Redline Draft Total Maximum Daily Loads for the Willamette Subbasins

Temperature

Changes made since advisory committee meeting 1 shown

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State of Oregon
DEQ Department of Environmental Quality

This document was prepared by
Oregon Department of Environmental Quality
Program Name
700 NE Multnomah Street, Suite 600
Portland Oregon, 97232
Contact: Contact
Phone: 503-555-5555
www.oregon.gov/deq

State of Oregon
DEQ Department of Environmental Quality

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800-452-4011 | TTY: 711 | deqinfo@deq.oregon.gov

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1. Introduction

report adopted by reference into rule explanation

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 developed for the applicable assessment units addressed by the TMDLs listed in Table 1.1. TMDLs for other 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	Bacteria (water contact recreation), DDT, dieldrin, Dissolved Oxygen, Mercury, Temperature, Turbidity
35888	Molalla-Pudding Subbasin TMDL and WQMP	12/31/2008	Bacteria (water contact recreation), DDT, dieldrin, chlordane, Iron, Nitrate, Temperature

1.2. TMDL prioritization

OAR 340-42-0040(3) requires DEQ or the 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. These TMDLs were identified as a high priority due to court order to Oregon and EPA to establish new temperature 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 WQMP (action ID 35888) (Table 1.1).

2. TMDL name and location

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

Temperature TMDLs for the Willamette Subbasins are developed for all waters determined to be waters of the state as defined under ORS 468B.005(10), including all perennial and intermittent streams, located in the 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). Waters excluded from the Willamette Subbasins TMDLs (Table 2.2) include 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, Cougar Dam, Blue River Dam, Dexter Dam, Fall Creek Dam, Cottage Grove Dam. The temperature TMDLs also do not include the section of the Columbia River that flows through the Lower Willamette Subbasin (HUC 17090012).

The map in Figure 1 provides an overview of where the temperature TMDLs are applicable. Appendix E of the Willamette Subbasin Technical support document, provides a list of all assessment units addressed by the TMDL.

The Willamette Subbasins is comprised of ten 10-digit subbasins as listed in Table 2.1.

Table 2.1 The Willamette Subbasins.

HU10 code	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

Table 2.2 Waters not included in the Willamette Subbasins Temperature TMDLs.

Waterbody	Extent
Willamette River	From the confluence of the Columbia River upstream to the confluence of Coast Fork of the Willamette and Middle Fork of the Willamette Rivers.
Multnomah Channel	From the confluence of the Columbia River upstream to The Willamette River.
Clackamas River	From the confluence with the Willamette River upstream to River Mill Dam.
Clackamas River	From the confluence with the Willamette River upstream to River Mill Dam.
Santiam River	From the confluence with the Willamette River upstream to the confluence of the North and South Santiam Rivers.
North Santiam River	From the confluence with the Santiam River upstream to Detroit Dam.
South Santiam River	From the confluence with the Santiam River upstream to Foster Dam.
Long Tom River	From the confluence with the Willamette River upstream to Fern Ridge Dam.
McKenzie River	From the confluence with the Willamette River upstream to the confluence with the South Fork McKenzie River.
South Fork McKenzie River	From the confluence with the McKenzie River upstream to Cougar Dam.
Blue River	From the confluence with the McKenzie River upstream to Blue River Dam.
Middle Fork Willamette River	From the confluence with the Willamette River upstream to Dexter Dam.
Fall Creek	From the confluence with the Middle Fork Willamette River upstream to Fall Creek Dam.
Coast Fork Willamette River	From the confluence with the Willamette River upstream to Cottage Grove Dam.
Row River	From the confluence with the Coast Fork Willamette River upstream to Dorena Dam.

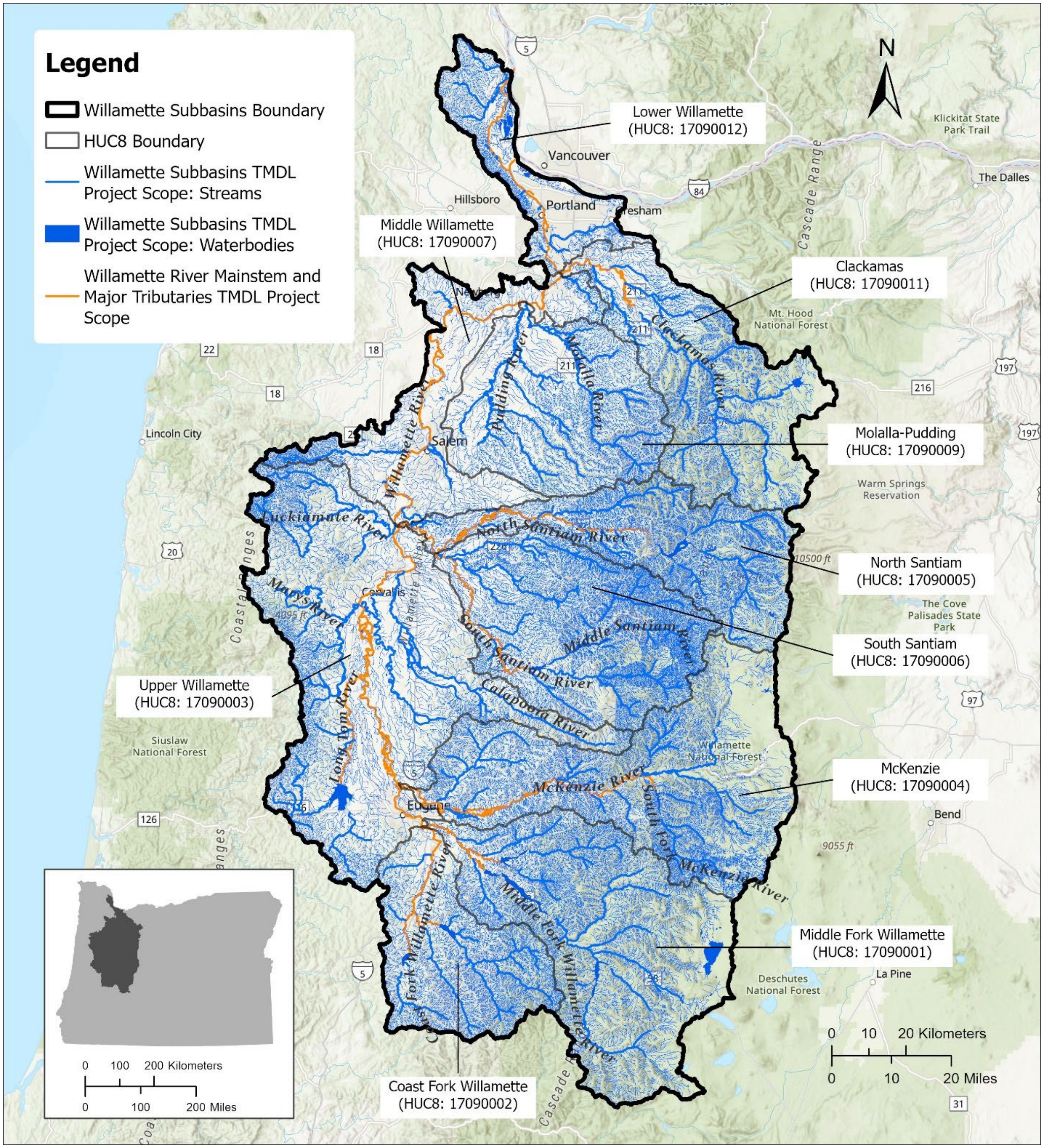


Figure 2.1 Willamette Subbasins temperature TMDLS project area overview.

