hamilton Creek	Year Round
OR_SR_1709000608_02_103993	Hamilton Creek	Spawning
OR_SR_1709000608_02_103996	Hamilton Creek	Year Round
OR_SR_1709000608_02_103996	Hamilton Creek	Spawning
OR_WS_170900060804_02_104398	HUC12 Name: Hamilton Creek	Year Round
OR_WS_170900060501_02_104384	HUC12 Name: Little Wiley Creek	Year Round
OR_WS_170900060705_02_104394	HUC12 Name: Lower Thomas Creek	Year Round
OR_SR_1709000602_02_103955	Latiwi Creek	Year Round
OR_SR_1709000608_02_103994	McDowell Creek	Year Round
OR_SR_1709000601_02_103934	Middle Santiam River	Year Round
OR_SR_1709000601_02_103936	Middle Santiam River	Year Round
OR_SR_1709000601_02_103938	Middle Santiam River	Year Round
OR_SR_1709000603_02_103965	Middle Santiam River	Year Round
OR_SR_1709000604_02_103969	Middle Santiam River	Spawning
OR_SR_1709000602_02_103954	Moose Creek	Year Round
OR_SR_1709000602_02_103954	Moose Creek	Spawning
OR_SR_1709000602_02_103941	Owl Creek	Year Round
OR_SR_1709000601_02_103935	Pyramid Creek	Year Round
OR_SR_1709000603_02_103957	Quartzville Creek	Year Round
OR_SR_1709000603_02_103960	Quartzville Creek	Year Round
OR_SR_1709000608_02_103997	Scott Creek	Year Round
OR_SR_1709000602_02_103953	Sheep Creek	Year Round
OR_SR_1709000602_02_103947	Soda Fork	Year Round
OR_SR_1709000607_02_103985	South Fork Neal Creek	Year Round
OR_SR_1709000602_02_103950	South Santiam River	Year Round
OR_SR_1709000602_02_103950	South Santiam River	Spawning
OR_SR_1709000604_02_103968	South Santiam River	Year Round
OR_SR_1709000604_02_103968	South Santiam River	Spawning
OR_SR_1709000608_02_103925	South Santiam River	Year Round
OR_SR_1709000608_02_103925	South Santiam River	Spawning
OR_SR_1709000607_02_103988	Thomas Creek	Year Round
OR_SR_1709000607_02_103991	Thomas Creek	Year Round
OR_SR_1709000607_02_103991	Thomas Creek	Spawning
OR_SR_1709000602_02_103942	Trout Creek	Year Round
OR_SR_1709000602_02_103948	Two Girls Creek	Year Round
OR_SR_1709000605_02_103971	Wiley Creek	Year Round
OR_SR_1709000605_02_103971	Wiley Creek	Spawning
OR_SR_1709000605_02_103972	Wiley Creek	Year Round
OR_SR_1709000605_02_103972	Wiley Creek	Spawning

Table 2-8: Middle Willamette Subbasin (17090007) Category 5 temperature impairments on the 2022 Integrated Report.

AU ID	AU Name	Use Period
OR_SR_1709000704_02_104017	Abernethy Creek	Year Round
OR_SR_1709000704_02_104594	Abernethy Creek	Year Round
OR_WS_170900070306_02_104417	HUC12 Name: Chehalem Creek	Year Round
OR_WS_170900070301_02_104413	HUC12 Name: Croisan Creek-Willamette River	Spawning
OR_WS_170900070301_02_104413	HUC12 Name: Croisan Creek-Willamette River	Year Round
OR_WS_170900070303_02_104415	HUC12 Name: Glenn Creek-Willamette River	Year Round
OR_WS_170900070304_02_104599	HUC12 Name: Lambert Slough-Willamette River	Year Round
OR_WS_170900070204_02_104412	HUC12 Name: Lower Mill Creek	Year Round
OR_WS_170900070203_02_104411	HUC12 Name: McKinney Creek	Year Round
OR_SR_1709000703_02_104007	Mill Creek	Year Round
OR_SR_1709000703_02_104007	Mill Creek	Spawning
OR_SR_1709000703_02_104012	Pringle Creek	Year Round
OR_SR_1709000701_02_104591	Rickreall Creek	Year Round
OR_SR_1709000703_02_104008	Shelton Ditch	Year Round
OR_SR_1709000703_02_104008	Shelton Ditch	Spawning
OR_SR_1709000701_05_104005	Willamette River	Year Round
OR_SR_1709000701_05_104005	Willamette River	Spawning
OR_SR_1709000703_04_104013	Willamette River	Year Round
OR_SR_1709000703_04_104013	Willamette River	Spawning
OR_SR_1709000703_88_104015	Willamette River	Year Round
OR_SR_1709000704_88_104020	Willamette River	Year Round
OR_LK_1709000703_02_100792	Willamette Slough	Year Round

Table 2-9: Molalla-Pudding Subbasin (17090009) Category 5 temperature impairments on the 2022 Integrated Report.

AU ID	AU Name	Use Period
OR_SR_1709000901_02_104062	Abiqua Creek	Year Round
OR_SR_1709000902_02_104070	Butte Creek	Year Round
OR_SR_1709000902_02_104072	Butte Creek	Year Round
OR_SR_1709000901_02_104069	Drift Creek	Year Round
OR_SR_1709000901_02_104069	Drift Creek	Spawning
OR_WS_170900090303_02_104470	HUC12 Name: Bear Creek	Year Round
OR_WS_170900090204_02_104467	HUC12 Name: Brandy Creek-Pudding River	Year Round
OR_WS_170900090101_02_104454	HUC12 Name: Headwaters Pudding River	Year Round
OR_WS_170900090202_02_104465	HUC12 Name: Middle Butte Creek	Year Round
OR_WS_170900090403_02_104474	HUC12 Name: Pine Creek-Molalla River	Year Round
OR_SR_1709000904_02_104086	Molalla River	Year Round
OR_SR_1709000904_02_104086	Molalla River	Spawning
OR_SR_1709000901_02_104067	Pudding River	Year Round
OR_SR_1709000905_02_104088	Pudding River	Year Round
OR_SR_1709000901_02_104595	Silver Creek	Year Round
OR_SR_1709000901_02_104066	South Fork Silver Creek	Year Round
OR_SR_1709000904_02_104087	Table Rock Fork	Year Round
OR_SR_1709000904_02_104087	Table Rock Fork	Spawning
OR_LK_1709000902_02_100830	Zollner Creek	Year Round

Table 2-10: Clackamas Subbasin (17090011) Category 5 temperature impairments on the 2022 Integrated Report.

AU ID	AU Name	Use Period
OR_SR_1709001104_02_104154	Clackamas River	Year Round
OR_SR_1709001104_02_104154	Clackamas River	Spawning
OR_SR_1709001104_02_104155	Clackamas River	Year Round
OR_SR_1709001104_02_104155	Clackamas River	Spawning
OR_SR_1709001106_02_104597	Clackamas River	Year Round
OR_SR_1709001106_02_104597	Clackamas River	Spawning

AU ID	AU Name	Use Period
OR_SR_1709001101_02_104142	Collawash River	Year Round
OR_SR_1709001101_02_104142	Collawash River	Spawning
OR_SR_1709001101_02_104144	Collawash River	Year Round
OR_SR_1709001105_02_104163	Eagle Creek	Year Round
OR_SR_1709001105_02_104163	Eagle Creek	Spawning
OR_SR_1709001104_02_104156	Fish Creek	Year Round
OR_SR_1709001104_02_104161	Fish Creek	Year Round
OR_SR_1709001104_02_104161	Fish Creek	Spawning
OR_WS_170900110406_02_104539	HUC12 Name: Helion Creek-Clackamas River	Year Round
OR_WS_170900110405_02_104538	HUC12 Name: North Fork Clackamas River	Year Round
OR_WS_170900110402_02_104535	HUC12 Name: Roaring River	Year Round
OR_WS_170900110607_02_104549	HUC12 Name: Rock Creek-Clackamas River	Year Round
OR_WS_170900110501_02_104540	HUC12 Name: Upper Eagle Creek	Year Round
OR_SR_1709001101_02_104145	Nohorn Creek	Year Round
OR_SR_1709001101_02_104145	Nohorn Creek	Spawning
OR_SR_1709001104_02_104152	North Fork Clackamas River	Year Round
OR_SR_1709001105_02_104165	North Fork Eagle Creek	Year Round
OR_SR_1709001104_02_104160	Roaring River	Spawning
OR_SR_1709001104_02_104157	Trout Creek	Year Round

Table 2-11: Lower Willamette Subbasin (17090012) Category 5 temperature impairments on the 2022 Integrated Report.

AU ID	AU Name	Use Period
OR_WS_170900120202_02_104555	HUC12 Name: Balch Creek-Willamette River	Year Round
OR_WS_170900120201_02_104554.1	HUC12 Name: Columbia Slough (Lower)	Year Round
OR_WS_170900120201_02_104554.2	HUC12 Name: Columbia Slough (Upper)	Year Round
OR_WS_170900120103_02_104552	HUC12 Name: Lower Johnson Creek	Year Round
OR_WS_170900120103_02_104552	HUC12 Name: Lower Johnson Creek	Spawning
OR_WS_170900120305_02_104561	HUC12 Name: Multnomah Channel	Year Round
OR_WS_170900120104_02_104553	HUC12 Name: Oswego Creek-Willamette River	Year Round
OR_WS_170900120104_02_104553	HUC12 Name: Oswego Creek-Willamette River	Spawning
OR_WS_170900120301_02_104557	HUC12 Name: South Scappoose Creek	Spawning
OR_WS_170900120101_02_104550	HUC12 Name: Upper Johnson Creek	Year Round
OR_WS_170900120101_02_104550	HUC12 Name: Upper Johnson Creek	Spawning
OR_SR_1709001201_02_104170	Johnson Creek	Year Round
OR_SR_1709001201_02_104170	Johnson Creek	Spawning
OR_SR_1709001203_02_104176	Milton Creek	Year Round
OR_SR_1709001203_02_104176	Milton Creek	Spawning
OR_SR_1709001203_88_104184	Multnomah Channel	Year Round
OR_SR_1709001203_02_104179	North Scappoose Creek	Year Round
OR_SR_1709001203_02_104179	North Scappoose Creek	Spawning
OR_SR_1709001203_02_104180	South Scappoose Creek	Year Round
OR_SR_1709001203_02_104180	South Scappoose Creek	Spawning
OR_SR_1709001201_88_104019	Willamette River	Year Round
OR_SR_1709001202_88_104175	Willamette River	Year Round

The locations of the waterbodies listed as impaired for temperature on DEQ's 2022 Clean Water Act Section 303(d) List are depicted in **Figure 2-2**. The Watershed GNIS Streams layer identifies the impaired streams within an impaired Watershed AU. A watershed AU is a fixed AU that groups all streams within a HUC12 subwatershed with a Strahler Stream Order of 4 or less for impairment consideration. Individual monitoring stations within a Watershed Unit are assessed for impairment, then the impairment determination is rolled up into a single Watershed Unit conclusion in order to meet EPA reporting requirements. The Streams layer in **Figure 2-2** identifies the large streams or rivers listed as temperature impaired, and the Waterbodies layer identifies the lakes or reservoirs listed as temperature impaired in the project area. Please see the Final Assessment Methodology of Oregon DEQ's 2022 Integrated Report for more information about how Oregon's waterbodies are assessed for water quality impairment (DEQ, 2022).

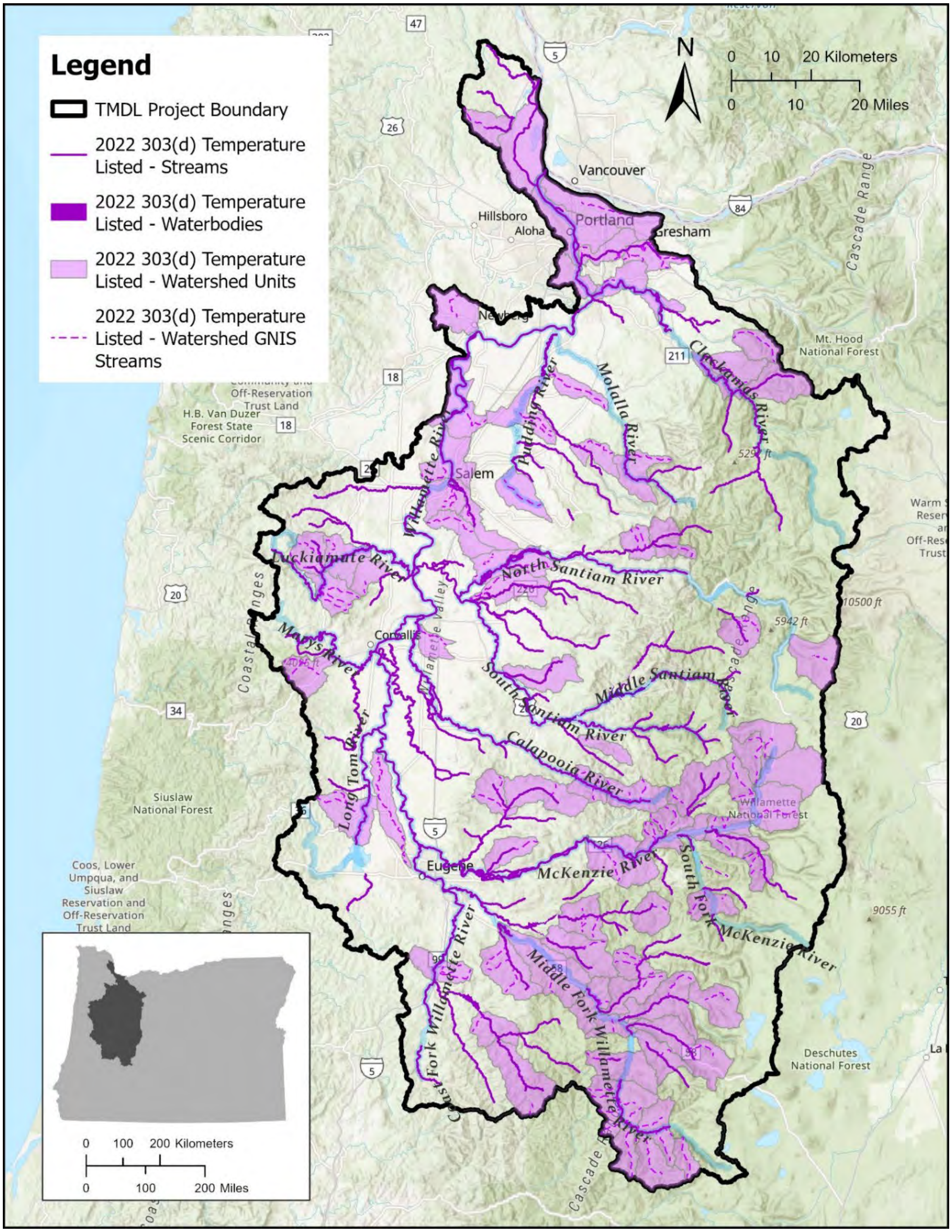


Figure 2-2: Willamette Subbasins and mainstem Category 5 temperature impairments on the 2022 Integrated Report.

2.2 Climate

The Willamette Basin has a temperate maritime climate with mild, wet winters and warm, dry summers. According to PRISM normals of annual conditions over the past 30 years (1991-2020), the average annual precipitation in the Willamette Basin ranges from around 985 mm (38") in the lower elevations of the Willamette Valley to over 4,160 mm (160") in the higher elevations of the Cascade Range (PRISM Climate Group, 2022) (**Figure 2-3**). The highest precipitation levels are typically seen during the winter months, with November to January being the wettest months. In contrast, the summer months are generally drier, with July and August being the driest months of the year.

In terms of temperature, the PRISM normals show that the average annual temperature in the Willamette Basin is around 15.3°C (59.6°F). However, temperatures can vary greatly depending on elevation and the time of year. The average annual maximum temperatures in the Willamette Basin range from 2.7°C (37°F) in the Willamette Valley to about 18°C (64°F) at the Cascade Range (**Figure 2-4**). The summer months are typically warm, with average temperatures of 26°C (78.8°F) in July and August. On the other hand, the winter months are cooler, with average temperatures of 6°C (42.8°F) in December and January.

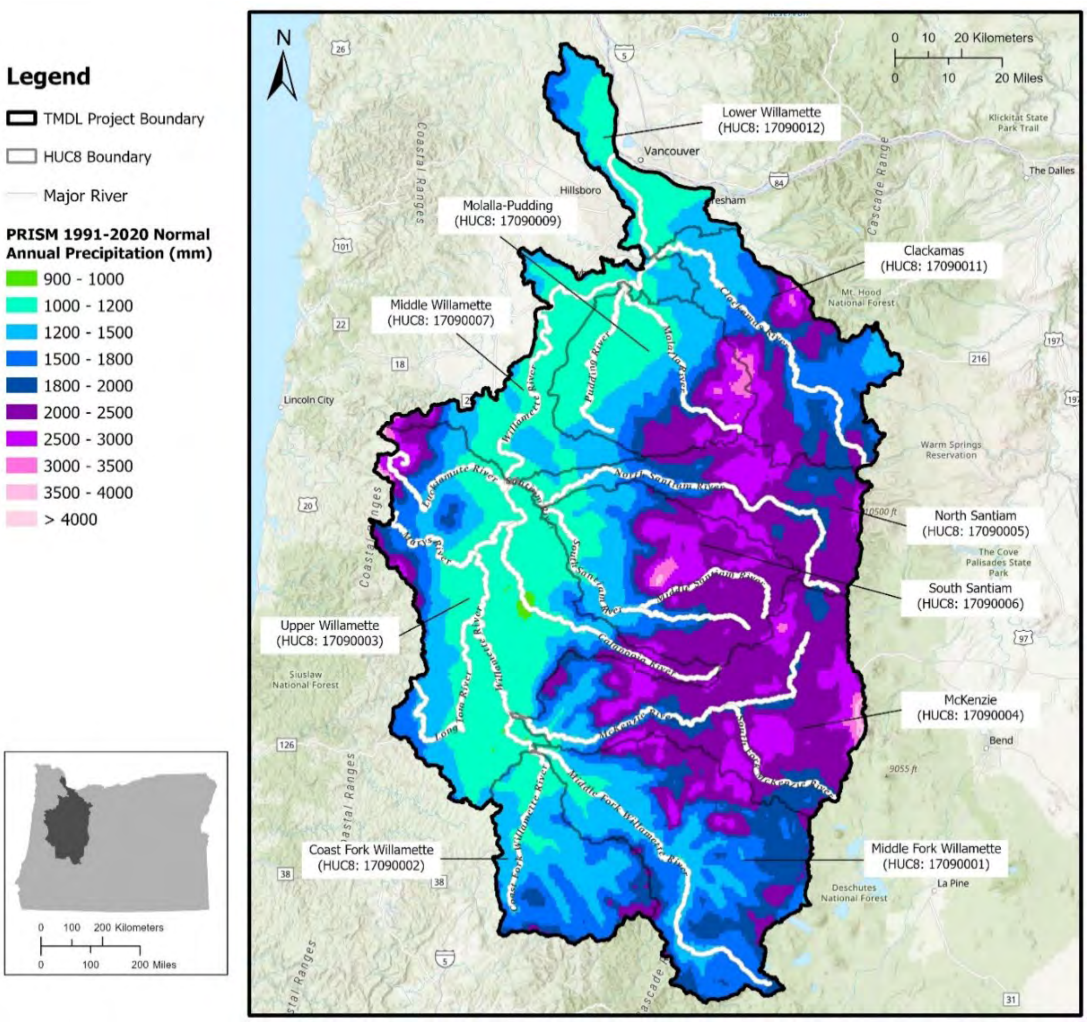


Figure 2-3: PRISM 1991-2020 Normal Annual Precipitation in the Willamette Subbasins temperature TMDL project area (Data Source: PRISM Climate Group, 2022).

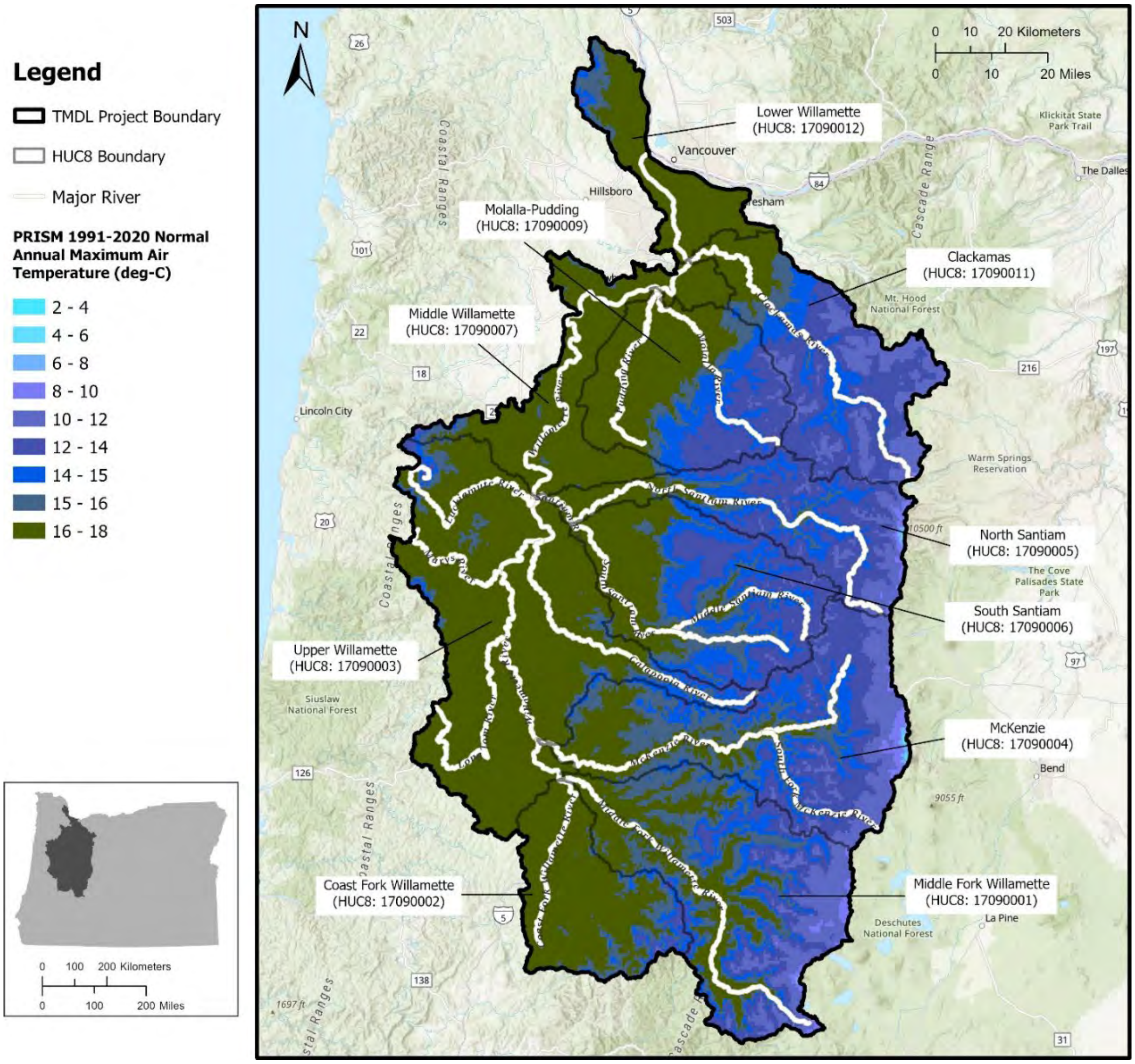


Figure 2-4: PRISM 1991-2020 Normal Annual Maximum Air Temperature in the Willamette Subbasins temperature TMDL project area (Data Source: PRISM Climate Group, 2022).

2.3 Hydrology

The Willamette Basin drains approximately 29,785 km^2 (11,500 mi^2) in northwestern Oregon between the Cascade and Coast Ranges. There are approximately 65,796 km (40,884 mi) of stream length in the Willamette Subbasins project area based on the National Hydrography Dataset (NHD). The Willamette River is formed by the confluence of two major tributaries, the Coast Fork Willamette River and the Middle Fork Willamette River. The Coast Fork originates in the foothills of the Cascade Mountains, while the Middle Fork originates in the high Cascades. These two rivers merge near the city of Eugene to form the Willamette River, which then travels about 187 miles before flowing into the Columbia River at river mile 101, at Portland.

The Willamette Basin includes numerous major tributaries, including the Coast Fork Willamette River, the Middle Fork Willamette River, the McKenzie River, the Long Tom River, the North and South Santiam Rivers, the Santiam River, and the Clackamas River. The Willamette Subbasins

TMDL has been revised to include the Willamette River mainstem and lower reaches of major tributaries downstream from dams.

The Willamette Basin also has many smaller tributaries. These include, but are not limited to, the Pudding River, Molalla River, Little North Santiam River, Luckiamute River, Marys River, Long Tom River upstream of Fern Ridge, and Mohawk River, which are covered in this TMDL.

Dams and reservoirs have a significant influence on the hydrology of the Willamette Basin. The U.S. Army Corps of Engineers (USACE) constructed a series of 11 dams with reservoirs and 2 re-regulating dams on major tributaries in the basin between 1941 and 1969, known as the Willamette Valley Project (**Table 2-12**). USACE operates the Willamette Valley Project based on the purposes authorized by Congress with the Flood Control Act of 1938. Flood control is the highest priority of the Willamette Project, but other purposes include flow augmentation for navigation, irrigation, hydroelectric power production, fisheries, recreation, and water quality. The project provides the capacity of seasonal storage of nearly 1.6 million acre-feet of water and a production capacity of 2,100 megawatts (MW) of electric power (USACE, 2019).

In addition to these large federal dams, there are Portland General Electric's (PGE) dams and reservoirs on the Clackamas River, Eugene Water and Electric Board (EWEB) operated projects in the McKenzie Subbasin, and over 350 smaller dams and reservoirs throughout the basin that are operated by local irrigation districts, municipalities, and private companies.

Table 2-12: Summary of USACE dams and reservoirs in the Willamette Basin.

Dam & Reservoir	Tributary Location	Year Complete	Total Storage in acre-feet	Summary Storage	# of Rec Areas	Power Generators	Draw-down Priority
Blue River	Blue River	1969	89,500	78,800	3	None	3rd
Cottage Grove	Coast Fork Willamette River	1942	32,900	28,700	5	None	5th
Fern Ridge	Long Tom River	1941	116,800	93,900	5	None	Last
Dexter	MF Willamette River	1954	NA, Reregulating	NA	2	1	NA
Lookout Point	MF Willamette River	1954	455,800	324,200	6	3	1st
Hills Creek	MF Willamette River	1961	355,500	194,000	5	2	4th
Fall Creek	MF Willamette River	1966	125,000	108,200	5	None	5th
Green Peter	Middle Santiam River	1968	428,100	249,900	3	2	5th
Big Cliff	North Santiam River	1953	NA, Reregulating	NA	None	1	NA
Detroit	North Santiam River	1953	455,100	281,000	7	2	Last
Dorena	Row River	1949	77,600	65,000	5	None	5th
Cougar	SF McKenzie River	1963	219,000	143,900	6	2	2nd
Foster	South Santiam River	1968	60,700	24,800	6	2	Last

Figure 2-5 shows the locations of large dams within the Willamette Subbasins temperature TMDL project area. This subset of dams was downloaded from two sources: the National

Inventory of Dams website (a repository maintained by USACE), and the Oregon Water Resources Department (OWRD) website (a repository listing only dams regulated by the State of Oregon). The 202 dams shown in the figure either meet or exceed ten feet in height or have storage capacities meeting or exceeding 9.2 acre-feet. They serve a variety of purposes, including but not limited to flood risk reduction, irrigation, water supply, hydroelectric power, recreation, and habitats for fish and wildlife. These dams are owned and operated by federal and local governments, state agencies, private entities, and public utilities. The first of these dams to be constructed was the Faraday Forebay dam, a PGE-owned dam for which construction was completed in 1907. The most recent dam to be constructed was the Sullivan Pond 3 dam near Lebanon, which was completed in 2009.

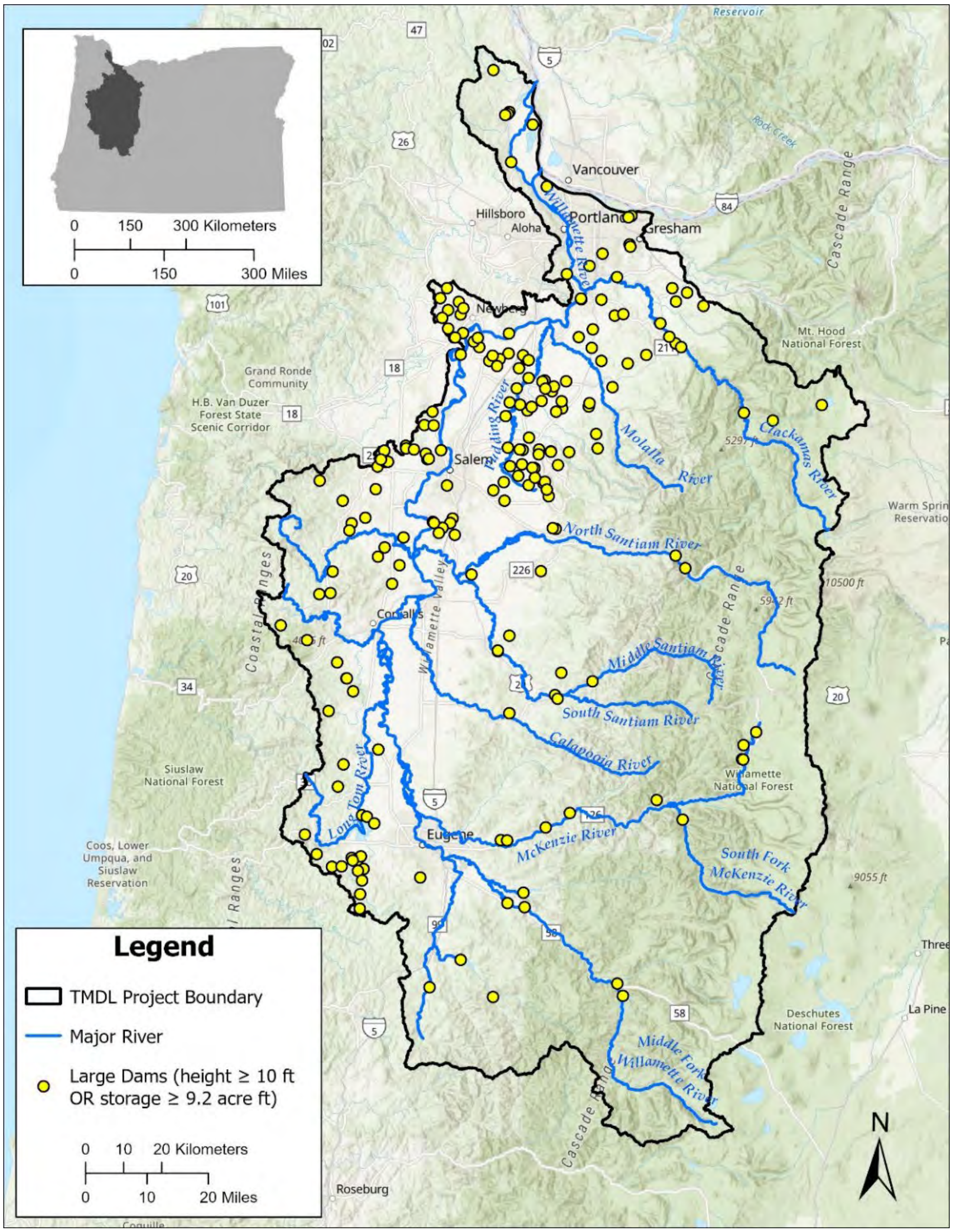


Figure 2-5: Large dams located within the Willamette Subbasins and mainstem temperature TMDL project area.

2.4 Intermittent streams

An intermittent stream as defined by Nadeau (2015) is a channel that contains water for only part of the year, typically during winter and spring when the streambed may be below the water table or when snowmelt from surrounding uplands provides sustained flow. The channel may or may not be well defined. The flow may vary greatly with stormwater runoff. An intermittent stream may lack the biological and hydrological characteristics commonly associated with the continuous conveyance of water. An intermittent stream may lack the biological and hydrological characteristics commonly associated with the continuous conveyance of water. Intermittent streams contribute to maintenance of cold water in downstream tributaries, even during periods when there is no surface flow (Ebersole et al., 2015).

The TMDL applies to intermittent streams for three primary reasons:

1) To protect aquatic life that may reside in intermittent streams. Intermittent streams can be "dry" but continue to support aquatic life in residual pools that remain during the dry periods. Residuals pools are often fed by sub surface flow. There is at least one published study in Oregon documenting the presence of juvenile salmonids in these residual pools over the summer (May and Lee, 2004). The temperature water quality standards apply to residual pools and the aquatic life that use them.

2) To protect downstream temperatures. Stream warming is cumulative and are not contained to just human activities within the reaches that are impaired. Activities in upstream tributaries, including intermittent streams, can influence stream temperatures downstream. For this reason, the EQC has developed standards protecting cold water (PCW) that already meets the biological based criteria and may not be currently listed as impaired (see OAR 340-0421-0028 (11)). In particular, intermittent streams are important for downstream temperatures because they can:

    a) Be flowing when temperature TMDLs apply. Streams classified as intermittent may only be "dry" in the summer or during low precipitation years. Temperature TMDLs apply to periods when downstream tributary temperatures exceed the applicable temperature standard. In the Willamette Subbasins the TMDL allocations apply May 1 – Oct 31 in most watersheds. Some watersheds require longer allocation periods (see Section 5). The TMDL allocation period includes months when intermittent streams may be flowing, such as in the spring or early fall when the spawning criterion apply.

    b) Become perennial or have longer periods of surface flow following timber harvest. Multiple studies have documented the increase to summer flow and annual water yield following a timber harvest (Hibbert, 1967; Rothacher, 1970; Harr et al., 1982; Keppeler and Ziemer, 1990; Bowling et al., 2000; Surfleet and Skaugset, 2013; Segura et al., 2020). Insufficient shade over these streams contributes to excessive solar loading, temperature increases, and may contribute to downstream warming.

    c) Be flowing subsurface because they are currently degraded. In Eastern Oregon there are examples of degraded intermittent streams becoming perennial after riparian restoration. Restoring the riparian vegetation will allow the system to aggrade, raising the water table and returning flow to the surface (Elmore and Beschta, 1987).

3) As a margin of safety to address the current inaccuracies associated with classification and mapping of intermittent streams, and their period of flow in relation to the period when TMDL

allocations apply. There are multiple approaches used to identify and map stream flow permanence and duration. Some of the more recent methods used in Oregon (Nadeau, 2015; Jaeger et al., 2019) are improvements over previous methods; and the classifications included in past versions of the NHD. Fritz et al. (2013) demonstrated that the flow permanence classifications included in the NHD only had about a 50% agreement with field-based observations. DEQ believes the current classifications are not accurate enough for reliable application and use for the TMDL.

For these reasons the TMDL allocations apply to intermittent streams unless field-based data is assembled to document a stream does not contain residual pools and does not have surface flow during the entire period the TMDL applies.

2.5 Land Use

Forestry, agriculture and urban uses dominate land use in the Willamette Subbasins TMDL project area, which is summarized in **Table 2-13** and **Figure 2-6** based on the 2019 National Land Cover Database (Dewitz and USGS, 2021). The majority of the basin is forestry, accounting for about 68% of the land in the basin. Forests are mainly located from the higher elevations to the foothills of the Coast and Cascade mountain ranges. These forests are primarily composed of Douglas fir and other conifers, and provide important habitat for a variety of wildlife, including salmon and steelhead. The land cover of the lower elevations of the basin is more heavily influenced by agriculture and urbanization. Agricultural land covers about 19% of the basin, including pasture and crops. Urban areas are prominent, with a total of 75 cities, including the three largest cities in the state (Portland, Eugene, and Salem). According to the 2010 census data, more than two million individuals, which accounts for over 50% of Oregon's overall population, reside in the Willamette Basin.

Table 2-13: Summary of land uses in the Willamette Subbasins TMDL project area based on the 2019 National Land Cover Database.

2019 NLCD Land Cover	Acres	Percent of Total Area
Evergreen Forest	3723099.4	58.30
Hay/Pasture	817292.4	12.80
Cultivated Crops	404290.1	6.30
Shrub/Scrub	346706.4	5.40
Mixed Forest	197931.8	3.10
Herbaceous	165112.3	2.60
Developed, Low Intensity	156196.8	2.40
Developed, Open Space	142817.1	2.20
Developed, Medium Intensity	130316.7	2.00
Open Water	75347.9	1.20
Woody Wetlands	63695.8	1.00
Developed, High Intensity	55271.5	0.90
Emergent Herbaceous Wetlands	54148.8	0.80
Barren Land	31091.2	0.50
Deciduous Forest	25684.6	0.40
Perennial Snow/Ice	2126.5	0.03

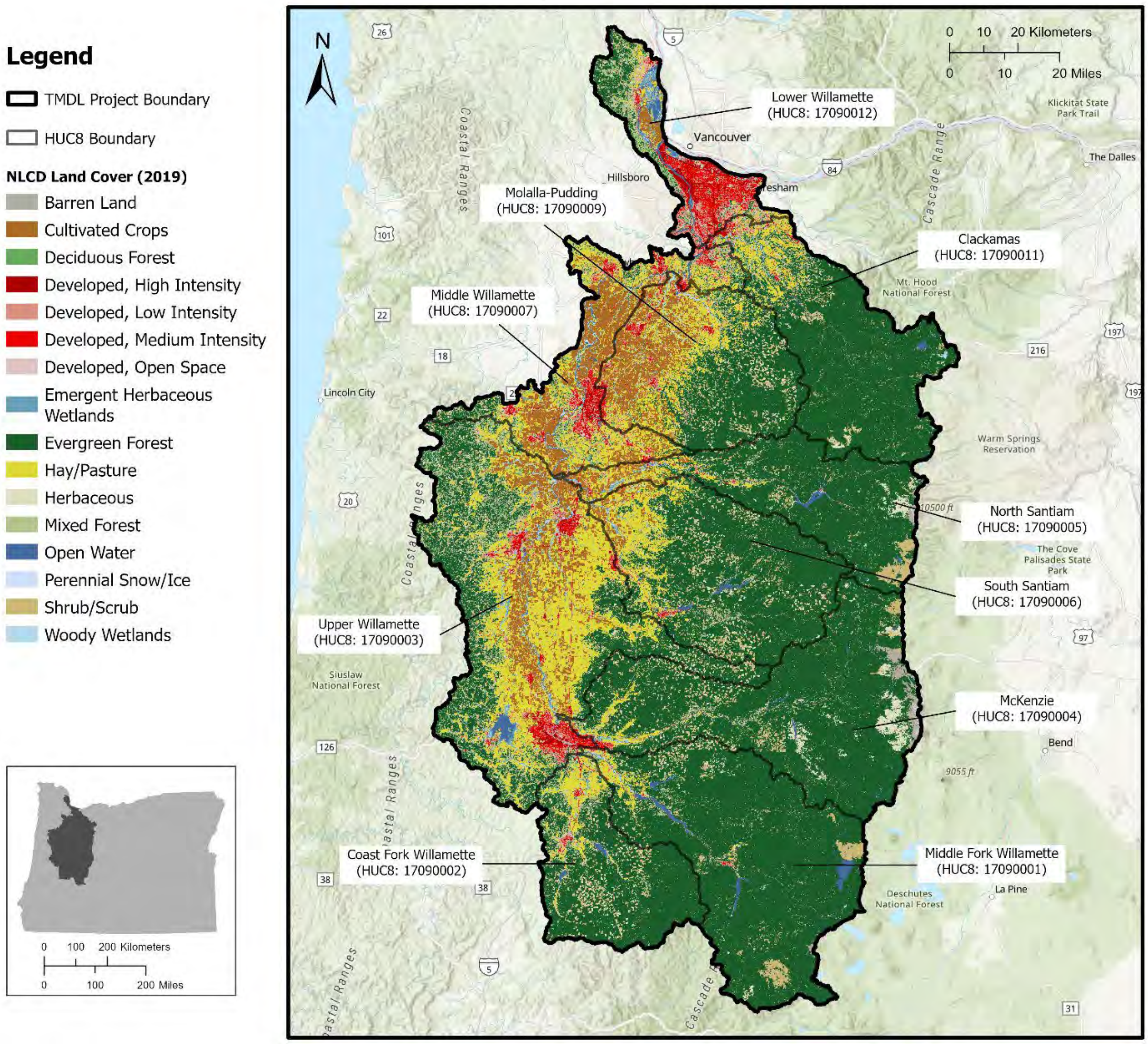


Figure 2-6: Land uses in the Willamette Subbasins TMDL project area based on the 2019 National Land Cover Database. (*Note: Shrub/Scrub and Herbaceous land uses can be areas where forest clearcuts have occurred and would be classified as forest after regrowth.)*

2.6 Land Ownership and Jurisdiction

The Willamette Subbasins TMDL project area is a complex landscape with a variety of landowners and jurisdictions (**Figure 2-7**). Land ownership and jurisdiction was determined using the Designated Management Agency (DMA) Geographic Information System (GIS) data described in Section 2.2 of the modeling report (TSD Appendix A). Land ownership within the subbasins includes private individuals, corporations, state and federal agencies, and tribal governments. Private individuals and corporations own the majority of the land in the basin, accounting for about 56%, particularly in the Willamette Valley where agriculture and urbanization are more prevalent. Federal agencies, such as the U.S. Forest Service (USFS) and the Bureau of Land Management (BLM), own and manage those portions of forested lands, accounting for about 34.4% and 5.5% of the basin, respectively. The Oregon Department of Forestry (ODF) manages about 27% of the land in the basin, including both private and public lands. Tribal governments also have important land ownership and management roles within the basin. The Confederated Tribes of Warm Springs has land holdings within the basin and has treaty rights to fish and hunt in the area.

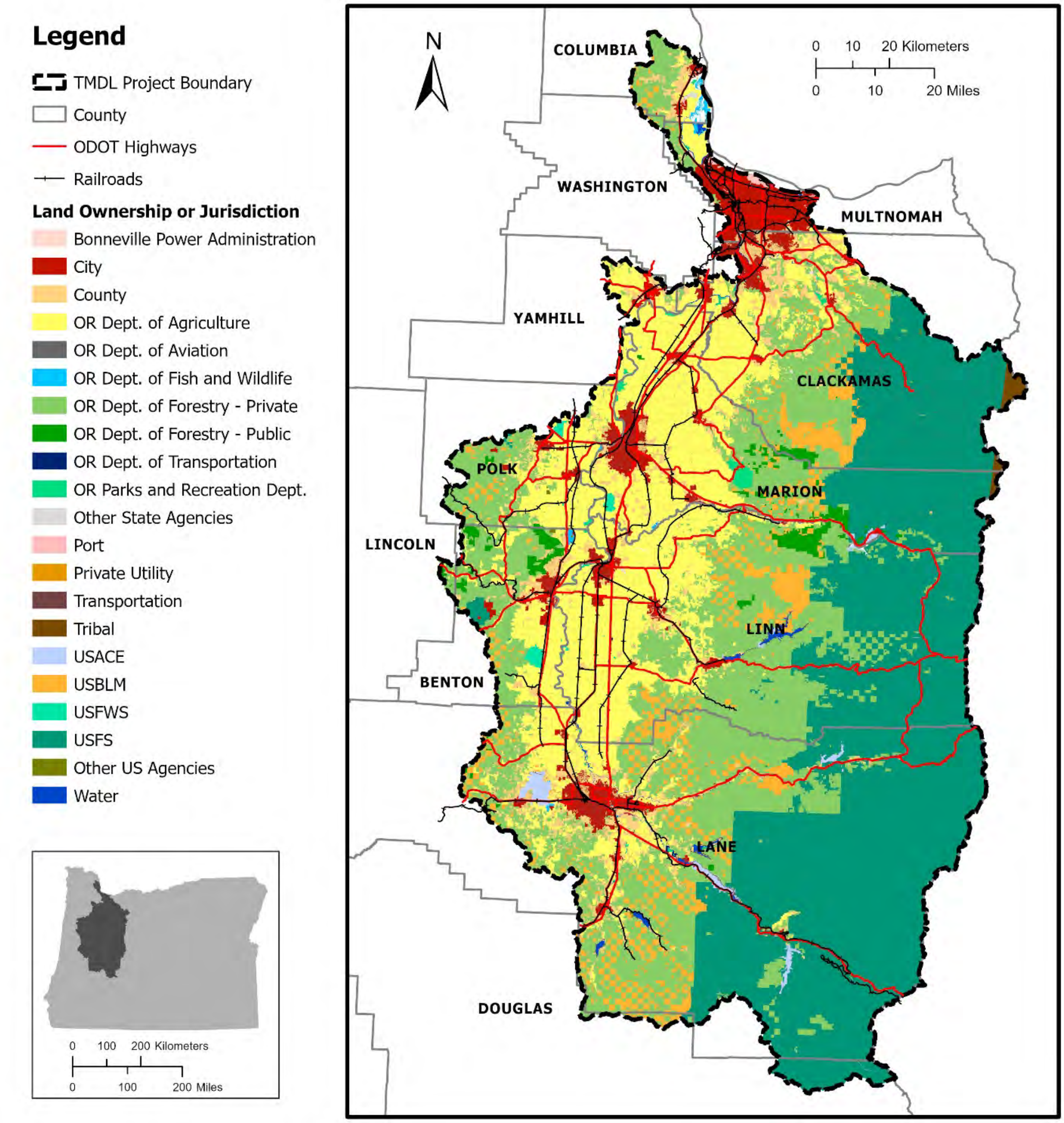


Figure 2-7: Land ownership and jurisdiction in the Willamette Subbasins temperature TMDL project area.

3 Pollutant identification

Temperature is the water quality parameter of concern, but heat or thermal loading, is the pollutant of concern causing impairment. Heat caused by human activities is of particular concern. Water temperature change (*ΔTw*) is a function of the heat transfer in a discrete volume and may be described in terms of changes in heat per unit volume. Conversely, a change in volume can also result in water temperature change for a defined amount of heat exchange.

$$\Delta Tw = \frac{\Delta Heat}{Density \times Specific\ Heat \times \Delta Volume}$$

The pollutants addressed by these temperature TMDLs are heat or thermal loads, with surrogate measures of effective shade.

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). 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 as a surrogate measure for thermal loading caused by solar radiation. Effective shade is the percent of the daily solar radiation flux blocked by vegetation and topography. Implementation of the surrogate measures ensures achievement of necessary pollutant reductions and the nonpoint load allocations for this temperature TMDL.

4 Temperature water quality standards and beneficial uses

EQC issued, and EPA approved, numeric and narrative water quality standards to protect designated *beneficial uses* in the Willamette (OAR 340-041-0344~0350, November 2003), and antidegradation policies to protect overall water quality. **Table 4-1** specifies the designated beneficial uses in the Willamette Subbasins surface water.

Table 4-1: Designated beneficial uses in the Willamette Subbasins as identified in OAR 340-041-0340 Table 340A.

Beneficial Uses	All Waterbodies
Public Domestic Water Supply	X
Private Domestic Water Supply	X
Industrial Water Supply	X
Irrigation	X
Livestock Watering	X
Fish and Aquatic Life	X
Wildlife and Hunting	X
Fishing	X
Boating	X

Beneficial Uses	All Waterbodies
Water Contact Recreation	X
Aesthetic Quality	X
Hydro Power	X
Commercial Navigation & Transportation	

Water quality criteria have been set at a level to protect the most sensitive beneficial uses. These TMDLs are designed such that meeting water quality standards for the most sensitive beneficial uses will be protective of all other uses. Fish and aquatic life are the most sensitive beneficial use for temperature. Oregon's water temperature criteria use salmonids' life cycles as indicators. If temperatures are protective of these indicator species, other species will share in this protection. The locations and periods of criteria applicability are determined from designated fish use maps in rule at OAR 340-041-0340 Figure 340A and Figure 340B. The maps from the rule have been reproduced and shown in **Figure 4-1** and **Figure 4-2**. **Figure 4-1** shows various designated fish uses and applicable criteria, while **Figure 4-2** shows salmon and steelhead spawning use designation, based on the NHD.

The temperature water quality standards for the Willamette Subbasins are based on the rolling seven-day average daily maximum (7DADM) and include the following numeric criteria:

- Salmon and steelhead spawning: 13.0°C (55.4°F) (OAR 340-041-0028(4)(a))
- Core cold water habitat: 16.0°C (60.8°F) (OAR 340-041-0028(4)(b))
- Salmon and trout rearing and migration: 18.0°C (64.4°F) (OAR 340-041-0028(4)(c))
- Salmon and steelhead migration corridors: 20.0°C (68.0°F) (OAR 340-041-0028(4)(d))
- Bull trout spawning and juvenile rearing: 12°C (53.6°F) (OAR 340-041-0028(4)(f))

The following narrative temperature water quality standards and other rule provisions also apply in the Willamette Subbasins:

- Cool Water Species (OAR 340-041-0028(9))
- Human use allowance (OAR 340-041-0028(12)(b))
- Minimum duties (OAR 340-041-0028(12)(a))
- Natural Lakes (OAR 340-041-0028(6))
- Protecting cold water (OAR 340-041-0028(11))
- The three basin rule: Clackamas, McKenzie, and North Santiam (OAR 340-041-0350)
- Antidegradation (OAR 340-041-0004)

Details of each rule are described in the sections that follow.

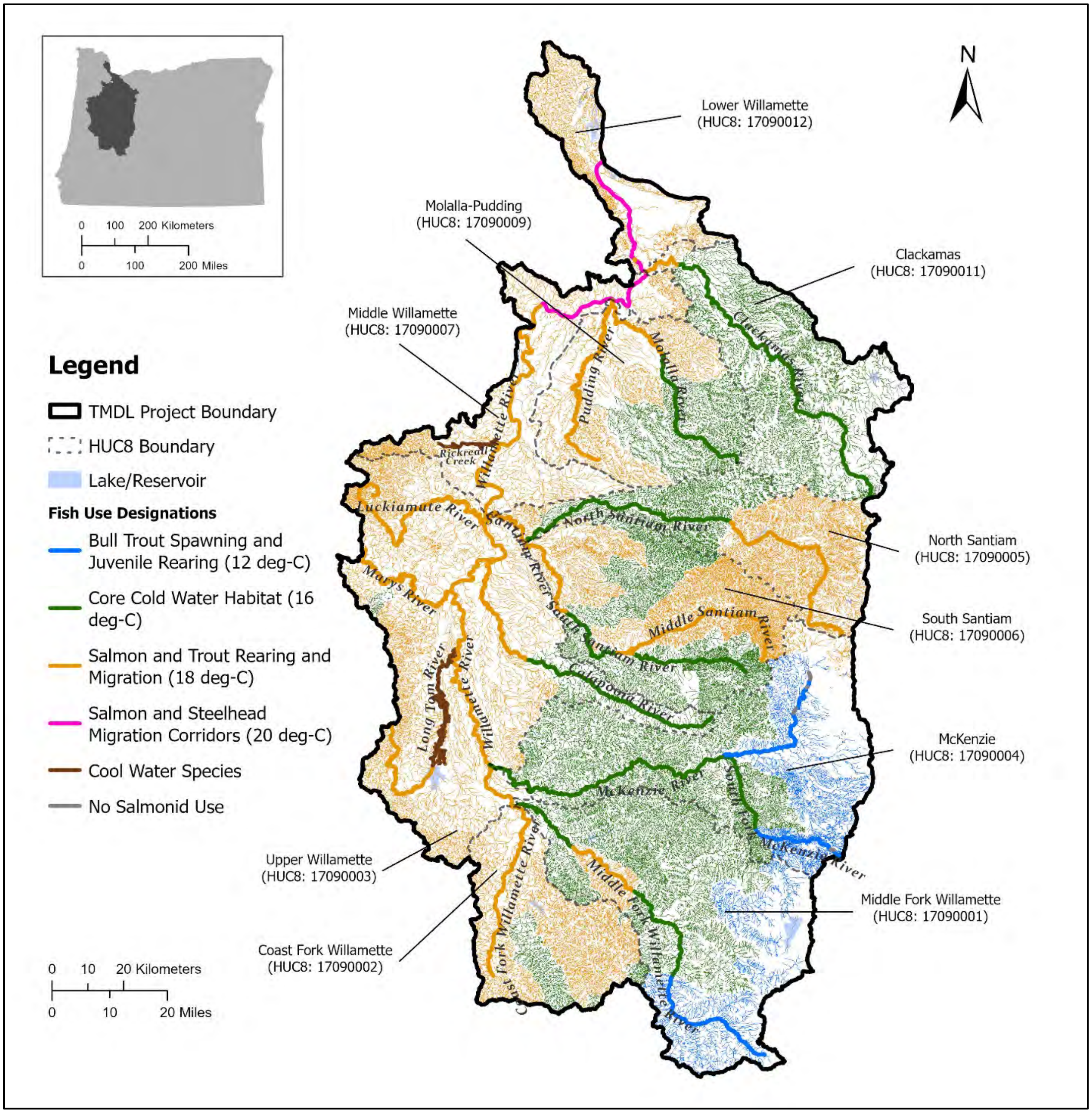


Figure 4-1: Fish use designations in the Willamette Subbasins TMDL project area.

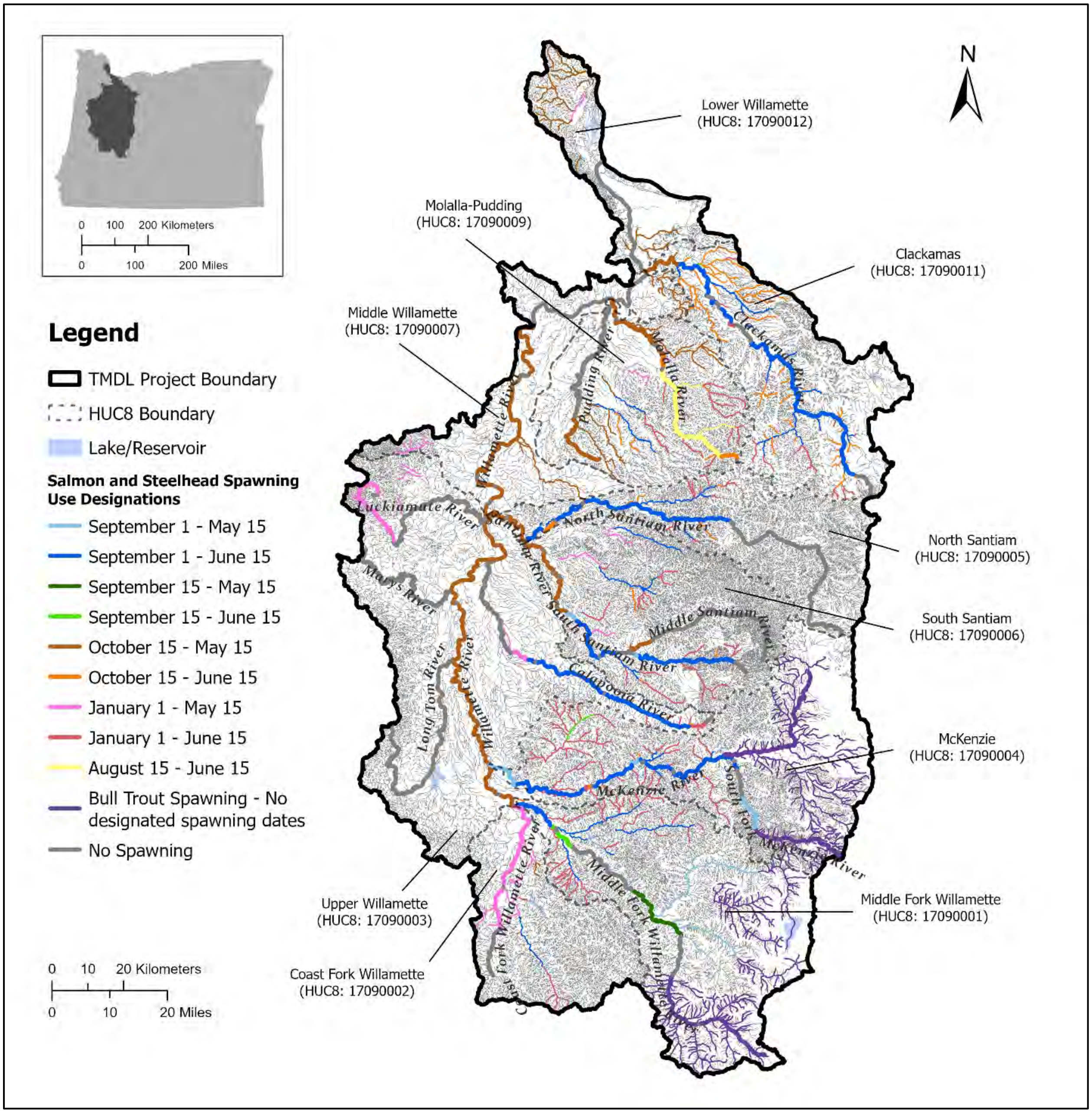


Figure 4-2: Salmon and steelhead spawning use designations in the Willamette Subbasins TMDL project area.

4.1 Salmon and steelhead spawning use

OAR 340-041-0028(4)(a). Waters that have been designated as having salmon and steelhead spawning use are identified in rule at OAR 340-041-0340 Figure 340B and shown in **Figure 4-2**. During the spawning period, these waters may not exceed 13.0°C (55.4°F) expressed as a 7DADM.

4.2 Core cold water habitat use

OAR 340-041-0028(4)(b). Waters that have been designated as having core cold water habitat use are identified in OAR 340-041-0340 Figure 340A and shown in **Figure 4-1**. These waters may not exceed 16.0°C (60.8°F) expressed as a 7DADM.

4.3 Salmon and trout rearing and migration

OAR 340-041-0028(4)(c). Waters that have been designated as having salmon and trout rearing and migration use are identified in OAR 340-041-0340 Figure 340A and shown in **Figure 4-1**. These waters may not exceed 18.0°C (64.4°F) expressed as a 7DADM.

4.4 Migration corridor use and cool water refugia

OAR 340-041-0028(4)(d). Waters that have been designated as having a migration corridor use are identified in OAR 340-041-0340 Figure 340A and shown in **Figure 4-1**. These waters may not exceed 20.0°C (68.0°F) expressed as a 7DADM. In addition, these waters must have cold water refugia that are sufficiently distributed so as to allow salmon and steelhead migration without significant adverse effects from higher water temperatures elsewhere in the water body. Cold water refugia is defined in OAR 340-041-0002(10) to mean those portions of a water body where or times during the diel temperature cycle when the water temperature is at least 2 degrees Celsius colder than the daily maximum temperature of the adjacent well-mixed flow of the water body.

4.5 Bull trout spawning and juvenile rearing

OAR 340-041-0028(4)(f). Waters that have been designated as having salmon and trout rearing and migration use are identified in OAR 340-041-0340 Figure 340A and shown in **Figure 4-1**. These waters may not exceed 12.0°C (53.6°F) expressed as a 7DADM.

In addition, the rule states that below Carmen Reservoir on the Upper McKenzie River, there may be no more than a 0.3°C (0.5°F) increase between the water temperature immediately upstream of the reservoir and the water temperature immediately downstream of the spillway when the ambient 7DADM stream temperature is 9.0°C (48°F) or greater, and no more than a 1.0°C (1.8°F) increase when the 7DADM stream temperature is less than 9°C.

4.6 Human use allowance

Oregon water quality standards have provisions for human use (OAR 340-041-0028(12)(b)). The human use allowance (HUA) is an insignificant addition of heat (0.3°C) authorized in waters that exceed the applicable temperature criteria. 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 biological criterion after complete mixing in the waterbody, and at the point of maximum impact (POMI). The rationale behind selection of 0.3°C for the HUA and how DEQ implements this portion of the standard can be found in DEQ (2003) and the Temperature IMD (DEQ, 2008a).

4.7 Natural lakes

OAR 340-041-0028(6). Natural lakes may not be warmed by more than 0.3°C (0.5°F) above the natural condition unless a greater increase would not reasonably be expected to adversely affect fish or other aquatic life. Absent a discharge or human modification that would reasonably be expected to increase temperature, DEQ will presume that the ambient temperature of a natural lake is the same as its natural thermal condition.

4.8 Cool water species

The narrative cool water species criterion in rule at OAR 340-041-0028(9)(a) states that “No increase in temperature is allowed that would reasonably be expected to impair cool water species.” The Long Tom River (Upper Willamette Subbasin) and Rickreall Creek (Middle Willamette Subbasin) are the only waterbodies designated for the cool water species use in the Willamette Subbasins. On the Long Tom River, the designation applies from the mouth at the confluence with the Willamette River (river mile 0) to Fern Ridge Dam (approximate river mile 24.1). On Rickreall Creek, the designation applies from the mouth at the confluence of the Willamette River (river mile 0) to the east end of Dallas City Park at approximately river mile 14. In the sections that follow, these reaches of the Long Tom River and Rickreall Creek are hereafter referred to as “the lower reaches”.

DEQ uses a stepwise approach to implement the narrative cool species water criterion (DEQ, 2008a). The Department bases its evaluations on the best available information and professional judgment. Pertinent information includes: the species present and their thermal requirements, physical characteristics of the waterbody, current ambient temperatures and the magnitude, duration and frequency of the proposed temperature increase.

DEQ followed the procedures of the Water Quality Standard Implementation IMD (DEQ, 2008a) to implement the narrative provision of the cool water species criterion. First, DEQ considered if it would be reasonable to apply the Redband & Lahontan Cutthroat Trout criterion of 20°C plus the 0.3°C HUA to the reach. The rationale, as outlined in DEQ’s temperature water quality standard implementation IMD is that a target temperature based on 20°C will not impair cool water species, which have more tolerance of warm temperatures than trout. This approach was rejected because 20°C does not appear to be attainable (see Section 4.8.5) and, as discussed later in this section, there are periods when winter steelhead are migrating in lower Rickreall Creek; and juvenile spring chinook salmon may rear or forage in the lower reach of the Long Tom River, winter steelhead and spring chinook salmon require temperatures less than 20°C. Instead, DEQ determined what cool water species are present in Rickreall Creek and the Long Tom River and identified target temperatures based on the thermal tolerance information available for those species. A temperature target was also identified for the peak periods when winter steelhead are migrating and when juvenile Chinook salmon are present.

4.8.1 Long Tom River temperatures

Continuous temperature data are available in the lower Long Tom River (**Figure 4-4** and **Figure 4-5**). The data show current temperatures peak between June and August and exceed 18°C from April 15 to October 30. Temperatures exceed 20°C from May 15 through the end of October. The plots include the selected lower Long Tom River temperature target for comparison.

Figure 4-3: Watershed boundaries (black line) and extent of the Cool Water Species use designation in the lower Long Tom River (brown line). Approximate location of USGS monitoring station 14170000 Monroe, OR (circle) and 14169000 Alvadore, OR (triangle) are shown.

DEQ has not modeled the background temperatures of the lower reach, so an estimate of background temperatures was derived using a nearby stream that was modeled. The background temperatures provide useful estimates of the range of potential temperature reductions possible in the lower Long Tom River and to estimate if a target temperature based on 20°C is attainable, as outlined in DEQ's temperature water quality standard implementation IMD (DEQ, 2008).

The Luckiamute River watershed is a tributary of the Willamette River, approximately 60 miles long, that drains the eastern Coast Range mountains with an outlet on the Willamette Valley floor. The mouth of the Luckiamute River is approximately 38 river miles north of the mouth of the Long Tom River along the Willamette River. DEQ estimated the background temperatures of the nearby Luckiamute River as part of the Willamette Subbasins TMDL. See the Willamette

Subbasins TMDL Technical Support Document Appendix A for more details. A temperature reduction refers to the decrease to 7DADM temperatures from full restoration of streamside vegetation in a system free of dam and reservoir operations, such as the Luckiamute.

Thermal pollutant sources identified for the Luckiamute River include lack of sufficient shade-producing streamside vegetation, and background sources. Along the Luckiamute River model extent, lack of sufficient streamside vegetation was associated with a mean effective shade gap of 9%, corresponding to daily maximum water temperature increases of 3.56°C at the point of maximum impact at model kilometer 42.8 (~ river mile 26) and 0.34°C at the mouth. The Luckiamute background model suggests temperature reductions of approximately 3.5°C to 0.3°C are possible depending on the position of a site along the watershed.

The temperature reductions suggested by the Luckiamute background model at both the mouth and point of maximum impact indicate that a 20 °C temperature target may not be attainable in the lower reach of the Long Tom River between June and September. The configuration of Fern Ridge Dam may also limit the amount of temperature reduction that is feasible with restoration (Rounds 2010).

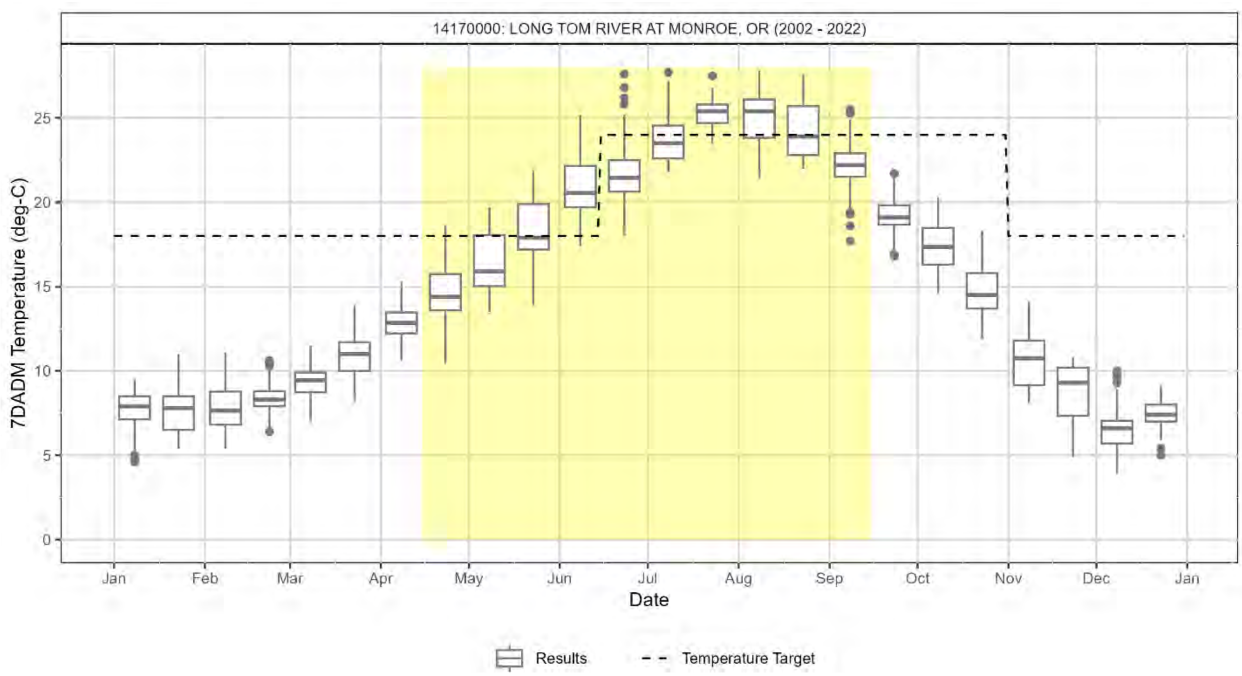


Figure 4-4: Box plots of bi-monthly 7DADM temperatures for the Long Tom River at USGS station 14170000 near Monroe, OR. Dashed line is the temperature targets of 24.0°C from June 1 to October 14 and 18.0°C from November 1 to June 14. Yellow shading indicates time periods when the targets are exceeded within the lower reach under current conditions.

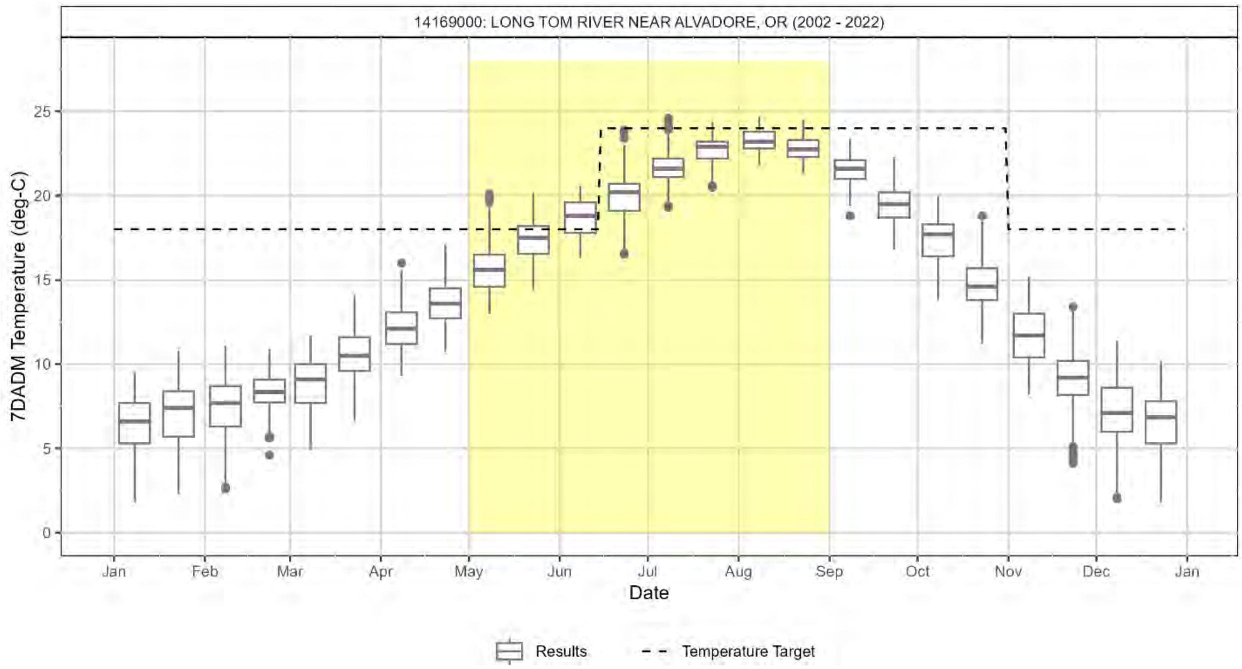


Figure 4-5: Box plots of bi-monthly 7DADM temperatures for the Long Tom River at USGS station 14169000 near Alvadore, OR. Dashed line is the temperature targets of 24.0ºC from June 1 to October 14 and 18.0ºC from November 1 to June 14. Yellow shading indicates time periods when the targets are exceeded under current conditions.

4.8.2 Long Tom River cool water species

DEQ reviewed the ODFW fish habitat distribution database and life stage timing tables for the Long Tom River watershed (ODFW, 2023) and consulted with the ODFW district biologist about the fish species in the lower Long Tom River. Based on this information, DEQ determined the resident cool water species that may be present in the lower Long Tom River are:

- Chiselmouth *(Acrocheilus alutaceus)* (An EPA RIS "Representative Important Species" for Oregon)
- Northern Pikeminnow *(Ptychocheilus oregonensis)*
- Redside Shiner *(Richardsonius balteatus)*
- Peamouth *(Mylocheilus caurinus)*
- Largescale Sucker (*Catostomus macrocheilus*)
- Mountain Sucker *(Catostomus platyrhynchus)*
- Sand Roller *(Percopsis transmontana)*
- Pacific Lamprey (*Entosphenus tridentatus*)

ODFW's information also shows that juvenile Spring Chinook salmon (*Oncorhynchus tshawytscha* may be present at least part of the year and Coastal Cutthroat trout (*Oncorhynchus clarkii*) are resident in tributaries to the lower reach and may utilize it for at least part of the year. Additionally, western pearlshell mussel (*Margaritifera falcata*) and western ridged mussel (*Gonidea angulate*) are present in the Willamette River side channels formed by the mouth of the Long Tom River, although these side channels receive flow from the Willamette mainstem and most of the side channel is designated for the 18.0ºC criterion for salmon and trout rearing and migration.

Based on review of available studies, Sand Roller and Redside shiner are the most temperature sensitive cool water species based on adult thermal tolerance and observed presence. Redside Shiner has an upper lethal temperature threshold between 22.8°C and 27.7°C (Black, 1953) and Sand Roller have preference temperatures of up 24.0 degrees Celsius and a recommended acute threshold of 27.0°C (Gray and Dauble 1979; Parsley et al. 1989, Tiffan et al. 2017).

Spawning of Chiselmouth, Northern Pikeminnow, Peamouth, and Mountain Sucker could occur in the lower reach between April and July, based on observations of spawning timing from the Columbia River, British Columbia, Montana, and Nevada. However, exact spawning timing for these species in the lower reach is unknown. These species initiate spawning when water temperatures exceed 12°C -18°C (Gadomski et al. 2001; Gray and Dabule 2001, Montana FWP, 2023, Roberge et al. 2001, Roberge et al. 2002, and Snyder 1983). Spawning habitat within the lower reach between Monroe and Fern Ridge Reservoir may also be limited (Hutchison 1966). DEQ could not identify documentation of lethal maximum temperatures for egg incubation for these species. Spawning in these species appears to be initiated as temperatures warm to a certain level, and the species may shift spawning to times when temperatures are favorable (Gadomski et al. 2001). Moodie found there was no survival of incubated Chiselmouth eggs unless temperatures were greater than 12°C (Moodie, 1966). Minimum, rather than maximum, thermal requirements may be the limiting factor for distribution of Chiselmouth (Rosenfeld, 2003).

No thermal tolerance studies for western pearlshell and western ridged mussels are available. Studies of thermal tolerance for 28 North American species belonging to the same order (*Unionida*) of freshwater mussels as the native Oregon species indicate a wide range of thermal tolerance between 21.4°C and 42.6°C with a mean tolerance of 32.8°C for juvenile and 36.3°C for adult life stages (Pandolfo et al. 2010, Fogelman et al. 2023). Black et al. documented western pearlshell growth in western Oregon, where maximum temperature averaged 25.1°C at one site, with annual range from 14.7°C to 26.8°C (Black et al. 2010). Western pearlshell and western ridged mussels are adapted to a wide geographic distribution on the west coast, from California to Alaska. They also have the capacity to burrow enabling them to occupy cooler micro-habitats or access thermal refuge, allowing them to tolerate unfavorable water temperature conditions to an extent (Blevins et al. 2019).

Table 4-2: Temperature tolerance endpoints for Long Tom River cool water species as reported in literature reviewed by DEQ.

Species	Acclimation Temperature (°C)	Endpoint	Endpoint Temperature (°C)	Source
Chiselmouth *(Acrocheilus alutaceus)*	NA	Observed absence in field	<20	Rosenfeld et. al. 2003
	NA	Adult preference	>20	Gray and Dabule, 2001
	NA	Spawning initiation	15	(Gray and Dauble, 2001
	NA	Spawning peak	13 – 20	(Gray and Dauble, 2001, Moodie 1966
	NA	100% mortality, eggs	≤12	Moodie 1966
Redside shiner *(Richardsonius balteatus)*	14	100% survival after 24 hours, adult	22.8	Black, 1953
		50% survival after 24 hours, adult	27.6	
		No survival after 24 hours, adult	30.3	
	NA	Spawning Initiation	14.5 – 18	Gray and Dauble, 2001
	NA	100% survival, egg incubation	21 – 23	Scharpf, 2008
Northern Pikeminnow	19-22	50% survival after 24 hours, adult	29.3	Black 1953

Species	Acclimation Temperature (°C)	Endpoint	Endpoint Temperature (°C)	Source
(Ptychocheilus oregonensis)	NA	Spawning Initiation (Columbia R. populations, May - June)	14 – 18	Gadomski et al. 2001, Gray and Dauble, 2001, Roberge et al. 2002
	NA	Adult preference	21.7 (“warmest available”)	Bartoo, 1972
Peamouth *(Mylocheilus caurinus)*	NA	Spawning Initiation	10 – 11	Gray and Dauble 2001
	NA	Spawning Initiation (Western Montana, May or June)	10 – 18	Roberge et al. 2001, Montana FWP 2023
	14	50% mortality after 24 hours	26.6	Black, 1953
	11.5	50% mortality after 24 hours, adult	27	
Largescale Sucker (*Catostomus macrocheilus*)	19	100% survival after 24 hours, adult	25.7	Black, 1953
	19	50% survival after 24 hours, adult	29.4	
	19	0% survival after 24 hours, adult	32.2	
Mountain Sucker *(Catostomus platyrhynchus)*	NA	Observed occurrence in field	10 – 28	Smith, 1966
	NA	Spawning Initiation (Truckee River, NV, May 1 – August 1)	11 – 19	Snyder, 1983
	20	Loss of Equilibrium	32.3 – 32.9	Schultz, 2011
	22.5	Loss of Equilibrium	32.6 – 33.2	
	25	Loss of Equilibrium	33.6 – 34	
	NA	Recommended Acute Tolerance (MDMT)	28	NVDEP 2016
Sand Roller *(Percopsis transmontana)*	NA	Observed presence in field (Columbia Basin)	2.5 – 24	Gray and Dauble 1979; Parsley et al. 1989
	NA	Adult preference, field observations	18-24	Tiffan et al. 2017

Black (1953) reported the upper lethal temperature for Redside Shiner as 27.6°C. The upper lethal temperature was based on 50% survival after 24 hours of exposure to various treatment temperatures. The treatment temperature at which all Redshide shiner survived after 24 hours was reported as 22.8°C. These results indicate that Redside Shiner have a reasonable margin of safety between complete survival and the point at which half the population died (4.8°C).

Oregon’s water quality criteria for temperature are based on a maximum 7DADM that reflects the highest average of maximum temperatures that fish are exposed to over a weeklong period for the year. Since most laboratory studies of thermal tolerance are based on continuous exposure to a single temperature, translation of the lab results to an equivalent 7DADM value is necessary to determine a temperature target consistent with Oregon’s water quality standards. Following EPA’s guidance for temperature standard development for Pacific Northwest States, a constant lab exposure temperature for 100% survival of Redside Shiner at 22.8°C corresponds to a 7DADM temperatures of 24.0°C (EPA 2003). The difference between weekly mean and weekly maximum temperatures in the lower Long Tom River is 2-3 degrees in the summer. Therefore, under a temperature target of 24.0°C as a 7DADM temperatures, fish would experience daily temperatures above the limit for 100% survival of Redshide Shiner (22.8°C) for only a small part of the day during the warmest 7-day period of the year. Given the wide margin between temperatures at 50% and 100% survival, exposure to maximum water temperatures greater than 22.8°C for just a few hours a day during this period will not likely cause harm to Redside Shiner.

Therefore, DEQ selected 24.0°C expressed as the instream seven-day average maximum temperature target plus an insignificant addition of heat for human use equal to 0.3°C as the target temperature. This target will approximate daily average temperatures that match the constant lab exposure temperature limit for 100% survival and reduce the risk of daily exposure to temperatures that could result in impairment to Redside shiner. This target will also ensure conditions within the preferred range for the next most sensitive species, Sand Roller and Mountain Sucker.

4.8.3 Long Tom River salmonid uses

ODFW's FHD and timing tables (**Table 4-3** and **Table 4-4**) indicate there is some limited Spring Chinook salmon rearing use of the lower reach with peak use from December 1 through May 15 downstream of the City of Monroe to the confluence with the Willamette River. At the time the use was designated, ODFW indicated the Long Tom River likely did not support a natural run of anadromous salmonids and juvenile Cutthroat trout were largely absent downstream of Fern Ridge Reservoir (Hutchison 1966, ODFW 1992). Hutchison et al. identified that Cutthroat trout are resident in tributaries of the lower reach, and appeared to have adapted to survive the high summertime temperatures typical of the lower river system. They also noted there is little spawning habitat between Monroe and Fern Ridge Reservoir (Hutchison 1966). Cutthroat trout are resident and regularly tagged in tributaries to the lower Long Tom River. (Bear Creek, Ferguson Creek, Owens Creek, Rattlesnake Creek, and Davidson Creek). Recapture data indicates that a minority of Cutthroat individuals migrate between these tributary creeks via the lower reach of the Long Tom River. However, no fish are sampled from the lower Long Tom River mainstem, and it is uncertain what months of the year these individuals use the lower reach to migrate (LTWC and ODFW, unpublished data).

In order to protect juvenile Chinook salmon and Cutthroat Trout that may be migrating or overwintering, DEQ will rely upon the 18.0°C target temperature established for protection of Salmon & Trout Rearing and Migration use suggested by EPA guidance (EPA, 2003) and adopted in Oregon's water quality standards (OAR 340-041-0028 (4)(c)). The 18.0°C temperature target is also fully protective of any life stage of Pacific Lamprey (Meeuwig et al. 2003, Whitesel 2023). This target is also within observed temperature ranges supporting spawning and egg incubation use by the cool water species Mountain Sucker, Peamouth, and Northern Pikeminnow which may occur within that timeframe.

Table 4-3: Anadromous salmonid species use in the Long Tom River subbasin (Source: ODFW 2003[1])

Long Tom R - Anadromous Species Waterway ID: MidWill06												
Life Stage/Activity/Species	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Upstream Adult Migration												
Spring Chinook salmon												
Adult Spawning												
Spring Chinook salmon												
Adult Holding												
Spring Chinook salmon												
Egg Incubation through Fry Emergence												
Spring Chinook salmon												
Juvenile Rearing												
Spring Chinook salmon												
Downstream Juvenile Migration												
Spring Chinook salmon												

Represents periods of peak use based on professional opinion, survey data, or other inform

Represents lesser level of use based on professional opinion,survey data, or other informa

Represents periods of presence OR uniformly distributed level of use

Table 4-4: Resident salmonid species use of the Long Tom River (Source: ODFW).

Long Tom R - Non-Anadromous Species Waterway ID: MidWill06												
Life Stage/Activity/Species	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Adult Fluvial or Adfluvial Migration												
Cutthroat Trout - Resident												
Adult Spawning												
Cutthroat Trout - Resident												
Adult/Sub-Adult Rearing												
Cutthroat Trout - Resident												
Egg Incubation through Fry Emergence												
Cutthroat Trout - Resident												
Juvenile Rearing												
Cutthroat Trout - Resident												
Juvenile/Sub-Adult Migration												
Cutthroat Trout - Resident												

Represents periods of peak use based on professional opinion, survey data, or other inform

Represents lesser level of use based on professional opinion,survey data, or other informa

Represents periods of presence OR uniformly distributed level of use

4.8.4 Long Tom River temperature target

Based on the literature review above the temperature targets for the lower Long Tom River are:

[1] ODFW Fish Life Stage Timing Tables https://nrimp.dfw.state.or.us/DataClearinghouse/default.aspx?p=202&XMLname=42654.xml

1) 24.0°C + the 0.3°C human use allowance (HUA) from June 15 through October 31 (based on thermal preference for Sand Roller and Mountain Sucker and thermal tolerance for Redside Shiner);
2) 18.0°C + HUA from November 1 to June 14 (Based on Spring Chinook rearing and juvenile migration; spawning preferences for Mountain Sucker, Peamouth, and Chiselmouth).

The human use allowance (HUA) applies because the maximum 7DADM temperature of the Long Tom River exceeds both 24.0°C and 18.0°C during their respective time periods. From June 15 through October 31, where the cool water species criterion applies in the Long Tom River, warming from anthropogenic sources shall be limited to a cumulative increase of no greater than 0.3°C above 24.0°C after complete mixing in the water body, and at the point of maximum impact. During November 1 through June 14 the numeric benchmark protecting cool water fish and migrating juvenile Chinook salmon is an instream 7DADM target of 18.0°C plus an insignificant addition of heat for human use equal to 0.3°C after complete mixing in the water body, and at the point of maximum impact. A summary of the temperature targets is presented in **Table 4-5**.

The provisions of the PCW criterion at OAR 340-41-0028(11) are also incorporated into the temperature target. If ambient 7DADM temperatures trend to always being cooler than both temperature targets presented in **Table 4-5** and all exceptions outlined in OAR 340-41-0028(11)(c) are not applicable, the PCW criterion shall be applied with the 0.3°C HUA based on an increase above the cooler ambient temperature.

The mixing zone and thermal plume limitations in OAR 340-041-0053 (2)(E)(d) will provide further protections against potential migration blockages when temperatures exceed 21.0°C. The TMDL assumes assessment and application of thermal plume limitations, as necessary, will be completed during the NPDES permit renewal process.

Table 4-5: Summary of temperature targets implementing the cool water species narrative in the lower Long Tom River.

Time period	7DADM Temperature Target (°C)	Most Temperature Sensitive Species
June 15 – October 31	24.0 + 0.3 HUA	Redside shiner (*Richardsonius balteatus*)
November 1 – June 14	18.0 + 0.3 HUA	Chinook Salmon (*Oncorhynchus tshawytscha*)

4.8.5 Rickreall Creek temperatures

Continuous temperature data (**Figure 4-6**) and instantaneous (grab) data (**Figure 4-7** and **Figure 4-8**) are available on lower Rickreall Creek. The data show temperatures peak in July and August and exceed 18°C from May 15 to September 30 near the mouth (**Figure 4-6**), and into October near the midpoint of the lower reach (**Figure 4-8**). Temperatures exceed 20°C from July through the end of September. The plots in **Figure 4-6** through **Figure 4-8** show boxplots of the seasonal variation of 7DADM and grab sample temperatures at monitoring locations on lower Rickreall Creek. Temperature data were grouped by the first and second half of each month. The month was split on the 15th with the first group including all results measured on the 1st through the 14th day and the second group including all results measured on the 15th through the end of the month. The boxplots are Tukey style boxplots with the middle line representing the median and ends of the box representing the temperature range between the first and third quartiles (25th – 75th percentile). The whiskers extend to values no further than 1.5 times the interquartile 7DADM temperature range (1.5 times the difference between 25th and 75th

percentiles). The points represent individual 7DADM or grab sample temperatures values beyond 1.5 times the interquartile range. The dashed line corresponds the selected lower Rickreall Creek temperature target (Section 4.8.8). The shaded yellow area identifies the period when temperatures exceed the temperature target.

DEQ has not modeled the background temperatures of lower reach of Rickreall Creek, so an estimate of possible background temperature was derived using a nearby stream that was modeled. This provides a useful estimate of the range of potential temperature reductions possible in Rickreall Creek and to evaluate if a target temperature based on 20°C is attainable, as outlined in DEQ's temperature water quality standard implementation IMD (DEQ, 2008a).

The Luckiamute River watershed is a tributary of the Willamette River, approximately 60 miles long, that drains the eastern Coast Range mountains with an outlet on the Willamette Valley floor. The mouth of the Luckiamute River is approximately 20 river miles south of the mouth of Rickreall Creek along the Willamette River. DEQ estimated the background temperatures of the nearby Luckiamute River as part of the Willamette Subbasins TMDL. See TSD Appendix A for more details. A temperature reduction refers to the decrease in 7DADM temperatures from full restoration of streamside vegetation in a system free of dam and reservoir operations.

Thermal pollutant sources identified for the Luckiamute River include lack of sufficient shade-producing streamside vegetation, and background sources. Along the Luckiamute River model extent, lack of sufficient streamside vegetation was associated with a mean effective shade gap of 9%, corresponding to daily maximum water temperature increases of 3.56°C at the POMI at model km 42.8 (~ river mile 26) and 0.34°C at the mouth. The Luckiamute background model suggests temperature reductions of approximately 3.5°C to 0.3°C are possible depending on the position of a site along the watershed. The temperature reductions suggested by the Luckiamute background model at the mouth, indicate that a 20°C temperature target may not be attainable in the lower reach of Rickreall Creek.

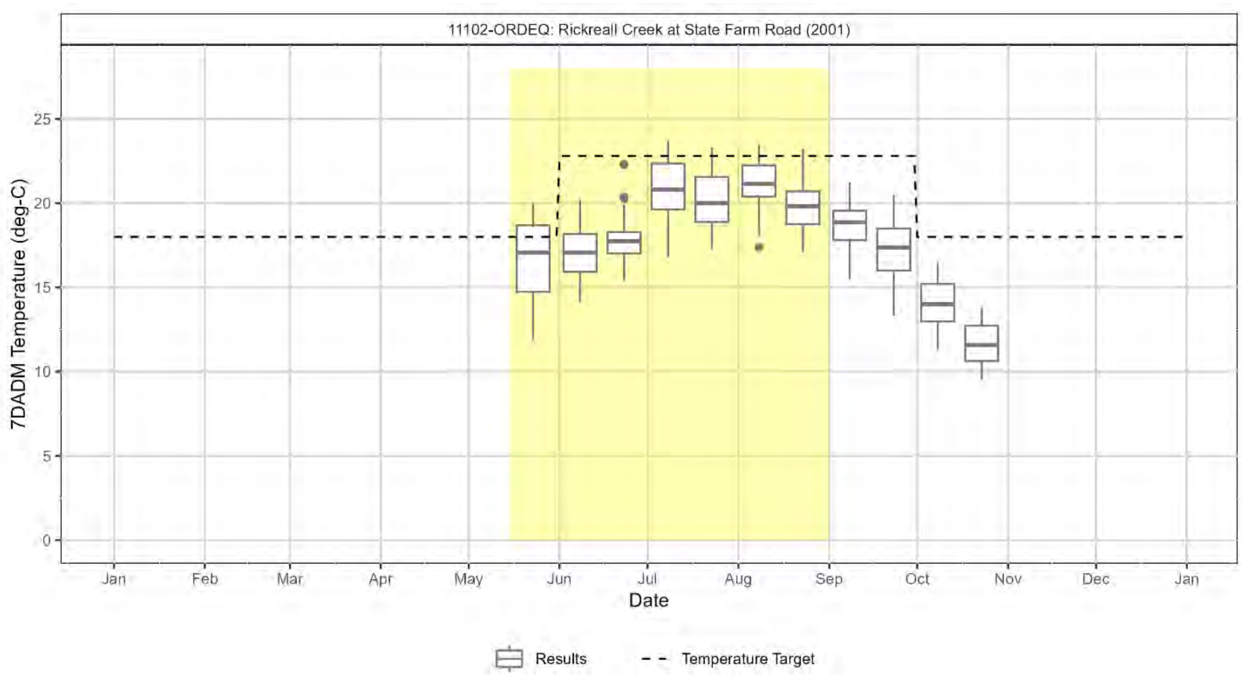


Figure 4-6: Distribution of 7DADM temperatures from continuously monitored temperature data from DEQ monitoring site 11102 (approximate river mile 0.9). The cool water species narrative

temperature targets are shown as dashed lines. The yellow shading indicates time periods were some 7DADM values exceeded the temperature target.