3. Pollutant identification

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

The pollutants addressed by this temperature TMDL are heat or thermal loads, with a surrogate measure for effective shade, percent consumptive use, and channel morphology.

Table 3.1 through Table 3.10 present stream assessment units 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 Environmental Protection Agency on September 1, 2022. Status category designations are prescribed by Sections 305(b) and 303(d) of the Clean Water Act. Assessment units listed in Category 5 (designated use is not supported or a water quality standard is not attained) require development of a TMDL. Locations of these listed segments are depicted in Figure 2.

DEQ developed this TMDL to address Category 5 listed assessment units and to protect all other assessment units and assessment categories, including "unassessed". The allocations, including surrogate measures, and implementation framework apply to all waters of the state, including all perennial and intermittent streams in the Willamette Subbasins, as described in Sections 2, 5, 8 and 9 of this document.

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.

Table 3.1 Middle Fork Willamette Subbasin (17090001) Category 5 temperature impairments on the 2022 Integrated Report.

Assessment Unit Name	Assessment Unit	Use Period
OR_LK_1709000105_02_100684	Packard Creek	Year Round
OR_LK_1709000109_02_100701	Fall Creek Lake	Year Round
OR_SR_1709000101_02_103713	Middle Fork Willamette River	Year Round
OR_SR_1709000102_02_103715	Hills Creek	Year Round
OR_SR_1709000102_02_103715	Hills Creek	Spawning
OR_SR_1709000103_02_103716	Salt Creek	Year Round
OR_SR_1709000103_02_103716	Salt Creek	Spawning
OR_SR_1709000104_02_103719	Salmon Creek	Year Round
OR_SR_1709000104_02_103719	Salmon Creek	Spawning
OR_SR_1709000105_02_104578	Packard Creek	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_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_103722	Christy Creek	Spawning
OR_SR_1709000106_02_103723	North Fork Middle Fork Willamette River	Year Round
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_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_1709000108_02_103730	Little Fall Creek	Year Round
OR_SR_1709000108_02_103730	Little Fall Creek	Spawning

Assessment Unit Name	Assessment Unit	Use Period
OR_SR_1709000109_02_103734	Hehe Creek	Year Round
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_103738	North Fork Winberry Creek	Year Round
OR_SR_1709000109_02_103741	Portland Creek	Year Round
OR_SR_1709000109_02_103742	Logan Creek	Year Round
OR_SR_1709000109_02_103743	Fall Creek	Year Round
OR_SR_1709000109_02_103743	Fall Creek	Spawning
OR_SR_1709000109_02_103744	Portland Creek	Year Round
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
OR_SR_1709000110_02_103749	Hills Creek	Year Round
OR_WS_170900010102_02_104186	HUC12 Name: Tumblebug Creek	Year Round
OR_WS_170900010105_02_104189	HUC12 Name: Staley Creek	Year Round
OR_WS_170900010106_02_104190	HUC12 Name: Echo Creek-Middle Fork Willamette River	Year Round
OR_WS_170900010202_02_104192	HUC12 Name: Lower Hills Creek	Year Round
OR_WS_170900010302_02_104194	HUC12 Name: Middle Salt Creek	Year Round
OR_WS_170900010303_02_104195	HUC12 Name: Lower Salt Creek	Spawning
OR_WS_170900010303_02_104195	HUC12 Name: Lower Salt Creek	Year Round
OR_WS_170900010402_02_104197	HUC12 Name: Upper Salmon Creek	Year Round
OR_WS_170900010403_02_104198	HUC12 Name: Lower Salmon Creek	Year Round
OR_WS_170900010501_02_104199	HUC12 Name: Coal Creek	Year Round
OR_WS_170900010502_02_104200	HUC12 Name: Buck Creek-Middle Fork Willamette River	Year Round
OR_WS_170900010503_02_104201	HUC12 Name: Packard Creek-Middle Fork Willamette	Year Round
OR_WS_170900010505_02_104202	HUC12 Name: Gray 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_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_170900010702_02_104212	HUC12 Name: Lost Creek	Year Round
OR_WS_170900010703_02_104213	HUC12 Name: Dexter Reservoir-Middle Fork Willamette River	Year Round
OR_WS_170900010901_02_104216	HUC12 Name: Delp Creek-Fall Creek	Year Round
OR_WS_170900010904_02_104219	HUC12 Name: Andy Creek-Fall Creek	Year Round
OR_WS_170900010905_02_104220	HUC12 Name: Winberry Creek	Year Round

Table 3.2 Coast Fork Willamette Subbasin (17090002) Category 5 temperature impairments on the 2022 Integrated Report.

Assessment Unit Name	Assessment Unit	Use Period
OR_LK_1709000202_02_100705	Dorena Lake	Year Round
OR_SR_1709000201_02_103752	Mosby Creek	Year Round
OR_SR_1709000201_02_103752	Mosby Creek	Spawning
OR_SR_1709000202_02_103755	Sharps Creek	Year Round
OR_SR_1709000202_02_103756	Martin Creek	Year Round
OR_SR_1709000202_02_103761	Row River	Year Round
OR_SR_1709000202_02_103765	Layng Creek	Year Round
OR_SR_1709000202_02_103766	Row River	Year Round

Assessment Unit Name	Assessment Unit	Use Period
OR_SR_1709000202_02_103771	Brice Creek	Year Round
OR_SR_1709000202_02_103775	Sharps Creek	Year Round
OR_SR_1709000202_02_103776	Sharps Creek	Year Round
OR_SR_1709000203_02_104586	Coast Fork Willamette River	Year Round
OR_WS_170900020203_02_104229	HUC12 Name: Sharps Creek	Year Round
OR_WS_170900020204_02_104230	HUC12 Name: King Creek-Row River	Year Round
OR_WS_170900020401_02_104238	HUC12 Name: Hill Creek-Coast Fork Willamette River	Year Round

Table 3.3 Upper Willamette Subbasin (17090003) Category 5 temperature impairments on the 2022 Integrated Report.

Assessment Unit Name	Assessment Unit	Use Period
OR_SR_1709000301_02_103790	Ferguson Creek	Year Round
OR_SR_1709000301_02_103796	Coyote Creek	Year Round
OR_SR_1709000302_02_103804	Marys River	Year Round
OR_SR_1709000302_02_103806	Muddy Creek	Year Round
OR_SR_1709000302_02_103812	Marys River	Year Round
OR_SR_1709000302_02_103813	Marys River	Year Round
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_1709000303_02_103819	Courtney Creek	Year Round
OR_SR_1709000304_02_103821	Calapooia River	Year Round
OR_SR_1709000305_02_103822	Little Luckiamute River	Year Round
OR_SR_1709000305_02_103824	Teal Creek	Year Round
OR_SR_1709000305_02_103825	Miller Creek	Year Round
OR_SR_1709000305_02_103828	North Fork Pedee Creek	Year Round
OR_SR_1709000305_02_103829	Luckiamute River	Year Round
OR_SR_1709000305_02_103832	Soap Creek	Year Round
OR_SR_1709000305_02_103833	Ritner Creek	Year Round
OR_SR_1709000306_02_103838	Muddy Creek	Year Round
OR_WS_170900030109_02_104251	HUC12 Name: Bear Creek-Long Tom River	Year Round
OR_WS_170900030204_02_104256	HUC12 Name: Greasy Creek	Year Round
OR_WS_170900030301_02_104264	HUC12 Name: Hands Creek-Calapooia River	Spawning
OR_WS_170900030301_02_104264	HUC12 Name: Hands Creek-Calapooia River	Year Round
OR_WS_170900030302_02_104265	HUC12 Name: Bigs Creek-Calapooia 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_WS_170900030505_02_104279	HUC12 Name: Jont Creek-Luckiamute River	Year Round
OR_WS_170900030510_02_104284	HUC12 Name: Berry Creek	Year Round
OR_WS_170900030603_02_104290	HUC12 Name: Flat Creek	Year Round

Table 3.4 McKenzie Subbasin (17090004) Category 5 temperature impairments on the 2022 Integrated Report.