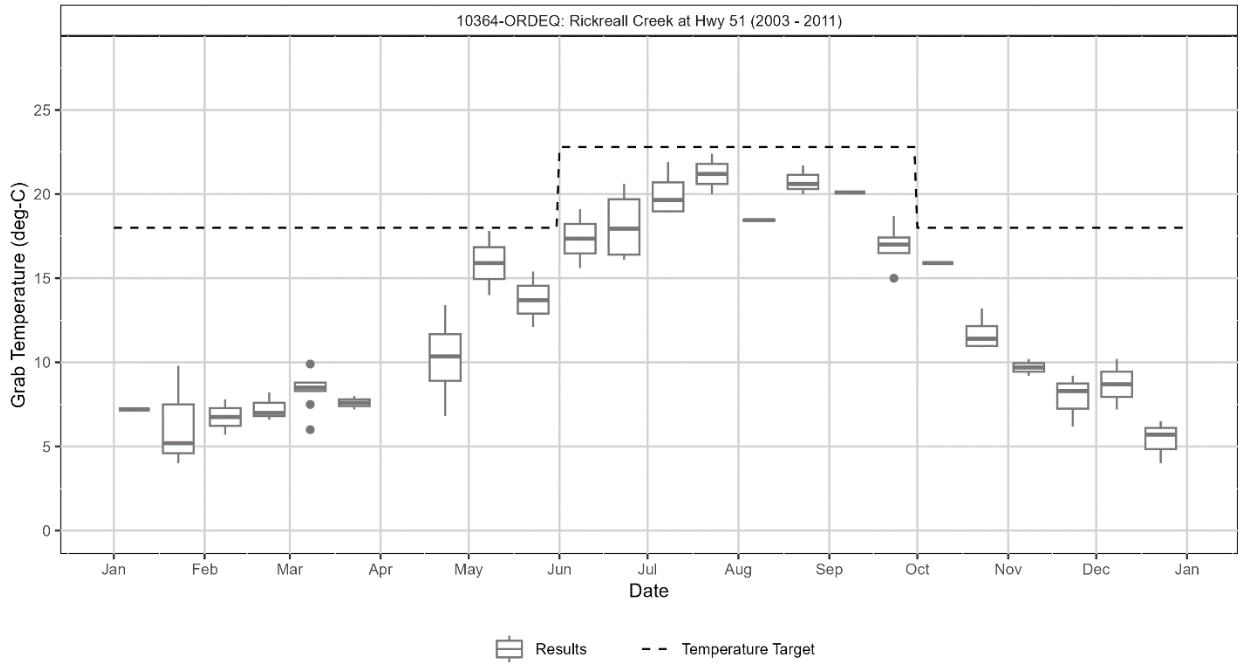


Figure 4-7: Distribution of temperatures from single sample grab data at DEQ monitoring site 10364 (approximate river mile 2.2) from 2003-2011. The cool water species narrative temperature targets are shown as dashed lines.

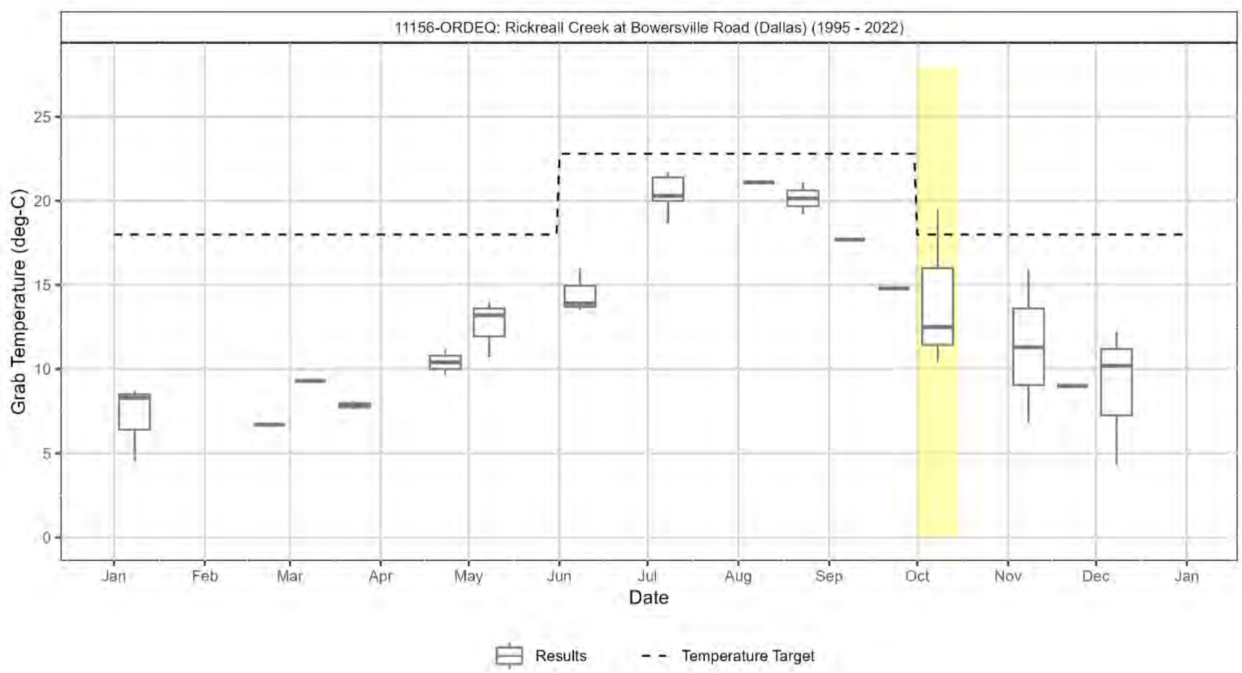


Figure 4-8: Distribution of temperatures from grab data collected at DEQ monitoring site 11156 (approximate river mile 10.7) from 1995-2022. The cool water species narrative temperature targets

are shown as dashed lines. The yellow shading indicates time periods where some grab temperature exceeded the temperature target.

4.8.6 Rickreall Creek cool water species

DEQ reviewed the Oregon Department of Fish & Wildlife (ODFW) fish habitat distribution database and life stage timing tables for the Rickreall Creek watershed (ODFW, 2023) and consulted with the ODFW district biologist about the fish species in the lower reach. Based on this information, DEQ determined the resident cool water species that may be present in Rickreall Creek downstream of Dallas include Speckled dace (*Rhinichthys osculus*), Redside shiner (*Richardsonius balteatus*), Largescale sucker (*Catostomus macrocheilus*), Prickly sculpin (*Cottus asper*), and Pacific lamprey (*Entosphenus tridentatus*). The exact timing of cool water species use of Lower Rickreall Creek is not fully understood, but multiple cool water species have been observed in the reach from April to November (Chastain et al., 2002). ODFW's information also show that adult and juvenile winter steelhead (*Oncorhynchus mykiss*) migrate through lower Rickreall Creek. The peak migration period in ODFW's timing tables is February 15 through May 31 (ODFW, 2023).

A review of available studies evaluating the temperature tolerance of the cool water species present in Lower Rickreall Creek was completed in order to identify a target temperature to implement the cool water species narrative rule. We found temperature tolerance studies for all species except Largescale sucker. A summary of the studies follows.

Carveth et al. (2006) reported four endpoint thermal maxima for Speckled dace collected from Arizona rivers. The lowest temperature of all the endpoints reported is the initial loss of equilibrium (ILOE) at 34.7°C (95% confidence interval of 0.4°C) for fishes acclimated to 25°C waters. Other endpoints reported are summarized in **Table 4-6**.

Beitinger et al. (2000) conducted a review and summarized the results of several temperature tolerances studies of multiple North American freshwater species. For Speckled dace, a study by Castleberry and Cech (1993) reported a loss of equilibrium at 32.4°C with a standard deviation of 1.90°C. The acclimation temperature was 20°C (**Table 4-6**).

John (1964) reported the ultimate incipient upper lethal temperature for Speckled dace is about 33°C for young fish and 32°C for older fish (**Table 4-6**). The fish were not acclimated for this study.

Black (1953) evaluated the temperature tolerance for some freshwater fish found in the Okanagan Lakes in British Columbia, Canada. The upper lethal temperatures, defined as the temperature at which 50 percent of the fish died in 24 hours, was 24.1°C for Prickly sculpin and 27.6°C for Redside shiner. All fish survived after 24 hours at treatment temperatures of 22.8°C for both species. No fish survived after 24 hours at treatment temperatures of 26.5 and 30.3°C for Prickly sculpin and Redside shiner, respectively (**Table 4-6**).

Whitesel and Uh (2023) reported the ultimate incipient upper lethal temperature after 7 days for larval Pacific lamprey was 28.3°C based on the time to death and 30.2°C based on the percent mortality approach (**Table 4-6**). In experiments of direct acute exposure, larval were acclimated to different temperatures ranging from 19.8 to 23.3°C for 7-9 days and then placed in various treatment temperatures. The LT50 was calculated, which is the number of hours at which 50% of the larval survived. The LT50 was 1 hour or less at treatment temperatures ranging from 31.1

to 33.4°C. The LT50 ranged from 43.1 to 80.5 hours in treatment temperatures of 29 to 29.3°C. In experiments of acclimated chronic exposure over a 30 day period, 100% of the larval lamprey survived in the treatment temperatures of constant exposure ranging from 21 to 27°C. No larval lamprey survived in constant treatment temperatures of 30 and 33°C over the 30-day period.

Table 4-6: Temperature tolerance endpoints for cool water species as reported in literature reviewed by DEQ.

Species	Acclimation Temperature (°C)	Endpoint	Endpoint Temperature (°C)	Source
Speckled dace (Rhinichthys osculus)	20	Initial loss of equilibrium	32.4 ± 1.90	Castleberry and Cech (1993) via Beitinger et al. (2000)
	25	Initial loss of equilibrium	34.4 ± 0.4	Carveth et al. (2006)
		Final loss of equilibrium	34.4 ± 0.4	
		Flaring opercula	35.9 ± 0.2	
		Death	36.0 ± 0.4	
	30	Initial loss of equilibrium	35.8 ± 0.6	
		Final loss of equilibrium	36.9 ± 0.1	
		Flaring opercula	37.0 ± 0.1	
		Death	36.9 ± 0.3	
	NA	Ultimate incipient upper lethal temperature	33 (young fish) 32 (old fish)	John (1964)
Redside shiner (Richardsonius balteatus)	14	100% survival after 24 hours	22.8	Black (1953)
		50% survival after 24 hours	27.6	
		No survival after 24 hours	30.3	
Prickly sculpin (Cottus asper)	18–19	100% survival after 24 hours	22.8	
		50% survival after 24 hours	24.1	
		No survival after 24 hours	26.5	
Pacific lamprey (Entosphenus tridentatus)		Ultimate incipient upper lethal temperature (7 days) based on time to death	28.3	Whitesel and Uh (2023)
		Ultimate incipient upper lethal temperature (7 days) based on percent mortality	30.2	

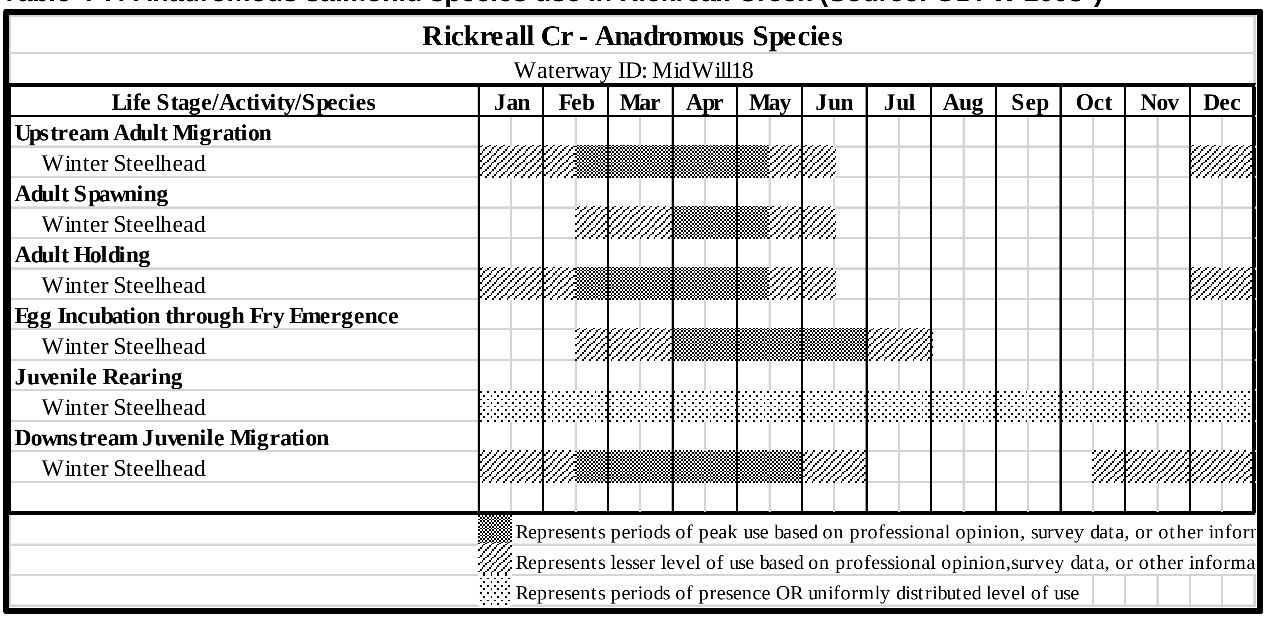
Based on review of available temperature tolerance studies, Prickly sculpin are the most temperature sensitive cool water species. Black (1953) reported the upper lethal temperature as 24.1°C. The upper lethal temperature was based on 50% survival after 24 hours of exposure to various treatment temperatures. Other endpoints reported for Prickly sculpin include the treatment temperature at which all fish survived after 24 hours (22.8°C) and the treatment temperatures with no survival after 24 hours (26.5°C).

These results indicate that Prickly sculpin have a narrow temperature margin between complete survival and the point at which half the population died (1.3°C). This was taken into consideration when setting the target temperature. Exposure to water temperatures greater than 24.1°C for just a few hours will likely not cause significant harm, but it is unclear if exposure for just a few hours a day over the course of 7 or more days would have a similar impact as a constant 24 hour exposure. Due to this uncertainty, DEQ selected the more protective endpoint (22.8°C) expressed as the instream 7DADM temperature target plus an insignificant addition of heat for human use equal to 0.3°C. This target will limit the exposure time to temperatures that would result in impairment to Prickly sculpin. This target applies from June 1 through September 30. The following section will explain when the cool water species applies versus when salmonid species uses apply.

4.8.7 Rickreall Creek salmonid uses

Rickreall Creek also provides habitat for cold water salmonid species, including steelhead trout (*Oncorhynchus mykiss*) and Coastal Cutthroat trout (*Oncorhynchus clarkii*). Various life stages are present in the watershed at certain times of year (ODFW, 2023). The following timing tables are for the entire Rickreall Creek basin. The lower reach is not spawning or egg incubation habitat and trout use is absent or limited during the warmer months.

Table 4-7: Anadromous salmonid species use in Rickreall Creek (Source: ODFW 2003[2])



[2] ODFW Fish Life Stage Timing Tables
https://nrimp.dfw.state.or.us/DataClearinghouse/default.aspx?p=202&XMLname=42654.xml

Table 4-8: Resident salmonid species use of Rickreall Creek (Source: ODFW, 2003[1])

Rickreall Cr - Non-Anadromous Species Waterway ID: MidWill18												
Life Stage/Activity/Species	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Adult Fluvial or Adfluvial Migration												
Cutthroat Trout - Resident	peak	peak	peak	peak / lesser	lesser	lesser				lesser	lesser / peak	peak
Adult Spawning												
Cutthroat Trout - Resident	peak	peak	peak	peak / lesser	lesser	lesser / –					lesser	peak
Adult/Sub-Adult Rearing												
Cutthroat Trout - Resident	presence	presence	presence	presence	presence	presence	presence	presence	presence	presence	presence	presence
Egg Incubation through Fry Emergence												
Cutthroat Trout - Resident	peak	peak	peak	peak	peak / lesser	lesser	lesser / –				lesser	peak
Juvenile Rearing												
Cutthroat Trout - Resident	presence	presence	presence	presence	presence	presence	presence	presence	presence	presence	presence	presence
Juvenile/Sub-Adult Migration												
Cutthroat Trout - Resident	presence	presence	presence	presence	presence	presence	presence	presence	presence	presence	presence	presence

- peak: Represents periods of peak use based on professional opinion, survey data, or other inforr
- lesser: Represents lesser level of use based on professional opinion,survey data, or other informa
- presence: Represents periods of presence OR uniformly distributed level of use

From the ODFW timing tables it is not clear what timing of use is specific to the lower reach versus within the watershed as a whole. The prime rearing habitat is likely upstream of the City of Dallas. Data on abundance of cold water species in the lower reach relative to the other waters of the Rickreall Creek watershed is limited. ODFW provided DEQ with some supplemental studies of fish presence in the Rickreall Creek Watershed.

A detailed survey of fish presence for multiple cool and cold-water species was conducted in Rickreall Creek in 2002 (Chastain et al., 2002). The authors sampled nine sites on the main stem of Rickreall Creek from river mile 0.56 to 28 monthly for a year, from April 2001 to March 2002. Four of the sites sampled (Sites #1-4) are within and representative of the lower reach (**Figure 4-9**). A fifth site (Site #5) is located at or above the endpoint of the lower reach in Dallas City Park, and therefore is not representative of the lower reach. The authors found the Rickreall Creek watershed has a relatively intact native fish community, and that sites #1-4 were dominated by cool water species (Chastain et al., 2002, Figure 2a).

No anadromous salmonid species were detected at site #1, near the mouth of Rickreall Creek, at any time of year (**Figure 4-10**). Coho, Chinook, and steelhead salmon were detected at sites #2-4 sporadically between October 1 and May 31 (**Figure 4-11** through **Figure 4-13**). Resident Cutthroat trout were detected sporadically between September 1 and April, but never in consecutive months except for Site #4 (**Figure 4-13**). One detection of Cutthroat trout occurred in July at site #3 (**Figure 4-12**). The total number of Cutthroat captured at site #3 and site #4 appears to be less than 10 individuals for the entire year (Chastain et al., 2002, Figure 7g).

In contrast, at site #6, approximately 2 stream miles upstream of Dallas City Park in the portion of Rickreall Creek designated for Salmon and Trout Rearing and Migration use, and expected to be more prime rearing habitat, anadromous salmon or resident Cutthroat trout were detected every month of the year. This suggests a low level or only sporadic use of the lower reach by cold water salmonid species, namely Cutthroat trout only, between June and October, consistent with the designated use of Cool Water Species (**Figure 4-14**).

Chapman et al. (2003) also conducted a bi-weekly snorkel survey within the lower reach at Villwok's Ford (approximate river mile 7.7) from May to September 2003. This site is identical to site #3 sampled by Chastain et al. in 2002. They did not detect any anadromous salmon species, including juvenile steelhead, at the site between May and September. Cutthroat trout were detected downstream of the ford in May, July, August and September, but only sporadically upstream of the ford one week of May and one week of June (**Table 4-9**). No counts of individuals detected were included in the study. The authors indicate that the ford is not a barrier to Cutthroat trout passage. Chastain et al. did not find Cutthroat trout at the same site during the same months in 2002, suggesting only low or sporadic levels of use by Cutthroat in the summer.

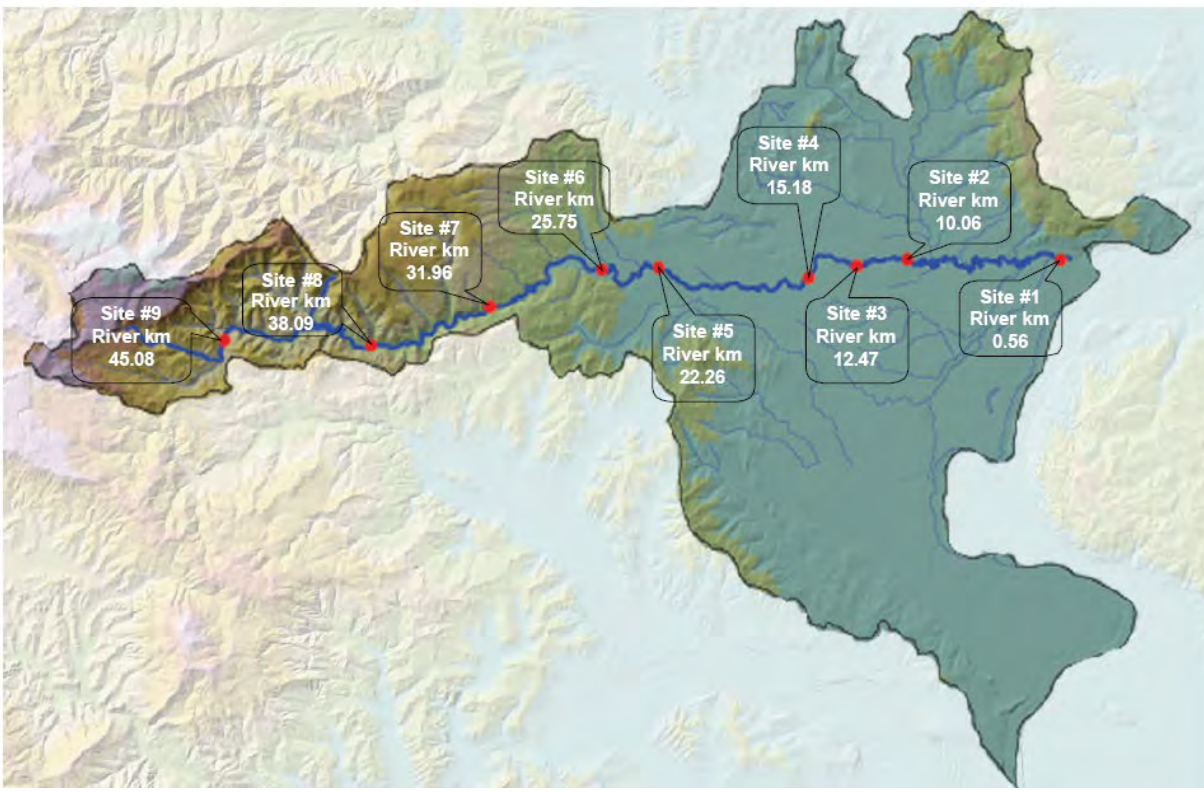


Figure 4-9: Sampling sites on the Rickreall Creek mainstem (from Chastain et al., 2002) Reaches below Site #5 are designated for cool water use.

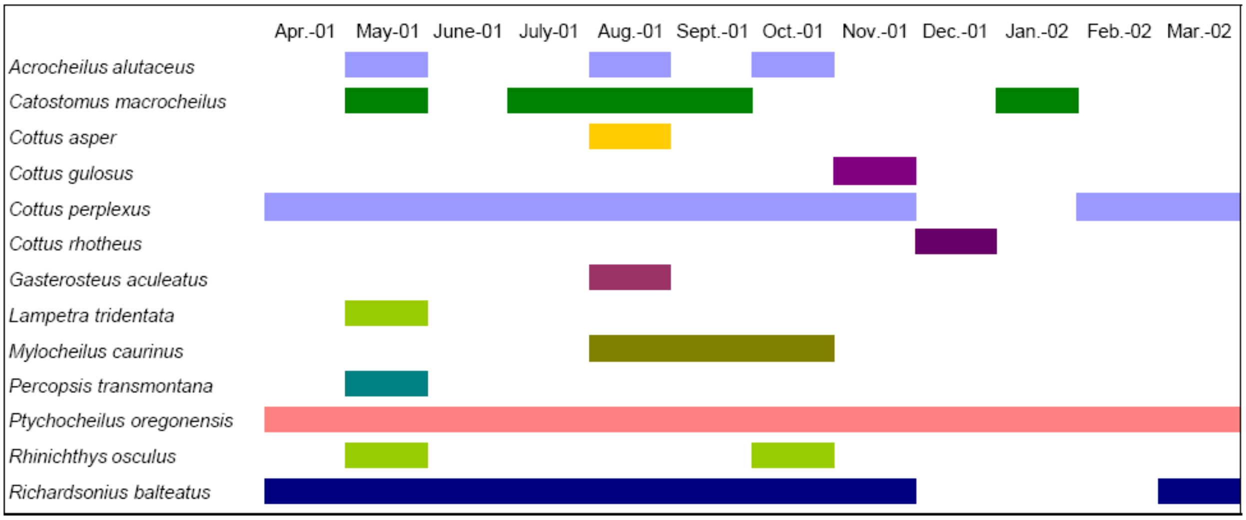


Figure 4-10: Temporal distribution of fish species encountered at approximately river mile 0.3 (Site #1) April 2001 – March 2002 (Chastain et al., 2002, Figure 3a). All species detected at this site are cool water species.

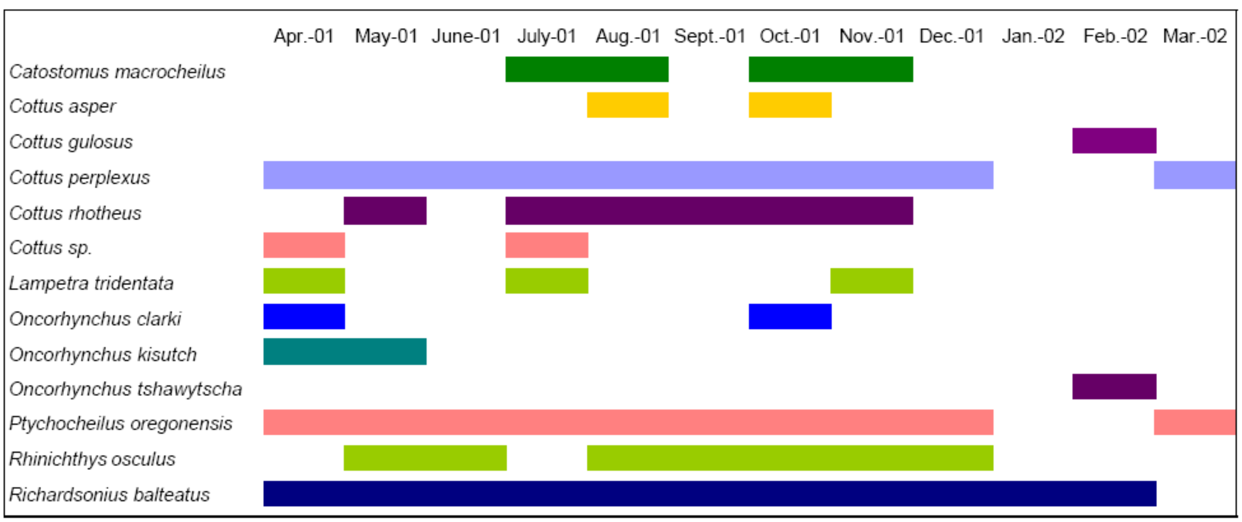


Figure 4-11: Temporal distribution of fish species encountered at approximately river mile 6.3 (Site #2) April 2001 – March 2002 (Chastain et al., 2002, Figure 3b). The salmonid species detected include: cutthroat trout (*O. clarkii*), Coho salmon (*O. kisutch*), and Chinook salmon (*O. tshawytscha*).

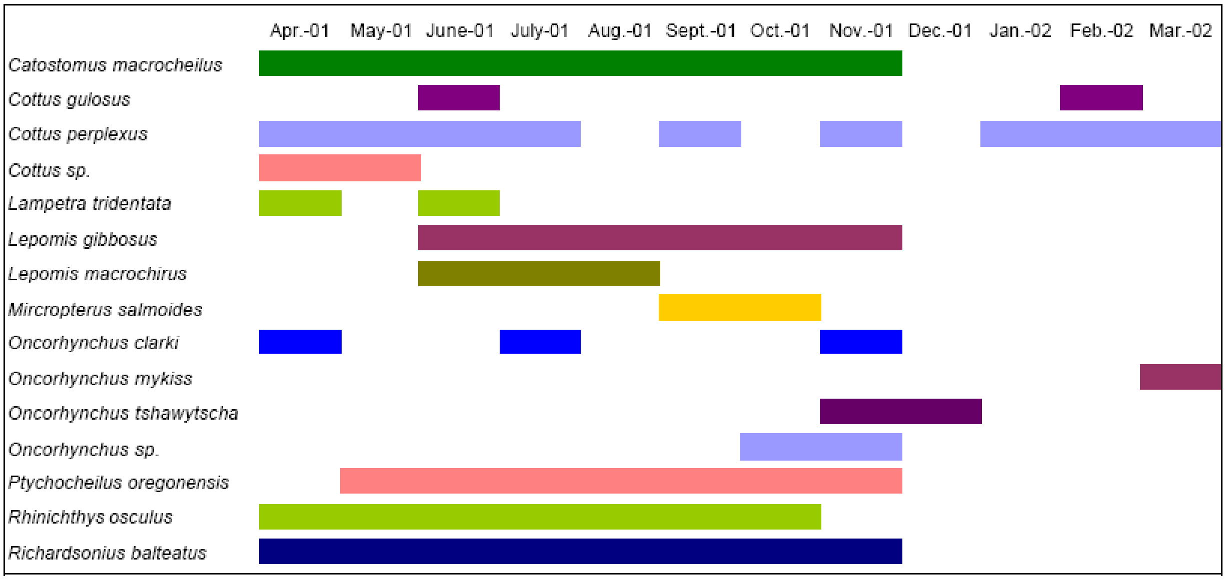


Figure 4-12: Temporal distribution of fish species encountered at approximately river mile 7.7 (Site #3) April 2001 – March 2002 (Chastain et al., 2002, Figure 3c). The salmonid species detected include: cutthroat trout (*O. clarkii*), steelhead/rainbow trout (*O. mykiss*), Coho salmon (*O. kisutch*), and Chinook salmon (*O. tshawytscha*).

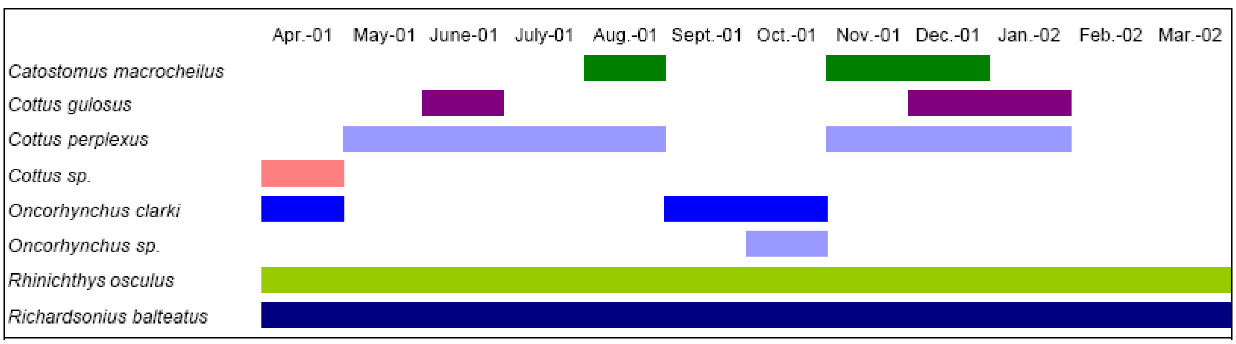


Figure 4-13: Temporal distribution of fish species encountered at approximately river mile 9.8 (Site #4) April 2001 – March 2002 (Chastain et al., 2002, Figure 3d). The salmonid species detected include: cutthroat trout (*O. clarkii*) and another salmonid (*Onchorhynchus spp*).

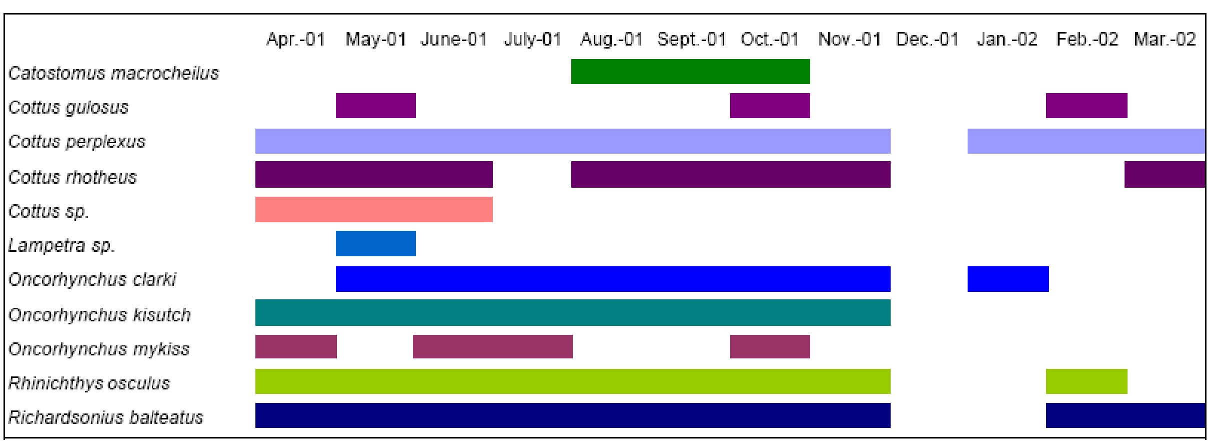


Figure 4-14: Temporal distribution of fish species encountered upstream of the lower reach for comparison, at approximately river mile 16 (Site #6) April 2001 – March 2002 (Chastain et al., 2002, Figure 3f).

Table 4-9: Species observed downstream and upstream of Villwok's Ford approximately river mile 12 (May – September 2003). (Chapman et al., undated, Table 10).

	Downstream of ford							
Species	**May 23**	**June 1**	**June 6**	**June 27**	**July 12**	**July 26**	**Aug. 18**	**Sept. 6**
Ptychocheilus oregonensis	No	Yes	No	Yes	Yes	Yes	Yes	No
Lepomis spp.	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Oncorhynchus clarki	Yes	Yes	No	No	Yes	Yes	Yes	Yes
Catostomus machrocheilus	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Lampetra tridentata	No	Yes	No	No	No	No	No	No
	Upstream of ford							
Ptychocheilus oregonensis	No	No	No	No	No	No	Yes	No
Lepomis spp.	No	No	No	No	No	No	No	No
Oncorhynchus clarki	Yes	No	No	No	No	Yes	No	No
Catostomus machrocheilus	Yes	Yes	Yes	No	Yes	Yes	No	Yes
Lampetra tridentata	No	No	No	No	No	No	No	No

4.8.8 Rickreall Creek temperature target

To protect the adult winter steelhead (*Oncorhynchus mykiss*), Coho salmon (*Oncorhynchus kisutch*), and Chinook salmon (*Oncorhynchus tshawytscha*) that may be migrating through the lower reach of Rickreall Creek, and juvenile winter steelhead or Coastal Cutthroat trout (*Oncorhynchus clarkii*) that may be rearing within the lower reach, DEQ will rely upon the 18.0°C target temperature established to protect salmon and trout rearing and migration uses suggested by EPA guidance (EPA, 2003) and adopted in Oregon's water quality standards (OAR 340-041-0028 (4)(c)). DEQ will apply the 18°C target plus the 0.3°C HUA from October 1 to May 31. This target temperature will also protect cool water fish.

To protect Prickly sculpin (*Cottus asper*), the most temperature sensitive cool water species in lower Rickreall Creek, DEQ will apply a temperature target of 22.8°C. DEQ will apply the 22.8°C target plus the 0.3°C HUA from June 1 to September 30. Warming from anthropogenic sources shall be limited to a cumulative increase of no greater than 0.3°C above the temperature targets after complete mixing in the waterbody, and at the POMI. A summary of the temperature targets is presented in **Table 4-10**.

The provisions of the PCW criterion at OAR 340-41-0028(11) are also incorporated into the temperature target. If ambient 7DADM temperatures trend to always being cooler than both temperature targets presented in **Table 4-10** and all exceptions outlined in OAR 340-41-0028(11)(c) are not applicable, the PCW criterion shall be applied with the 0.3°C HUA based on an increase above the cooler ambient temperature.

The mixing zone and thermal plume limitations in OAR 340-041-0053 (2)(E)(d) will provide further protections against potential migration blockages and acute thermal impacts. The TMDL assumes assessment and application of thermal plume limitations, as necessary, will be completed during the NPDES permit renewal process.

Table 4-10: Summary of temperature targets implementing the cool water species narrative in lower Rickreall Creek.

Time period	7DADM Temperature Target (°C)	Most Temperature Sensitive Species
June 1 – September 30	22.8 + 0.3 HUA	Prickly sculpin (*Cottus asper*)
October 1 – May 31	18.0 + 0.3 HUA	Winter steelhead (*Oncorhynchus mykiss*)

4.9 Three basin rule: Clackamas, McKenzie, and North Santiam

The three basin rule OAR 340-41-0350 applies to the waters of the Clackamas River Subbasin (17090011), The McKenzie River subbasin (17090004) above the Hayden Bridge (river mile 15), and the North Santiam Subbasin (17090005). The rule prohibits new or increased waste discharges with some exceptions.

4.10 Protecting cold water

The “protecting cold water” criterion in OAR 340-041-0028(11) applies to waters of the state that have summer ambient 7DADM temperatures that are colder than the biologically based criteria. With some exceptions (summarized in **Figure 4-15**), these waters may not be warmed cumulatively by anthropogenic point and nonpoint sources by more than 0.3°C (0.5°F) above the colder water ambient temperature. This applies to all anthropogenic sources taken together at the POMI where salmon, steelhead or bull trout are present. A summary of how DEQ implements this portion of the standard can be found in the PCW IMD (DEQ, 2011) and the Temperature IMD (DEQ, 2008a).

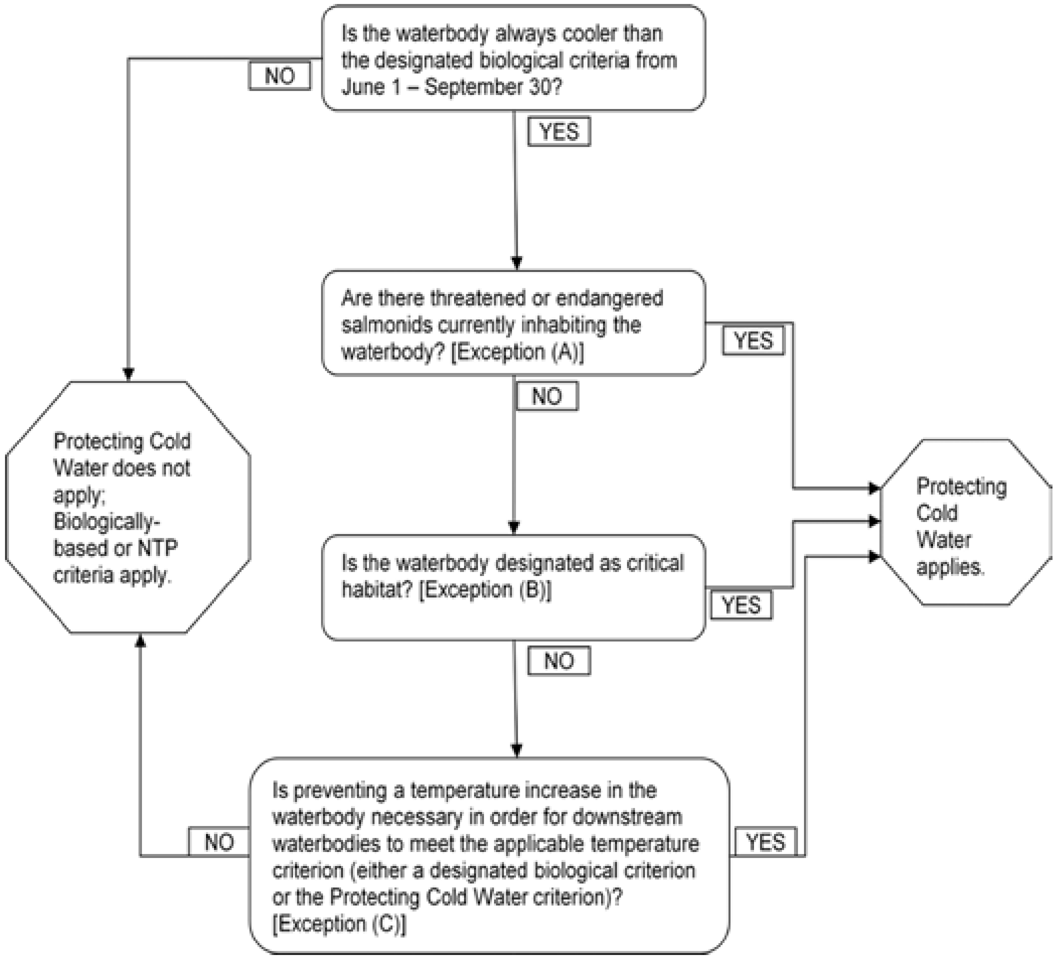


Figure 4-15: Flowchart to determine applicability of the PCW criterion. Extracted from DEQ, 2011.

4.11 Statewide narrative criteria

Statewide narrative criteria at OAR 340-041-0007(1) apply to all waters of the state. The highest and best practicable treatment and/or control of wastes, 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.

5 Seasonal variation and critical period for temperature

Per OAR 340-042-0040(4)(j) and 40 CFR 130.7(c)(1), TMDLs must identify any seasonal variation and the critical condition or period of each pollutant, if applicable.

DEQ reviewed available temperature data to determine seasonal temperature variation and the critical period. The critical period is based on the frequency and period when 7DADM stream temperatures exceed the applicable temperature criteria. **Table 5-1** summarizes the water temperature monitoring data used to designate critical periods.

Figure 5-1 through **Figure 5-53** show boxplots of the seasonal variation of 7DADM temperatures and the period of exceedance at select monitoring locations identified as having Category 5 temperature impairments on the 2022 Integrated Report. When multiple monitoring sites were available, the sites with multiple years of data were selected. Temperature data were grouped by the first and second half of each month. The month was split on the 15th with the first group including all results measured on the 1st through the 14th day and the second group including all results measured on the 15th through the end of the month. The boxplots are Tukey style boxplots with the middle line representing the median and ends of the box representing the temperature range between the first and third quartiles (25th – 75th percentile). The whiskers extend to values no further than 1.5 times the interquartile 7DADM temperature range (i.e., 1.5 times the difference between 25th and 75th percentiles). The points represent individual 7DADM temperature values beyond 1.5 times the interquartile range. The dashed line corresponds to the applicable temperature criteria. The shaded yellow area identifies the period when any 7DADM temperature exceeded the appliable temperature criteria.

The plots show that maximum stream temperatures typically occur in July or August. This period usually coincides with the lowest annual stream flows, maximum solar radiation fluxes, and warmest ambient air temperature conditions. The warmest median 7DADM temperatures were observed in the Middle Willamette. Monitoring data at Claggett Creek at Mainline Drive in the Middle Willamette Subbasin (**Figure 5-34**) show the median 7DADM temperature from 2013 to 2019 was close to 25°C from July 1 to September 1.

The period and frequency of temperature criteria exceedance varies based on monitoring location. Monitoring locations in the Johnson Creek Watershed had the longest periods of exceedance. Near the mouth of Crystal Springs, 7DADM temperatures exceeded the applicable criteria approximately February 15 through November 15 (**Figure 5-43**). Exceedances occurred approximately March 1 through November 15 in Johnson Creek near Milwaukie (**Figure 5-44**). At other monitoring sites the earliest exceedances occurred in April (McKenzie Subbasin **Figure 5-22**, or Lower Willamette Subbasin **Figure 5-45**) and the latest occurred at the end of December (South Santiam Subbasin **Figure 5-31**).

The seasonal variation downstream of some large dams and reservoirs show seasonal shifts in maximum temperatures relative to monitoring sites upstream of the dam and reservoir. For example, maximum 7DADM temperatures shift from July and August to September, October, and November downstream of Blue River Dam (**Figure 5-19** and **Figure 5-20**) Green Peter Dam (**Figure 5-29**, **Figure 5-30**, and **Figure 5-31**), and Hills Creek Dam (**Figure 5-1**, **Figure 5-2**, and **Figure 5-3**). For this reason, the critical period applied to the AUs downstream of these dams extends into November or December (**Table 5-2**).

DEQ uses the critical period to determine when allocations apply. In setting the allocation period, DEQ relied upon monitoring sites with the longest period of exceedance. When downstream monitoring sites have longer exceedance periods relative to upstream waters, the longer period is used as the critical period for upstream waterbodies. For example, temperature data show the McKenzie River period of exceedance is typically May 1 – October 31 (**Figure 5-23**); however in the Willamette River the period of exceedance is April 1 – November 15. Because of the significant flow and temperature influence the McKenzie River has on the

Willamette River, the critical period on the McKenzie River was set to be the same as the Willamette River. This is a margin of safety to ensure warming of upstream waters does not contribute to downstream exceedances.

The frequency of exceedance was also considered. If any individual 7DADM temperature values beyond 1.5 times the interquartile range exceeded the criterion (shown as points on the boxplots), that period was not usually included in the critical period. These 7DADM values represent approximately 2% or fewer of all observations in that 15-day period.

The critical periods for waterbodies in the Willamette Subbasins are presented in **Table 5-2**. Allocations presented in the TMDL apply during these periods.

Table 5-1: Water temperature monitoring locations and periods used to determine seasonal temperature variation and critical periods for the Willamette Subbasins.

Monitoring Location ID	Monitoring Location	Monitoring Period	Number of 7DADM values
14162200	Blue River at Blue River, OR	01/01/02 - 12/31/22	7592
14161100	Blue River Below Tidbits Creek, Nr Blue River, OR	10/29/08 - 10/23/22	4857
10896-ORDEQ	Butte Creek at Hwy 211	07/04/02 - 08/16/06	386
14164550	Camp Crk at Camp Crk Rd Bridge, Nr Springfield, OR	07/18/17 - 12/31/22	1912
14164700	Cedar Creek at Springfield, OR	07/17/17 - 12/31/22	1972
14210000	Clackamas River at Estacada, OR	01/01/02 - 10/17/22	7091
14211010	Clackamas River near Oregon City, OR	06/27/02 - 10/24/22	7326
CGT1	Claggett Creek at Mainline Dr NE	05/08/13 - 10/11/19	923
14153500	Coast Fork Willamette River below Cottage Grove Dam, OR	01/01/02 - 12/31/22	7488
14211546	Crystal Springs Creek at Mouth at Portland, OR	12/12/02 - 12/18/12	3490
14151000	Fall Creek below Winberry Creek, near Fall Creek, OR	01/01/02 - 12/22/22	7557
40089-ORDEQ	Ferguson Ck 0.1 Miles DS of Territorial Rd	05/21/17 - 10/28/20	638
40088-ORDEQ	Ferguson Ck 270 Meters DS SFK Mouth	05/21/17 - 10/28/20	638
40073-ORDEQ	Ferguson Creek 0.1 Miles Upstream of Eber Creek Confluence	05/21/17 - 10/28/20	638
MHNF-039	Fish Creek Temp Monitoring	07/30/09 - 06/02/20	1173
14144900	Hills Cr Ab Hills Cr Res, Nr Oakridge, OR	06/23/10 - 10/26/22	4462
14211550	Johnson Creek at Milwaukie, OR	01/01/02 - 12/31/22	7584
14182500	Little North Santiam River Near Mehama, OR	01/01/02 - 12/31/22	5546
14170000	Long Tom River at Monroe, OR	01/01/02 - 11/29/22	1777
14169000	Long Tom River near Alvadore, OR	01/01/02 - 11/27/22	7097
14164900	McKenzie River Abv Hayden Br, at Springfield, OR	07/01/09 - 12/31/22	4920

Monitoring Location ID	Monitoring Location	Monitoring Period	Number of 7DADM values
14145500	MF Willamette River Abv Salt Crk, Near Oakridge, OR	10/07/08 - 12/31/22	5138
14148000	MF Willamette River Blw N Fork, Nr Oakridge, OR.	11/20/08 - 10/25/22	4707
14152000	Middle Fork Willamette River at Jasper, OR	02/13/02 - 10/25/22	7198
14150000	Middle Fork Willamette River Near Dexter, OR	01/01/02 - 12/01/22	7606
14144800	Middle Fork Willamette River Nr Oakridge, OR	07/29/10 - 10/26/22	4107
14186200	Middle Santiam R Blw Green Peter Dam Nr Foster, OR	10/30/07 - 12/31/22	5222
14185800	Middle Santiam R Near Cascadia, OR	08/24/10 - 11/01/22	4441
39130-ORDEQ	Milton Cr DS of Old Portland Rd On Boise Cascade Side of Road	07/04/17 - 11/02/21	1035
14184100	North Santiam River at Greens Bridge, near Jefferson, Or	06/07/09 - 10/04/22	4841
14181500	North Santiam River at Niagara, OR	01/01/02 - 12/31/22	7587
14185900	Quartzville Creek Near Cascadia, OR	10/29/08 - 11/01/22	5023
11102-ORDEQ	Rickreall Creek at State Farm Road	05/22/01 - 10/23/01	149
14181750	Rock Creek Near Mill City, OR	10/07/05 - 01/04/09	1170
14154500	Row River Above Pitcher Creek, Near Dorena, OR	08/13/09 - 12/31/22	4589
UmpNF-069	Row River Above Sharps Creek LTWT	06/24/04 - 09/24/19	1337
14155500	Row River near Cottage Grove, OR	01/01/02 - 12/31/22	7607
WNF-099	Salmoncreek_Mouth_LTWT	07/15/09 - 10/09/19	800
WNF-100	Saltcreek_Mouth_LTWT	07/01/08 - 10/04/17	416
14189050	Santiam River Near Jefferson, OR	01/01/02 - 12/31/22	7474
23566-ORDEQ	Scappoose Creek - North Scappoose Creek at Hwy 30	07/05/17 - 10/05/21	1013
UmpNF-072	Sharps Creek at The Mouth LTWT	06/24/04 - 09/24/19	1291
UmpNF-073	Sharps Creek at The Quarry LTWT	06/24/04 - 09/26/17	1181
31879-ORDEQ	Silver Creek at Silverton, OR	07/09/02 - 09/22/05	428
14159500	South Fork McKenzie River Near Rainbow, OR	01/01/02 - 12/18/22	7563
14185000	South Santiam River Below Cascadia, OR	11/05/08 - 12/31/22	5088
14187200	South Santiam River near Foster, OR	01/01/02 - 12/31/22	7430
40313-ORDEQ	South Scappoose 160 M Above Scappoose Vernonia Hwy	07/05/17 - 09/20/21	1055
14174000	Willamette River at Albany, OR	01/01/02 - 10/03/22	7451
14166000	Willamette River at Harrisburg, OR	01/01/02 - 12/31/22	7620
14192015	Willamette River at Keizer, OR	01/01/02 - 09/30/19	6151
14197900	Willamette River at Newberg, OR	01/22/02 - 12/31/22	6235

Monitoring Location ID	Monitoring Location	Monitoring Period	Number of 7DADM values
14158100	Willamette River at Owosso Bridge at Eugene, OR	11/16/10 - 10/24/22	4295
14211720	Willamette River at Portland, OR	01/01/02 - 12/31/22	6335

Table 5-2: Designated critical periods for waterbodies in the Willamette Subbasins.

Subbasin	Watershed or Waterbody Name, AU ID	Critical Period
Middle Fork Willamette Subbasin 17090001	All waters, except those noted	May 1 – October 31
	Middle Fork Willamette River from Hills Creek Dam to North Fork Middle Fork Willamette River OR_SR_1709000105_02_104580 OR_SR_1709000105_02_103720	May 1 – November 30
	Middle Fork Willamette River from North Fork Middle Fork Willamette River to Dexter Reservoir OR_SR_1709000107_02_103725	May 1 – November 15
	Middle Fork Willamette River downstream from Dexter Reservoir OR_SR_1709000107_02_104583 OR_SR_1709000110_02_103750 OR_SR_1709000110_02_104584	April 1 – November 15
	Fall Creek downstream from Fall Creek Dam OR_SR_1709000109_02_103735	April 1 – November 15
	Lookout Point Lake OR_LK_1709000107_02_100700 Dexter Reservoir OR_LK_1709000107_02_100699	May 1 – November 15
Coast Fork Willamette Subbasin 17090002	All waters, except those noted	May 1 – October 31
	Coast Fork Willamette River downstream from Cottage Grove Dam OR_SR_1709000203_02_104585 OR_SR_1709000204_02_103787	April 1 – November 15
	Row River downstream from Dorena Dam. OR_SR_1709000202_02_103779	April 1 – November 15
Upper Willamette Subbasin 17090003	All waters, except those noted	May 1 – October 31
	Long Tom River downstream of Fern Ridge Reservoir OR_SR_1709000301_02_10379	April 1 – November 15
	Willamette River	April 1 – November 15
	All waters, except those noted	May 1 – October 31
	McKenzie River Watershed (1709000407)	April 1 – November 15

Subbasin	Watershed or Waterbody Name, AU ID	Critical Period
McKenzie River Subbasin 17090004	Lower Blue River from Blue River Dam to McKenzie River AU: OR_SR_1709000404_02_104569	May 1 – November 15
North Santiam Subbasin 17090005	All waters, except those noted	May 1 – October 31
	North Santiam River downstream from Detroit Dam OR_SR_1709000504_02_103906 OR_SR_1709000506_02_103930	April 1 – November 15
South Santiam Subbasin 17090006	All waters, except those noted	May 1 – October 31
	Middle Santiam River from Green Peter Dam to Foster Lake: OR_SR_1709000604_02_103969	May 1 – November 30
	South Santiam River downstream from Foster Dam OR_SR_1709000608_02_103925	April 1 – November 15
	Santiam River OR_SR_1709000506_02_10392	April 1 – November 15
Middle Willamette Subbasin 17090007	All waters, except those noted	May 1 – October 31
	Willamette River upstream of the Yamhill River	April 1 – November 15
	Willamette River downstream of the Yamhill River	June 1 – September 30
Molalla-Pudding Subbasin 17090009	All waters	May 1 – October 31
Clackamas Subbasin 17090011	All waters, except those noted	May 1 – October 31
	Clackamas River downstream of River Mill Dam OR_SR_1709001106_02_104597	April 1 – November 15
Lower Willamette Subbasin 17090012	All waters, except those noted	April 1 – October 31
	Johnson Creek Watershed (1709001201)	February 15 – November 15
	Willamette River downstream of the Yamhill River	June 1 – September 30
	Multnomah Channel OR_SR_1709001203_88_10418	June 1 – September 30

5.1 Middle Fork Willamette Subbasin seasonal variation

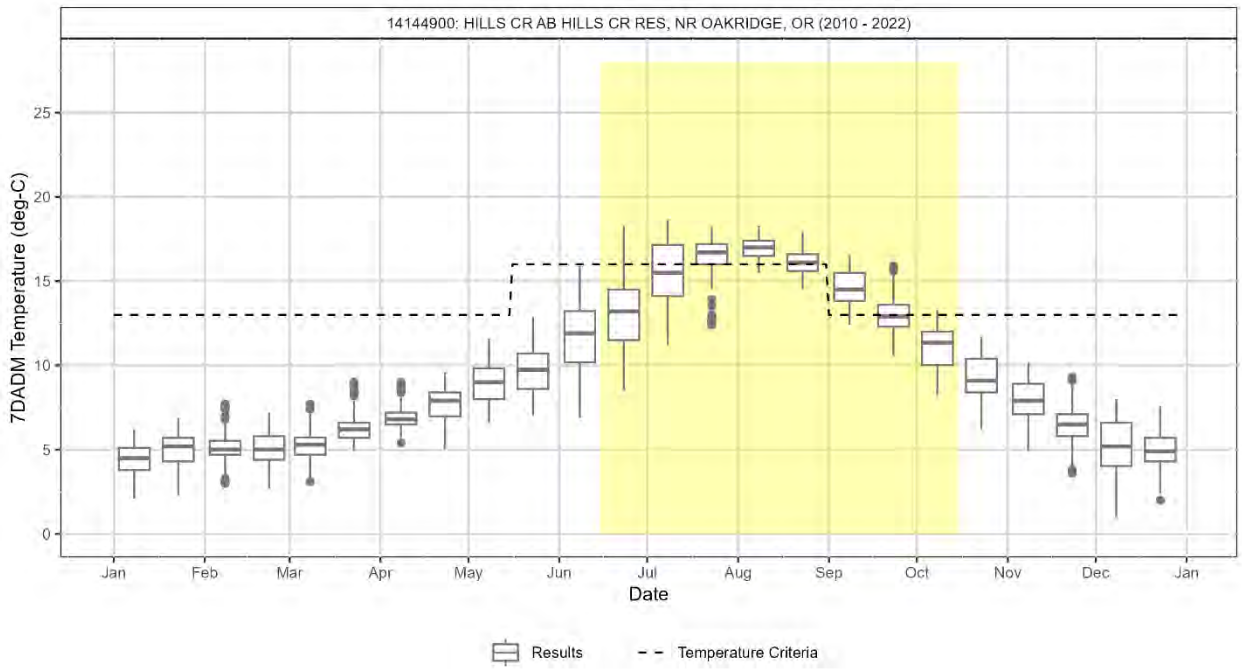


Figure 5-1: Seasonal variation on the Hills Creek Above Hills Creek Reservoir Near Oakridge temperature monitoring site in the Middle Fork Willamette Subbasin.

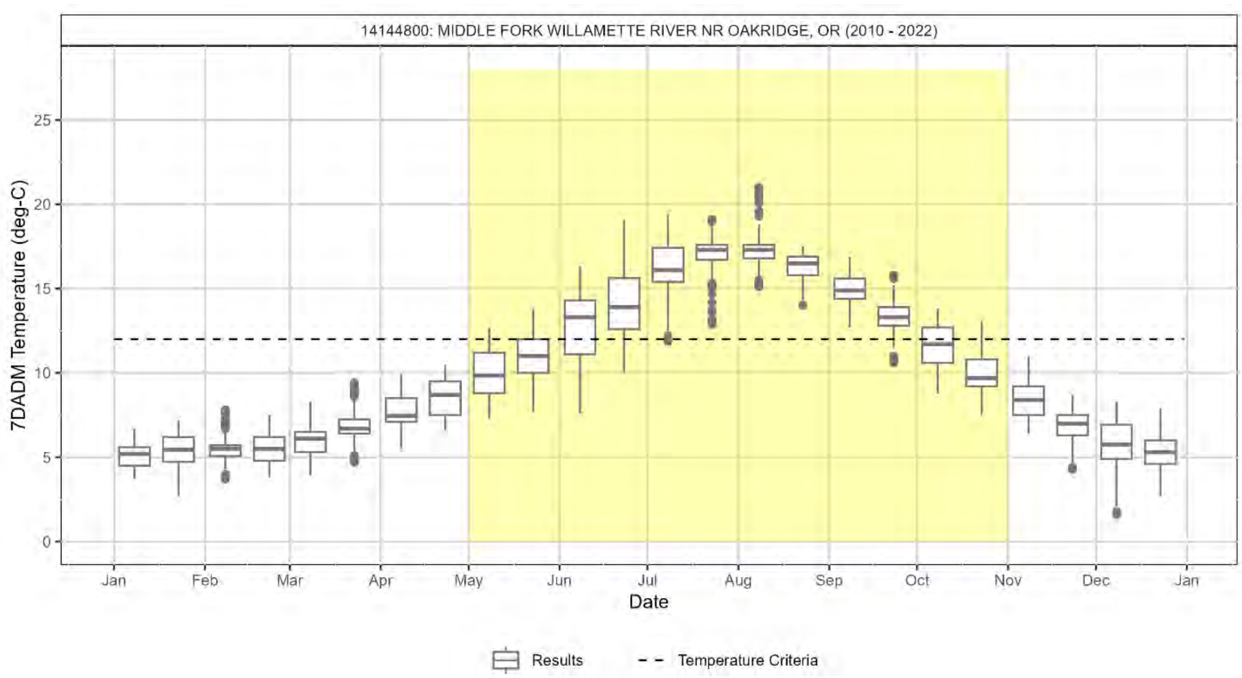


Figure 5-2: Seasonal variation on the Middle Fork Willamette River Near Oakridge temperature monitoring site (upstream from Hills Creek Reservoir) in the Middle Fork Willamette Subbasin.

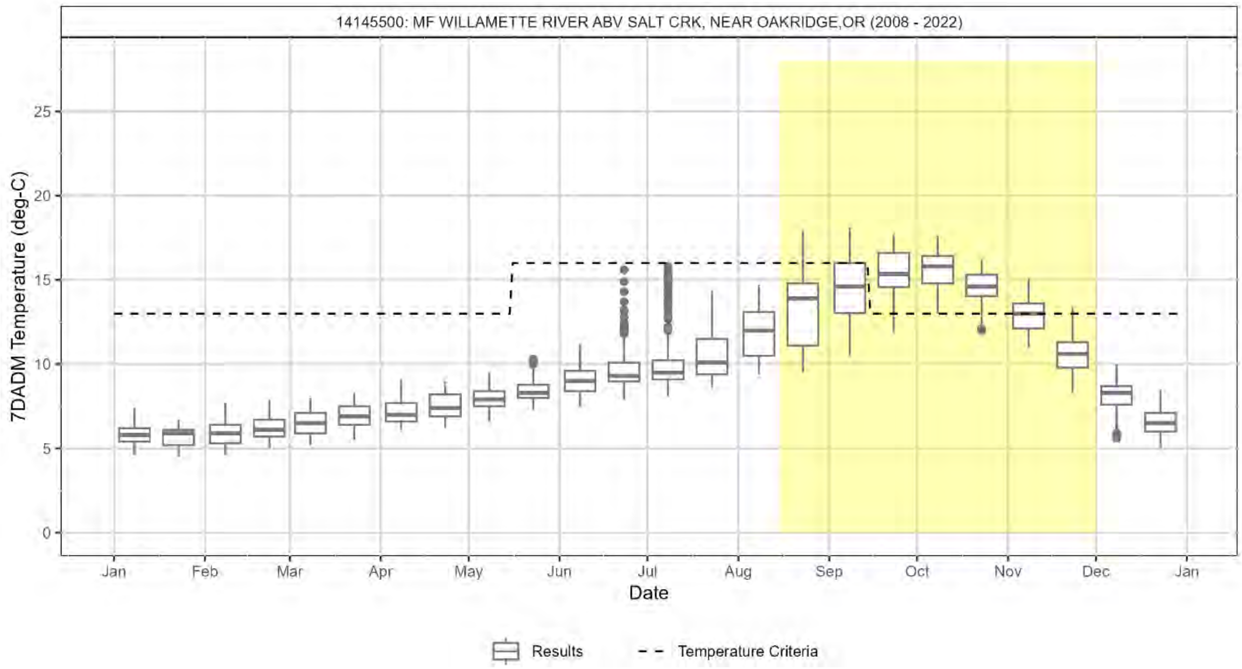


Figure 5-3: Seasonal variation on the Middle Fork Willamette River above Salt Creek monitoring site (downstream from Hills Creek Dam) in the Middle Fork Willamette Subbasin.

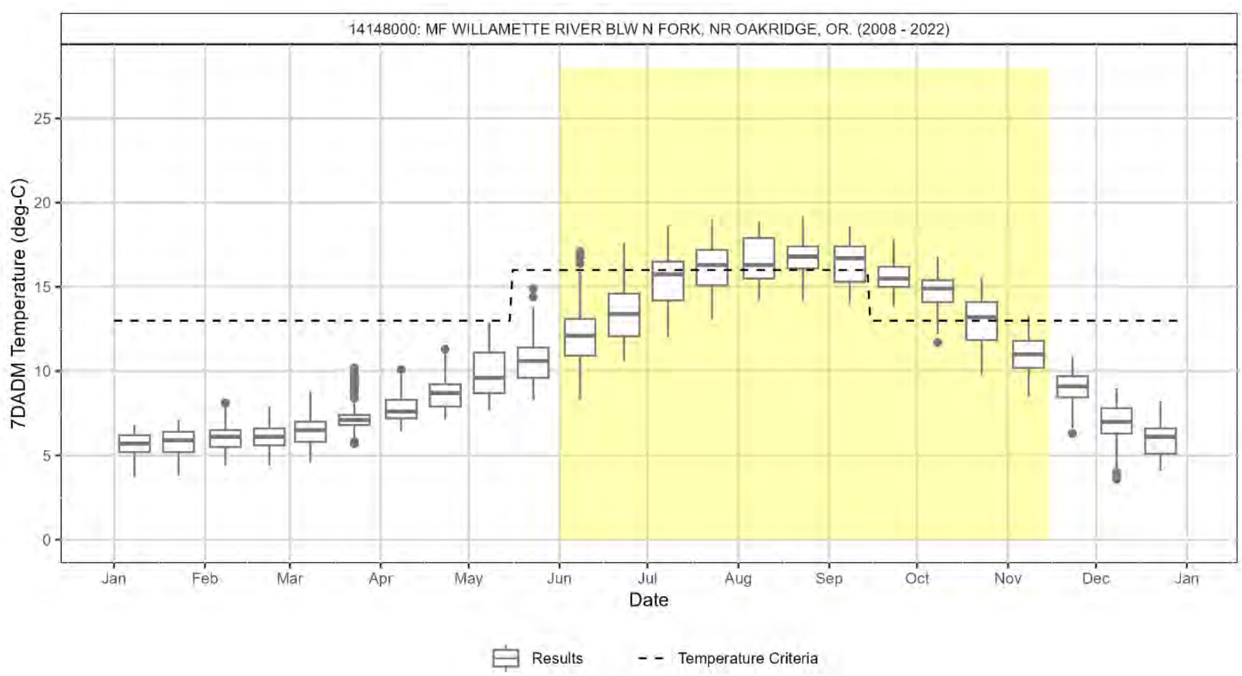


Figure 5-4: Seasonal variation on the Middle Fork Willamette River below North Fork near Oakridge monitoring site (Upstream from Green Peter Dam, downstream from Hills Creek Dam) in the Middle Fork Willamette Subbasin.

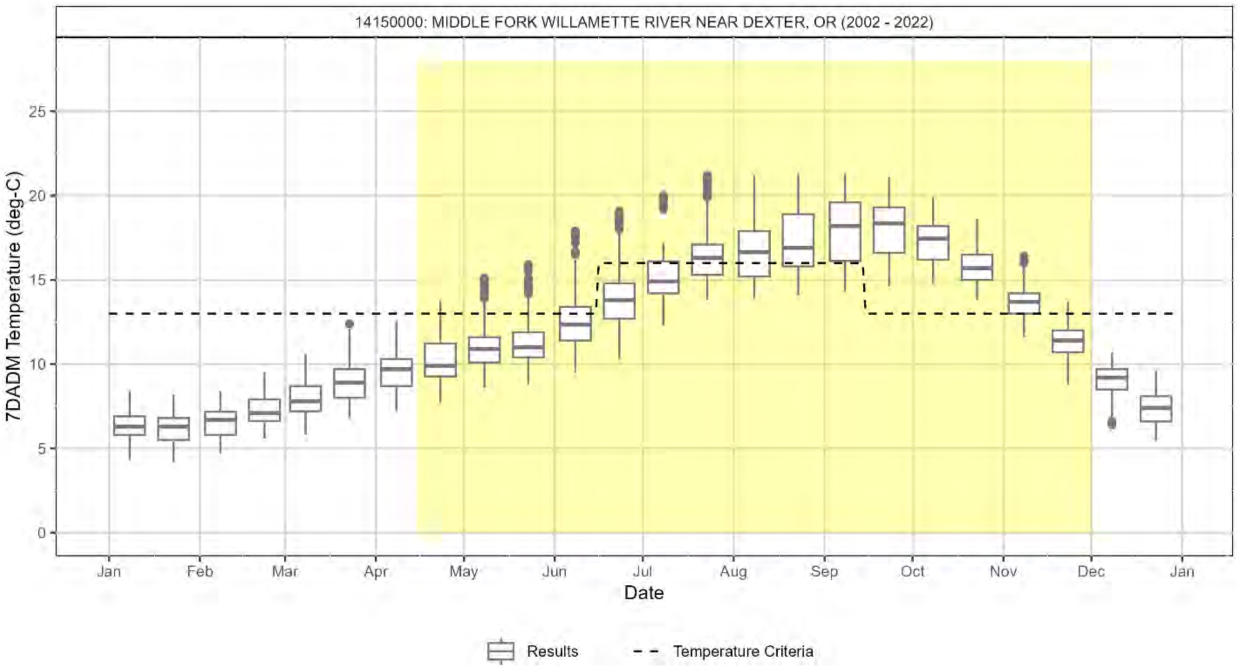


Figure 5-5: Seasonal variation on the Middle Fork Willamette River near Dexter, OR (downstream from Dexter Dam) in the Middle Fork Willamette Subbasin.

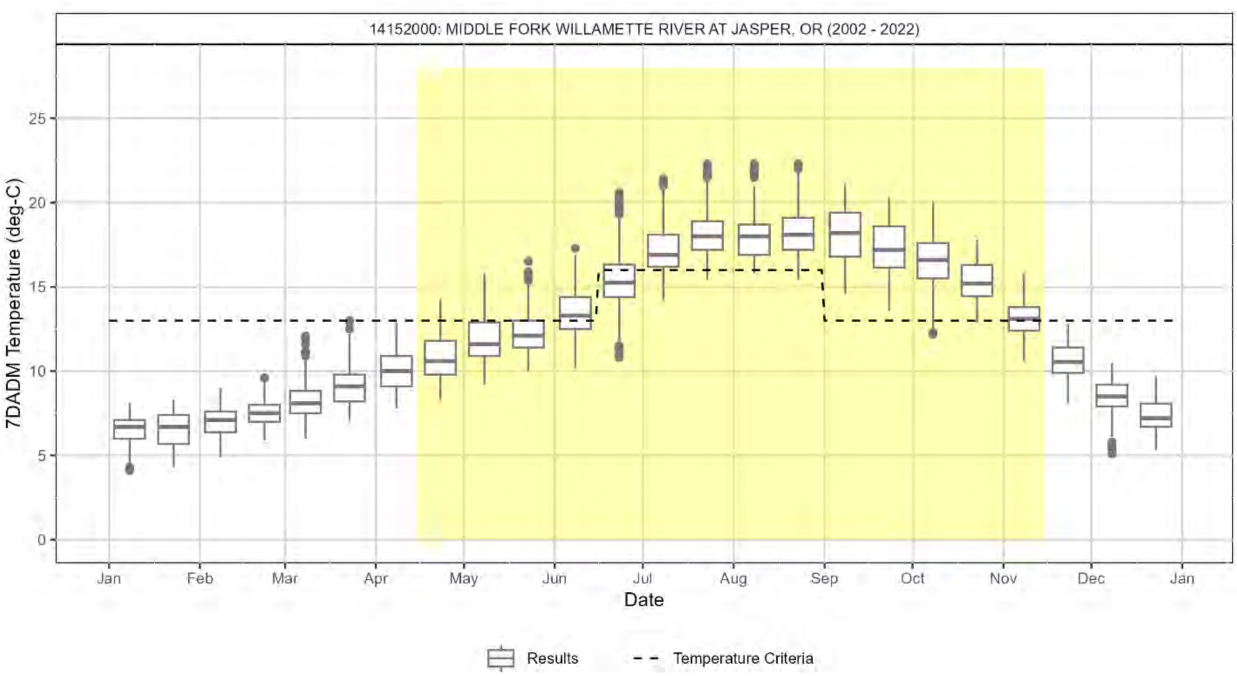


Figure 5-6: Seasonal variation on the Middle Fork Willamette River at Jasper, in the Middle Fork Willamette Subbasin.

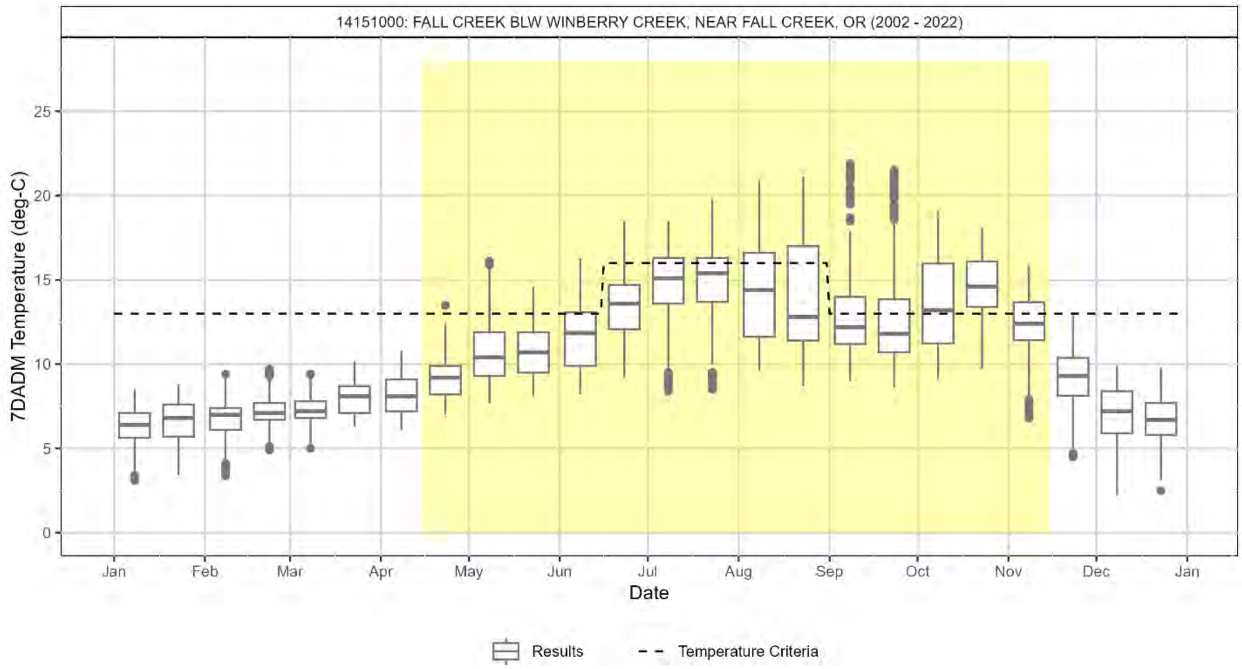


Figure 5-7: Seasonal variation on Fall Creek below Winberry Creek (downstream of Fall Creek Dam), in the Middle Fork Willamette Subbasin.

5.2 Coast Fork Willamette Subbasin seasonal variation

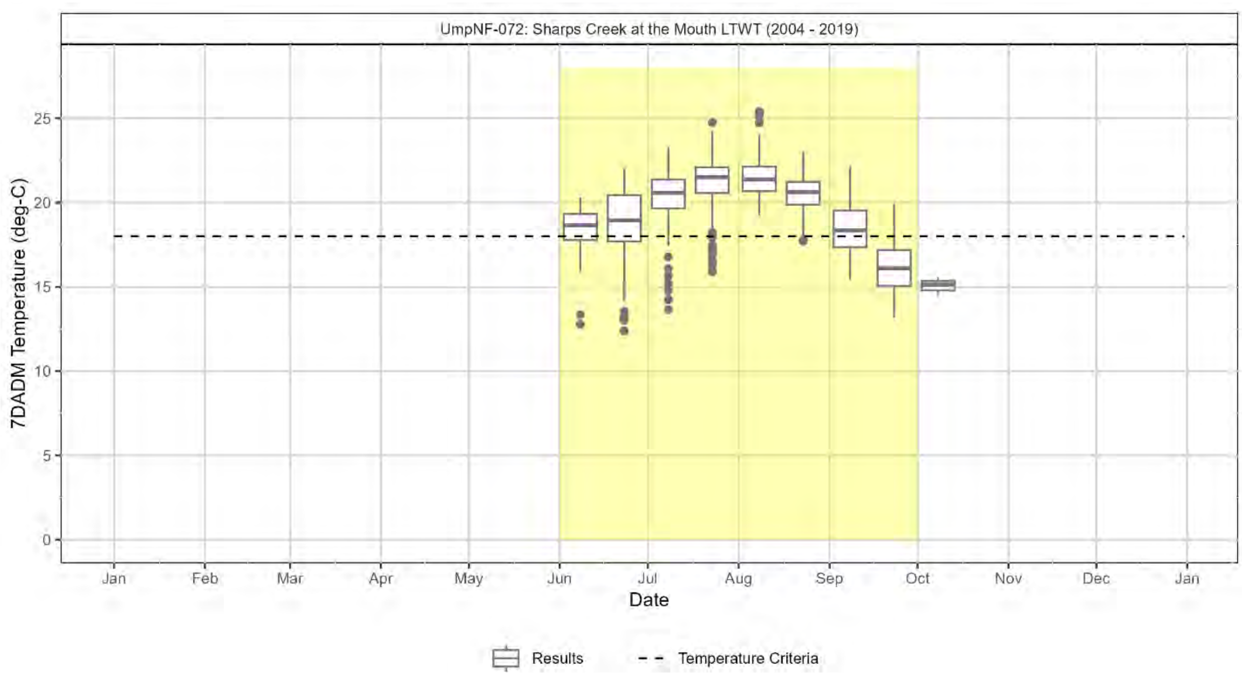


Figure 5-8: Seasonal variation at the Sharps Creek at mouth temperature monitoring site in the Coast Fork Willamette Subbasin.

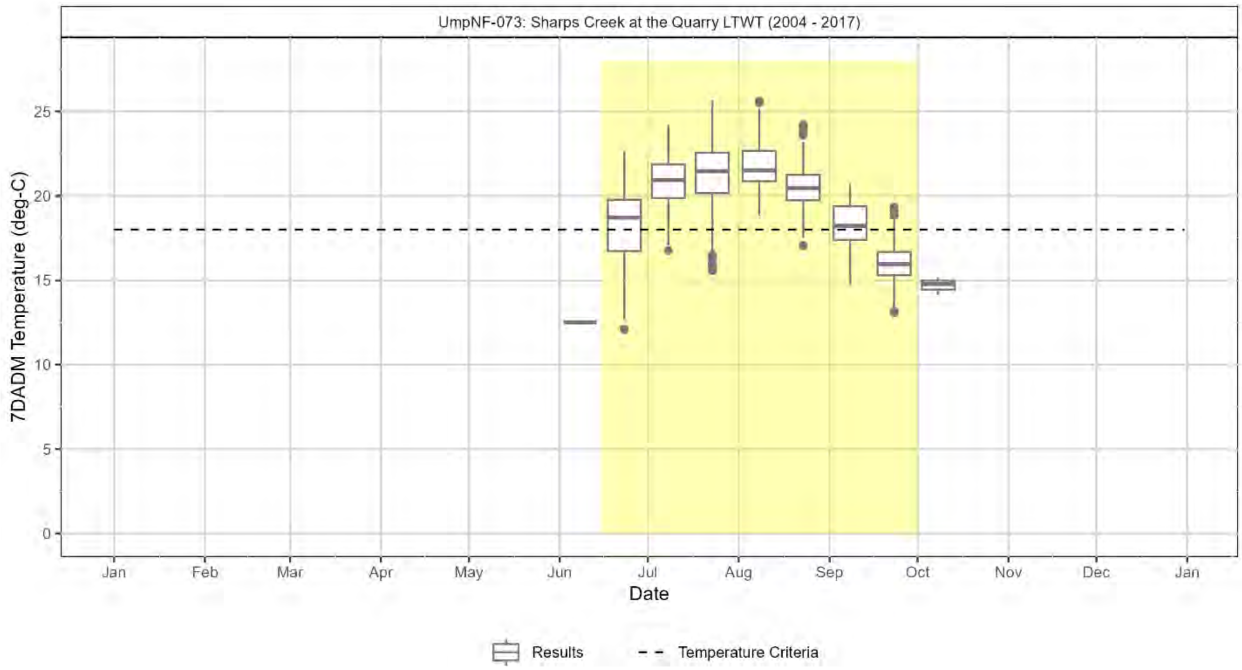


Figure 5-9: Seasonal variation at the Sharps Creek at quarry temperature monitoring site in the Coast Fork Willamette Subbasin.

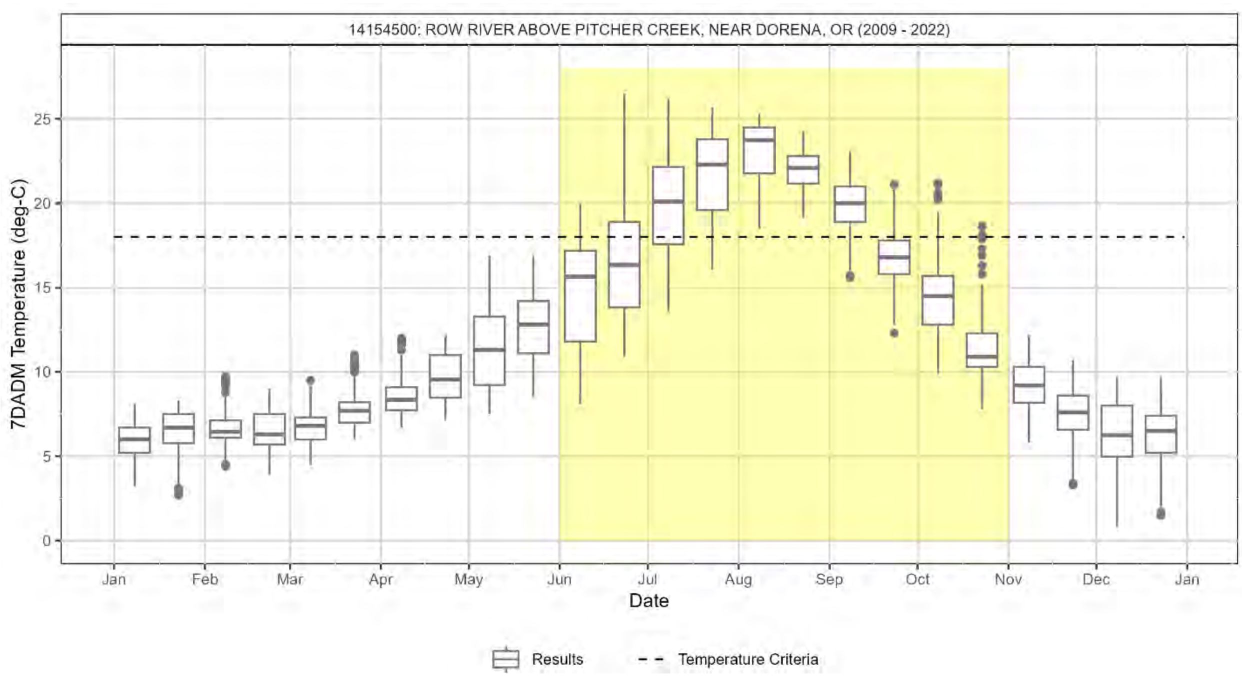


Figure 5-10: Seasonal variation at the Row River above Pitcher Creek temperature monitoring site in the Coast Fork Willamette Subbasin.

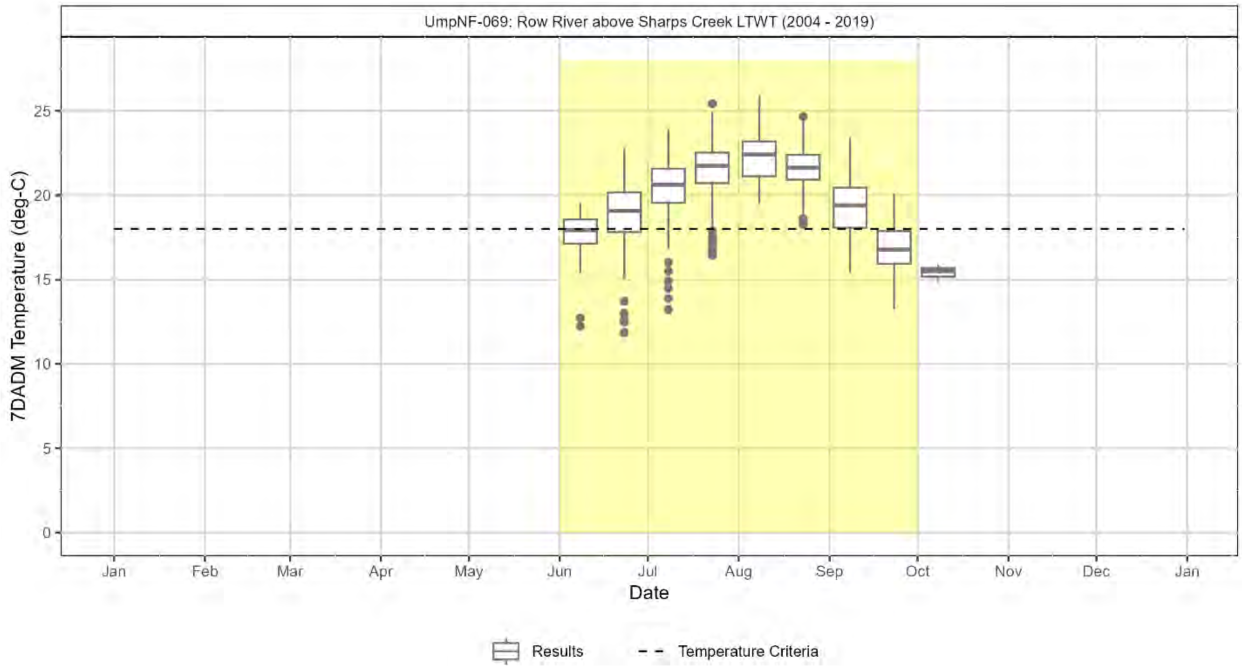


Figure 5-11: Seasonal variation at the Row River above Sharps Creek temperature monitoring site in the Coast Fork Willamette Subbasin.

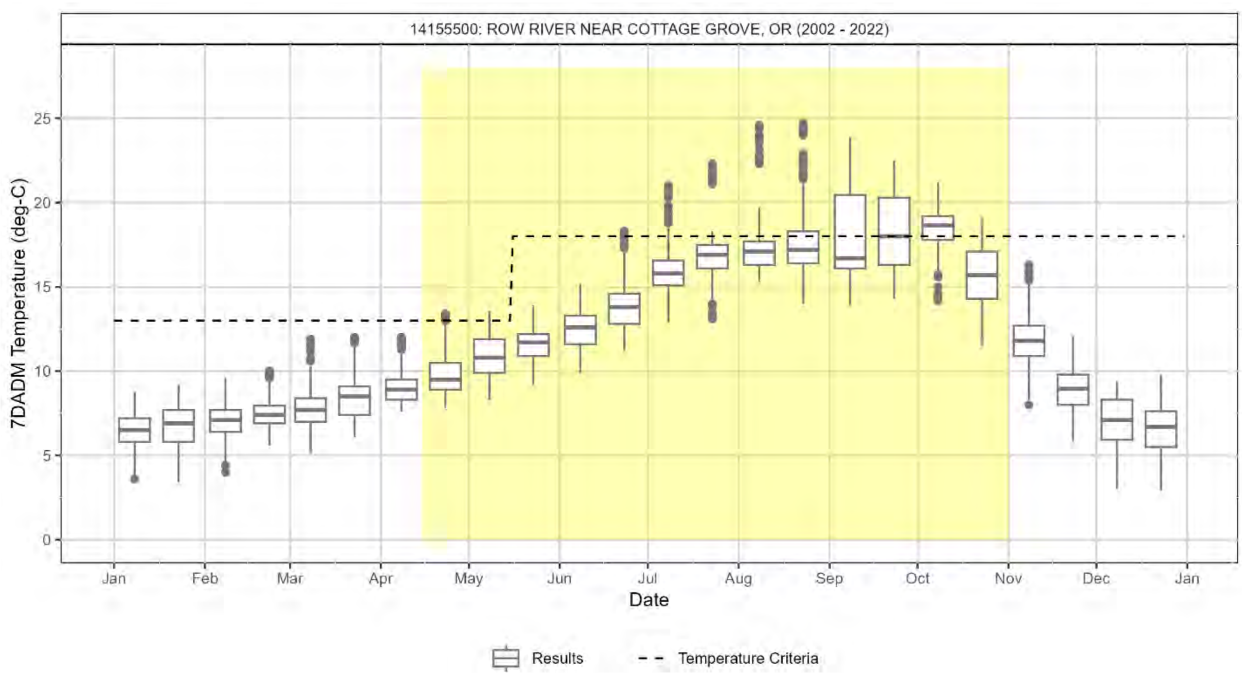


Figure 5-12: Seasonal variation on the Row River near Cottage Grove below Cottage Grove Dam in the Coast Fork Willamette Subbasin.