Assessment Unit Name	Assessment Unit	Use Period
OR_SR_1709000401_02_103855	Horse Creek	Year Round
OR_SR_1709000401_02_103856	Horse Creek	Year Round
OR_SR_1709000403_02_103862	French Pete Creek	Year Round
OR_SR_1709000403_02_103865	Augusta Creek	Year Round
OR_SR_1709000404_02_104571	Lookout Creek	Year Round
OR_SR_1709000404_02_104574	Upper Blue River	Year Round
OR_SR_1709000404_02_104576	Quentin Creek	Year Round
OR_SR_1709000404_02_104577	Upper Blue River	Year Round

Assessment Unit Name	Assessment Unit	Use Period
OR_SR_1709000405_02_103867	Quartz 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_103872	Shotgun Creek	Year Round
OR_SR_1709000406_02_103873	Mill Creek	Year Round
OR_SR_1709000406_02_103874	Mill Creek	Year Round
OR_SR_1709000406_02_103875	Cartwright Creek	Year Round
OR_SR_1709000406_02_103875	Cartwright Creek	Spawning
OR_SR_1709000406_02_103877	Mohawk River	Year Round
OR_SR_1709000406_02_103877	Mohawk River	Spawning
OR_SR_1709000406_02_103879	McGowan Creek	Year Round
OR_SR_1709000406_02_103879	McGowan Creek	Spawning
OR_SR_1709000407_02_103882	Deer Creek	Year Round
OR_SR_1709000407_02_103882	Deer Creek	Spawning
OR_SR_1709000407_02_103889	Camp Creek	Year Round
OR_SR_1709000407_02_103889	Camp Creek	Spawning
OR_SR_1709000407_02_103891	Cedar Creek	Year Round
OR_SR_1709000407_02_103891	Cedar Creek	Spawning
OR_WS_170900040104_02_104303	HUC12 Name: Middle Horse Creek	Year Round
OR_WS_170900040105_02_104304	HUC12 Name: Lower Horse Creek	Year Round
OR_WS_170900040202_02_104306	HUC12 Name: Hackleman Creek-McKenzie River	Year Round
OR_WS_170900040203_02_104307	HUC12 Name: Smith River	Year Round
OR_WS_170900040204_02_104308	HUC12 Name: Kink Creek-McKenzie River	Year Round
OR_WS_170900040205_02_104309	HUC12 Name: Deer Creek	Year Round
OR_WS_170900040206_02_104310	HUC12 Name: Boulder Creek-McKenzie River	Year Round
OR_WS_170900040209_02_104313	HUC12 Name: Florence Creek-McKenzie River	Year Round
OR_WS_170900040304_02_104317	HUC12 Name: Rebel Creek-South Fork McKenzie River	Year Round
OR_WS_170900040402_02_104323	HUC12 Name: Upper Blue River	Year Round
OR_WS_170900040403_02_104324	HUC12 Name: Lower Blue 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_170900040601_02_104327	HUC12 Name: Headwaters Mohawk River	Year Round
OR_WS_170900040602_02_104328	HUC12 Name: Shotgun Creek-Mohawk River	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_170900040705_02_104336	HUC12 Name: Camp Creek	Year Round

Table 3.5 North Santiam Subbasin (17090005) Category 5 temperature impairments on the 2022 Integrated Report.

Assessment Unit Name	Assessment Unit	Use Period
OR_SR_1709000502_02_103902	Boulder Creek	Year Round
OR_SR_1709000503_02_103907	Blowout Creek	Year Round
OR_SR_1709000503_02_103909	Blowout Creek	Year Round
OR_SR_1709000505_02_103923	Elkhorn Creek	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_1709000506_02_103926	Chehulpum Creek	Year Round
OR_SR_1709000506_02_103928	Bear Branch	Year Round
OR_SR_1709000506_02_103929	Stout Creek	Year Round
OR_WS_170900050203_02_104345	HUC12 Name: Marion Creek	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_WS_170900050504_02_104563	HUC12 Name: Middle Little North Santiam River	Year Round

Assessment Unit Name	Assessment Unit	Use Period
OR_WS_170900050602_02_104360	HUC12 Name: Bear Branch-North Santiam River	Year Round
OR_WS_170900050603_02_104361	HUC12 Name: Marion Creek-North Santiam River	Spawning
OR_WS_170900050603_02_104361	HUC12 Name: Marion Creek-North Santiam River	Year Round

Table 3.6 South Santiam Subbasin (17090006) Category 5 temperature impairments on the 2022 Integrated Report.

Assessment Unit Name	Assessment Unit	Use Period
OR_LK_1709000603_02_100771	Green Peter Lake	Year Round
OR_LK_1709000604_02_100772	Foster Lake	Year Round
OR_SR_1709000601_02_103934	Middle Santiam River	Year Round
OR_SR_1709000601_02_103935	Pyramid Creek	Year Round
OR_SR_1709000601_02_103936	Middle Santiam River	Year Round
OR_SR_1709000601_02_103938	Middle Santiam River	Year Round
OR_SR_1709000602_02_103941	Owl Creek	Year Round
OR_SR_1709000602_02_103942	Trout Creek	Year Round
OR_SR_1709000602_02_103947	Soda Fork	Year Round
OR_SR_1709000602_02_103948	Two Girls Creek	Year Round
OR_SR_1709000602_02_103949	Canyon Creek	Year Round
OR_SR_1709000602_02_103950	South Santiam River	Year Round
OR_SR_1709000602_02_103950	South Santiam River	Spawning
OR_SR_1709000602_02_103953	Sheep Creek	Year Round
OR_SR_1709000602_02_103954	Moose Creek	Year Round
OR_SR_1709000602_02_103954	Moose Creek	Spawning
OR_SR_1709000602_02_103955	Latiwi Creek	Year Round
OR_SR_1709000603_02_103957	Quartzville Creek	Year Round
OR_SR_1709000603_02_103960	Quartzville Creek	Year Round
OR_SR_1709000603_02_103965	Middle Santiam River	Year Round
OR_SR_1709000604_02_103968	South Santiam River	Year Round
OR_SR_1709000604_02_103968	South Santiam River	Spawning
OR_SR_1709000604_02_103969	Middle Santiam River	Spawning
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
OR_SR_1709000606_02_103973	Beaver Creek	Year Round
OR_SR_1709000606_02_103978	Crabtree Creek	Year Round
OR_SR_1709000606_02_103978	Crabtree Creek	Spawning
OR_SR_1709000607_02_103985	South Fork Neal Creek	Year Round
OR_SR_1709000607_02_103986	Bilyeu Creek	Year Round
OR_SR_1709000607_02_103988	Thomas Creek	Year Round
OR_SR_1709000607_02_103989	Bilyeu Creek	Year Round
OR_SR_1709000607_02_103991	Thomas Creek	Year Round
OR_SR_1709000607_02_103991	Thomas Creek	Spawning
OR_SR_1709000608_02_103993	Hamilton Creek	Year Round
OR_SR_1709000608_02_103993	Hamilton Creek	Spawning
OR_SR_1709000608_02_103994	McDowell Creek	Year Round
OR_SR_1709000608_02_103996	Hamilton Creek	Year Round
OR_SR_1709000608_02_103996	Hamilton Creek	Spawning
OR_SR_1709000608_02_103997	Scott 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_WS_170900060804_02_104398	HUC12 Name: Hamilton Creek	Year Round

Table 3.7 Middle Willamette Subbasin (17090007) Category 5 temperature impairments on the 2022 Integrated Report.