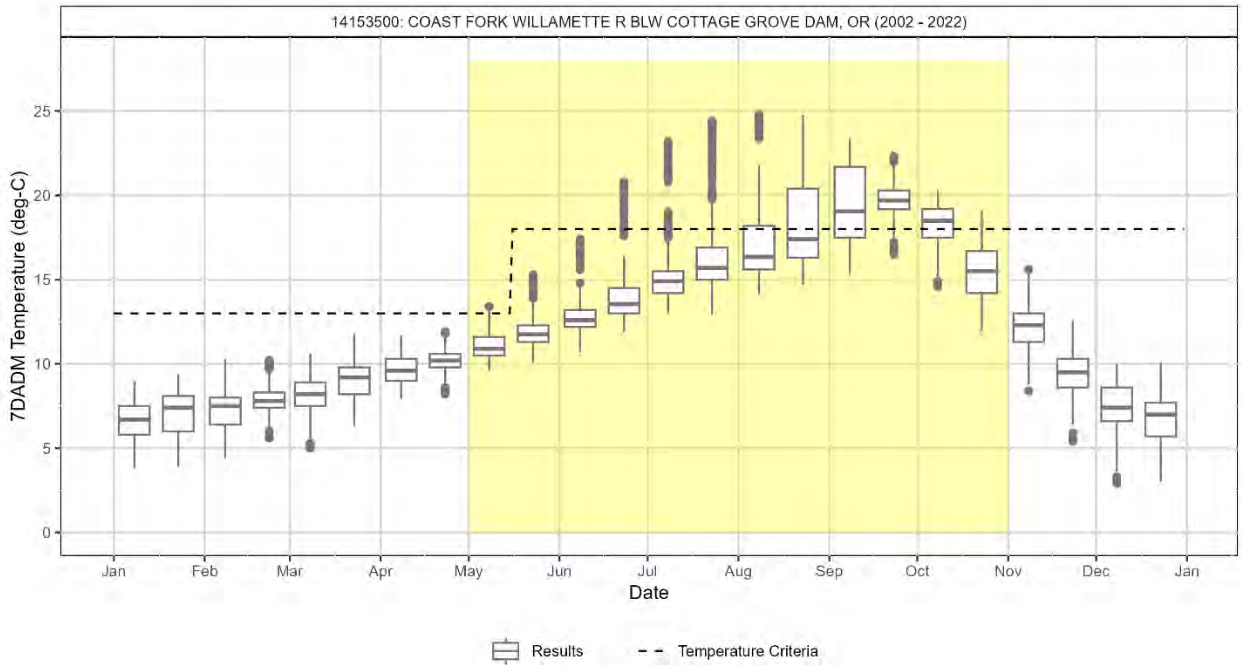


Figure 5-13: Seasonal variation on the Coast Fork Willamette River below Cottage Grove Dam in the Coast Fork Willamette Subbasin.

5.3 Upper Willamette Subbasin seasonal variation

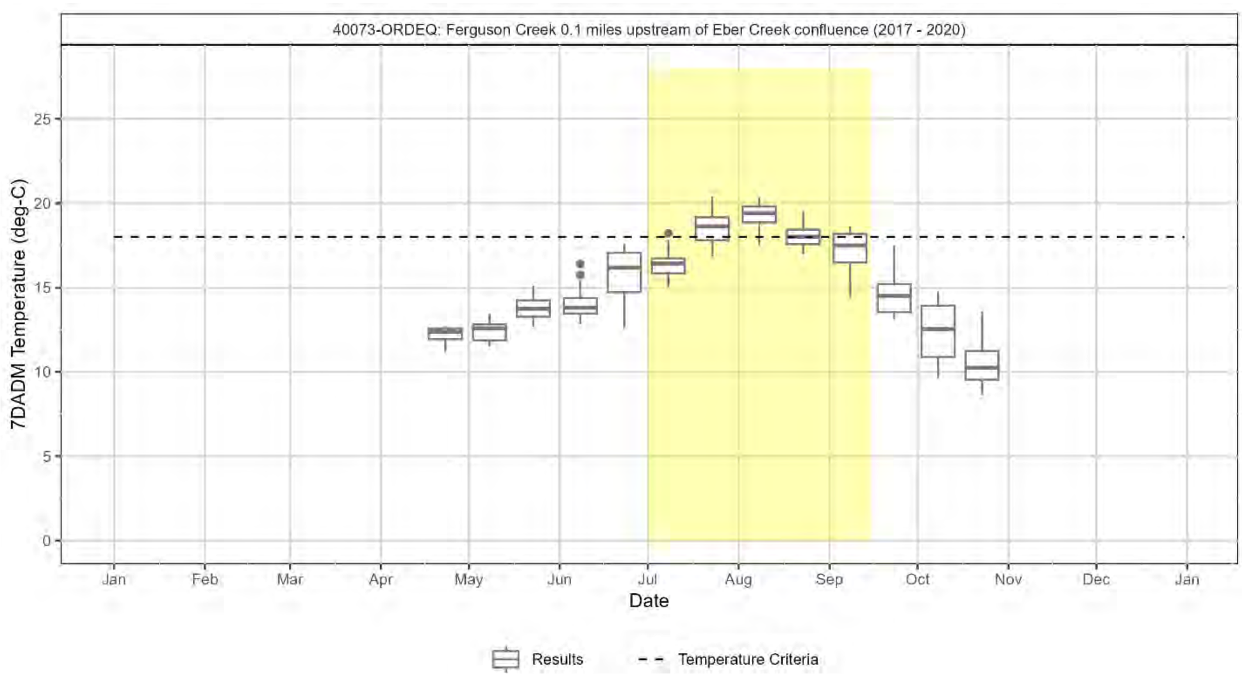


Figure 5-14: Seasonal variation at the Ferguson Creek upstream of Eber Creek confluence temperature monitoring site in the Upper Willamette Subbasin.

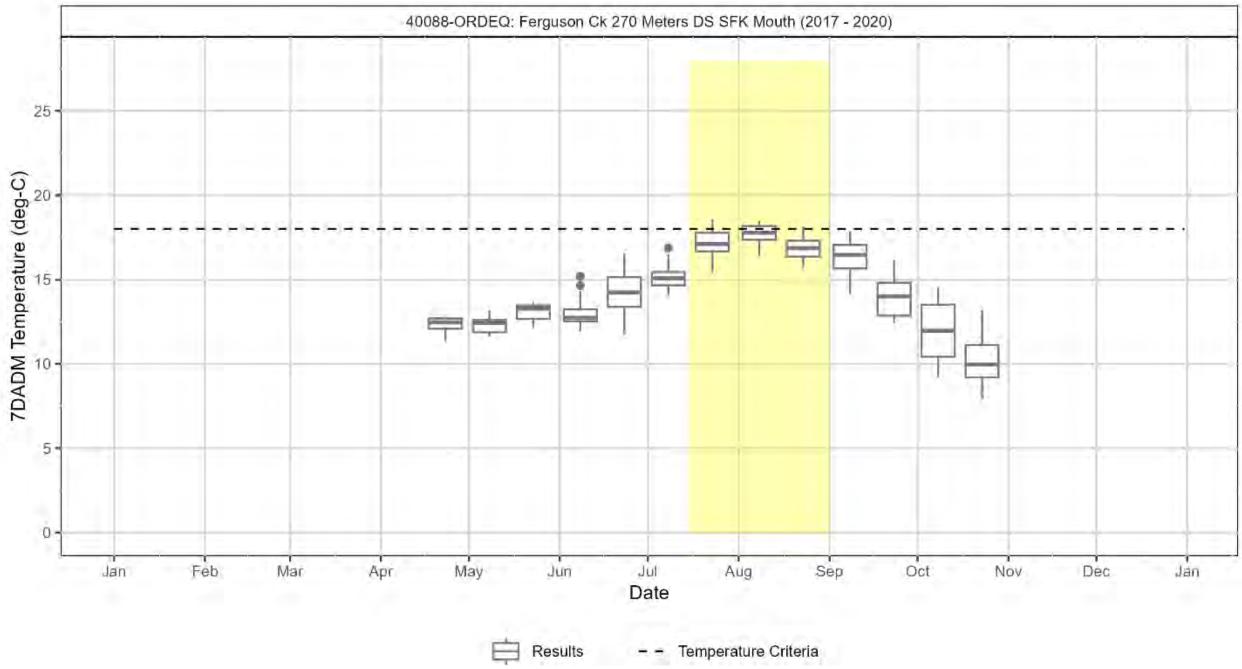


Figure 5-15: Seasonal variation at the Ferguson Creek downstream of South Fork Ferguson Creek temperature monitoring site in the Upper Willamette Subbasin.

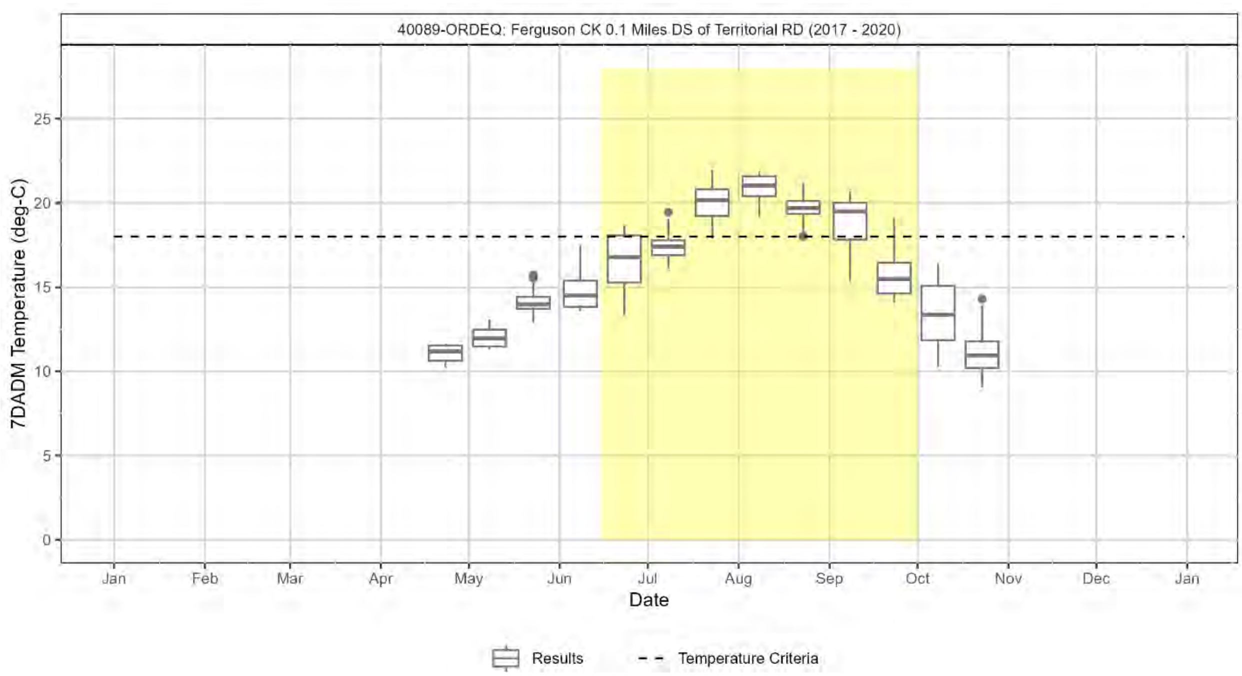


Figure 5-16: Seasonal variation at the Ferguson Creek downstream of Territorial Road temperature monitoring site in the Upper Willamette Subbasin.

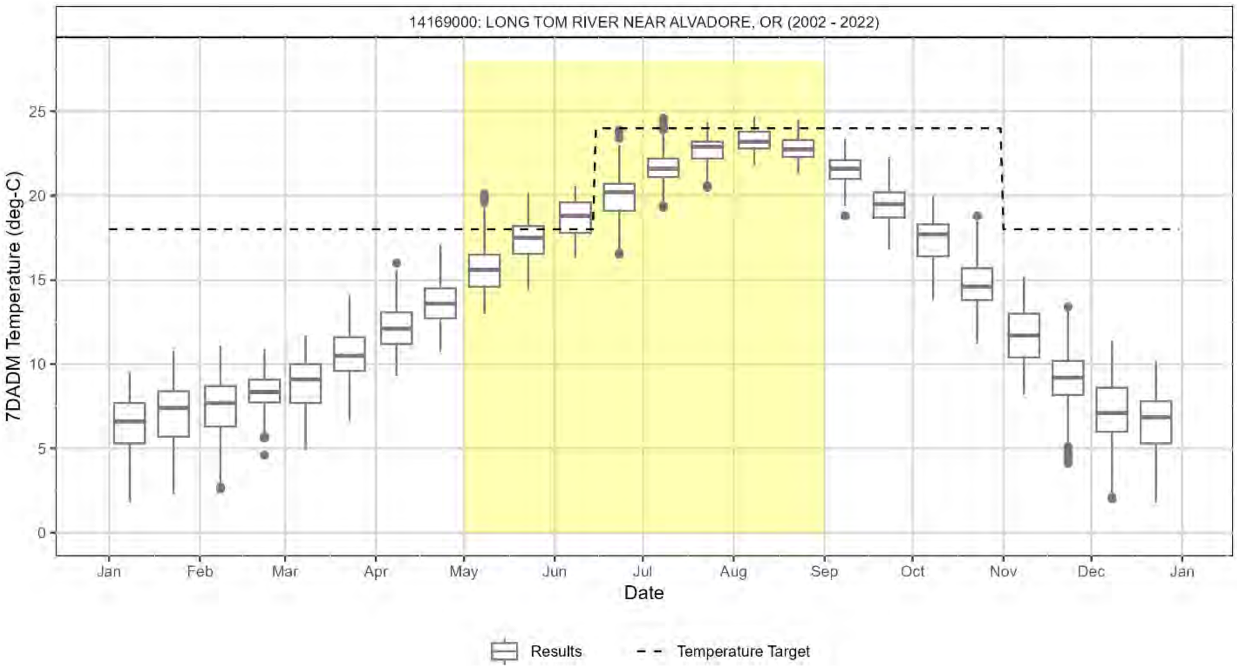


Figure 5-17: Seasonal variation on the Long Tom River near Alvadore, OR in the Upper Willamette Subbasin.

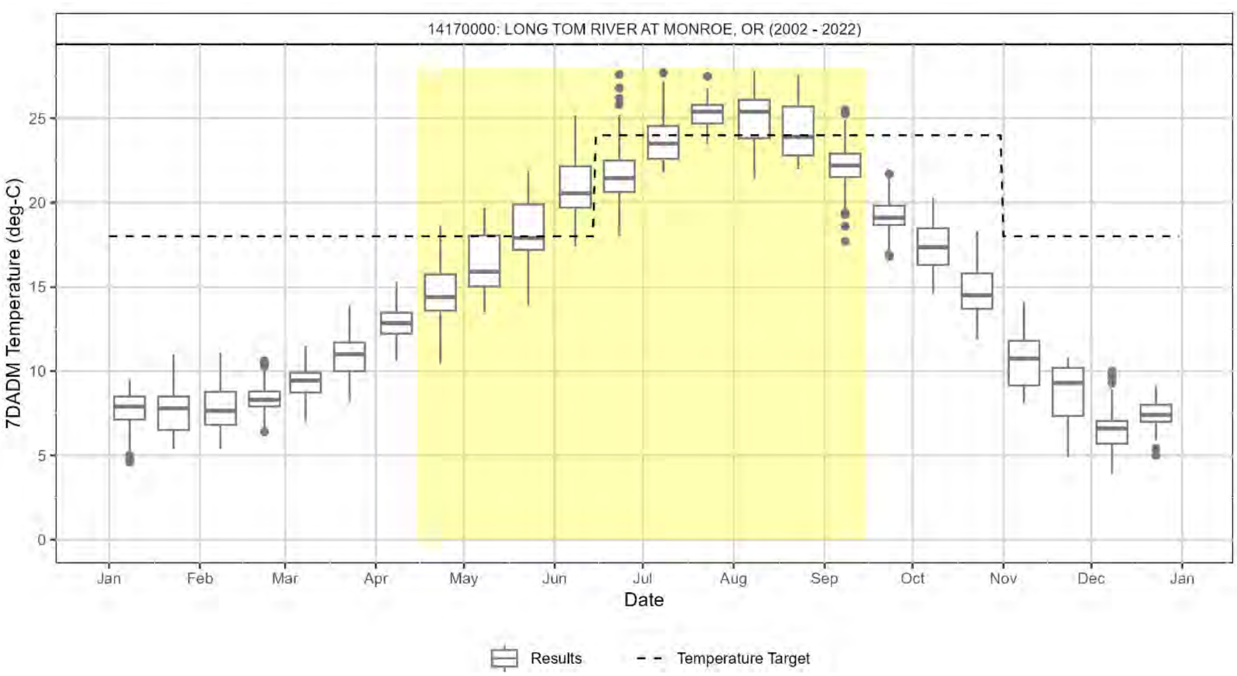


Figure 5-18: Seasonal variation on the Long Tom River at Monroe in the Upper Willamette Subbasin.

5.4 McKenzie Subbasin seasonal variation

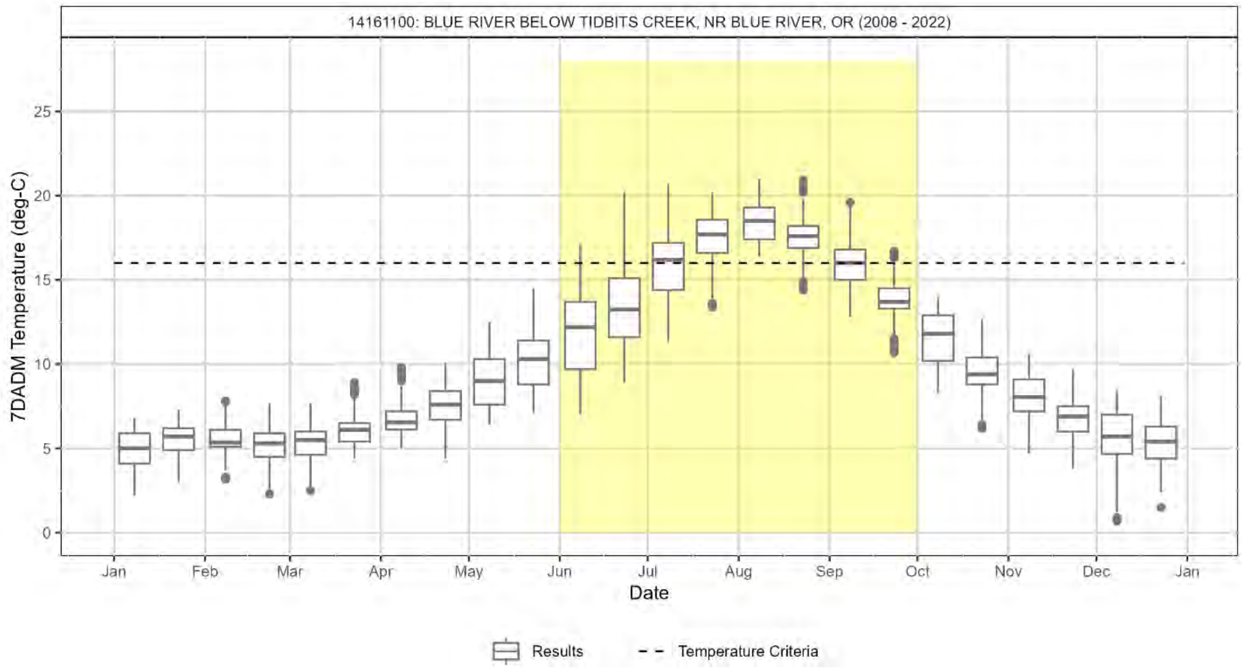


Figure 5-19: Seasonal variation at Blue River below Tidbits Creek, Oregon (upstream of Blue River Dam) in the McKenzie Subbasin.

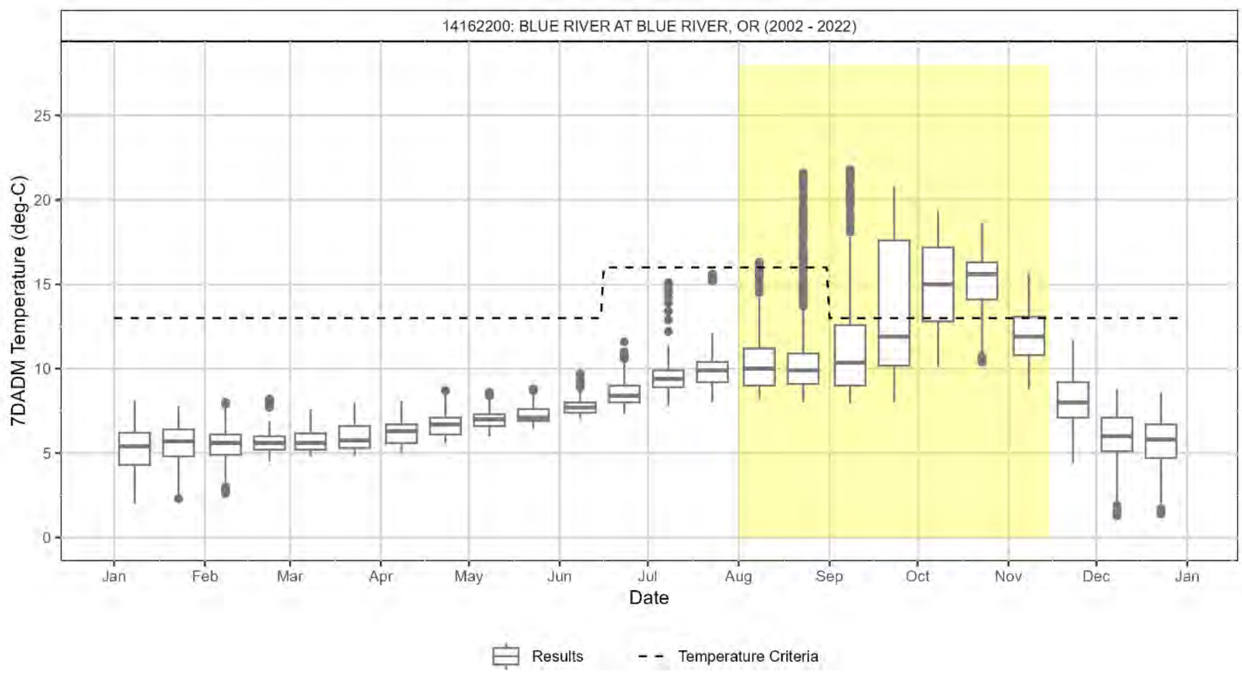


Figure 5-20: Seasonal variation at Blue River at Blue River, Oregon (downstream of Blue River Dam) in the McKenzie Subbasin.

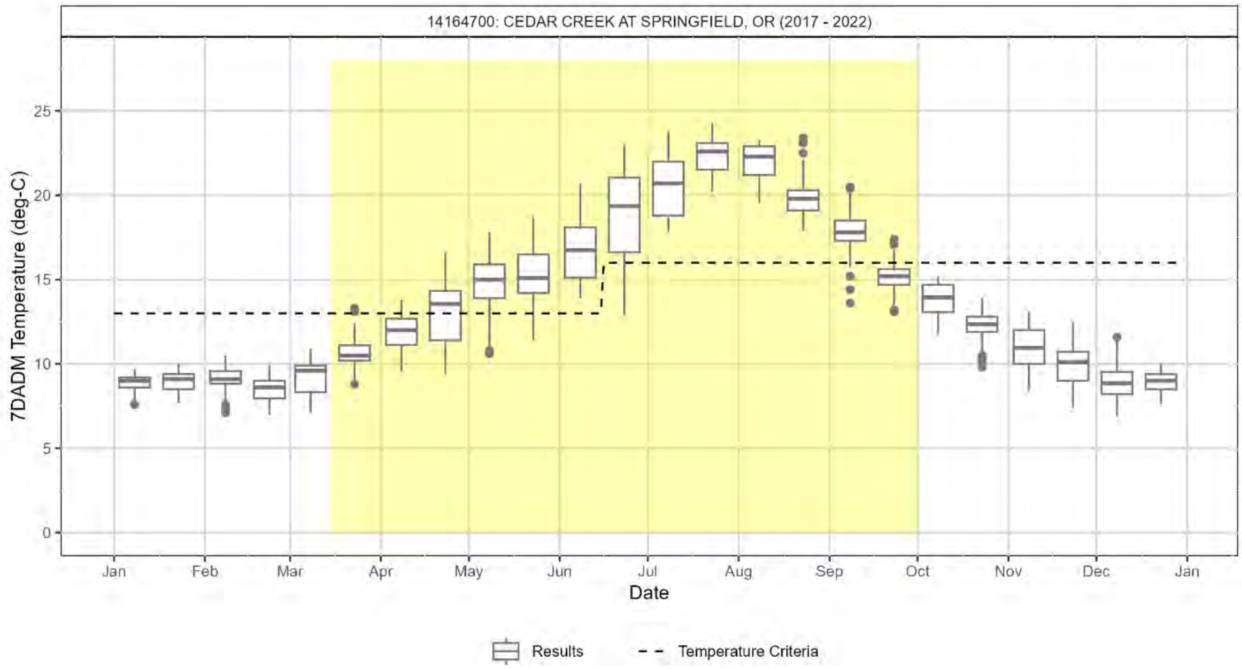


Figure 5-21: Seasonal variation at the Cedar Creek at Springfield, Oregon temperature monitoring site in the McKenzie Subbasin.

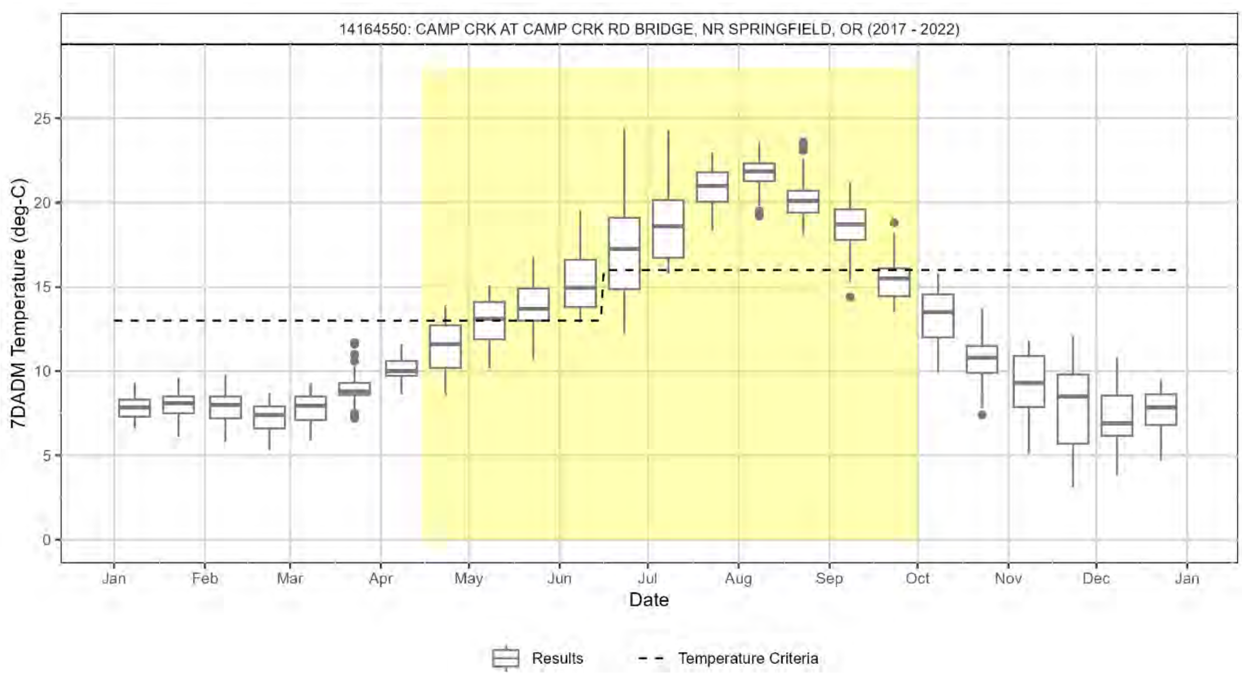


Figure 5-22: Seasonal variation at the Camp Creek at Camp Creek Road Bridge temperature monitoring site in the McKenzie Subbasin.

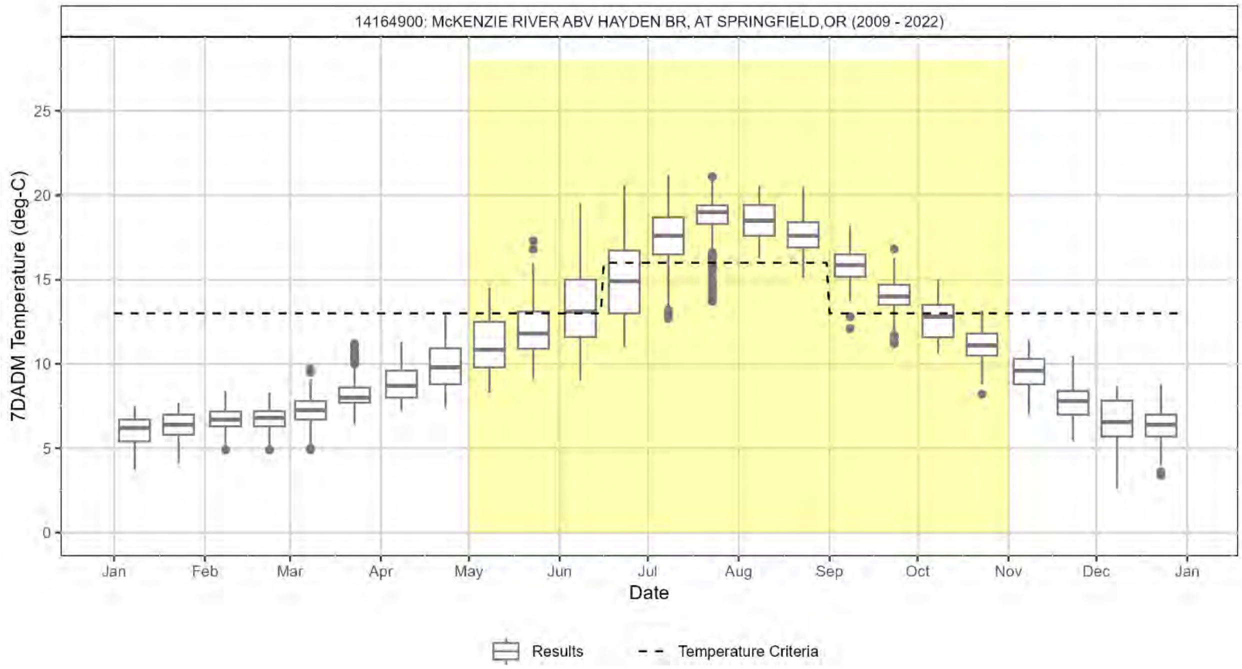


Figure 5-23: Seasonal variation at the McKenzie River above Hayden Bridge temperature monitoring site in the McKenzie Subbasin.

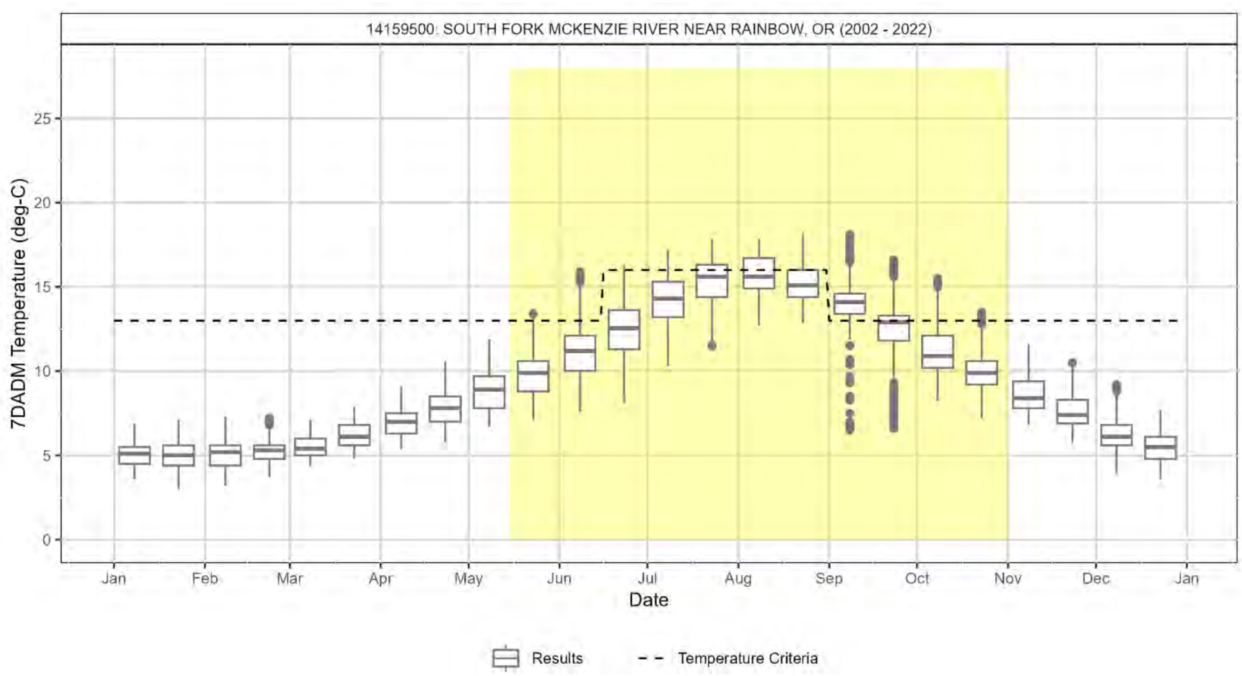


Figure 5-24: Seasonal variation on the South Fork McKenzie River near Rainbow temperature monitoring site in the McKenzie Subbasin.

5.5 North Santiam Subbasin seasonal variation

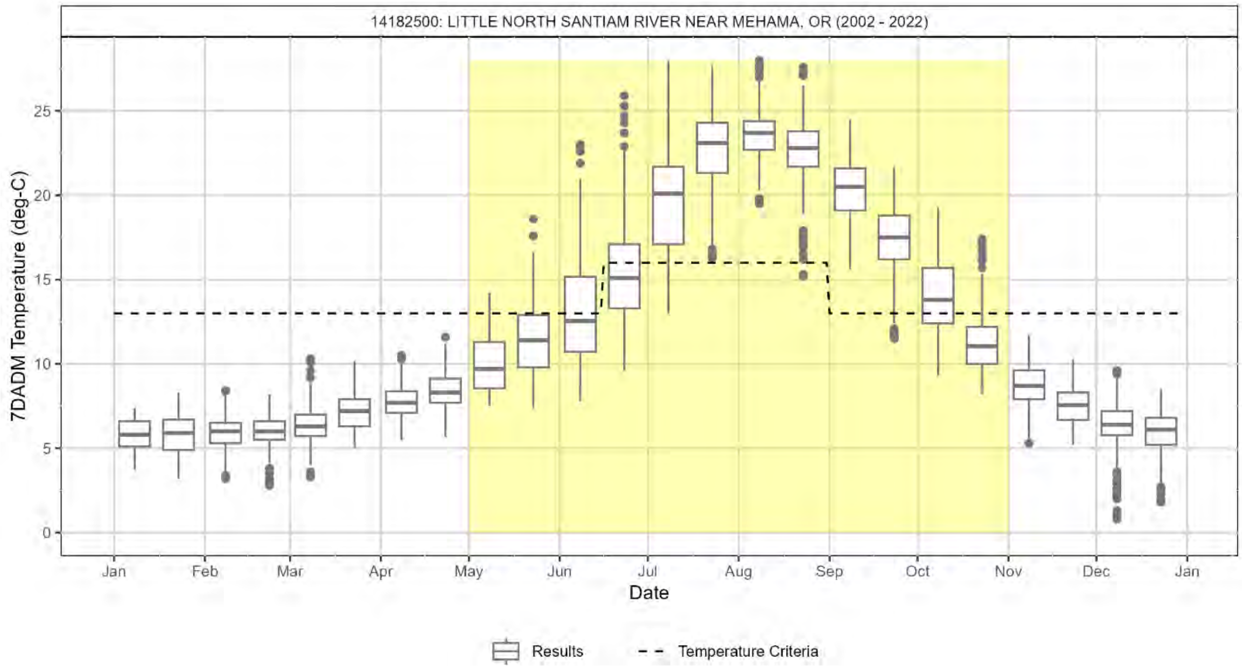


Figure 5-25: Seasonal variation at the Little North Santiam River near Mehama, Oregon temperature monitoring site in the North Santiam Subbasin.

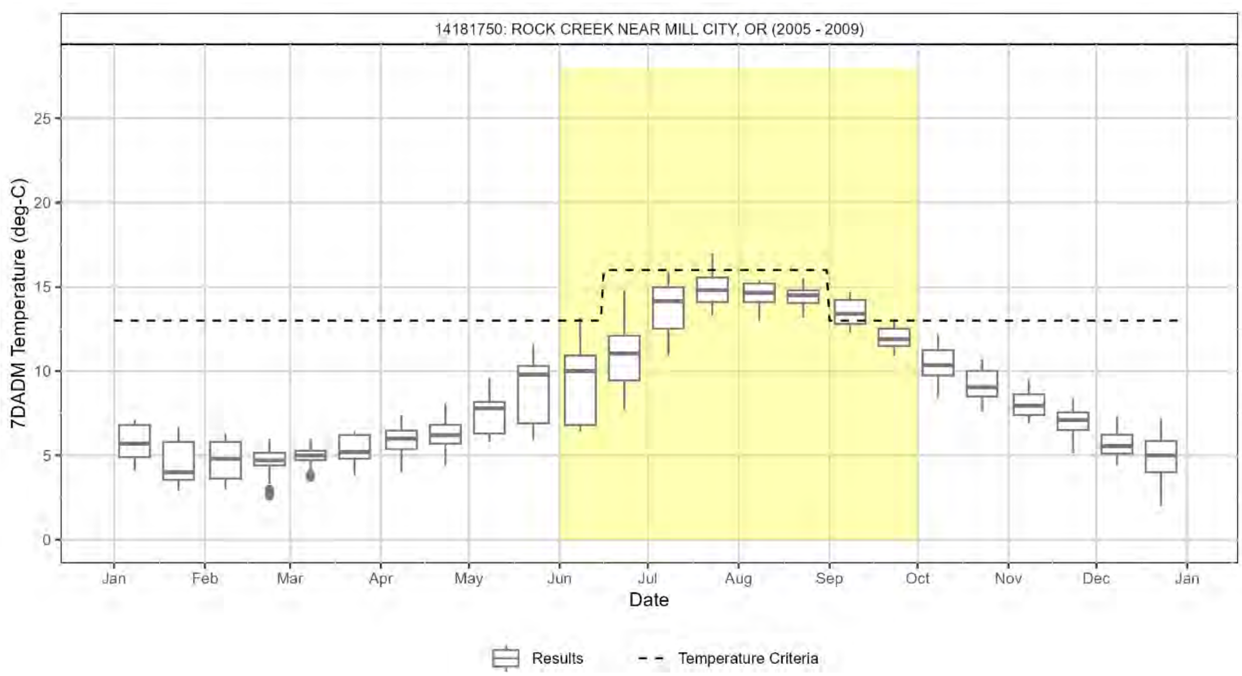


Figure 5-26: Seasonal variation at the Rock Creek near Mill City, Oregon monitoring site in the North Santiam Subbasin.

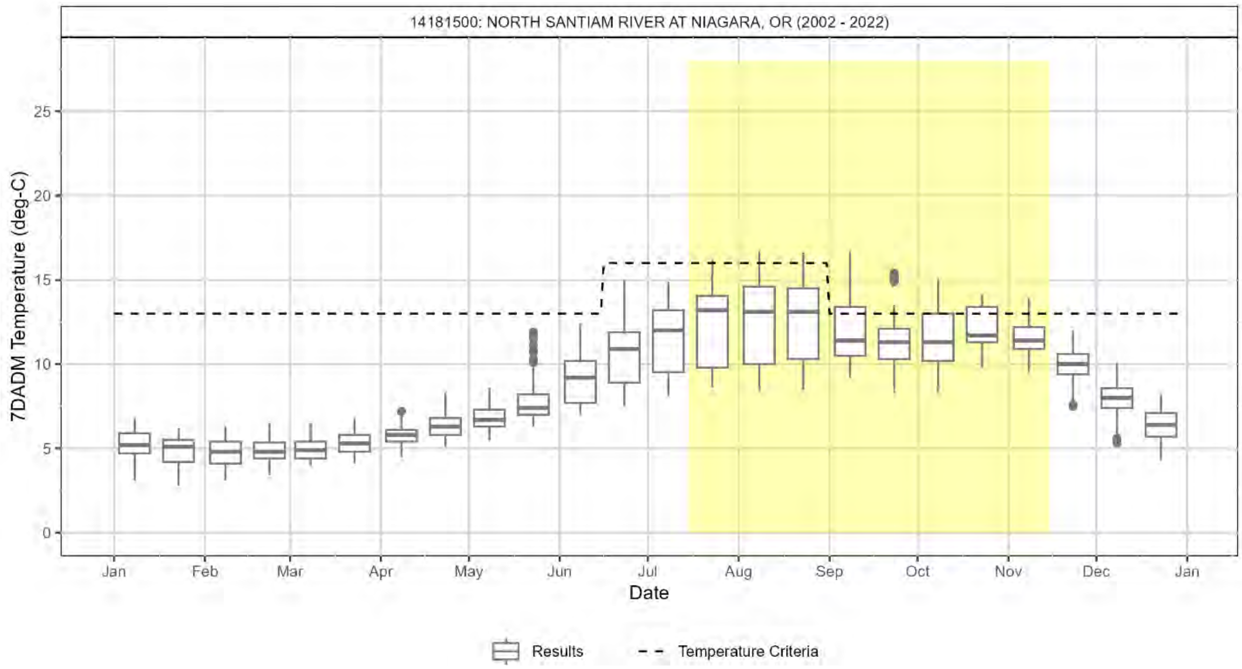


Figure 5-27: Seasonal variation on the North Santiam River at Niagara, Oregon in the North Santiam Subbasin.

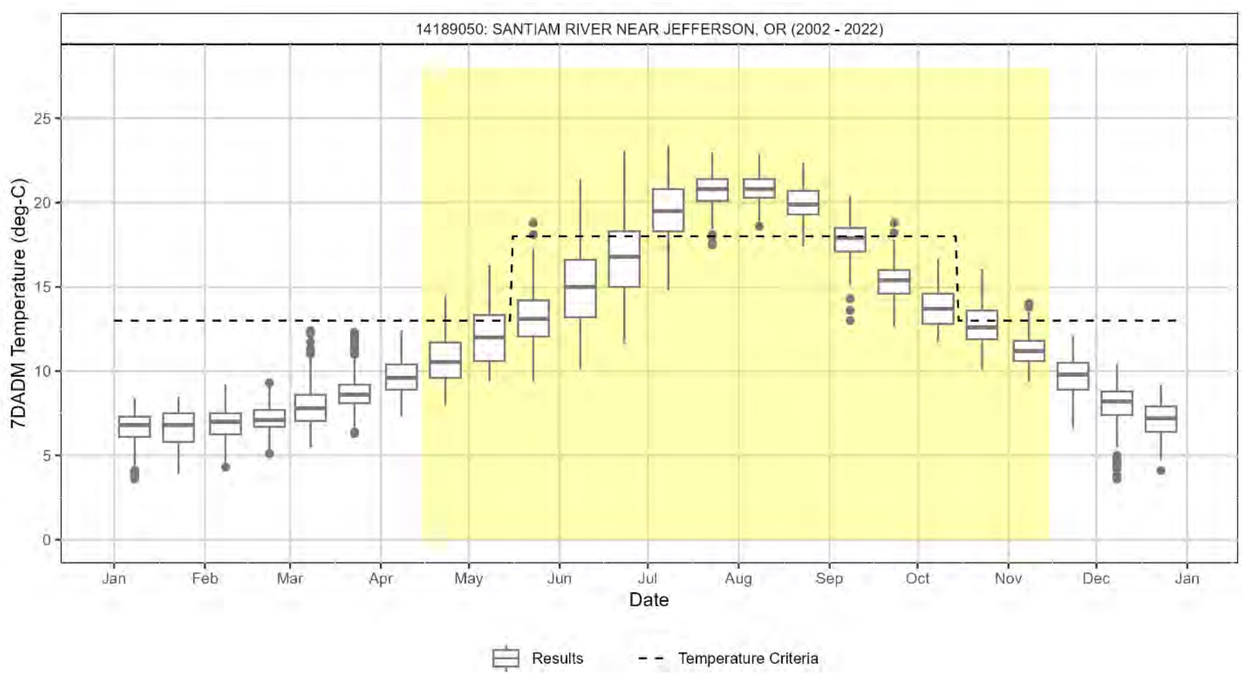


Figure 5-28: Seasonal variation on the Santiam River near Jefferson, Oregon in the North Santiam Subbasin.

5.6 South Santiam Subbasin seasonal variation

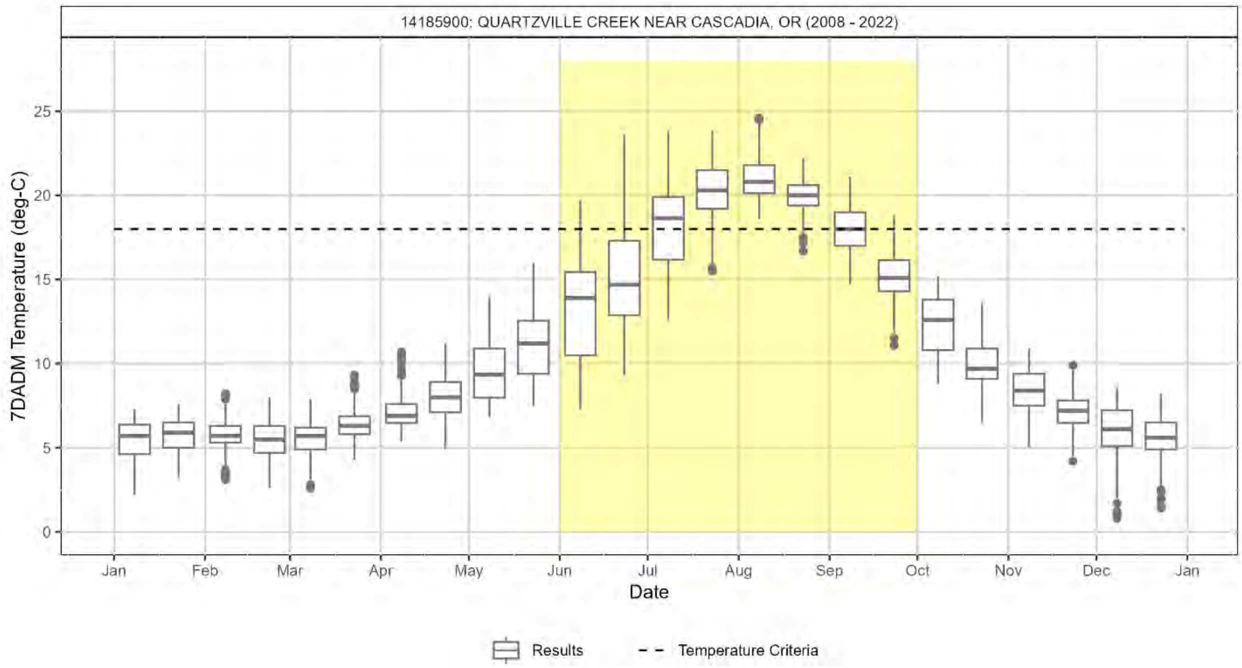


Figure 5-29: Seasonal variation at the Quartzville Creek Near Cascadia monitoring site (upstream of Green Peter Dam) in the South Santiam Subbasin.

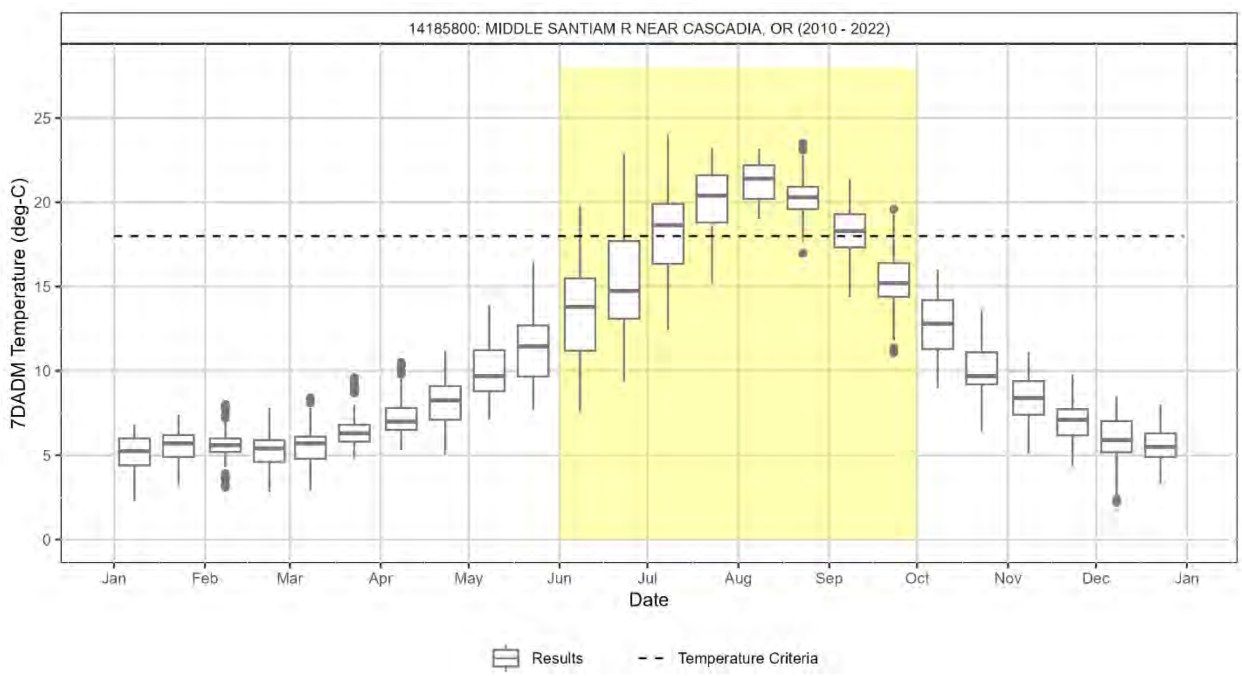


Figure 5-30: Seasonal variation at the Middle Santiam River Near Cascadia monitoring site (upstream of Green Peter Dam) in the South Santiam Subbasin.

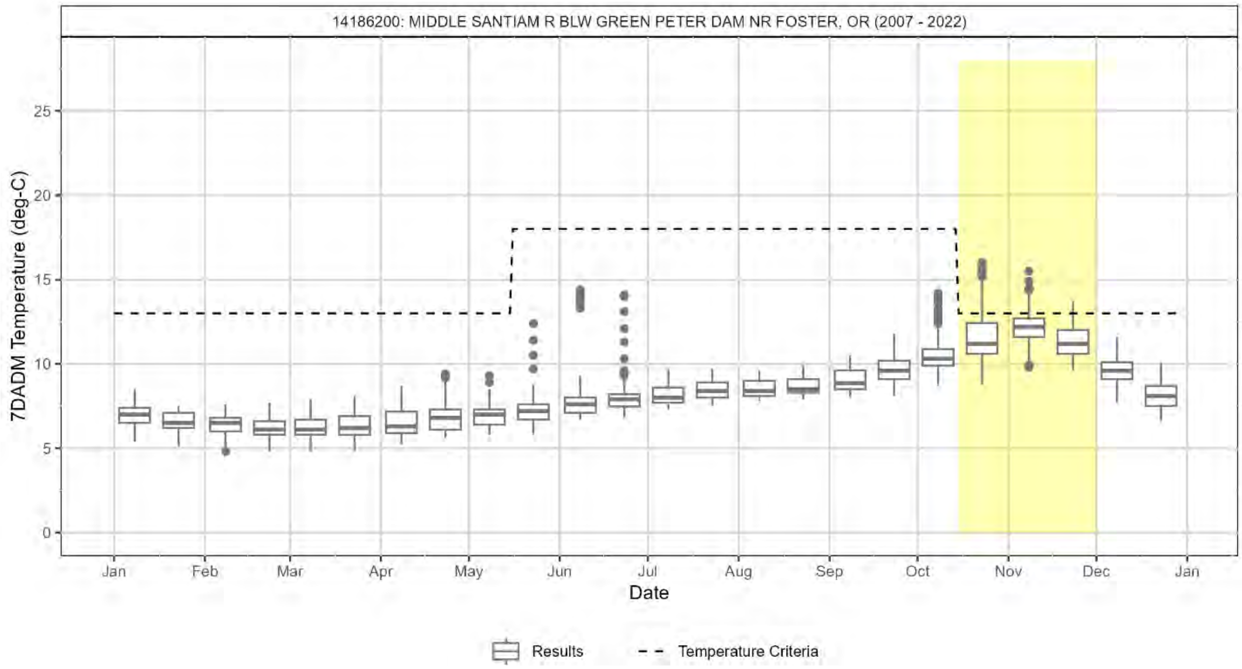


Figure 5-31: Seasonal variation at the Middle Santiam River below Green Peter Dam monitoring site in the South Santiam Subbasin.

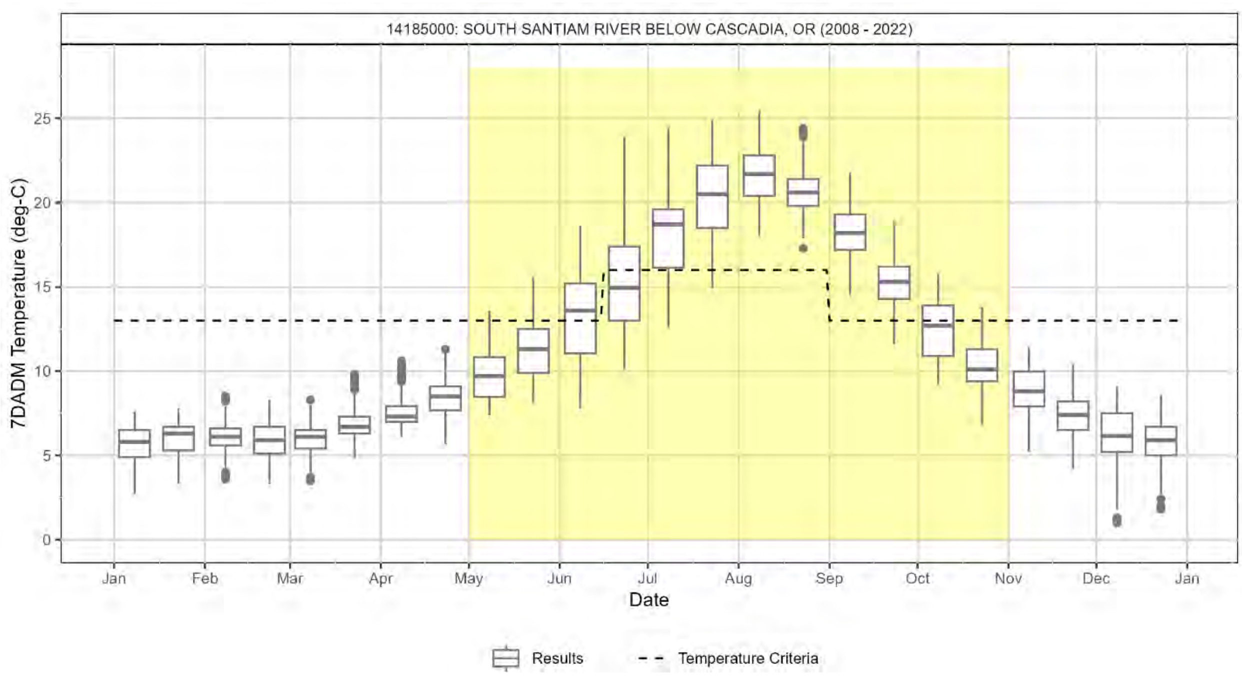


Figure 5-32: Seasonal variation at the South Santiam River below Cascadia, Oregon monitoring site in the South Santiam Subbasin.

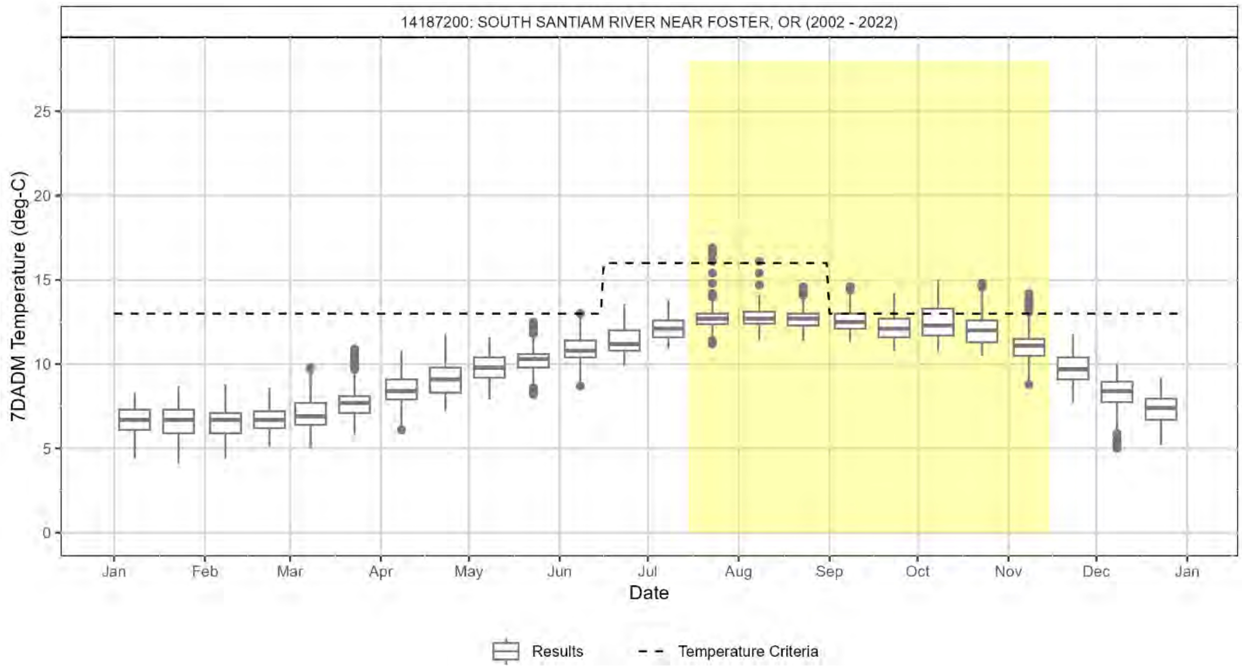


Figure 5-33: Seasonal variation on the South Santiam near Foster, Oregon (below Foster Dam) in the South Santiam Subbasin.

5.7 Middle Willamette Subbasin seasonal variation

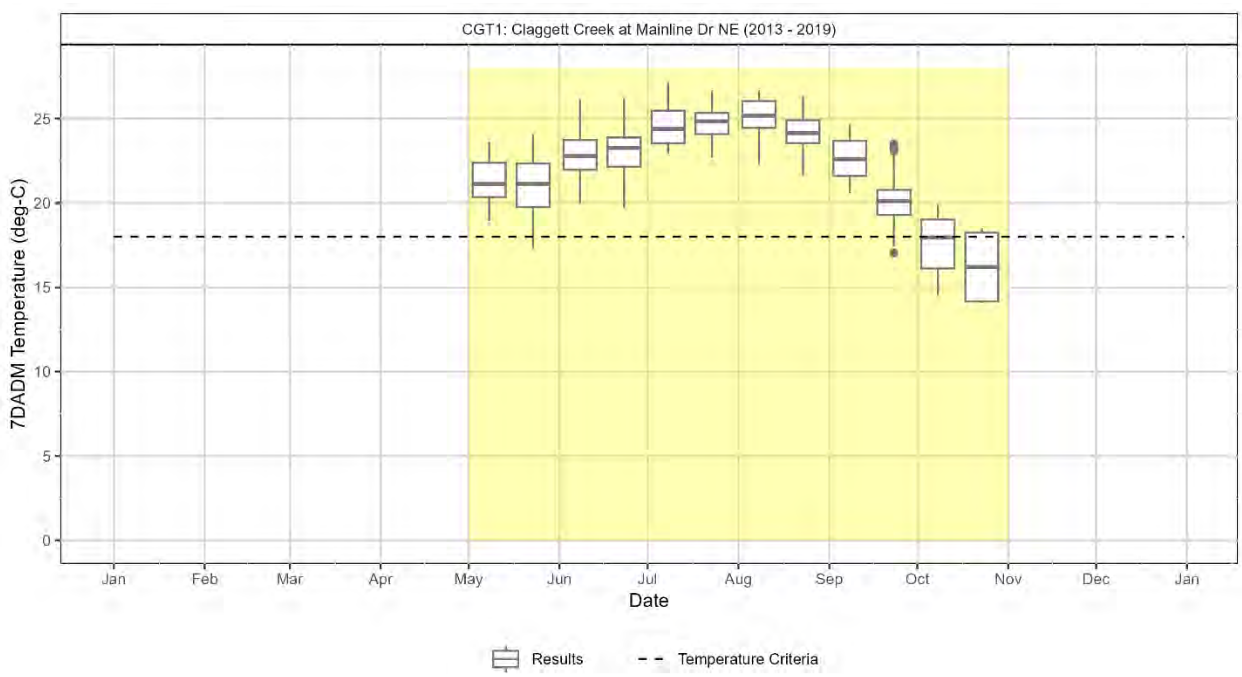


Figure 5-34: Seasonal variation at the Claggett Creek at Mainline Drive temperature monitoring site in the Middle Willamette Subbasin.

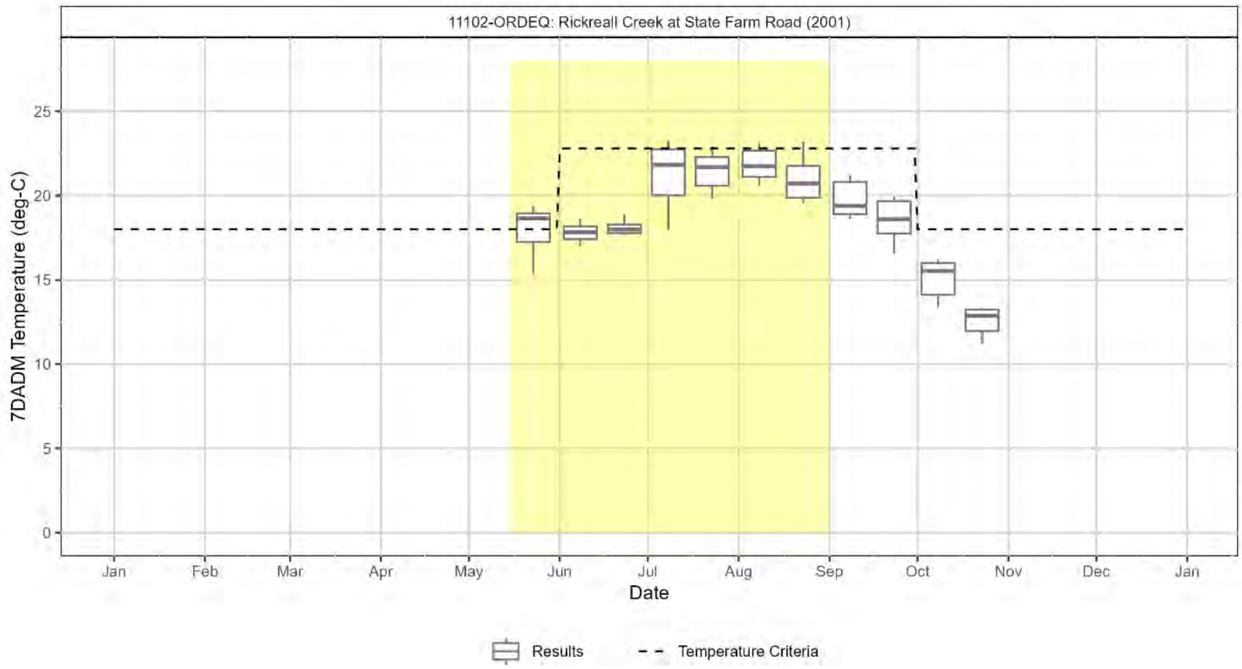


Figure 5-35: Seasonal variation at the Rickreall Creek at State Farm Road temperature monitoring site in the Middle Willamette Subbasin.

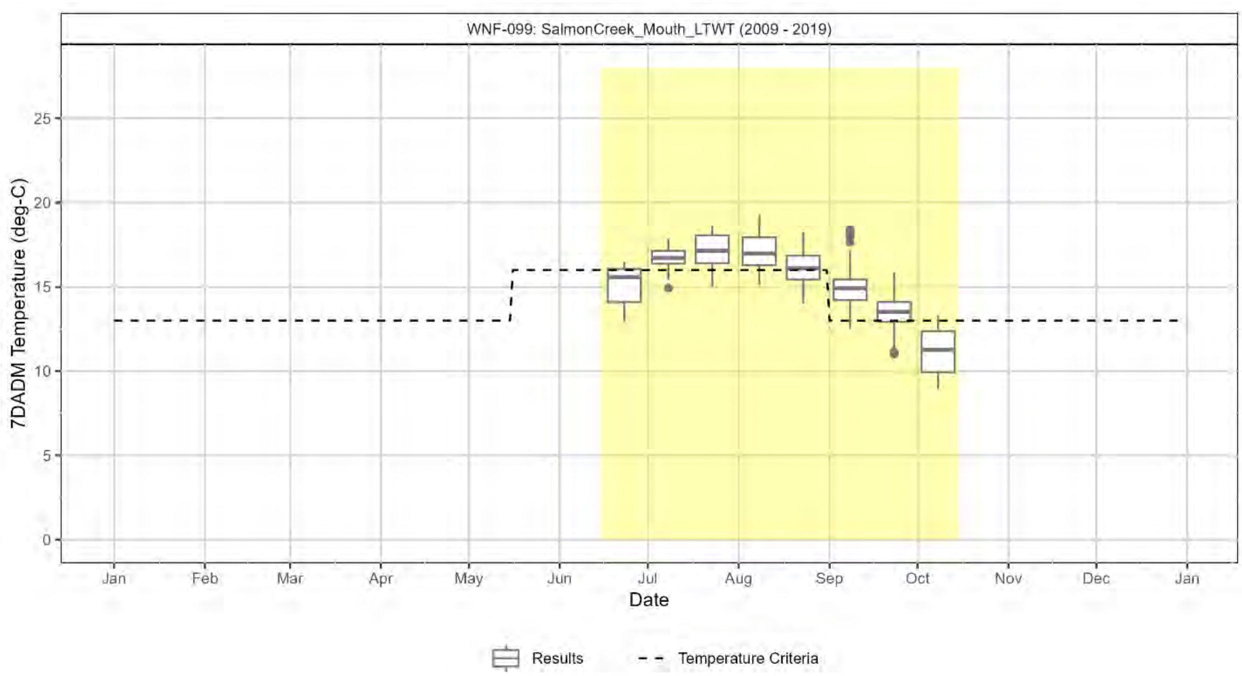


Figure 5-36: Seasonal variation at the Salmon Creek at mouth temperature monitoring site in the Middle Fork Willamette Subbasin.

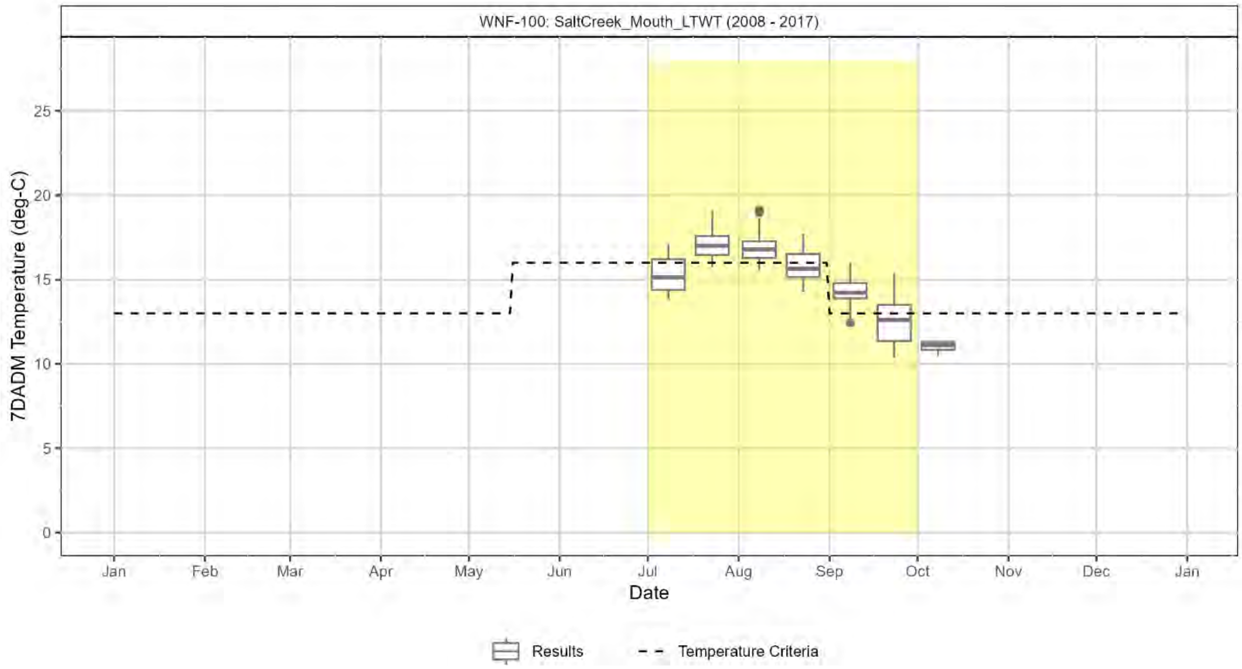


Figure 5-37: Seasonal variation at the Salt Creek at mouth temperature monitoring site in the Middle Fork Willamette Subbasin.

5.8 Molalla-Pudding Subbasin seasonal variation

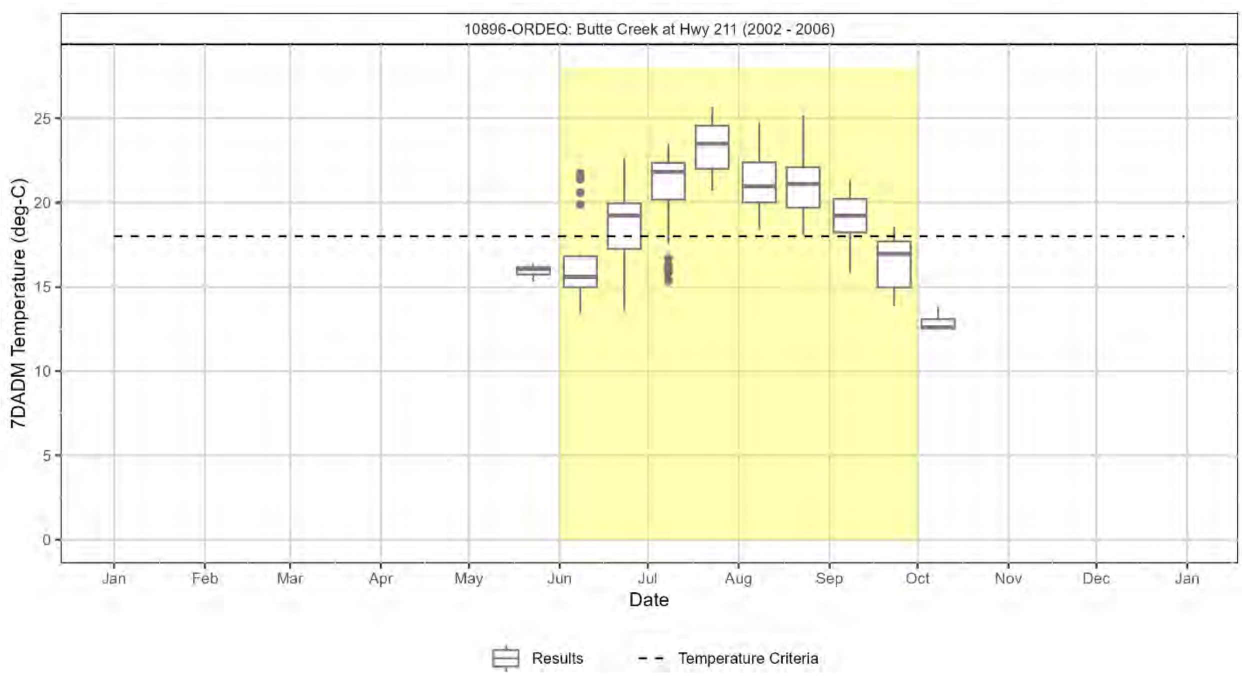


Figure 5-38: Seasonal variation at the Butte Creek at Highway 211 temperature monitoring site in the Molalla-Pudding Subbasin.

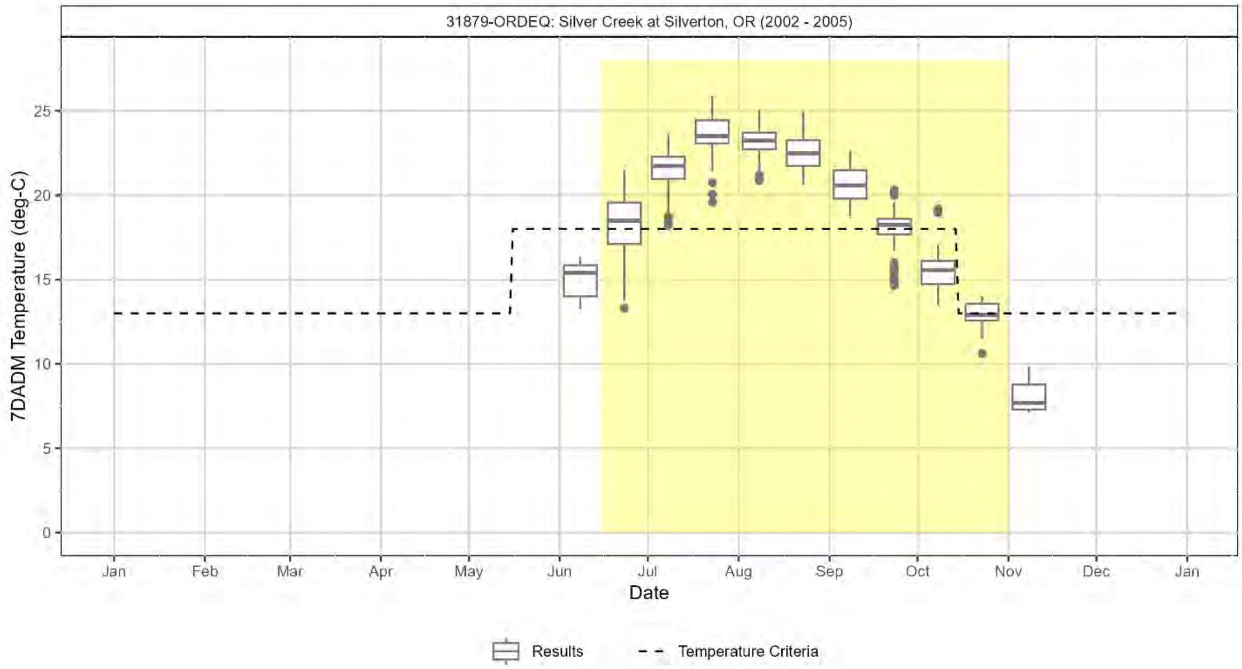


Figure 5-39: Seasonal variation at the Silver Creek at Silverton, Oregon temperature monitoring site in the Molalla-Pudding Subbasin.

5.9 Clackamas Subbasin seasonal variation

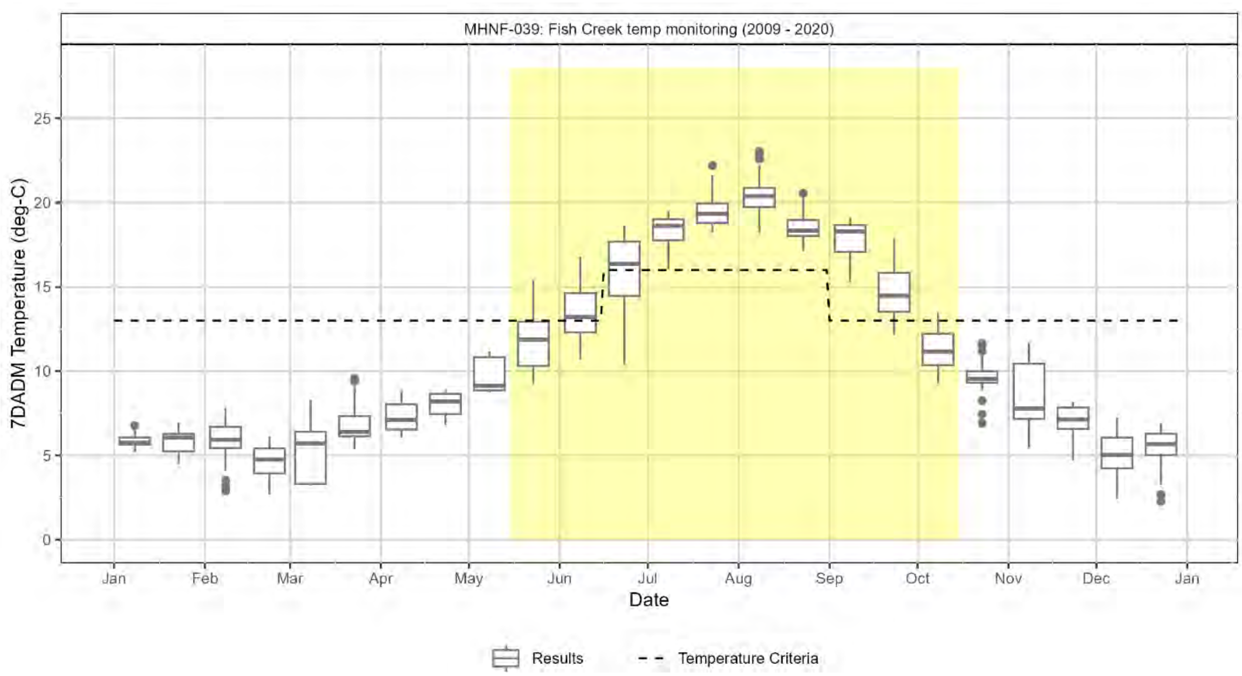


Figure 5-40: Seasonal variation at the Fish Creek temperature monitoring site in the Clackamas Subbasin.

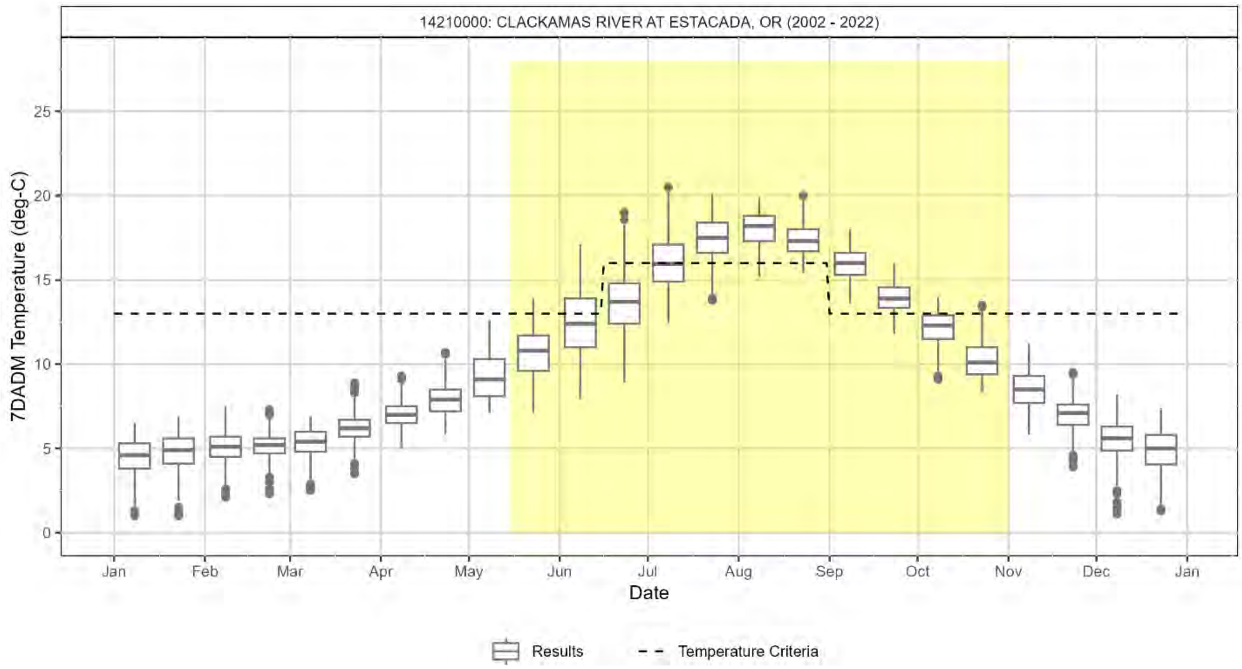


Figure 5-41: Seasonal variation on the Clackamas River at Estacada, Oregon (downstream of River Mill Dam) in the Clackamas Subbasin.

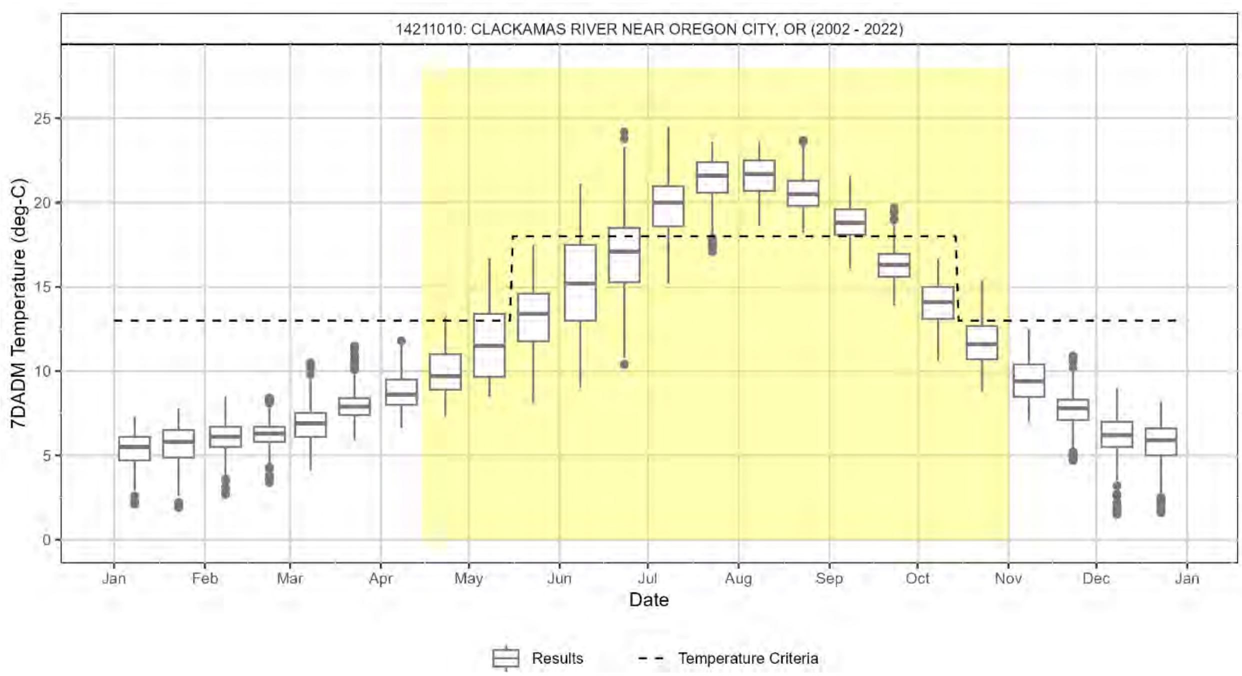


Figure 5-42: Seasonal variation on the Clackamas river near Oregon City, Oregon in the Clackamas Subbasin.

5.10 Lower Willamette Subbasin seasonal variation

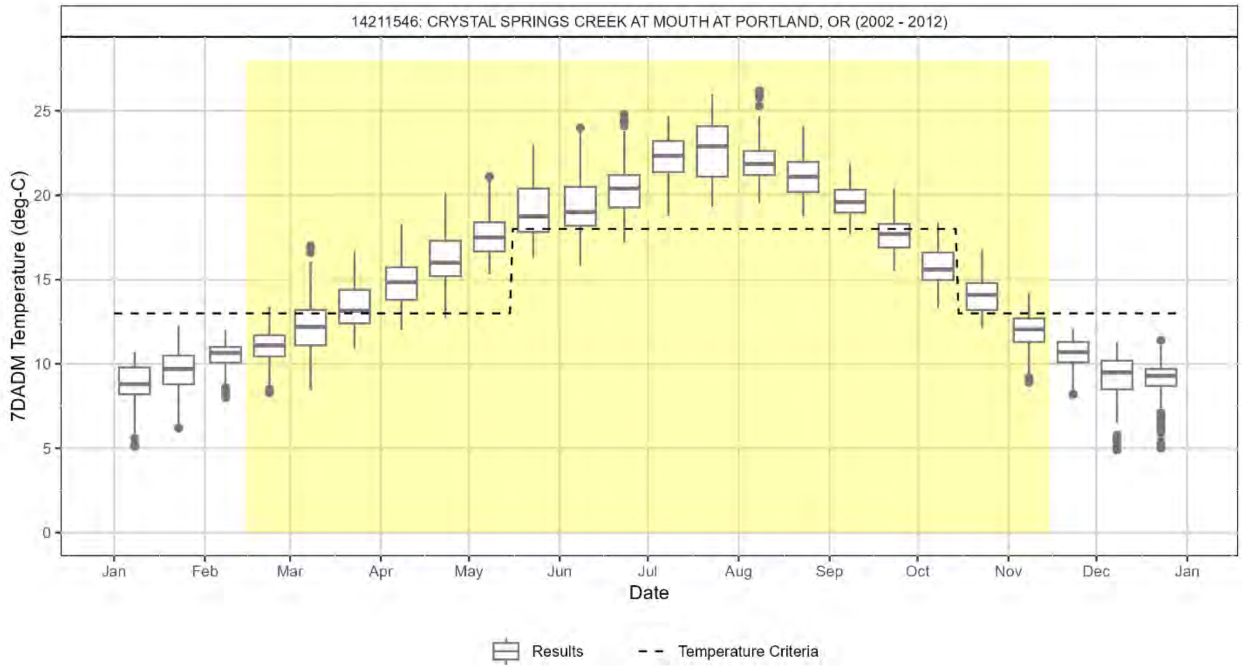


Figure 5-43: Seasonal variation at the Crystal Springs at mouth temperature monitoring site in the Johnson Creek Watershed (HUC 1709001201).

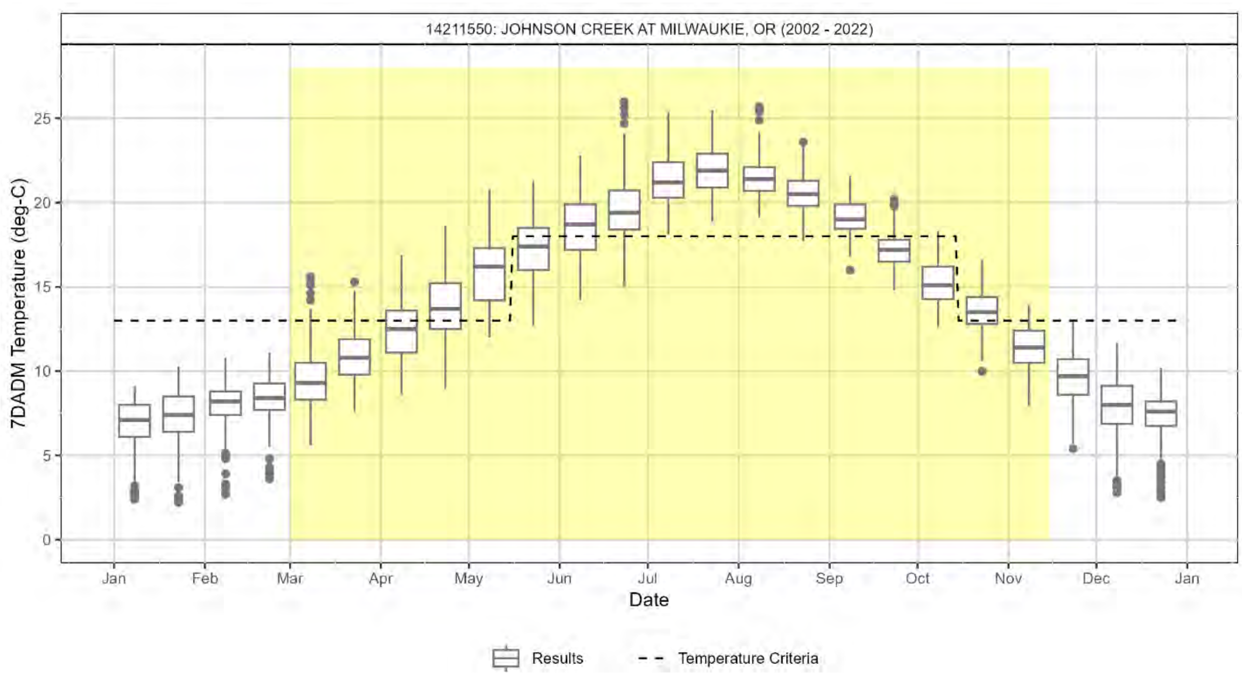


Figure 5-44: Seasonal variation at the Johnson Creek at Milwaukie temperature monitoring site in the Johnson Creek Watershed (HUC 1709001201).

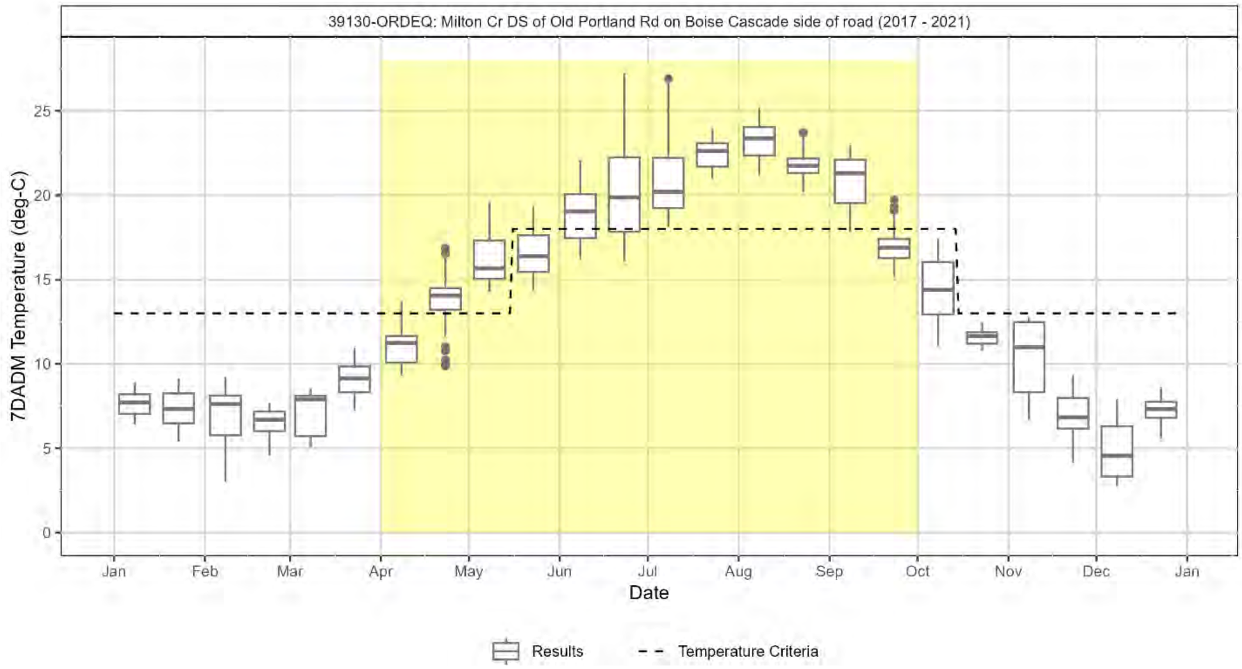


Figure 5-45: Seasonal variation at the Milton Creek upstream of Old Portland Road temperature monitoring site in the Lower Willamette Subbasin.

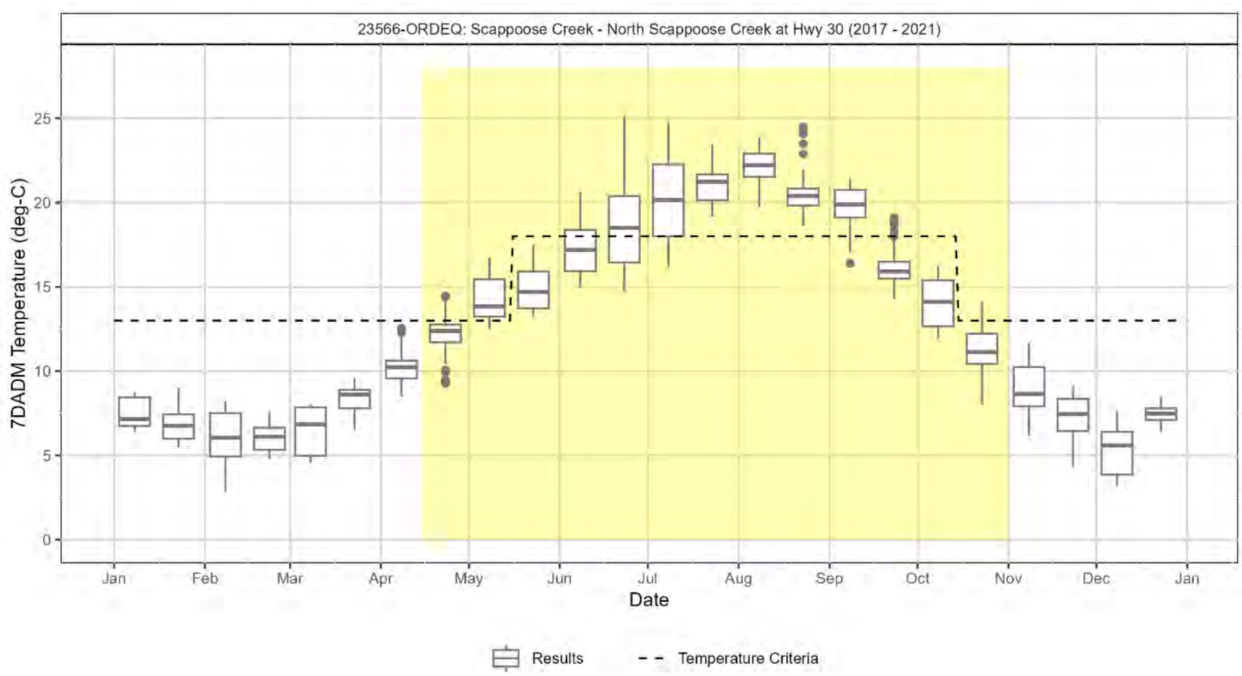


Figure 5-46: Seasonal variation at the North Scappoose Creek at Highway 30 temperature monitoring site in the Lower Willamette Subbasin.

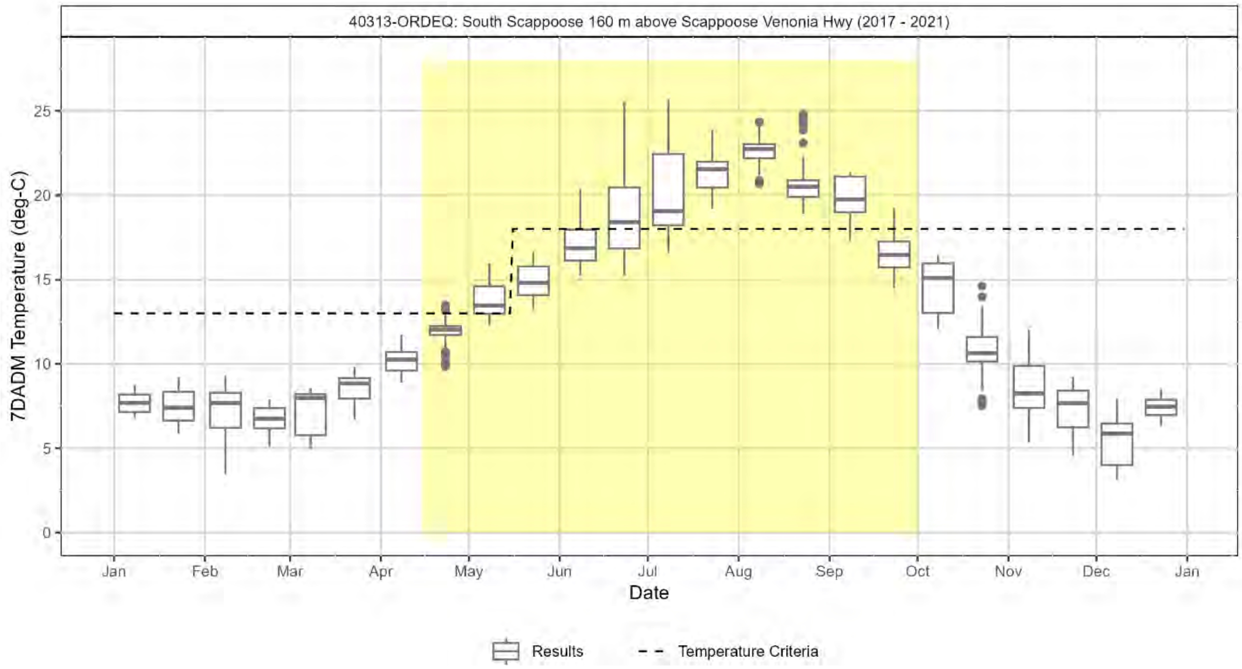


Figure 5-47: Seasonal variation at the South Scappoose Creek above Vernonia Highway temperature monitoring site in the Lower Willamette Subbasin.

5.11 Willamette River seasonal variation

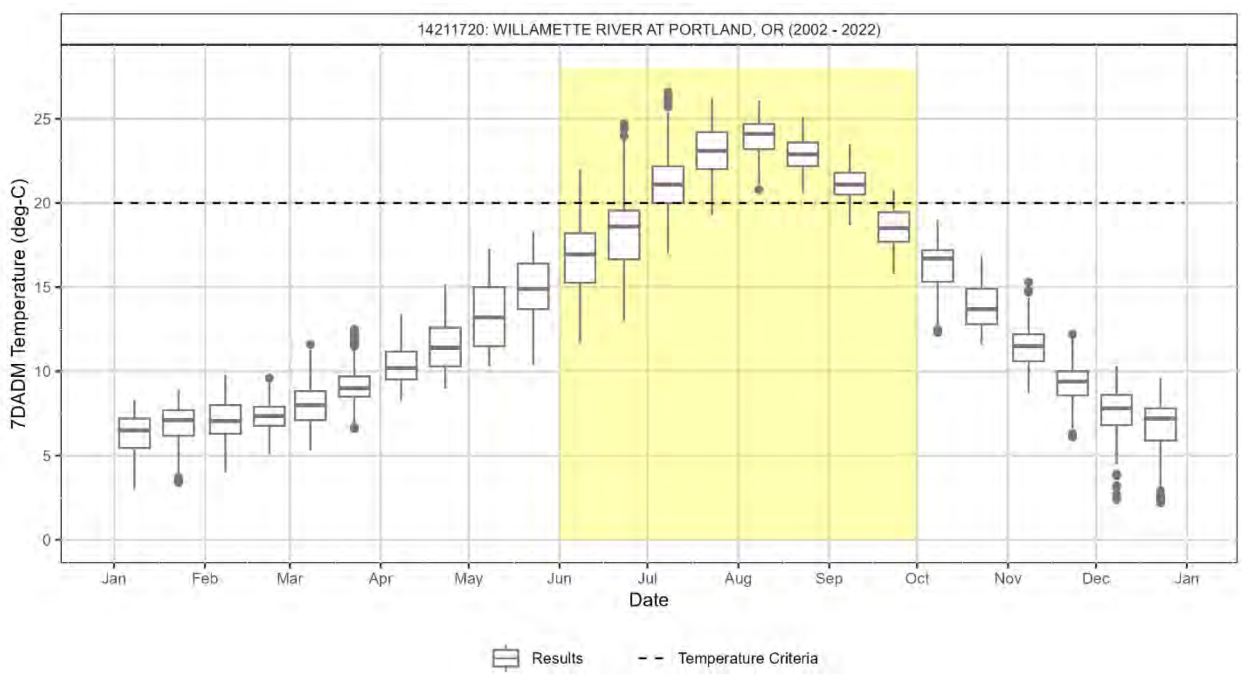


Figure 5-48: Seasonal variation on the Willamette River at Portland in the Lower Willamette Subbasin.

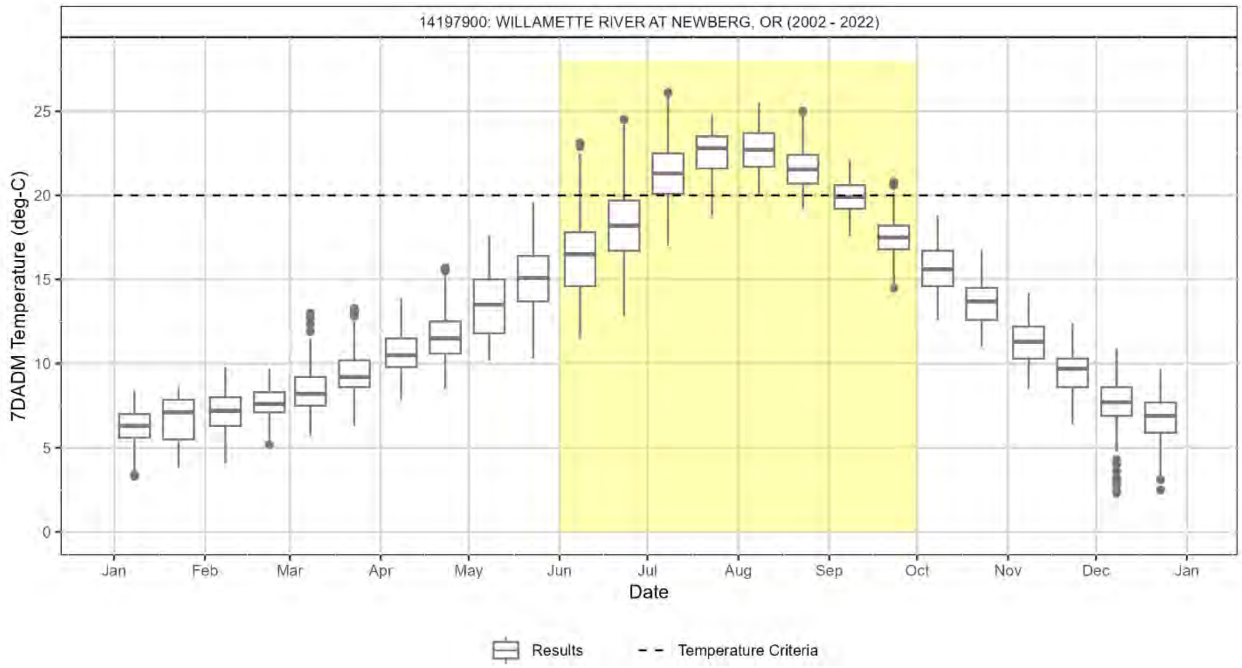


Figure 5-49: Seasonal variation on the Willamette River at Newberg in the Middle Willamette Subbasin.

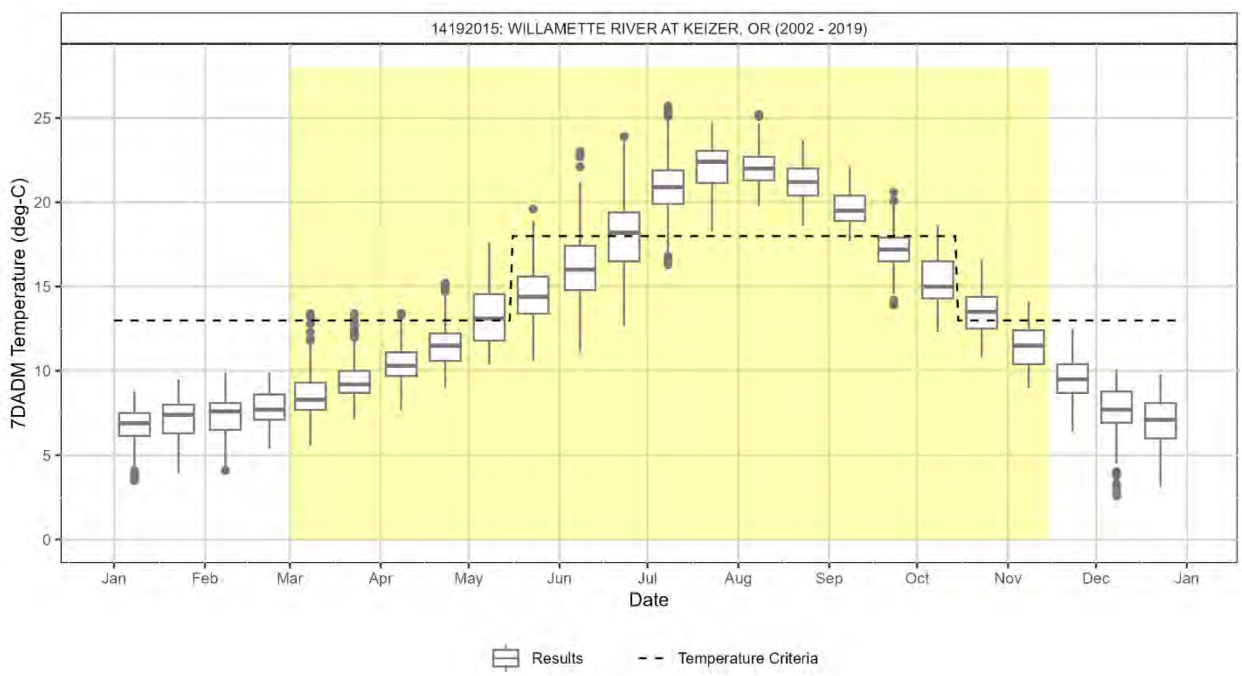


Figure 5-50: Seasonal variation on the Willamette River at Keizer in the Middle Willamette Subbasin.

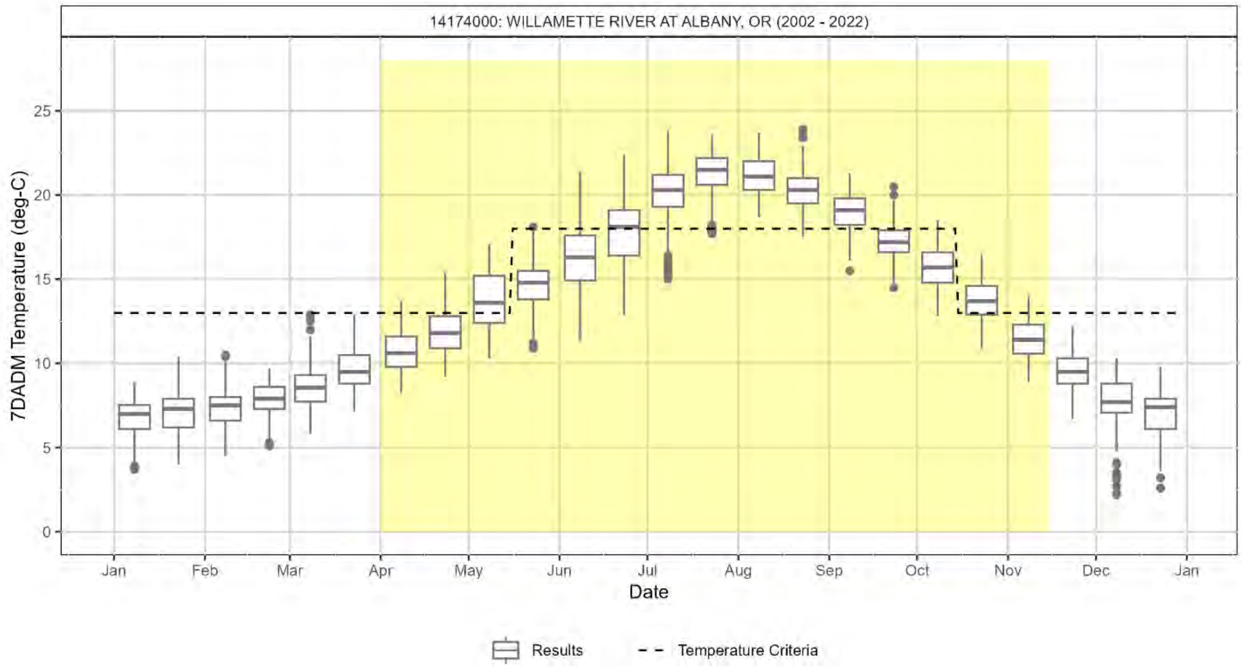


Figure 5-51: Seasonal variation on the Willamette River at Albany in the Upper Willamette Subbasin.

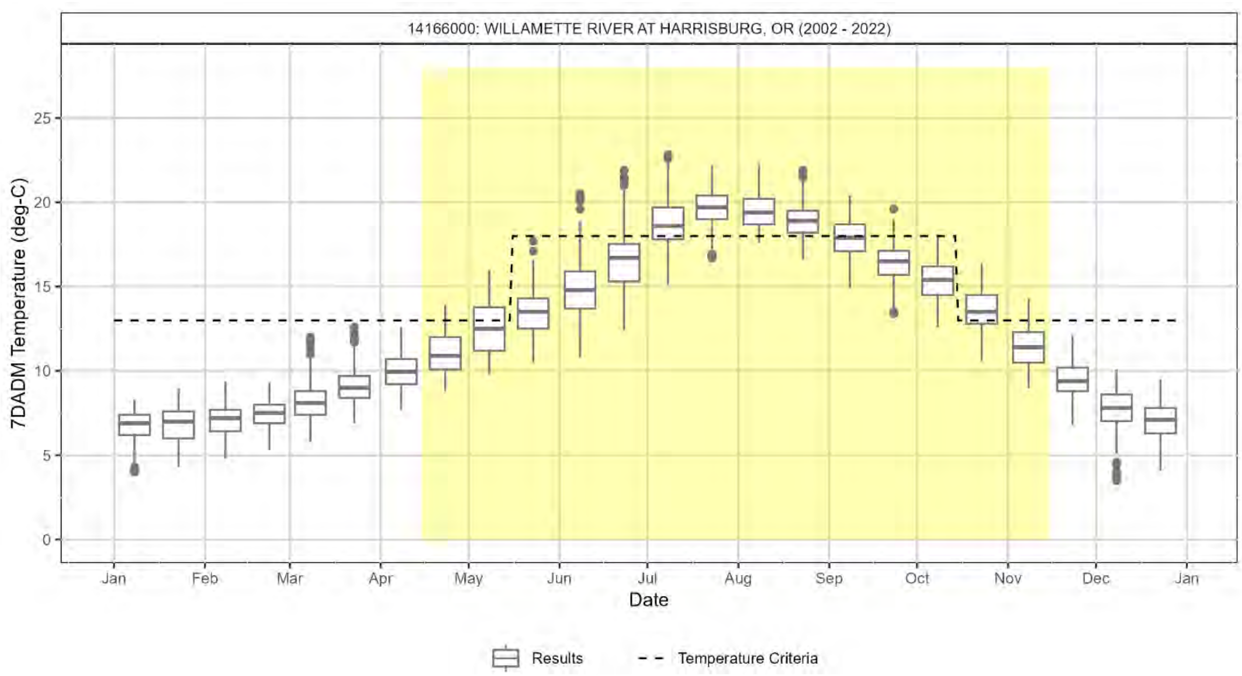


Figure 5-52: Seasonal variation on the Willamette River at Harrisburg in the Upper Willamette Subbasin.

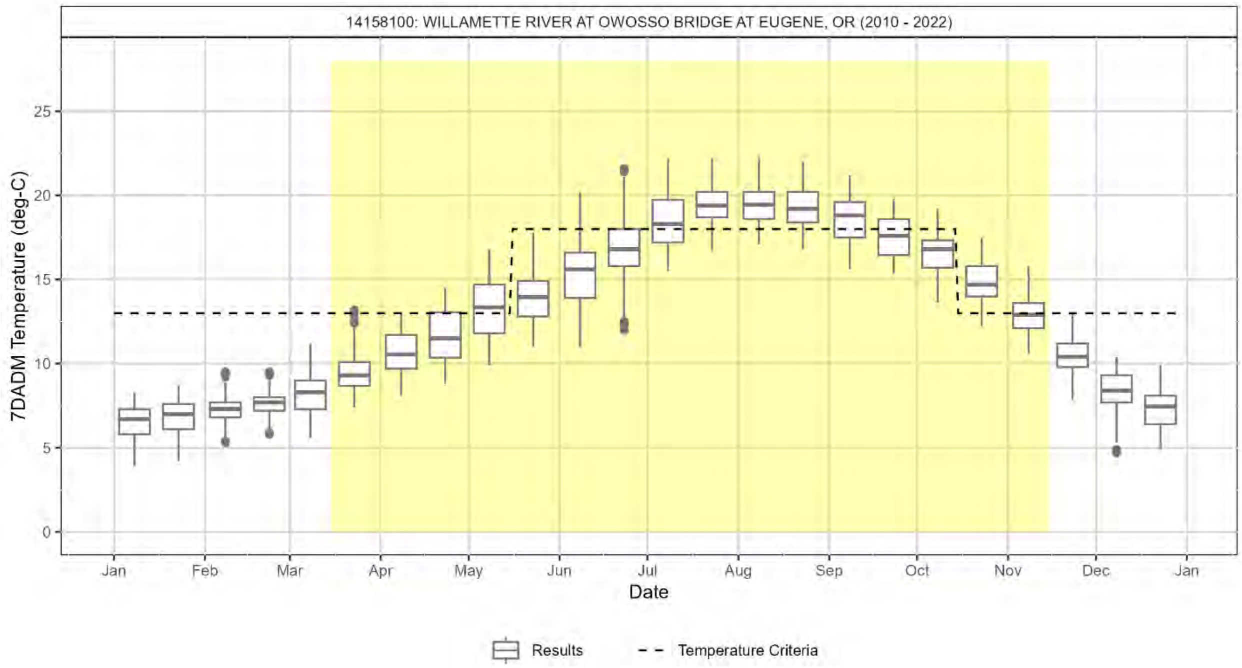


Figure 5-53: Seasonal variation on the Willamette River at Owosso Bridge at Eugene in the Upper Willamette Subbasin.

6 Temperature water quality data evaluation and analyses

A critical TMDL element is water quality data evaluation and analysis to the extent that existing data allow. To understand the water quality impairment, assess potential pollutant sources, and evaluate the ability of various management scenarios in achieving the TMDL and applicable temperature water quality standards, the analysis requires a predictive component. DEQ uses models to evaluate potential stream warming sources and, to the extent existing data allow, their current and TMDL allocation pollutant loads. Heat Source and CE-QUAL-W2 models were used in this effort and are described in Appendices A-B and J-L of this document.

6.1 Analysis overview

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

1. Stream temperatures spanning months at ≤500 m longitudinal resolution.
2. Solar radiation fluxes and daily effective shade at ≤200 m longitudinal resolution.
3. Stream temperature responses due to changes in:
    a. Streamside vegetation,
    b. Water withdrawals and upstream tributaries' stream flow,
    c. Channel morphology,
    d. Effluent temperature and flow discharge from NPDES permitted facilities.

Figure 6-1 provides an overview of the type of analyses completed for this TMDL. Water quality models were used to support analysis on many streams. These models have specific input and calibration data requirements. Data types and how they supported the TMDL analysis are summarized in **Figure 6-1** and are described more fully in Appendix A, Appendix B, Appendix J and Appendix K. All data are available to the public with a public records request.

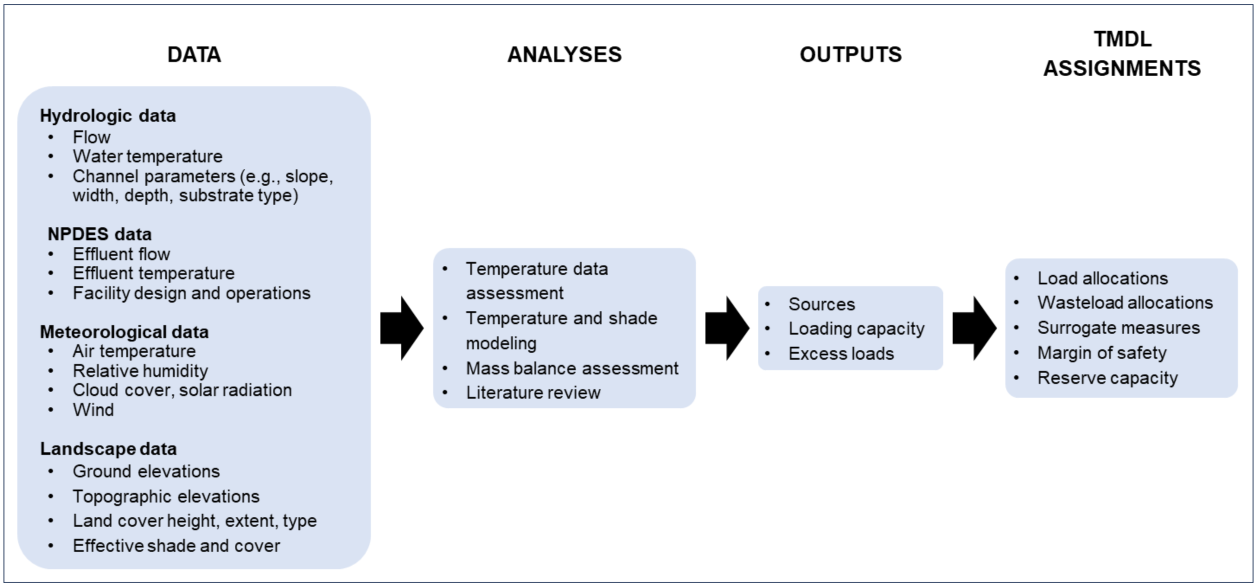


Figure 6-1: Willamette Subbasins temperature analysis overview.

6.2 Data overview

As illustrated in **Figure 6-1**, data for numerous hydrologic, meteorologic, and landscape/ geographic parameters within the spatial and temporal boundaries of the TMDL are required to conduct effective analysis for TMDL development. Section 2 of Appendix B to this document describes these parameters, their applications in this TMDL development, and provides information on the specific datasets and sources utilized for this effort. All data are available upon request.

Table 6-1: Data types used in the Willamette Subbasins Temperature TMDL modeling.

Data Source Type	Dataset Types	Data Sources
Field-acquired	• Continuous stream temperature • Stream flow rate: continuous & instantaneous • Point source discharge temperatures & flows	DEQ Ambient Water Quality Monitoring System (AWQMS); USGS National Water Information System (NWIS); DEQ data solicitation responses; NPDES Discharge Monitoring Reports
GIS and/or remotely sensed	• 3-ft Digital Elevation Model (DEM) • Light Detection and Ranging (LiDAR) • Aerial imagery: Digital Orthophoto Quads (DOQs) • Thermal Infrared Radiometry (TIR) temperature data	Oregon Department of Geology and Mineral Industries (DOGAMI); Oregon LiDAR Consortium (OLC); Watershed Sciences, Inc.
Derived from above data types via: (a) quantitative methods or (b) proxy substitution (for certain tributary flows & temps.)	• Stream position, channel width, channel bottom width, elevation, gradient • Topographic shade angles • Land cover mapping • Tributary flows & temperatures	DEMs, LiDAR, DOQs (for stream morphology, land cover, topography, & geography); USGS StreamStats, historical data, proxy site data, estimated data (for tributary flows & temperatures if direct monitoring data were unavailable)

6.3 Model setup and application overview

As described in the TSD model report appendices (Appendix A, Appendix B, Appendix J, Appendix K, Appendix L, and Appendix M), DEQ and partners set up and calibrated temperature and shade models for numerous streams in the Willamette Subbasins (**Figure 6-2**). Temperature models were developed for:

- Johnson Creek (Lower Willamette Subbasin)
- Multnomah Channel (Lower Willamette Subbasin)
- Clackamas River (Clackamas Subbsin)
- Molalla River (Molalla-Pudding Subbasin)
- Pudding River (Molalla-Pudding Subbasin)
- Little North Santiam River (North Santiam Subbasin)
- North Santiam River (North Santiam Subbasin)
- Santiam River (North Santiam Subbasin)
- Thomas Creek (South Santiam Subbasin)
- Crabtree Creek (South Santiam Subbasin)
- South Santiam River (South Santiam Subbasin)
- Luckiamute River (Upper Willamette Subbasin)
- Mohawk River (McKenzie Subbasin)
- McKenzie River (McKenzie Subbasin)
- Coyote Creek (Upper Willamette Subbasin)
- Long Tom River (Upper Willamette Subbasin)
- Coast Fork Willamette River (Coast Fork Willamette Subbasin)
- Mosby Creek (Coast Fork Willamette Subbasin)
- Row River (Coast Fork Willamette Subbasin)
- Fall Creek (Middle Fork Willamette Subbasin)
- Middle Fork Willamette River (Middle Fork Willamette Subbasin)
- Willamette River (Lower Willamette, Middle Willamette, and Upper Willamette Subbasins)

Shade models were developed for:

- Select streams in the Lower Willamette Subbasin including Columbia Slough, Tryon Creek, and Johnson Creek Watersheds, and streams that flow to the Willamette River and Multnomah Channel on the west side of the Tualatin Mountains in the Balch Creek-Willamette River subwatershed (170900120202) and Multnomah Channel subwatershed (170900120305)
- Streams in the Southern portion of the Willamette Basin where LiDAR data were available.

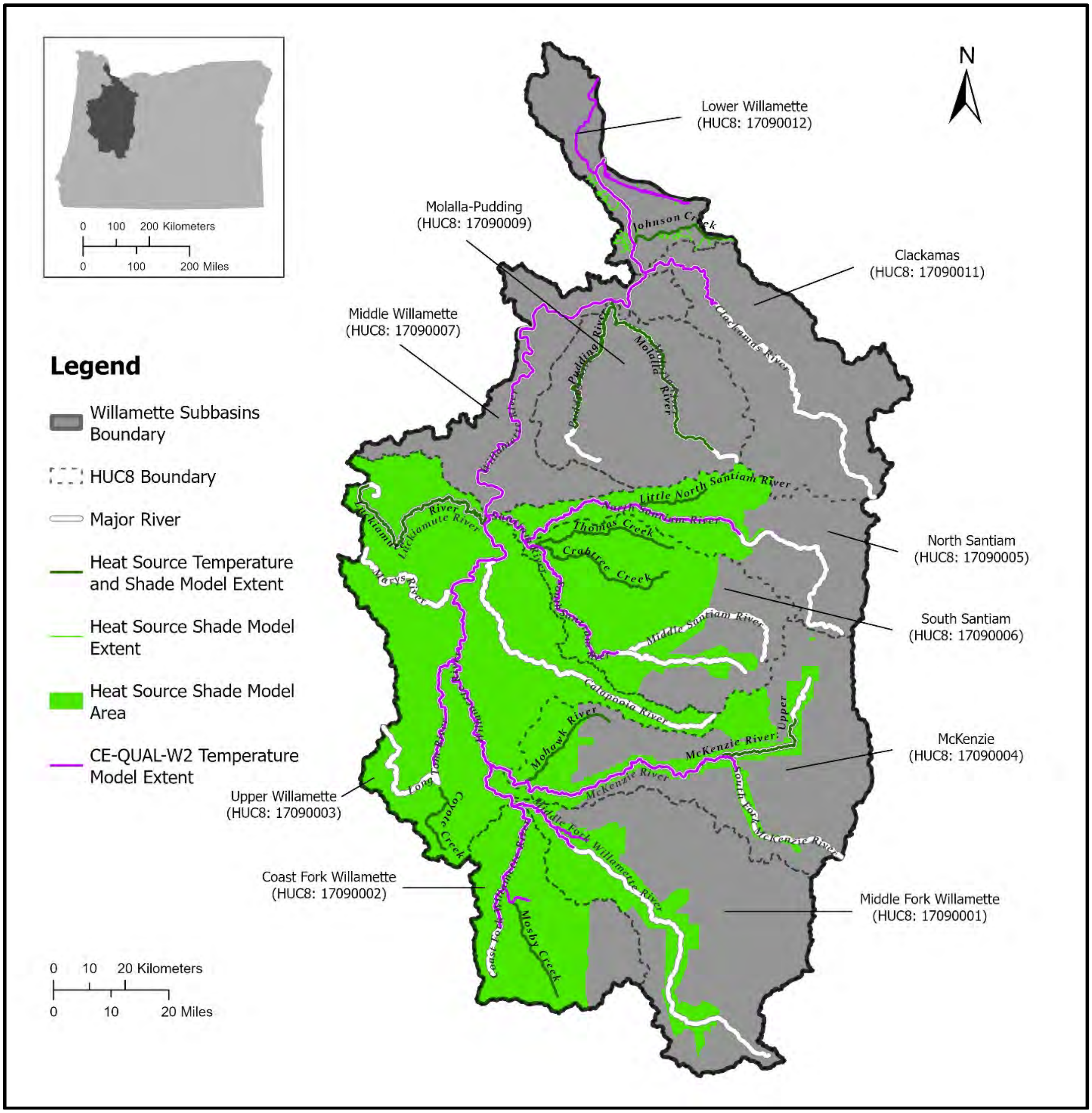


Figure 6-2: Overview of TMDL project area and model extents.

The setup and calibration for many of these models was completed by DEQ for the Willamette Basin TMDL and WQMP (DEQ, 2006) and Molalla-Pudding Subbasin TMDL (DEQ, 2008c). During development, the models were adjusted iteratively until acceptable goodness-of-fit was achieved relative to the observed current conditions. DEQ did not make adjustments to the original calibrated temperature models with the exception of a minor correction to the meteorological inputs on Johnson Creek. The Heat Source shade models and the CE-QUAL-W2 temperature model on the lower McKenzie River are new to this TMDL and were not available for the 2006 TMDL. DEQ and City of Portland developed the shade models. USGS updated the McKenzie River CE-QUAL-W2 model for the year 2015 (Stratton et al., 2022).

Adjustments were made to the various model scenarios developed for the 2006 and 2008 TMDL with some new scenarios developed. The adjustments were principally focused on updating point source effluent discharge inputs based on more recent data, adding new sources, removing sources no longer discharging, and assessment of various management scenarios such as changes in riparian conditions and water withdrawal rates.

The results of these models were used in tandem with applicable temperature criteria to complete a source assessment and cumulative effects analysis, determine TMDL allocations and surrogate measures that attain the applicable temperature criteria, and develop information that will support TMDL implementation and development of the TMDL WQMP. It was not possible to model all waters with a temperature listing, so the determination of sources and source categories is principally based on the findings from the streams that were modelled or were assessed using available data. Results from the modeled reaches and reaches with available data are relevant in the larger watershed context.

A summary of the source assessment finding can be found in Section 7. The detailed model calibration and scenario results are provided in the TSD model report appendices (Appendix A, Appendix B, Appendix J, and Appendix K).

6.4 The 7Q10 low-flow statistic

The “7Q10” is a summary low-flow statistic equal to the lowest seven-day average flow that occurs once every ten years (on average). For the Willamette Subbasins temperature TMDL, estimated 7Q10s were used to calculate numeric loading capacities and allocations. DEQ calculated annual 7Q10s for temperature-impaired streams in the Willamette Subbasins (**Table** 6-2), and for the receiving waterbodies that have NPDES permitted discharges with a WLA (**Table 6-3**).

The 7Q10 estimates were based on the following approaches:

1) If sufficient daily mean flow data from USGS or OWRD gaging stations were available for a given waterbody, 7Q10 estimates were calculated using these data. Available flow data were retrieved for up to a 30-year period (October 1, 1992 to September 31, 2022). DEQ relied on quality control protocols implemented by USGS and OWRD. Only data with a result status of “Approved” (USGS) or “Published” (OWRD) were included in 7Q10 calculations. 7Q10s were calculated by the method of EPA’s DFLOW program (Rossman, 1990), which computes extreme design flows using the log-Pearson Type III probability distribution. A minimum of 10 years of flow data were used with some exceptions. For ungaged locations, if there were sufficient gage data from confluent streams, 7Q10s were estimated from (a) the sum of daily mean flows (for upstream gages), or (b) the difference of mean daily flows (for downstream gages), prior to application of the DFLOW procedure. The 7Q10s calculated based on gage data are reported to the nearest tenth of a cubic foot per second (cfs) for values less than 10 cfs and to whole numbers for values greater than or equal to 10 cfs.

2) If insufficient daily mean flow data from USGS and OWRD stream flow gaging stations were available, the web-based tool StreamStats (USGS, 2019) was used to estimate 7Q10s. The 7Q10s are reported with the same level of significant figures as the values calculated using the gage method, except for values equal to or greater than 1000 cfs, which are reported to three significant figures. Details of StreamStats are described below.

3) 7Q10s calculated and reported elsewhere (e.g., consultant studies, water quality permits, TMDLs) may have been used. In such cases, DEQ relied on the source's data quality and reported the values as they were provided.

4) For tidally influenced streams, DEQ reviewed each situation and made 7Q10 estimates based on the best available data from the relevant gaging stations. Methods are described for each case.

5) 7Q10s immediately downstream of the USACE' projects at Cougar Dam, Detroit Dam, Green Peter Dam, Hills Creek Dam, and Lookout Point Dam were calculated based on a seasonal period corresponding to TMDL allocation period due to some low flows occurring outside the allocation period (**Table 6-3**). At Detroit Dam there were multiple days with missing flow records. Linear interpolation was used to estimate flow for the missing days.

StreamStats version 4 is a web-based GIS application developed by the USGS (https://streamstats.usgs.gov/ss/). StreamStats has a map-based interface that allows the user to determine drainage area delineations, basin characteristics, and estimates of stream flow statistics for user-selected locations along available streams. The program also provides users with access to stream monitoring data by selecting USGS data-collection stations in the map application and providing access to flow statistics and other information for the stations. StreamStats provides estimates of various stream flow statistics for user-selected sites by solving site-specific regression equations. The regression equations were developed through a process, known as regionalization, which involves use of regression analysis to relate stream flow statistics computed for a group of selected stream gages (usually within a state) to basin characteristics measured for the stream gages. Basin characteristics are used to obtain estimates of the stream flow statistics for ungaged sites.

StreamStats regression equations for Oregon were developed by Cooper (2005) and Risley et al. (2008). These equations were based on basin characteristics and flow statistics (e.g., historical percentile flow-exceedance values and annual and monthly 7Q10). Flow statistics were computed at 466 gaging stations across Oregon and proximal out-of-states areas. This study area was divided into 10 regions based on ecological, topographic, geologic, hydrologic, and climatic criteria. StreamStats includes 910 annual and monthly regression equations to estimate 7Q10s for ungaged stream sites in the 10 aforementioned regions. These equations were developed for unregulated streams (without major dams, constructed reservoirs, catchment development, or significant diversions/withdrawals). If the equations are applied to ungaged streams subject to such influences, the resultant estimates may require adjustment to approximate actual flows.

The StreamStats user selects a stream location of interest and the program estimates the associated drainage area and summary flow statistics. For this TMDL, DEQ's procedure specified that selected stream locations should be the most downstream location on each stream for which DEQ required flow estimates; the exception was if DEQ required 7Q10 estimates for NPDES permitted point source receiving waters, in which case the selected stream location was immediately upstream of the point source outfall. StreamStats also estimates basin characteristics for the selected catchment, including drainage area, mean annual precipitation, mean slope, and climatic characteristics (Cooper, 2005; Risley et al., 2008). If estimates are outside suggested parameter ranges, the warning message "extrapolated with uncertainty" appears in the StreamStats report.

Table 6-2: The 7Q10 low-flow estimates for modeled temperature-impaired rivers in the Willamette Subbasins.

AU Name	AU ID	Estimated 7Q10 (cfs)	Flow Estimation Method	Flow Estimation Latitude/Longitude	Gage Period
Clackamas River	OR_SR_1709001106_02_104597	671	USGS: 14211010	45.379, -122.577	2001-06-01 ~ 2022-09-30
Coast Fork Willamette River	OR_SR_1709000203_02_104585	38	USGS: 14153500	43.721, -123.05	1992-10-01 ~ 2022-09-30
Coast Fork Willamette River	OR_SR_1709000204_02_103787	132	USGS: 14157500	43.98, -122.966	1992-10-01 ~ 2022-09-30
Coyote Creek	OR_SR_1709000301_02_103796	5.9	StreamStats	44.052, -123.269	
Crabtree Creek	OR_SR_1709000606_02_103978	25	StreamStats	44.673, -122.946	
Johnson Creek	OR_SR_1709001201_02_104170	11	USGS: 14211550	45.453, -122.643	1992-10-01 ~ 2022-09-30
Little North Santiam River	OR_SR_1709000505_02_104564	21	USGS: 14182500	44.792, -122.579	1992-10-01 ~ 2022-09-30
Long Tom River	OR_SR_1709000301_02_103791	22	USGS: 14170000	44.313, -123.296	1992-10-01 ~ 2022-09-30
Luckiamute River	OR_SR_1709000305_02_103829	16	USGS: 14190500	44.783, -123.235	1992-10-01 ~ 2022-09-30
McKenzie River	OR_SR_1709000405_02_103866	740	StreamStats	44.111, -122.422	
McKenzie River	OR_SR_1709000407_02_103884	1537	USGS: 14164900	44.071, -122.965	2007-03-22~ 2022-09-30
Middle Fork Willamette River	OR_SR_1709000107_02_104583	1002	USGS: 14150000	43.946, -122.837	1992-10-01 ~ 2022-09-30
Middle Fork Willamette River	OR_SR_1709000110_02_104584	1278	USGS: 14152000	43.998, -122.906	1992-10-01 ~ 2022-09-30
Mohawk River	OR_SR_1709000406_02_103870	4.3	StreamStats	44.191, -122.84	
Mohawk River	OR_SR_1709000406_02_103871	16	USGS: 14165000	44.093, -122.957	1992-10-01 ~ 2022-09-30
Mohawk River	OR_SR_1709000406_02_103877	3	StreamStats	44.213, -122.827	
Molalla River	OR_SR_1709000904_02_104086	38	StreamStats	45.083, -122.488	
Mosby Creek	OR_SR_1709000201_02_103752	11	StreamStats	43.779, -123.011	
North Santiam River	OR_SR_1709000504_02_103906	859	USGS: 14181500	44.754, -122.297	1992-10-01 ~ 2022-09-30
North Santiam River	OR_SR_1709000506_02_103930	914	USGS: 14183000	44.789, -122.619	1992-10-01 ~ 2022-09-30
Pudding River	OR_SR_1709000901_02_104067	3.1	StreamStats	45.0, -122.842	
Pudding River	OR_SR_1709000905_02_104088	10	USGS: 14202000	45.233, -122.75	1993-06-21 ~ 2022-09-30
Santiam River	OR_SR_1709000506_02_103927	1144	USGS: 14189000	44.715, -123.014	1992-10-01 ~ 2022-09-30
South Fork McKenzie River	OR_SR_1709000403_02_104590	220	USGS: 14159500	44.135, -122.248	1992-10-01 ~ 2022-09-30

AU Name	AU ID	Estimated 7Q10 (cfs)	Flow Estimation Method	Flow Estimation Latitude/Longitude	Gage Period
South Santiam River	OR_SR_1709000608_02_103925	615	USGS: 14187500	44.498, -122.823	1992-10-01 ~ 2022-09-30
Thomas Creek	OR_SR_1709000607_02_103988	6.9	USGS: 14188800	44.712, -122.77	2002-10-01 ~ 2022-09-30
Thomas Creek	OR_SR_1709000607_02_103991	13	StreamStats	44.713, -122.719	
Willamette River	OR_SR_1709000306_05_103854	3877	USGS: 14174000	44.639, -123.107	1992-10-01 ~ 2022-09-30
Willamette River	OR_SR_1709000701_05_104005	5684	USGS: 14191000	44.944, -123.043	1992-10-01 ~ 2022-09-30
Willamette River	OR_SR_1709000703_88_104015	5734	USGS: 14197900	45.285, -122.961	2001-10-01 ~ 2022-09-30
Willamette River	OR_SR_1709000704_88_104020	5988	USGS: 14197900 + 14207500 + 14200000 + 14202000	45.285, -122.961 45.351, -122.676 45.244, -122.687 45.233, -122.750	2002-10-01 ~ 2022-09-30
Willamette River	OR_SR_1709001201_88_104019	6740	USGS: 14197900 + 14207500 + 14211010 + 14200000 + 14202000	45.285, -122.961 45.351, -122.676 45.379, -122.577 45.244, -122.687 45.233, -122.750	2002-10-01 ~ 2022-09-30
Willamette River	OR_SR_1709001202_88_104175	6740	USGS: 14197900 + 14207500 + 14211010 + 14200000 + 14202000	45.285, -122.961 45.351, -122.676 45.379, -122.577 45.244, -122.687 45.233, -122.750	2002-10-01 ~ 2022-09-30

Table 6-3: The 7Q10 low-flow estimates for NPDES permitted discharges receiving a numeric wasteload allocation in this TMDL.

Facility Name (Facility Number)	Stream	Estimated 7Q10 (cfs)	Flow Estimation Method	Flow Estimation Latitude/Longitude	Gage Period
Albany Water Treatment Plant (66584)	Calapooia River	24	StreamStats	44.635, -123.114	
Alpine Community (100101)	Muddy Creek	0.4	StreamStats	44.33, -123.352	
Arclin (16037)	28th Street Canal	0	StreamStats. The storm ditch is not represented on the StreamStats network. Used nearest location	44.058, -122.986	
Arclin (81714)	Columbia Slough	30	Based on permit mixing zone study (SECOR, 2002)		
ATI Albany Operations (64300)	Oak Creek	1.4	StreamStats	44.602, -123.107	
Aumsville STP (4475)	Beaver Creek	0.7	StreamStats	44.852, -122.872	

Facility Name (Facility Number)	Stream	Estimated 7Q10 (cfs)	Flow Estimation Method	Flow Estimation Latitude/Longitude	Gage Period
Aurora STP (110020)	Pudding River	10	USGS: 14202000	45.233, -122.750	1993-06-21 ~2022-09-30
Bakelite Chemicals LLC (32650)	Murder Creek	0	StreamStats	44.661, -123.069	
Bakelite Chemicals LLC (32864)	Amazon Creek	0	StreamStats	44.121, -123.19	
Blount Oregon Cutting Systems Division (63545)	Minthorne Creek	0	StreamStats	45.436, -122.612	
Boeing of Portland - Fabrication Division (9269)	Osburn Creek	0	StreamStats	45.541, -122.446	
Brownsville STP (11770)	Calapooia River	14	StreamStats	44.396, -122.998	
City of Silverton Drinking WTP (81398)	Unnamed Tributary to Abiqua Creek	0	StreamStats	44.008, -122.774	
Coburg Wastewater Treatment Plant (115851)	Muddy Creek	0	StreamStats	44.152, -123.058	
Coffin Butte Landfill (104176)	Roadside ditch to Soap Creek tributary	0	StreamStats	44.698, -123.23	
Columbia Helicopters (100541)	Unnamed Stream RM 1.8 (Trib to Pudding River)	0	Assumed zero	45.278, -122.733	
Corvallis Rock Creek WTP (20160)	Marys River	0	StreamStats	44.51, -123.456	
Creswell STP (20927)	Camas Swale Creek	0	StreamStats	43.928, -123.037	
Dallas STP (22546)	Rickreall Creek	4.2	StreamStats	44.92, -123.258	
Dallas WTP (22550)	Rickreall Creek	3.3	StreamStats	44.928, -123.363	
Deer Creek Estates Water Association	Mill Creek	0.7	StreamStats	45.235, -122.758	
Duraflake (97047)	Murder Creek	0	StreamStats	44.664, -123.066	
Estacada STP (27866)	River Mill Reservoir	317	StreamStats	45.296, -122.347	
EWEB Carmen-Smith (28393)	McKenzie River Outfall 001A/B	146	StreamStats	44.288, 122.035	
EWEB Carmen-Smith (28393)	McKenzie River Outfall 002A/B	496	USGS: 14158850	44.268, -122.050	1992-10-01 ~2022-09-30
EWEB Hayden Bridge Filter Plant (28385)	McKenzie River	1537	USGS: 14164900	44.071, -122.965	2007-03-22 ~2022-09-30

Facility Name (Facility Number)	Stream	Estimated 7Q10 (cfs)	Flow Estimation Method	Flow Estimation Latitude/Longitude	Gage Period
Falls City STP (28830)	Little Luckiamute River	5.3	StreamStats	44.865, -123.43	
Foster Farms (97246)	Camas Swale Creek	0	StreamStats	43.93, -123.027	
Fujimi Corporation - SW Commerce Circle (107178)	Coffee Lake Creek	0	StreamStats	45.338, -122.779	
Gervais STP (33060)	Pudding River	6.6	USGS: 14201340 - 14201300	45.151, -122.804 45.100, -122.822	1997-10-01 ~2022-09-30
Halsey STP (36320)	Muddy Creek	5.0	StreamStats	44.383, -123.136	
Hubbard STP (40494)	Mill Creek	0	StreamStats	45.186, -122.814	
Hull-Oakes Lumber Co. (107228)	Oliver Creek	0	StreamStats	44.36, -123.412	
International Paper - Springfield 108921 : ORG383548	Irving Slough	0	StreamStats. Irving Slough is not represented on the StreamStats network. Used nearest location.	44.065, -122.975	
International Paper Springfield Paper Mill (96244)	McKenzie River	Annual: 1537	USGS: 14164900	44.071, -122.965	2007-03-22 ~2022-09-30
		Spring Spawning (May 1- Jun. 15): 2442			
		Fall Spawning (Sep. 1- Oct. 31): 1630			
	Outfall 003 - Storm Ditch near 42nd St.	0	StreamStats. The storm ditch is not represented on the StreamStats network. Used nearest location on Q Street Canal	44.0623, -123.0069	
J.H. Baxter & Co., Inc. (6553)	Amazon Diversion Canal	0.6	StreamStats	44.062, -123.196	
JLR, LLC (32536)	Pudding River	6.9	USGS: 14201340	45.151, -122.804	1997-10-01 ~2022-09-30
Junction City STP (44509)	Flat Creek	0	StreamStats	44.218, -123.23	
Kingsford Manufacturing Company - Springfield Plant (46000)	Patterson Slough	0	StreamStats. Patterson Slough is not represented on the StreamStats network. Used nearest location.	44.062, -123.063	

Facility Name (Facility Number)	Stream	Estimated 7Q10 (cfs)	Flow Estimation Method	Flow Estimation Latitude/Longitude	Gage Period
Knoll Terrace Mhc (46990)	Mountain View Creek	0	StreamStats	44.625, -123.227	
Lakewood Utilities, Ltd (96110)	Mill Creek	0	StreamStats	45.206, -122.789	
Lane Community College (48854)	Russel Creek	0	StreamStats	44.009, -123.037	
Lowell STP (51447)	Dexter Reservoir (20 feet from penstock)	1002	USGS Gage 14150000. Assumed flow in the penstock as measured by USGS gage defined flow available for mixing.	43.946, -122.837	1992-10-01 ~2022-09-30
Mcfarland Cascade Pole & Lumber Co (54370)	Storm Ditch to Amazon Creek	0	StreamStats	44.092, -123.198	
Molalla Municipal Water Treatment Plant (109846)	Molalla River	0	StreamStats	45.129, -122.54	
Molalla STP (57613)	Molalla River	56	StreamStats	45.15, -122.544	
Mt. Angel STP (58707)	Pudding River	6.6	USGS: 14201340 - 14201300	45.151, -122.804 45.100, -122.822	1997-10-01 ~2022-09-30
Murphy Veneer, Foster Division (97070)	Wiley Creek	4.2	USGS: 14187000	44.372, -122.623	1992-10-01 ~2022-09-30
Norpac Foods- Plant #1, Stayton (84820)	Salem Ditch	0	StreamStats	44.799, -122.806	
Norpac Foods - Brooks Plant No. 5 (84791)	Fitzpatrick Creek	0	StreamStats	45.056, -122.955	
Oakridge STP (62886)	Middle Fork Willamette River	514	USGS: 14148000 - 14147500	43.801, -122.561 43.757, -122.505	1992-10-01 ~2022-09-30
ODC - Oregon State Penitentiary (109727)	Mill Creek	6.5	StreamStats	44.931, -123.007	
ODFW - Leaburg Hatchery (64490)	McKenzie River	Annual: 1537 Spring Spawning (May 1-Jun. 15): 2442 Fall Spawning (Sep. 1-Oct. 31): 1630	USGS: 14164900	44.071, -122.965	2007-03-22 ~2022-09-30

Facility Name (Facility Number)	Stream	Estimated 7Q10 (cfs)	Flow Estimation Method	Flow Estimation Latitude/Longitude	Gage Period
ODFW - Marion Forks Hatchery (64495)	Horn Creek	6.3	DEQ permit renewal fact sheet, Appendix D. (DEQ, 2022)	44.135, -122.610	
ODFW – McKenzie River Hatchery (64500)	McKenzie River	Annual: 1537 Spring Spawning (May 1-Jun. 15): 2442 Fall Spawning (Sep. 1-Oct. 31): 1630	USGS: 14164900	44.071, -122.965	2007-03-22 ~2022-09-30
ODFW - Roaring River Hatchery (64525)	Roaring River	0.5	StreamStats	44.627, -122.719	
ODFW - Willamette Fish Hatchery (64585)	Salmon Creek	110	StreamStats	43.748, -122.444	
Philomath WTP (100048)	Marys River	6.7	USGS: 14171000	44.525, -123.334	2000-09-30 ~2022-09-30
Philomath WWTP (103468)	Marys River	6.7	USGS: 14171000	44.525, -123.334	2000-09-30 ~2022-09-30
Row River Valley Water District	Layng Creek	12	StreamStats	43.704, -122.753	
RSG Forest Products - Liberal (72596)	Molalla River	0	StreamStats	45.191, -122.592	
Sandy WWTP (78615)	Tickle Creek	0.2	StreamStats	45.405, -122.347	
SCIO STP (79633)	Thomas Creek	6.9	USGS: 14188800	44.712, -122.770	2002-10-01 ~2022-09-30
Seneca Sawmill Company (80207)	Ditch to A-1 Amazon Channel	0	StreamStats	44.116, -123.174	
SFPP, L.P. (103159)	Flat Creek	0	StreamStats	44.092, -123.149	
Sherman Bros. Trucking (36646)	Little Muddy Creek	0.2	StreamStats	44.285, -123.06	
Silverton STP (81395)	Silver Creek	14	StreamStats	45.008, -122.803	
Sunstone Circuits (26788)	Milk Creek	10.5	Using 7Q10 reported in 2008 TMDL		
Tangent STP (87425)	Calapooia River	20	StreamStats	44.553, -123.147	
Timberlake STP (90948)	Clackamas River	254	StreamStats	45.087, -122.065	
USFW - Eagle Creek National Fish Hatchery (91035)	Eagle Creek	21	StreamStats	45.278, -122.196	

Facility Name (Facility Number)	Stream	Estimated 7Q10 (cfs)	Flow Estimation Method	Flow Estimation Latitude/Longitude	Gage Period
Veneta STP (92762)	Long Tom River	6.4	USGS: 14166500	44.050, -123.426	1992-10-01 ~2022-09-30
WES (Boring STP) (16592)	North Fork Deep Creek	0.24	2009 mixing zone study (WES, 2009).		Based off of four years of flow data measured at the facility
Westfir STP (94805)	N Fk Middle Fk Willamette R	174	StreamStats	43.759, -122.522	
Willamette Leadership Academy (34040)	Wild Hog Creek	0	StreamStats	43.991, -123.007	
Woodburn WWTP (98815)	Pudding River	6.9	USGS: 14201340	45.151, -122.804	1997-10-01 ~2022-09-30
U.S. Army Corp of Engineers, Cougar Project (126712)	South Fork McKenzie River	236	USGS: 14159500	44.131, -122.244	1992-10-01 ~2022-09-30
U.S. Army Corp of Engineers, Detroit Project (126716)	Big Cliff Reservoir	743	USACE flow data at Detroit Dam	44.723, -122.251	2004-10-01 ~2024-09-30
U.S. Army Corp of Engineers, Green Peter Project (126717)	Middle Santiam River	33	USACE flow data at Green Peter	44.449, -122.550	2004-01-01 ~2024-06-01
U.S. Army Corp of Engineers, Hills Creek Project (126699)	Middle Fork Willamette River	309	USGS: 14145500	43.711, -122.424	1992-10-01 ~2022-09-30
U.S. Army Corp of Engineers, Lookout Point Project (126700)	Dexter Reservoir	1145	USACE flow data at Lookout Point	43.915, -122.754	2004-01-01 ~2024-06-01
Adair Village STP (500)	Willamette River	Annual: 3877 Spring Spawning (Apr. 1 - May 15): 6308 Fall Spawning (Oct.15 - Nov.30): 4443	USGS: 14174000	44.639, -123.107	1992-10-1 ~ 2022-09-30
AM WRF (1098)	Willamette River	Annual: 3877 Spring Spawning (Apr. 1 - May 15): 6308	USGS: 14174000	44.639, -123.107	1992-10-1 ~ 2022-09-30

Facility Name (Facility Number)	Stream	Estimated 7Q10 (cfs)	Flow Estimation Method	Flow Estimation Latitude/Longitude	Gage Period
		Fall Spawning (Oct.15 - Nov.30): 4443			
ARKEMA (68471)	Willamette River	Tier 1: Annual: 6740	USGS: 14197900 + 14207500 + 14211010	45.285, -122.961 45.351, -122.676 45.379, -122.577	2001-06-01 ~ 2022-09-30
		Tier 2: Annual: 6740			
Ash Grove Cement - Rivergate Lime Plant (3690)	Willamette River	Annual: 6740	USGS: 14197900 + 14207500 + 14211010	45.285, -122.961 45.351, -122.676 45.379, -122.577	2001-06-01 ~ 2022-09-30
ATI Millersburg Teledyne Wah Chang (87645)	Willamette River	Annual: 3877	USGS: 14174000	44.639, -123.107	1992-10-1 ~ 2022-09-30
		Spring Spawning (Apr. 1 - May 15): 6308			
		Fall Spawning (Oct.15 - Nov.30): 4443			
BDC/Willamette LLC (109444)	Willamette River	Annual: 6740	USGS: 14197900 + 14207500 + 14211010	45.285, -122.961 45.351, -122.676 45.379, -122.577	2001-06-01 ~ 2022-09-30
WES Blue Heron Discharge. (72634)	Willamette River	Annual: 5988	USGS: 14197900 + 14207500	45.285, -122.961 45.351, -122.676	2001-10-01 ~ 2022-09-30
Brooks Sewage Treatment Plant (100077)	Willamette River	Annual: 5684	USGS: 14191000	44.944, -123.043	1992-10-1 ~ 2022-09-30
		Spring Spawning (Apr. 1 - May 15): 10688			
		Fall Spawning (Oct.15 - Nov.30): 7133			
Canby Regency Mobile Home Park (97612)	Willamette River	Annual: 5790	USGS: 14197900 + 14200000 + 14202000	45.285, -122.961 45.244, -122.687 45.233, -122.750	2002-10-01 ~ 2022-09-30
Canby STP (13691)	Willamette River	Annual: 5790	USGS: 14197900 + 14200000 + 14202000	45.285, -122.961 45.244, -122.687 45.233, -122.750	2002-10-01 ~ 2022-09-30
Cascade Pacific Pulp, LLC (36335)	Willamette River	Annual: 3609		44.270, -123.174	1992-10-1 ~ 2022-09-30

Facility Name (Facility Number)	Stream	Estimated 7Q10 (cfs)	Flow Estimation Method	Flow Estimation Latitude/Longitude	Gage Period
		Spring Spawning (Apr. 1 - May 15): 5330	USGS/OWRD: 14166000 + 14170000	44.313, -123.296	
		Fall Spawning (Oct.15 - Nov.30): 4280			
Century Meadows Sanitary System (CMSS) (96010)	Willamette River	Annual: 5734	USGS: 14197900	45.285, -122.961	2001-10-01 ~ 2022-09-30
Corvallis STP (20151)	Willamette River	Annual: 3683	USGS: 14171600	44.566, -123.257	1992-10-1 ~ 2022-09-30
		Spring Spawning (Apr. 1 - May 15): 5800			
		Fall Spawning (Oct.15 - Nov.30): 4149			
Cottage Grove Lumber (96188)	Coast Fork Willamette River	Annual: 38	USGS: 14153500	43.721, -123.050	1992-10-1 ~ 2022-09-30
		Spring Spawning (Apr. 1 - May 15): 61			
		Fall Spawning (Jan.15 - NA): NA			
Cottage Grove STP (20306)	Coast Fork Willamette River	Annual: 38	USGS: 14153500	43.721, -123.050	1992-10-1 ~ 2022-09-30
		Spring Spawning (Apr. 1 - May 15): 61			
		Fall Spawning (Jan.15 - NA): NA			
Covanta Marion, Inc (89638)	Willamette River	Annual: 5684	USGS: 14191000	44.944, -123.043	1992-10-1 ~ 2022-09-30
		Spring Spawning (Apr. 1 - May 15): 10688			

Facility Name (Facility Number)	Stream	Estimated 7Q10 (cfs)	Flow Estimation Method	Flow Estimation Latitude/Longitude	Gage Period
		Fall Spawning (Oct.15 - Nov.30): 7133			
Dundee STP (25567)	Willamette River	Annual: 5734	USGS: 14197900	45.285, -122.961	2001-10-01 ~ 2022-09-30
Evraz Oregon Steel (64905)	Willamette River	Annual: 6740	USGS: 14197900 + 14207500 + 14211010	45.285, -122.961 45.351, -122.676 45.379, -122.577	2001-06-01 ~ 2022-09-30
Forest Park Mobile Village (30554)	Willamette River	Annual: 5988	USGS: 14197900 + 14207500	45.285, -122.961 45.351, -122.676	2001-10-01 ~ 2022-09-30
Frank Lumber Co. Inc. (30904)	North Santiam River	Annual: 859	USGS: 14181500	44.754, -122.297	1992-10-1 ~ 2022-09-30
		Spring Spawning (Apr. 1 - Jun. 15): 987			
		Fall Spawning (Sep.1 - Nov.30): 957			
Hollingsworth & Vose Fiber Co - Corvallis (28476)	Willamette River	Annual: 3683	USGS: 14171600	44.566, -123.257	1992-10-1 ~ 2022-09-30
		Spring Spawning (Apr. 1 - May 15): 5800			
		Fall Spawning (Oct.15 - Nov.30): 4149			
Halsey Mill (105814)	Willamette River	Annual: 3609	USGS/OWRD: 14166000 + 14170000	44.270, -123.174 44.313, -123.296	1992-10-1 ~ 2022-09-30
		Spring Spawning (Apr. 1 - May 15): 5330			
		Fall Spawning (Oct.15 - Nov.30): 4280			
	Willamette River	Annual: 3480	USGS: 14166000	44.270, -123.174	1992-10-1 ~ 2022-09-30

Facility Name (Facility Number)	Stream	Estimated 7Q10 (cfs)	Flow Estimation Method	Flow Estimation Latitude/Longitude	Gage Period
Harrisburg Lagoon Treatment Plant (105415)		Spring Spawning (Apr. 1 - May 15): 5204			
		Fall Spawning (Oct.15 - Nov.30): 3853			
Independence STP (41513)	Willamette River	Annual: 5684	USGS: 14191000	44.944, -123.043	1992-10-1 ~ 2022-09-30
		Spring Spawning (Apr. 1 - May 15): 10688			
		Fall Spawning (Oct.15 - Nov.30): 7133			
Jasper Wood Products, LLC (100097)	Middle Fork Willamette River	Annual: 1089	USGS: 1415000 + 14141000	43.946, -122.837 43.944, -122.775	1992-10-1 ~ 2022-09-30
		Spring Spawning (Apr. 1 - Jun. 15): 1097			
		Fall Spawning (Sep.15 - Nov.30): 1589			
Jefferson STP (43129)	Santiam River	Annual: 1144	USGS: 14189000	44.715, -123.014	1992-10-1 ~ 2022-09-30
		Spring Spawning (Apr. 1 - May 15): 3275			
		Fall Spawning (Oct.15 - Nov.30): 2278			
Lebanon WWTP (49764)	South Santiam River	Annual: 506	USGS/OWRD: 14187500 - 14187600	44.498, -122.823 44.515, -122.865	1992-10-1 ~ 2022-09-30
		Spring Spawning (Apr. 1 - May 15): 1043			

Facility Name (Facility Number)	Stream	Estimated 7Q10 (cfs)	Flow Estimation Method	Flow Estimation Latitude/Longitude	Gage Period
		Fall Spawning (Oct.15 - Nov.30): 726			
Monmouth STP (57871)	Willamette River	Annual: 5684	USGS: 14191000	44.944, -123.043	1992-10-1 ~ 2022-09-30
		Spring Spawning (Apr. 1 - May 15): 9945			
		Fall Spawning (Oct.15 - Nov.30): 7133			
Monroe STP (57951)	Long Tom River	Annual: 22	USGS: 14170000	44.313, -123.296	1992-10-1 ~ 2022-09-30
		Spring Spawning (Apr. 1 - May 31): 55			
		Fall Spawning (Dec.1 - Dec.31): 83			
MWMC - Eugene/Springfield STP (55999)	Willamette River	Annual: 1508	USGS/OWRD: 14157500 + 14152000	43.980, -122.966 43.998, -122.906	1992-10-1 ~ 2022-09-30
		Spring Spawning (Apr. 1 - May 15): 1906			
		Fall Spawning (Oct.15 - Nov.30): 1925			
Newberg OR, LLC (72615)	Willamette River	Annual: 5734	USGS: 14197900	45.285, -122.961	2001-10-01 ~ 2022-09-30
Newberg - Wynooski Road STP (102894)	Willamette River	Annual: 5734	USGS: 14197900	45.285, -122.961	2001-10-01 ~ 2022-09-30
NW Natural Gas Site Remediation (120589)	Willamette River	Annual: 6740	USGS: 14197900 + 14207500 + 14211010	45.285, -122.961 45.351, -122.676 45.379, -122.577	2001-06-01 ~ 2022-09-30
Oak Lodge Water Services Water Reclamation Facility (62795)	Willamette River	Annual: 6740	USGS: 14197900 + 14207500 + 14211010	45.285, -122.961 45.351, -122.676 45.379, -122.577	2001-06-01 ~ 2022-09-30

Facility Name (Facility Number)	Stream	Estimated 7Q10 (cfs)	Flow Estimation Method	Flow Estimation Latitude/Longitude	Gage Period
ODFW - Clackamas River Hatchery (64442)	Clackamas River	Annual: 627	USGS: 14210000	45.300, -122.354	1992-10-1 ~ 2022-09-30
		Spring Spawning (Apr. 1 - Jun. 15): 1186			
		Fall Spawning (Sep.1 - Nov.30): 645			
ODFW - Dexter Ponds (64450)	Middle Fork Willamette River	Annual: 1002	USGS: 14150000	43.946, -122.837	1992-10-1 ~ 2022-09-30
		Spring Spawning (Apr. 1 - Jun. 15): 986			
		Fall Spawning (Sep.15 - Nov.30): 1301			
ODFW - Minto Fish Facility (Marion Forks Hatchery) (64495)	North Santiam River	Annual: 859	USGS: 14181500	44.754, -122.297	1992-10-1 ~ 2022-09-30
		Spring Spawning (Apr. 1 - Jun. 15): 987			
		Fall Spawning (Sep.1 - Nov.30): 957			
ODFW - South Santiam Hatchery (64560)	South Santiam River	Annual: 621	USGS: 14187200	44.412, -122.689	1992-10-1 ~ 2022-09-30
		Spring Spawning (Apr. 1 - Jun. 15): 841			
		Fall Spawning (Sep.1 - Nov.30): 677			
OHSU Center For Health And Healing (113611)	Willamette River	Annual: 6740	USGS: 14197900 + 14207500 + 14211010	45.285, -122.961 45.351, -122.676 45.379, -122.577	2001-06-01 ~ 2022-09-30
	Willamette River	Annual: 3683	USGS: 14171600	44.566, -123.257	1992-10-1 ~ 2022-09-30

Facility Name (Facility Number)	Stream	Estimated 7Q10 (cfs)	Flow Estimation Method	Flow Estimation Latitude/Longitude	Gage Period
OSU John L. Fryer Aquatic Animal Health Lab (103919)		Spring Spawning (Apr. 1 - May 15): 5800			
		Fall Spawning (Oct.15 - Nov.30): 4149			
Salem Willow Lake STP (78140)	Willamette River	Annual: 5684	USGS: 14191000	44.944, -123.043	1992-10-1 ~ 2022-09-30
		Spring Spawning (Apr. 1 - May 15): 10688			
		Fall Spawning (Oct.15 - Nov.30): 7133			
Scappoose STP (78980)	Multnomah Channel	Annual: 10.4	StreamStats		
		Spring Spawning (Apr. 1 - May 15): 991			
		Fall Spawning (Jan.1 - NA): NA			
Siltronic Corporation (93450)	Willamette River	Annual: 6740	USGS: 14197900 + 14207500 + 14211010	45.285, -122.961 45.351, -122.676 45.379, -122.577	2001-06-01 ~ 2022-09-30
SLLI (74995)	Willamette River	Annual: 6740	USGS: 14197900 + 14207500 + 14211010	45.285, -122.961 45.351, -122.676 45.379, -122.577	2001-06-01 ~ 2022-09-30
Stayton STP (84781)	North Santiam River	Annual: 914	USGS: 14183000	44.789, -122.617	1992-10-1 ~ 2022-09-30
		Spring Spawning (Apr. 1 - Jun. 15): 1482			
		Fall Spawning (Sep.1 - Nov.30): 1018			
Sweet Home STP (86840)	South Santiam River	Annual: 621	USGS: 14187200	44.412, -122.689	1992-10-1 ~ 2022-09-30

Facility Name (Facility Number)	Stream	Estimated 7Q10 (cfs)	Flow Estimation Method	Flow Estimation Latitude/Longitude	Gage Period
		Spring Spawning (Apr. 1 - Jun. 15): 841			
		Fall Spawning (Sep.1 - Nov.30): 677			
Tryon Creek WWTP (70735)	Willamette River	Annual: 6740	USGS: 14197900 + 14207500 + 14211010	45.285, -122.961 45.351, -122.676 45.379, -122.577	2001-06-01 ~ 2022-09-30
Univar USA Inc (100517)	Willamette River	Annual: 6740	USGS: 14197900 + 14207500 + 14211010	45.285, -122.961 45.351, -122.676 45.379, -122.577	2001-06-01 ~ 2022-09-30
Vigor Industrial (70596)	Willamette River	Annual: 6740	USGS: 14197900 + 14207500 + 14211010	45.285, -122.961 45.351, -122.676 45.379, -122.577	2001-06-01 ~ 2022-09-30
WES Blue Heron Discharge. (72634)	Willamette River	Annual: 5988	USGS: 14197900 + 14207500	45.285, -122.961 45.351, -122.676	2001-10-01 ~ 2022-09-30
WES (Kellogg Creek WWTP) (16590)	Willamette River	Annual: 6740	USGS: 14197900 + 14207500 + 14211010	45.285, -122.961 45.351, -122.676 45.379, -122.577	2001-06-01 ~ 2022-09-30
WES (Tri-City WPCP) (89700)	Willamette River	Annual: 5988	USGS: 14197900 + 14207500	45.285, -122.961 45.351, -122.676	2001-10-01 ~ 2022-09-30
Willamette Falls Paper Company (21489)	Willamette River	Annual: 5988	USGS: 14197900 + 14207500	45.285, -122.961 45.351, -122.676	2001-10-01 ~ 2022-09-30
Wilsonville STP (97952)	Willamette River	Annual: 5734	USGS: 14197900	45.285, -122.961	2001-10-01 ~ 2022-09-30

7 Pollutant sources and load contributions

A key element of TMDL development is a complete, comprehensive source assessment for the relevant water quality pollutant(s). This includes identification of all relevant point and nonpoint sources to the impaired waterbody, characterization/quantification of their pollutant load contributions, determination of seasonal variation, and delineation of periods when applicable temperature criteria are exceeded at various locations, to the extent that existing data allow. The TMDL report and its appendices describe the significant thermal pollutant sources identified within the Willamette Subbasins temperature TMDL area and the data sources that DEQ utilized for TMDL modeling.

7.1 Point sources

Individual and general NPDES permittees were identified as significant sources of thermal loading to streams in the Willamette Subbasins.

7.1.1 Individual NPDES permitted point sources

There are 69 domestic or industrial individual NPDES permitted point source discharges and 21 individual Municipal Separate Storm Sewer System (MS4) NPDES permittees within the Willamette Subbasins project area (**Table 7-1** and **Table 7-2**). The specific AUs where these NPDES permitted point source discharge is summarized in Appendix D.

The USACE submitted applications to DEQ for individual NPDES permits for non-contact cooling water, filter backwash, and powerhouse sump discharges at Big Cliff Dam, Cougar Dam, Detroit Dam, Dexter Dam, Foster Dam, Green Peter Dam, Hills Creek Dam, and Lookout Point Dam. These discharges were also evaluated and included.

The domestic or industrial individual NPDES permitted point sources are potential sources of thermal load and were assigned numeric WLAs in this TMDL. DEQ completed a review of published literature and other studies related to stormwater runoff and stream temperature in Oregon and found there is not sufficient evidence to demonstrate that stormwater discharges authorized under the current municipal (MS4s) Phase I individual permits or registrants under the MS4 phase II, construction (1200-C), and industrial (1200-A and 1200-Z) general stormwater permits contribute to exceedances of the temperature standard.
The substantive findings are summarized below.

A review of available studies from the midwestern and eastern United States indicated that, under certain conditions, runoff from impervious pavement or runoff retained in uncovered open ponds can produce short-duration warm discharges (Herb et. al., 2008; Jones and Hunt, 2009; UNH Stormwater Center, 2011; Winston et al., 2011; Hester and Bauman, 2013). Yet, runoff temperature changes are highly dependent on many factors including air temperature, dewpoint, pavement type, percent imperviousness, and the amount of impervious surface shielded from solar radiation (Nelson and Palmer, 2007; Herb et al., 2008; Thompson et al., 2008; Winston et al., 2011; Jones et al., 2012; Sabouri et al., 2013; Zeiger and Hubbert, 2015). When they occur, such warmed runoff discharges can create “surges” associated with typically short-duration stream temperature increases (Hester and Bauman, 2013; Wardynski et al., 2014; Zeiger and Hubbert, 2015). However, studies that evaluated stormwater discharges over longer (e.g., 7-day) averaging periods such as those used in assessing TMDL attainment (i.e., 7DADM) did not indicate exceedances above biologically-based benchmarks (Wardynski et al., 2014; WDOE, 2011a and 2011b).

Additionally, DEQ evaluated rainfall, cloud cover, air temperature, and stream temperature data from warm seasons for three years in the Miles Creeks area of the Middle Columbia-Hood Subbasin (DEQ, 2008b). DEQ concluded that stormwater discharges likely do not to contribute to temperature standard exceedances in the study area. This is because (1) the standard is based on 7DADM temperatures such that a majority of days within each 7-day period would need have precipitation-runoff influences to affect the 7DADM, (2) exceedances are assessed for the critical summer period, and (3) 95% of summer time 7-day periods had fewer than 3 days of rain, while 80% had less than one day of rain. Thus, there are generally not enough runoff events to significantly influence 7DADMs for temperature in the critical period of this TMDL.

Portland International Airport is an individual NPDES permitted point source that only discharges stormwater during the TMDL allocation period. Portland International Airport is prohibited in the current NPDES permit from discharging from June 1 to September 30. Since Portland International Airport discharges entirely stormwater from April 1 to May 31, it is included in **Table 7-2** as a stormwater facility.

Table 7-1: Individual NPDES permitted point source discharges that have the potential to contribute thermal loads to Willamette Subbasins 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 (AU ID)	River mile
Adair Village STP	NPDES-DOM-Da	500	OR0023396	Willamette River (OR_SR_1709000306_05_103854)	122
Albany Millersburg WRF	NPDES-DOM-Ba	1098	OR0028801	Willamette River (OR_SR_1709000306_05_103854)	118
Alpine Community	NPDES-DOM-Db	100101	OR0032387	Muddy Creek (OR_SR_1709000302_02_103808)	25.6
Arclin	NPDES-IW-B10	81714	OR0000892	Columbia Slough (OR_WS_170900120201_02_104554.1)	6
Arclin	NPDES-IW-B16	16037	OR0021857	Patterson Slough (OR_WS_170900030601_02_104287)	1.8
Arkema	NPDES-IW-B14	68471	OR0044695	Willamette River (OR_SR_1709001202_88_104175)	7.2
Ash Grove Cement - Rivergate Lime Plant	NPDES-IW-B16	3690	OR0001601	Willamette River (OR_SR_1709001202_88_104175)	3.3
ATI Albany Operations	NPDES-IW-B08	64300	OR0001716	Oak Creek (OR_WS_170900030402_02_104273)	1.6
ATI Millersburg	NPDES-IW-B07	87645	OR0001112	Willamette River (OR_SR_1709000306_05_103854)	2
Aumsville STP	NPDES-DOM-Db	4475	OR0022721	Beaver Creek (OR_WS_170900070202_02_104410)	2.5
Aurora STP	NPDES-DOM-Db	110020	OR0043991	Pudding River (OR_SR_1709000905_02_104088)	8.8
Bakelite Chemicals LLC	NPDES-IW-B16	32864	OR0002101	Amazon Creek (OR_WS_170900030108_02_104250)	2.7
Bakelite Chemicals LLC	NPDES-IW-B16	32650	OR0032107	Murder Creek (OR_WS_170900030610_02_104298)	0.6
Blount Oregon Cutting Systems Division	NPDES-IW-B16	63545	OR0032298	Minthorne Creek (OR_WS_170900120102_02_104551)	0.9
Boeing Of Portland – Fabrication Division	NPDES-IW-B16	9269	OR0031828	Osburn Creek (OR_WS_170900120201_02_104554.2)	1.6
Brooks STP	NPDES-DOM-Db	100077	OR0033049	Willamette River (OR_SR_1709000703_04_104013)	71.7
Brownsville STP	NPDES-DOM-Db	11770	OR0020079	Calapooia River (OR_SR_1709000303_02_103816)	31.6

Permittee	Permit type	DEQ WQ File Number	EPA Number	Receiving water name (AU ID)	River mile
Canby Regency Mobile Home Park	NPDES-DOM-Da	97612	OR0026280	Willamette River (OR_SR_1709000704_88_104020)	31.6
Canby STP	NPDES-DOM-C1a	13691	OR0020214	Willamette River (OR_SR_1709000704_88_104020)	33
Cascade Pacific Pulp, LLC	NPDES-IW-B01	36335	OR0001074	Willamette River (OR_SR_1709000306_05_103854)	147.7
Century Meadows Sanitary System (CMSS)	NPDES-DOM-Da	96010	OR0028037	Willamette River (OR_SR_1709000704_88_104020)	42.8
Coburg Wastewater Treatment Plant	NPDES-DOM-Da	115851	OR0044628	Muddy Creek (OR_WS_170900030606_02_104294)	50.7
Coffin Butte Landfill	NPDES-IW-B15	104176	OR0043630	Roadside ditch to Soap Creek tributary (OR_WS_170900030511_02_104285)	4.5
Columbia Helicopters	NPDES-IW-B16	100541	OR0033391	Unnamed Stream (tributary to Pudding River) (OR_WS_170900090502_02_104481)	2
Corvallis STP	NPDES-DOM-Ba	20151	OR0026361	Willamette River (OR_SR_1709000306_05_103854)	130.8
Cottage Grove STP	NPDES-DOM-C2a	20306	OR0020559	Coast Fork Willamette River (OR_SR_1709000203_02_104585)	20.6
Covanta Marion, Inc	NPDES-IW-B16	89638	OR0031305	Willamette River (OR_SR_1709000703_04_104013)	72
Creswell STP	NPDES-DOM-Db	20927	OR0027545	Unnamed stream (tributary to Camas Swale Creek) (OR_WS_170900020403_02_104240)	4
Dallas STP	NPDES-DOM-C1a	22546	OR0020737	Rickreall Creek (OR_SR_1709000701_02_104591)	9.3
Dundee STP	NPDES-DOM-Db	25567	OR0023388	Willamette River (OR_SR_1709000703_04_104013)	51.7
Duraflake	NPDES-IW-B20	97047	OR0000426	Murder Creek (OR_WS_170900030610_02_104298)	0.57
Estacada STP	NPDES-DOM-Da	27866	OR0020575	Clackamas River (OR_LK_1709001106_02_100850)	23.3
Evraz Oregon Steel	NPDES-IW-B08	64905	OR0000451	Willamette River (OR_SR_1709001202_88_104175)	2.4
EWEB Carmen-Smith Trail Bridge Powerhouse	NPDES-IW-B16	28393	OR0000680	McKenzie River (OR_SR_1709000402_02_104588)	76
EWEB Carmen-Smith Carmen Powerhouse	NPDES-IW-B16	28393	OR0000680	Trail Bridge Reservoir/McKenzie River (OR_LK_1709000402_02_100742)	77
Falls City STP	NPDES-DOM-Da	28830	OR0032701	Little Luckiamute River (OR_SR_1709000305_02_103822)	12
Forest Park Mobile Village	NPDES-DOM-Da	30554	OR0031267	Willamette River (OR_SR_1709000704_88_104020)	28.2
Foster Farms	NPDES-IW-B04	97246	OR0026450	Camas Swale Creek (OR_SR_1709000204_02_103786)	3.3
Frank Lumber Co. Inc.	NPDES-IW-B19	30904	OR0000124	North Santiam River (OR_SR_1709000504_02_103906)	32.5

Permittee	Permit type	DEQ WQ File Number	EPA Number	Receiving water name (AU ID)	River mile
Fujimi Corporation – SW Commerce Circle	NPDES-IW-B15	107178	OR0040339	Coffee Lake Creek (OR_WS_170900070402_02_104419)	1.8
Gervais STP	NPDES-DOM-Db	33060	OR0027391	Pudding River (OR_SR_1709000902_02_104073)	28.2
GP Halsey Mill	NPDES-IW-B01	105814	OR0033405	Willamette River (OR_SR_1709000306_05_103854)	147.7
Halsey STP	NPDES-DOM-Db	36320	OR0022390	Muddy Creek (OR_SR_1709000306_02_103838)	23
Harrisburg Lagoon Treatment Plant	NPDES-DOM-Db	105415	OR0033260	Willamette River (OR_SR_1709000306_05_103854)	158.4
Hollingsworth & Vose Fiber Co - Corvallis	NPDES-IW-B15	28476	OR0000299	Willamette River (OR_SR_1709000306_05_103854)	132.5
Hubbard STP	NPDES-DOM-Da	40494	OR0020591	Mill Creek (OR_WS_170900090502_02_104481)	5.3
Hull-Oakes Lumber Co.	NPDES-IW-B19	107228	OR0038032	Oliver Creek (OR_SR_1709000302_02_103807)	4.8
Independence STP	NPDES-DOM-Db	41513	OR0020443	Willamette River (OR_SR_1709000701_05_104005)	95.5
International Paper – Springfield Paper Mill (Outfall 1 + Outfall 2)	NPDES-IW-B01	96244	OR0000515	McKenzie River (OR_SR_1709000407_02_103884)	8
International Paper – Springfield Paper Mill (Outfall 3)	NPDES-IW-B01	96244	OR0000515	Storm Ditch to Q Street Canal (OR_WS_170900030601_02_104287)	0
J.H. Baxter & Co., Inc.	NPDES-IW-B21	6553	OR0021911	Amazon Diversion Canal (OR_WS_170900030108_02_104250)	1.5
Jasper Wood Products, LLC	NPDES-IW-B21	100097	OR0042994	Middle Fork Willamette River (OR_SR_1709000110_02_104584)	9
Jefferson STP	NPDES-DOM-Da	43129	OR0020451	Santiam River (OR_SR_1709000506_02_103927)	9.2
JLR, LLC	NPDES-IW-B05	32536	OR0001015	Pudding River (OR_SR_1709000902_02_104073)	27
Junction City STP	NPDES-DOM-Db	44509	OR0026565	Flat Creek (OR_WS_170900030603_02_104290)	9.2
Kingsford Manufacturing Company – Springfield Plant	NPDES-IW-B20	46000	OR0031330	Patterson Slough (OR_WS_170900030601_02_104287)	3.7
Knoll Terrace MHC	NPDES-DOM-Db	46990	OR0026956	Mountain View Creek (OR_WS_170900030609_02_104297)	0.4
Lakewood Utilities, Ltd	NPDES-DOM-Da	96110	OR0027570	Mill Creek (Molalla-Pudding Subbasin) (OR_WS_170900090502_02_104481 _	3.9
Lane Community College	NPDES-DOM-Db	48854	OR0026875	Russel Creek (OR_WS_170900020405_02_104242)	0.7

Permittee	Permit type	DEQ WQ File Number	EPA Number	Receiving water name (AU ID)	River mile
Lebanon WWTP	NPDES-DOM-C1a	49764	OR0020818	South Santiam River (OR_SR_1709000608_02_103925)	17.4
Lowell STP	NPDES-DOM-Da	51447	OR0020044	Dexter Reservoir 20 ft upstream of the Dexter dam penstock (OR_LK_1709000107_02_100699)	
Mcfarland Cascade Pole & Lumber Co	NPDES-IW-B21	54370	OR0031003	Storm Ditch to Amazon Creek (OR_WS_170900030108_02_104250)	1.8
Molalla STP	NPDES-DOM-Db	57613	OR0022381	Molalla River (OR_SR_1709000906_02_104093)	8.2
Monmouth STP	NPDES-DOM-Db	57871	OR0020613	Willamette River (OR_SR_1709000701_05_104005)	95.5
Monroe STP	NPDES-DOM-Db	57951	OR0029203	Long Tom River (OR_SR_1709000301_02_103791)	6.9
Mt. Angel STP	NPDES-DOM-Da	58707	OR0028762	Pudding River (OR_SR_1709000901_02_104064)	37.5
Murphy Veneer, Foster Division	NPDES-IW-B20	97070	OR0021741	Wiley Creek (OR_SR_1709000605_02_103971)	0.9
MWMC - Eugene/Springfield STP	NPDES-DOM-A2	55999	OR0031224	Willamette River (OR_SR_1709000306_05_103854)	178
Newberg - Wynooski Road STP	NPDES-DOM-C1a	102894	OR0032352	Willamette River (OR_SR_1709000703_88_104015)	49.7
Newberg OR, LLC	NPDES-IW-B01	72615	OR0000558	Willamette River (OR_SR_1709000703_88_104015)	49.7
Norpac Foods – Brooks Plant No. 5	NPDES-IW-B04	84791	OR0021261	Fitzpatrick Creek (OR_WS_170900090109_02_104462)	1
Norpac Foods-Plant #1, Stayton	NPDES-IW-B04	84820	OR0001228	Salem Ditch (flows to Mill Creek) (OR_WS_170900070201_02_104409)	3.7
NW Natural Gas Site Remediation	NPDES-IW-B14	120589	OR0044687	Willamette River (OR_SR_1709001202_88_104175)	6.4
Oak Lodge Water Services Water Reclamation Facility	NPDES-DOM-C1a	62795	OR0026140	Willamette River (OR_SR_1709001201_88_104019)	20.1
Oakridge STP	NPDES-DOM-Da	62886	OR0022314	Middle Fork Willamette River (OR_SR_1709000105_02_103720)	39.8
ODC – Oregon State Penitentiary	NPDES-IW-B15	109727	OR0043770	Mill Creek (Middle Willamette Subbasin) (OR_SR_1709000703_02_104007)	2.5
ODFW - Clackamas River Hatchery	NPDES-IW-B17	64442	OR0034266	Clackamas River (OR_SR_1709001106_02_104597)	22.6
ODFW - Dexter Ponds	GEN 300-J	64450	ORG133514	North Santiam River (OR_SR_1709000504_02_103906)	41.1
ODFW – Leaburg Hatchery	NPDES-IW-B17	64490	OR0027642	McKenzie River (OR_SR_1709000407_02_103884)	33.7
ODFW – Marion Forks Hatchery	NPDES-IW-B17	64495	OR0027847	Horn Creek (OR_WS_170900050203_02_104345)	0.1

Permittee	Permit type	DEQ WQ File Number	EPA Number	Receiving water name (AU ID)	River mile
ODFW – McKenzie River Hatchery	NPDES-IW-B17	64500	OR0029769	McKenzie River (OR_SR_1709000407_02_103884)	31.5
ODFW - Minto Fish Facility	NPDES-IW-B17	64495	OR0027847	Middle Fork Willamette River (OR_SR_1709000107_02_104583)	
ODFW - South Santiam Hatchery	GEN 300-J	64560	ORG133511	South Santiam River (OR_SR_1709000608_02_103925)	
OHSU Center For Health and Healing	NPDES-IW-B16	113611	OR0034371	Willamette River (OR_SR_1709001202_88_104175)	14.5
OSU John L. Fryer Aquatic Animal Health Lab	NPDES-IW-B15	103919	OR0032573	Willamette River (OR_SR_1709000306_05_103854)	130.6
Philomath WWTP	NPDES-DOM-Db	103468	OR0032441	Marys River (OR_SR_1709000302_02_103813)	10.2
RSG Forest Products – Liberal	NPDES-IW-B19	72596	OR0021300	Unnamed ditch to Molalla River (OR_WS_170900090607_02_104488)	9.8
Salem Willow Lake STP	NPDES-DOM-A2	78140	OR0026409	Willamette River (OR_SR_1709000703_04_104013)	78.4
Sandy WWTP	NPDES-DOM-Da	78615	OR0026573	Tickle Creek (OR_WS_170900110604_02_104546)	3.1
Scappoose STP	NPDES-DOM-Da	78980	OR0022420	Multnomah Channel (OR_SR_1709001203_88_104184)	10.6
Scio STP	NPDES-DOM-Db	79633	OR0029301	Thomas Creek (OR_SR_1709000607_02_103988)	7.2
Seneca Sawmill Company	NPDES-IW-B19	80207	OR0022985	Ditch to A-1 Amazon Channel (OR_WS_170900030108_02_104250)	7.0
SFPP, L.P.	NPDES-IW-B15	103159	OR0044661	Unnamed tributary to Flat Creek (OR_WS_170900030603_02_104290)	7.9
Sherman Bros. Trucking	NPDES-DOM-Db	36646	OR0021954	Little Muddy Creek (OR_SR_1709000306_02_103838)	8
Siltronic Corporation	NPDES-IW-B14	93450	OR0030589	Willamette River (OR_SR_1709001202_88_104175)	6.6
Silverton STP	NPDES-DOM-C1a	81395	OR0020656	Silver Creek (OR_SR_1709000901_02_104595)	2.4
SLLI	NPDES-IW-B15	74995	OR0001741	Willamette River (OR_SR_1709001202_88_104175)	7
Stayton STP	NPDES-DOM-C2a	84781	OR0020427	North Santiam River (OR_SR_1709000506_02_103930)	14.9
Sunstone Circuits	NPDES-IW-B15	26788	OR0031127	Milk Creek (OR_SR_1709000906_02_104091)	5.3
Sweet Home STP	NPDES-DOM-C2a	86840	OR0020346	South Santiam River (OR_SR_1709000608_02_103925)	31.5
Tangent STP	NPDES-DOM-Db	87425	OR0031917	Calapooia River (OR_SR_1709000304_02_103821)	10.8
Timberlake STP	NPDES-DOM-Da	90948	OR0023167	Clackamas River (OR_SR_1709001104_02_104155)	51.1
Tryon Creek WWTP	NPDES-DOM-Ba	70735	OR0026891	Willamette River (OR_SR_1709001201_88_104019)	20.3
U.S. Army Corp of Engineers Big Cliff Project	NPDES-DOM-Da	126715	Not Assigned	North Santiam River (OR_SR_1709000504_02_103906)	45.2

Permittee	Permit type	DEQ WQ File Number	EPA Number	Receiving water name (AU ID)	River mile
U.S. Army Corp of Engineers Cougar Project	NPDES-DOM-Da	126712	Not Assigned	South Fork McKenzie River (OR_SR_1709000403_02_104590)	4.5
U.S. Army Corp of Engineers Detroit Project	NPDES-DOM-Da	126716	Not Assigned	Big Cliff Reservoir (OR_LK_1709000503_02_100770)	0
U.S. Army Corp of Engineers Dexter Project	NPDES-DOM-Da	126714	Not Assigned	Middle Fork Willamette River (OR_SR_1709000107_02_104583)	15.7
U.S. Army Corp of Engineers Foster Project	NPDES-DOM-Da	126713	Not Assigned	South Santiam River (OR_SR_1709000608_02_103925)	35.7
U.S. Army Corp of Engineers Green Peter Project	NPDES-DOM-Da	126717	Not Assigned	Middle Santiam River (OR_SR_1709000604_02_103969)	5.3
U.S. Army Corp of Engineers Hills Creek Project	NPDES-DOM-Da	126699	Not Assigned	Middle Fork Willamette River (OR_SR_1709000105_02_104580)	44.3
U.S. Army Corp of Engineers Lookout Point Project	NPDES-DOM-Da	126700	Not Assigned	Dexter Reservoir (OR_LK_1709000107_02_100699)	0
Univar USA Inc	NPDES-IW-B15	100517	OR0034606	Willamette River (OR_SR_1709001202_88_104175)	9
USFW – Eagle Creek National Fish Hatchery	NPDES-IW-B17	91035	OR0000710	Eagle Creek (OR_SR_1709001105_02_104162)	12.3
Veneta STP	NPDES-DOM-Db	92762	OR0020532	Long Tom River (OR_SR_1709000301_02_103789)	34.9
Vigor Industrial	NPDES-IW-B15	70596	OR0022942	Willamette River (OR_SR_1709001202_88_104175)	8.2
WES - Boring STP	NPDES-DOM-Db	16592	OR0031399	North Fork Deep Creek (OR_WS_170900110605_02_104547)	3
WES - Blue Heron Discharge	NPDES-IW-B01	72634	OR0000566	Willamette River (OR_SR_1709000704_88_104020)	27.8
WES - Kellogg Creek WWTP	NPDES-DOM-A3	16590	OR0026221	Willamette River (OR_SR_1709001201_88_104019)	18.5
WES - Tri-City WPCP	NPDES-DOM-A3	89700	OR0031259	Willamette River (OR_SR_1709000704_88_104020)	25.5
Westfir STP	NPDES-DOM-Da	94805	OR0028282	Nork Fork Middle Fork Willamette River (OR_SR_1709000106_02_103721)	1
Willamette Falls Paper Company	NPDES-IW-B01	21489	OR0000787	Willamette River (OR_SR_1709000704_88_104020)	27.5
Willamette Leadership Academy	NPDES-DOM-Db	34040	OR0027235	Wild Hog Creek (OR_WS_170900020405_02_104242)	2
Wilsonville STP	NPDES-DOM-C1a	97952	OR0022764	Willamette River (OR_SR_1709000704_88_104020)	38.5
Woodburn WWTP	NPDES-DOM-C1a	98815	OR0020001	Pudding River (OR_SR_1709000902_02_104073)	21.4

Table 7-2: Individual NPDES Municipal Separate Storm Sewer System (MS4) permittees and stormwater related individual permittees in the Willamette Subbasins.