Assessment Unit Name	Assessment Unit	Use Period
OR_SR_1709000701_02_104591	Rickreall Creek	Year Round
OR_SR_1709000703_02_104007	Mill Creek	Year Round
OR_SR_1709000703_02_104007	Mill Creek	Spawning
OR_SR_1709000703_02_104008	Shelton Ditch	Year Round
OR_SR_1709000703_02_104008	Shelton Ditch	Spawning
OR_SR_1709000703_02_104012	Pringle Creek	Year Round
OR_SR_1709000704_02_104017	Abernethy Creek	Year Round
OR_SR_1709000704_02_104594	Abernethy Creek	Year Round
OR_WS_170900070203_02_104411	HUC12 Name: McKinney Creek	Year Round
OR_WS_170900070204_02_104412	HUC12 Name: Lower Mill 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_170900070306_02_104417	HUC12 Name: Chehalem Creek	Year Round

Table 3.8 Molalla-Pudding Subbasin (17090009) Category 5 temperature impairments on the 2022 Integrated Report.

Assessment Unit Name	Assessment Unit	Use Period
OR_LK_1709000902_02_100830	Zollner Creek	Year Round
OR_SR_1709000901_02_104062	Abiqua Creek	Year Round
OR_SR_1709000901_02_104066	South Fork Silver Creek	Year Round
OR_SR_1709000901_02_104067	Pudding River	Year Round
OR_SR_1709000901_02_104069	Drift Creek	Year Round
OR_SR_1709000901_02_104069	Drift Creek	Spawning
OR_SR_1709000901_02_104595	Silver Creek	Year Round
OR_SR_1709000902_02_104070	Butte Creek	Year Round
OR_SR_1709000902_02_104072	Butte Creek	Year Round
OR_SR_1709000904_02_104086	Molalla River	Year Round
OR_SR_1709000904_02_104086	Molalla River	Spawning
OR_SR_1709000904_02_104087	Table Rock Fork	Year Round
OR_SR_1709000904_02_104087	Table Rock Fork	Spawning
OR_SR_1709000905_02_104088	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_170900090204_02_104467	HUC12 Name: Brandy Creek-Pudding River	Year Round
OR_WS_170900090303_02_104470	HUC12 Name: Bear Creek	Year Round
OR_WS_170900090403_02_104474	HUC12 Name: Pine Creek-Molalla River	Year Round

Table 3.9 Clackamas Subbasin (17090011) Category 5 temperature impairments on the 2022 Integrated Report.

Assessment Unit Name	Assessment Unit	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_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_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_1709001104_02_104156	Fish Creek	Year Round
OR_SR_1709001104_02_104157	Trout Creek	Year Round

Assessment Unit Name	Assessment Unit	Use Period
OR_SR_1709001104_02_104160	Roaring River	Spawning
OR_SR_1709001104_02_104161	Fish Creek	Year Round
OR_SR_1709001104_02_104161	Fish Creek	Spawning
OR_SR_1709001105_02_104163	Eagle Creek	Year Round
OR_SR_1709001105_02_104163	Eagle Creek	Spawning
OR_SR_1709001105_02_104165	North Fork Eagle Creek	Year Round
OR_WS_170900110402_02_104535	HUC12 Name: Roaring River	Year Round
OR_WS_170900110405_02_104538	HUC12 Name: North Fork Clackamas River	Year Round
OR_WS_170900110406_02_104539	HUC12 Name: Helion Creek-Clackamas River	Year Round
OR_WS_170900110501_02_104540	HUC12 Name: Upper Eagle Creek	Year Round
OR_WS_170900110607_02_104549	HUC12 Name: Rock Creek-Clackamas River	Year Round

Table 3.10 Lower Willamette Subbasin (17090012) Category 5 temperature impairments on the 2022 Integrated Report.

Assessment Unit Name	Assessment Unit	Use Period
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_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_WS_170900120101_02_104550	HUC12 Name: Upper Johnson Creek	Spawning
OR_WS_170900120101_02_104550	HUC12 Name: Upper Johnson Creek	Year Round
OR_WS_170900120103_02_104552	HUC12 Name: Lower Johnson Creek	Spawning
OR_WS_170900120103_02_104552	HUC12 Name: Lower Johnson Creek	Year Round
OR_WS_170900120104_02_104553	HUC12 Name: Oswego Creek-Willamette River	Spawning
OR_WS_170900120104_02_104553	HUC12 Name: Oswego 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_170900120202_02_104555	HUC12 Name: Balch Creek-Willamette River	Year Round
OR_WS_170900120301_02_104557	HUC12 Name: South Scappoose Creek	Spawning
OR_WS_170900120305_02_104561	HUC12 Name: Multnomah Channel	Year Round