Permittee	Permit type	DEQ WQ File Number	EPA Number
City of Eugene	NPDES-DOM-MS4-1	107989	ORS107989
City of Fairview	NPDES-DOM-MS4-1	108013	ORS108013
City of Gresham			
City Of Portland	NPDES-DOM-MS4-1	108015	ORS108015
Port of Portland			
City of Gladstone	NPDES-DOM-MS4-1	108016	ORS108016
City of Happy Valley			
City of Johnson City			
City of Lake Oswego			
City of Milwaukie			
City of Oregon City			
City of Rivergrove			
City of West Linn			
City of Wilsonville			
Clackamas County			
Oak Lodge Water Services			
WES (Clackamas Co. Service District #1)			
City of Salem	NPDES-DOM-MS4-1	108919	ORS108919
ODOT	NPDES-DOM-MS4-1	110870	ORS110870
Multnomah County	NPDES-DOM-MS4-1	120542	ORS120542
Portland International Airport	NPDES-IW-B15	107220	OR0040291

7.1.2 General NPDES permitted point sources

There are multiple categories of general NPDES permit types with registrants in the Willamette Subbasins including:

- 100-J Industrial Wastewater: NPDES cooling water
- 200-J Industrial Wastewater: NPDES filter backwash
- 300-J Industrial Wastewater: NPDES fish hatcheries
- 400-J Industrial Wastewater: NPDES log ponds
- 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
- 1500-A Industrial Wastewater: NPDES petroleum hydrocarbon cleanup
- 1700-A Industrial Wastewater: NPDES wash water
- MS4 – Phase ll – Stormwater: NPDES Municipal Separate Storm Sewer System

DEQ determined the following general permit categories may have potential to discharge thermal loads that contribute to exceedances of the applicable temperature criteria (**Table 7-3**):

- 100-J Industrial Wastewater: NPDES cooling water
- 200-J Industrial Wastewater: NPDES filter backwash
- 300-J Industrial Wastewater: NPDES fish hatcheries

Other registrants to the industrial wastewater general permits were found to have a de minimis temperature increase based on the permit requirements, available dilution, or frequency and magnitude of discharge. Discussion of the stormwater general permits is addressed in the stormwater review in Section 7.1.1.

Table 7-3: General NPDES permit registrants that have the potential to contribute thermal loads to Willamette Subbasins streams at a frequency or magnitude that contributes to exceedances of the temperature standard.

Registrant	General Permit	DEQ WQ File Number	EPA Number	Receiving water name (AU ID)	River mile
Americold Logistics, LLC	100-J	87663	ORG253544	Claggett Creek (OR_WS_170900070303_02_104415)	4.9
EWEB Leaburg	100-J	28391	ORG253525	Leaburg Canal (OR_SR_1709000407_02_103884)	34
EWEB Walterville	100-J	28395	ORG253526	Walterville Canal (OR_SR_1709000407_02_103884)	21
First Premier Properties - Spinnaker II Office Building	100-J	110603	ORG253511	Stone Quarry Lake (OR_LK_1709000703_02_100809)	0.8
Forrest Paint Co.	100-J	100684	ORG253508	Amazon Creek (OR_WS_170900030106_02_104248)	17.0
Holiday Plaza	100-J	108298	ORG253504	Stone Quarry Lake (OR_LK_1709000703_02_100809)	0.2
Malarkey Roofing	100-J	52638	ORG250024	Columbia Slough (OR_WS_170900120201_02_104554.1)	5.9
Miller Paint Company	100-J	103774	ORG250040	Columbia Slough OR_WS_170900120201_02_104554.2)	Un-known
Owens-Brockway Glass Container Plant	100-J	65610	ORG250029	Johnson Lake (OR_WS_170900120201_02_104554.2)	0
PCC Structurals, Inc.	100-J	71920	ORG250015	Mount Scott Creek (OR_WS_170900120102_02_104551)	2.3
Sundance Lumber Company, Inc.	100-J	107401	ORG253618	Ditch to Q Street Canal (OR_WS_170900030601_02_104287	14.0
Ventura Foods, LLC	100-J	103832	ORG250005	Unnamed tributary to Columbia Slough (OR_WS_170900120201_02_104554.2)	Un-known
Albany Water Treatment Plant	200-J	66584	ORG383501	Calapooia River (OR_SR_1709000304_02_103821)	0.1
City of Silverton Drinking WTP	200-J	81398	ORG383527	Unnamed tributary to Abiqua Creek (OR_WS_170900090107_02_104460	Un-known
Corvallis Rock Creek Water Treatment Plant	200-J	20160	ORG383513	Rock Creek (OR_WS_170900030204_02_104256)	13.5
Dallas Water Treatment Plant	200-J	22550	ORG383529	Rickreall Creek (OR_SR_1709000701_02_104591)	17.0
Deer Creek Estates Water Association	200-J	23650	ORG383526	Mill Creek OR_WS_170900090502_02_104481)	7.1
EWEB – Hayden Bridge Filter Plant	200-J	28385	ORG383503	McKenzie River (OR_SR_1709000407_02_103884)	8
International Paper – Springfield	200-J	108921	ORG383548	Irving Slough (OR_WS_170900030601_02_104287)	Un-known
Molalla Municipal Water Treatment Plant	200-J	109846	ORG380014	Ditch to Molalla River (OR_WS_170900090607_02_104488)	Un-known
Philomath Water Treatment Plant	200-J	100048	ORG383536	Marys River (OR_SR_1709000302_02_103813)	12.2

Registrant	General Permit	DEQ WQ File Number	EPA Number	Receiving water name (AU ID)	River mile
Row River Valley Water District	200-J	100075	ORG383534	Layng Creek (OR_SR_1709000202_02_103765)	1.4
ODFW - Dexter Ponds	300-J	64450	ORG133514	Middle Fork Willamette River (OR_SR_1709000107_02_104583)	15.7
ODFW - Roaring River Hatchery	300-J	64525	ORG133506	Roaring River (OR_SR_1709000606_02_103974)	1.1
ODFW - South Santiam Hatchery	300-J	64560	ORG133511	South Santiam River (OR_SR_1709000608_02_103925)	37.8
ODFW - Willamette Fish Hatchery	300-J	64585	ORG133507	Salmon Creek (OR_SR_1709000104_02_103719)	0.4

7.1.2.1 100-J Cooling water/heat pumps

The 100-J general permit issued on April 15, 2024 covers discharges of non-contact cooling water, defrost water, heat pump transfer water, and cooling tower blowdown. Also included are cooling and sump water discharges from hydropower facilities. The 100-J permit requirements are summarized in **Table 7-4**.

Table 7-4: 100-J general permit requirements relevant for temperature.

Parameter	Limit	Notes
Effluent Flow	0.5 MGD daily maximum	No limit for hydropower facilities
Effluent Temperature	32°C daily maximum 13.3°C 7-day rolling average during periods where salmon and steelhead spawning is a designated use 9.3°C 7-day rolling average during periods where bull trout spawning is a designated use	
Excess Thermal Load Limit	Q_{ed} * S_{MZ}* 1.14 (as a 7-day rolling average in million kcal/day)	See permit Table A1-1 and Table A2-1 equation terms
Thermal Load Limit	25 daily maximum = Flow (MGD) x Effluent Temperature (°F)	No limit for hydropower facilities

To determine if registrants have potential to increase stream temperature, DEQ reviewed discharge data from available Discharge Monitoring Reports (DMRs). The effluent flows of DMRs reviewed ranged from no flow up to about 0.25 MGD. Reported temperatures ranged from 15°C to 25°C. For the TMDL analysis, DEQ used **Equation 9-** to estimate the temperature increase assuming 100% mix with different river flow ranges and effluent temperatures authorized by the permit. The 100-J permit requirements relevant for temperature are summarized in **Table 7-4**. Effluent flows were set between 0.005 MGD and the permit maximum of 0.5 MGD. Effluent temperatures were set at the maximum temperature allowed by the various permit limits summarized in **Table 7-4**, including the excess thermal load and thermal load limits. The thermal load limit of 25 usually determined the maximum effluent temperature at low 7Q10 flows. The river temperature was assumed to be at the applicable temperature criteria. Based on the results of this analysis, the current 100-J permit requirements authorize non-hydropower registrants to have potential thermal loads that increase stream temperatures up to a maximum of 0.30°C above the applicable temperature criteria. When river flow is 43 cfs and higher, the potential warming under all effluent cases is limited to 0.075°C or less. Hydropower facilities covered under the permit do not have a maximum flow limit or a thermal load limit. Depending on actual effluent discharge rates, hydropower discharges may have temperature increases up to 0.30°C when river flow is 68 cfs or less. Because these facilities have reasonable potential to increase stream temperature, they are provided a narrative wasteload allocation.

7.1.2.2 200-J Filter backwash

The 200-J general permit covers discharge or land application of filter backwash, settling basin, and reservoir cleaning water which have been adequately treated prior to discharge. Flushing of raw water intakes after storm events and spring runoff are also allowed.

To determine if registrants have potential to increase stream temperature, DEQ reviewed discharge data for all registrants using available DMRs and permit application information. Maximum effluent flows varied for each facility and ranged between 2,400 gallons/day (Deer Creek Estates Water Association) up to about 1.35 MGD (EWEB Hayden Bridge Filter Plant, June 2019). Temperature is not reported on 200-J DMRs so a maximum temperature could not be determined. A maximum effluent temperature of 24°C was used when year-round criterion apply and 17°C was used during the spawning period for estimation purposes. The current 200-J permit requirement relevant for temperature is a 30:1 minimum dilution ratio between river and effluent flow. This dilution ratio was used to estimate the maximum effluent flow under critical condition 7Q10 river flows. During periods of no flow, the 200-J permit does not authorize discharge. If the annual 7Q10 was zero, 0.1 cfs was used for determination of a maximum effluent flow. If the DMR or permit application reported maximum effluent flow less than the dilution based effluent flow, the maximum effluent flow was used instead. An estimated change in temperature was calculated using the 7Q10 river flow, maximum reported or dilution based effluent flow, and the estimated effluent temperature and applicable temperature criteria. Based on the results, 200-J registrants have potential to increase stream temperatures up to a maximum of about 0.19°C above the year-round temperature criterion and 0.13°C above the spawning criterion (**Table 7-5**). Because these facilities have reasonable potential to increase stream temperature, they are provided a numeric WLA. It should be noted that the actual temperature increase from 200-J registrants may be less than estimated here, particularly during the spawning period when river flows are expected to be greater than the annual 7Q10.

Table 7-5: Summary of estimated temperature impacts from 200-J registrants located in the Willamette Subbasins.

NPDES Permittee WQ File# : EPA Number	Annual 7Q10* River flow (cfs)	Temp Criteria (°C)	Maximum DMR Effluent Flow (cfs)	Dilution Based or Reported Effluent Flow (cfs)	Estimated Maximum Effluent Temp (°C)	Change in Temp Year Round (°C)	Change in Temp Spawning Period (°C)
Albany Water Treatment Plant 66584 : ORG383501	24	18.0	1.3	0.80	24.0	0.19	NA
City of Silverton Drinking WTP 81398 : ORG383527	0*	18.0 13.0	0.077	0.077	24.0 17.0	0.19	0.13
Corvallis Rock Creek WTP 20160 : ORG383513	0*	18.0	0.371	0.03	24.0	0.19	NA
Dallas WTP 22550 : ORG383529	3.3	18.0 13.0	0.17	0.11	24.0 17.0	0.19	0.13

Molalla Municipal Drinking WTP 109846 : ORG380014	0*	18.0	0.080	0.16	24.0	0.19	NA
Philomath WTP 100048 : ORG383536	6.7	18.0	0.32	0.22	24.0	0.19	NA
Row River Valley Water District 100075 : ORG383534	12	18.0	0.77	0.38	24.0	0.02	NA
International Paper - Springfield 108921 : ORG383548	0*	18.0	0.77	0.77	24.0	0.19	NA
EWEB Hayden Bridge Filter Plant 28385 : ORG383503	1537	16.0 13.0	2.09	2.09	24.0 17.0	0.01	0.005
Deer Creek Estates Water Association 23650 : ORG383526	0.7	18.0	0.0037	0.0037	24.0	0.03	NA
*During periods of no flow, the 200-J permit does not authorize discharge. If the annual 7Q10 is zero, 0.1 cfs was used to calculate the 30:1 minimum dilution ratio.							

7.1.2.3 300-J Fish hatcheries

The current 300-J general permit issued on October 3, 2002 covers treated discharges from aquatic animal production facilities which produce at least 20,000 pounds of fish per year but have less than 300,000 pounds on hand at any time.

DEQ reviewed effluent temperature and effluent flow data for ODFW hatcheries registered under the 300-J permit and determined they have potential thermal loads that could increase stream temperatures above the applicable temperature criteria. Because these facilities have reasonable potential to increase stream temperature, they are provided a numeric WLA.

7.2 Nonpoint and background 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.” Generally, nonpoint thermal sources in the Willamette Subbasins include activities associated with agriculture, forestry, dam and reservoir management, and development. Example sources and/or activities that contribute nonpoint thermal loads that increase stream temperature include:

- Human-caused increases in solar radiation loading to streams from stream-side vegetation disturbance or removal;
- 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 applicable 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 and reservoirs to minimize temperature warming, and,
- Maintenance of minimum instream flows.

7.2.1 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 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. Stream temperature warming from climate change is a background source as the majority of the climate change causing pollutants emanate from outside of Oregon.

The 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. As such, it was not possible to develop a model in which all human influences were controlled or accounted for. As a best estimate, background thermal sources were quantified for the modeled rivers with delineable anthropogenic influences (i.e., dams and reservoirs, vegetation alterations, point source discharges) accounted for, thus isolating the remaining background sources.

In some of the rivers modeled, thermal loading from background sources contributed to exceedances of the applicable temperature criteria and therefore were identified as significant source of thermal loading. Reductions from background sources will be required to attain the applicable temperature criteria. The contribution from background sources for each model stream is summarized in model river sections below.

7.2.2 Dams and reservoirs

Reservoirs attenuate flood flows and hold spring runoff. Stored water is released when reservoir capacity is met or to augment stream flows during the dry months of summer and early fall. As currently constructed and operated, the release of water from many reservoirs modifies natural temperature patterns downstream during late summer and early fall, but also during spring and early summer. The temperature seasonal shifts occur because stored water in reservoirs stratifies, and the reservoirs were typically constructed with regulating outlets near the bottom of each structure.

Seasonal pattern shifts are of concern because water temperature triggers aquatic life activities such as spawning, length of time needed for incubation, and fry emergence. The food supplies (macroinvertebrates) that salmonids rely on are also affected by seasonal temperature shifts. In late summer and early autumn, the reservoirs are drawn down to provide flood storage capacity for the coming winter precipitation. During this time, thermal stratification in the reservoirs breaks down but reservoir water temperatures remain warmer than inflowing upstream tributary temperatures. This is also the season when fall spawning fish have moved into reaches below the reservoirs to wait for spawning. Salmon and trout will hold in the coldest water they can find to wait for stream temperatures to cool enough to trigger their spawning migration.

Alternately, colder winter waters are released during spring and early summer when inflowing upstream tributary temperatures are warmer than stored reservoir waters. This is the season when fall-spawned fry should be emerging, but the colder water shifts the timing of their emergence. Spring spawning is also delayed until winter water temperatures warm up enough to trigger spawning. Late spring spawning can indicate that fry emergence occurs when summer water temperatures are too warm for emerging fry.

USGS evaluated the thermal effects of 14 dams in the Willamette River Basin and found that dams have a substantial and measurable effect on downstream streamflow and water temperature (Rounds, 2010). The temperature effects of each dam are specific to the characteristics and operation of each structure. In general, the larger, taller dams typically release water from a mid-depth or deeper outlet in the upstream impoundment, which tends to be colder in mid-summer than it would be without the dam. In September or October, a large amount of water is released from many of these dams to make room for flood storage, which can bring warmer surface waters down to the elevation of the outlet, thus releasing the warmest water of the year during a time period when the river without the dam would be cooler because of shorter days and colder air temperatures. USGS concluded that the thermal effects of the dams are greatest at the dam sites, where the 7DADM temperatures are as much as 6 to 10 °C cooler or warmer compared to what would occur without the dams. Downstream, the effects decrease, but are still in the 0.5°C to 1.0°C range near the mouth of the Willamette River (Rounds, 2010).

In the Lower Willamette Subbasin, multiple studies have examined the thermal impacts of in-channel ponds on water temperature and found that human built in-channel ponds showed trends on raising downstream temperature (Holzer, 2020; Fairbairn, 2022). For example, Holzer (2020) demonstrated that most in-channel ponds increased the amount of time that a stream segment exceeded the temperature standard by several weeks. Fairbairn (2022) found that human constructed ponds in the Johnson Creek (n=14), Columbia Slough (n=1) and Sandy River (n=2) Watersheds increased median 7DADM stream temperatures by -1.0°C to 6°C. Nine of the seventeen human constructed in channel ponds raised the median 7DADM stream temperature by greater than 1°C.

7.2.3 Water management and withdrawals

DEQ assessed the impact of consumptive use water withdrawals on stream temperature for four of the modeled streams.

- In Johnson Creek (Lower Willamette Subbsin) we evaluated stream temperature response to water withdrawals and found that a 4% reduction of natural streamflow resulted in a stream temperature increase equal to the portion of the HUA allocated to water withdrawals (0.05°C).
- In the Molalla River (Molalla-Pudding Subbasin) we evaluated stream temperature response to removing water withdrawals entirely and found that withdrawals were responsible for a 1.50°C temperature increase at the POMI.

- In the Pudding River (Molalla-Pudding Subbasin) we evaluated stream temperature response to removing water withdrawals entirely and found that withdrawals were responsible for a 4.01°C temperature increase at the POMI.
- In Thomas Creek (South Santiam Subbasin) we evaluated stream temperature response to removing water withdrawals entirely and found that withdrawals were responsible for a 1.83°C temperature increase at the POMI.

7.2.4 Channel simplificaiton

Stream channel simplification for flood control or navigation and watershed development also influences stream temperature. Historically, floodplains have not been treated as an integral part of the stream channel and this has lead to development in areas prone to channel migration and flooding (Kondolf and Keller, 1991). Channelization and bank armoring to protect these areas exacerbates erosion and flooding elsewhere in the basin unless much of the channel is armored (Sear 1994). Bank armoring and the loss of floodplain connectivity diminish over-bank flows that create and maintain channel complexity. Without access to floodplains high streamflows can cause channel down cutting and lower seasonal water tables. Riparian vegetation, off channel habitats and cold water refugia may all be negatively affected by such actions.

Upland and floodplain development also result in high levels of impervious areas in some areas of the basin. Increased impervious area within a watershed results in greater stormwater runoff and diminished groundwater recharge. Summer base flows are lower in small watersheds with substantial impervious area as a result of this loss of groundwater contribution during dry periods. This contributes to warmer stream temperatures and poorer water quality.

In the Willamette Basin, 150 years of river management for flood control and navigation has resulted in a loss of channel complexity, floodplain connectivity and other important stream processes. A consequence of channel simplification is the likely simplification of thermal regimes throughout the basin. Total stream channels in the Willamette river declined from 355 miles to 264 miles from the first surveys until 1995 (Gregory, et al 2002, p.18). The greatest loss of channel complexity was reported in the Upper Willamette Subbasin from Albany to Eugene. Here, nearly half the stream network was lost through channelization and other navigation improvement work. The loss of side channels, alcoves and other off-channel habitats, along with flood plain connectivity and hyporheic exchange likely has diminished water quality in the alluvial reaches of the upper Willamette (Lee and Risley 2002), the availability of cool water refugia, and perhaps even affected mainstem temperatures in the river itself (Landers, et al, 2002, p.27). An example of channel complexity loss for the Willamette River reach near Harrisburg (RM 162) is shown in **Figure 7-1**. As shown, most of the sinuosity and channel complexity that the channel had in 1850 has been lost.

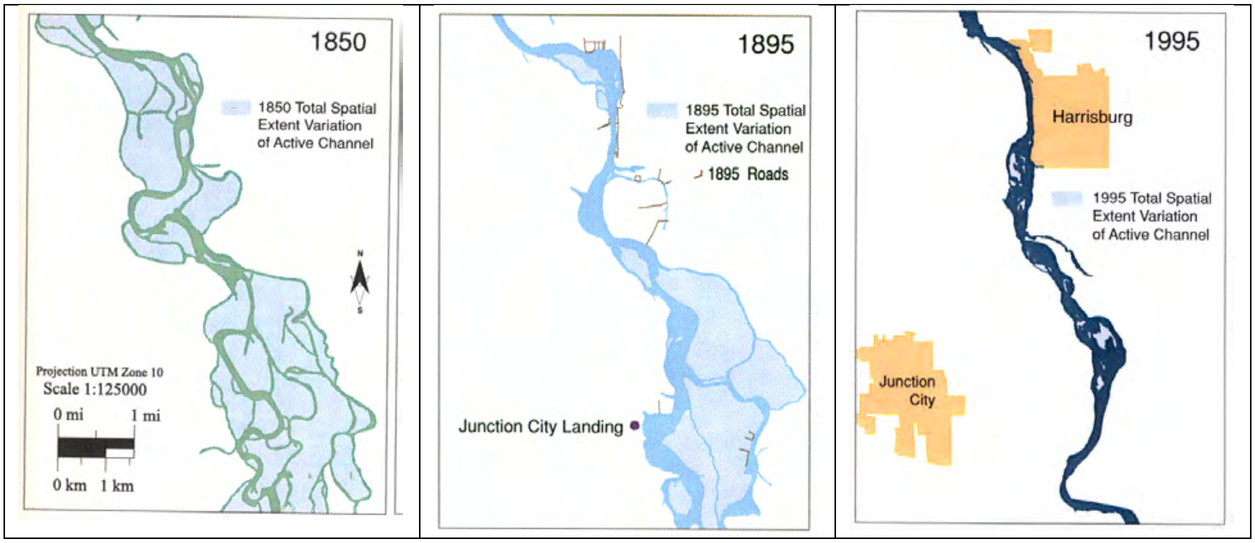


Figure 7-1: Changes in Willamette River channel complexity in the Harrisburg area (PNERC, 1998)

Narrow side channels or multi-braided channels may be more effectively shaded by vegetation than a single channel and the loss of this channel complexity may contribute to high stream temperatures. In addition, complex channels with floodplain connectivity have significantly greater hyporheic flow than simple channels. Water that flows through gravel remains cool because it is isolated from heating by solar radiation and atmospheric influences. Historic hyporheic connectivity may have been five times as great as current values, which would have resulted in a significantly greater percentage of river water flowing through hyporheic zones than today (PNERC, 2002).

Little specific information is available on historic channel bathymetry and because it is difficult to accurately model hyporheic flow, no attempts have been made to model historic channel complexity using the Willamette River models. However, the model utilized, CE-QUAL-W2, can model multiple channels and could be used to analyze the impact that potential side channel remediation projects might have on stream temperature.

7.2.5 Climate change

DEQ completed a literature review to assess climate change-driven stream temperature impacts. Based on that review (Appendix G), stream temperature impacts from climate change can range from +0.05°C to +0.27°C per decade on unregulated streams and -0.48°C to +0.52°C per decade on regulated streams. Stream temperature trends in regulated systems are more variable, as upstream flow and temperature management can confound natural long-term warming trends in the data (Isaak et al., 2012).

7.2.6 Johnson Creek

Thermal pollutant sources identified for Johnson Creek in the Lower Willamette Subbasin include lack of sufficient shade-producing streamside vegetation, consumptive use water withdrawals, tributaries to Johnson Creek with waters exceeding the temperature criteria, and background sources. See TSD Appendix A for details. Briefly, along the Johnson Creek model extent:

- Lack of sufficient streamside vegetation was associated with a mean effective shade gap of 26 percentage points, corresponding to daily maximum water temperature increases of 8.27°C at the POMI at model km 18.9, and 3.76°C at the mouth.
- Warming from tributary waters that exceeded water quality criteria was associated with daily maximum water temperature increases of 1.52°C at the POMI at model km 2, and 1.40°C at the mouth.
- Reducing USGS estimated mean August stream flow for Johnson Creek by 4% resulted in a daily maximum water temperature increase equal to the portion of the HUA allocated to water withdrawals (0.05°C) at the flow reference site at model km 1.2. The greatest daily maximum temperature change between these two scenarios was 0.16°C at model km 25.5.
- Reducing USGS estimated mean August stream flow for Johnson Creek by 20% (the consumptive use rate above which OWRD assumes water quality impacts) resulted in daily maximum water temperature increases of 0.90°C at the POMI at model km 25.5, and 0.29°C at the flow reference site at model km 1.2.
- Background sources were associated with a water temperature standard exceedance of 1.83°C above the applicable numeric criteria at model km 11.7. This means that to attain the temperature criteria, background sources need to have a temperature reduction of 1.83°C.

7.2.7 Molalla River

Thermal pollutant sources identified for the Molalla River include lack of sufficient shade-producing streamside vegetation, channel modification, consumptive use water withdrawals, and background sources. See TSD Appendix A for details. Briefly, along the Molalla River model extent:

- Lack of sufficient streamside vegetation was associated with a mean effective shade gap of 14 percentage points, corresponding to 7DADM water temperature increases of 2.42°C at the POMI at model km 70.06, and 0.52°C at the mouth.
- Surface water withdrawals were associated with 7DADM water temperature increases of 1.50°C at the POMI at model km 19.86, and 1.07°C at the mouth.
- Channel modifications, such as decreases in channel width, were associated with 7DADM water temperature increases of 1.09°C at the POMI at model km 36.36, and 0.31°C at the mouth.
- WLAs for the Molalla STP have the potential to cool the river up to 0.3°C at their point of discharge at model km 34.08. This is due to the relatively high ambient temperatures of the Molalla River. All model scenarios indicate that Molalla River water temperatures are expected to exceed water temperature standards along most of the modeled reach.
- Background sources were associated with a water temperature standard exceedance of 9.16°C above the applicable numeric criteria at model km 35.76. This means that to attain the temperature criteria, background sources need to have a temperature reduction of 9.16°C.

7.2.8 Pudding River

Thermal pollutant sources identified for the Pudding River include lack of sufficient shade-producing streamside vegetation, consumptive use water withdrawals, tributaries to Pudding River with waters exceeding the temperature criteria, and background sources. See TSD Appendix A for details. Briefly, along the Pudding River model extent:

- Lack of sufficient streamside vegetation was associated with a mean effective shade gap of 11 percentage points, corresponding to 7DADM water temperature increases of 3.97°C at the POMI at model km 82.1, and 1.95°C at the mouth.
- Wasteload allocations for Woodburn WWTP and JLR have the potential to increase 7DADM water temperature by 0.03°C at the POMI at model km 24.8, but are not expected to have an impact at the mouth.
- Surface water withdrawals were associated with 7DADM water temperature increases of 4.01°C at the POMI at model km 82.9, and 1.68°C at the mouth.
- Reducing surface water withdrawals to 25% of normal consumptive use was associated with 7DADM water temperature increases of 0.61°C at the POMI at model km 82, and 0.3°C at the mouth relative to the 7DADM water temperature at natural stream flows.
- Reducing surface water withdrawals to 50% of normal consumptive use was associated with 7DADM water temperature increases of 1.37°C at the POMI at model km 82, and 0.69°C at the mouth relative to the 7DADM water temperature at natural stream flows.
- Reducing surface water withdrawals to 75% of normal consumptive use was associated with 7DADM water temperature increases of 2.51°C at the POMI at model km 82.4, and 1.15°C at the mouth relative to the 7DADM water temperature at natural stream flows.
- Warming from tributary waters that exceeded water quality criteria was associated with 7DADM water temperature increases of 8.65°C at the POMI at model km 84.6, and 1.19°C at the mouth.
- Background sources were associated with a water temperature standard exceedance of 3.86°C above the applicable numeric criteria at model km 11.4. This means that to attain the temperature criteria, background sources need to have a temperature reduction of 3.86°C.

7.2.9 Litte North Santiam River

Thermal pollutant sources identified for the Little North River include lack of sufficient shade-producing streamside vegetation, and background sources. See TSD Appendix A for details. Briefly, along the Little North Santiam River model extent:

- Lack of sufficient streamside vegetation was associated with a mean effective shade gap of 9 percentage points, corresponding to daily maximum water temperature increases of 1.72°C at the POMI at model km 13.7, and 0.65°C at the mouth.
- Background sources were associated with a water temperature standard exceedance of 8.89°C above the applicable numeric criteria at model km 1.0. This means that to attain the temperature criteria, background sources need to have a temperature reduction of 8.89°C.

7.2.10 Thomas Creek

Thermal pollutant sources identified for Thomas Creek in the South Santiam Subbasin include lack of sufficient shade-producing streamside vegetation, consumptive use water withdrawals, tributaries to Thomas Creek with waters exceeding the temperature criteria, and background sources. See TSD Appendix A for details. Briefly, along the Thomas Creek model extent:

- Lack of sufficient streamside vegetation was associated with a mean effective shade gap of less than 1 percentage point, corresponding to daily maximum water temperature increases of 1.14°C at the POMI at model km 32.3. This indicates that current vegetation is nearly at site potential conditions.
- Surface water withdrawals were associated with daily maximum water temperature increase of 1.83°C at the POMI at model km 4.8, and 0.10°C at the mouth.
- Warming from tributary waters that exceeded water quality criteria was associated with daily maximum water temperature increases of 1.08°C at the POMI at model km 30.2, and 0.60°C at the mouth.
- Background sources were associated with a water temperature standard exceedance of 8.91°C above the applicable numeric criteria at model km 30.6. This means that to attain the temperature criteria, background sources need to have a temperature reduction of 8.91°C.

7.2.11 Crabtree Creek

Thermal pollutant sources identified for Crabtree Creek in the South Santiam Subbasin include lack of sufficient shade-producing streamside vegetation, and background sources. See TSD Appendix A for details. Briefly, along Crabtree Creek model extent:

- Lack of sufficient streamside vegetation was associated with a mean effective shade gap of 13 percentage points, corresponding to daily maximum water temperature increases of 3.78°C at the POMI at model km 5.2, and 1.93°C at the mouth.
- Background sources were associated with a water temperature standard exceedance of 7.39°C above the applicable numeric criteria at model km 35.1. This means that to attain the temperature criteria, background sources need to have a temperature reduction of 7.39°C.

7.2.12 Luckiamute River

Thermal pollutant sources identified for the Luckiamute River in the Upper Willamette Subbasin include lack of sufficient shade-producing streamside vegetation, and background sources. See TSD Appendix A for details. Briefly, along the Luckiamute River model extent:

- Lack of sufficient streamside vegetation was associated with a mean effective shade gap of 9 percentage points, corresponding to daily maximum water temperature increases of 3.56°C at the POMI at model km 42.8, and 0.34°C at the mouth.
- Background sources were associated with a water temperature standard exceedance of 7.18°C above the applicable numeric criteria at model km 2.1. This means that to attain the temperature criteria, background sources need to have a temperature reduction of 7.18°C.

7.2.13 Mohawk River

Thermal pollutant sources identified for the Mohawk River in the McKenzie Subbasin include lack of sufficient shade-producing streamside vegetation, and background sources. See TSD Appendix A for details. Briefly, along the Mohawk River model extent:

- Lack of sufficient streamside vegetation was associated with a mean effective shade gap of 13 percentage points, corresponding to daily maximum water temperature increases of 2.87°C at the POMI at model km 29.6, and 0.32°C at the mouth.
- Background sources were associated with a water temperature standard exceedance of 7.53°C above the applicable numeric criteria at model km 5.7. This means that to attain the temperature criteria, background sources need to have a temperature reduction of 7.53°C.

7.2.14 McKenzie River

Thermal pollutant sources identified for the McKenzie River include lack of sufficient shade-producing streamside vegetation, point sources, and background sources. See TSD Appendix A for details regarding the Upper McKenzie River Model. See TSD Appendix K for details regarding the Lower McKenzie River model. Briefly, along the Upper McKenzie River model extent:

- Lack of sufficient streamside vegetation was associated with a mean effective shade gap of 20 percentage points, corresponding to daily maximum water temperature increases of 0.43°C at the POMI at model km 10.0, and 0.36°C at just upstream of Quartz Creek at model km 0.0.
- WLAs for EWEB's Trail Bridge Powerhouse facility has the potential to warm the river 0.02°C at the point of discharge. The impact dissipates moving downstream. The impact is 0.015°C at the confluence with the South Fork McKenzie River.
- Background sources were not associated with a water temperature standard exceedance.

On the South Fork McKenzie River and McKenzie River downstream from the South Fork:

- Lack of sufficient streamside vegetation was associated with a mean effective shade gap of 14 percentage points, corresponding to a 7DADM temperature increase of 0.84°C at the POMI at model mile 17.5, and 0.74°C at the mouth.
- Wasteload allocations for EWEB's Trail Bridge Powerhouse facility, USACE Cougar facility, ODFW's Leaburg Fish Hatchery, ODFW's McKenzie Fish Hatchery, and International Paper – Springfield result in maximum 7DADM temperatures increases of 0.20°C (Spring spawning period), 0.22 °C (Summer non-spawning period), and 0.22 °C (Fall spawning period) at the POMI, located at the International Paper's outfall. Note that as discussed in Appendix K, the temperature impact was 0.23°C at the river mouth on two days when flow was less than 7Q10. When flow is greater than or equal to 7Q10, the impact of modeled point source impacts does not exceed 0.22°C.

7.2.15 Coyote Creek

Thermal pollutant sources identified for Coyote Creek in the Upper Willamette Subbasin include lack of sufficient shade-producing streamside vegetation, and background sources. See TSD Appendix A for details. Briefly, along the Coyote Creek model extent:

- Lack of sufficient streamside vegetation was associated with a mean effective shade gap of 23 percentage points, corresponding to daily maximum water temperature increases of 7.87°C at the POMI at model km 35, and 2.61°C at the mouth.
- Background sources were associated with a water temperature standard exceedance of 7.18°C above the applicable numeric criteria at model km 1.7. This means that to attain the temperature criteria, background sources need to have a temperature reduction of 7.18°C.

7.2.16 Mosby Creek

Thermal pollutant sources identified for Mosby Creek in the Coast Fork Willamette Subbasin include lack of sufficient shade-producing streamside vegetation, and background sources. See TSD Appendix A for details. Briefly, along the Mosby Creek model extent:

- Lack of sufficient streamside vegetation was associated with a mean effective shade gap of 4 percentage points, corresponding to daily maximum water temperature increases of 3.05°C at the POMI at model km 28.1, and 1.50°C at the mouth.
- Background sources were associated with a water temperature standard exceedance of 8.81°C above the applicable numeric criteria at model km 9.8. This means that to attain the temperature criteria, background sources need to have a temperature reduction of 8.81°C.

7.2.17 Southern Willamette shade

Thermal pollutant sources identified for the Southern Willamette analysis include lack of sufficient shade-producing vegetation. See TSD Appendix A for details. Briefly, within the Southern Willamette model extent:

- Lack of sufficient streamside vegetation was associated with a mean effective shade gap of 28 percentage points over the entire model assessment area (approximately 21,410 stream kilometers).
- ODF, Oregon Department of Agriculture (ODA), USFS, and BLM were the DMAs responsible for the largest number of assessed stream nodes totaling about 88% of the assessed stream network (18,986 km out of 21,410 total assessed kilometers).
- Of the four DMAs with the largest percentage of stream miles, ODA had the largest mean shade gap of 53 percentage points over the 4,823 stream kilometers of agricultural lands assessed.
- Private non-federal forestlands regulated by ODF have the largest number of assessed stream nodes (8603 km) with a mean shade gap of 26 percentage points.
- While individual cities typically have fewer assessed stream kilometers relative to other DMAs, streams within the city limits of 32 cities were assessed. 16 of the cities had mean shade gaps greater than 50 percentage points.

- The Muddy Creek-Willamette River Watershed (1709000306) had the largest number of assessed stream nodes (827 km out of 1398 total assessed kilometers) with effective shade gaps exceeding 50 percentage points.

7.2.18 Lower Willamette shade

Thermal pollutant sources identified for the Lower Willamette analysis include lack of sufficient shade-producing vegetation. See TSD Appendix A and B for details. Briefly, within the Lower Willamette model extent:

- Lack of sufficient streamside vegetation was associated with a mean effective shade gap of 13 percentage points over the entire model assessment area (approximately 201 stream kilometers).
- The assessed streams in the Johnson Creek-Willamette River watershed (1709001201) had the largest mean shade gap of 14 percentage points over the 109 stream kilometers assessed.
- The streams on the westside of the Willamette River draining the Tualatin Mountains in the Multnomah Channel Watershed (1709001203) had the lowest mean shade gap of 3 percentage points over the 5 stream kilometers assessed.
- The City of Portland had the largest number of stream kilometers (5.6 km) with mean effective shade gaps exceeding 50 percentage points, followed by Clackamas County and ODA.

8 Loading capacity and excess loads

As described in the TMDL report, the pollutant load that a waterbody can receive and still meet water quality standards is called the loading capacity (LC). For temperature, a thermal loading capacity is assigned to all AUs in the Willamette Subbasins. Loading capacity is calculated using **Equation 8-1**.

$$LC = (T_C + \mathrm{HUA}) \cdot Q_R \cdot C_F \qquad \textbf{Equation 8-1}$$

where,

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

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

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

$Q_R =$ The daily mean river flow rate in cubic feet per second (cfs).

$C_F =$ Conversion factor using flow in cfs: 2,446,665

$$\left(\frac{1\,m}{3.2808\,ft}\right)^3 \cdot \frac{1000\,kg}{1\,m^3} \cdot \frac{86400\,sec}{1\,day} \cdot \frac{1\,kcal}{1\,kg\ \cdot 1°\mathrm{C}} = 2{,}446{,}665$$

Table 8-1 presents the loading capacity for select temperature impaired Category 5 AUs modeled for the TMDL analysis at the critical 7Q10 low flow. It is intended that **Equation 8-1** be used to calculate the loading capacity for any AU or stream location in the Willamette Subbasins not identified in **Table 8-1** or when river flows are greater than 7Q10. In cases when there are two year-round applicable temperature criteria that apply to the same AU, the more stringent criteria shall be used for the loading capacity.

Table 8-1: Thermal loading capacity (LC) for modeled AUs by applicable fish use period at 7Q10 flow.

AU Name and AU ID	Annual 7Q10 (cfs)	Year Round Criterion + HUA (°C)	Spawning Criterion + HUA (°C)	7Q10 LC Year Round (kilocalories/day)	7Q10 LC Spawning (kilocalories/day)
Clackamas River OR_SR_1709001106_02_104597	671	16.3	13.3	26,759.91E+6	21,834.77E+6
Coast Fork Willamette River OR_SR_1709000203_02_104585	38	18.3	13.3	1,701.41E+6	1,236.54E+6
Coast Fork Willamette River OR_SR_1709000204_02_103787	132	18.3	13.3	5,910.16E+6	4,295.37E+6
Coyote Creek OR_SR_1709000301_02_103796	5.9	18.3	NA	264.17E+6	NA
Crabtree Creek OR_SR_1709000606_02_103978	25	16.3	13.3	997.02E+6	813.52E+6
Johnson Creek OR_SR_1709001201_02_104170	11	18.3	13.3	492.51E+6	357.95E+6
Little North Santiam River OR_SR_1709000505_02_104564	21	16.3	13.3	837.49E+6	683.35E+6
Long Tom River OR_SR_1709000301_02_103791	22	24.3	18.3	1,307.99E+6	985.03E+6
Luckiamute River OR_SR_1709000305_02_103829	16	18.3	13.3	716.38E+6	520.65E+6
McKenzie River OR_SR_1709000407_02_103884	1537	16.3	13.3	61,296.54E+6	50,014.97E+6
Middle Fork Willamette River OR_SR_1709000107_02_104583	1002	16.3	13.3	39,960.4E+6	32,605.73E+6
Middle Fork Willamette River OR_SR_1709000110_02_104584	1278	16.3	13.3	50,967.46E+6	41,586.94E+6
Mohawk River OR_SR_1709000406_02_103871	16	16.3	13.3	638.09E+6	520.65E+6
Molalla River OR_SR_1709000904_02_104086	38	16.3	13.3	1,515.46E+6	1,236.54E+6
Mosby Creek OR_SR_1709000201_02_103752	11	16.3	13.3	438.69E+6	357.95E+6
North Santiam River OR_SR_1709000504_02_103906	859	16.3	13.3	34,257.47E+6	27,952.41E+6
North Santiam River OR_SR_1709000506_02_103930	914	16.3	13.3	36,450.9E+6	29,742.15E+6
Pudding River OR_SR_1709000905_02_104088	10	18.3	NA	447.74E+6	NA
Santiam River OR_SR_1709000506_02_103927	1144	18.3	13.3	51,221.42E+6	37,226.5E+6
South Santiam River OR_SR_1709000608_02_103925	615	16.3	13.3	24,526.59E+6	20,012.5E+6
Thomas Creek OR_SR_1709000607_02_103988	6.9	18.3	NA	308.94E+6	NA
Willamette River OR_SR_1709000306_05_103854	3877	18.3	13.3	173,588.68E+6	126,160.08E+6
Willamette River OR_SR_1709000701_05_104005	5684	18.3	13.3	254,495.24E+6	184,961.02E+6
Willamette River OR_SR_1709000703_88_104015	5734	20.3	NA	284,792.3E+6	NA
Willamette River OR_SR_1709000704_88_104020	5988	20.3	NA	297,407.79E+6	NA

AU Name and AU ID	Annual 7Q10 (cfs)	Year Round Criterion + HUA (°C)	Spawning Criterion + HUA (°C)	7Q10 LC Year Round (kilocalories/day)	7Q10 LC Spawning (kilocalories/day)
Willamette River OR_SR_1709001201_88_104019	6740	20.3	NA	334,757.6E+6	NA
Willamette River OR_SR_1709001202_88_104175	6740	20.3	NA	334,757.6E+6	NA

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

Because flow monitoring data were not available at most temperature monitoring locations, it was not possible to calculate the excess thermal load. Instead, the excess temperature and percent load reduction were calculated for each AU where temperature data were available. The extensive monitoring across the Willamette subbasin represents a wide range of waterbodies; however not all streams in the Willamette subbasins have monitoring data. **Equation 8-2** can be used to determine excess temperature and percent reduction for additional streams if data becomes available in the future. Temperature data collected in Willamette Subbasins between 1/1/2012 and 12/31/2022 were downloaded from DEQ's AWQMS database. Following data review and filtering for acceptable data quality there were 452 temperature monitoring stations available where excess temperature could be calculated. The maximum excess temperature and corresponding percent reduction were summarized in **Table 8-2** for each AU and each temperature criteria applicable on that AU.

The excess temperature is the maximum difference between the monitored 7DADM river temperature and the applicable numeric criterion including the HUA. The percent load reduction (**Equation 8-2**) represents the maximum portion of the actual thermal loading that must be reduced to attain the TMDL loading capacity.

The percent load reduction is mathematically equal to the percent temperature reduction calculated from the monitoring data. 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 shown in **Table 8-2** were calculated from temperatures in degrees Celsius.

$$\mathrm{PR} = \frac{(T_R - T_C - \mathrm{HUA})}{T_R} \cdot 100$$ **Equation 8-2**

where,

$\mathrm{PR} =$ Percent load reduction (%). If PR < 0, PR = 0

$T_R =$ The maximum 7DADM ambient river temperature (ºC).

$T_C =$ The applicable river temperature criterion (ºC).

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

Table 8-2: Excess temperature and percent load reduction for AUs with available temperature data in the Willamette Subbasins.

AU Name	AU ID	Maximum 7DADM River Temperature (°C)	Applicable Criterion + HUA (°C)	Excess Temperature (°C)	Percent Load Reduction
Alex Creek	OR_SR_1709000202_02_103762	16.7	18.3	0.0	0.0
Big Creek	OR_SR_1709001104_02_104153	13.7	16.3	0.0	0.0
Blowout Creek	OR_SR_1709000503_02_103907	21.0	18.3	2.7	12.9
Boulder Creek	OR_SR_1709000502_02_103902	19.3	18.3	1.0	5.3
Breitenbush River	OR_SR_1709000501_02_103892	17.5	18.3	0.0	0.0
Brice Creek	OR_SR_1709000202_02_103771	23.1	18.3	4.8	20.6
Calapooia River	OR_SR_1709000303_02_103815	16.0	16.3	0.0	0.0
Camp Creek	OR_SR_1709000407_02_103889	19.3	13.3	6.0	31.1
Camp Creek	OR_SR_1709000407_02_103889	22.4	16.3	6.1	27.2
Canyon Creek	OR_SR_1709000602_02_103949	20.7	16.3	4.4	21.4
Cedar Creek	OR_SR_1709000407_02_103891	20.9	13.3	7.6	36.4
Cedar Creek	OR_SR_1709000407_02_103891	24.3	16.3	8.0	32.9
Christy Creek	OR_SR_1709000106_02_103722	15.5	16.3	0.0	0.0
Clackamas River	OR_SR_1709000704_02_104597	17.7	13.3	4.4	24.9
Clackamas River	OR_SR_1709000704_02_104597	20.5	16.3	4.2	20.5
Clackamas River	OR_SR_1709000704_02_104597	24.5	18.3	6.2	25.3
Clackamas River	OR_SR_1709001104_02_104154	16.6	13.3	3.3	19.8
Clackamas River	OR_SR_1709001104_02_104154	18.5	16.3	2.2	11.9
Clackamas River	OR_SR_1709001104_02_104155	16.2	13.3	2.9	17.9
Clackamas River	OR_SR_1709001104_02_104155	19.5	16.3	3.2	16.5
Clackamas River	OR_SR_1709001106_02_104597	17.7	13.3	4.4	24.9
Clackamas River	OR_SR_1709001106_02_104597	20.5	16.3	4.2	20.5
Clackamas River	OR_SR_1709001106_02_104597	24.5	18.3	6.2	25.3
Coast Fork Willamette River	OR_SR_1709000203_02_104585	12.5	13.3	0	0.0
Coast Fork Willamette River	OR_SR_1709000203_02_104585	24.2	18.3	5.9	24.4
Collawash River	OR_SR_1709001101_02_104142	17.4	13.3	4.1	23.5
Collawash River	OR_SR_1709001101_02_104142	19.8	16.3	3.5	17.8

AU Name	AU ID	Maximum 7DADM River Temperature (°C)	Applicable Criterion + HUA (°C)	Excess Temperature (°C)	Percent Load Reduction
Collawash River	OR_SR_1709001101_02_104144	16.3	13.3	3.0	18.6
Collawash River	OR_SR_1709001101_02_104144	20.5	16.3	4.2	20.4
Fall Creek	OR_SR_1709000109_02_103737	21.6	13.3	8.3	38.3
Fall Creek	OR_SR_1709000109_02_103737	24.5	16.3	8.2	33.3
Fall Creek	OR_SR_1709000109_02_103743	18.6	13.3	5.3	28.5
Fall Creek	OR_SR_1709000109_02_103743	22.4	16.3	6.1	27.3
Fall Creek	OR_SR_1709000109_02_103735	21.9	13.3	8.6	39.3
Fall Creek	OR_SR_1709000109_02_103735	20.8	16.3	4.5	21.6
Fish Creek	OR_SR_1709001104_02_104161	19.1	13.3	5.8	30.4
Fish Creek	OR_SR_1709001104_02_104161	21.2	16.3	4.9	23.0
French Pete Creek	OR_SR_1709000403_02_103862	15.7	16.3	0.0	0.0
Grass Creek	OR_SR_1709000202_02_103780	15.6	16.3	0.0	0.0
Hamilton Creek	OR_SR_1709000608_02_103996	27.3	16.3	11.0	40.3
Hehe Creek	OR_SR_1709000109_02_103734	21.0	16.3	4.7	22.5
Hills Creek	OR_SR_1709000102_02_103715	16.5	13.3	3.2	19.4
Hills Creek	OR_SR_1709000102_02_103715	18.7	16.3	2.4	12.8
Horse Creek	OR_SR_1709000401_02_103856	13.8	12.3	1.5	10.9
HUC12 Name: Andy Creek-Fall Creek	OR_WS_170900010904_02_104219	18.3	16.3	2.0	10.7
HUC12 Name: Balch Creek-Willamette River	OR_WS_170900120202_02_104555	21.8	18.3	3.5	15.9
HUC12 Name: Boulder Creek-McKenzie River	OR_WS_170900040206_02_104310	14.4	12.3	2.1	14.8
HUC12 Name: Buck Creek-Middle Fork Willamette River	OR_WS_170900010502_02_104200	18.9	12.3	6.6	34.9
HUC12 Name: Canyon Creek	OR_WS_170900090601_02_104482	8.2	18.3	0.0	0.0
HUC12 Name: Columbia Slough (Lower)	OR_WS_170900120201_02_104554.1	26.8	18.3	8.5	31.8
HUC12 Name: Columbia Slough (Upper)	OR_WS_170900120201_02_104554.2	29.5	18.3	11.2	38.0
HUC12 Name: Cougar Creek-South Fork McKenzie River	OR_WS_170900040308_02_104321	15.0	16.3	0.0	0.0
HUC12 Name: Cougar Reservoir-South Fork McKenzie	OR_WS_170900040307_02_104320	14.6	16.3	0.0	0.0

AU Name	AU ID	Maximum 7DADM River Temperature (°C)	Applicable Criterion + HUA (°C)	Excess Temperature (°C)	Percent Load Reduction
HUC12 Name: Croisan Creek-Willamette River	OR_WS_170900070301_02_104413	19.6	13.3	6.3	32.0
HUC12 Name: Croisan Creek-Willamette River	OR_WS_170900070301_02_104413	24.8	18.3	6.5	26.2
HUC12 Name: Dartmouth Creek-North Fork Middle For*	OR_WS_170900010608_02_104210	16.5	16.3	0.2	1.2
HUC12 Name: Deer Creek	OR_WS_170900040205_02_104309	20.0	12.3	7.7	38.4
HUC12 Name: Echo Creek-Middle Fork Willamette River	OR_WS_170900010106_02_104190	15.6	12.3	3.3	21.1
HUC12 Name: Eighth Creek-North Fork Middle Fork Willamette	OR_WS_170900010607_02_104209	16.2	16.3	0.0	0.0
HUC12 Name: Elk Creek-McKenzie River	OR_WS_170900040502_02_104326	15.3	13.3	2.0	12.9
HUC12 Name: Elk Creek-McKenzie River	OR_WS_170900040502_02_104326	17.9	16.3	1.6	8.8
HUC12 Name: Elk Creek-South Fork McKenzie River	OR_WS_170900040301_02_104314	8.4	12.3	0.0	0.0
HUC12 Name: Fish Creek	OR_WS_170900110403_02_104536	16.0	16.3	0.0	0.0
HUC12 Name: Flat Creek	OR_WS_170900030603_02_104290	25.7	18.3	7.4	28.8
HUC12 Name: Glenn Creek-Willamette River	OR_WS_170900070303_02_104415	27.2	18.3	8.9	32.7
HUC12 Name: Greasy Creek	OR_WS_170900030204_02_104256	25.0	16.3	8.7	34.8
HUC12 Name: Greasy Creek	OR_WS_170900030204_02_104256	19.1	18.3	0.8	4.1
HUC12 Name: Hackleman Creek-McKenzie River	OR_WS_170900040202_02_104306	12.3			
HUC12 Name: Helion Creek-Clackamas River	OR_WS_170900110406_02_104539	16.5	16.3	0.2	1.2
HUC12 Name: Hill Creek-Coast Fork Willamette River	OR_WS_170900020401_02_104238	25.9	18.3	7.6	29.3
HUC12 Name: Kink Creek-McKenzie River	OR_WS_170900040204_02_104308	12.7	12.3	0.4	3.1
HUC12 Name: Last Creek-Pinhead Creek	OR_WS_170900110204_02_104526	10.4	16.3	0.0	0.0
HUC12 Name: Layng Creek	OR_WS_170900020201_02_104227	17.6	18.3	0.0	0.0
HUC12 Name: Lowe Creek-Clackamas River	OR_WS_170900110203_02_104525	15.6	16.3	0.0	0.0
HUC12 Name: Lower Johnson Creek	OR_WS_170900120103_02_104552	19.9	13.3	6.6	33.1
HUC12 Name: Lower Johnson Creek	OR_WS_170900120103_02_104552	23.1	18.3	4.8	20.8
HUC12 Name: Lower Mill Creek	OR_WS_170900070204_02_104412	25.9	18.3	7.6	29.3
HUC12 Name: Lower Quartzville Creek	OR_WS_170900060305_02_104379	23.7	18.3	5.4	22.8

AU Name	AU ID	Maximum 7DADM River Temperature (°C)	Applicable Criterion + HUA (°C)	Excess Temperature (°C)	Percent Load Reduction
HUC12 Name: Maxfield Creek-Luckiamute River	OR_WS_17090003 0503_02_104277	21.1	18.3	2.8	13.3
HUC12 Name: McKinney Creek	OR_WS_17090007 0203_02_104411	26.9	18.3	8.6	32.0
HUC12 Name: Middle Little Luckiamute River	OR_WS_17090003 0507_02_104281	17.5	18.3	0.0	0.0
HUC12 Name: Minto Creek-North Santiam River	OR_WS_17090005 0205_02_104347	11.4	18.3	0.0	0.0
HUC12 Name: Morgan Creek-North Santiam River	OR_WS_17090005 0604_02_104362	23.0	16.3	6.7	29.1
HUC12 Name: Multnomah Channel	OR_WS_17090012 0305_02_104561	18.5	18.3	0.2	1.2
HUC12 Name: North Fork Clackamas River	OR_WS_17090011 0405_02_104538	17.0	16.3	0.7	4.2
HUC12 Name: North Fork Eagle Creek	OR_WS_17090011 0502_02_104541	12.8	16.3	0.0	0.0
HUC12 Name: Oswego Creek-Willamette River	OR_WS_17090012 0104_02_104553	14.1	13.3	0.8	5.7
HUC12 Name: Oswego Creek-Willamette River	OR_WS_17090012 0104_02_104553	20.7	18.3	2.4	11.7
HUC12 Name: Owl Creek	OR_WS_17090006 0205_02_104371	15.5	16.3	0.0	0.0
HUC12 Name: Paddys Valley-Middle Fork Willamette *	OR_WS_17090001 0101_02_104185	10.0	12.3	0.0	0.0
HUC12 Name: Pedee Creek-Luckiamute River	OR_WS_17090003 0504_02_104278	19.5	18.3	1.2	6.3
HUC12 Name: Pot Creek-Clackamas River	OR_WS_17090011 0205_02_104527	10.1	16.3	0.0	0.0
HUC12 Name: Quartz Creek	OR_WS_17090004 0501_02_104325	11.7	13.3	0.0	0.0
HUC12 Name: Quartz Creek	OR_WS_17090004 0501_02_104325	16.3	16.3	0.0	0.2
HUC12 Name: Roaring River	OR_WS_17090011 0402_02_104535	24.0	16.3	7.7	32.1
HUC12 Name: Sauers Creek-North Santiam River	OR_WS_17090005 0208_02_104350	15.8	18.3	0.0	0.0
HUC12 Name: Sharps Creek	OR_WS_17090002 0203_02_104229	16.3	16.3	0.0	0.0
HUC12 Name: Smith River	OR_WS_17090004 0203_02_104307	23.4	12.3	11.1	47.4
HUC12 Name: Smith River	OR_WS_17090004 0203_02_104307	18.7			
HUC12 Name: South Fork Clackamas River	OR_WS_17090011 0404_02_104537	12.8	16.3	0.0	0.0
HUC12 Name: Staley Creek	OR_WS_17090001 0105_02_104189	16.4	12.3	4.1	25.0
HUC12 Name: Straight Creek-North Santiam River	OR_WS_17090005 0202_02_104344	14.2	18.3	0.0	0.0
HUC12 Name: Tumblebug Creek	OR_WS_17090001 0102_02_104186	15.4	12.3	3.1	20.2

AU Name	AU ID	Maximum 7DADM River Temperature (°C)	Applicable Criterion + HUA (°C)	Excess Temperature (°C)	Percent Load Reduction
HUC12 Name: Upper Canyon Creek	OR_WS_170900060204_02_104370	17.6	16.3	1.3	7.6
HUC12 Name: Upper Clear Creek	OR_WS_170900110601_02_104543	13.1	16.3	0.0	0.0
HUC12 Name: Upper Eagle Creek	OR_WS_170900110501_02_104540	17.7	16.3	1.4	8.0
HUC12 Name: Upper Johnson Creek	OR_WS_170900120101_02_104550	19.4	13.3	6.1	31.4
HUC12 Name: Upper Johnson Creek	OR_WS_170900120101_02_104550	29.3	18.3	11.0	37.5
HUC12 Name: Whitewater Creek	OR_WS_170900050206_02_104348	14.1	18.3	0.0	0.0
HUC12 Name: Winberry Creek	OR_WS_170900010905_02_104220	19.5	16.3	3.2	16.4
Johnson Creek	OR_SR_1709001201_02_104170	21.3	13.3	8.0	37.6
Johnson Creek	OR_SR_1709001201_02_104170	28.9	18.3	10.6	36.6
Junetta Creek	OR_SR_1709000202_02_103763	16.6	18.3	0.0	0.0
Layng Creek	OR_SR_1709000202_02_103765	24.3	18.3	6.0	24.8
Layng Creek	OR_SR_1709000202_02_103770	16.6	18.3	0.0	0.0
Little Fall Creek	OR_SR_1709000108_02_103730	16.1	13.3	2.8	17.2
Little Fall Creek	OR_SR_1709000108_02_103730	18.1	16.3	1.8	10.1
Little North Santiam River	OR_SR_1709000505_02_104564	23.0	13.3	9.7	42.2
Little North Santiam River	OR_SR_1709000505_02_104564	28.1	16.3	11.8	42.0
Long Tom River	OR_SR_1709000301_02_103791	24.7	24.3	0.4	1.6
Lookout Creek	OR_SR_1709000404_02_104571	20.9	16.3	4.6	22.0
Lower Blue River	OR_SR_1709000404_02_104569	21.8	13.3	8.5	39
Lower Blue River	OR_SR_1709000404_02_104569	21.6	16.3	5.3	24.5
Marion Creek	OR_SR_1709000502_02_103897	17.4	18.3	0.0	0.0
Martin Creek	OR_SR_1709000202_02_103756	19.9	18.3	1.6	8.0
McDowell Creek	OR_SR_1709000608_02_103994	21.7	18.3	3.4	15.6
McKenzie River	OR_SR_1709000402_02_104587	8.4	12.3	0.0	0.0
McKenzie River	OR_SR_1709000402_02_104588	11.8	12.3	0.0	0.0
McKenzie River	OR_SR_1709000407_02_103884	19.5	13.3	6.2	31.8
McKenzie River	OR_SR_1709000407_02_103884	21.2	16.3	4.9	23.1

AU Name	AU ID	Maximum 7DADM River Temperature (°C)	Applicable Criterion + HUA (°C)	Excess Temperature (°C)	Percent Load Reduction
Middle Fork Willamette River	OR_SR_1709000101_02_103713	13.4	12.3	1.1	8.1
Middle Fork Willamette River	OR_SR_1709000105_02_104579	21.0	12.3	8.7	41.4
Middle Fork Willamette River	OR_SR_1709000105_02_104580	17.7	13.3	4.4	24.9
Middle Fork Willamette River	OR_SR_1709000105_02_104580	18.1	16.3	1.8	9.9
Middle Fork Willamette River	OR_SR_1709000107_02_103725	17.8	13.3	4.5	25.3
Middle Fork Willamette River	OR_SR_1709000107_02_103725	19.2	16.3	2.9	15.1
Middle Fork Willamette River	OR_SR_1709000107_02_104583	21.1	13.3	7.8	37.0
Middle Fork Willamette River	OR_SR_1709000107_02_104583	21.3	16.3	5	23.5
Middle Fork Willamette River	OR_SR_1709000110_02_104584	21.1	13.3	7.8	37.0
Middle Fork Willamette River	OR_SR_1709000110_02_104584	22.3	16.3	6	26.9
Middle Santiam River	OR_SR_1709000601_02_103936	19.7	18.3	1.4	7.3
Middle Santiam River	OR_SR_1709000603_02_103965	24.0	18.3	5.7	23.8
Middle Santiam River	OR_SR_1709000604_02_103969	16.0	13.3	2.7	16.9
Middle Santiam River	OR_SR_1709000604_02_103969	14.4	18.3	0.0	0.0
Mill Creek	OR_SR_1709000702_02_104007	18.6	13.3	5.3	28.6
Mill Creek	OR_SR_1709000702_02_104007	25.3	18.3	7.0	27.8
Moose Creek	OR_SR_1709000602_02_103954	19.3	16.3	3.0	15.4
Nohorn Creek	OR_SR_1709001101_02_104145	17.1	16.3	0.8	4.7
North Fork Clackamas River	OR_SR_1709001104_02_104152	19.2	16.3	2.9	15.1
North Fork Middle Fork Willamette River	OR_SR_1709000106_02_103721	20.7	13.3	7.4	35.7
North Fork Middle Fork Willamette River	OR_SR_1709000106_02_103721	22.9	16.3	6.6	28.8
North Fork Pedee Creek	OR_SR_1709000305_02_103828	20.2	18.3	1.9	9.5
North Santiam River	OR_SR_1709000502_02_103899	17.9	18.3	0.0	0.0
North Santiam River	OR_SR_1709000503_02_103906	16.7	13.3	3.4	20.4
North Santiam River	OR_SR_1709000503_02_103906	16.7	16.3	0.4	2.4
North Santiam River	OR_SR_1709000504_02_103906	16.7	13.3	3.4	20.4
North Santiam River	OR_SR_1709000504_02_103906	16.7	16.3	0.4	2.4

AU Name	AU ID	Maximum 7DADM River Temperature (°C)	Applicable Criterion + HUA (°C)	Excess Temperature (°C)	Percent Load Reduction
North Santiam River	OR_SR_1709000506_02_103930	19.2	13.3	5.9	30.7
North Santiam River	OR_SR_1709000506_02_103930	21.1	16.3	4.8	22.7
Oak Grove Fork Clackamas River	OR_SR_1709001103_02_104149	12.2	16.3	0.0	0.0
Oak Grove Fork Clackamas River	OR_SR_1709001103_02_104150	12.6	13.3	0.0	0.0
Oak Grove Fork Clackamas River	OR_SR_1709001103_02_104150	13.8	16.3	0.0	0.0
Owl Creek	OR_SR_1709000602_02_103941	19.2	16.3	2.9	15.2
Portland Creek	OR_SR_1709000109_02_103741	22.5	16.3	6.2	27.4
Pringle Creek	OR_SR_1709000703_02_104012	25.1	18.3	6.8	27.1
Pyramid Creek	OR_SR_1709000601_02_103935	20.3	18.3	2.0	9.8
Quartz Creek	OR_SR_1709000405_02_103867	12.1	13.3	0.0	0.0
Quartz Creek	OR_SR_1709000405_02_103867	16.3	16.3	0.0	0.2
Quartzville Creek	OR_SR_1709000603_02_103957	19.3	18.3	1.0	5.2
Quartzville Creek	OR_SR_1709000603_02_103960	22.0	18.3	3.7	16.7
Rebel Creek	OR_SR_1709000403_02_103861	13.3	16.3	0.0	0.0
Ritner Creek	OR_SR_1709000305_02_103833	21.8	18.3	3.5	16.0
Roaring River	OR_SR_1709000403_02_103864	7.2	12.3	0.0	0.0
Roaring River	OR_SR_1709001104_02_104160	14.2	13.3	0.9	6.3
Roaring River	OR_SR_1709001104_02_104160	15.4	16.3	0.0	0.0
Row River	OR_SR_1709000202_02_103761	25.1	18.3	6.8	27.1
Row River	OR_SR_1709000202_02_103766	25.1	18.3	6.8	27.1
Row River	OR_SR_1709000202_02_103779	13.6	13.3	0.3	2.2
Row River	OR_SR_1709000202_02_103779	23	18.3	4.7	20.4
Salmon Creek	OR_SR_1709000104_02_103719	13.5	12.3	1.2	9.1
Salmon Creek	OR_SR_1709000104_02_103719	18.4	13.3	5.1	27.6
Salmon Creek	OR_SR_1709000104_02_103719	19.3	16.3	3.0	15.7
Salt Creek	OR_SR_1709000103_02_103716	16.1	13.3	2.8	17.1
Salt Creek	OR_SR_1709000103_02_103716	17.9	16.3	1.6	8.7

AU Name	AU ID	Maximum 7DADM River Temperature (°C)	Applicable Criterion + HUA (°C)	Excess Temperature (°C)	Percent Load Reduction
Santiam River	OR_SR_1709000506_02_103927	16.3	13.3	3	18.4
Santiam River	OR_SR_1709000506_02_103927	23.4	18.3	5.1	21.8
Separation Creek	OR_SR_1709000401_02_103857	10.0	12.3	0.0	0.0
Sharps Creek	OR_SR_1709000202_02_103755	24.0	18.3	5.7	23.8
Sharps Creek	OR_SR_1709000202_02_103775	19.2	18.3	0.9	4.6
Sheep Creek	OR_SR_1709000602_02_103953	20.9	16.3	4.6	21.9
Shelton Ditch	OR_SR_1709000703_02_104008	18.5	13.3	5.2	28.2
Shelton Ditch	OR_SR_1709000703_02_104008	23.8	18.3	5.5	23.1
Soda Fork	OR_SR_1709000602_02_103947	16.1	16.3	0.0	0.0
South Fork McKenzie River	OR_SR_1709000403_02_104589	8.7	12.3	0	0
South Fork McKenzie River	OR_SR_1709000403_02_104589	13.1	13.3	0	0
South Fork McKenzie River	OR_SR_1709000403_02_104589	14.9	16.3	0	0
South Fork McKenzie River	OR_SR_1709000403_02_104589	8.7	12.3	0.0	0.0
South Fork McKenzie River	OR_SR_1709000403_02_104589	13.1	13.3	0.0	0.0
South Fork McKenzie River	OR_SR_1709000403_02_104589	14.9	16.3	0.0	0.0
South Fork McKenzie River	OR_SR_1709000403_02_104590	16.2	13.3	2.9	17.9
South Fork McKenzie River	OR_SR_1709000403_02_104590	17.8	16.3	1.5	8.4
South Santiam River	OR_SR_1709000506_02_103925	15.0	13.3	1.7	11.3
South Santiam River	OR_SR_1709000506_02_103925	14.1	16.3	0.0	0.0
South Santiam River	OR_SR_1709000602_02_103950	18.1	13.3	4.8	26.4
South Santiam River	OR_SR_1709000602_02_103950	21.4	16.3	5.1	23.7
South Santiam River	OR_SR_1709000604_02_103968	21.8	13.3	8.5	39.0
South Santiam River	OR_SR_1709000604_02_103968	24.4	16.3	8.1	33.2
South Santiam River	OR_SR_1709000608_02_103925	15	13.3	1.7	11.3
South Santiam River	OR_SR_1709000608_02_103925	14.1	16.3	0	0.0
Teal Creek	OR_SR_1709000305_02_103824	20.3	18.3	2.0	9.9
Trout Creek	OR_SR_1709000602_02_103942	17.2	16.3	0.9	5.5

AU Name	AU ID	Maximum 7DADM River Temperature (°C)	Applicable Criterion + HUA (°C)	Excess Temperature (°C)	Percent Load Reduction
Trout Creek	OR_SR_1709001104_02_104157	16.3	16.3	0.0	0.0
Upper Blue River	OR_SR_1709000404_02_104574	20.6	16.3	4.3	20.9
Whitewater Creek	OR_SR_1709000502_02_103898	12.4	18.3	0.0	0.0
Willamette River	OR_SR_1709000306_05_103854	17.5	13.3	4.2	24.0
Willamette River	OR_SR_1709000306_05_103854	23.8	18.3	5.5	23.1
Willamette River	OR_SR_1709000703_04_104013	17.6	13.3	4.3	24.4
Willamette River	OR_SR_1709000703_04_104013	25.7	18.3	7.4	28.8
Willamette River	OR_SR_1709000703_88_104015	26.1	20.3	5.8	22.2
Willamette River	OR_SR_1709001202_88_104175	26.6	20.3	6.3	23.7
Winberry Creek	OR_SR_1709000109_02_103747	20.2	13.3	6.9	34.2
Winberry Creek	OR_SR_1709000109_02_103747	22.5	16.3	6.2	27.6

9 Allocation approach

Figure 9-1 provides three separate conceptual representations of the total load to a temperature-impaired water. The left (completely orange) block shows the total load, with the bisecting lines representing the load that would meet the biologically-based numeric criteria plus the HUA (the temperature standard). The middle block represents the portions of the total load contributed by the different source categories (point, nonpoint, and background). The right block illustrates how the loading capacity element of the TMDL defines the various allocations.

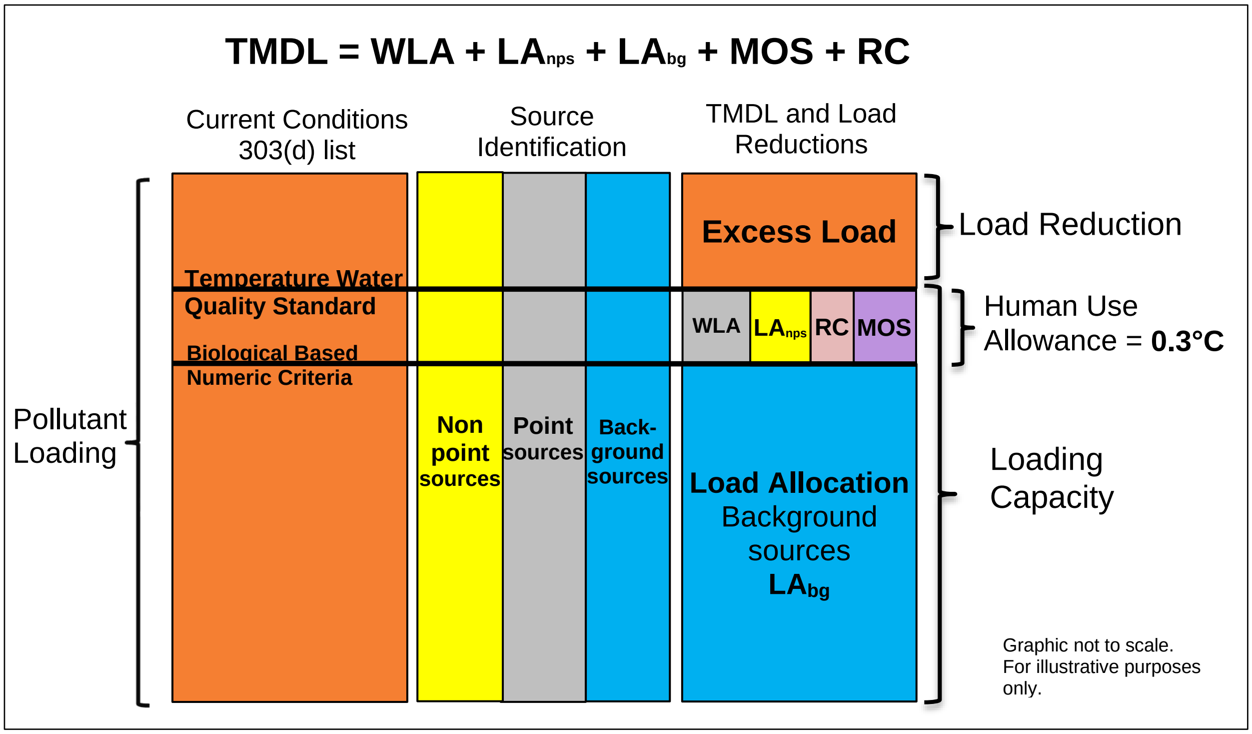


Figure 9-1: Conceptual representation and breakdown of total pollutant loading to a temperature-impaired waterbody.

Wasteload allocations (shown as WLA) are the portion of the TMDL loading capacity allocated to point sources and load allocations (shown as LA_{nps} and LA_{bg}) are the portion attributed to nonpoint sources, including background sources. OAR 340-042-0040(6) identifies the factors that DEQ or EQC may consider when distributing wasteload and load allocations.

The factors include:

a) Contributions from sources;
b) Costs of implementing measures;
c) Ease of implementation;
d) Timelines for attainment of water quality standards;
e) Environmental impacts of allocations;
f) Unintended consequences;
g) Reasonable assurances of implementation;
h) Any other relevant factor.

Oregon's temperature standard provides a framework for how the loading capacity is distributed between human sources of warming and background sources. The HUA at OAR 340-041-0028(12)(b)(B) identifies the portion of the loading capacity reserved for human uses. The rule requires that wasteload and load allocations restrict all NPDES point sources and nonpoint sources to a cumulative increase of no greater than 0.30°C (0.5°F) above the applicable criteria after complete mixing in the waterbody, and at the POMI. DEQ allocated a thermal load equivalent to a 0.30°C increase to human sources and the remainder of the loading capacity to background sources. Distribution of the human use allowance is discussed in 9.1.

9.1 Human use allowance (HUA)

When distributing the thermal loads associated with a 0.30°C increase, DEQ considered the magnitude of the thermal load contributed from known sources, ease of implementing the allocations, the environmental impact of those contributions including where the impact occurs, and how the source contribution impacts cumulative warming.

DEQ's approach to point sources was to assign an equal portion of the HUA equal to 0.075°C, up to a maximum of 0.20°C at the point of discharge from all NPDES permitted point sources in an AU, with some exceptions as described in Section 9.2. DEQ did not assign more than 0.20°C to any individual point source in order to have capacity available for nonpoint sources and reserve capacity.

As summarized in Section 7.2 lack of streamside vegetation is one of the largest sources of stream warming contributing multiple degrees of warming where it was assessed. Nonpoint sources of solar loading were assigned a zero human use allowance, meaning a reduction in streamside vegetation may not cause an increase in temperature above the applicable criterion.

The solar loading allocation is implemented through an effective shade target. Effective shade can be easily measured in the field and is simpler to monitor relative to a thermal load. Based on an extensive literature review, DEQ determined that a vegetation buffer width based on a slope distance of 120 ft would be sufficient in most cases to have no warming and attain the shade targets (TSD Appendix I). Effective shade surrogate measure targets represent a surrogate for the amount of solar loading that will attain the HUA and load allocations for nonpoint sources managing streamside vegetation.

DEQ choose to assign a portion of the human use allowance to existing infrastructure (roads, railroads, buildings, and utility corridors) over other land uses because moving, rebuilding, or modifying this infrastructure in addition to restoring streamside vegetation is a much more complex and potentially costly endeavor compared to restoring or protecting existing streamside vegetation in areas without infrastructure constraints. DEQ heard from municipalities commenting on the TMDL these land uses are difficult constraints to restore. In addition, other land uses without infrastructure constraints represent a much higher percentage of streamside area raising issues related to the appropriate amount of vegetation reduction that could occur spatially and over time while still maintaining a small increase such as < 0.05°C, that does not contribute to cumulative temperature impacts downstream.

Based on results presented in Appendix I, very small absolute changes in shade at a site level (not watershed mean) produce measurable temperature increases. We conclude from our data review that the vegetation reduction that will maintain a very small increase such as < 0.05°C, is going to be similar to what is required to maintain no temperature increase. Therefore, to limit the potential for cumulative warming, and as a margin of safety, the assigned human use allowance was set to zero.

DEQ assigned a load allocation and HUA of up to 0.05°C for temperature impacts associated with surface water withdrawals. This nonpoint source category accounts for warming from the withdrawal of water that is intended for consumptive uses (such as irrigation), and the warming that might occur as that water moves through a canal or ditch before being returned to the natural river. DEQ Section 7.2.3 summarizes the temperature impacts from consumptive uses evaluated by DEQ.

DEQ assigned a load allocation and HUA of 0.00°C (no warming) to temperature impacts associated with dam and reservoir operations, except for the PGE Willamette Falls Hydroelectric Project. This nonpoint source category accounts for warming from dam impoundment and the release of the impounded water back into the natural channel. The no warming requirement is unchanged from the 2006 Willamette Basin TMDL (DEQ, 2006) except this TMDL includes requirements for additional dam and reservoir operators. The 2006 TMDL focused on USACE Willamette Project, EWEB projects, and PGE dam and reservoirs. A surrogate measure temperature target was developed to implement the dam and reservoir HUA and load allocation, (see Section 9.4.1). The PGE Willamette Falls Hydroelectric Project, which influences Willamette River reaches for which spawning is not a designated use, is provided a load allocation of 0.10ºC. This is also unchanged from the 2006 TMDL.

In most AUs, the total assigned portion of the human use allowance to nonpoint sources is an increase relative to the 2006 Willamette Basin temperature TMDL (DEQ, 2006).

DEQ set aside remaining human use allowance for reserve capacity to accommodate future growth, new sources, or to make allocation corrections to any existing source(s) that were assigned an erroneous allocation or may not have been identified during the development of this TMDL. Where possible, DEQ tried to maintain at least 0.01°C for reserve capacity.

9.2 Point source wasteload allocations (WLAs)

DEQ's approach to point sources which do not discharge to the Willamette River or major tributaries (Figure 9-2) was to assign an equal portion of the HUA (0.075°C) up to a maximum of 0.20°C at the point of discharge from all NPDES permitted point sources in an AU, with some exceptions described below. An HUA of 0.075°C to 0.20°C was selected because many of the current NPDES permit limits are based on this amount of allowed warming and it is consistent with the allocation approach in DEQ's 2006 Willamette Basin temperature TMDL (DEQ, 2006).

DEQ's approach to point sources which discharge to the Willamette River or major tributaries (Figure 9-3) was to estimate maximum current thermal loads of each discharge during spring spawning, summer non-spawning, and fall spawning periods. Evaluations were performed to determine if individual or cumulative impacts of current thermal loads exceed acceptable levels. For most cases, it was determined that thermal WLAs could be set equal to or slightly greater than current maximum current thermal loads. In several cases of relatively large thermal loads, WLAs were set to less than current thermal loads.

The following describes other factors DEQ considered when assigning an HUA to point sources:

- If a point source is not authorized to discharge in the current NPDES permit (maximum effluent flow = 0), for most facilities an HUA of 0.00°C was assigned during the no discharge period. A human use allocation of zero means there may be no warming above the applicable temperature criteria.
- When analysis completed for the TMDL indicated current thermal loads are less than 0.075°C, the HUA assigned was reduced to be consistent with the current thermal load.
- The assigned HUA was increased above 0.075°C to a maximum of 0.20°C for any single point source when analysis indicated that 0.075 would result in immediate noncompliance. DEQ only increased the HUA if there was sufficient loading capacity available. Point sources were not assigned more than 0.20°C in order to have capacity available for nonpoint sources and reserve capacity. An assessment of current thermal

loading was not possible for all point sources due to project time constraints or lack of data. DEQ prioritized source assessment for point sources discharging to modeled streams; based on information DEQ received at TMDL Rule Advisory Committee meetings; based on comments received during the public comment period, or for facilities that DEQ staff knew or suspected an allocation based on an assigned 0.075 HUA would result in immediate noncompliance. These staff judgments were based on previous communications with the permittee, compliance history, review of DMRs, facility inspections, information contained in the permit or permit fact sheets, and previous analysis.

- On modeled streams, a characterization of point source discharge and cumulative effects analysis was completed. The results of the characterization and modeling informed the portion of the HUA assigned. Model based analysis were completed for point sources discharging to the McKenzie River, Pudding River, and Molalla River.
- On unmodeled streams where a cumulative effects modeling analysis was not completed, the total portion of the HUA allocated to the point source sector represents the sum of the individual HUA assignments. For example, a stream with two NPDES discharges that each have 0.075°C assigned at the point of discharge would have a point source sector allocation of 0.15°C cumulatively at the POMI. DEQ considered the sum of HUA assignments from upstream NPDES discharges when assigning the point source sector for downstream AUs. This was done to ensure there would be no exceedance to the allocated portion of the HUA. The approach is protective based on model results from other streams that show the temperature impacts dissipating moving downstream from the outfall.

Section 9.2.1 summarizes the assigned portion of the HUA for each point source, the findings from the assessment of current thermal loading, and the source of effluent discharge used in the wasteload allocation equation.

Figure 9-2 and **Figure 9-3** show the portion of the HUA assigned to NPDES point sources for each AU within the Willamette subbasins TMDL project area and the Willamette mainstem and major tributaries TMDL project area, respectively. **Figure 9-4** and **Figure 9-5** illustrate the total number of NPDES point sources discharging to each AU within the Willamette subbasins TMDL project area and the Willamette mainstem and major tributaries TMDL project area, respectively. The total count includes point sources discharging to a particular AU as well as those discharging to an AU directly upstream. For example, an AU with a total point source count of one could represent two potential scenarios, the first being that a single point source discharges directly to the AU with no immediate upstream sources. Alternatively, a point source count of one could indicate that no point sources discharge to the AU itself, but that a point source discharges to an AU directly upstream.

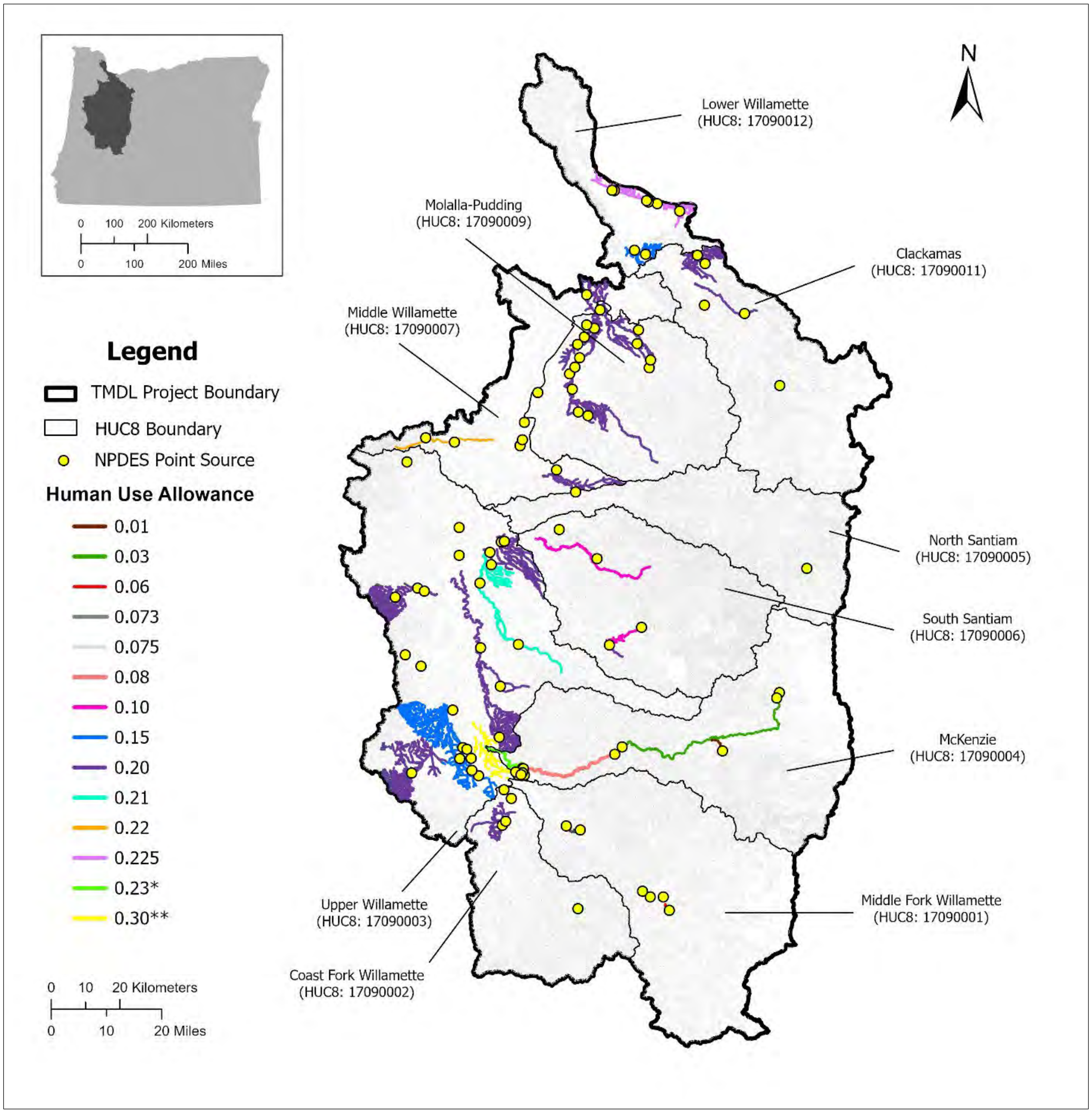


Figure 9-2: Assigned HUAs for NPDES point sources in each AU within the Willamette subbasins TMDL project area.

*HUA of 0.23 applies to the assessment unit OR_SR_1709000407_02_103884 (McKenzie River Mile 0 – 10.8) during the fall spawning period. During the spring spawning period and the summer non-spawning period, HUAs of 0.20 and 0.22 apply, respectively.

**HUA of 0.30 applies to the assessment unit OR_WS_170900030601_02_ 104287 between May 1 and May 31. From June 1 through October 31, the HUA is 0.225.

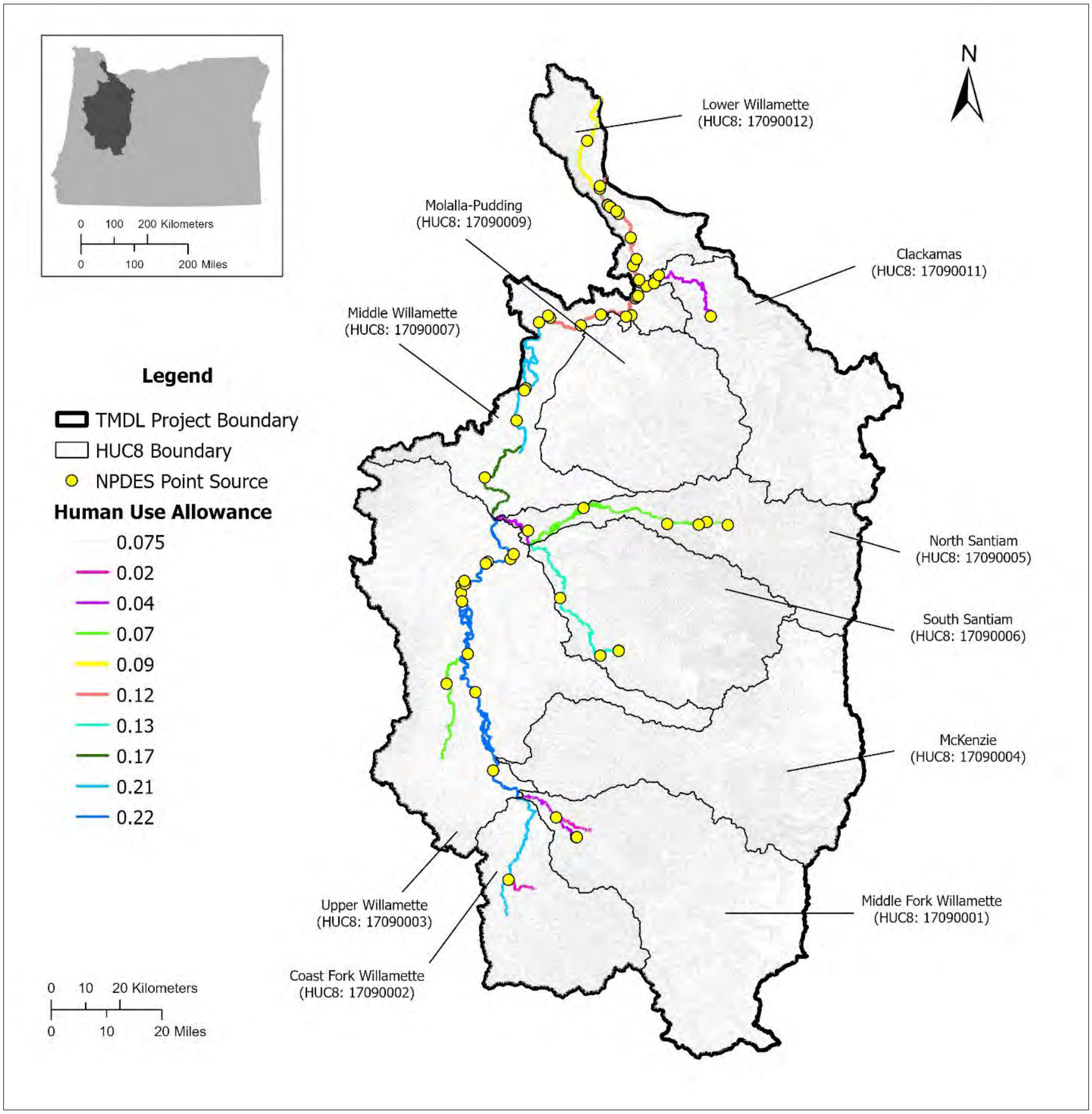


Figure 9-3: Assigned HUAs for NPDES point sources in each AU within the Willamette mainstem and major tributaries TMDL project area.

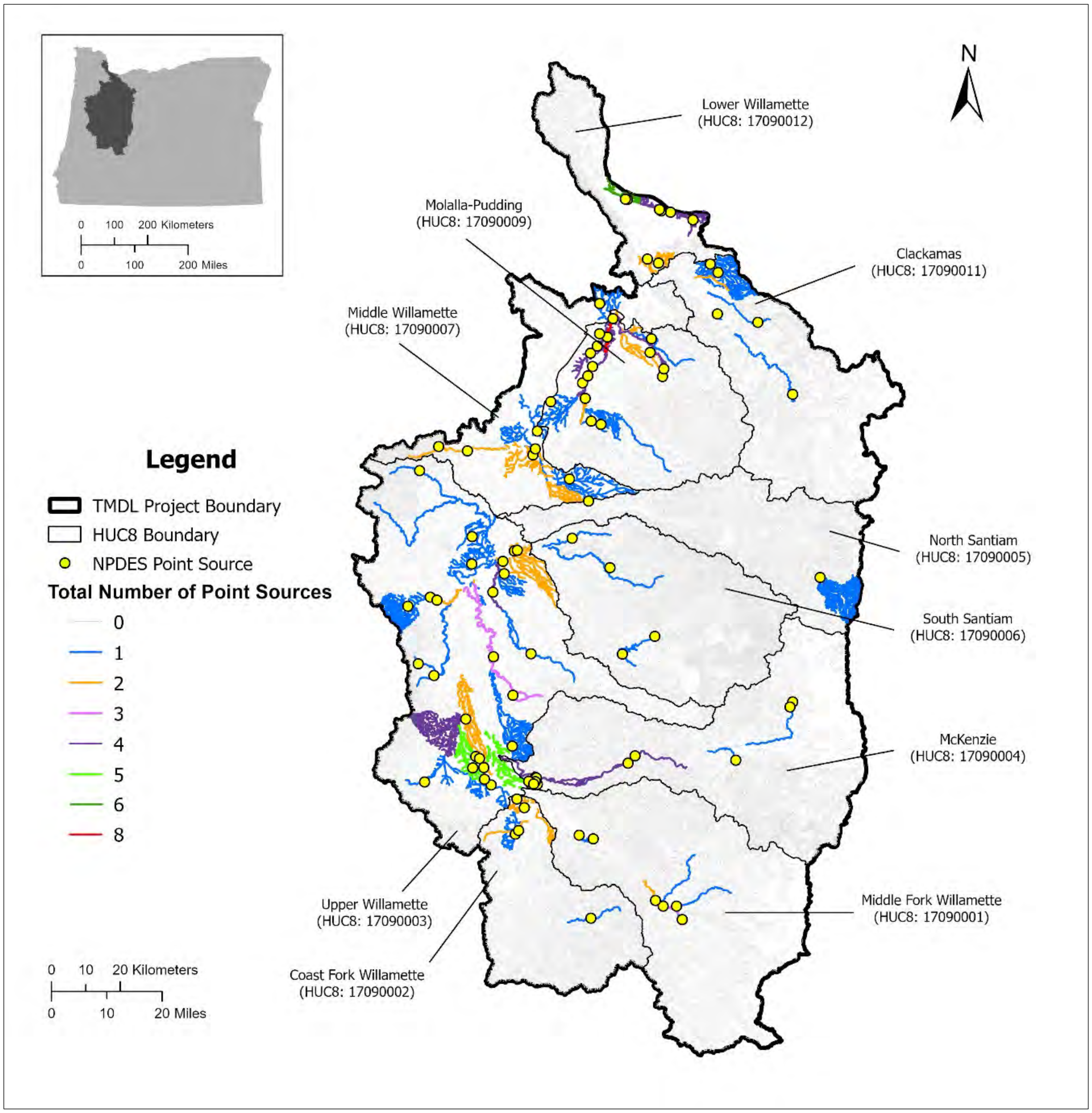


Figure 9-4: Total number of NPDES point sources discharging to each AU within the Willamette subbasins TMDL project area.

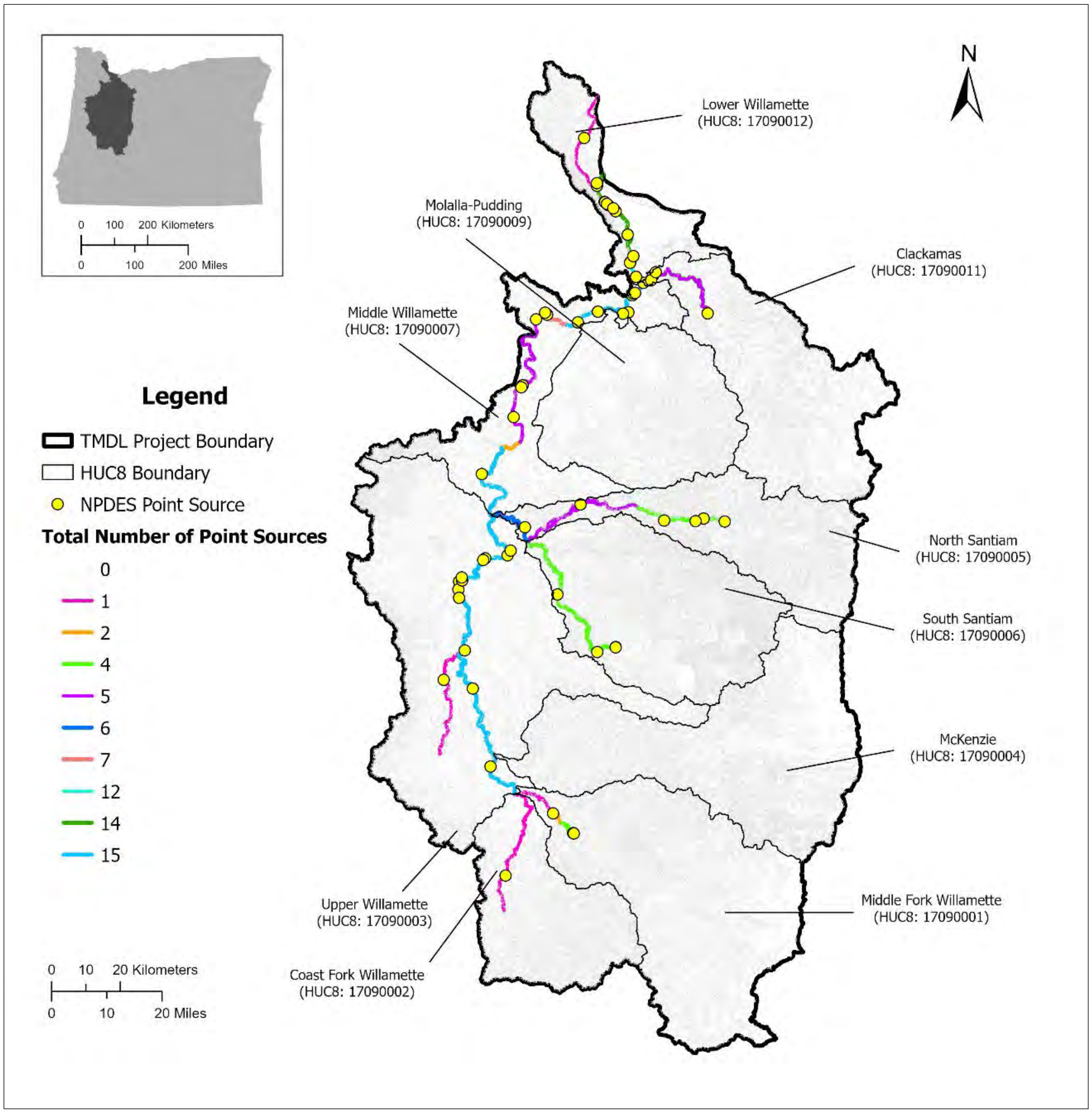


Figure 9-5: Total number of NPDES point sources discharging to each AU within the Willamette River mainstem and major tributaries TMDL project area.

9.2.1 HUA assignments to point sources

This section summarizes the assigned portion of the HUA for each point source, the rationale, the findings from the assessment of current thermal loading, and the source of effluent discharge used in the wasteload allocation equation. Unless noted, 7Q10 was assumed as the river flow for the loading assessments. 7Q10 details for each point source are summarized in Section 6.4 and **Table 6-3**.

For Willamette Mainstem reaches, the assigned portion of the HUA for each point source, the rationale, the findings from the assessment of current thermal loading, and the source of effluent discharge used in the wasteload allocation equation are described in Appendix M.

9.2.1.1 Albany Water Treatment Plant (66584)

The assessment of thermal loading for Albany Water Treatment Plant (WQ File#: 66584, EPA Number:ORG383501) found that an HUA of 0.075°C would result in noncompliance. The assigned HUA is increased to 0.20°C, which reduces the noncompliance days based on the data available. The effluent flow used in the wasteload allocation equation is based on the maximum effluent flow reported in DMRs, which is 0.81 MGD (1.3 cfs) from August 2018. Temperature is not reported on 200-J DMRs so a maximum temperature could not be determined. A maximum effluent temperature of 24°C was used when year-round criterion apply for estimation purposes. See Section 7.1.2.2 for additional details.

9.2.1.2 Alpine Community (100101)

Alpine Community (WQ File#: 100101, EPA Number: OR0032387) is assigned an HUA of 0.00°C based on no discharge requirements in the NPDES permit for the allocation period. The average dry weather design flow (ADWDF) reported in the permit is 0.02 MGD (0.03 cfs).

9.2.1.3 Arclin (16037)

Arclin (WQ File#: 16037, EPA Number: OR0021857) is assigned an HUA of 0.075°C. The effluent flow used in the wasteload allocation equation is based on the maximum effluent flow allowed in the permit, which is 1.00 MGD (1.55 cfs).

9.2.1.4 Arclin (81714)

Arclin (WQ File#: 81714, EPA Number: OR0000892) is assigned an HUA of 0.075°C. The effluent flow used in the wasteload allocation equation is from the NPDES Permit Evaluation and Fact Sheet dated July 21, 2009, which is 0.93 cfs.

9.2.1.5 ATI Albany Operations (64300)

ATI Albany Operations (WQ File#: 64300, EPA Number: OR0001716) is assigned an HUA of 0.01°C. Discharge is intermittent and effluent temperatures rarely exceed the temperature criterion because wastewater is mixed with cooler groundwater. An assessment of loading was completed for the period of May – October 2014-2020. During this period there were only two days reported on DMRs with daily maximum effluent temperatures warmer than the criterion. These two days did not result in warming over the 7-day averaging period (zero increase). DEQ assigned 0.01°C to allow for some warming in the event there is a ramp up of days with warmer temperatures. The effluent flow used in the wasteload allocation equation is based on the maximum effluent flow reported in DMRs, 2.278 MGD (3.5 cfs) on September 17, 2015.

9.2.1.6 Aumsville STP (4475)

Aumsville STP (WQ File#: 4475, EPA Number: OR0022721) is assigned an HUA of 0.00°C based on no discharge requirements in the NPDES permit for the allocation period. The ADWDF reported in the permit is 0.335 MGD (0.52 cfs).

9.2.1.7 Aurora STP (110020)

Aurora STP (WQ File#: 110020, EPA Number: OR0043991) is assigned an HUA of 0.00°C based on no discharge requirements in the NPDES permit for the allocation period. The ADWDF reported in the permit is 0.087 MGD (0.1 cfs)

9.2.1.8 Bakelite Chemicals LLC (32650)

Bakelite Chemicals LLC (WQ File#: 32650, EPA Number: OR0032107) is assigned an HUA of 0.00°C based on no discharge requirements in the NPDES permit for the allocation period.

9.2.1.9 Bakelite Chemicals LLC (32864)

Bakelite Chemicals LLC (WQ File#:32864, EPA Number: OR0002101) is assigned an HUA of 0.00°C during the no discharge period described in the NPDES permit (June 1 – October 31). When discharge is allowed during the allocation period, the assigned HUA is 0.075°C. The effluent flow used in the wasteload allocation equation for the discharge period is based on discharge reported on May 2019 and 2020 DMRs for Outfall 001, which is 0 cfs.

9.2.1.10 Blount Oregon Cutting Systems Division (63545)

The assessment of thermal loading for Blount Oregon Cutting Systems Division (WQ File#: 63545, EPA Number: OR0032298) found that an HUA of 0.075°C would not result in exceedances based on the data available. Therefore, the assigned HUA is 0.075°C. The effluent flow used in the wasteload allocation equation is the maximum flow from August 2009 to July 2012 reported in the Permit Evaluation Report dated August 19, 2010, which is the 0.19 cfs.

9.2.1.11 Boeing of Portland – Fabrication Division (9269)

Boeing of Portland – Fabrication Division (WQ File #: 9269, EPA Number: OR0031828) is assigned an HUA of 0.075°C. The effluent flow used in the wasteload allocation equation is the average combined discharge flow for 2012 reported in the Permit Evaluation Report dated June 18, 2012, which is 0.46 cfs.

9.2.1.12 Brownsville STP (11770)

Brownsville STP (WQ File#: 11770, EPA Number: OR0020079) is assigned an HUA of 0.00°C based on no discharge requirements in the NPDES permit for the allocation period.

9.2.1.13 City of Silverton Drinking WTP (81398)

The City of Silverton Drinking WTP (WQ File#: 81398, EPA Number: ORG383527) is assigned an HUA of 0.20°C based on the assessment of loading and allocation in the 2008 TMDL. The effluent flow used in the wasteload allocation calculation is the maximum typical average monthly discharge reported between 2000 and 2007 in the 2008 TMDL (pages 2-28), which is 0.05 MGD (0.08 cfs). Temperature is not reported on 200-J DMRs so a maximum temperature could not be determined. A maximum effluent temperature of 24°C was used when year-round criterion apply and 17°C was used during the spawning period for estimation purposes. See Section 7.1.2.2 for additional details.

9.2.1.14 Coburg Wastewater Treatment Plant (115851)

The assessment of thermal loading for Coburg Wastewater Treatment Plant (WQ File#: 115851, EPA Number: OR0044628) found that an HUA of 0.075°C would result in noncompliance. The assigned HUA is increased to 0.20°C, which reduces the noncompliance days based on the data available. The effluent flow used in the wasteload allocation equation is the ADWDF reported in the NPDES permit, which is 0.44 MGD (0.68 cfs).

9.2.1.15 Coffin Butte Landfill (104176)

Coffin Butte Landfill (WQ File#:104176, EPA Number: OR0043630) is assigned an HUA of 0.075°C. The effluent flow used in the wasteload allocation equation is based on a review of DMRs showing no discharge (0 MGD).

9.2.1.16 Columbia Helicopters (100541)

Columbia Helicopters (WQ File#: 100541, EPA Number: OR0033391) is assigned an HUA of 0.075°C. The effluent flow used in the wasteload allocation equation is the peak design flow listed in the Permit Evaluation Report received 2/6/2007 (expired March 19, 2019), which is 0.01 cfs. Based on review of DMRs, Columbia Helicopters has very infrequent discharge.

9.2.1.17 Corvallis Rock Creek WTP (20160)

The assessment of thermal loading for Corvallis Rock Creek WTP (WQ File#: 20160, EPA Number: ORG383513) found that an HUA of 0.075°C would result in noncompliance. The assigned HUA was increased to 0.20°C, which reduces the noncompliance days based on the data available. The effluent flow used in the wasteload allocation equation is the maximum flow reported in recent DMRs, which is 0.24 MGD (0.37 cfs) reported in August 2019. Temperature is not reported on 200-J DMRs so a maximum temperature could not be determined. A maximum effluent temperature of 24°C was used when year-round criterion apply for estimation purposes. See Section 7.1.2.2 for additional details.

9.2.1.18 Creswell STP (20927)

Creswell STP (WQ File#: 20927, EPA Number: OR0027545) is assigned an HUA of 0.00°C during the no discharge period described in the NPDES permit (June 1 – October 31). The assessment of thermal loading for discharge during the allocation period found that an HUA of 0.075°C would result in noncompliance. When discharge is allowed during the allocation period, the assigned HUA is increased to 0.20°C, which reduces the noncompliance days based on the data available. The effluent flow used in the wasteload allocation equation for the discharge period is based on the maximum flow reported in DMRs for April and May in 2019 and 2020, which is 3.29 MGD (5.09 cfs). The ADWDF in the NPDES permit is 0.20 MGD (0.31 cfs).

The assigned HUA was increased to 0.20°C, which reduced the noncompliance days based on the data available.

9.2.1.19 Dallas STP (22546)

The assessment of thermal loading for Dallas STP (WQ File#: 22546, EPA Number: OR0020737) found that an HUA of 0.075°C would result in noncompliance. The assigned HUA is increased to 0.11°C, which reduces the noncompliance days based on the data available. The effluent flow used in the wasteload allocation equation is the ADWDF from the NPDES permit, which is 2.0 MGD (3.09 cfs).

9.2.1.20 Dallas WTP (22550)

The assessment of thermal loading for Dallas WTP (WQ File#: 22550, EPA Number: ORG383529) found that an HUA of 0.075°C would result in noncompliance. The assigned HUA is increased to 0.11°C, which reduces the noncompliance days based on the data available. The assigned HUA could not be increased because available capacity has been distributed to other NPDES permitted point sources. The effluent flow used in the wasteload allocation equation is the maximum flow reported in recent DMRs, which is 0.1111 MGD (0.17 cfs) from August 2020. Temperature is not reported on 200-J DMRs so a maximum temperature could not be determined. A maximum effluent temperature of 24°C was used when year-round criterion apply and 17°C was used during the spawning period for estimation purposes. See Section 7.1.2.2 for additional details.

9.2.1.21 Deer Creek Estates Water Association (23650)

The assessment of thermal loading for Deer Creek Estates Water Association (WQ File#: 23650, EPA Number: ORG383526) found that an HUA of 0.075°C would result in noncompliance. The assigned HUA is increased to 0.20°C, which reduces the noncompliance days based on the data available. The effluent flow used in the wasteload allocation equation is from the 1978 NPDES permit application, which is 2,400 gallons/day (0.004 cfs). Temperature is not reported on 200-J DMRs so a maximum temperature could not be determined. A maximum effluent temperature of 24°C was used when year-round criterion apply for estimation purposes. See Section 7.1.2.2 for additional details.

9.2.1.22 Duraflake (97047)

The assessment of thermal loading for Duraflake (WQ File#: 97047, EPA Number: OR0000426) found that an HUA of 0.075°C would result in noncompliance. The assigned HUA is increased to 0.20°C, which reduces the noncompliance days based on the data available. The effluent flow used in the wasteload allocation equation is the sum of the 95th percentile flows from outfall 002 and outfall 003 reported in the NPDES permit, which is 0.356854 MGD (0.55 cfs).

9.2.1.23 Estacada STP (27866)

Estacada STP (WQ File#: 27866, EPA Number: OR0020575) is assigned an HUA of 0.075°C. The effluent flow used in the wasteload allocation equation is the maximum flow reported in the NPDES Permit Evaluation from May to October 2009, which is 0.84 cfs.

9.2.1.24 EWEB Carmen-Smith Carmen Powerhouse Outfalls 001A and 001B (28393)

EWEB Carmen-Smith Powerhouse Outfalls 001A and 001B (WQ File#: 28393, EPA Number: OR0000680) are assigned an HUA of 0.075°C. The effluent flow used in the wasteload allocation equation is based on the NPDES permit requirement limiting Outfall 001 maximum flow to 1.73 MGD (2.68 cfs).

9.2.1.25 EWEB Carmen-Smith Trail Bridge Powerhouse Outfalls 002A and 002B (28393)

The assessment of thermal loading for EWEB Carmen-Smith Powerhouse Outfalls 002A and 002B (WQ File#: 28393, EPA Number: OR0000680) found that an HUA of 0.030°C would result in compliance based on data available. The effluent flow used in the wasteload allocation equation is based on the NPDES permit requirement limiting Outfall 002 average flow to 0.6 MGD (0.93 cfs). The WLA was also evaluated in the Upper McKenzie River Heat Source model and downstream of the South Fork McKenzie in the McKenzie River CE-QUAL-W2 model.

9.2.1.26 EWEB Hayden Bridge Filter Plant (28385)

The assessment of thermal loading for EWEB Hayden Bridge Filter Plant (WQ File#: 28385, EPA Number: ORG383503) found that an HUA of 0.010°C would result in compliance based on data available. Effluent temperatures were not available and estimated to be 24°C when year-round criterion apply and 17°C during spawning. The effluent flow used in the wasteload allocation equation is the maximum flow reported in recent DMRs, which is 1.35 MGD (2.09 cfs) from June 2019. Temperature is not reported on 200-J DMRs so a maximum temperature could not be determined. A maximum effluent temperature of 24°C was used when year-round criterion apply and 17°C was used during the spawning period for estimation purposes. See Section 7.1.2.2 for additional details.

9.2.1.27 Falls City STP (28830)

Falls City STP (WQ File#: 28830, EPA Number: OR0032701) is assigned an HUA of 0.00°C based on no discharge requirements in the NPDES permit for the allocation period.

9.2.1.28 Foster Farms (97246)

Foster Farms (WQ File#: 97246, EPA Number: OR0026450) is assigned an HUA of 0.00°C based on no discharge requirements in the NPDES permit for the allocation period.

9.2.1.29 Fujimi Corporation – SW Commerce Circle (107178)

The assessment of thermal loading for Fujimi Corporation (WQ File#: 107178, EPA Number: OR0040339) found that an HUA of 0.075°C would result in noncompliance. The assigned HUA is increased to 0.20°C, which reduces the noncompliance days based on the data available. The effluent flow used in the wasteload allocation equation is discharge reported on the Permit Evaluation and Fact Sheet dated September 4, 2012, which is 0.2 cfs.

9.2.1.30 Gervais STP (33060)

Gervais STP (WQ File#: 33060, EPA Number: OR0027391) is assigned an HUA of 0.00°C based on no discharge requirements in the NPDES permit for the allocation period. The ADWDF reported in the NPDES permit is 0.22 MGD (0.34 cfs).

9.2.1.31 Halsey STP (36320)

Halsey STP (WQ File#: 36320, EPA Number: OR0022390) is assigned an HUA of 0.00°C based on no discharge requirements in the NPDES permit for the allocation period. The ADWDF reported in the NPDES permit is 0.197 MGD (0.30 cfs).

9.2.1.32 Hubbard STP (40494)

Hubbard STP (WQ File#:40494, EPA Number: OR0020591) is assigned an HUA of 0.20°C based on the assessment of loading and allocation in the 2008 Molalla-Pudding TMDL (DEQ, 2008c). The effluent flow used in the wasteload allocation equation is the maximum monthly dry weather design flow reported in the 2022 NPDES Permit Fact Sheet, which is 0.35 cfs.

9.2.1.33 Hull-Oakes Lumber Co. (107228)

The assessment of thermal loading for Hull-Oakes Lumber Co. (WQ File#: 107228, EPA Number: OR0038032) found that an HUA of 0.075°C would result in compliance based on the data available. The effluent flow used in the wasteload allocation equation is the maximum flow reported for Outfall 002 in recent DMRs, which is 0.05 MGD (0.08 cfs). The NPDES permit states that Outfall 001 does not discharge from July 1 to October 31.

9.2.1.34 International Paper – Springfield - 200-J (108921)

The assessment of thermal loading for International Paper – Springfield (WQ File#: 108921, EPA Number: ORG383548) found that an HUA of 0.075°C would result in noncompliance based on the data available. The assigned HUA could not be increased because all available capacity has been distributed to other NPDES permitted point sources that discharge to the canal and ditch network leading to Q Street Canal. The effluent flow used in the wasteload allocation equation is the maximum discharge reported in recent DMRs, which is 0.0045 MGD (0.01 cfs) from June 2020. Temperature is not reported on 200-J DMRs so a maximum temperature could not be determined. A maximum effluent temperature of 24°C was used when year-round criterion apply for estimation purposes. See Section 7.1.2.2 for additional details.

9.2.1.35 International Paper – Springfield Outfalls 001 and 002 (96244)

International Paper – Springfield Outfalls 001 and 002 (WQ File#: 96244, EPA Number: OR0000515) is assigned a HUA of 0.12°C during the Spring spawning period (April 1 – June 15), 0.20°C during the non-spawning period (June 16 – August 31), and 0.19°C during the Fall spawning period (September 1 – November 15). Cumulative effects modeling shows that these allocations will result in a maximum river temperature increases due to point sources of 0.22°C during the summer and fall and less during spring. The spawning and non-spawning periods given are relative to the wasteload allocation period for the point of discharge and are not representative of the entire spawning period for the McKenzie River. The April 1 – November 15 period during which wasteload allocations apply is based on the period of temperature criteria exceedance for the Willamette River upstream from Newberg Pool. This April 1 – November 15 is used because McKenzie River thermal loads impact Willamette River temperature. The effluent flow used in the wasteload allocation equation is 28.9 cfs. 28.9 cfs is the effluent flow rate that, along with effluent temperature, results in the greatest river temperature impact for conditions of 7Q10 design low river flow and river temperature equal to the applicable criteria (13°C during spawning periods and 16°C during non-spawning periods).

9.2.1.36 International Paper – Springfield Outfall 003 (96244)

International Paper – Springfield Outfall 003 (WQ File#: 96244, EPA Number: OR0000515) is assigned an HUA of 0.075°C. The effluent flow used in the wasteload allocation equation is the maximum discharge reported in May – October in DMRs from 2013 to 2016, which is 2.0 MGD (3.09 cfs).

9.2.1.37 J.H. Baxter & Co (6553)

J.H. Baxter & Co (WQ File#: 6553, EPA Number: OR0021911) is assigned an HUA of 0.075°C. The effluent flow used in the wasteload allocation equation is the average discharge flow reported in the NPDES Permit Evaluation dated 9/13/2010, which is 0.12 cfs. J.H. Baxter has stopped operation of wood treating, but their NPDES permit is still active and there remains a discharge associated with groundwater and stormwater treatment. It is expected discharge will continue until the site has been fully remediated.

9.2.1.38 JLR (32536)

JLR (WQ File#: 32536, EPA Number: OR0001015) is assigned an HUA of 0.01°C based on the assessment of loading and allocation in the 2008 Molalla-Pudding TMDL (DEQ, 2008c). The effluent flow used in the wasteload allocation equation is the maximum discharge reported in 2018-2020 DMRs from April to October, which is 0.5 cfs.

9.2.1.39 Junction City STP (44509)

Junction City STP (WQ File#: 44509, EPA Number: OR0026565) is assigned an HUA of 0.0°C based on no discharge requirements in the NPDES permit for the allocation period.

9.2.1.40 Kingsford Manufacturing Company – Springfield Plant (46000)

Kingsford Manufacturing Company - Springfield Plant (WQ File#: 46000, EPA Number: OR0031330) is assigned an HUA of 0.0°C when the no discharge requirements in the NPDES permit apply (June 1 – October 31). An HUA of 0.075°C is assigned when discharge is permitted during the allocation period (May 1 – May 31). When discharge is permitted, the effluent flow used in the wasteload allocation equation is the maximum effluent flow reported in recent DMRs, which is 0.08 cfs in April 2020.

9.2.1.41 Knoll Terrace Mhc (46990)

Knoll Terrace Mhc (WQ File#: 46990, EPA Number: OR0026956) is assigned an HUA of 0.0°C based on no discharge requirements in the NPDES permit. The ADWDF from the NPDES permit is 0.06 MGD (0.09 cfs).

9.2.1.42 Lakewood Utilities, Ltd (96110)

Lakewood Utilities, Ltd (WQ File#: 96110, EPA Number: OR0027570) is assigned an HUA of 0.0°C based on no discharge requirements in the NPDES permit.

9.2.1.43 Lane Community College (48854)

Lane Community College (WQ File#: 48854, EPA Number: OR0026875) is assigned an HUA of 0.0°C based on no discharge requirements in the NPDES permit. The ADWDF from the NPDES permit is 0.142 MGD (0.22 cfs)

9.2.1.44 Lowell STP (51447)

The assessment of thermal loading for Lowell STP (WQ File#: 51447, EPA Number: OR0020044) found that an HUA of 0.013 would result in compliance based on the data available. The effluent flow used in the wasteload allocation equation is the maximum discharge reported during the allocation period in DMRs from 2015 to 2020, which is 0.790 MGD (1.22 cfs) in July 2017.

9.2.1.45 Mcfarland Cascade Pole & Lumber Co (54370)

Mcfarland Cascade Pole & Lumber Co (WQ File#: 54370, EPA Number: OR0031003) is assigned an HUA of 0.0°C based on NPDES permit limitations requiring effluent temperatures to not exceed 17.8°C from May 1 to October 31. When this requirement is met, there are no stream temperature increases above the applicable temperature criterion.

9.2.1.46 Molalla Municipal Drinking WTP (109846)

Molalla Municipal Drinking WTP (WQ File#: 109846, EPA Number: ORG380014) is assigned an HUA of 0.20°C based on the assessment of thermal loading and allocation given in the 2008 Molalla-Pudding TMDL (DEQ, 2008c). The effluent flow used in the wasteload allocation equation is based on the maximum reported on recent DMRs, 0.1024 MGD (0.16 cfs) June 2021. Temperature is not reported on 200-J DMRs so a maximum temperature could not be determined. A maximum effluent temperature of 24°C was used when year-round criterion apply and 17°C was used during the spawning period for estimation purposes. See Section 7.1.2.2 for additional details.

9.2.1.47 Molalla STP (57613)

The assessment of thermal loading for Molalla STP (WQ File#: 57613, EPA Number: OR0022381) found that an HUA of 0.10°C would result in compliance based on the data available. The effluent flow used in the wasteload allocation equation is the maximum effluent flow reported between March and October in recent DMRs, which is 2.234 MGD (3.46 cfs).

9.2.1.48 Mt. Angel STP (58707)

Mt. Angel STP (WQ File#: 58707, EPA Number: OR0028762) is assigned an HUA of 0.0°C based on no discharge requirements in the NPDES permit for the allocation period. The ADWDF in the permit is 0.56 MGD (0.87 cfs).

9.2.1.49 Murphy Veneer, Foster Division (97070)

The assessment of thermal loading for Murphy Veneer found that an HUA of 0.075°C would result in noncompliance. This assessment was based on allocation period effluent data from 2019 and 2020 DMRs. The assigned HUA was increased to 0.20°C, which reduced the noncompliance days based on the data available. The effluent flow used in the wasteload allocation calculation is the 7-day average flow between June 1 and June 15 reported in the NPDES Permit Evaluation Report dated July 1, 2010, which is 1.11 cfs.

9.2.1.50 Norpac Foods- Plant #1, Stayton (84820)

The assessment of thermal loading for Norpac Foods – Plant #1 (WQ File#: 84820, EPA Number: OR0001228) found that an HUA of 0.075°C would result in noncompliance. This assessment was based on allocation period effluent data from 2019 and 2020 DMRs. The assigned HUA is increased to 0.20°C, which reduces the noncompliance days based on the data available. The effluent flow used in the wasteload allocation calculation is the peak processing flow reported in the NPDES Permit Evaluation Report, which is 6.19 cfs.

9.2.1.51 Oakridge STP (62886)

The assessment of thermal loading for Oakridge STP (WQ File#: 62886, EPA Number: OR0022314) found that an HUA of 0.075°C would result in compliance based on the data available. The effluent flow used in the wasteload allocation calculation is the ADWDF from the NPDES permit, which is 0.47 MGD (0.73 cfs).

9.2.1.52 ODC – Oregon State Penitentiary (109727)

The assessment of thermal loading for Oregon State Penitentiary (WQ File#:109727, EPA Number: OR0043770) found that an HUA of 0.075°C would result in compliance based on the data available. The effluent flow used in the wasteload allocation calculation is the maximum flow authorized in the NPDES permit, which is 1.6 MGD (2.48 cfs).

9.2.1.53 ODFW – Marion Forks Fish Hatchery (64495)

ODFW – Marion Forks Fish Hatchery (WQ File#: 64495, EPA Number: OR0027847) is assigned an HUA of 0.075°C. The effluent flow used in the wasteload allocation equation is the maximum flow from data submitted by ODFW, which is 18.6 cfs.

9.2.1.54 ODFW – Roaring River Fish Hatchery (64525)

The assessment of thermal loading completed by ODFW for ODFW - Roaring River Hatchery (WQ File#:64525, EPA Number: ORG133506) found that an HUA of 0.10°C would result in compliance based on the data available. The effluent flow used in the wasteload allocation equation is the maximum flow from data submitted by ODFW, which is 14.2 cfs.

9.2.1.55 ODFW – Willamette Fish Hatchery (64585)

ODFW - Willamette Fish Hatchery (WQ File#: 64585, EPA Number: ORG133507) is assigned an HUA of 0.075°C. The effluent flow used in the wasteload allocation equation is the maximum of the combined discharges from Outfalls 001 and 002 as summarized from data submitted by ODFW.

9.2.1.56 ODFW – Leaburg Fish Hatchery (64490)

ODFW Leaburg Fish Hatchery (WQ File#: 64490, EPA Number: OR0027642) is assigned an HUA of 0.074°C during the Spring spawning period (April 1 – June 15), 0.012°C during the non-spawning period (June 16 – August 31), and 0.026°C during the Fall spawning period (September 1 – November 15). The spawning and non-spawning periods given are relative to the wasteload allocation period for the point of discharge and are not representative of the entire spawning period for the McKenzie River. The effluent discharge used in the wasteload allocation equation for the spring spawning period is 92.4 cfs, the non-spawning period is 39.1 cfs, and the fall spawning period is 78.3 cfs. The effluent flows used in the wasteload allocation equations are from discharge data submitted by ODFW for the period of 2016 to 2023.

9.2.1.57 ODFW – McKenzie River Fish Hatchery (64500)

ODFW McKenzie River Fish Hatchery (WQ File#: 64500, EPA Number: OR0029769) is assigned an HUA of 0.002°C during the Spring spawning period (April 1 – June 15), 0.033°C during the non-spawning period (June 16 – August 31), and 0.002°C during the Fall spawning period (September 1 – November 15). The spawning and non-spawning periods given are relative to the wasteload allocation period for the point of discharge and are not representative of the entire spawning period for the McKenzie River. The effluent discharge used in the wasteload allocation equation for the spring spawning period is 12.7 cfs, the non-spawning period is 11.8 cfs, and the fall spawning period is 1.0 cfs. The effluent flows used in the wasteload allocation equations are from discharge data submitted by ODFW for the period of 2016 to 2023.

9.2.1.58 Philomath WTP (100048)

The assessment of thermal loading for Philomath WTP (WQ File#: 100048, EPA Number: ORG383536) found that an HUA of 0.075 would result in noncompliance. The assigned HUA is increased to 0.20°C. The effluent flow used in the wasteload allocation equation is the maximum daily discharge reported in the NPDES Permit Application dated 12/06/2001, which is 0.207 MGD (0.32 cfs). Temperature is not reported on 200-J DMRs so a maximum temperature could not be determined. A maximum effluent temperature of 24°C was used when year-round criterion apply and 17°C was used during the spawning period for estimation purposes. See Section 7.1.2.2 for additional details.

9.2.1.59 Philomath WWTP (103468)

Philomath WWTP (WQ File#: 103468, EPA Number: OR0032441) is assigned an HUA of 0.0°C based on no discharge requirements in the NPDES permit for the allocation period.

9.2.1.60 PNW Veg Co DBA Norpac Foods No. 5 (84791)

PNW Veg Co DBA Norpac Foods No. 5 (WQ File#: 84791, EPA Number: OR0021261) is assigned an HUA of 0.0°C based on no discharge requirements in the NPDES permit for the allocation period.

9.2.1.61 Row River Valley Water District (100075)

The assessment of thermal loading for Row River Valley Water District (WQ File#: 100075, EPA Number: ORG383534) found that an HUA assignment of 0.075°C would result in compliance based on the data available. The effluent flow used in the wasteload allocation equation is the maximum reported in DMRs between October 2012 and May 2013, which is 0.028 MGD (0.04 cfs). Temperature is not reported on 200-J DMRs so a maximum temperature could not be determined. A maximum effluent temperature of 24°C was used when year-round criterion apply for estimation purposes. See Section 7.1.2.2 for additional details.

9.2.1.62 RSG Forest Products – Liberal (72596)

RSG Forest Products – Liberal (WQ File#: 72596, EPA Number: OR0021300) is assigned an HUA of 0.20°C. An assessment of thermal loading was not completed for this facility due to a lack of discharge data. The HUA was increased from what was assigned in the 2008 Molalla-Pudding TMDL (0.16°C) to minimize the likelihood of noncompliance.

9.2.1.63 Sandy WWTP (78615)

Sandy WWTP (WQ File#: 78615, EPA Number: OR0026573) is assigned an HUA of 0.0°C based on no discharge requirements in the NPDES permit for the allocation period. DEQ is aware that a HUA of 0.0°C may result in noncompliance during wet weather periods. The City of Sandy WWTP is under an EPA consent decree to upgrade and add treatment capacity. At the time of writing, the city has provided DEQ with an NPDES permit application to upgrade and construct a new outfall to the Sandy River. DEQ evaluated this potential discharge in the Temperature TMDLs for the Lower Columbia-Sandy Subbasin (DEQ, 2024) and provided a wasteload allocation based on the discharge location proposed in the NPDES application. DEQ believes this allocation will be sufficient to allow summer and wet weather discharge.

9.2.1.64 Scio STP (79633)

Scio STP (WQ File#: 79633, EPA Number: OR0029301) is assigned an HUA of 0.0°C based on no discharge requirements in the NPDES permit for the allocation period. The ADWDF in the NPDES permit is 0.09 MGD (0.14 cfs).

9.2.1.65 Seneca Sawmill Company (80207)

Seneca Sawmill Company (WQ File#: 80207, EPA Number: OR0022985) is assigned an HUA of 0.0°C based on NPDES permit requirements limiting effluent temperature to no more than 18.0°C, which results in no increases above the applicable temperature criterion. The effluent flow reported in the Permit Evaluation and Fact Sheet dated June 15, 2006 is 1.19 cfs.

9.2.1.66 SFPP (103159)

SFPP (WQ File#: 103159, EPA Number: OR0044661) is assigned an HUA of 0.075°C. The effluent flow used in the wasteload allocation equation is flow reported in the Permit Evaluation Report dated August 19, 2009, which is 0.02 cfs.

9.2.1.67 Sherman Bros. Trucking (36646)

Sherman Bros. Trucking (WQ File#: 36646, EPA Number: OR0021954) is assigned an HUA of 0.0°C based on no discharge requirements in the NPDES permit for the allocation period. The ADWDF in the NPDES permit is 0.014 MGD (0.02 cfs).

9.2.1.68 Silverton STP (81395)

Silverton STP (WQ File#: 81395, EPA Number: OR0020656) is assigned an HUA of 0.20°C based on the assessment of loading and allocation in the 2008 Molalla-Pudding TMDL (DEQ, 2008c). The effluent flow used in the wasteload allocation equation is the ADWDF from the NPDES permit, which is 2.5 MGD (3.87 cfs).

9.2.1.69 Sunstone Circuits (26788)

Sunstone Circuits (WQ File#: 26788, EPA Number: OR0031127) is assigned an HUA of 0.04°C based on the assessment of loading and allocation in the 2008 Molalla-Pudding TMDL (DEQ, 2008c). The effluent flow used in the wasteload allocation equation is the design flow from the NPDES permit, which is 0.065 cfs.

9.2.1.70 Tangent STP (87425)

Tangent STP (WQ File#: 87425, EPA Number: OR0031917) is assigned an HUA of 0.0°C based on no discharge requirements in the NPDES permit for the allocation period. The ADWDF in the NPDES permit is 0.11 MGD (0.17 cfs).

9.2.1.71 Timberlake STP (90948)

Timberlake STP (WQ File#: 90948, EPA Number: OR0023167) is assigned an HUA of 0.0°C based on no discharge requirements in the NPDES permit for the allocation period. The ADWDF in the NPDES permit is 0.144 MGD (0.22 cfs).

9.2.1.72 USFW – Eagle Creek National Fish Hatchery (91035)

USFW - Eagle Creek National Fish Hatchery (WQ File#: 91035, EPA Number: OR0000710) is assigned an HUA of 0.20°C based on the assessment of loading and allocation in the 2006 Willamette Basin TMDL (DEQ, 2006). The effluent flow used in the wasteload allocation equation is the effluent flow reported in the 2006 TMDL, which is 52.6 cfs. The 7Q10 calculated upstream of the intake is 21 cfs. However, the NPDES permit fact sheet states the hatchery withdrawals all of the stream flow except for some small amount of leakage past the diversion structure at the intake. For this reason, the 7Q10 flow used to calculate the wasteload allocation was set to zero.

9.2.1.73 U.S. Army Corp of Engineers - Cougar Project (126712)

USACE Cougar Project (WQ File#: 126712) is assigned an HUA of 0.01°C based on an assessment of loading and cumulative effects modeling (TSD Appendix K). The estimated 7DADM temperature increase based on available data is about 0.002ºC during the year-round period and 0.003 ºC during spawning. There were limited effluent data available (one or two grab samples) so the HUA was increased to account for the uncertain characterization. The effluent flow used in the wasteload allocation equation is the sum of the maximum effluent flow rates (0.1368 MGD) reported for each outfall on the NPDES permit application dated 9/23/2019. For effluent temperature the maximum value used was either the flow weighted maximum effluent temperature from all outfalls on the permit application or the maximum 7DADM river temperature downstream of the dam (USGS 14159500) which approximates the temperatures being pulled from the intake and used for non-contact cooling water. River flows were assumed to be at seasonal 7Q10s. See Section 6.4 for 7Q10 details.

9.2.1.74 U.S. Army Corp of Engineers - Detroit Project (126716)

USACE Detroit Project (WQ File#: 126716) is assigned an HUA of 0.10°C based on an assessment of loading. The estimated maximum 7DADM temperature increase based on available data is about 0.082ºC during the year-round period. Spawning does not apply in Big Cliff Reservoir, the receiving stream. There were limited effluent data available (one grab sample per outfall) so the HUA was increased to account for the uncertain characterization. The effluent flow used in the wasteload allocation equation is the sum of the maximum effluent flow rates (5.13 MGD) reported for each outfall on the NPDES permit application dated 9/23/2019. For effluent temperature the maximum value (25.9°C) reported on the permit application was used. River flows were assumed to be at seasonal 7Q10. See Section 6.4 for 7Q10 details.

9.2.1.75 U.S. Army Corp of Engineers - Green Peter Project (126717)

USACE Green Peter Project (WQ File#: 126717) is assigned an HUA of 0.10°C based on an assessment of loading. Based on available effluent data Green Peter will not have a 7DADM temperature increase during the year-round period as temperatures do not exceed the applicable criterion. In the spawning period, the 7DADM temperature increase is estimated to be 0.075 ºC. There were limited effluent data available (one or two grab samples) so the HUA was increased to account for the uncertain characterization. The effluent flow used in the wasteload allocation equation is the sum of the maximum effluent flow rates (1.368 MGD) reported for each outfall on the NPDES permit application dated 9/23/2019. For effluent temperature the maximum value used was either the flow weighted maximum effluent temperature from all outfalls on the permit application or the maximum 7DADM river temperature downstream of the dam (USGS 14186200) which approximates the temperatures being pulled from the intake and used for non-contact cooling water. For the loading assessment seasonal 7Q10s were calculated for each designated use period using the total outflow from the dam including spillway, powerhouse, and regulating outlets 2004 – 2024 (data from USACE). Seasonal 7Q10s are 661 cfs (spring spawning, 5/1 – 5/15), 42 cfs (summer, 5/16-10/14), and 82 cfs (fall spawning, 10/15 – 11/30). See Section 6.4 for 7Q10 details. The maximum temperature increases of 0.075 ºC occurred in the fall spawning period.

9.2.1.76 U.S. Army Corp of Engineers - Hills Creek Project (126699)

USACE Hills Creek Project (WQ File#: 126699) is assigned an HUA of 0.06°C based on an assessment of loading. The estimated maximum 7DADM temperature increase based on available data is about 0.02ºC during the year-round period and 0.04 ºC during spawning. There were limited effluent data available (one or two grab samples) so the HUA was increased to account for the uncertain effluent characterization. The effluent flow used in the wasteload allocation equation is the sum of the maximum effluent flow rates (1.8432 MGD) reported for each outfall on the NPDES permit application dated 9/23/2019. For effluent temperature the maximum value used was either the flow weighted maximum effluent temperature from all outfalls on the permit application or the maximum 7DADM river temperature downstream of the dam (USGS 14145500) which approximates the temperatures being pulled from the intake and used for non-contact cooling water. River flows were assumed to be at seasonal 7Q10s. See Section 6.4 for 7Q10 details.

9.2.1.77 U.S. Army Corp of Engineers - Lookout Point Project (126700)

USACE Lookout Point Project (WQ File#: 126700) is assigned an HUA of 0.06°C based on an assessment of loading. The estimated maximum 7DADM temperature increase based on available data is about 0.008ºC during the year-round period. Spawning does not apply in Dexter Reservoir, the receiving stream. There were limited effluent data available (one or two grab samples) so the HUA was increased to account for the uncertain effluent characterization. The effluent flow used in the wasteload allocation equation is the sum of the maximum effluent flow rates (1.82 MGD) reported for each outfall on the NPDES permit application dated 9/23/2019. For effluent temperature the maximum value used was either the flow weighted maximum effluent temperature from all outfalls on the permit application or the maximum 7DADM river temperature at the outlet of Dexter Dam (DEXO USACE monitoring site). Temperature data at Green Peter Dam was more limited so Dexter was instead. River flows were assumed to be at seasonal 7Q10s calculated using the total outflow from the dam including spillway, powerhouse, and regulating outlets 2004 – 2024 (data from USACE). See Section 6.4 for 7Q10 details.

9.2.1.78 Veneta STP (92762)

Veneta STP (WQ File#: 92762, EPA Number: OR0020532) is assigned an HUA of 0.0°C from June 1 through September 30 based on no discharge requirements in the NPDES permit. The facility is permitted to discharge during the allocation period from May 1 to May 31 and from October 1 to October 31. The assessment of thermal loading during the discharge periods found that an HUA of 0.075°C would result in noncompliance. The assigned HUA was increased to 0.20°C for May 1 to May 31 and for October 1 to October 31, which reduced the noncompliance days based on the data available. The effluent flow used in the wasteload allocation equation is the maximum flow reported on DMRs from May and October in 2018, 2019 and 2020, which is 0.633 MGD (0.98 cfs). See Section 6.4 for 7Q10 details.

9.2.1.79 WES – Boring STP (16592)

The assessment of thermal loading for Boring STP (WQ File#: 16592, EPA Number: OR0031399) found that an HUA of 0.075°C would result in noncompliance. The assigned HUA was increased to 0.20°C, which eliminated the noncompliance days based on the data available. The effluent flow used in the wasteload allocation equation is the maximum flow reported on DMRs from April through October in 2019 and 2020, which is 0.036 MGD (0.06 cfs). DEQ estimated daily mean river flow of North Fork Deep Creek at Boring STP's outfall for the analysis period (2019-2020) using the drainage area ratio method. USGS 14211400 Johnson Creek at Regner Road (15.36 square miles) was used as the reference gage. The watershed area upstream of the outfall was estimated as 10.6 square miles using USGS StreamStats. The minimum estimated river flow during the 2019-2020 period was 0.3 cfs, which is close to the 7Q10 of 0.24 cfs.

9.2.1.80 Westfir STP (94805)

The assessment of thermal loading for Westfir STP (WQ File#: 94805, EPA Number: OR0028282) found that an HUA of 0.075°C would result in compliance based on the data available. The effluent flow used in the wasteload allocation equation is the ADWDF from the NPDES permit, which is 0.03 MGD (0.05 cfs).

9.2.1.81 Willamette Leadership Academy (34040)

Willamette Leadership Academy (WQ File#: 34040, EPA Number: OR0027235) is assigned an HUA of 0.0°C based on no discharge requirements in the NPDES permit for the allocation period. The ADWDF in the NPDES permit is 0.007 MGD (0.01 cfs).

9.2.1.82 Woodburn WWTP (98815)

Woodburn WWTP (WQ File#: 98815, EPA Number: OR0020001) is assigned an HUA of 0.20°C based on the assessment of thermal loading and allocation given in the Molalla-Pudding TMDL (DEQ, 2008c). The effluent flow used in the wasteload allocation equation is the ADWDF from the NPDES permit, which is 5.037 MGD (7.79 cfs).

9.2.2 Wasteload allocations

Wasteload allocations for NPDES permitted point sources listed in **Table 9-1** were calculated using **Equation 9-**. Wasteload allocations apply during the critical periods discussed in Section 5.

Wasteload allocations may be implemented in NPDES permits in any of the following ways:

1) Incorporate the 7Q10 wasteload allocation in **Table 9-1** as a static numeric limit. Permit writers may recalculate the static limit using different values for 7Q10 (Q_R) and effluent discharge (Q_E), if better estimates are available (including the use of seasonal values, as appropriate).

2) Incorporate **Equation 9-** 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. The assigned portion of the HUA (ΔT) is based on the value in **Table 9-1**. Permit writers may recalculate the 7Q10 using seasonal or annual values, as appropriate, if better estimates are available.

Table 9-1: Thermal wasteload allocations (WLA) for point sources.

NPDES Permittee WQ File Number : EPA Number	Assigned HUA ΔT (°C)	WLA period start	WLA period end	7Q10 River flow (cfs)	Effluent discharge (cfs)	7Q10 WLA[1] (kcals/day)
Adair Village STP 500 : OR0023396	0.001	4/1	5/15	6308	1.3	15.437E+6
	0.001	5/16	10/14	3877	0.2	9.486E+6
	0.002	10/15	11/30	4443	1.3	21.747E+6
Albany Millersburg WRF [2] 1098 : OR0028801	0.010	4/1	5/15	6308	14.3	154.686E+6
	0.017	5/16	10/14	3877	13.7	161.827E+6
	0.037	10/15	11/30	4443	25.1	404.482E+6
Albany Water Treatment Plant 66584 : ORG383501	0.20	5/1	10/31	24	1.30	12.38E+6
Alpine Community 100101 : OR0032387	0.00	5/1	10/31	0.4	0.03	0
Arclin 16037 : OR0021857	0.075	5/1	10/31	0	1.55	0.284E+6
Arclin 81714 : OR0000892	0.075	4/1	10/31	30	0.93	5.675E+6
Arkema 68471 : OR0044695	0.001	6/1	9/30	6740	0.14	16.491E+6
Ash Grove Cement - Rivergate Lime Plant 3690 : OR0001601	0.00	6/1	9/30	5934	0	0
ATI Albany Operations 64300 : OR0001716	0.01	5/1	10/31	1.4	3.52	0.12E+6

NPDES Permittee WQ File Number : EPA Number	Assigned HUA ΔT (°C)	WLA period start	WLA period end	7Q10 River flow (cfs)	Effluent discharge (cfs)	7Q10 WLA[1] (kcals/day)
ATI Millersburg [2] 87645 : OR0001112	0.010	4/1	5/15	6308	5.2	154.463E+6
	0.011	5/16	10/14	3877	5.2	104.483E+6
	0.012	10/15	11/15	4443	5.4	130.605E+6
Aumsville STP 4475 : OR0022721	0.00	5/1	10/31	0.7	0.52	0
Aurora STP 110020 : OR0043991	0.00	5/1	10/31	10	0.1	0
Bakelite Chemicals LLC 32650 : OR0032107	0.00	5/1	10/31	0	0.0	0
Bakelite Chemicals LLC 32864 : OR0002101	0.075	5/1	5/31	0	0.0	0
	0.00	6/1	10/31	0	0.0	0
Blount Oregon Cutting Systems Division 63545 : OR0032298	0.075	2/15	11/15	0	0.19	0.034E+6
Boeing Of Portland - Fabrication Division 9269 : OR0031828	0.075	4/1	10/31	0	0.46	0.085E+6
Brooks STP 100077 : OR0033049	0.001	4/1	5/15	11955	1.6	29.254E+6
	0.001	5/16	10/14	5684	0.4	13.908E+6
	0.002	10/15	11/15	7133	1.6	34.912E+6
Brownsville STP 11770 : OR0020079	0.00	5/1	10/31	14	0.0	0
Canby Regency Mobile Home Park 97612 : OR0026280	0.001	6/1	9/30	5790	0.06	14.166E+6
Canby STP 13691 : OR0020214	0.004	6/1	9/30	5790	3.1	56.695E+6
Cascade Pacific Pulp, LLC 36335 : OR0001074	0.024	4/1	5/15	5330	16.5	313.946E+6
	0.049	5/16	10/14	3609	17.3	434.745E+6
	0.037	10/15	11/15	4280	14.5	388.767E+6
Century Meadows Sanitary System (CMSS) 96010 : OR0028037	0.001	6/1	9/30	5734	0.6	14.031E+6
City of Silverton Drinking WTP 81398 : ORG383527	0.20	5/1	10/31	0	0.08	0.038E+6
Coburg Wastewater Treatment Plant 115851 : OR0044628	0.20	5/1	10/31	0	0.68	0.333E+6
Coffin Butte Landfill 104176 : OR0043630	0.075	5/1	10/31	0	0.0	0
Columbia Helicopters 100541 : OR0033391	0.075	5/1	10/31	0	0.01	0.002E+6
Corvallis Rock Creek WTP 20160 : ORG383513	0.20	5/1	10/31	0	0.37	0.182E+6
Corvallis STP	0.015	4/1	5/15	5800	15.3	213.421E+6

NPDES Permittee WQ File Number : EPA Number	Assigned HUA ΔT (°C)	WLA period start	WLA period end	7Q10 River flow (cfs)	Effluent discharge (cfs)	7Q10 WLA[1] (kcals/day)
20151 : OR0026361	0.015	5/16	10/14	3683	11.7	135.595E+6
	0.031	10/15	11/15	4149	24.0	316.508E+6
Cottage Grove STP 20306 : OR0020559	0.154	4/1	5/15	61	2.1	23.775E+6
	0.206	5/16	11/15	38	2.8	20.564E+6
Covanta Marion, Inc 89638 : OR0031305	0.001	4/1	5/15	10688	0.2	26.15E+6
	0.002	5/16	10/14	5684	0.3	27.815E+6
	0.001	10/15	11/15	7133	0.2	17.453E+6
Creswell STP 20927 : OR0027545	0.20	5/1	5/31	0	5.09	2.491E+6
	0.00	6/1	10/31	0	0.31	0
Dallas STP 22546 : OR0020737	0.11	5/1	10/31	4.2	3.09	1.963E+6
Dallas WTP 22550 : ORG383529	0.11	5/1	10/31	3.3	0.17	0.934E+6
Deer Creek Estates Water Association 23650 : ORG383526	0.20	5/1	10/31	0.7	0.004	0.344E+6
Dundee STP 25567 : OR0023388	0.002	6/1	9/30	5734	1.1	28.064E+6
Duraflake 97047 : OR0000426	0.20	5/1	10/31	0	0.55	0.270E+6
Estacada STP 27866 : OR0020575	0.075	5/1	10/31	317	0.84	58.323E+6
Evraz Oregon Steel 64905 : OR0000451	0.002	6/1	9/30	6740	1.2	32.987E+6
EWEB Carmen Powerhouse (Outfalls 001A and 001B) 28393 : OR0000680	0.075	5/1	10/31	146	2.68	27.282E+6
EWEB Trail Bridge Powerhouse (Outfalls 002A and 002B) 28393 : OR0000680	0.030	5/1	10/31	496	0.93	36.475E+6
EWEB Hayden Bridge Filter Plant 28385 : ORG383503	0.011	4/1	11/15	1538	2.09	41.449E+6
Falls City STP 28830 : OR0032701	0.00	5/1	10/31	5.3	0.0	0
Forest Park Mobile Village 30554 : OR0031267	0.001	6/1	9/30	5988	0.02	14.651E+6
Foster Farms 97246 : OR0026450	0.00	5/1	10/31	0	0.0	0
Frank Lumber Co. Inc. 30904 : OR0000124	0.04	4/1	6/15	987	3	96.888E+6
	0.04	6/16	8/31	859	3	84.361E+6
	0.04	9/1	11/15	957	4.4	94.089E+6
Fujimi Corporation - SW Commerce Circle 107178 : OR0040339	0.20	5/1	10/31	0	0.2	0.094E+6

NPDES Permittee WQ File Number : EPA Number	Assigned HUA ΔT (°C)	WLA period start	WLA period end	7Q10 River flow (cfs)	Effluent discharge (cfs)	7Q10 WLA[1] (kcals/day)
Gervais STP 33060 : OR0027391	0.00	5/1	10/31	6.6	0.34	0
GP Halsey Mill 105814 : OR0033405	0.010	4/1	5/15	5330	5.3	130.537E+6
	0.016	5/16	10/14	3609	4.9	141.472E+6
	0.011	10/15	11/15	4280	4.0	115.297E+6
Halsey STP 36320 : OR0022390	0.00	5/1	10/31	5.0	0.30	0
Harrisburg Lagoon Treatment Plant 105415 : OR0033260	0.002	4/1	4/30	5204	1.9	25.474E+6
	0.004	5/1	10/31	3480	1.6	34.073E+6
	0.003	11/1	11/15	3853	1.9	28.295E+6
Hollingsworth & Vose Fiber Co – Corvallis 28476 : OR0000299	0.001	4/1	5/15	5800	0.1	14.191E+6
	0.001	5/16	10/14	3683	0.2	9.012E+6
	0.001	10/15	11/15	4149	0.1	10.151E+6
Hubbard STP 40494 : OR0020591	0.20	5/1	10/31	0	0.35	0.169E+6
Hull-Oakes Lumber Co. 107228 : OR0038032	0.075	5/1	10/31	0	0.08	0.014E+6
Independence STP 41513 : OR0020443	0.005	4/1	5/15	10688	3.9	130.797E+6
	0.005	5/16	10/14	5684	3.8	69.581E+6
	0.003	10/15	11/15	7133	6.2	52.402E+6
International Paper - Springfield 108921 : ORG383548 (200-J discharge)	0.075	5/1	10/31	0	0.01	0.001E+6
International Paper - Springfield (Outfall 001 + Outfall 002) 96244 : OR0000515	0.12	4/1	6/15	2,442	28.9	725.456E+6
	0.20	6/16	8/31	1,537	28.9	766.247E+6
	0.19	9/1	11/15	1,630	28.9	771.167E+6
International Paper - Springfield (Outfall 003) 96244 : OR0000515	0.075	5/1	10/31	0	3.09	0.568E+6
J.H. Baxter & Co 6553 : OR0021911	0.075	5/1	10/31	0.6	0.12	0.132E+6
Jasper Wood Products 100097 : OR0042994	0.00	6/1	9/30	6691	0	0
Jefferson STP 43129 : OR0020451	0.002	4/1	5/15	3275	0.6	16.029E+6
	0.006	5/16	10/14	1144	0.8	16.806E+6
	0.003	10/15	11/15	2278	0.6	16.725E+6
JLR 32536 : OR0001015	0.01	5/1	10/31	6.9	0.5	0.181E+6
Junction City STP 44509 : OR0026565	0.00	5/1	10/31	0	0.0	0
Kingsford Manufacturing Company - Springfield Plant 46000 : OR0031330	0.075	5/1	5/31	0	0.08	0.015E+6
	0.00	6/1	10/31	0	0	0

NPDES Permittee WQ File Number : EPA Number	Assigned HUA ΔT (°C)	WLA period start	WLA period end	7Q10 River flow (cfs)	Effluent discharge (cfs)	7Q10 WLA[1] (kcals/day)
Knoll Terrace Mhc 46990 : OR0026956	0.00	5/1	10/31	0	0.09	0
Lakewood Utilities, Ltd 96110 : OR0027570	0.00	5/1	10/31	0	0.0	0
Lane Community College 48854 : OR0026875	0.00	5/1	10/31	0	0.22	0
Lebanon WWTP 49764 : OR0020818	0.03	4/1	5/15	1043	4.1	76.857E+6
	0.05	5/16	10/14	506	4.9	62.50E+6
	0.08	10/15	11/15	726	12.3	144.51E+6
Lowell STP 51447 : OR0020044	0.013	5/1	11/15	1,002	1.22	31.909E+6
Mcfarland Cascade Pole & Lumber Co 54370 : OR0031003	0.00	5/1	10/31	0	0.0	0
Molalla Municipal Drinking WTP 109846 : ORG380014	0.20	5/1	10/31	0	0.16	0.078E+6
Molalla STP 57613 : OR0022381	0.10	5/1	10/31	56	3.46	14.547E+6
Monmouth STP 57871 : OR0020613	0.004	4/1	5/15	10688	5.8	104.657E+6
	0.005	5/16	10/14	5684	4.3	69.587E+6
	0.003	10/15	11/15	7133	5.8	52.399E+6
Monroe STP 57951 : OR0029203	0.08	4/1	4/30	55	1.2	11.00E+6
	0.03	5/1	10/31	22	0.2	1.629E+6
	0.03	11/1	11/15	55	1.2	4.125E+6
Mt. Angel STP 58707 : OR0028762	0.00	5/1	10/31	6.6	0.87	0
Murphy Veneer, Foster Division 97070 : OR0021741	0.20	5/1	10/31	4.2	1.11	2.598E+6
MWMC - Eugene/Springfield STP 55999 : OR0031224	0.118	4/1	5/15	1906	42.6	562.573E+6
	0.093	5/16	10/14	1508	55.0	355.645E+6
	0.188	10/15	11/15	1925	86.3	925.144E+6
Newberg - Wynooski Road STP 102894 : OR0032352	0.006	6/1	9/30	5734	6.2	84.266E+6
Newberg OR, LLC 72615 : OR0000558	0.00	6/1	9/30	5934	0	0
Norpac Foods- Plant #1, Stayton 84820 : OR0001228	0.20	5/1	10/31	0	6.19	3.028E+6
NW Natural Gas Site Remediation 120589 : OR0044687	0.001	6/1	9/30	6740	0.7	16.492E+6
Oak Lodge Water Services Water Reclamation Facility 62795 : OR0026140	0.003	6/1	9/30	6740	4	49.501E+6
Oakridge STP 62886 : OR0022314	0.075	5/1	11/30	514	0.73	94.452E+6

NPDES Permittee WQ File Number : EPA Number	Assigned HUA ΔT (°C)	WLA period start	WLA period end	7Q10 River flow (cfs)	Effluent discharge (cfs)	7Q10 WLA[1] (kcals/day)
ODC - Oregon State Penitentiary 109727 : OR0043770	0.075	5/1	10/31	6.5	2.48	1.647E+6
ODFW - Clackamas River Hatchery 64442 : OR0034266	0.072*	4/1	6/15	1186	42.1	216.342E+6*
	0.261*	6/16	8/31	627	41.0	426.571E+6*
	0.283*	9/1	11/15	645	42.0	475.683E+6*
ODFW - Dexter Ponds 64450 : ORG133514	0.036*	4/1	6/15	986	48.0	91.075E+6*
	0.189*	6/16	9/14	1002	48.0	485.541E+6*
	0.255*	9/15	11/15	1301	48.0	841.641E+6*
ODFW - Leaburg Hatchery 64490 : OR0027642	0.074*	4/1	6/15	2,442	92.4	458.861E+6*
	0.012*	6/16	8/31	1,537	39.1	46.274E+6*
	0.026*	9/1	11/15	1,630	78.3	108.671E+6*
ODFW - Marion Forks Hatchery 64495 : OR0027847	0.075*	5/1	10/31	6.3	18.6	4.562E+6*
ODFW - McKenzie River Hatchery 64500 : OR0029769	0.002	4/1	6/15	2442	12.7	12.012E+6
	0.033	6/16	8/31	1537	11.8	125.05E+6
	0.002	9/1	11/15	1,630	1.0	7.981E+6
ODFW - Minto Fish Facility 64495 : OR0027847	0.03*	4/1	6/15	987	30	74.648E+6*
	0.03*	6/16	8/31	859	36	65.693E+6*
	0.03*	9/1	11/15	957	41	73.253E+6*
ODFW - Roaring River Hatchery 64525 : ORG133506	0.10*	5/1	10/31	0.5	14.2	3.597E+6*
ODFW - South Santiam Hatchery 64560 : ORG133511	0.02*	4/1	6/15	841	10.6	41.672E+6*
	0.02*	6/16	8/31	621	25.9	31.655E+6*
	0.02*	9/1	11/15	677	28.5	34.522E+6*
ODFW - Willamette Fish Hatchery 64585 : ORG133507	0.075*	5/1	10/31	110	79.0	34.681E+6*
OHSU Center For Health and Healing 113611 : OR0034371	0.001	6/1	9/30	6740	0.06	16.491E+6
OSU John L. Fryer Aquatic Animal Health Lab 103919 : OR0032573	0.001	4/1	5/15	5800	0.9	14.193E+6
	0.001	5/16	10/14	3683	1.2	9.014E+6
	0.001	10/15	11/15	4149	0.9	10.153E+6
Philomath WTP 100048 : ORG383536	0.20	5/1	10/31	6.7	0.32	3.435E+6
Philomath WWTP 103468 : OR0032441	0.00	5/1	10/31	6.7	0.0	0
PNW Veg Co DBA Norpac Foods No. 5 84791 : OR0021261	0.00	5/1	10/31	0	0.0	0
Row River Valley Water District 100075 : ORG383534	0.075	5/1	10/31	12	0.04	2.210E+6
RSG Forest Products - Liberal 72596 : OR0021300	0.20	5/1	10/31	0	1.24	0.606E+6

NPDES Permittee WQ File Number : EPA Number	Assigned HUA ΔT (°C)	WLA period start	WLA period end	7Q10 River flow (cfs)	Effluent discharge (cfs)	7Q10 WLA[1] (kcals/day)
Philomath WTP 100048 : ORG383536	0.20	5/1	10/31	6.7	0.32	3.435E+6
Salem Willow Lake STP 78140 : OR0026409	0.024	4/1	5/15	10688	52.9	630.705E+6
	0.036	5/16	10/14	5684	38.3	504.02E+6
	0.058	10/15	11/15	7133	80.2	1,023.60E+6
Sandy WWTP 78615 : OR0026573	0.00	5/1	10/31	0.2	0.00	0
Scappoose STP 78980 : OR0022420	NA	6/1	9/30	NA	0.9	21.00E+6
Scio STP 79633 : OR0029301	0.00	5/1	10/31	6.9	0.14	0
Seneca Sawmill Company 80207 : OR0022985	0.00	5/1	10/31	0	1.19	0
SFPP 103159 : OR0044661	0.075	5/1	10/31	0	0.02	0.004E+6
Sherman Bros. Trucking 36646 : OR0021954	0.00	5/1	10/31	0.2	0.02	0
Siltronic Corporation 93450 : OR0030589	0.007	6/1	9/30	6740	4.2	115.506E+6
Silverton STP 81395 : OR0020656	0.20	5/1	10/31	14	3.87	8.743E+6
SLLI 74995 : OR0001741	0.001	6/1	9/30	6740	0.04	16.491E+6
Stayton STP 84781 : OR0020427	0.02	4/1	6/15	1482	1.8	72.607E+6
	0.02	6/16	8/31	914	1.9	44.818E+6
	0.02	9/1	11/15	1018	1.8	49.902E+6
Sunstone Circuits 26788 : OR0031127	0.04	5/1	10/31	10.5	0.065	1.034E+6
Sweet Home STP 86840 : OR0020346	0.02	4/1	6/15	841	2.6	41.28E+6
	0.03	6/16	8/31	621	2.1	45.736E+6
	0.04	9/1	11/15	667	3.5	65.62E+6
Tangent STP 87425 : OR0031917	0.00	5/1	10/31	20	0.17	0
Timberlake STP 90948 : OR0023167	0.00	5/1	10/31	254	0.22	0
Tryon Creek WWTP 70735 : OR0026891	0.004	6/1	9/30	6740	12.8	66.087E+6
Univar USA Inc 100517 : OR0034606	0.001	6/1	9/30	6740	0.04	16.491E+6
USFW - Eagle Creek National Fish Hatchery 91035 : OR0000710	0.20*	5/1	10/31	0	52.6	25.739E+6*
Veneta STP 92762 : OR0020532	0.20	5/1	5/31	6.4	0.98	3.611E+6
	0.00	6/1	9/30	6.4	0.00	0
	0.20	10/1	10/31	6.4	0.98	3.611E+6

NPDES Permittee WQ File Number : EPA Number	Assigned HUA ΔT (°C)	WLA period start	WLA period end	7Q10 River flow (cfs)	Effluent discharge (cfs)	7Q10 WLA[1] (kcals/day)
U.S Army Corp of Engineers Big Cliff Project 126715 : Not assigned	0.004	4/1	11/15	859	1.1	8.418E+6
U.S. Army Corp of Engineers Cougar Project 126712: Not Assigned	0.01	5/1	10/31	236**	0.21	5.779E+6
U.S. Army Corp of Engineers Detroit Project 126716: Not Assigned	0.10	5/1	10/31	743**	7.94	183.729E+6
U.S Army Corp of Engineers Dexter Project 126714 : Not assigned	0.001	4/1	11/15	1002	0.7	2.453E+6
U.S Army Corp of Engineers Foster Project 126713 : Not assigned	0.003	4/1	11/15	621	1.4	4.568E+6
U.S. Army Corp of Engineers Green Peter Project 126717 : Not Assigned	0.10	5/1	11/30	33**	2.12	8.592E+6
U.S. Army Corp of Engineers Hills Creek Project 126699 : Not Assigned	0.06	5/1	11/30	309**	2.85	45.78E+6
U.S. Army Corp of Engineers Lookout Point Project 126700 : Not Assigned	0.06	5/1	11/15	1145**	2.82	168.50E+6
Vigor Industrial 70596 : OR0022942	0.005	6/1	9/30	6740	2.4	82.482E+6
WES - Blue Heron Discharge 72634 : OR0000566	0.00	6/1	9/30	5988	0	0
WES - Boring STP 16592 : OR0031399	0.20	5/1	10/31	0.24	0.06	0.145E+6
WES - Kellogg Creek WWTP 16590 : OR0026221	0.007	6/1	9/30	6740	15.5	115.699E+6
WES - Tri-City WPCP 89700 : OR0031259	0.015	6/1	9/30	5988	18.4	220.435E+6
Westfir STP 94805 : OR0028282	0.075	5/1	10/31	174	0.05	31.937E+6
Willamette Falls Paper Company 21489 : OR0000787	0.007	6/1	9/30	5988	6.5	102.666E+6
Willamette Leadership Academy 34040 : OR0027235	0.00	5/1	10/31	0	0.01	0
Wilsonville STP 97952 : OR0022764	0.005	6/1	9/30	5734	4.2	70.197E+6
Woodburn WWTP 98815 : OR0020001	0.20	5/1	10/31	6.7	7.79	7.092E+6

[1] Listed WLAs were calculated based on the 7Q10 flow.
[2] ATI Millersburg and Albany-Millersburg Water Reclamation Facility discharge to the same outfall, but each holds an individual NPDES permit and is assigned its own thermal wasteload allocation

NPDES Permittee WQ File Number : EPA Number	Assigned HUA ΔT (°C)	WLA period start	WLA period end	7Q10 River flow (cfs)	Effluent discharge (cfs)	7Q10 WLA[1] (kcals/day)
Notes: WLA = wasteload allocation; kcals/day = kilocalories/day * When the minimum duties provision at OAR 340-041-0028(12)(a) applies, ΔT = 0.0 and the WLA = 0 kilocalories/day. ** Listed 7Q10s calculated based on a seasonal period corresponding to WLA period.						

9.2.3 Requirements for 100-J general permit registrants

The existing 100-J general permit requirements relevant to water temperature are described in Section 7.1.2.1. Because permit registrants have reasonable potential to increase stream temperature, the TMDL includes narrative wasteload allocation requirements for registrants to the 100-J general permit. The wasteload allocation for current and future registrants to the 100-J general permit is equal to loads permitted by the 100-J general permit and the TMDL requirements identified **Table 9-2** and **Table 9-3**.

With some exceptions, 100-J registrants have been assigned a cumulative HUA of 0.075°C (**Table 9-2**). An HUA of 0.075°C will address any warming authorized by the 100-J (see Section 7.1.2.1 for analysis of warming). In addition, each AU has a maximum number of registrants that may discharge based on the 7Q10 stream flow at the discharge location. With some exceptions noted in **Table 9-2,** watershed AUs may only have one registrant due to low flows. Limiting the maximum number of registrants is necessary to ensure the assigned HUA is attained. Additional registrants above the maximum require reserve capacity. The flow categories in **Table 9-2** are set up so the combined sum of warming from each registrant at the point of discharge does not exceed the maximum warming allowed for that AU. As the river flow increases and provides increased dilution, the maximum number of registrants allowed also increases. On select AUs (Columbia Slough. McKenzie River, and Stone Quarry Lake) the maximum number of registrants and assigned HUA reflect the current number of 100-J registrants. Some AUs do not have sufficient loading capacity for new 100-J registrants because it has been assigned to other NPDES permittees. **Table 9-3** identifies the AUs with insufficient loading capacity. On these AUs, the assigned HUA is zero and new 100-J registrants cannot increase stream temperature above the applicable temperature criteria. A maximum number of registrants is not needed as there is no temperature increase allowed.

Table 9-2: TMDL requirements for 100-J registrants in the Willamette Subbasins.

AU 7Q10 stream flow (cfs)	Assigned HUA (°C)*	Maximum number of registrants per AU
<= 149	0.075	1
> 149 and <= 297	0.075	2
> 297 and <= 521	0.075	3
> 521 and <= 652	0.075	4
> 652 and <= 990	0.075	5
> 990 and <= 1154	0.075	6
> 1154 and <= 1319	0.075	7
> 1319 and <= 1484	0.075	8
> 1484	0.075	9
McKenzie River OR_SR_1709000407_02_103884	0.02	2
Columbia Slough OR_WS_170900120201_02_104554.2	0.225	3
Other Watershed AUs	0.075	1
Stone Quarry Lake OR_LK_1709000703_02_100809	0.15	2
Other natural lake or pond AUs where the Natural Lakes temperature criterion apply (OAR 340-041-0028(6))	0.075	1
*Assigned HUA is zero for AUs listed in **Table 9-3**		

Table 9-3 AUs where new 100-J general permit registrants may not increase temperature above the applicable criteria.

AU ID	AU or Stream Name	Assigned HUA (°C)
OR_LK_1709000107_02_100699	Dexter Reservoir	0.00
OR_LK_1709000402_02_100742	Trail Bridge Reservoir	0.00
OR_LK_1709000503_02_100770	Big Cliff Reservoir	0.00
OR_LK_1709001106_02_100850	Estacada Lake	0.00
OR_LK_1709001202_02_100858	Fairview Lake	0.00
OR_SR_1709000104_02_103719	Salmon Creek	0.00
OR_SR_1709000105_02_103720	Middle Fork Willamette River	0.00
OR_SR_1709000105_02_104580	Middle Fork Willamette River	0.00
OR_SR_1709000106_02_103721	North Fork Middle Fork Willamette River	0.00
OR_SR_1709000202_02_103765	Layng Creek	0.00
OR_SR_1709000301_02_103789	Long Tom River	0.00
OR_SR_1709000302_02_103807	Oliver Creek	0.00
OR_SR_1709000302_02_103813	Marys River	0.00
OR_SR_1709000402_02_103858	McKenzie River	0.00
OR_SR_1709000402_02_104587	McKenzie River	0.00
OR_SR_1709000402_02_104588	McKenzie River	0.00

AU ID	AU or Stream Name	Assigned HUA (°C)
OR_SR_1709000403_02_104590	South Fork McKenzie River	0.00
OR_SR_1709000405_02_103866	McKenzie River	0.00
OR_SR_1709000405_02_103868	McKenzie River	0.00
OR_SR_1709000405_02_103869	McKenzie River	0.00
OR_SR_1709000605_02_103971	Wiley Creek	0.00
OR_SR_1709000606_02_103974	Roaring River	0.00
OR_SR_1709000701_02_104591	Rickreall Creek	0.00
OR_SR_1709000703_02_104007	Mill Creek	0.00
OR_SR_1709000901_02_104595	Silver Creek	0.00
OR_SR_1709000902_02_104073	Pudding River	0.00
OR_SR_1709001105_02_104162	Eagle Creek	0.00
OR_WS_170900020403_02_104240	Unnamed tributary to Camas Swale Creek	0.00
OR_WS_170900030108_02_104250	Amazon Creek, Amazon Diversion Canal	0.00
OR_WS_170900030204_02_104256	Rock Creek	0.00
OR_WS_170900030511_02_104285	Ditch to Soap Creek tributary	0.00
OR_WS_170900030603_02_104290	Unnamed tributary to Flat Creek	0.00
OR_WS_170900030606_02_104294	Muddy Creek	0.00
OR_WS_170900030610_02_104298	Murder Creek	0.00
OR_WS_170900050203_02_104345	Horn Creek	0.00
OR_WS_170900070201_02_104409	Salem Ditch	0.00
OR_WS_170900070402_02_104419	Coffee Lake Creek	0.00
OR_WS_170900090107_02_104460	Unnamed tributary to Abiqua Creek	0.00
OR_WS_170900090502_02_104481	Mill Creek	0.00
OR_WS_170900090607_02_104488	Unnamed tributary to Molalla River	0.00
OR_WS_170900110605_02_104547	North Fork Deep Creek	0.00

9.2.4 Wasteload allocation equation

Equation 9-1 was used to calculate the thermal wasteload allocations in **Table 9-1**.

$$WLA = (\Delta T) \cdot (Q_E + Q_R) \cdot C_F$$ **Equation 9-1**

where,

$WLA =$ Wasteload allocation (kilocalories/day), expressed as a rolling seven-day average.

$\Delta T =$ The assigned portion of the HUA at the point of discharge. Represents the maximum temperature increase (ºC) above the applicable temperature criterion using 100% of river flow not to be exceeded by each individual source from all outfalls combined. When the minimum duties provision at OAR 340-041-0028(12)(a) applies, ∆T = 0.0. **Equation 9-6** was used to determine if the minimum duties provision applies.

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

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

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

$C_F =$ Conversion factor using flow in cfs: 2,446,899

$$\left(\frac{1\ m}{3.2808\ ft}\right)^3 \cdot \frac{1000\ kg}{1\ m^3} \cdot \frac{86400\ sec}{1\ day} \cdot \frac{1\ kcal}{1\ kg\ \cdot 1℃} = 2{,}446{,}899$$

9.2.5 WLA attainment equation

When evaluating current discharge, DEQ used **Equation 9-2** to calculate the excess thermal loading (ETL). The ETL was compared against the wasteload allocation (WLA) to assess attainment.

$$ETL = \left(T_E - T_{C,i}\right) \cdot Q_E \cdot C_F$$ **Equation 9-2**

where,

$ETL =$ The daily excess thermal load (kilocalories/day), expressed as a rolling seven-day average.

$T_{C,i} =$ The point of discharge applicable river temperature criterion (ºC) (T_c); or when the minimum duties provision at OAR 340-041-0028(12)(a) applies $T_{C,i}$ = the 7DADM measured at the facility intake (T_i). **Equation 9-6** was used to determine if the minimum duties provision applies.

$T_E =$ The daily maximum effluent temperature (ºC)

$Q_E =$ The daily mean effluent flow (cfs or MGD)

$C_F =$ Conversion factor for flow in cfs: 2,446,665

$$\left(\frac{1\ \text{m}}{3.2808\ \text{ft}}\right)^3 \cdot \frac{1000\ kg}{1\ m^3} \cdot \frac{86400\ sec}{1\ day} \cdot \frac{1\ kcal}{1\ kg\ \cdot 1℃} = 2{,}446{,}665$$

Conversion factor for flow in millions of gallons per day (MGD): 3,785,411

$$\frac{1\ m^3}{264.17\ gal} \cdot \frac{1000\ kg}{1\ m^3} \cdot \frac{1000000\ gal}{1\ million\ gal} \cdot \frac{1\ kcal}{1\ kg\ \cdot 1℃} = 3{,}785{,}441$$

9.2.6 Calculating current change in temperature

Equation 9-3 was used to assess the change in temperature based on point source effluent discharge, river flow, and the applicable temperature criteria.

$$\Delta T_{Current} = \left(\frac{Q_E}{Q_E + Q_R}\right) \cdot (T_E - T_C)$$ **Equation 9-3**

where,

$\Delta T_{Current} =$ The current river temperature increase (ºC) above the applicable river temperature criterion using 100% of river flow.

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

$$\frac{1 \text{ million } gallons}{1\ day} \cdot \frac{1.5472\ ft^3}{1 \text{ million gallons}} = 1.5472$$

$Q_R =$ 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.

$T_E =$ The daily maximum effluent temperature (ºC)

$T_C =$ The point of discharge applicable river temperature criterion (ºC). When the minimum duties provision at OAR 340-041-0028(12)(a) applies T_C = the 7DADM measured at the facility intake.

9.2.7 Calculating acceptable effluent temperatures

Equation 9-4 was used to calculate the daily maximum effluent temperatures (ºC) acceptable under the allocated portion of the HUA (ΔT) and the wasteload allocation (WLA).

$$T_{E\_WLA} = \frac{(Q_E + Q_R) \cdot (T_C + \Delta T) - (Q_R \cdot T_C)}{Q_E}$$ **Equation 9-4a** (using ΔT)

$$T_{E\_WLA} = \frac{(WLA)}{Q_E \cdot C_F} + T_C$$ **Equation 9-4b** (using WLA)

where,

$T_{E\_WLA} =$ Daily maximum effluent temperature (ºC) allowed under the wasteload allocation.
When T_{E_WLA} is > 32°C, T_{E_WLA} = 32°C as required by the thermal plume limitations in OAR 340-041-0053(2)(d)(B).

$WLA =$ Wasteload allocation (kilocalories/day) from **Equation 9-**.

$\Delta T =$ The assigned portion of the HUA at the point of discharge. Represents the maximum temperature increase (ºC) above the applicable river temperature criterion using 100% of river flow not to be exceeded by each individual source from all outfalls combined. When the minimum duties provision at OAR 340-041-0028(12)(a) applies, ΔT = 0.0.

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

$$\frac{1 \text{ million } gallons}{1\ day} \cdot \frac{1.5472\ ft^3}{1 \text{ million gallons}} = 1.5472$$

$Q_R =$ 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.

$T_{C,i} =$ The point of discharge applicable river temperature criterion (ºC) (T_c); or when the minimum duties provision at OAR 340-041-0028(12)(a) applies $T_{C,i}$ = the 7DADM measured at the facility intake (T_i).

$C_F =$ Conversion factor for flow in cfs: 2,446,665

$$\left(\frac{1\,m}{3.2808\,ft}\right)^3 \cdot \frac{1000\,kg}{1\,m^3} \cdot \frac{86400\,sec}{1\,day} \cdot \frac{1\,kcal}{1\,kg\ \cdot 1℃} = 2{,}446{,}665$$

9.2.8 Calculating acceptable effluent flows

Equation 9-5 was used to calculate the daily mean effluent flow (cfs) acceptable under the allocated portion of the HUA (Δ*T*) and the wasteload allocation (WLA).

$$Q_{E\_WLA} = \frac{(Q_R \cdot T_C) - ((T_C + \Delta T) * Q_R)}{T_C + \Delta T - T_E}$$ **Equation 9-5a** (using ΔT)

$$Q_{E\_WLA} = \frac{(WLA)}{(T_E - T_C) * C_F}$$ **Equation 9-5b** (using WLA)

where,

$Q_{E\_WLA} =$ Daily mean effluent flow (cfs) allowed under the wasteload allocation.