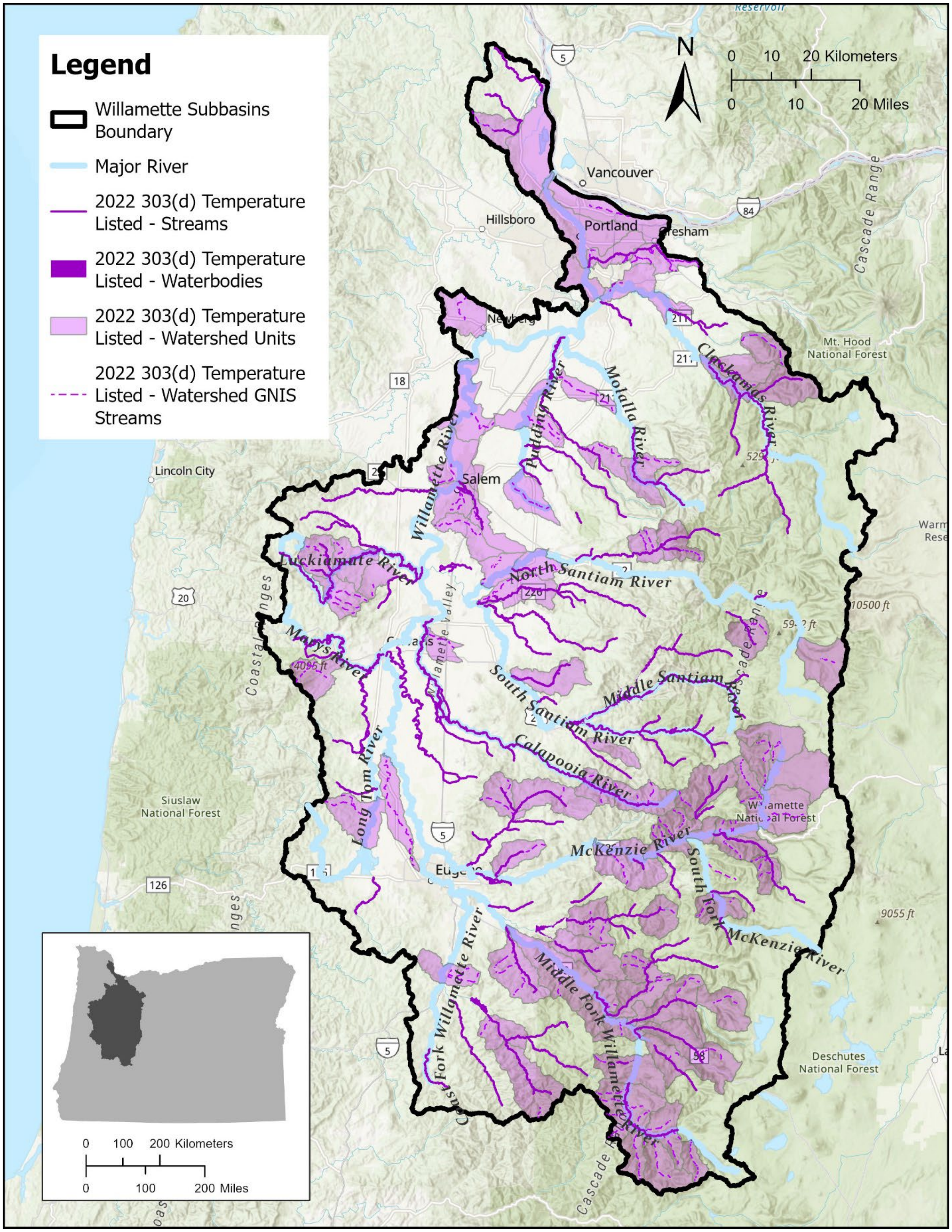


Figure 3.1. Willamette Subbasins category 5 temperature impairments on the 2022 Integrated Report.

4. Water quality standards and beneficial uses

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

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

Table 4.1 Designated beneficial uses in the 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
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 water temperatures, coliform bacteria concentrations, dissolved chemical substances, toxic materials,	All waters of the state	Fish and aquatic life

Parameter	Rule Citation	Summary of applicable standards	Waters where standards are applicable	Most sensitive beneficial use
		radioactivity, turbidities, color, odor and other deleterious factors at the lowest possible levels.		
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) (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 degrees Celsius (0.5 Fahrenheit) 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 degrees Celsius (48 degrees Fahrenheit) or greater, and no more than a 1.0 degree Celsius (1.8 degrees Fahrenheit) increase when the seven-day-average stream temperature is less than 9 degrees Celsius.	See OAR Figures 340A and 340B	Salmonid and steelhead Spawning Bull Trout spawning and juvenile rearing use
	OAR 340-041-0028(6)	Natural lakes may not be warmed by more than 0.3 degrees Celsius (0.5 degrees Fahrenheit) above the natural condition unless a greater increase would not reasonably be expected to adversely affect fish or other 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 bulltrout presence
	OAR 340-041-0028(12)(b)	(B) Human Use Allowance. Following a temperature TMDL or other		

Parameter	Rule Citation	Summary of applicable standards	Waters where standards are applicable	Most sensitive beneficial use
		cumulative effects analysis, wasteload and load allocations will restrict all NPDES point sources and nonpoint sources to a cumulative increase of no greater than 0.3˚C (0.5˚F) above the applicable criteria after complete mixing in the water body, and at the point of maximum impact.	All waters of the state	Salmonid and steelhead Spawning

5. Seasonal variation and critical period for Temperature

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

[summarize seasonality and The critical periods and refer to xx Basin TMDL Technical and Policy Support Document]period is set based on when 7DADM stream temperature typically exceed the applicable criteria. Based on analysis of temperature data, the critical period is May 1 through October 31.

[Additional seasonality summary]

6. Temperature water quality data evaluation overview

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

[insert figure]

Figure 6: Schematic ofA 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 models were used in this effort and are described in Technical Support document model appendices.

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

1. Stream temperatures spanning months at ≤500m longitudinal resolution.
2. Solar radiation fluxes and daily effective shade at ≤100m longitudinal resolution.
~~1.~~3. Stream temperature ~~evaluation approach~~responses due to changes in:

    a. Streamside vegetation,
    b. Water withdrawals and upstream tributaries' stream flow,
    c. Channel morphology in the upstream catchment,
    d. Effluent temperature and flow discharge from NPDES permitted facilities.

Figure 6.1 provides an overview of the analyses completed for this TMDL.

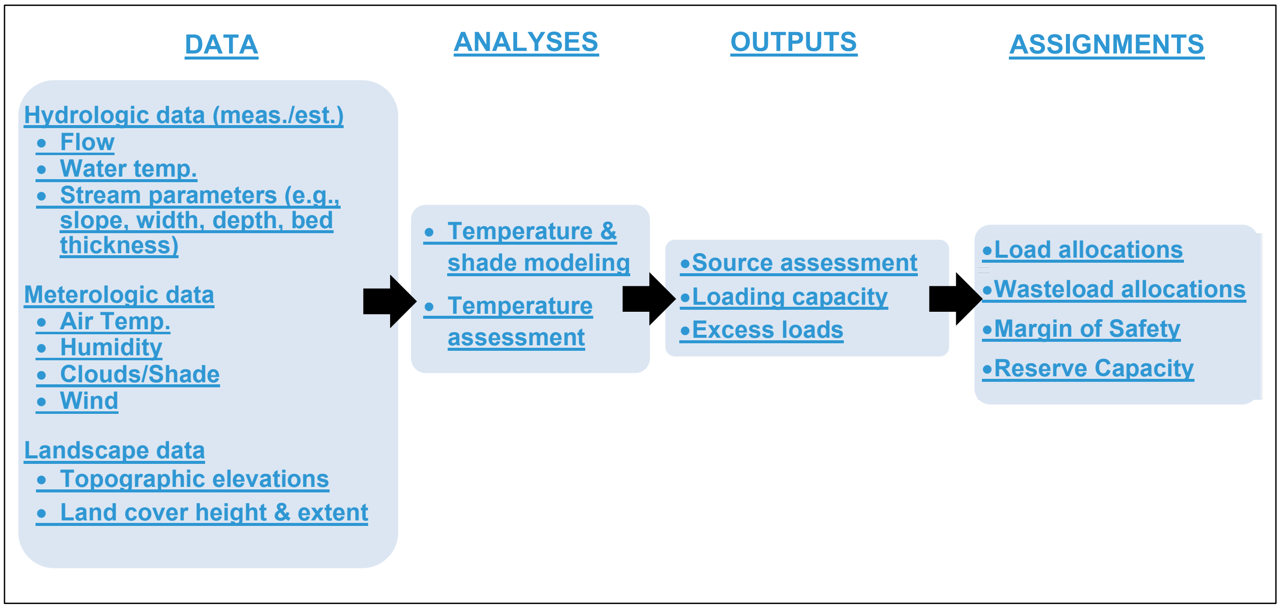


Figure 6.1 Willamette Subbasins temperature analysis overview.