$WLA =$ Wasteload allocation (kilocalories/day) from **Equation 9-**.

$\Delta T =$ The assigned portion of the HUA at the point of discharge. Represents maximum temperature increase (ºC) above the applicable river temperature criterion using 100% of river flow not to be exceeded by each individual source from all outfalls combined. When the minimum duties provision at OAR 340-041-0028(12)(a) applies, Δ*T* = 0.0.

$T_E =$ The daily maximum effluent temperature (ºC).

$Q_R =$ 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.

$T_{C,i} =$ The point of discharge applicable river temperature criterion (ºC) (T_c); or when the minimum duties provision at OAR 340-041-0028(12)(a) applies $T_{C,i}$ = the 7DADM measured at the facility intake (T_i).

$C_F =$ Conversion factor for flow in cfs: 2,446,665

$$\left(\frac{1\,m}{3.2808\,ft}\right)^3 \cdot \frac{1000\,kg}{1\,m^3} \cdot \frac{86400\,sec}{1\,day} \cdot \frac{1\,kcal}{1\,kg\ \cdot 1℃} = 2{,}446{,}665$$

9.2.9 Determination of when minimum duties provision applies

The minimum duties provision at OAR 340-041-0028(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 point sources, DEQ is implementing the minimum duties provision if a facility operation meets acceptable operation and design requirements. The facility must be operated as a “flow through” facility where intake water moves through the facility and is not processed as part of an industrial or wastewater treatment operation. If a facility mixes the intake water with other wastewater or as a method to cool equipment DEQ considers the thermal effects of this operation to be part of the facility’s own activity and the minimum duties provision is not applicable. The intake water must also be returned to the same stream where the intake is located. If the water is not returned to the same stream the thermal effects are not from the receiving stream and therefore attributed to the facility's own discharge.

When the minimum duties provision applies, the facility cannot add any additional thermal loading to the intake temperatures when the intake temperatures are warmer than the maximum effluent discharge temperatures allowed by the wasteload allocation. The purpose is to ensure the facility controls for thermal effects resulting from passing the water through and not from upstream sources.

In the Willamette Subbasins, DEQ determined that facilities listed in **Table 9-4** likely operate as flow through facilities.

For new facilities or facilities where the intake or outfall locations have been moved, DEQ will use the approach described above to determine if the minimum duties provision is applicable. For example, ODFW McKenzie River Hatchery, which discharges to the McKenzie River, currently uses water from a tributary, Cogswell Creek. If the ODFW McKenzie River Hatchery intake(s) are moved to the same stream where the outfall is located, the minimum duties provision may be applied.

Table 9-4: NPDES permittees where the minimum duties provision may be implemented as part of the TMDL wasteload allocation.

NPDES Permittee	WQ File Number : EPA Number	Intake and Receiving Stream	AU
ODFW - Marion Forks Fish Hatchery	64495 : OR0027847	Horn Creek	OR_WS_170900050203_02_104345
ODFW - Roaring River Fish Hatchery	64525 : ORG133506	Roaring River	OR_SR_1709000606_02_103974
ODFW - Willamette Fish Hatchery	64585 : ORG133507	Salmon Creek	OR_SR_1709000104_02_103719
ODFW - Leaburg Fish Hatchery	64490 : OR0027642	McKenzie River	OR_SR_1709000407_02_103884
USFW - Eagle Creek National Fish Hatchery	91035 : OR0000710	Eagle Creek	OR_SR_1709001105_02_104162
ODFW - Clackamas River Hatchery	64442 - OR0034266	Clackamas River RM 22.6	
ODFW - Dexter Ponds	64450	Middle Fork Willamette River RM 15.7	
ODFW - Minto Fish Facility	64495 - OR0027847	North Santiam River RM 41.1	
ODFW South Santiam Hatchery	64560	South Santiam River RM 37.8	

When assessing the wasteload allocation for attainment, DEQ used the approach described in **Equation 9-6** to implement the minimum duties provision.

The minimum duties provision applies on days when $T_{E\_WLA} < T_i$. **Equation 9-6**

When the minimum duties applies, there may be no increase in temperature above the intake temperature (T_i) and the assigned portion of the HUA is zero (ΔT = 0.0).
where,

$T_{E\_WLA} =$ Daily maximum effluent temperature (ºC) allowed under the wasteload allocation as calculated using **Equation 9-4**.

$T_i =$ The daily maximum influent temperature (ºC) measured at the facility intake.

9.3 Nonpoint source load allocations (LAs)

Load allocations are assigned to background sources and anthropogenic nonpoint sources on all waters in the Willamette Subbasins. Load allocations for background sources are calculated using **Equation 9-7**.

$$LA_{BG} = (T_C) \cdot (Q_R) \cdot C_F$$ **Equation 9-7**

where,

$LA_{BG} =$ Load allocation to background sources (kilocalories/day).

$T_C =$ The applicable temperature criteria, not including the HUA. When there are two year-round applicable temperature criteria that apply to the same AU, the more stringent criteria shall be used.

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

$C_F =$ Conversion factor using flow in cfs: 2,446,665

$$\left(\frac{1\text{ m}}{3.2808\text{ ft}}\right)^3 \cdot \frac{1\,m^3}{35.31\,ft^3} \cdot \frac{1000\,kg}{1\,m^3} \cdot \frac{86400\,sec}{1\,day} \cdot \frac{1\,kcal}{1\,kg\ \cdot 1℃} = 2{,}446{,}665$$

Table 9-5 presents the load allocation assigned to background sources for temperature impaired Category 5 AUs that were modeled for the TMDL analysis. The load allocation presented is based on the critical 7Q10 low flow. **Equation 9-7** shall be used to calculate the load allocation to background sources for any AU or stream location in the Willamette Subbasins not identified in **Table 9-5** or when river flows are greater than 7Q10.

Equation 9-7 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.

Load allocations assigned to anthropogenic nonpoint sources on any AU or stream location in the Willamette Subbasins are calculated using **Equation 9-8**. The portions of the HUA (ΔT) assigned to nonpoint sources or source categories are presented in Section 9.1 HUA allocations of the Willamette Subbasins TMDL.

$$LA_{NPS} = (\Delta T) \cdot (Q_R) \cdot C_F$$ **Equation 9-8**

where,

$LA_{NPS} =$ Load allocation to anthropogenic nonpoint sources (kilocalories/day).

$\Delta T =$ The portion of the HUA assigned to each nonpoint source or source category representing the maximum cumulative temperature increase (ºC) from the nonpoint source or source category. When the minimum duties provision at OAR 340-041-0028(12)(a) applies, ΔT = 0.0.

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

$C_F =$ Conversion factor using flow in cfs: 2,446,665

$$\left(\frac{1\text{ m}}{3.2808\text{ ft}}\right)^3 \cdot \frac{1\,m^3}{35.31\,ft^3} \cdot \frac{1000\,kg}{1\,m^3} \cdot \frac{86400\,sec}{1\,day} \cdot \frac{1\,kcal}{1\,kg\,\cdot 1℃} = 2{,}446{,}665$$

Table 9-5: Thermal load allocations (LA) for background sources.

AU Name and AU ID	Annual 7Q10 (cfs)	Year Round Criterion (°C)	Spawning Criterion (°C)	LA period start	LA period end	7Q10 LA Year Round (kcal/day)	7Q10 LA Spawning (kcal/day)
Clackamas River OR_SR_1709001106_02_104597	671	16	13	4/1	11/15	26,267.4E+6	21,342.26E+6
Coast Fork Willamette River OR_SR_1709000203_02_104585	38	18	13	4/1	11/15	1,673.52E+6	1,208.65E+6
Coast Fork Willamette River OR_SR_1709000204_02_103787	132	18	13	4/1	11/15	5,813.28E+6	4,198.48E+6
Coyote Creek OR_SR_1709000301_02_103796	5.9	18	NA	5/1	10/31	259.84E+6	NA
Crabtree Creek OR_SR_1709000606_02_103978	25	16	13	5/1	10/31	978.67E+6	795.17E+6
Johnson Creek OR_SR_1709001201_02_104170	11	18	13	2/15	11/15	484.44E+6	349.87E+6
Little North Santiam River OR_SR_1709000505_02_104564	21	16	13	5/1	10/31	822.08E+6	667.94E+6
Long Tom River OR_SR_1709000301_02_103791	22	24	18	4/1	11/15	1,291.84E+6	968.88E+6
Luckiamute River OR_SR_1709000305_02_103829	16	18	13	5/1	10/31	704.64E+6	508.91E+6
McKenzie River OR_SR_1709000407_02_103884	1537	16	13	4/1	11/15	60,168.39E+6	48,886.81E+6
Middle Fork Willamette River OR_SR_1709000107_02_104583	1002	16	13	4/1	11/15	39,224.93E+6	31,870.26E+6
Middle Fork Willamette River OR_SR_1709000110_02_104584	1278	16	13	4/1	11/15	50,029.41E+6	40,648.89E+6
Mohawk River OR_SR_1709000406_02_103871	16	16	13	5/1	10/31	626.35E+6	508.91E+6
Molalla River OR_SR_1709000904_02_104086	38	16	13	5/1	10/31	1,487.57E+6	1,208.65E+6
Mosby Creek OR_SR_1709000201_02_103752	11	16	13	5/1	10/31	430.61E+6	349.87E+6
North Santiam River OR_SR_1709000504_02_103906	859	16	13	4/1	11/15	33,626.96E+6	27,321.91E+6
North Santiam River OR_SR_1709000506_02_103930	914	16	13	4/1	11/15	35,780.03E+6	29,071.27E+6
Pudding River OR_SR_1709000905_02_104088	10	18	NA	5/1	10/31	440.4E+6	NA
Santiam River OR_SR_1709000506_02_103927	1144	18	13	4/1	11/15	50,381.73E+6	36,386.8E+6
South Santiam River OR_SR_1709000608_02_103925	615	16	13	4/1	11/15	24,075.18E+6	19,561.09E+6
Thomas Creek OR_SR_1709000607_02_103988	6.9	18	NA	5/1	10/31	303.88E+6	NA
Willamette River OR_SR_1709000306_05_103854	3877	18	13	4/1	11/15	170,742.96E+6	123,314.36E+6
Willamette River OR_SR_1709000701_05_104005	5684	18	13	4/1	11/15	250,323.19E+6	180,788.97E+6
Willamette River OR_SR_1709000703_88_104015	5734	20	NA	6/1	9/30	280,583.54E+6	NA
Willamette River OR_SR_1709000704_88_104020	5988	20	NA	6/1	9/30	293,012.6E+6	NA

Willamette River OR_SR_1709001201_88_104019	6740	20	NA	6/1	9/30	329,810.44E+6	NA
Willamette River OR_SR_1709001202_88_104175	6740	20	NA	6/1	9/30	329,810.44E+6	NA

9.4 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 allocations.

9.4.1 Dam and reservoir operations

Dam and reservoir operations (except for the PGE Willamette Falls Hydroelectric Project) have been assigned 0.00ºC of the HUA and the equivalent load allocation as calculated using **Equation 9-8**. Monitoring stream temperature, rather than a thermal load, is easier and a more meaningful approach for reservoir management. Temperature increases are mathematically related to excess thermal loading and directly linked to the temperature water quality standard. For these reasons, DEQ is using a surrogate measure to implement the load allocation for dam and reservoir operations.

DEQ has developed the following surrogate measure temperature approach to implement the load allocation. The surrogate measure compliance point is located immediately downstream of the dam where impounded water is returned to the free-flowing stream. The surrogate measure is:

a) The 7DADM temperatures immediately upstream of the reservoirs. If multiple streams flow into the reservoir, 7DADM temperatures upstream of the reservoirs may be calculated as a flow weighted mean of temperatures from each inflowing tributary. The estimated free flowing (no dam) temperatures may be calculated using a mechanistic or empirical model to account for any warming or cooling that would occur through the reservoir reaches absent the dam and reservoir operations. The results may be applied as the temperature surrogate measure or to adjust the 7DADM temperatures monitored immediately upstream of the reservoirs. Use of the model approach for the surrogate measure must be approved by DEQ.

b) Additional adjustments to the surrogate temperature target calculated or measured under item a) may be allowed when all the following are true:

   i. Monitoring data shows 7DADM temperatures do not exceed the applicable temperature criteria plus assigned HUA in the AU downstream of the dam;
   ii. The PCW criterion at OAR 340-041-0028(11) does not apply. DEQ has evaluated which dams the PCW criterion likely apply in Section 9.4.1.1;
   iii. A cumulative effects analysis, approved by DEQ, demonstrates that dam release water temperatures warmer than the surrogate measure calculated or measured under item a) will result in attainment of the dam and reservoir assigned HUA above the applicable criteria in downstream waters.

The dam and reservoir surrogate measure will attain the assigned HUA and load allocation because it targets 7DADM temperatures no warmer than those upstream of the reservoir. The surrogate measure also implements the minimum duties provision in rule at OAR 340-041-0028(12)(a). This provision states that anthropogenic sources are only responsible for controlling the thermal effects of their own discharge or activity in accordance with their overall heat contribution. For dam and reservoir operations, the surrogate measure reflects temperatures upstream of the reservoir (or no dam temperatures), thus ensuring dam operators are only responsible for temperature increases caused by the dam and reservoir operations.

For implementation of the low flow conditions provision at OAR 340-041-0028(12)(d), the 7Q10 shall be calculated at a gage upstream of the reservoir or at nearby monitoring gage that isn't influenced by the dam's operations.

9.4.1.1 Protecting cold water criterion and dams in the Willamette Subbasins

There are approximately 202 large instream dams located within the Willamette Subbasins temperature TMDL project area. The list of dams was obtained from the USACE National Inventory of Dams (NID) database and a similar database maintained by the OWRD, dam safety program. For each of these dams, DEQ was interested in determining whether the PCW criterion applied to immediate downstream and upstream reaches.

The PCW criterion has multiple components to determine applicability. These components include:

a) having summer 7DADM ambient temperatures that are always colder than the biologically based criteria;
b) salmon, steelhead, or bull trout presence;
c) no threatened or endangered salmonid presence;
d) no critical habitat designation; and
e) the colder ambient water is not necessary to ensure that downstream temperatures achieve and maintain compliance with the applicable temperature criteria.

DEQ evaluated components a) – d) using available information following the process outlined in **Figure 4-15**.

Several sources were examined to determine if summer 7DADM ambient temperatures that are always colder than the biologically based criteria. The results of Oregon's 2022 Integrated Report were first used to determine whether the dam was located on a Category 5 temperature-impaired AU. A Category 5 temperature impairment (either year-round or spawning) precludes qualification for the PCW criterion. As such, if downstream or upstream AUs were listed as impaired for temperature, it was noted that the PCW did not apply. If an AU was identified as attaining for temperature (Category 2), it was assumed ambient 7DADM temperatures are always colder than the biologically based criteria.

The NorWeST SSN stream temperature models developed by Isaak et al. (2017) were also used to determine if temperatures are always colder than the biologically based criteria. These models use covariates derived from NHD and other sources to make temperature predictions to all river and stream reaches in various subregions in the Pacific Northwest. DEQ used the model outputs for the Oregon Coast processing unit. The specific model outputs were from the MWMT S2_02_11 composite scenario which is the prediction of the 10-year average (2002-2011) August Maximum Weekly Maximum (MWMT) stream temperature. The MWMT is similar to the 7DADM.

The NorWeST model outputs consists of point temperature predictions as well as reach average temperature predictions. Where available, NorWeST temperatures upstream and downstream of each reservoir were compared to the applicable year-round (non-spawning) 7DADM temperature criterion. If the MWMT S2_02_11 scenario temperatures exceeded the applicable temperature criterion immediately upstream or downstream of the dam and reservoir, it was reported that the PCW did not apply. Conversely, if the MWMT S2_02_11 temperature was less than the criterion both up and downstream, it was assumed ambient 7DADM temperatures are always colder than the biologically based criteria. In the rare instance of a discrepancy between the Integrated Report and the NorWeST data, priority for PCW determination was given to the Integrated Report. One major limitation in the Norwest data is that the model does not make predictions during the fall when the spawning criterion apply.

The applicability of the PCW criterion was not always immediately apparent. In multiple instances, while the NHD stream network showed an upstream reach flowing into a reservoir, no upstream NorWeST data existed. In these cases, it was noted that the applicability of the PCW criterion was unclear. For other dams, there existed a short downstream NHD line with no corresponding NorWeST data until the stream flowed into a connecting stream. In these cases, it was noted that the applicability of the PCW was unclear. For off-channel lagoons associated with treatment systems, N/A was reported. For reservoirs with no inflowing streams such as offstream irrigation ponds, N/A was selected for upstream and Integrated Report/NorWeST data were evaluated for the downstream reach. When it was unclear whether the reservoir connected to a downstream flowline, it was noted that the applicability of the PCW was unclear.

ODFW’s fish habitat distribution (FHD) GIS database were used to evaluate presence of salmon, steelhead, or bull trout. NOAA’s National Marine Fishery Service and U.S. Fish & Wildlife Service GIS features were used to evaluate threatened or endangered salmonid presence and critical habitat designations.

Based on these methods, DEQ determined that the PCW criterion likely applies at three dams in the Willamette Subbasins (**Table 9-6**).

Table 9-6: Dams where the protecting colder water criterion likely applies.

Dam name	NID ID	Dam owner	Latitude	Longitude	Stream	Notes
Carmen Diversion	OR00539	EWEB	44.3384	-122.0057	McKenzie River	Based on NorWest model S2_02_11 showing MWMT temperatures < 12°C, downstream SSBT presence, threatened Chinook and Bull Trout, and designated critical habitat
Harriet Lake	OR00546	PGE	45.0746	-121.9697	Oak Grove River	Based on attaining status on DEQ 2022 IR (OR_SR_1709001103_02_104150), downstream SSBT presence, threatened Steelhead, Chinook, and Coho, and designated critical habitat
Trail Bridge and Trail Bridge Saddle Dike	OR00540	EWEB	44.2734	-122.0507	McKenzie River	Based on attaining status on DEQ 2022 IR (OR_SR_1709000402_02_104588; OR_SR_1709000402_02_104587), upstream and downstream SSBT presence, threatened Chinook and Bull Trout, and designated critical habitat

9.4.2 Site specific effective shade surrogate measure

Effective shade surrogate measure targets shown in **Table 9-7** and **Table 9-8** represent a surrogate for the amount of solar loading that will attain the HUA and load allocations for nonpoint sources managing streamside vegetation. The surrogate measure is the arithmetic mean of the effective shade values at all model nodes assigned to each DMA (**Equation 9-9**). **Equation 9-9** may be used to recalculate the mean effective shade targets if DMA boundaries change or the DMA boundary needs to be corrected. **Equation 9-9** may also be used to recalculate the mean effective shade targets based on an updated shade gap assessments following the process and methods outlined in the WQMP.

Figure 9-6 shows the gap between current and target effective shade at the subwatershed level in the Lower Willamette model area. **Figure 9-7** shows the gap between current and target effective shade at the subwatershed level in the Southern Willamette model area.

Changes in the target effective shade from the values presented in **Table 9-7** and **Table 9-8** 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, HUA, or the load allocations. They remain the same as presented in this TMDL.

$$\overline{ES} = \frac{\sum ES_{n_i}}{n_i}$$ **Equation 9-9**

Where,

$\overline{ES} =$ The mean effective shade for DMA *i.*

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

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

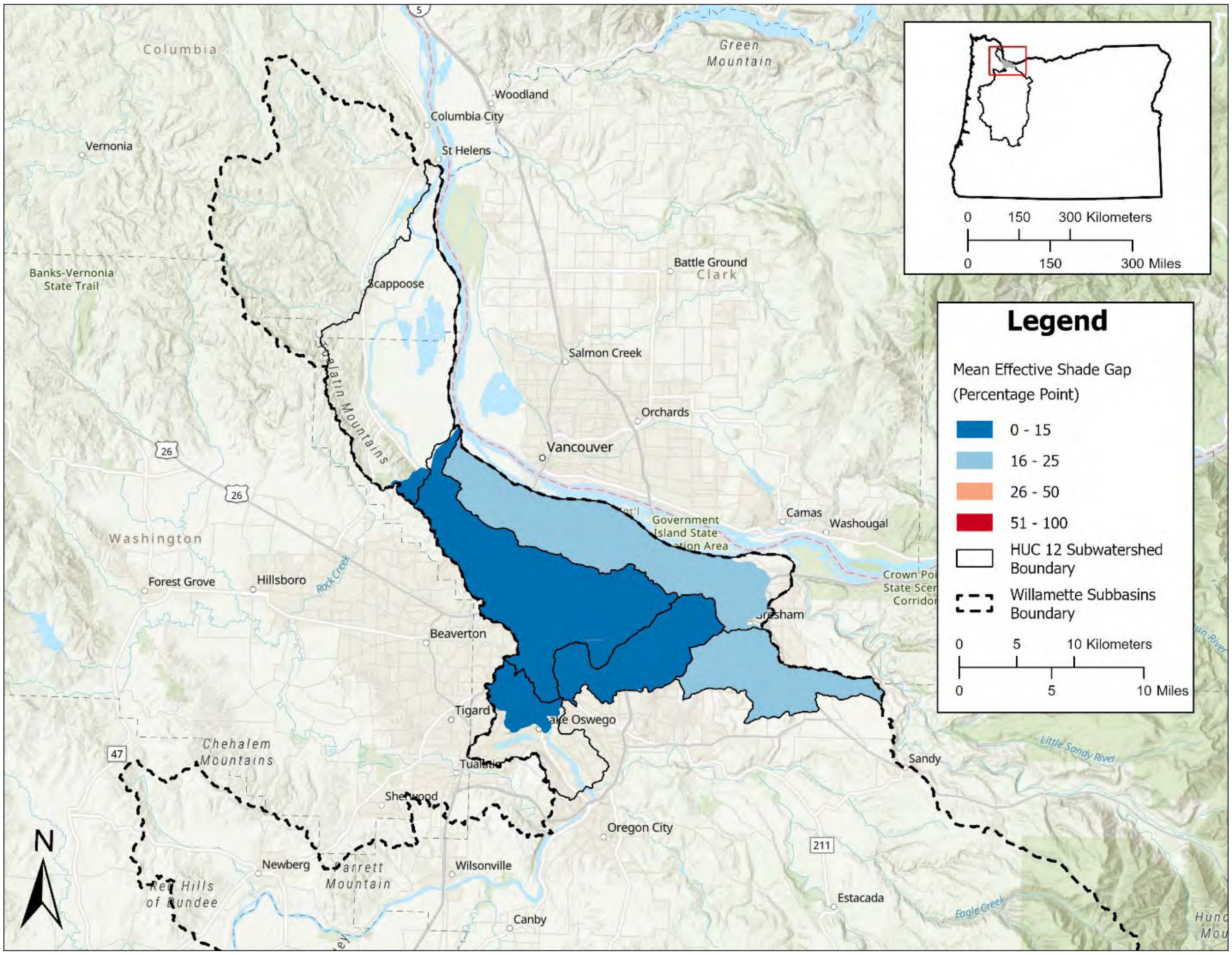


Figure 9-6: Lower Willamette Subbasin model area and mean effective shade gap for each HUC12 subwatershed within the model extent.

Table 9-7: Site specific effective shade surrogate measure targets to meet nonpoint source load allocations for specific model extents.

Model Stream	Total Kilometers Assessed	Assessed Effective Shade (%)	TMDL Target Effective Shade (%)	Shade Gap
Clackamas River	36.5	13	37	24
Coast Fork Willamette River	46.7	35	54	19
Fall Creek	11.5	29	47	18
Long Tom River	38.2	25	57	32
Middle Fork Willamette River	26.6	16	26	10
Molalla River	75.36	27	41	14
North Santiam River	79.6	19	34	15
Pudding River	85.55	44	52	8
Row River	12.2	24	54	30
Santiam River	19.5	11	19	8
South Santiam River	58.4	7	21	14
Willamette River	257.8	11	20	9

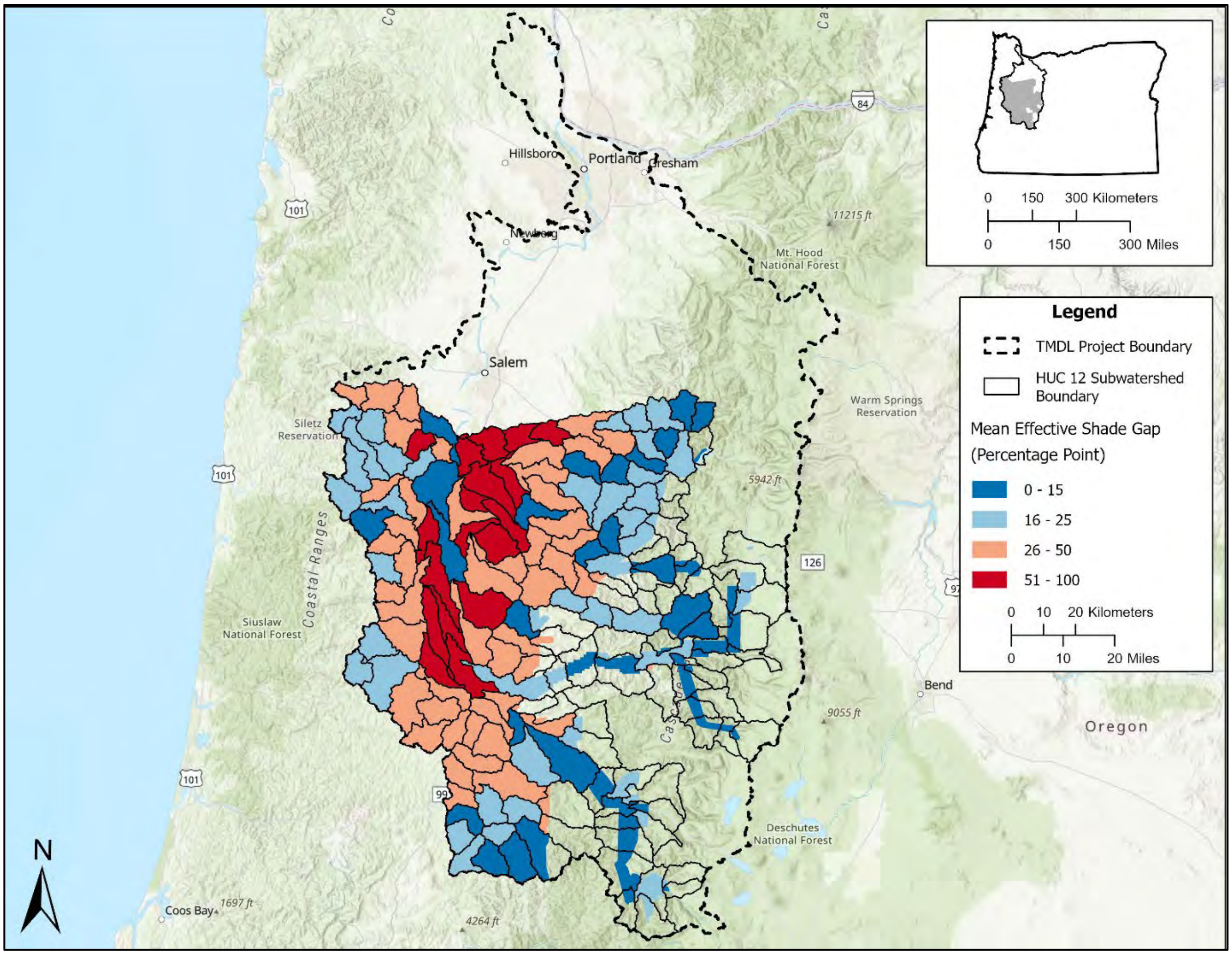


Figure 9-7: Southern Willamette model area and mean effective shade gap for each HUC12 subwatershed within the model extent.

Table 9-8: Site specific effective shade surrogate measure targets to meet nonpoint source load allocations for DMAs in all model areas in the Willamette Subbasins.

DMA	Total Kilometers Assessed	Assessed Effective Shade (%)	TMDL Target Effective Shade (%)	Shade Gap
Albany & Eastern Railroad	0.3	71	74	3
BNSF	0.1	35	42	7
Benton County	122.3	54	85	31
Bonneville Power Administration	2.3	34	94	60
Central Oregon & Pacific Railroad	0.2	32	75	43
City of Adair Village	2	27	93	66
City of Albany	54.4	27	55	28
City of Aurora	0.2	28	33	5
City of Brownsville	4	28	67	39
City of Canby	3.9	23	38	15
City of Coburg	2.8	22	91	69
City of Corvallis	76.4	40	63	23
City of Cottage Grove	19.1	40	67	27
City of Creswell	5.3	19	77	58
City of Dundee	0.1	19	16	-3
City of Eugene	161.7	21	62	41
City of Fairview	0.1	21	54	33
City of Falls City	9	56	96	40
City of Gates	8.2	30	60	30
City of Gladstone	3.8	11	35	24
City of Gresham	16	63	81	18
City of Halsey	1.6	8	87	79
City of Happy Valley	2.7	36	58	22
City of Harrisburg	4.1	10	27	17
City of Independence	2.4	14	22	8
City of Jefferson	5.9	22	40	18
City of Junction City	11.6	9	85	76
City of Keizer	3.1	12	18	6
City of Lake Oswego	5.8	83	90	7
City of Lebanon	18.8	25	61	36
City of Lowell	2.7	33	90	57
City of Lyons	4.4	21	43	22
City of McMinnville	0.1	15	20	5
City of Mill City	8	20	53	33
City of Millersburg	19.5	21	59	38
City of Milwaukie	2.9	62	80	18
City of Molalla	0.1	5	29	24
City of Monmouth	0.5	82	89	7
City of Monroe	3.5	27	50	23
City of Newberg	0.7	5	19	14
City of Oakridge	9.2	28	75	47
City of Oregon City	0.7	2	12	10
City of Philomath	7.6	37	88	51
City of Portland	127.4	61	73	12
City of Salem	14.5	12	24	12
City of Scio	1.7	51	59	8
City of Springfield	55.4	21	59	38
City of Stayton	10.2	24	43	19
City of Sweet Home	34.3	17	50	33
City of Tangent	10.9	48	82	34
City of Veneta	8.7	50	95	45
City of Waterloo	0.5	27	46	19
City of West Linn	2.1	4	11	7

DMA	Total Kilometers Assessed	Assessed Effective Shade (%)	TMDL Target Effective Shade (%)	Shade Gap
City of Westfir	3.1	29	80	51
City of Wilsonville	4.3	10	13	3
Clackamas County	27.8	42	62	20
Lane County	879.7	41	71	30
Lincoln County	0.2	9	96	87
Linn County	224.9	30	62	32
Marion County	60.8	30	53	23
Multnomah County	9.7	75	90	15
Oregon Department of Agriculture	5505.7	28	69	41
Oregon Department of Aviation	0.2	4	66	62
Oregon Department of Fish and Wildlife	21.8	24	58	34
Oregon Department of Forestry - Private	8684.7	69	94	25
Oregon Department of Forestry - Public	530.1	84	96	12
Oregon Department of Geology and Mineral Industries	8.2	27	57	30
Oregon Department of State Lands	7	25	40	15
Oregon Department of Transportation	81.6	26	55	29
Oregon Military Department	0.2	0	86	86
Oregon Parks and Recreation Department	95.7	19	30	11
Polk County	65.9	47	87	40
Port of Coos Bay	1.9	56	93	37
Port of Portland	2.1	29	45	16
Portland & Western Railroad	2.6	37	52	15
State of Oregon (unidentified agency)	12.5	14	25	11
U.S. Army Corps of Engineers	83.5	46	70	24
U.S. Bureau of Land Management	2607.9	87	95	8
U.S. Department of Agriculture	1.2	29	49	20
U.S. Department of Defense	1.5	47	85	38
U.S. Fish and Wildlife Service	43.5	36	62	26
U.S. Forest Service	2985.4	84	95	11
U.S. Government (unidentified agency)	15.8	33	53	20
Union Pacific Railroad	7.5	35	52	17
Yamhill County	2.1	11	12	1

9.4.3 Effective shade curve surrogate measure

Effective shade curves are applicable to any stream that does not have site specific shade targets (Section 9.4.2). Effective shade curves represent the maximum possible effective shade for a given vegetation type. The values presented within the effective shade curves (**Figure 9-10** to **Figure 9-31**) represent the mean effective shade target for different mapping units, stream aspects, and active channel widths. The vegetation height, density, overhang, and buffer widths used for each mapping unit vegetation type is summarized in **Table 9-9**. See TSD Appendix A and C for additional details on the model approach for shade curves and the methodologies used to determine the mapping units and vegetation characteristics. Section 14 of the TMDL provides tables of the plotted shade curve values. A map of all mapping units in the Willamette Basin can be found in the TSD Appendix H: Willamette Subbasins Interactive TMDL Map. This is an interactive HTML map that can be opened in an internet browser.

Local geology, geography, soils, climate, legacy impacts, natural disturbance rates, and other 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 9-9: Vegetation height, density, overhang, and horizontal distance buffer widths used to derive generalized effective shade curve targets for each mapping unit.

Mapping Unit	Height (m)	Height (ft)	Density (%)	Overhang (m)	Buffer Width (m)
Qff1	40.7	134	70	4.9	36.8
Qfc	37.7	124	64	4.5	36.8
Qalc	26.9	88	71	3.2	36.8
Qg1	21.6	71	64	2.6	36.8
Qau	22.6	74	69	2.7	36.8
Qalf	17.5	57	68	2.1	36.8
Qff2	21.5	71	66	2.6	36.8
Qbf	22.0	72	68	2.6	36.8
Tvc	27.8	91	65	3.3	36.8
Qtg	40.5	133	72	4.9	36.8
Tvw	35.1	115	65	4.2	36.8
Tcr	36.9	121	68	4.4	36.8
Tm	29.7	97	68	3.6	36.8
QTt	25.2	83	66	3.0	36.8
QTb	35.2	115	64	4.2	36.8
Qls	44.0	144	65	5.3	36.8
OW	1.9	6	74	0.2	36.8
Upland Forest	40.9	134	75	4.9	36.8
1d/1f - Coast Range - Volcanics and Willapa Hills	36.0	118.1	75	3.9	36.8
3a -Willamette Valley - Portland/Vancouver Basin	26.0	85.3	75	1.9	36.8
3c -Willamette Valley - Prairie Terraces	33.2	108.9	75	1.9	36.8
3d - Willamette Valley – Valley Foothills	31.0	101.7	75	1.9	36.8

How to use a shade curve:

1. Determine the applicable mapping unit for the stream location you are applying a shade curve to.

   Example: Your site of interest is in the Rickreall Creek watershed, in the City of Independence, along the west bank of a tributary to the Willamette River. Open the Willamette Subbasins Interactive TMDL Map (TSD Appendix H) and select the Shade Curve Mapping Units Layer in the Map Legend to add it to the map. You may also want to select the City Boundaries Layer and the Stream Names Layer to help identify your site of interest. Once you have identified your site of interest, click that point on the map and you will see a pop-up box that identifies the Shade Curve Mapping Unit for that point. In this example, you identify the mapping unit at your site to be Qalc (Quaternary alluvium floodplain deposits) (**Figure 9-8**).

2. Determine the stream aspect from north.

Example: Standing in-stream mid-channel, facing north determine the river's aspect as 0º or 180º from north (this means the river reach runs south to north).

3. Determine the active channel width of the stream reach.

   Example: At your location you measure the active channel width using a tape measure or laser range finder and determine that it is 25 ft.

4. Use the appropriate mapping unit shade curve, stream aspect line and active channel width (x-axis), to determine the percent effective shade of your site (y-axis). This is the non-point source load allocation of the stream reach at system potential vegetation.

   Example: You have determined that the appropriate shade curve mapping unit for your site is Qalc (**Figure 9-9**). Since you are located on a tributary with an East-West stream aspect and an active channel width of 25 ft, you use the dotted line to determine the effective shade. By reading the y-axes, you determine that the effective shade to be ~83% when system potential vegetation is applied to the left and right bank of the stream reach. System potential vegetation defines the average riparian vegetation height as 88.2 ft (26.9 m), and the stand density (canopy density) as 71%.

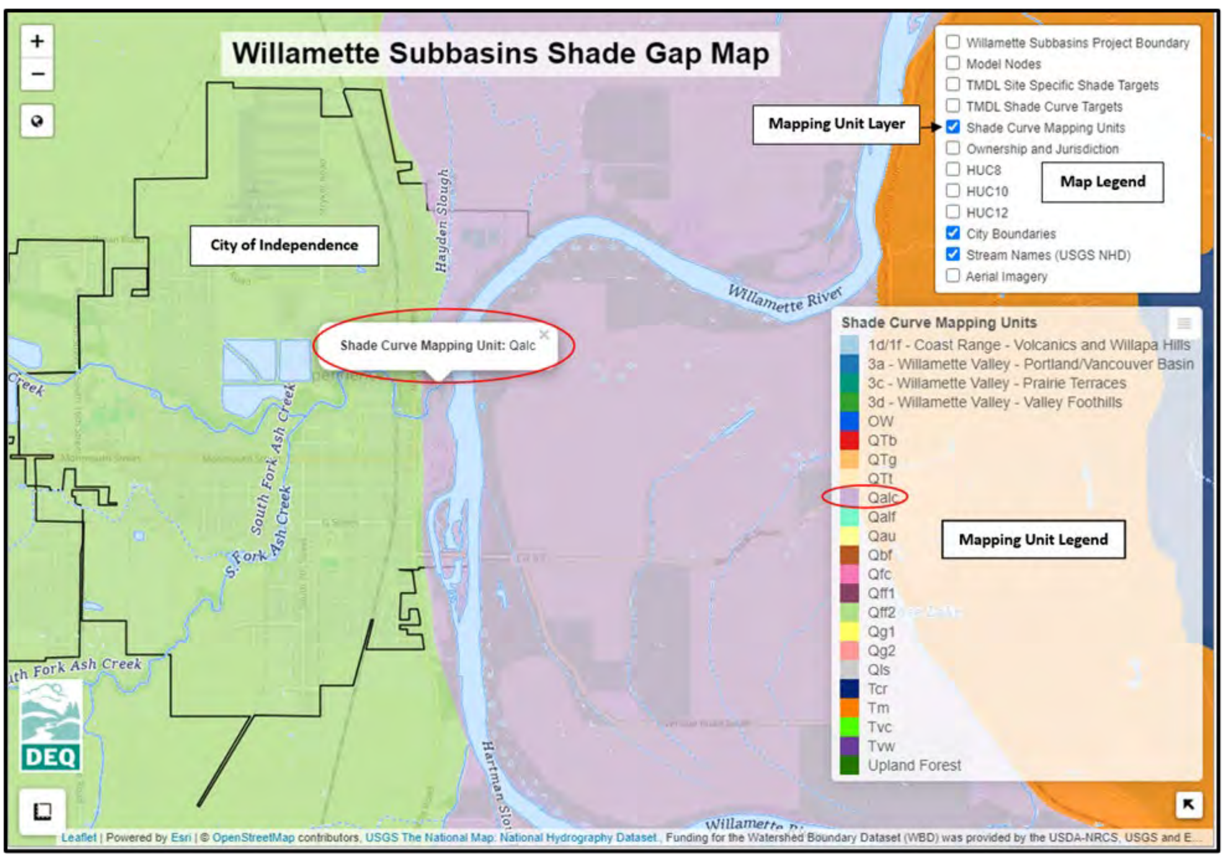


Figure 9-8: Mapping units in the example area of interest from the Willamette Subbasins Interactive TMDL Map.

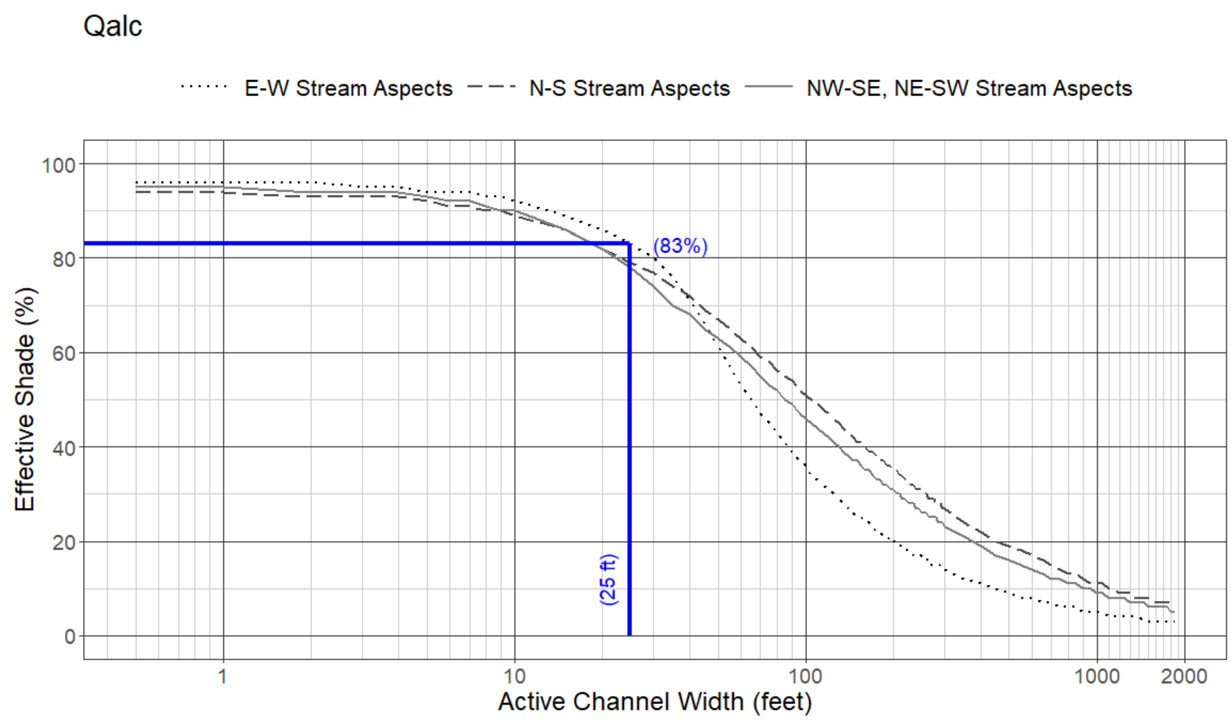


Figure 9-9: Example illustrating use of the shade curve for the Qalc mapping unit based on a north to south aspect and an active channel width of 25 ft.

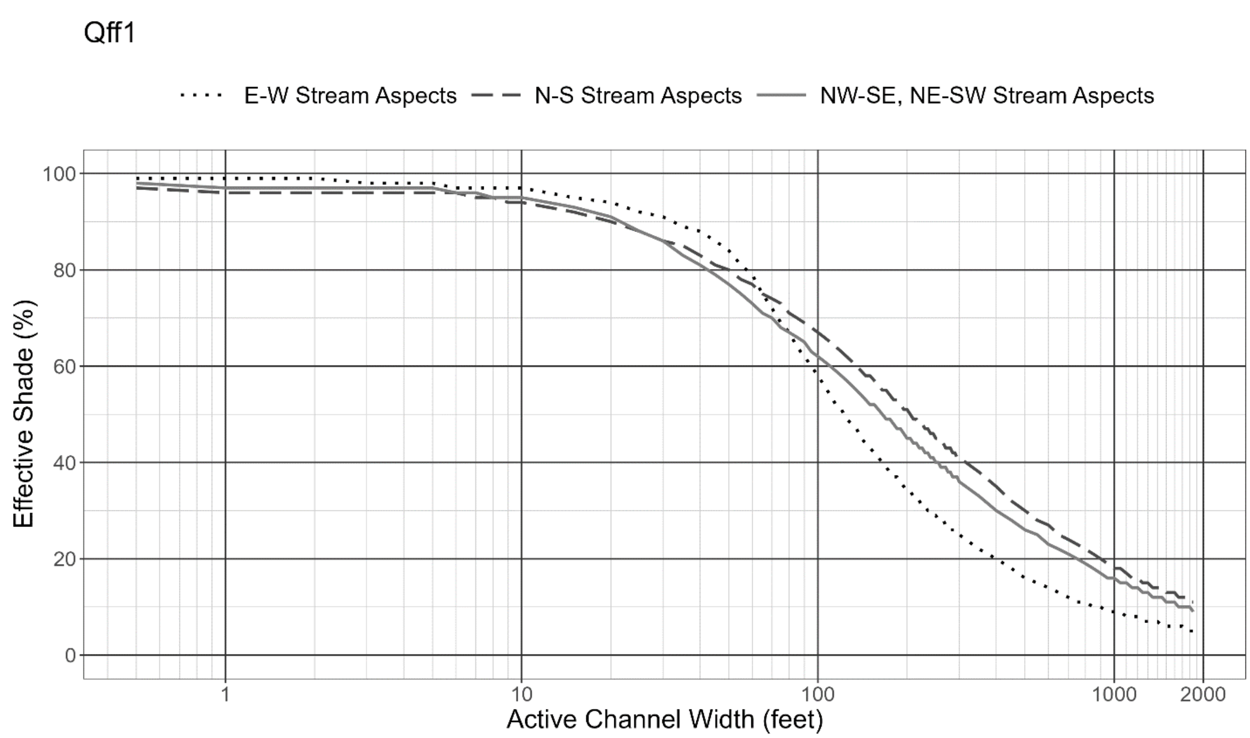


Figure 9-10: Effective shade targets for stream sites in the Qff1 mapping unit.

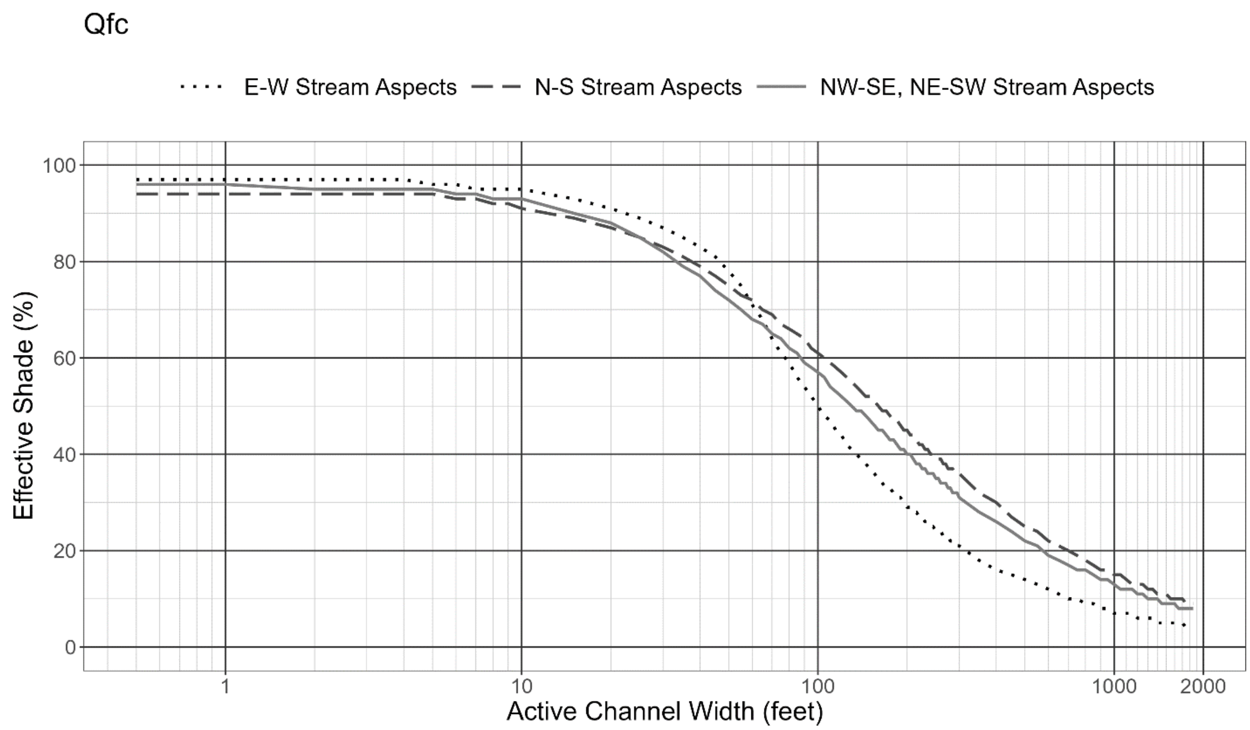


Figure 9-11: Effective shade targets for stream sites in the Qfc mapping unit.

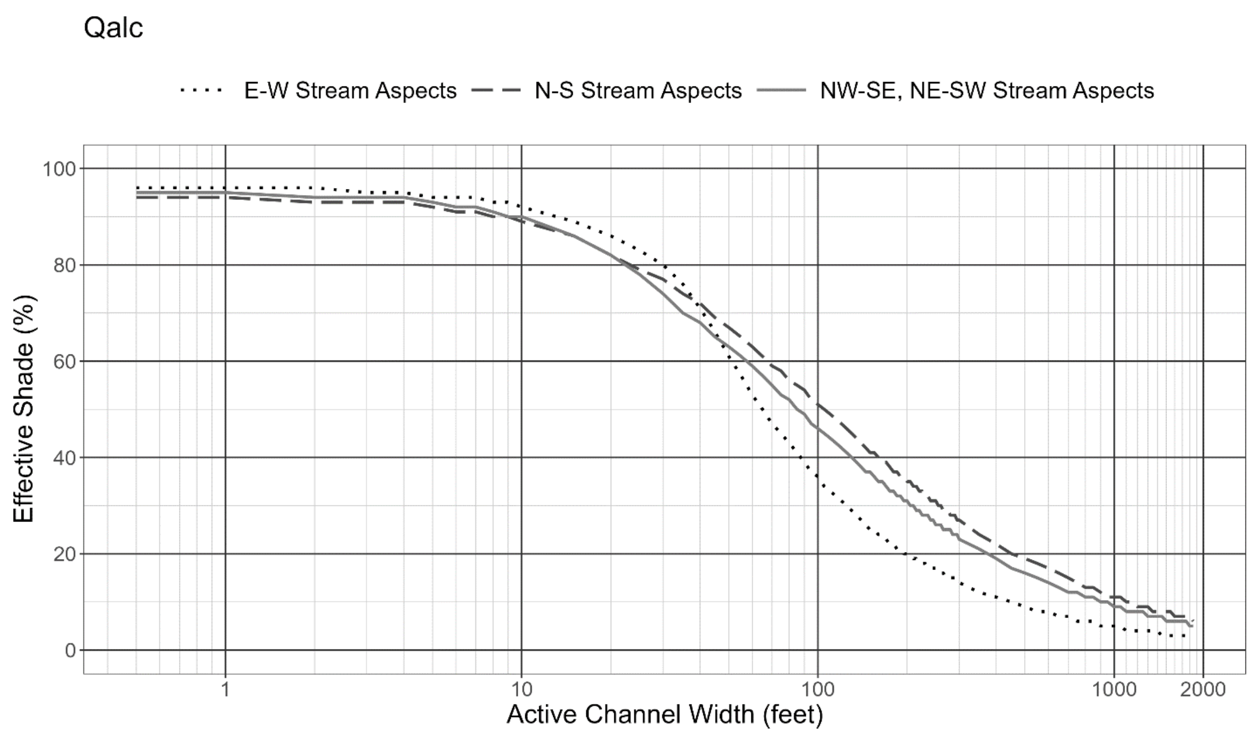


Figure 9-12: Effective shade targets for stream sites in the Qalc mapping unit.

Qg1

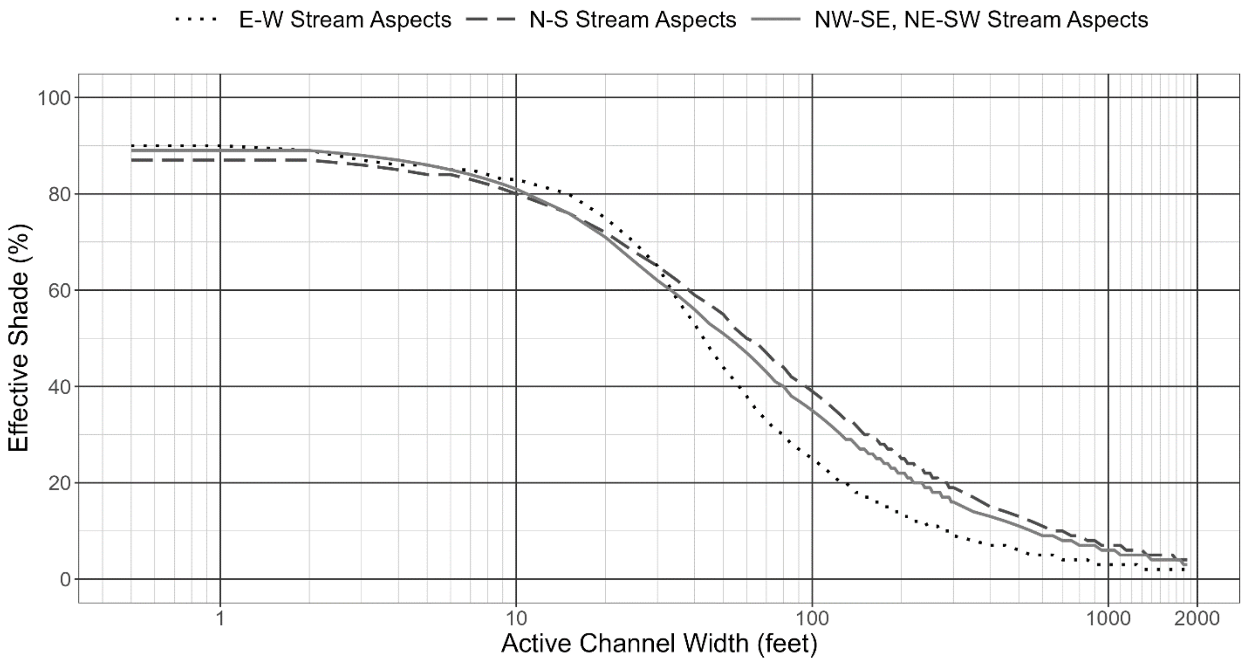


Figure 9-13: Effective shade targets for stream sites in the Qg1 mapping unit.

Qau

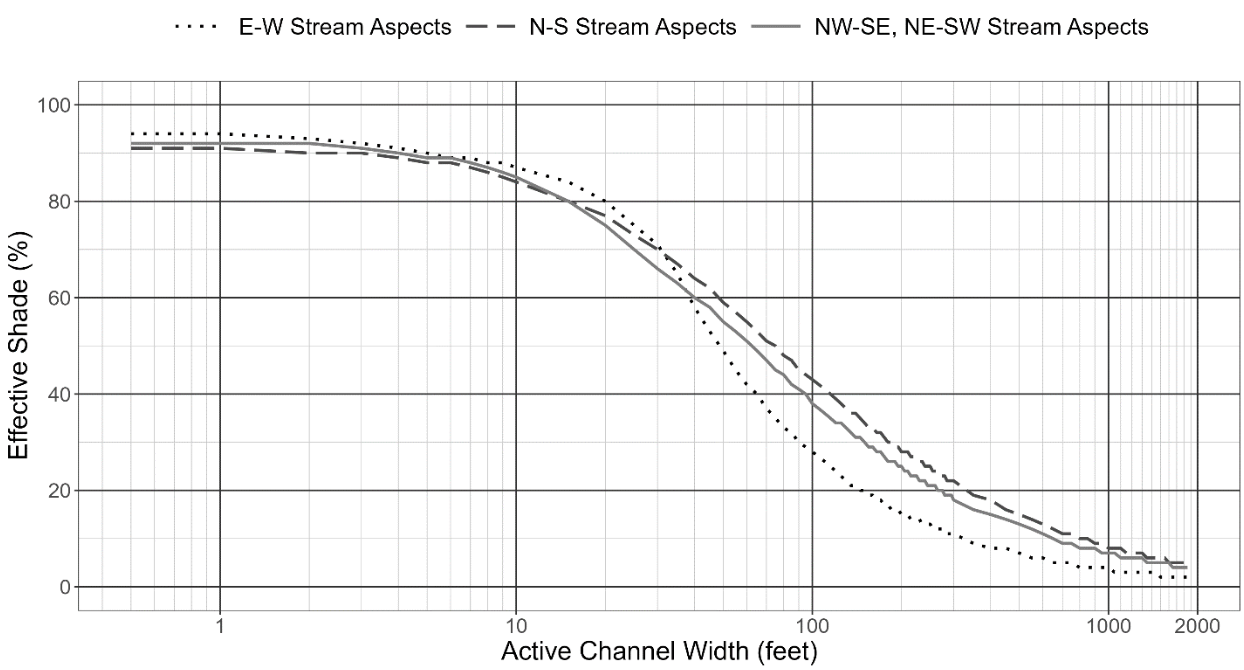


Figure 9-14: Effective shade targets for stream sites in the Qau mapping unit.

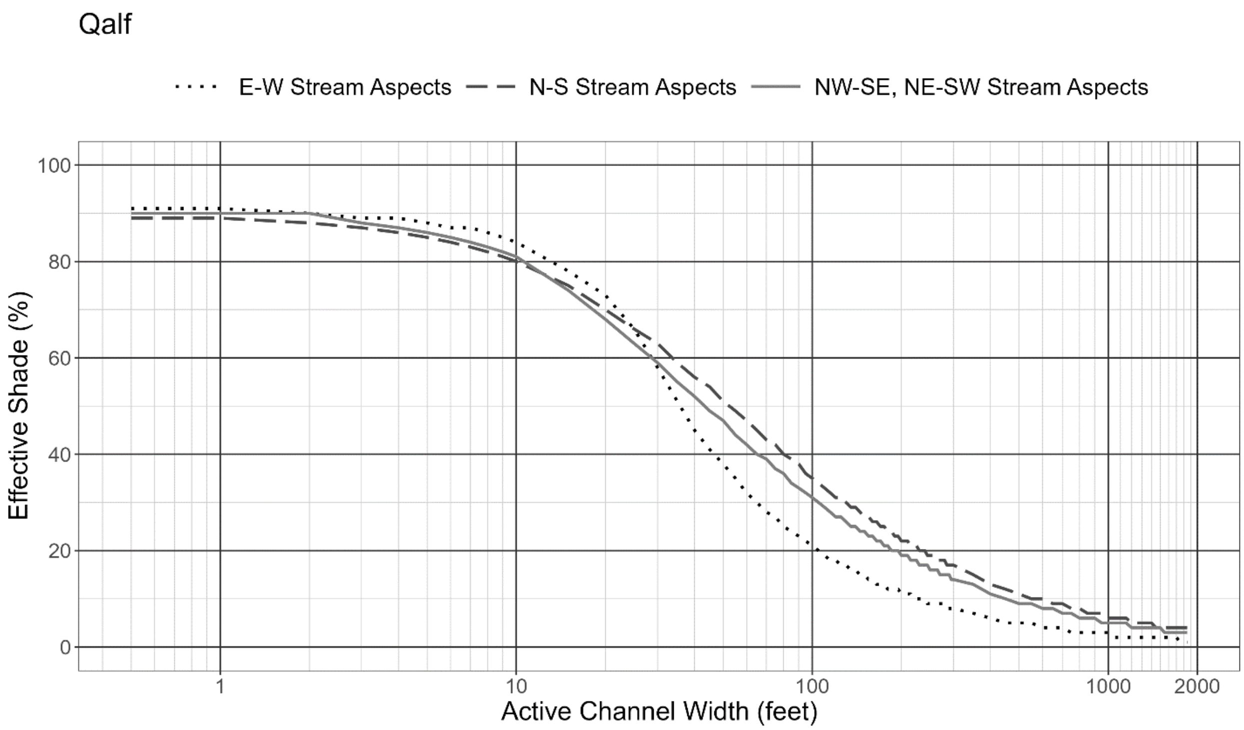


Figure 9-15: Effective shade targets for stream sites in the Qalf mapping unit.

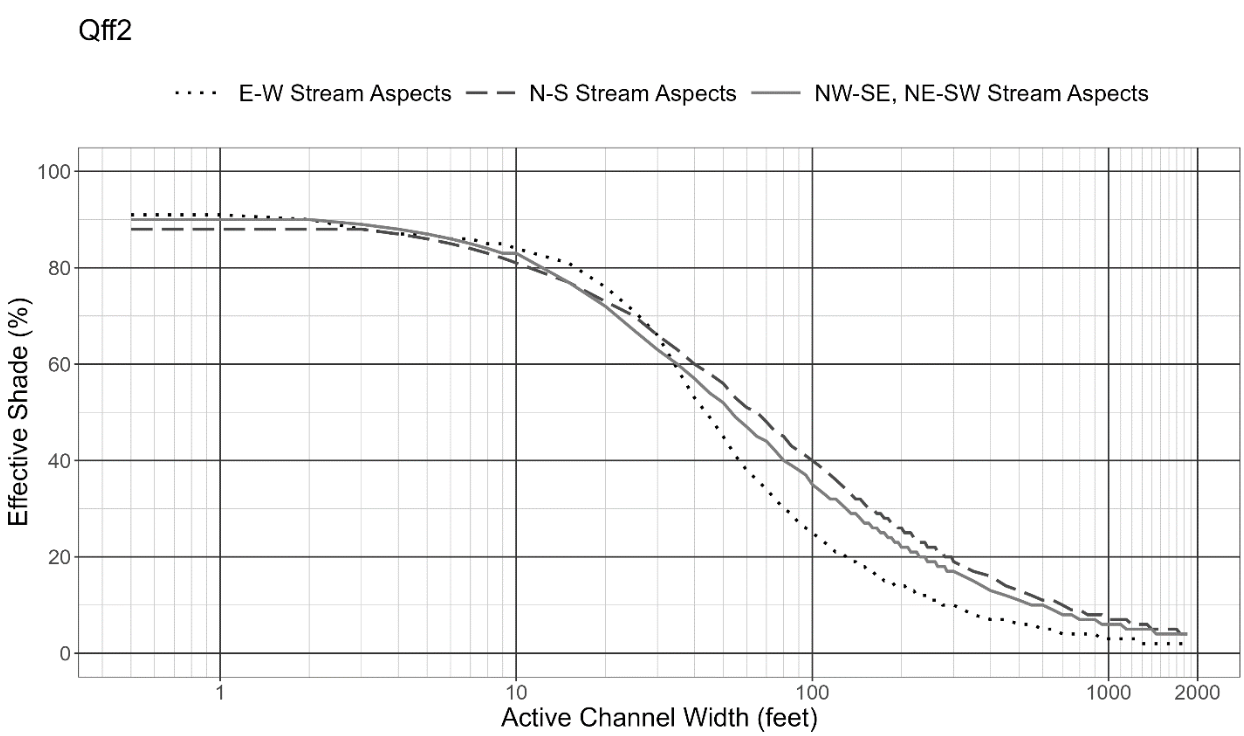


Figure 9-16: Effective shade targets for stream sites in the Qff2 mapping unit.

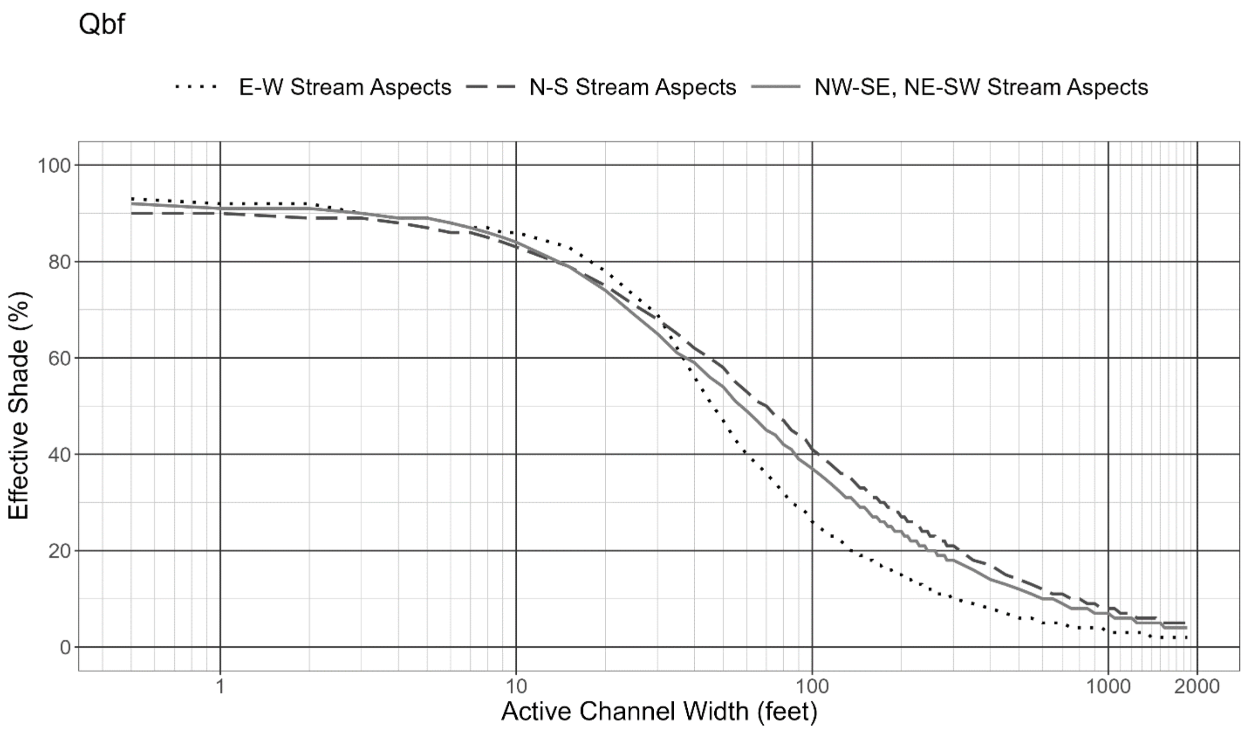


Figure 9-17: Effective shade targets for stream sites in the Qbf mapping unit.

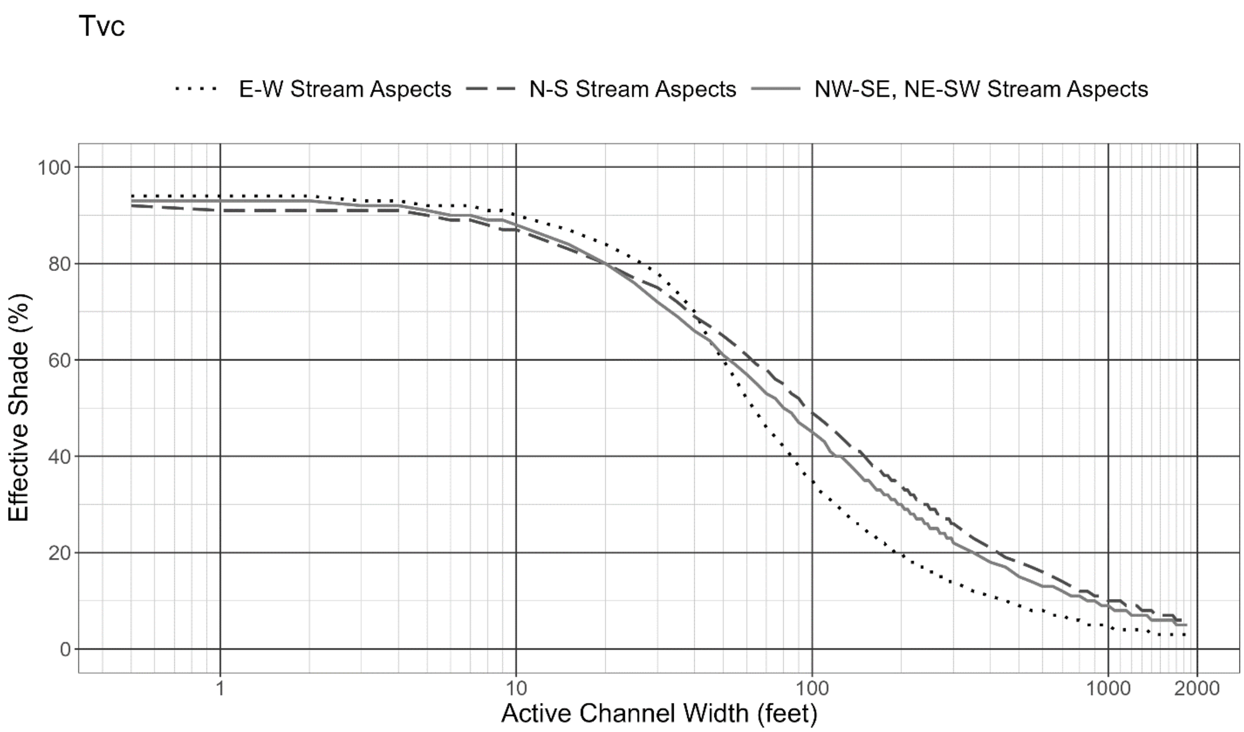


Figure 9-18: Effective shade targets for stream sites in the Tvc mapping unit.

Qtg

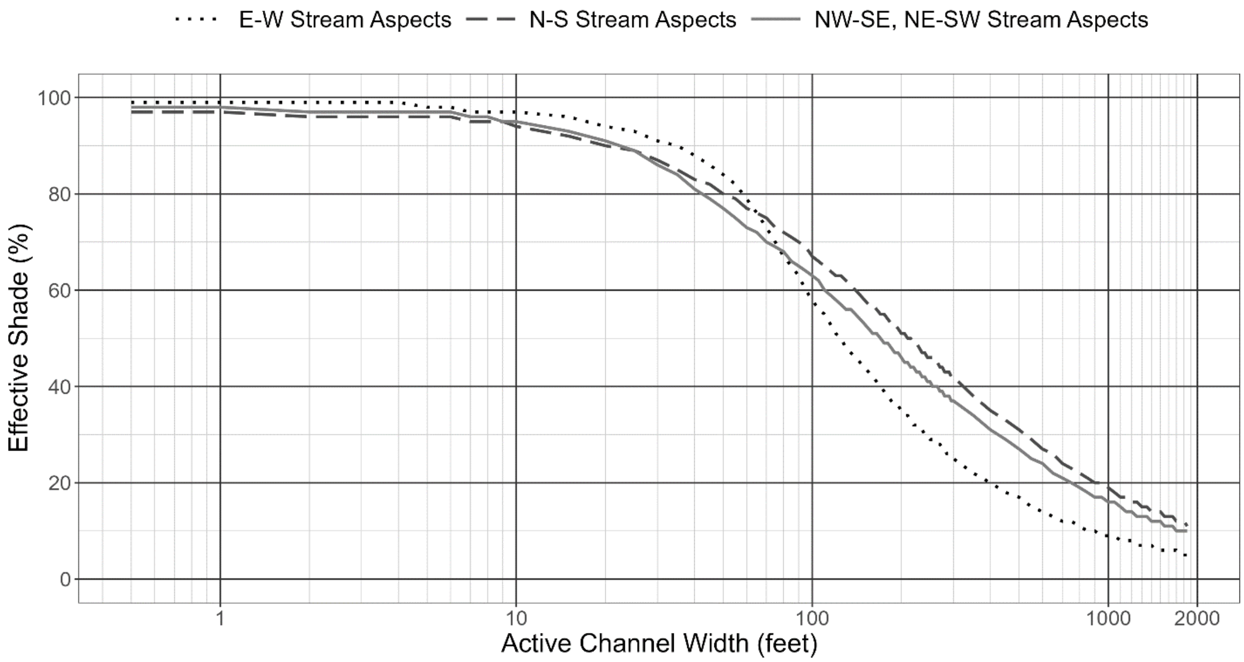


Figure 9-19: Effective shade targets for stream sites in the Qtg mapping unit.

Tvw

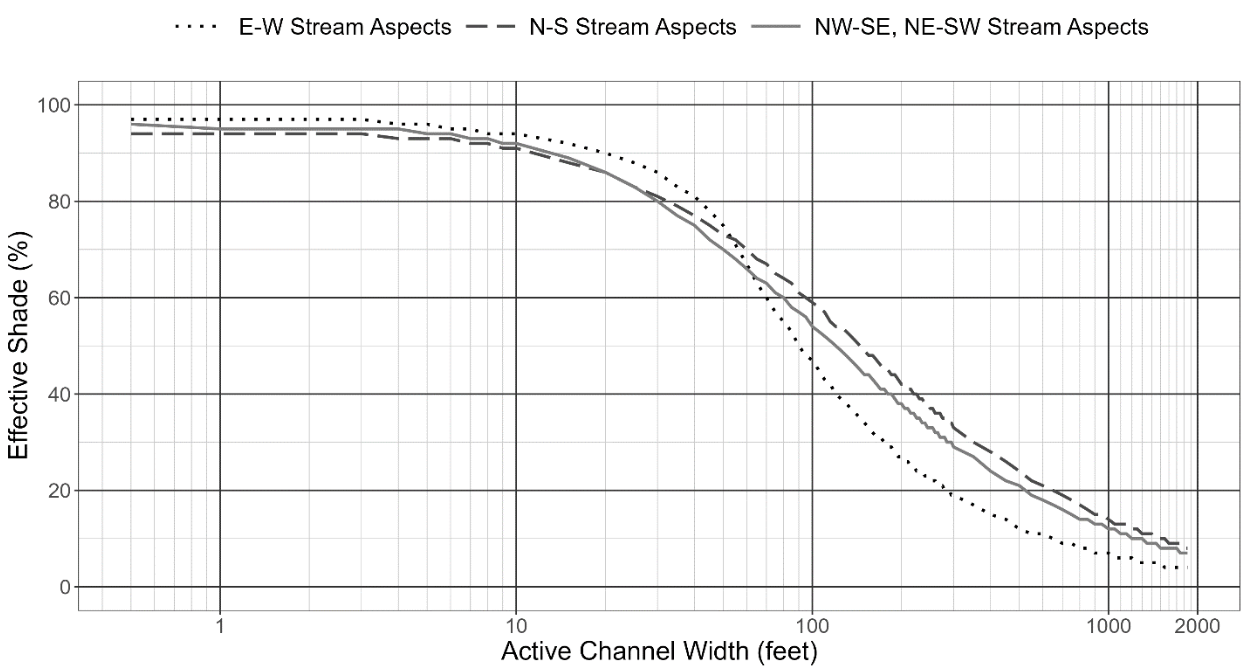


Figure 9-20: Effective shade targets for stream sites in the Tvw mapping unit.

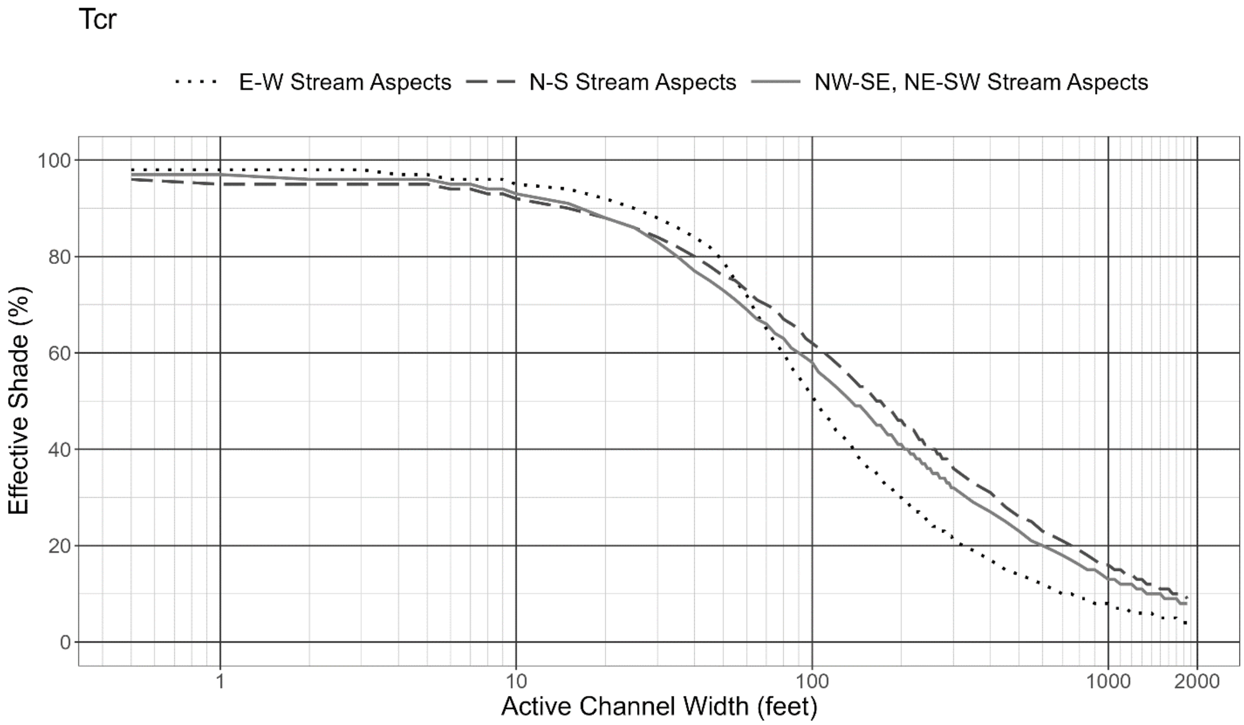


Figure 9-21: Effective shade targets for stream sites in the Tcr mapping unit.

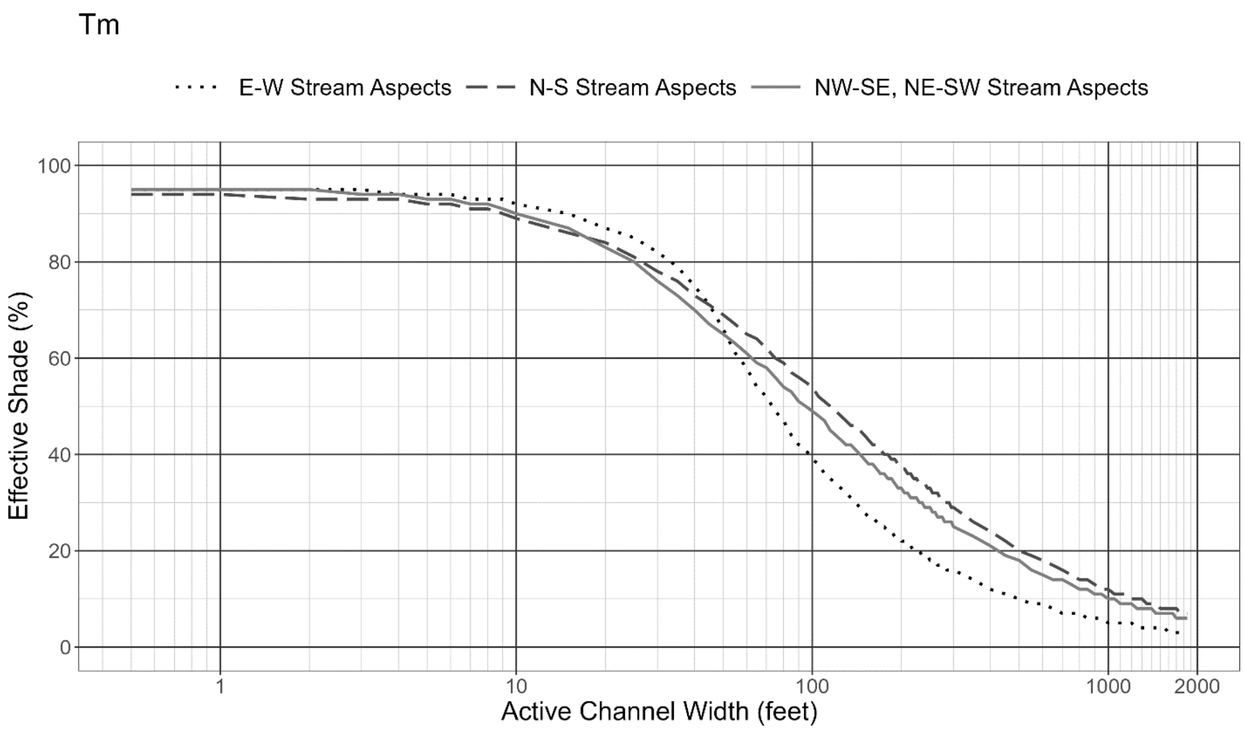


Figure 9-22: Effective shade targets for stream sites in the Tm mapping unit.

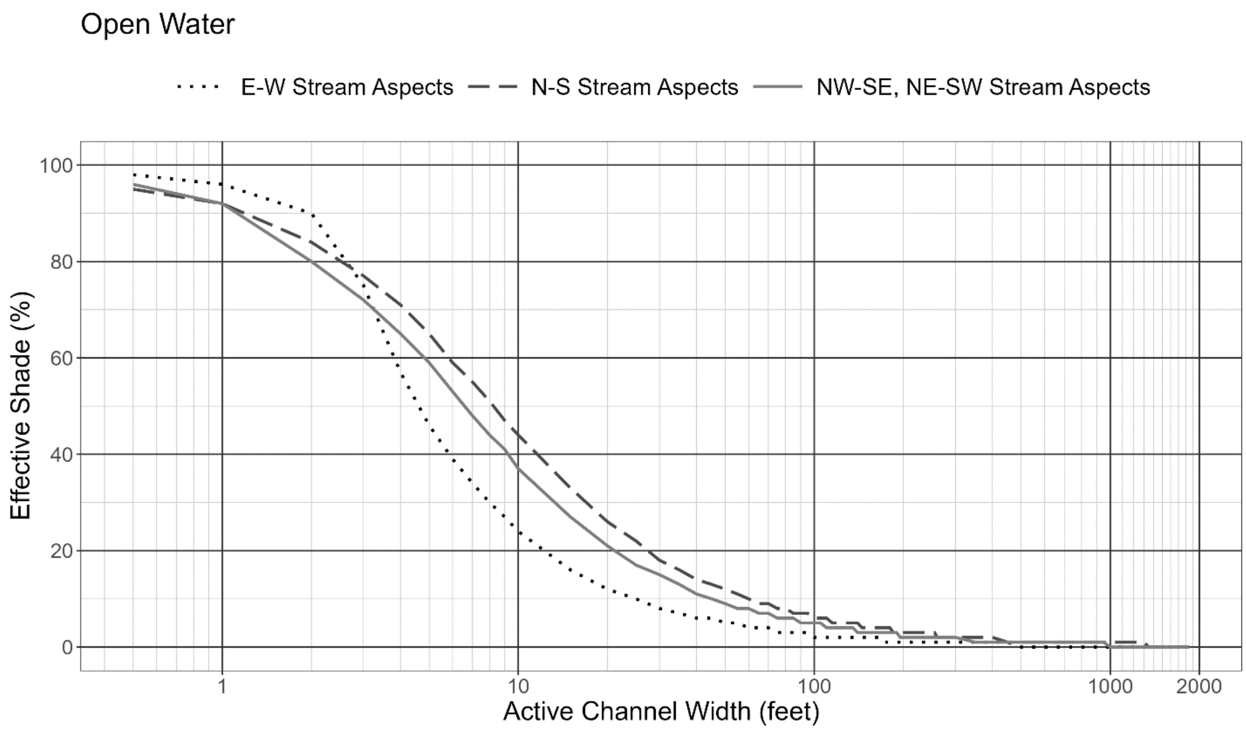


Figure 9-23: Effective shade targets for stream sites in the Open Water (OW) mapping unit.

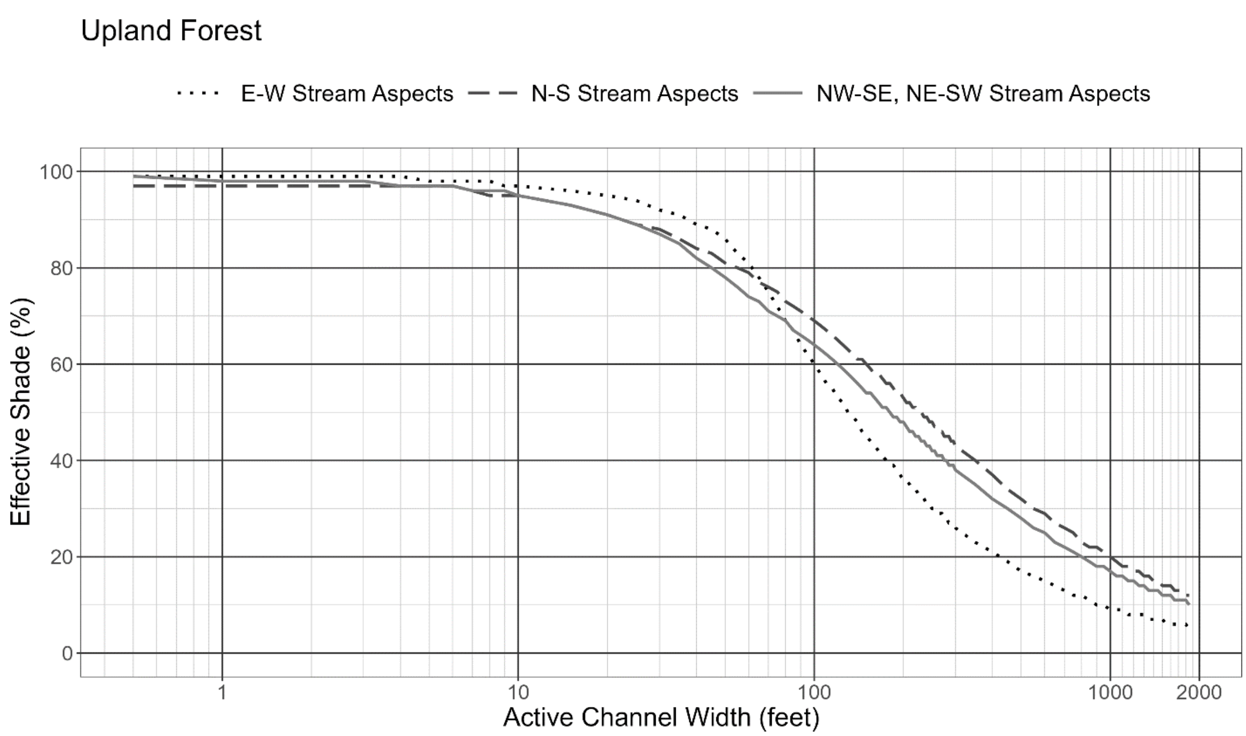


Figure 9-24: Effective shade targets for stream sites in the Upland Forest mapping unit.

QTt

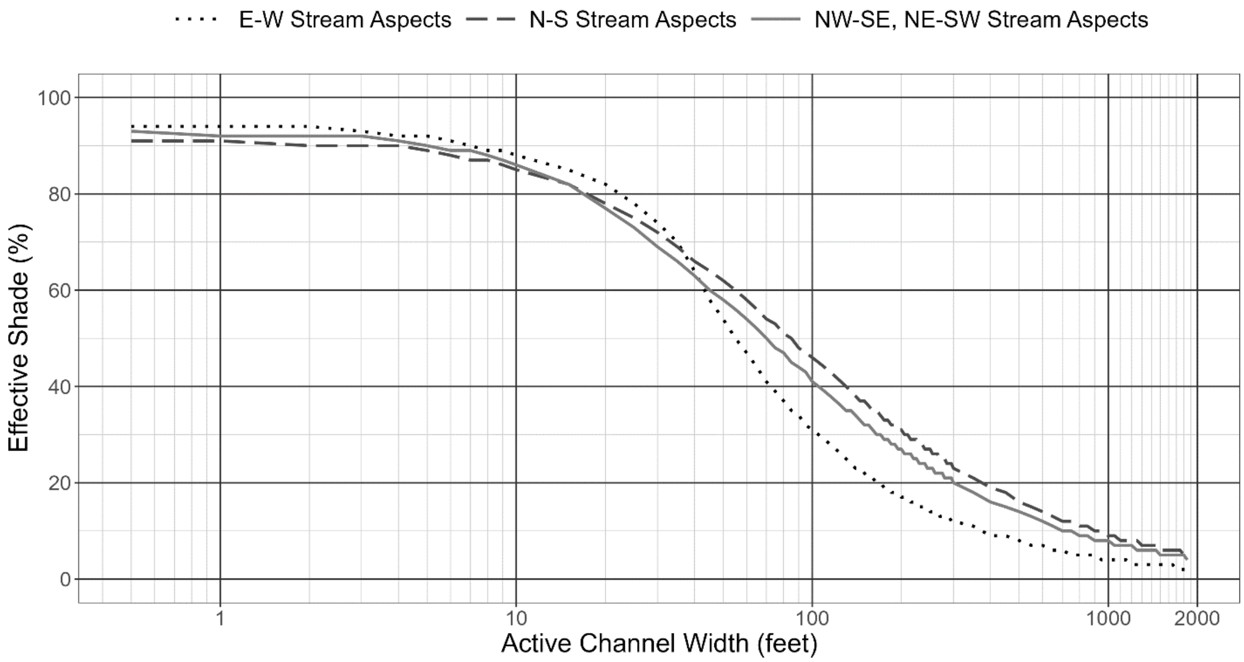


Figure 9-25: Effective shade targets for stream sites in the QTt mapping unit.