7. Pollutant sources or source categories

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

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

There are ~~60~~61 domestic or industrial individual NPDES permitted point source dischargers within the Willamette Subbasins identified as potential sources of thermal load (Table 7.1). There also are 10 individual Municipal Separate Storm Sewer System (MS4) NPDES permits identified as potential sources of thermal load.

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

Table 7.1 Individual NPDES permitted point source discharges that contribute thermal loads to 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	River mile
Alpine Community	NPDES-DOM-Db	100101	OR0032387	Muddy Creek	25.6
Arclin	NPDES-IW-B16	16037	OR0021857	Patterson Slough	1.8
Arclin	NPDES-IW-B10	81714	OR0000892	Columbia Slough	6
ATI Albany Operations	NPDES-IW-B08	64300	OR0001716	Oak Creek	1.6
Aumsville STP	NPDES-DOM-Db	4475	OR0022721	Beaver Creek	2.5
Aurora STP	NPDES-DOM-Db	110020	OR0043991	Pudding River	8.8
Blount Oregon Cutting Systems Division	NPDES-IW-B16	63545	OR0032298	Mount Scott Creek	0.9
Boeing Of Portland - Fabrication Division	NPDES-IW-B16	9269	OR0031828	Osburn Creek	1.6
Brownsville STP	NPDES-DOM-Db	11770	OR0020079	Calapooia River	31.6
Coburg Wastewater Treatment Plant	NPDES-DOM-Da	115851	OR0044628	Muddy Creek	50.7
Coffin Butte Landfill	NPDES-IW-B15	104176	OR0043630	Roadside ditch to Soap Creek tributary	4.5
Columbia Helicopters	NPDES-IW-B16	100541	OR0033391	Unnamed Stream (tributary to Pudding River)	2
Creswell STP	NPDES-DOM-Db	20927	OR0027545	Camas Swale Creek	4
Dallas STP	NPDES-DOM-C1a	22546	OR0020737	Rickreall Creek	10.5
Duraflake	NPDES-IW-B20	97047	OR0000426	Murder Creek	0.57
Estacada STP	NPDES-DOM-Da	27866	OR0020575	Clackamas River	23.3
EWEB Carmen-Smith	NPDES-IW-B16	28393	OR0000680	McKenzie River	82
Falls City STP	NPDES-DOM-Da	28830	OR0032701	Little Luckiamute River	12
Foster Farms	NPDES-IW-B04	97246	OR0026450	Camas Swale Creek	3.3

Fujimi Corporation - SW Commerce Circle	NPDES-IW-B15	107178	OR0040339	Coffee Lake Creek	1.8
Georgia-Pacific Chemicals LLC	NPDES-IW-B16	32864	OR0002101	Amazon Creek	2.7
Gervais STP	NPDES-DOM-Db	33060	OR0027391	Pudding River	28.2
GP Millersburg Resin Plant	NPDES-IW-B16	32650	OR0032107	Murder Creek	0.6
Halsey STP	NPDES-DOM-Db	36320	OR0022390	Muddy Creek	23
Hubbard STP	NPDES-DOM-Da	40494	OR0020591	Mill Creek	5.3
Hull-Oakes Lumber Co.	NPDES-IW-B19	107228	OR0038032	Oliver Creek	4.8
International Paper – Springfield Paper Mill	NPDES-IW-B01	96244	OR0000515	Outfall 003 - Storm Ditch - Near 42nd St.	
J.H. Baxter & Co., Inc.	NPDES-IW-B21	6553	OR0021911	Amazon Diversion Canal	1.5
JLR, LLC	NPDES-IW-B05	32536	OR0001015	Pudding River	27
Junction City STP	NPDES-DOM-Db	44509	OR0026565	Flat Creek	9.2
Kingsford Manufacturing Company - Springfield Plant	NPDES-IW-B20	46000	OR0031330	Patterson Slough	3.7
Knoll Terrace MHC	NPDES-DOM-Db	46990	OR0026956	Mountain View Creek	0.4
Lakewood Utilities, Ltd	NPDES-DOM-Da	96110	OR0027570	Mill Creek (Molalla-Pudding Subbasin)	3.9
Lane Community College	NPDES-DOM-Db	48854	OR0026875	Russel Creek	0.7
Mcfarland Cascade Pole & Lumber Co	NPDES-IW-B21	54370	OR0031003	Storm Ditch to Amazon Creek	1.8
Molalla STP	NPDES-DOM-Db	57613	OR0022381	Molalla River	8.2
Mt. Angel STP	NPDES-DOM-Da	58707	OR0028762	Pudding River	37.5
Murphy Veneer, Foster Division	NPDES-IW-B20	97070	OR0021741	Wiley Creek	0.9
Norpac Foods - Brooks Plant No. 5	NPDES-IW-B04	84791	OR0021261	Fitzpatrick Creek	1
Norpac Foods- Plant #1, Stayton	NPDES-IW-B04	84820	OR0001228	Salem Ditch (flows to Mill Creek)	18.5
Oakridge STP	NPDES-DOM-Da	62886	OR0022314	Middle Fork Willamette River	39.8
ODC - Oregon State Penitentiary	NPDES-IW-B15	109727	OR0043770	Mill Creek (Middle Willamette Subbasin)	2.5
ODFW - Marion Forks Hatchery	NPDES-IW-B17	64495	OR0027847	Horn Creek	72.1
Philomath WWTP	NPDES-DOM-Db	103468	OR0032441	Marys River	10.2
Portland International Airport	NPDES-IW-B15	107220	OR0040291	Columbia Slough	2.7
RSG Forest Products - Liberal	NPDES-IW-B19	72596	OR0021300	Unnamed ditch to Molalla River	9.8
Sandy WWTP	NPDES-DOM-Da	78615	OR0026573	Tickle Creek	3.1
Scio STP	NPDES-DOM-Db	79633	OR0029301	Thomas Creek	7.2
Seneca Sawmill Company	NPDES-IW-B19	80207	OR0022985	Ditch to A-1 Amazon Channel	7.0
SFPP, L.P.	NPDES-IW-B15	103159	OR0044661	Amazon Creek	7.9
Sherman Bros. Trucking	NPDES-DOM-Db	36646	OR0021954	Little Muddy Creek	8
Silverton STP	NPDES-DOM-C1a	81395	OR0020656	Silver Creek	2.4

Sunstone Circuits	NPDES-IW-B15	26788	OR0031127	Milk Creek	5.3298
Tangent STP	NPDES-DOM-Db	87425	OR0031917	Calapooia River	10.8
Timberlake STP	NPDES-DOM-Da	90948	OR0023167	Clackamas River	51.1
USFW - Eagle Creek National Fish Hatchery	NPDES-IW-B17	91035	OR0000710	Eagle Creek	12.3
Veneta STP	NPDES-DOM-Db	92762	OR0020532	Long Tom River	34.9
WES (Boring STP)	NPDES-DOM-Db	16592	OR0031399	North Fork Deep Creek	3
Westfir STP	NPDES-DOM-Da	94805	OR0028282	Nork Fork Middle Fork Willamette River	1
Willamette Leadership Academy	NPDES-DOM-Db	34040	OR0027235	Wild Hog Creek	2
Woodburn WWTP	NPDES-DOM-C1a	98815	OR0020001	Pudding River	21.4

Table 7.2 Individual NPDES Municipal Separate Storm Sewer System permittees in the Willamette Subbasins.