QTb

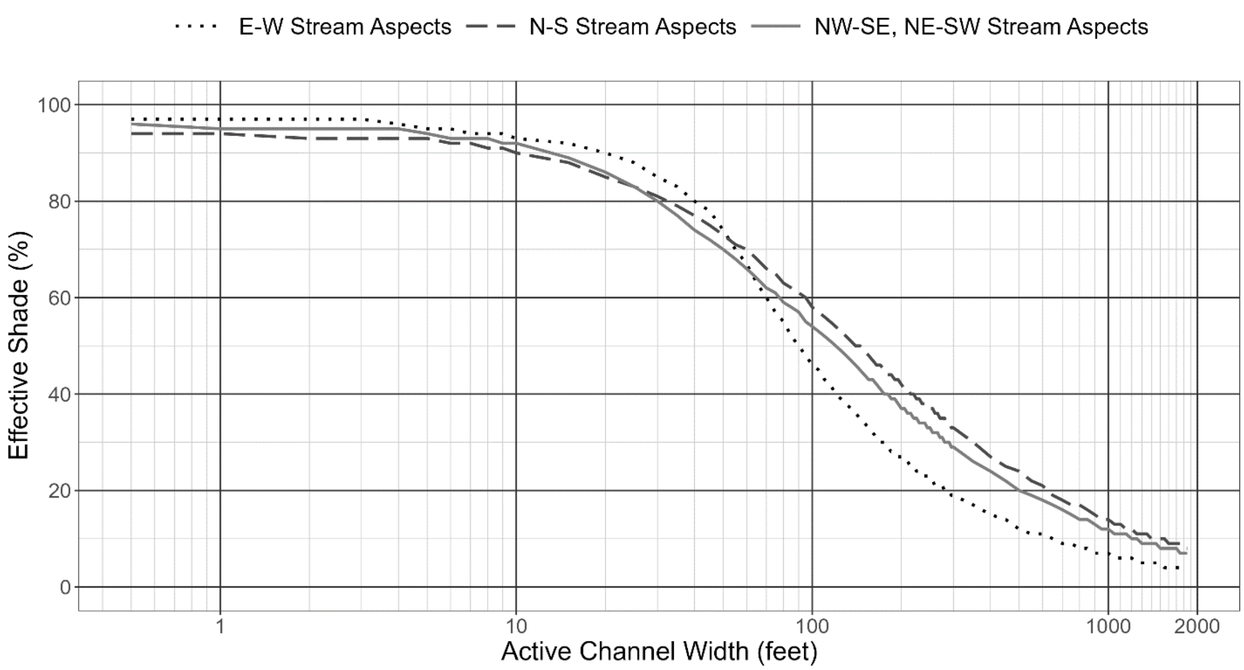


Figure 9-26: Effective shade targets for stream sites in the QTb mapping unit.

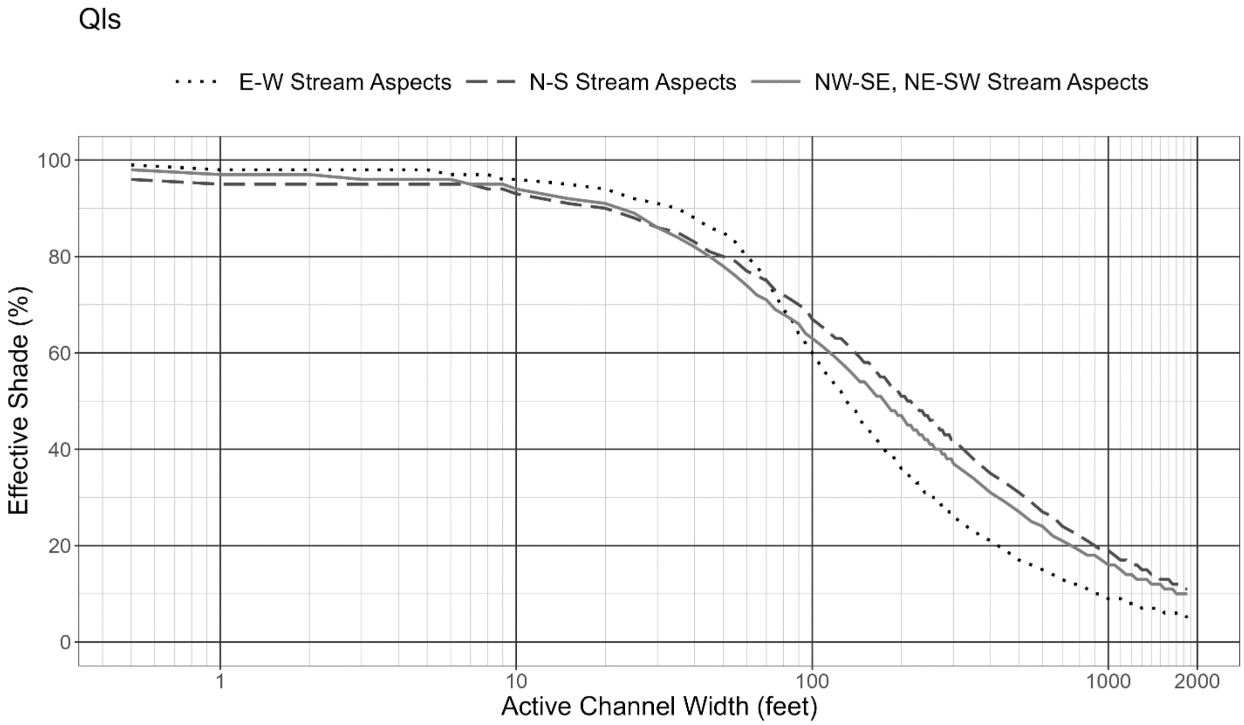


Figure 9-27: Effective shade targets for stream sites in the Qls mapping unit.

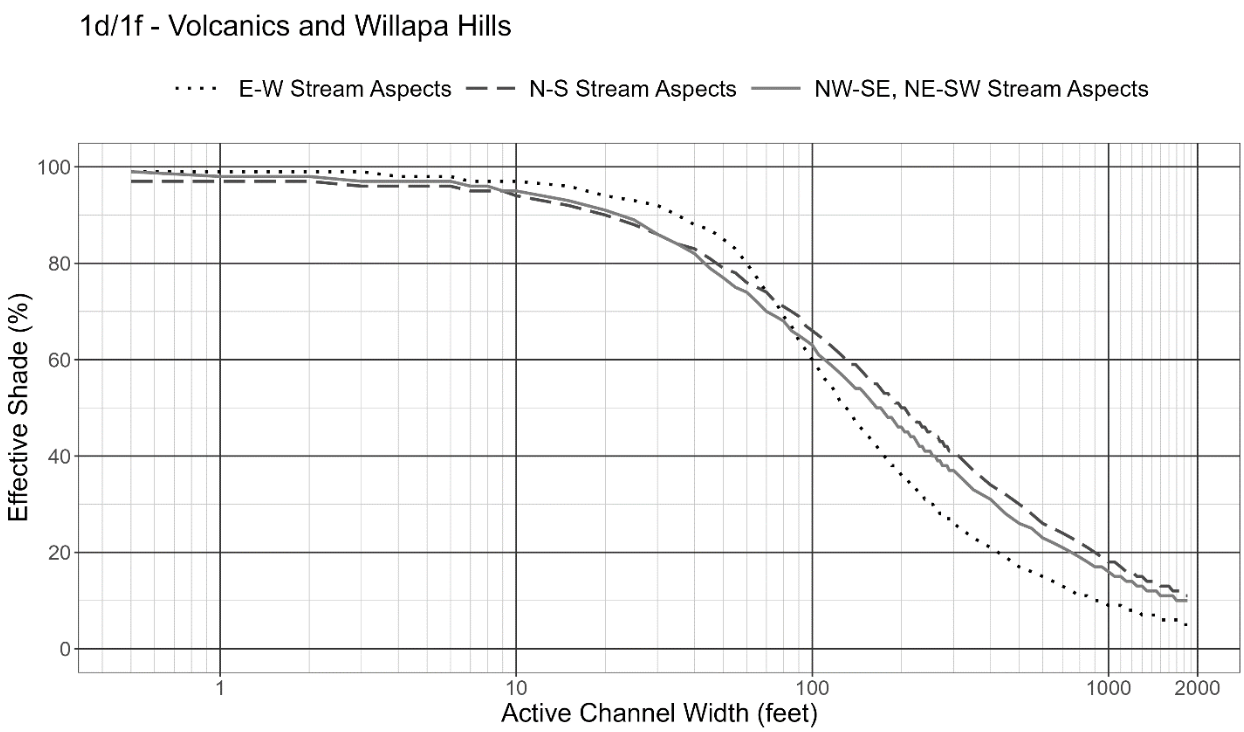


Figure 9-28: Effective shade targets for stream sites in Ecoregion 1d/1f - Volcanics and Willapa Hills.

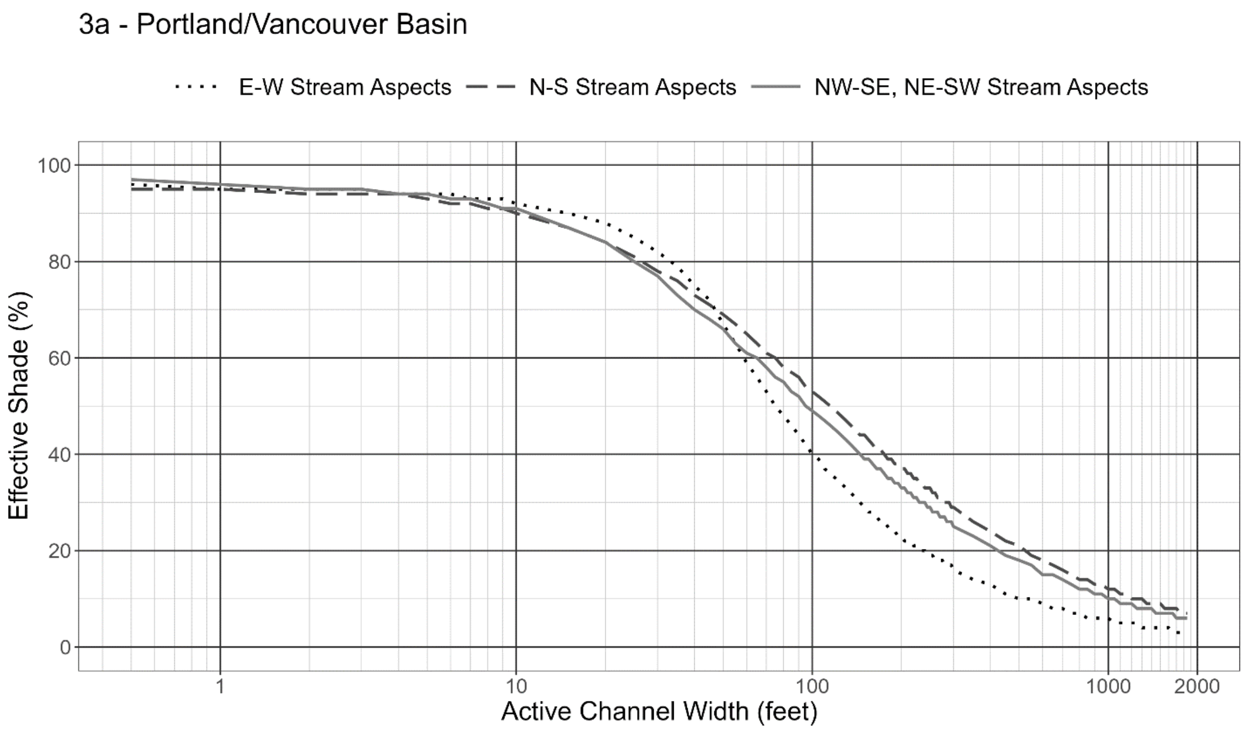


Figure 9-29: Effective shade targets for stream sites in Ecoregion 3a - Portland/Vancouver Basin.

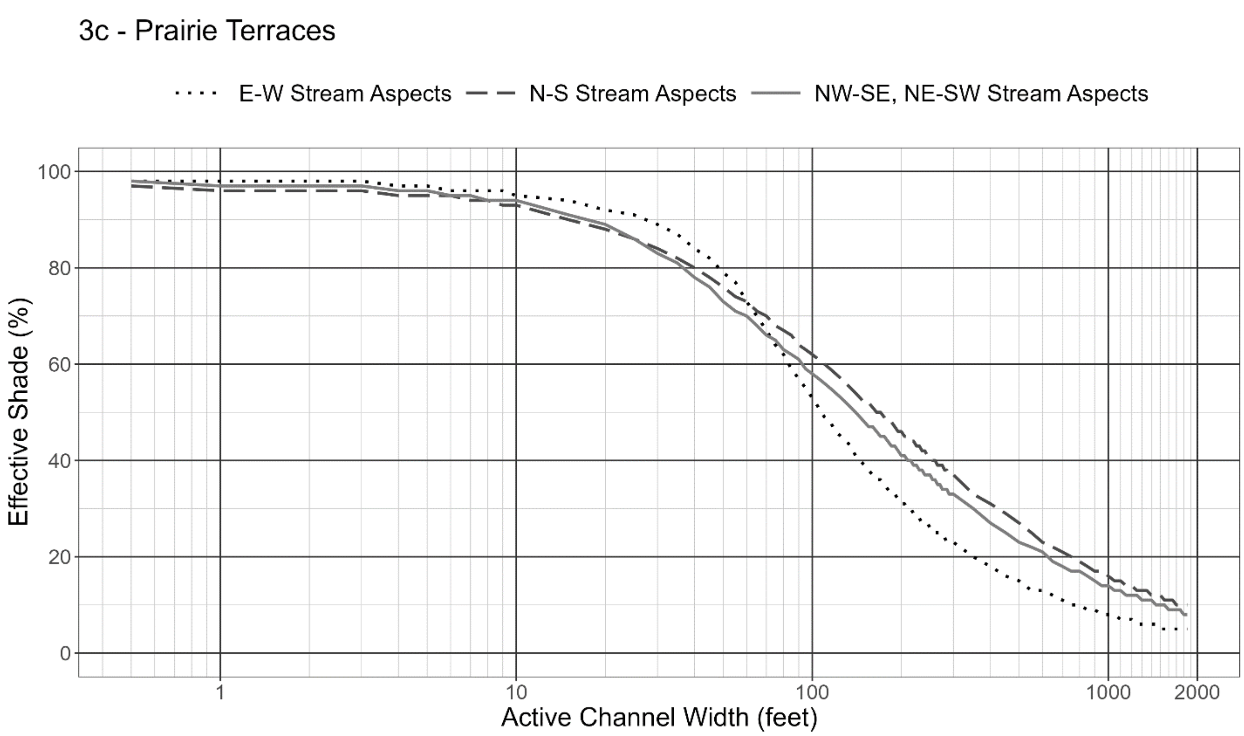


Figure 9-30: Effective shade targets for stream sites in Ecoregion 3c - Prairie Terraces.

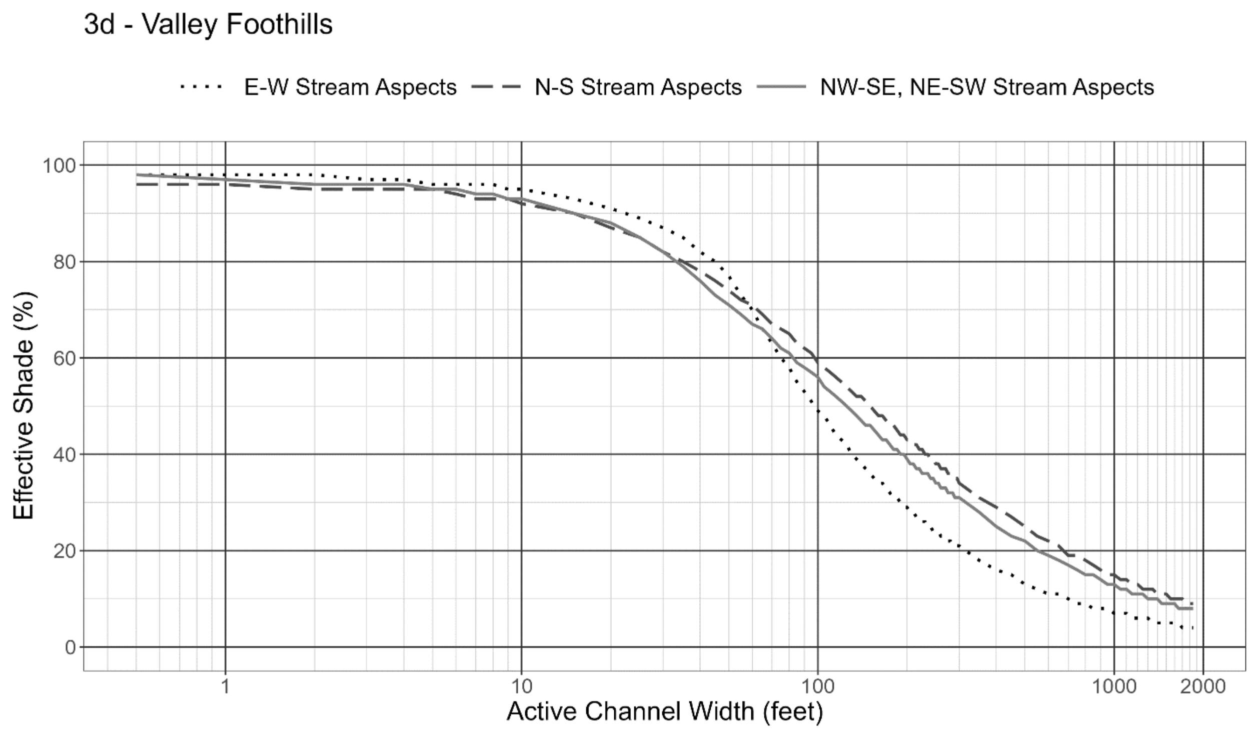


Figure 9-31: Effective shade targets for stream sites in Ecoregion 3d - Valley Foothills.

9.5 Allocation summary

Table 9-10 through **Table 9-19** present examples of allocation calculations for sources or source categories on select temperature impaired AUs. The allocations to background sources were calculated using **Equation 9-7** and were based on the applicable year-round criterion and the spawning criterion in the respective AU. In cases when there was more than one year-round criterion applicable in the AU, the minimum criterion was used. The allocations to NPDES point sources were calculated using **Equation 9-**. The allocations to nonpoint sources were calculated using **Equation 9-8**. All allocations presented in **Table 9-10** through **Table 9-19** were calculated using the annual 7Q10 river flow rate. As summarized in the TMDL, allocations may be dynamic and calculated using the relevant equations when river flow rates are greater than 7Q10.

The HUA assignments to anthropogenic sources or source categories are equal to 0.30°C. Wasteload allocations to point sources and load allocations to nonpoint sources are based on loads equivalent to the allowed 0.30°C increase. For some NPDES permitted point sources and nonpoint sources, the maximum cumulative impact at the POMI in an AU is less than the sum of the individual HUA assignments at their respective points of discharge or activity due to heat dissipation within the AU.

Table 9-10: Allocation summary for Coyote Creek (AU: OR_SR_1709000301_02_103796) based on an annual 7Q10 of 5.9 cfs and a year-round criterion of 18°C. The allocation period is May 1 through October 31.

Source or Source Category	Assigned HUA (°C)	7Q10 Allocation Year Round (kilocalories/day)	7Q10 Allocation Spawning (kilocalories/day)
Background	0.0	259.84E+6	NA
NPDES point sources	0.075	1.08E+6	NA
Nonpoint source dam and reservoir operations	0.0	0	NA
Water management activities and water withdrawals	0.05	0.72E+6	NA
Solar loading from existing transportation corridors and utility infrastructure	0.02	0.29E+6	NA
Solar loading from other nonpoint source sectors	0.0	0	NA
Reserve capacity	0.155	2.24E+6	NA
Total Allocated Load:		264.17E+6	NA
Loading Capacity:		264.17E+6	NA

Table 9-11: Allocation summary for Crabtree Creek (AU: OR_SR_1709000606_02_103978) based on an annual 7Q10 of 25 cfs, a year-round criterion of 16°C, and a spawning criterion of 13°C. The allocation period is May 1 through October 31.

Source or Source Category	Assigned HUA (°C)	7Q10 Allocation Year Round (kilocalories/day)	7Q10 Allocation Spawning (kilocalories/day)
Background	0.0	978.67E+6	795.17E+6
NPDES point sources	0.10	6.12E+6	6.12E+6
Nonpoint source dam and reservoir operations	0.0	0	0
Water management activities and water withdrawals	0.05	3.06E+6	3.06E+6
Solar loading from existing transportation corridors and utility infrastructure	0.02	1.22E+6	1.22E+6
Solar loading from other nonpoint source sectors	0.0	0	0
Reserve capacity	0.13	7.95E+6	7.95E+6
Total Allocated Load:		997.02E+6	813.52E+6
Loading Capacity:		997.02E+6	813.52E+6

Table 9-12: Allocation summary for Johnson Creek (AU: OR_SR_1709001201_02_104170) based on an annual 7Q10 of 11 cfs, a year-round criterion of 18°C, and a spawning criterion of 13°C. The allocation period is February 15 through November 15.

Source or Source Category	Assigned HUA (°C)	7Q10 Allocation Year Round (kilocalories/day)	7Q10 Allocation Spawning (kilocalories/day)
Background	0.0	484.44E+6	349.87E+6
NPDES point sources	0.075	2.02E+6	2.02E+6
Nonpoint source dam and reservoir operations	0.0	0	0
Water management activities and water withdrawals	0.05	1.35E+6	1.35E+6
Solar loading from existing transportation corridors and utility infrastructure	0.02	0.54E+6	0.54E+6
Solar loading from other nonpoint source sectors	0.0	0	0
Reserve capacity	0.155	4.17E+6	4.17E+6
Total Allocated Load:		492.51E+6	357.95E+6
Loading Capacity:		492.51E+6	357.95E+6

Table 9-13: Allocation summary for the Little North Santiam River (AU: OR_SR_1709000505_02_104564) based on an annual 7Q10 of 21 cfs, a year-round criterion of 16°C, and a spawning criterion of 13°C. The allocation period is May 1 through October 31.

Source or Source Category	Assigned HUA (°C)	7Q10 Allocation Year Round (kilocalories/day)	7Q10 Allocation Spawning (kilocalories/day)
Background	0.0	822.08E+6	667.94E+6
NPDES point sources	0.075	3.85E+6	3.85E+6
Nonpoint source dam and reservoir operations	0.0	0	0
Water management activities and water withdrawals	0.05	2.57E+6	2.57E+6
Solar loading from existing transportation corridors and utility infrastructure	0.02	1.03E+6	1.03E+6
Solar loading from other nonpoint source sectors	0.0	0	0
Reserve capacity	0.155	7.96E+6	7.96E+6
Total Allocated Load:		837.49E+6	683.35E+6
Loading Capacity:		837.49E+6	683.35E+6

Table 9-14: Allocation summary for the Luckiamute River (AU: OR_SR_1709000305_02_103829) based on an annual 7Q10 of 16 cfs, a year-round criterion of 18°C, and a spawning criterion of 13°C. The allocation period is May 1 through October 31.

Source or Source Category	Assigned HUA (°C)	7Q10 Allocation Year Round (kilocalories/day)	7Q10 Allocation Spawning (kilocalories/day)
Background	0.0	704.64E+6	508.91E+6
NPDES point sources	0.075	2.94E+6	2.94E+6
Nonpoint source dam and reservoir operations	0.0	0	0
Water management activities and water withdrawals	0.05	1.96E+6	1.96E+6
Solar loading from existing transportation corridors and utility infrastructure	0.02	0.78E+6	0.78E+6
Solar loading from other nonpoint source sectors	0.0	0	0
Reserve capacity	0.155	6.07E+6	6.07E+6
Total Allocated Load:		716.38E+6	520.65E+6
Loading Capacity:		716.38E+6	520.65E+6

Table 9-15: Allocation summary for the Mohawk River (AU: OR_SR_1709000406_02_103871) based on an annual 7Q10 of 16 cfs, a year-round criterion of 16°C, and a spawning criterion of 13°C. The allocation period is May 1 through October 31.

Source or Source Category	Assigned HUA (°C)	7Q10 Allocation Year Round (kilocalories/day)	7Q10 Allocation Spawning (kilocalories/day)
Background	0.0	626.35E+6	508.91E+6
NPDES point sources	0.075	2.94E+6	2.94E+6
Nonpoint source dam and reservoir operations	0.0	0	0
Water management activities and water withdrawals	0.05	1.96E+6	1.96E+6
Solar loading from existing transportation corridors and utility infrastructure	0.02	0.78E+6	0.78E+6
Solar loading from other nonpoint source sectors	0.0	0	0
Reserve capacity	0.155	6.07E+6	6.07E+6
Total Allocated Load:		638.09E+6	520.65E+6
Loading Capacity:		638.09E+6	520.65E+6

Table 9-16: Allocation summary for the Molalla River (AU: OR_SR_1709000904_02_104086) based on an annual 7Q10 of 38 cfs, a year-round criterion of 16°C, and a spawning criterion of 13°C. The allocation period is May 1 through October 31.

Source or Source Category	Assigned HUA (°C)	7Q10 Allocation Year Round (kilocalories/day)	7Q10 Allocation Spawning (kilocalories/day)
Background	0.0	1,487.57E+6	1,208.65E+6
NPDES point sources	0.20	18.59E+6	18.59E+6
Nonpoint source dam and reservoir operations	0.0	0	0
Water management activities and water withdrawals	0.05	4.65E+6	4.65E+6
Solar loading from existing transportation corridors and utility infrastructure	0.02	1.86E+6	1.86E+6
Solar loading from other nonpoint source sectors	0.0	0	0
Reserve capacity	0.03	2.79E+6	2.79E+6
Total Allocated Load:		1,515.46E+6	1,236.54E+6
Loading Capacity:		1,515.46E+6	1,236.54E+6

Table 9-17: Allocation summary for Mosby Creek (AU: OR_SR_1709000201_02_103752) based on an annual 7Q10 of 11 cfs, a year-round criterion of 16°C, and a spawning criterion of 13°C. The allocation period is May 1 through October 31.

Source or Source Category	Assigned HUA (°C)	7Q10 Allocation Year Round (kilocalories/day)	7Q10 Allocation Spawning (kilocalories/day)
Background	0.0	430.61E+6	349.87E+6
NPDES point sources	0.075	2.02E+6	2.02E+6
Nonpoint source dam and reservoir operations	0.0	0	0
Water management activities and water withdrawals	0.05	1.35E+6	1.35E+6
Solar loading from existing transportation corridors and utility infrastructure	0.02	0.54E+6	0.54E+6
Solar loading from other nonpoint source sectors	0.0	0	0
Reserve capacity	0.155	4.17E+6	4.17E+6
Total Allocated Load:		438.69E+6	357.95E+6
Loading Capacity:		438.69E+6	357.95E+6

Table 9-18: Allocation summary for the Pudding River (AU: OR_SR_1709000905_02_104088) based on an annual 7Q10 of 10 cfs, and a year-round criterion of 18°C. The allocation period is May 1 through October 31.

Source or Source Category	Assigned HUA (°C)	7Q10 Allocation Year Round (kilocalories/day)	7Q10 Allocation Spawning (kilocalories/day)
Background	0.0	440.4E+6	NA
NPDES point sources	0.20	4.89E+6	NA
Nonpoint source dam and reservoir operations	0.0	0	NA
Water management activities and water withdrawals	0.05	1.22E+6	NA
Solar loading from existing transportation corridors and utility infrastructure	0.02	0.49E+6	NA
Solar loading from other nonpoint source sectors	0.0	0	NA
Reserve capacity	0.03	0.73E+6	NA
Total Allocated Load:		447.74E+6	NA
Loading Capacity:		447.74E+6	NA

Table 9-19: Allocation summary for Thomas Creek (AU: OR_SR_1709000607_02_103988) based on an annual 7Q10 of 6.9 cfs, and a year-round criterion of 18°C. The allocation period is May 1 through October 31.

Source or Source Category	Assigned HUA (°C)	7Q10 Allocation Year Round (kilocalories/day)	7Q10 Allocation Spawning (kilocalories/day)
Background	0.0	302.18E+6	NA
NPDES point sources	0.075	1.26E+6	NA
Nonpoint source dam and reservoir operations	0.0	0	NA
Water management activities and water withdrawals	0.05	0.84E+6	NA
Solar loading from existing transportation corridors and utility infrastructure	0.02	0.34E+6	NA
Solar loading from other nonpoint source sectors	0.0	0	NA
Reserve capacity	0.155	2.6E+6	NA
Total Allocated Load:		307.22E+6	NA
Loading Capacity:		307.22E+6	NA

10 Water quality standards attainment

10.1 Point sources

DEQ’s approach to point source allocations is to distribute an equal portion of the HUA (0.075°C) with some exceptions, as described below. An HUA of 0.075°C is selected because many of the current NPDES permit limits are based on this amount of allowed warming, and it is consistent with allocations provided in DEQ’s 2006 Willamette Basin temperature TMDL.

Exceptions were made when the point source was not authorized to discharge in the current NPDES permit (maximum effluent flow = 0). For these point sources, an HUA of 0.0°C was assigned during the no discharge period. An HUA assignment of zero means there may be no warming above the applicable temperature criteria.

Exceptions were also made based on the results of thermal loading assessments completed by DEQ. In some cases, analysis indicated that current thermal loads are less than 0.075°C, so the allocation could be reduced to minimize cumulative effects. In other cases, analysis indicated that an HUA assignment of 0.075°C would result in immediate noncompliance, so DEQ increased the allocation where possible. Facility specific assessment summaries and HUA assignments are described in Section 9.2.1 HUA assignments to point sources.

Cumulative warming effects were considered throughout the HUA assignment and wasteload allocation process. On unmodeled streams with more than one point source, and where a cumulative effects analysis was not completed, it was assumed that warming impacts from individual point sources did not dissipate with distance from the outfall. This means that the total portion of the HUA assigned to the point source sector represents the sum of the HUA assignments to individual point sources. For example, if a stream has two NPDES point sources that each have an HUA assignment of 0.075°C, the HUA assignment to all NPDES point sources at the POMI on that stream is 0.15°C. This approach is protective based on model results from other streams that show temperature impacts from point sources dissipating moving downstream from the outfall. DEQ also mapped the outfall locations to AUs and adjusted the HUA assignments on AUs that did not have point sources, but that were downstream of AUs with dischargers, to ensure that there would be no warming above the HUA assigned to point sources. This is a margin of safety that ensures cumulative warming from all point sources will not exceed the portion of the HUA assigned to the point source sector. See Willamette Subbasins Temperature TMDL Section 9.1 Thermal Allocations for stream specific HUA assignments to point sources.

On modeled streams, DEQ completed a cumulative effects analysis to determine the water temperature impacts of point sources discharging at their wasteload allocations. Modeling wasteload allocations allowed DEQ to assess how warming from point sources occurred over space and time, and to confirm that the applicable temperature criteria would be attained.

Cumulative effects model analyses were completed for the Molalla River, Pudding River, and McKenzie River. In the Molalla River and Pudding River, the point source sector is allocated 0.2°C of cumulative warming. In both rivers, wasteload allocations have a cooling effect due to the relatively high water temperatures of the receiving water bodies. The Molalla STP wasteload allocation has the potential to cool the Molalla River about 0.3°C at the point of discharge (**Figure 10-1**). Pudding River point source wasteload allocations have the potential to cool the river less than 0.1°C (**Figure 10-2**).

In the upper McKenzie River, the EWEB Trail Bridge Powerhouse wasteload allocation increases McKenzie River temperature no more than 0.02°C (**Figure 10-3**). In the lower McKenzie River the EWEB Trail Bridge Powerhouse, McKenzie River Hatchery, Leaburg Hatchery, and International Paper wasteload allocations increase river temperature cumulatively 0.19°C during the spring spawning period (**Figure 10-4**), 0.21°C during the summer period (**Figure 10-5**), and 0.21°C during the fall spawning period (**Figure 10-6**). Note that as discussed in TSD Appendix K, the temperature impact was slightly more than 0.21°C at the river mouth on two days when flow was less than 7Q10. When flow is greater than or equal to 7Q10, the impact of modeled point source impacts does not exceed 0.21°C.

These model results confirm that cumulative warming from point sources will not exceed the portion of the HUA assigned to point sources on the Molalla River, Pudding River or McKenzie River.

10.1.1 Molalla and Pudding Rivers point source impacts

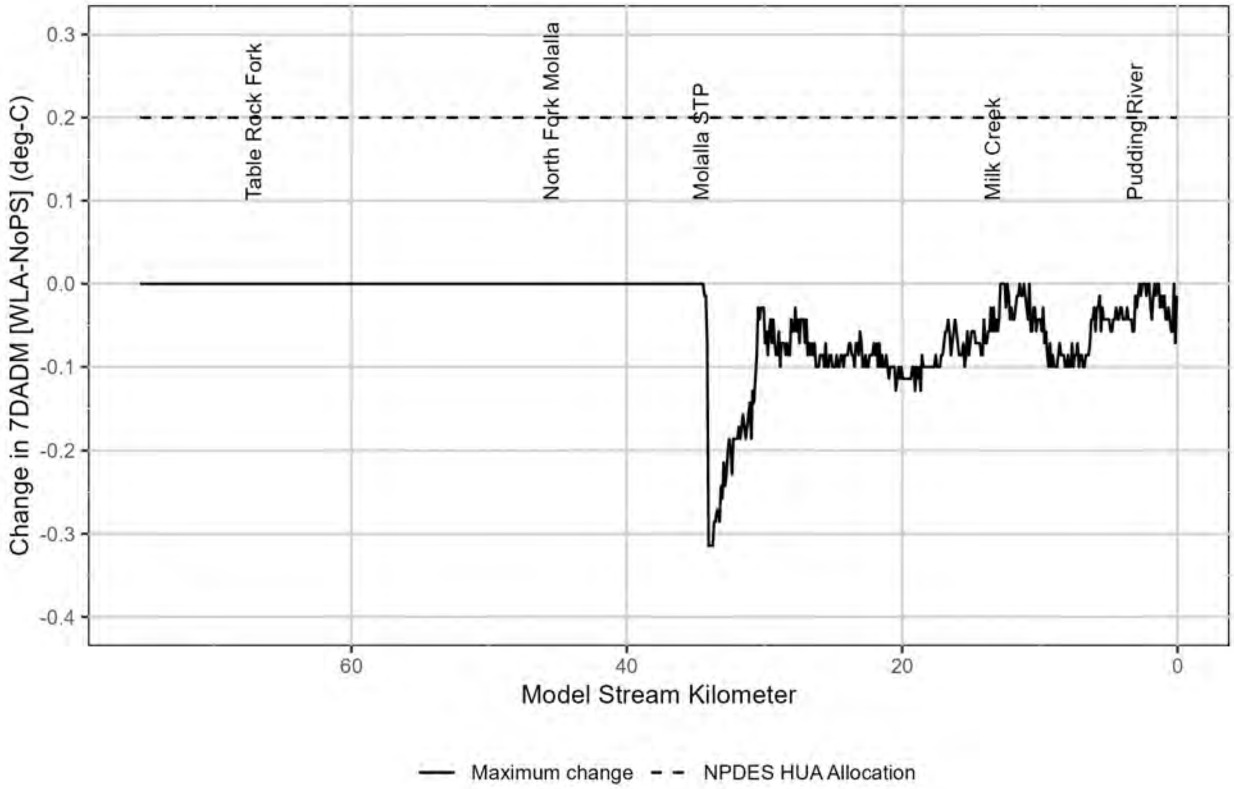


Figure 10-1: Change in maximum 7DADM stream temperatures between the Wasteload Allocations and No Point Sources scenarios for the Molalla River over the entire model period.

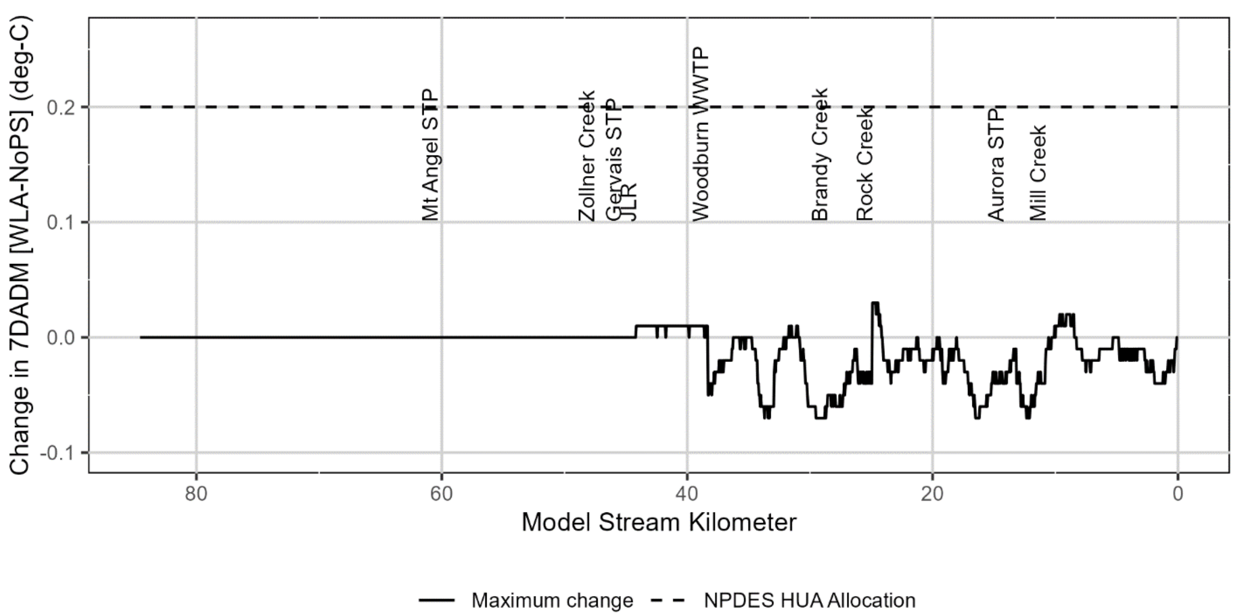


Figure 10-2: Change in maximum 7DADM stream temperatures between the Wasteload Allocations and No Point Sources scenarios for the Pudding River over the entire model period.

10.1.2 McKenzie River point source impacts

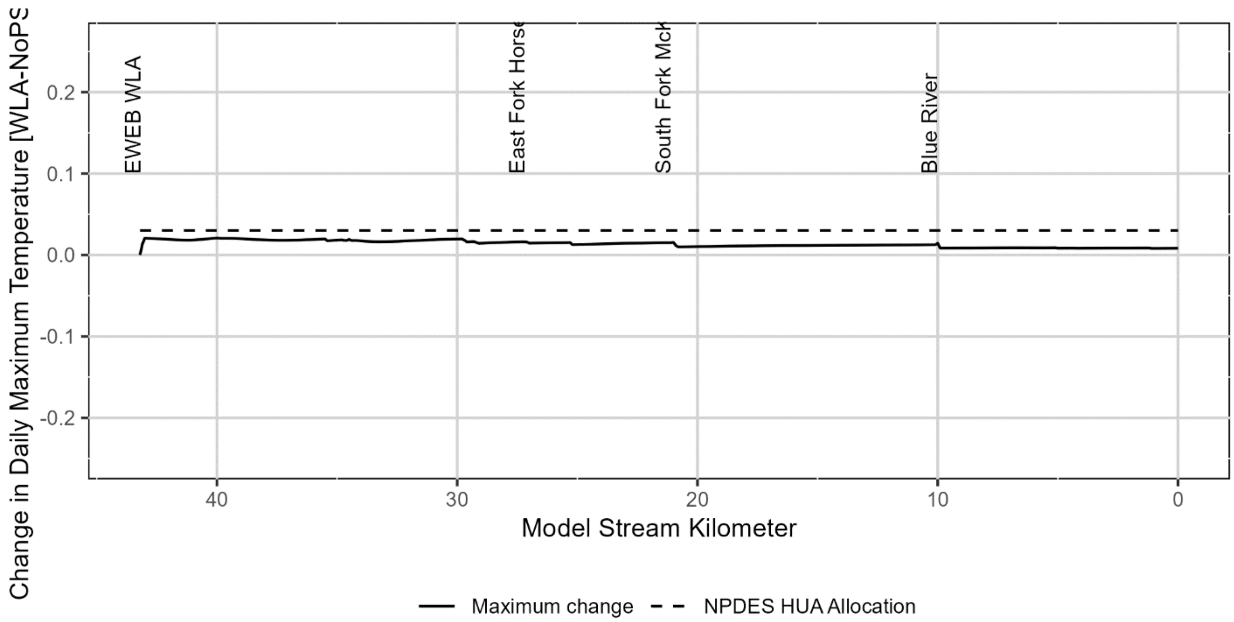


Figure 10-3: Change in daily maximum stream temperature between the Wasteload Allocations and No Point Sources model scenarios for the upper McKenzie River.

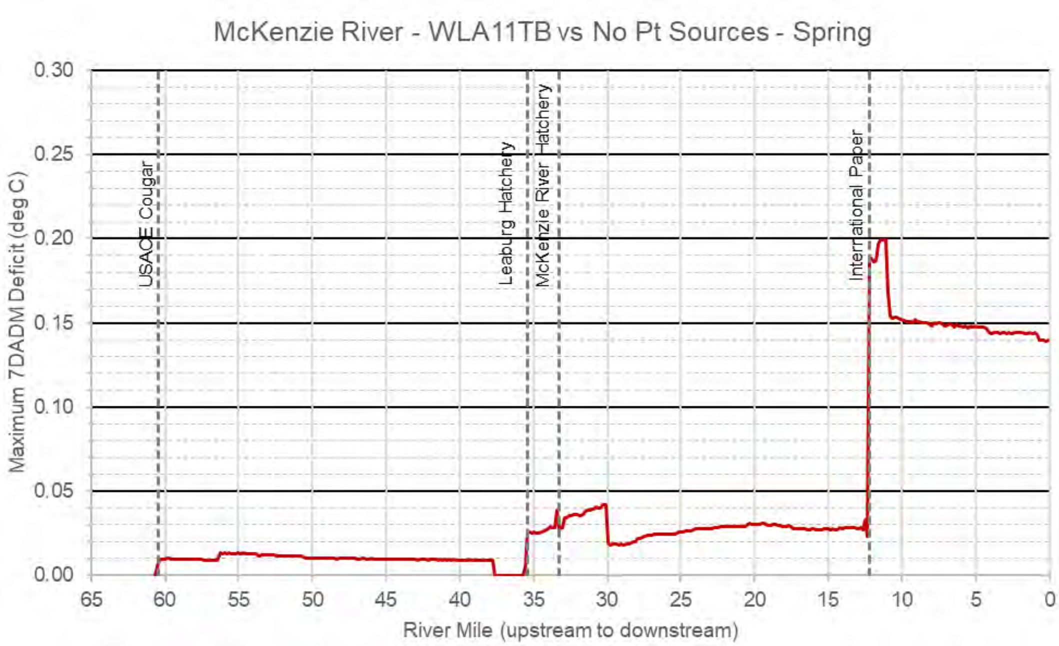


Figure 10-4: Change in maximum 7DADM stream temperatures between the Wasteload Allocations and No Point Sources scenarios for the McKenzie River over the spring spawning period.

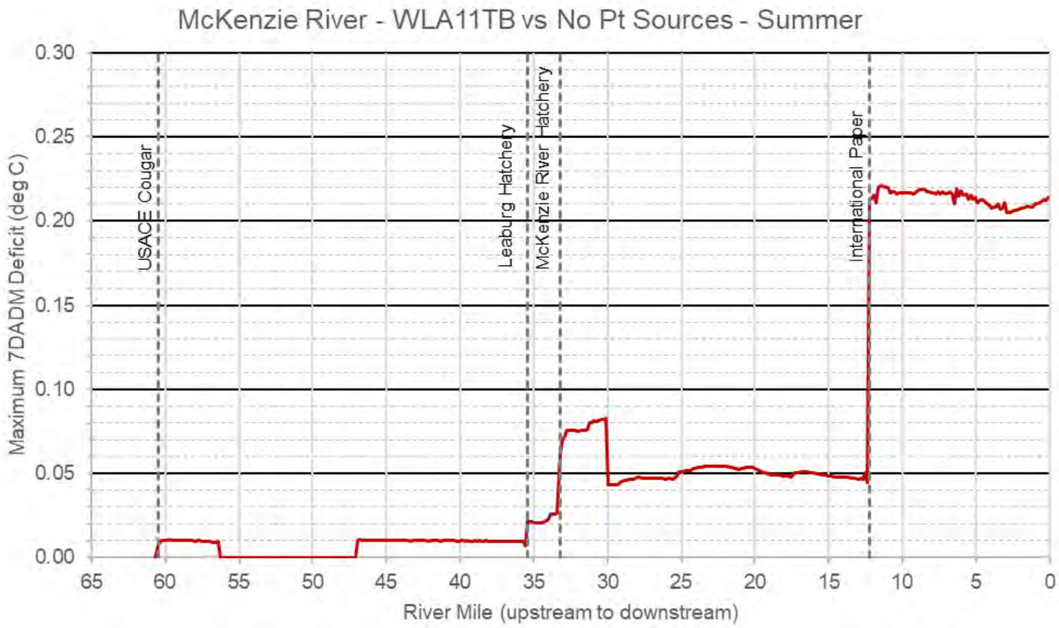


Figure 10-5: Change in maximum 7DADM stream temperatures between the Wasteload Allocations and No Point Sources scenarios for the McKenzie River over the summer period.

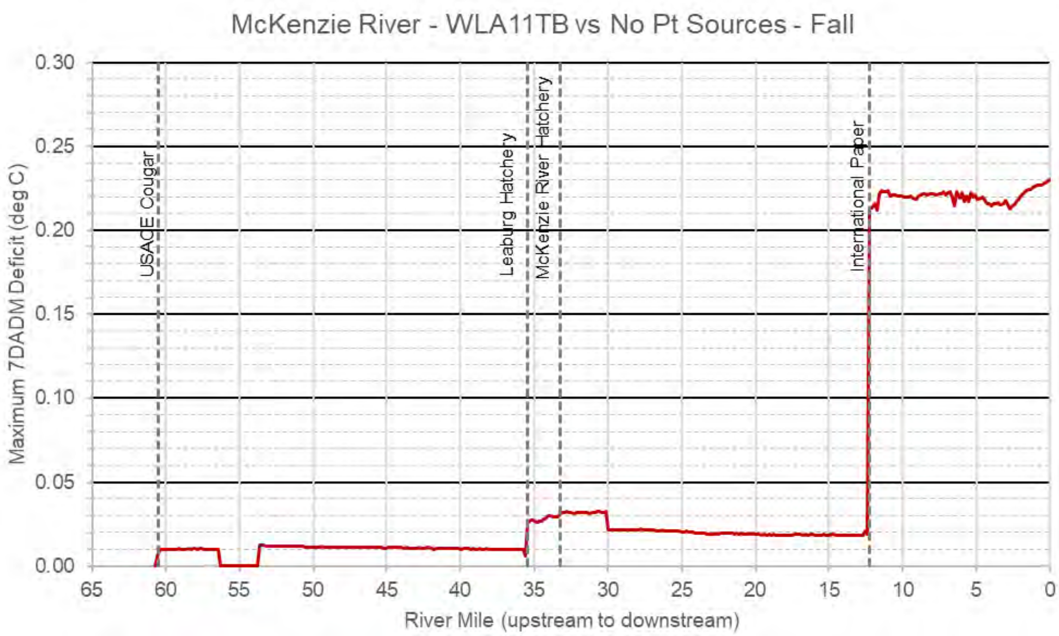


Figure 10-6: Change in maximum 7DADM stream temperatures between the Wasteload Allocations and No Point Sources scenarios for the McKenzie River over the fall spawning period.

10.1.3 Long Tom River point source impacts

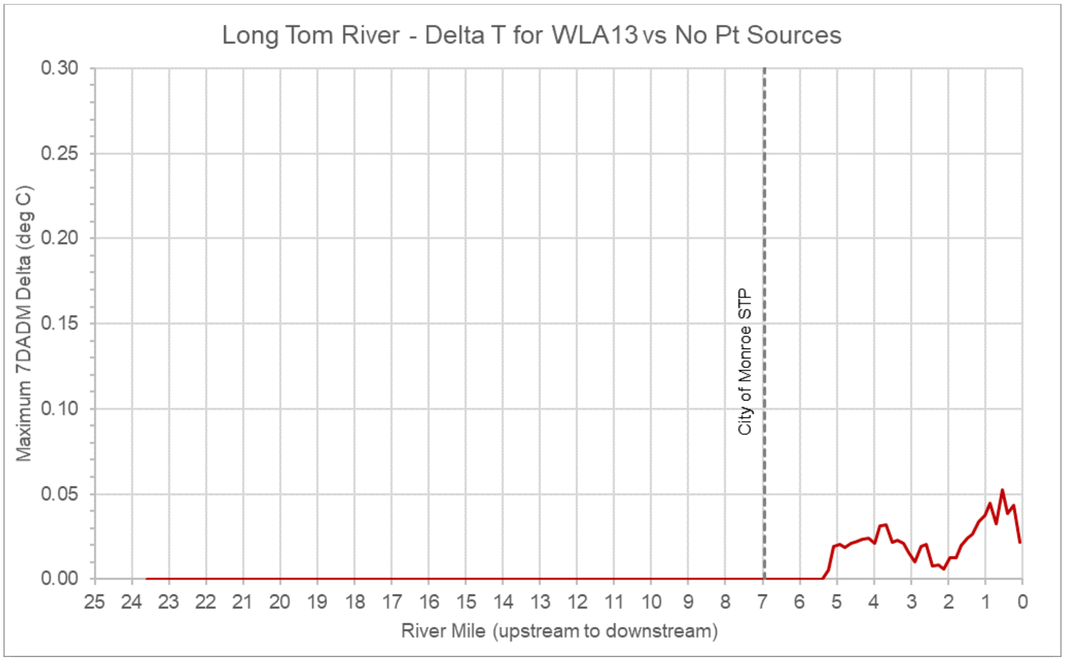


Figure 10-7: Change in maximum 7DADM stream temperatures between the Wasteload Allocations and No Point Sources scenarios for the Long Tom River over all time periods

10.1.4 Santiam, North Santiam, and South Santiam River point source impacts

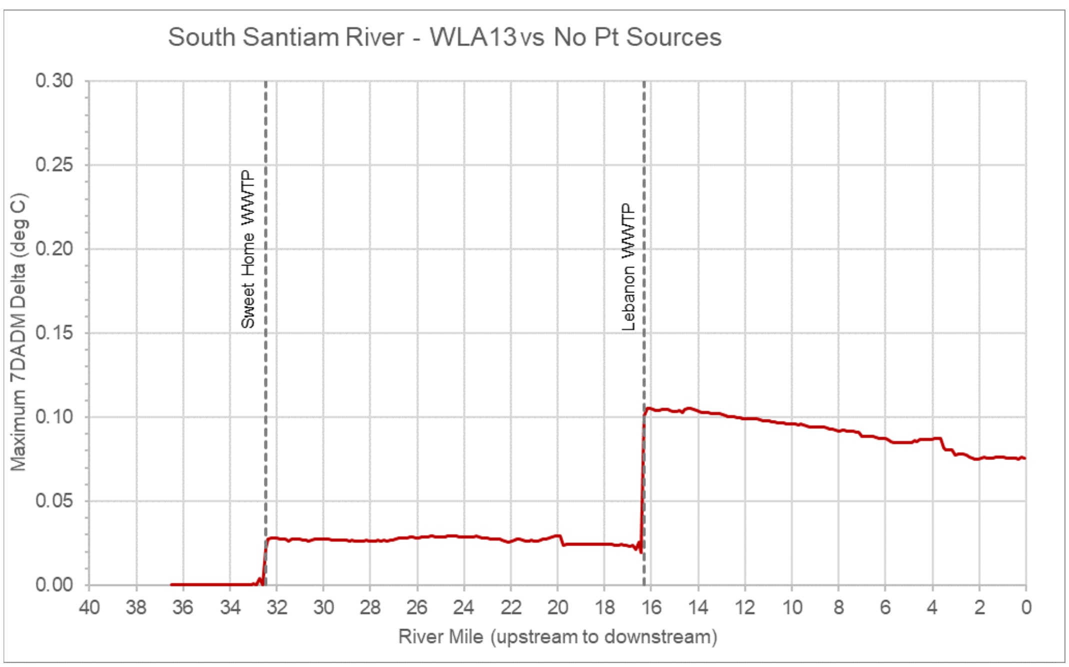


Figure 10-8: Change in maximum 7DADM stream temperatures between the Wasteload Allocations and No Point Sources scenarios for the South Santiam River over all time periods

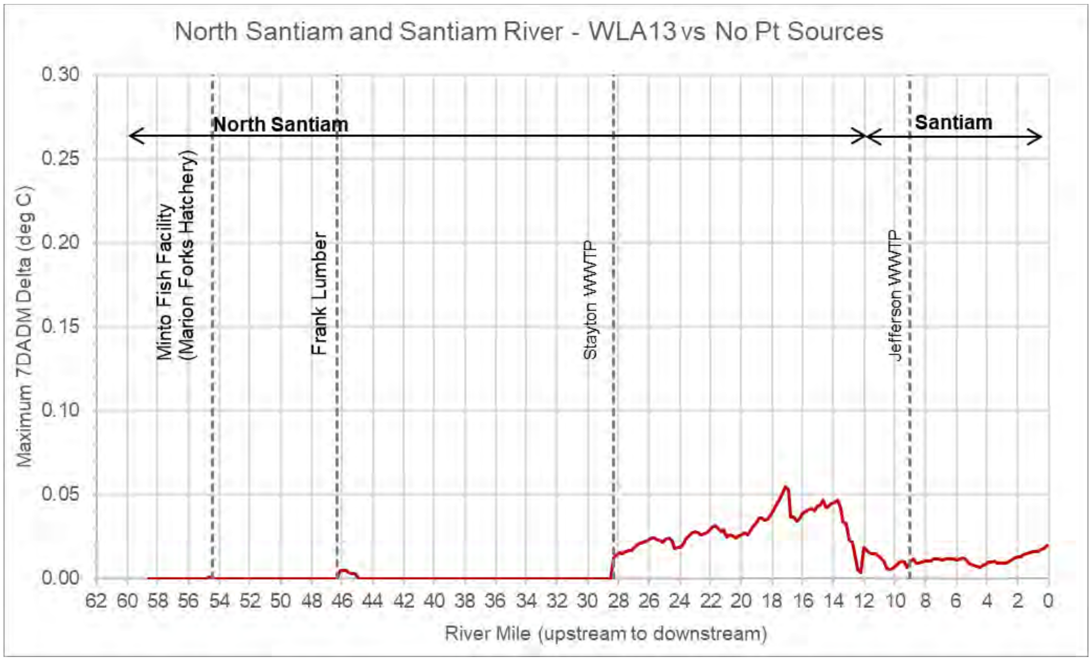


Figure 10-9: Change in maximum 7DADM stream temperatures between the Wasteload Allocations and No Point Sources scenarios for the North Santiam and Santiam Rivers over all time periods

10.1.5 Clackamas River point source impacts

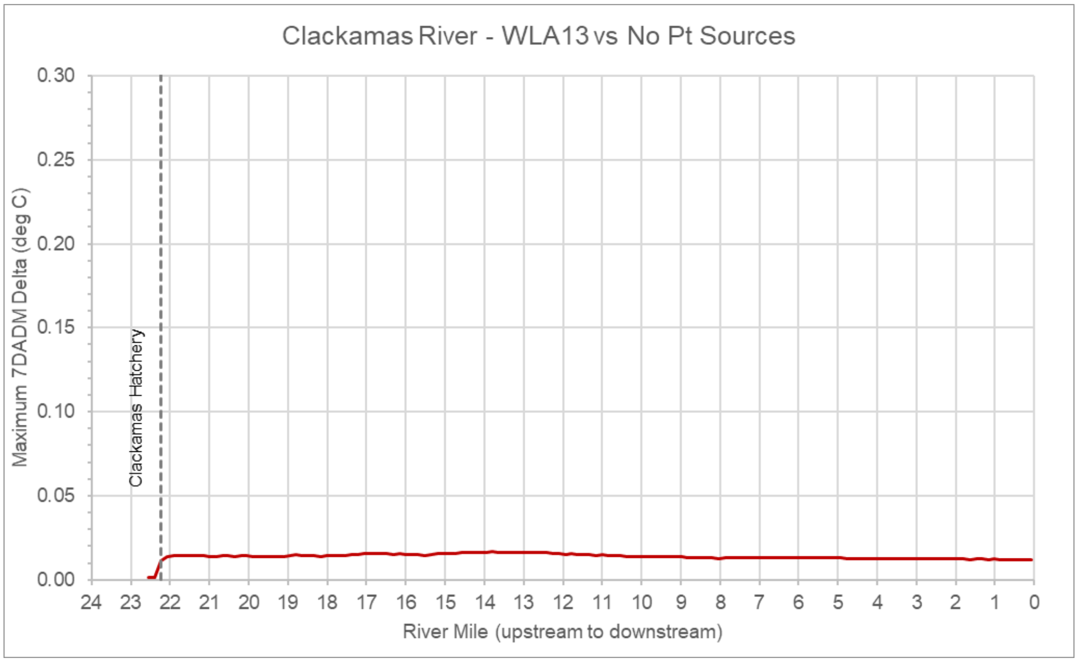


Figure 10-10: Change in maximum 7DADM stream temperatures between the Wasteload Allocations and No Point Sources scenarios for the Clackamas River over all time periods

10.1.6 Coast and Middle Fork Willamette point source impacts

The impact of the City of Cottage Grove WWTP at its WLA on river temperature, while relatively large, does not exceed 0.20ºC. The impact drops significant downstream from the confluence of the Row River. In addition to the individual point sources provided, up to 0.01ºC of impact is assigned to point source discharges covered by General NPDES permits in this area, for a total HUA assignment to point sources of 0.21ºC. Due to the relatively large point source impacts, reserve capacity upstream from Row River was reduced to 0.02ºC in this AU (OR_SR_1709000203_02_104585).

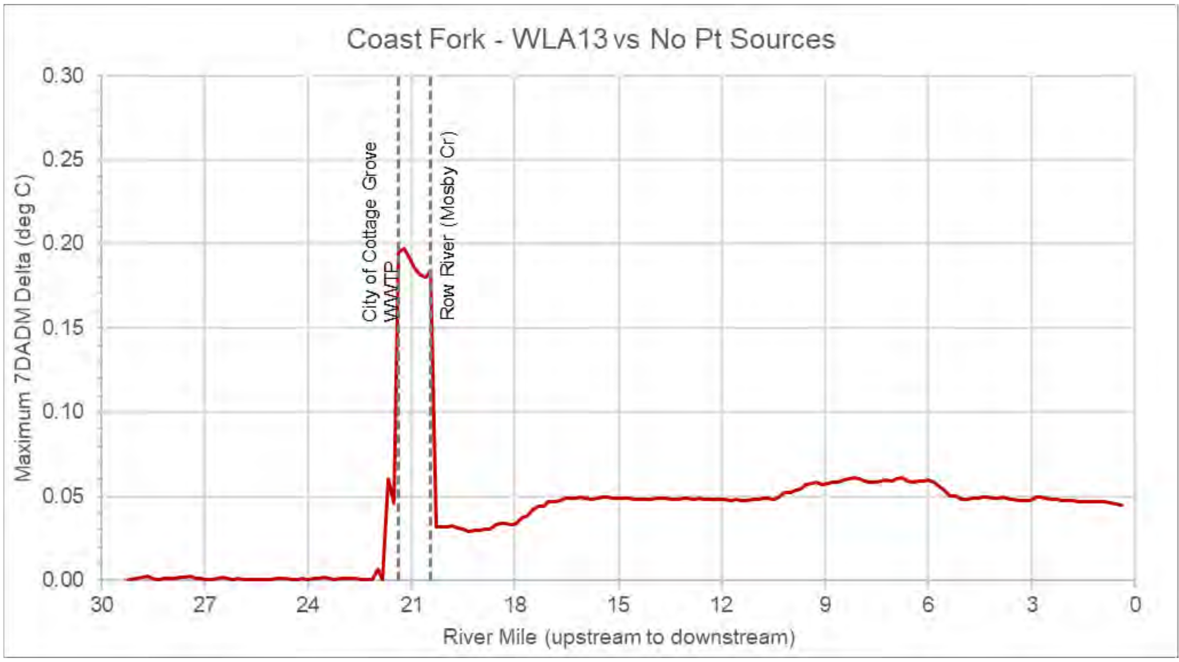


Figure 10-11: Change in maximum 7DADM stream temperatures between the Wasteload Allocations and No Point Sources scenarios for the Coast Fork Willamette River over all time periods

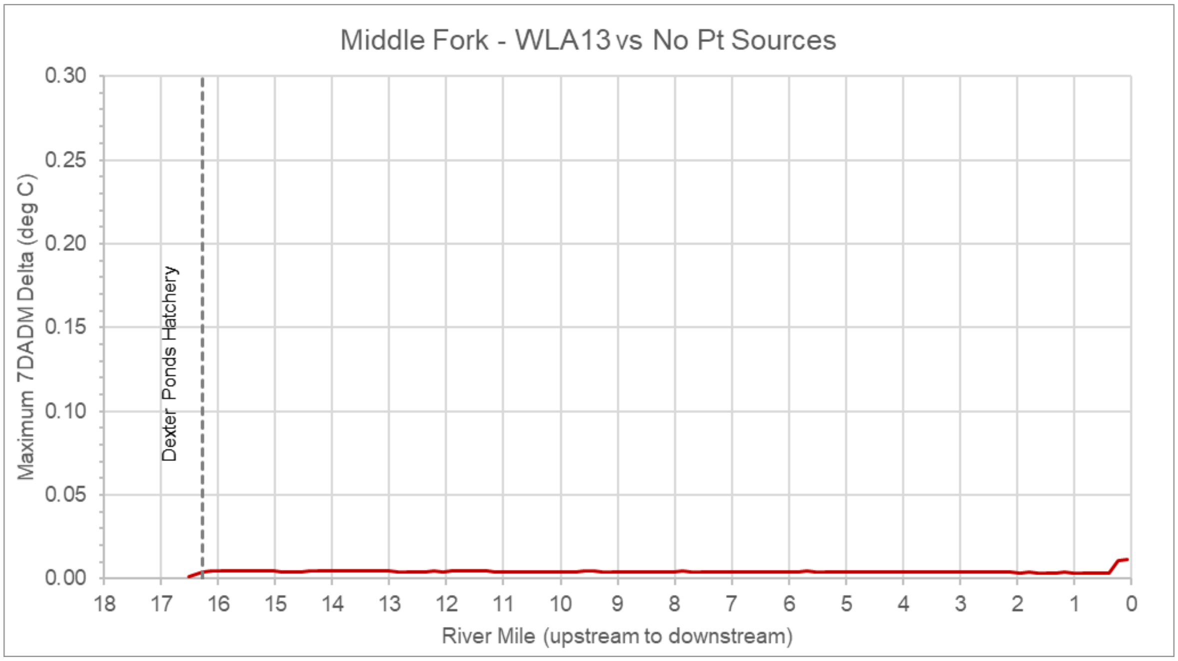


Figure 10-12: Change in maximum 7DADM stream temperatures between the Wasteload Allocations and No Point Sources scenarios for the Middle Fork Willamette River over all time periods

10.1.7 Willamette River point source impacts

The upper Willamette River is the location of the point of maximum impact (POMI) of point sources for reaches modeled downstream from USACE reservoirs. The POMI is located upstream of the confluence of the Santiam River at RM 109. Major point sources which impact river temperature include MWMC WWTP which discharges upstream from the McKenzie River, IP Springfield which discharges to the McKenzie River, Cascade Pacific and GP Halsey Mills at RM 149, Cities of Corvallis and Albany WWTPs, and ATI Millersburg. Plots are provided for spring spawning, summer non-spawning, and fall spawning periods. The maximum impacts of point sources for wasteload allocations provided (McKenzie River WLA Scenario 11 and Willamette River WLA Scenario 13) are 0.16^{o}C during the spring spawning period, 0.22^{o}C during the summer, and 0.20^{o}C during the fall spawning period. In addition to the individual point sources provided, up to 0.01^{o}C of impact is assigned to point source discharges covered by General NPDES permits in this area, for a total HUA assignment to point sources of 0.23^{o}C. Due to the relatively large point source impacts at the POMI, reserve capacity was reduced to 0.02^{o}C in this AU (OR_SR_1709000306_05_103854).

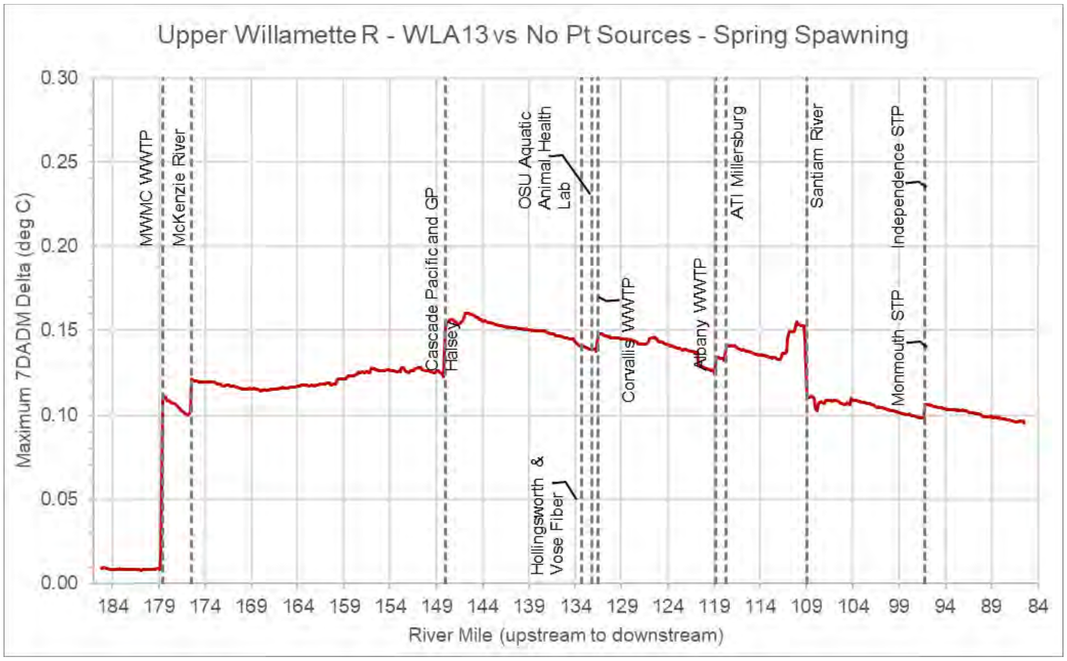


Figure 10-13: Change in maximum 7DADM stream temperatures between the Wasteload Allocations and No Point Sources scenarios for the upper Willamette River over the spring spawning period.

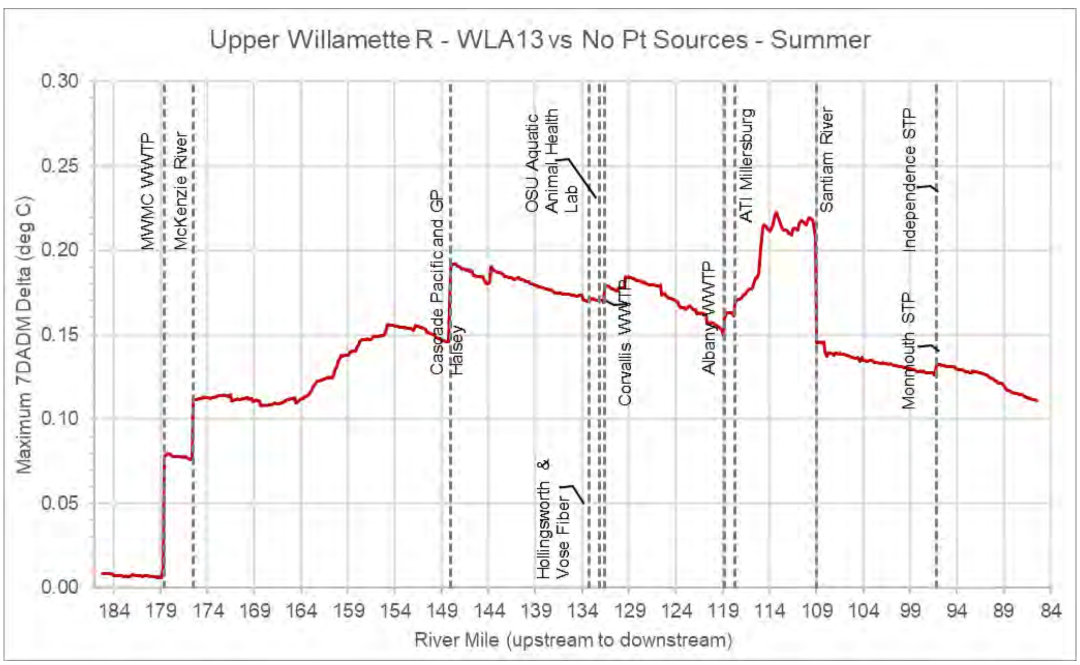


Figure 10-14: Change in maximum 7DADM stream temperatures between the Wasteload Allocations and No Point Sources scenarios for the upper Willamette River over the summer non-spawning period.

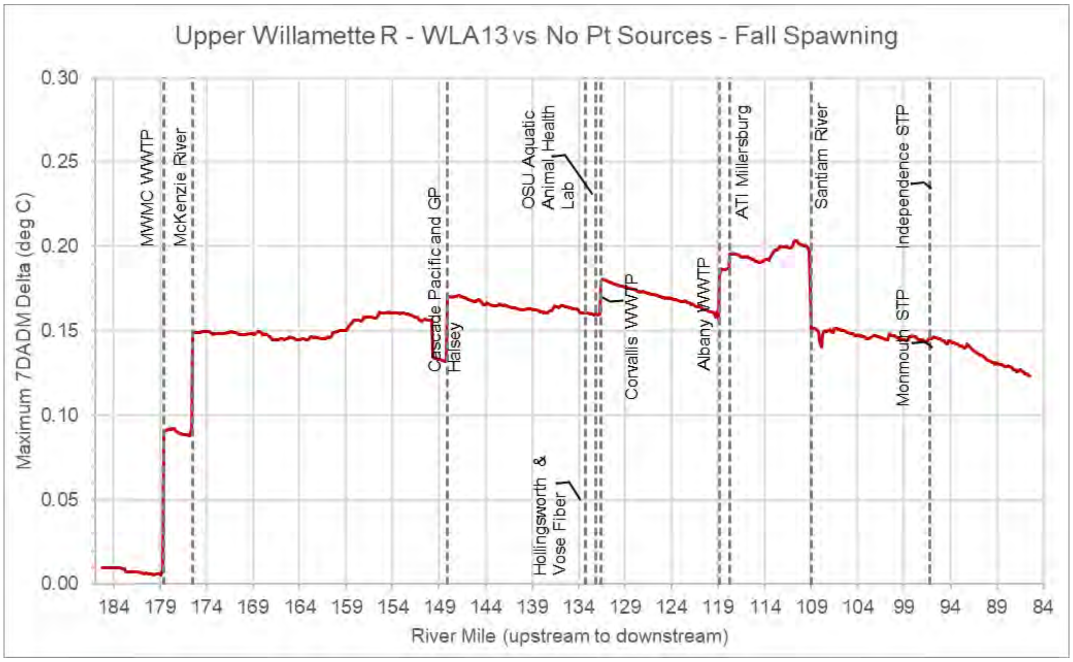


Figure 10-15: Change in maximum 7DADM stream temperatures between the Wasteload Allocations and No Point Sources scenarios for the upper Willamette River over the fall spawning period.

Impacts in the middle Willamette River between RM 85 upstream from Salem and Willamette Falls are less. The maximum impact in this reach is 0.19°C. In addition to the individual point sources provided, up to 0.02°C of impact is assigned to point source discharges covered by General NPDES permits in this area, for a total HUA assignment to point sources of 0.21°C. Due to the relatively large point source impacts at the POMI, reserve capacity was reduced to 0.02°C in this AU (OR_SR_1709000703_04_104013).

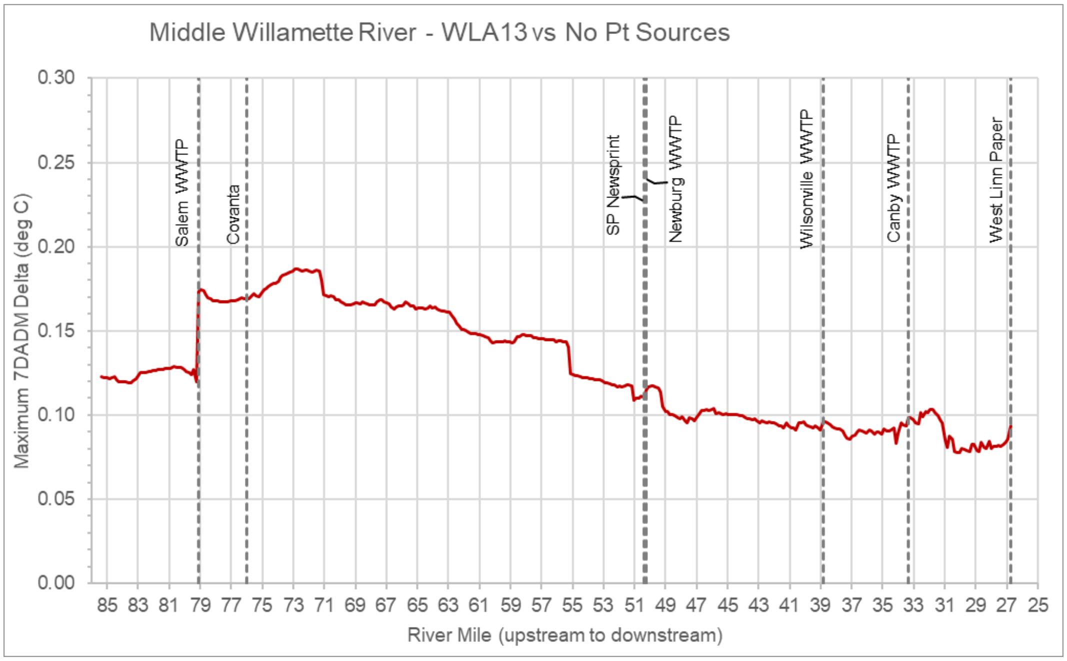


Figure 10-16: Change in maximum 7DADM stream temperatures between the Wasteload Allocations and No Point Sources scenarios for the middle Willamette River over all time periods

The maximum impact of WLAs in the tidally influenced lower Willamette River downstream from Willamette Falls, including Portland Harbor, is up to 0.11ºC at Tri City WWTP and Kellogg Creek WWTP disharges and less than 0.10ºC elsewhere. Impacts in Multnomah Channel are less than 0.07ºC. Note that in addition to point source allocations, a load allocation of 0.10ºC has been assigned to PGE Willamette Falls Project, for a total impact of point sources at wasteload allocations (WLA13) and Willamette Falls of 0.21ºC. An allocation of 0.01ºC to General NPDES permits brings the impact of WLAs plus Willamette Falls LA to 0.22ºC.

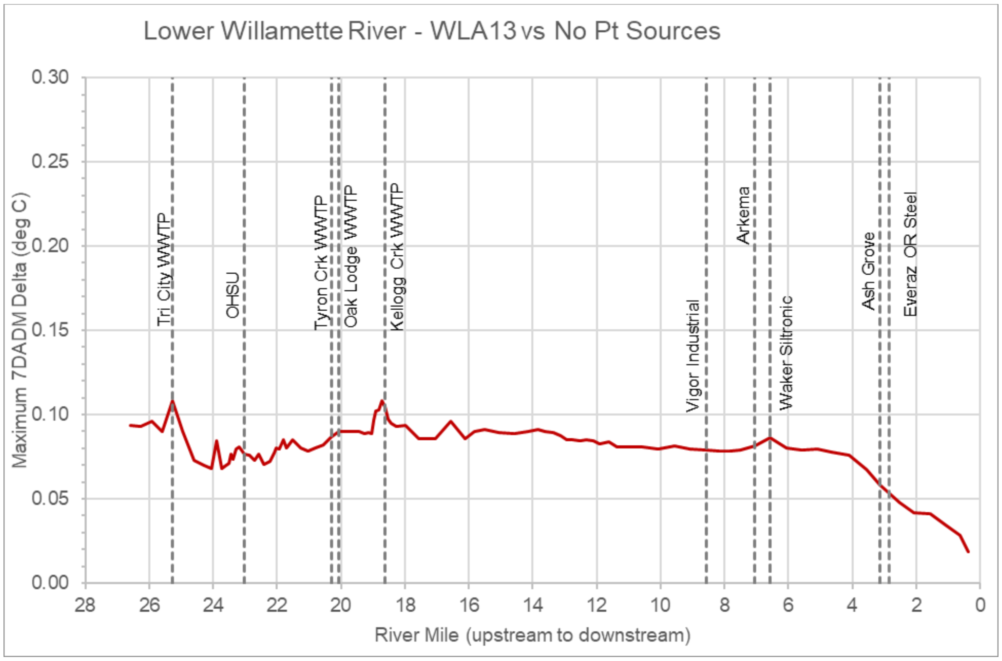


Figure 10-17: Change in maximum 7DADM stream temperatures between the Wasteload Allocations and No Point Sources scenarios for the lower Willamette River over all time periods

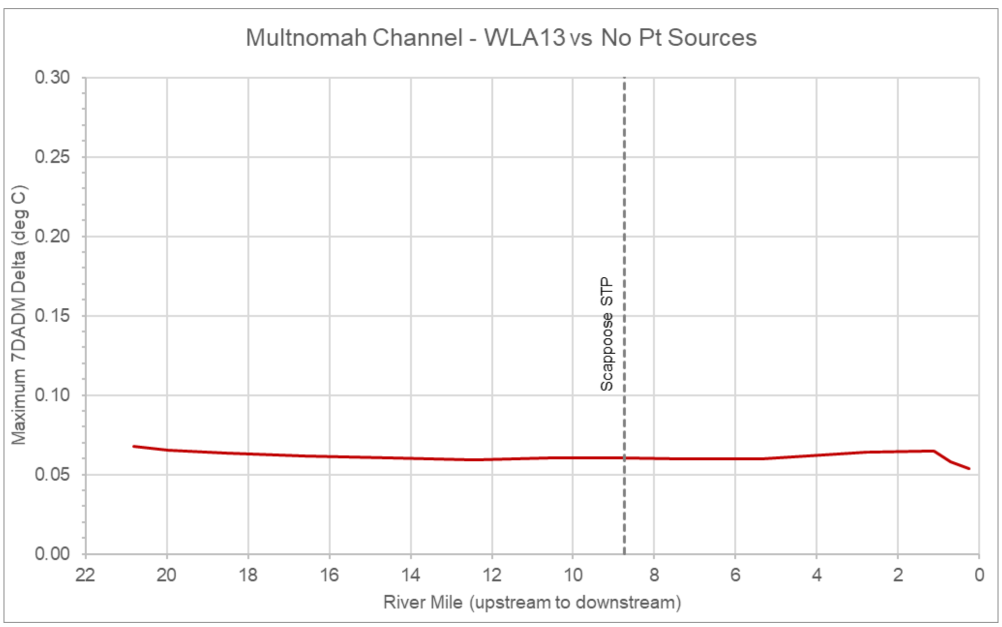


Figure 10-18: Change in maximum 7DADM stream temperatures between the Wasteload Allocations and No Point Sources scenarios for the Multnomah Channel over all time periods

10.2 Nonpoint sources

DEQ's approach to nonpoint source allocations is to distribute portions of the HUA to three nonpoint source categories. Water management activities and water withdrawals are allocated up to 0.05°C, solar loading from existing transportation corridors, existing buildings, and existing utility infrastructure is allocated 0.02°C, and solar loading from all other nonpoint source sectors is allocated 0.0°C of warming.

The portion of the HUA allocated to nonpoint source categories was set to ensure no more than 0.3°C of cumulative warming from all NPDES point sources and nonpoint sources on a given waterbody. The nonpoint source HUA allocation will be implemented by assessing the cumulative warming of a waterbody by all nonpoint sources. This ensures cumulative warming from all nonpoint sources will not exceed the portion of the HUA allocated to nonpoint sources.

DMAs responsible for nonpoint source categories are expected to meet their HUA assignments, which were calculated to attain water quality standards. The HUA allocations for nonpoint source categories are achieved through the implementation of load allocations and surrogate measures. DMAs are responsible for implementing management activities that achieve the surrogate measure targets appropriate to their source category and location. A DMA has achieved their load allocation when surrogate measure targets are met. When all DMAs within a nonpoint source category have met their surrogate measure targets and achieved their load allocations, the HUA allocation to that nonpoint source category is achieved.

The dam and reservoir surrogate measure will attain the assigned HUA and load allocation because it targets 7DADM temperatures no warmer than those upstream of the reservoir. The surrogate measure also implements the minimum duties provision in rule at OAR 340-041-0028(12)(a). This provision states that anthropogenic sources are only responsible for controlling the thermal effects of their own discharge or activity in accordance with their overall heat contribution. For dam and reservoir operations, the surrogate measure reflects temperatures upstream of the reservoir (or no dam temperatures), thus ensuring dam operators are only responsible for temperature increases caused by the dam and reservoir operations.

Effective shade surrogate measure targets are set at levels that assume no anthropogenic warming of the stream. When effective shade targets are met, the HUA assignments and load allocations to solar loading from nonpoint sources are achieved.

11 Water quality management plan support

11.1 Adequacy of Agricultural Water Quality Management programs in attaining TMDL load allocations and effective shade surrogate measures

The Oregon Legislature passed the Agricultural Water Quality Management Act in 1993, which directed ODA to adopt rules as necessary and to develop plans to prevent water pollution from agricultural activities (ORS 568.900 to 568.933 and ORS 561.191 and OAR chapter 603, divisions 90 and 95). Subsequently, ODA worked with Local Advisory Committees (LACs) and

Soil and Water Conservation Districts (SWCDs) to develop Agricultural Water Quality Area Rules and Area Plans for 38 watershed-based management areas across the state.

The Willamette Subbasins TMDL includes eight management areas: North Coast, Lower Willamette, Clackamas, Middle Willamette, Molalla-Pudding/French Prairie/North Santiam, South Santiam, Southern Willamette, and Upper Willamette/Upper Siuslaw. Each management area has agricultural water quality regulatory requirements, called Area Rules. Each management area also has an Agricultural Water Quality Management Area Plan, which is not regulatory but guides landowners in how to protect water quality from agricultural activities.

OAR 603-095 require agricultural activities to allow streamside vegetation to establish and grow to provide shade on perennial and some intermittent streams. **Table 11-1** summarizes the streamside management measures required by state law for the seven management areas included in this TMDL. Specific requirements differ depending on the management area; however, most management areas identify vegetation goals based on site capability, which is not clearly defined. However, in OAR 603-095 there are no requirements for streamside vegetation to be established on agricultural lands when streamside vegetation deficiency is not caused by an agricultural activity.

Table 11-1: Summary of OAR 603-095 for streamside management in seven management areas within the Willamette Subbasins Temperature TMDL project area.

Agricultural Water Quality Management Area	Prevention and Control Measures*
North Coast	Allow the natural and managed regeneration and growth of riparian vegetation trees, shrubs, grasses, and sedges along natural waterways to provide shade to moderate water temperatures and bank stability to maintain erosion near background levels. Management activities minimize the degradation of established native vegetation while allowing for the presence of nonnative vegetation. Management activities maintain at least 50% of each year's new growth of woody vegetation -- both trees and shrubs.
Clackamas Subbasin	Allow the establishment, growth, and/or maintenance of native or non-native riparian vegetation appropriate to site capability, sufficient to encourage shade, protect streamside area during high stream flow events expected to occur in a 25-year, 24-hour storm event.
Lower Willamette	Allow the development of riparian vegetation along streams to provide shade for minimizing solar heating of the stream, streambank stability from flows in a 25-year, 24-hour storm event, filtration, settlement, and biological uptake of sediment, organic material, nutrients, and pesticides in surface runoff by intercepting or slowing overland flow, improvement to water storage capacity of the riparian zone, protection of streams from flashy flows by infiltrating runoff and overland flow. Riparian vegetation includes grasses, sedges, shrubs and trees that are consistent with site capability, and site development can be through allowing natural processes or active management. Management within the riparian area is allowed, and sufficient riparian width is site specific, and may vary by soil type, hydrology, climate, geology, man-made limitations, and other factors.

Agricultural Water Quality Management Area	Prevention and Control Measures*
	Drainage and irrigation ditches are not subject to these prevention control measures.
Molalla-Pudding/French Prairie/North Santiam	Allow natural or managed development of riparian vegetation and riparian function over time along all streams. Riparian width is site specific and may vary, for example by soil type, size of stream, and agricultural use. Natural or managed establishment and maintenance includes riparian vegetation, such as grasses, sedges, shrubs, and trees, appropriate to site capability, that in the normal course of time will provide shade and protect streambank stability from flows at or below those expected in a 25-year, 24-hour storm event.
South Santiam	Allow establishment and maintenance of riparian vegetation consistent with site capability that promotes infiltration of overland flows, moderation of solar heating, and streambank stability. Management within the riparian area is allowed, and minimal breaks in shade vegetation for essential management activities are considered appropriate.
Southern Willamette	Allow establishment and maintenance of vegetation along perennial streams consistent with capability of the site to provide riparian functions necessary to help moderate solar heating and for streambanks to withstand flows in a 25-year, 24-hour storm event.
Upper Willamette/Upper Siuslaw	Allow establishment and development of riparian vegetation along perennial and intermittent streams for streambank stability, shading, and proper riparian function, consistent with site capability. Legally constructed drainage and irrigation ditches are exempt.
Yamhill	Allow the establishment, growth, and/or maintenance of riparian vegetation appropriate to the site. Vegetation must provide shade, protect the streamside area to maintains its integrity during high stream flow events in a 25-year, 24-hour storm event. Any agricultural activity that degrades riparian vegetation will be replanted or restored as soon as practical. Indicator of non-compliance is active streambank sloughing or erosion from tillage, grazing, or destruction of vegetation by landowner or occupier.

*Prevention and Control Measures are identified in OAR for each management area for various agricultural activities. The ones summarized in this table are specific to streamside management.

Each management area has an Area Plan, which is not regulatory and does not establish prohibitions on agricultural activities that may impact water quality or require active restoration on agricultural lands. Instead, Area Plans rely on outreach and education, and voluntary landowner actions to implement conservation and management activities that protect water quality. ODA continues to work with LACs, SWCDs, DEQ and other watershed partners to implement, evaluate, and update Area Plans through their Biennial Review process for each of the management areas included in this TMDL.

As part of the biennial review process, DEQ prepares and submits to ODA specific feedback about water quality in the management areas. DEQ's assessments also address land conditions, agricultural activities, and implementation gaps that likely contribute to water quality impairments. DEQ has identified that a high priority for many management areas is to protect and reestablish riparian vegetation. The Area Plans for the eight management areas included in this TMDL have all been reviewed by DEQ within the last three years. Some of these reviews were completed as part of ODA's light biennial review process; during light reviews ODA convenes members of the LAC to report out on restoration and land management accomplishments and water quality status and trends within the management area, but ODA does not change or update plans during a light review. **Table 11-2** is a summary of the most recent updates for these Area Plans. Updates to Area Plans typically occur during the full biennial review process.

Table 11-2: Summary of the most recent updates to Area Plans, which occur during ODA's full biennial review process.

Agricultural Water Quality Management Area	Date of most recent Area Plan update
North Coast	2018
Clackamas	2022
Lower Willamette	2020
Middle Willamette	2020
Molalla-Pudding/French Prairie/North Santiam	2018
South Santiam	2019
Southern Willamette	2019
Upper Willamette/Upper Siuslaw	2023

ODA, through coordination with agency and local partners, identifies geographic areas of focus, called Strategic Implementation Areas, for targeted outreach to landowners, land condition assessment and enforcement. The SIA process includes an assessment and compliance evaluation of agricultural lands, outreach to landowners, technical assistance, monitoring of water quality and land conditions, and landowner follow up as needed. ODA identified 12 SIAs in the TMDL project area between 2014 and 2021. While ODA has conducted initial landowner outreach and facilitated local SIA planning meetings for some of these SIAs, as of 2023, ODA has reported limited restoration or enhancement projects as an outcome of the SIA process in this TMDL project area.

There continue to be water quality impairments in all seven of the management areas included in this TMDL. Specifically, water temperatures continue to be identified as impaired on Oregon's Section 303(d) list. In addition, results from the modeling and shade gap analyses DEQ completed for this TMDL indicate that extensive riparian areas are deficient in providing shade along streams. The shade gap results for the Southern Willamette model area and the Lower Willamette model area on land managed for agriculture is 53% and 20%, respectively. However, the shade gaps of specific HUC12 watersheds within the model area represent a broad range.

ODA assesses riparian vegetation against the Area Rules for streamside management. The Area Rules are regulatory requirements limited to agricultural activities and are not consistent with and do not include specific reference to the TMDL load allocations for temperature and surrogate shade measures. Area Rules do not apply to agricultural land conditions that are not directly impacted by agricultural activities. It is unclear what steps can be taken when landowners are in compliance with Area Rules, yet land conditions contribute to water quality standard exceedances and are unable to meet TMDL load allocations. There has been a lack of implementation of area plans to achieve TMDL allocations and there are no or few assurances that voluntary landowner action will be able to bridge the gap between current and needed riparian condition and function. ODA has also not been able to adequately incorporate or implement water quality priorities as identified in the 2006 TMDL or as part of the Biennial Review process. Therefore, ODA is required to develop a temperature TMDL implementation plan to be submitted to DEQ for review and approval.

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13 Appendices

The TSD includes the following appendices:

Appendix A: Heat Source Model Report
Appendix B: City of Portland Shade Model Report
Appendix C: Potential Near-Stream Land Cover
Appendix D: Assessment Units addressed by Temperature TMDLs for the Willamette Subbasins
Appendix E: Southern Willamette Effective Shade Results
Appendix F: Lower Willamette Effective Shade Results
Appendix G: Climate Change and Stream Temperature in Oregon: A Literature Synthesis
Appendix H: Willamette Subbasins Interactive TMDL Map
Appendix I: Stream Buffer Width Literature Review
Appendix J: Tetra Tech Model Calibration Report
Appendix K: Tetra Tech Model Scenario Report
Appendix L: DEQ McKenzie River Model Scenario Report
Appendix M: DEQ Willamette River Mainstem and Major Tributaries Model Scenario Report