Permittee	Permit type	DEQ WQ File Number	EPA Number
Corvallis Municipal Stormwater	NPDES-DOM-MS4-2	113605	ORS113605
Springfield Municipal Stormwater	NPDES-DOM-MS4-2	84048	ORS084048
Turner Municipal Stormwater	NPDES-DOM-MS4-2	113607	ORS113607
Eugene, City Of	NPDES-DOM-MS4-1	107989	ORS107989
Gresham, City Of	NPDES-DOM-MS4-1	108013	ORS108013
Portland, City Of	NPDES-DOM-MS4-1	108015	ORS108015
Salem, City Of	NPDES-DOM-MS4-1	108919	ORS108919
WES (Clackamas Co. Service District #1)	NPDES-DOM-MS4-1	108016	ORS108016
ODOT	NPDES-DOM-MS4-1	110870	ORS110870
Multnomah County	NPDES-DOM-MS4-1	120542	ORS120542

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 2 - 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 when river flow is < 44 cfs, or any flow range for hydropower facilities
- 200-J
- 300-J

There are six registrants to the 100-J, six registrants to the 200-J, and two 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 minimus temperature increase based on the permit requirements, available dilution, or frequency and magnitude of discharge based on review of available discharge data.

Based on a review of published literature and other studies related to stormwater runoff and stream temperature in Oregon, DEQ found there is not sufficient evidence to demonstrate that stormwater discharges authorized under the current municipal (MS4s) permits or the construction (1200-C) and industrial (1200-A and 1200-Z) general stormwater permits contribute to exceedances of the temperature standard.

Table 7.3 General NPDES permit registrants that 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	River mile
Americold Logistics, LLC	100-J	87663	ORG253544	Claggett Creek	4.9
Forrest Paint Co.	100-J	100684	ORG253508	Amazon Creek	17.0
Holiday Plaza	100-J	108298	ORG253504	Unknown	0.2
Malarkey Roofing	100-J	52638	ORG250024	Columbia Slough	5.9
Miller Paint Company	100-J	103774	ORG250040	Unknown	
Owens-Brockway Glass Container Plant	100-J	65610	ORG250029	Unknown	
PCC Structurals, Inc.	100-J	71920	ORG250015	Mount Scott Creek	2.3
First Premier Properties - Spinnaker II Office Building	100-J	110603	ORG253511	Unknown	0.8
Sundance Lumber Company, Inc.	100-J	107401	ORG253618	Stream without a name	14.0
Ventura Foods, LLC	100-J	103832	ORG250005	Unknown	
Albany Water Treatment Plant	200-J	66584	ORG383501	Calapooia River	0.1
Corvallis Rock Creek Water Treatment Plant	200-J	20160	ORG383513	Marys River	13.5
Dallas Water Treatment Plant	200-J	22550	ORG383529	Rickreall Creek	17.0
Molalla Municipal Water Treatment Plant	200-J	109846	ORG380014	Molalla River	21.6
Philomath Water Treatment Plant	200-J	100048	ORG383536	Marys River	12.2
Row River Valley Water District	200-J	100075	ORG383534	Laying Creek	1.4
Silverton Water Treatment Plant	200-J	81398	ORG383527	Silver Creek	3.9
ODFW - Roaring River Hatchery	300-J	64525	ORG133506	Roaring River	1.1
ODFW - Willamette Fish Hatchery	300-J	64585	ORG133507	Salmon Creek	0.4

7.2. Thermal nonpoint sources

OAR 340-41-0002 (42) defines nonpoint sources as "diffuse or unconfined sources of pollution where wastes can either enter, or be conveyed by the movement of water, into waters of the state." Nonpoint sources of heat in the 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 stream-side 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 reservoirs to minimize temperature warming.
- Maintenance of minimum instream flows

7.3. Thermal background sources

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

The amount of background thermal loading a stream receives is influenced by a number of landscape and meteorological characteristics, such as: substrate and channel morphology conditions; streambank and channel elevations; near stream vegetation; groundwater; hyporheic flow; tributary inflows; precipitation; cloudiness; air temperature; relative humidity and others. Many of these factors, however, are influenced by anthropogenic impacts related to the surrogate measures. Background sources of warming were explicitly quantified for xx Basin and subtracted from anthropogenic loads.

8. Loading capacity and excess loads

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

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

$$LC = (T_C + \mathrm{HUA}) \cdot Q_R \cdot C_F$$ **Equation 1**

where,

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

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

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

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

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

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

Equation 1 shall be used to calculate the thermal loading capacity for any surface water location in the Willamette Subbasins. Table 8.1 presents the minimum loading capacity for select temperature impaired category 5 assessment units modeled for the TMDL analysis. The loading capacities in Table 8.1 were calculated based on the 7Q10 low flow. **Equation 1** may be used to calculate the loading capacity when river flows are greater than 7Q10. **Equation 1** may also be used to calculate the loading capacity if in the future the applicable temperature criteria are updated and approved by EPA.

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

AU Name and AU ID	Annual 7Q10 (cfs)	Non-Spawning Criterion + HUA (deg-C)	Spawning Criterion + HUA (deg-C)	Minimum Loading Capacity Non-Spawning (kilocalories/day)	Minimum Loading Capacity Spawning (kilocalories/day)
Mosby Creek OR_SR_1709000201_02_103752	10.7	16.3	13.3	426,722,843	348,184,896
Coyote Creek OR_SR_1709000301_02_103796	5.9	18.3	NA	264,166,420	NA
Luckiamute River OR_SR_1709000305_02_103829	15.9	18.3	13.3	711,373,841	517,009,404
Mohawk River OR_SR_1709000406_02_103871	15.7	16.3	13.3	624,217,004	509,330,439
Little North Santiam River OR_SR_1709000505_02_104564	19.5	16.3	13.3	776,380,456	633,488,348
Crabtree Creek OR_SR_1709000606_02_103978	25.4	16.3	13.3	1,012,968,243	826,532,370
Thomas Creek OR_SR_1709000607_02_103988	6.9	18.3	NA	307,215,372	NA
Molalla River OR_SR_1709000904_02_104086	38.1	16.3	13.3	1,519,452,365	1,239,798,555
Pudding River OR_SR_1709000905_02_104088	10.4	18.3	NA	467,027,454	NA
Johnson Creek OR_SR_1709001201_02_104170	11.1	18.3	13.3	497,335,067	361,451,169

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 assessment unit where temperature data were available (Table 8.2). The excess temperatures are the maximum difference between the monitored 7dadm river temperatures and applicable numeric criteria plus the human use allowance. The percent load reduction represents the portion of the actual thermal loading that must be reduced to attain the TMDL loading capacity. The percent load reduction can be calculated from the excess temperature and is mathematically equal to the percent load reduction calculated from the excess load. This is because the river flow rate used to calculate a thermal load is the same number in the numerator and denominator and is cancelled out when calculating the percent reduction. The percent load reductions were calculated from temperatures measured in degrees Celsius with reduction to thermal loading that is should also be measured and calculated from temperatures measured in degrees Celsius (rather than Fahrenheit or Kelvin).

Table 8.2 Excess temperature and percent load reduction for various assessment units in the Willamette Subbasins.

Assessment Unit Name	Assessment Unit 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
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
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
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
Middle Fork Willamette River	OR_SR_1709000105_02_104579	21.0	12.3	8.7	41.4
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
Christy Creek	OR_SR_1709000106_02_103722	15.5	16.3	0.0	0.0
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
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

Hehe Creek	OR_SR_1709000109_02_103734	21.0	16.3	4.7	22.5
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
Portland Creek	OR_SR_1709000109_02_103741	22.5	16.3	6.2	27.4
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
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
Sharps Creek	OR_SR_1709000202_02_103755	24.0	18.3	5.7	23.8
Martin Creek	OR_SR_1709000202_02_103756	19.9	18.3	1.6	8.0
Row River	OR_SR_1709000202_02_103761	25.1	18.3	6.8	27.1
Alex Creek	OR_SR_1709000202_02_103762	16.7	18.3	0.0	0.0
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
Row River	OR_SR_1709000202_02_103766	25.1	18.3	6.8	27.1
Layng Creek	OR_SR_1709000202_02_103770	16.6	18.3	0.0	0.0
Brice Creek	OR_SR_1709000202_02_103771	23.1	18.3	4.8	20.6
Sharps Creek	OR_SR_1709000202_02_103775	19.2	18.3	0.9	4.6
Grass Creek	OR_SR_1709000202_02_103780	15.6	16.3	0.0	0.0
Calapooia River	OR_SR_1709000303_02_103815	16.0	16.3	0.0	0.0
Teal Creek	OR_SR_1709000305_02_103824	20.3	18.3	2.0	9.9
North Fork Pedee Creek	OR_SR_1709000305_02_103828	20.2	18.3	1.9	9.5
Ritner Creek	OR_SR_1709000305_02_103833	21.8	18.3	3.5	16.0
Horse Creek	OR_SR_1709000401_02_103856	13.8	12.3	1.5	10.9
Separation Creek	OR_SR_1709000401_02_103857	10.0	12.3	0.0	0.0
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
Rebel Creek	OR_SR_1709000403_02_103861	13.3	16.3	0.0	0.0
French Pete Creek	OR_SR_1709000403_02_103862	15.7	16.3	0.0	0.0
Roaring River	OR_SR_1709000403_02_103864	7.2	12.3	0.0	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
Lookout Creek	OR_SR_1709000404_02_104571	20.9	16.3	4.6	22.0
Upper Blue River	OR_SR_1709000404_02_104574	20.6	16.3	4.3	20.9
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
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
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
Breitenbush River	OR_SR_1709000501_02_103892	17.5	18.3	0.0	0.0
Marion Creek	OR_SR_1709000502_02_103897	17.4	18.3	0.0	0.0
Whitewater Creek	OR_SR_1709000502_02_103898	12.4	18.3	0.0	0.0
North Santiam River	OR_SR_1709000502_02_103899	17.9	18.3	0.0	0.0
Boulder Creek	OR_SR_1709000502_02_103902	19.3	18.3	1.0	5.3
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
Blowout Creek	OR_SR_1709000503_02_103907	21.0	18.3	2.7	12.9
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
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
Pyramid Creek	OR_SR_1709000601_02_103935	20.3	18.3	2.0	9.8
Middle Santiam River	OR_SR_1709000601_02_103936	19.7	18.3	1.4	7.3
Owl Creek	OR_SR_1709000602_02_103941	19.2	16.3	2.9	15.2
Trout Creek	OR_SR_1709000602_02_103942	17.2	16.3	0.9	5.5
Soda Fork	OR_SR_1709000602_02_103947	16.1	16.3	0.0	0.0
Canyon Creek	OR_SR_1709000602_02_103949	20.7	16.3	4.4	21.4
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
Sheep Creek	OR_SR_1709000602_02_103953	20.9	16.3	4.6	21.9
Moose Creek	OR_SR_1709000602_02_103954	19.3	16.3	3.0	15.4
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
Middle Santiam River	OR_SR_1709000603_02_103965	24.0	18.3	5.7	23.8
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
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
McDowell Creek	OR_SR_1709000608_02_103994	21.7	18.3	3.4	15.6
Hamilton Creek	OR_SR_1709000608_02_103996	27.3	16.3	11.0	40.3
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
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
Pringle Creek	OR_SR_1709000703_02_104012	25.1	18.3	6.8	27.1
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

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
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
Nohorn Creek	OR_SR_1709001101_02_104145	17.1	16.3	0.8	4.7
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
North Fork Clackamas River	OR_SR_1709001104_02_104152	19.2	16.3	2.9	15.1
Big Creek	OR_SR_1709001104_02_104153	13.7	16.3	0.0	0.0
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
Trout Creek	OR_SR_1709001104_02_104157	16.3	16.3	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
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
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
HUC12 Name: Paddys Valley-Middle Fork Willamette *	OR_WS_170900010101_02_104185	10.0	12.3	0.0	0.0
HUC12 Name: Tumblebug Creek	OR_WS_170900010102_02_104186	15.4	12.3	3.1	20.2
HUC12 Name: Staley Creek	OR_WS_170900010105_02_104189	16.4	12.3	4.1	25.0
HUC12 Name: Echo Creek-Middle Fork Willamette Riv*	OR_WS_170900010106_02_104190	15.6	12.3	3.3	21.1
HUC12 Name: Buck Creek-Middle Fork Willamette Riv*	OR_WS_170900010502_02_104200	18.9	12.3	6.6	34.9
HUC12 Name: Gray Creek-Middle Fork Willamette Riv*	OR_WS_170900010505_02_104202	17.7	13.3	4.4	24.9
HUC12 Name: Gray Creek-Middle Fork Willamette Riv*	OR_WS_170900010505_02_104202	18.1	16.3	1.8	9.9
HUC12 Name: Eighth Creek-North Fork Middle Fork W*	OR_WS_170900010607_02_104209	16.2	16.3	0.0	0.0
HUC12 Name: Dartmouth Creek-North Fork Middle For*	OR_WS_170900010608_02_104210	16.5	16.3	0.2	1.2
HUC12 Name: Andy Creek-Fall Creek	OR_WS_170900010904_02_104219	18.3	16.3	2.0	10.7

HUC12 Name: Winberry Creek	OR_WS_170900010905_02_104220	19.5	16.3	3.2	16.4
HUC12 Name: Layng Creek	OR_WS_170900020201_02_104227	17.6	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: Hill Creek-Coast Fork Willamette River	OR_WS_170900020401_02_104238	25.9	18.3	7.6	29.3
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: Maxfield Creek-Luckiamute River	OR_WS_170900030503_02_104277	21.1	18.3	2.8	13.3
HUC12 Name: Pedee Creek-Luckiamute River	OR_WS_170900030504_02_104278	19.5	18.3	1.2	6.3
HUC12 Name: Middle Little Luckiamute River	OR_WS_170900030507_02_104281	17.5	18.3	0.0	0.0
HUC12 Name: Flat Creek	OR_WS_170900030603_02_104290	25.7	18.3	7.4	28.8
HUC12 Name: Hackleman Creek-McKenzie River	OR_WS_170900040202_02_104306	12.3			
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: Kink Creek-McKenzie River	OR_WS_170900040204_02_104308	12.7	12.3	0.4	3.1
HUC12 Name: Deer Creek	OR_WS_170900040205_02_104309	20.0	12.3	7.7	38.4
HUC12 Name: Boulder Creek-McKenzie River	OR_WS_170900040206_02_104310	14.4	12.3	2.1	14.8
HUC12 Name: Elk Creek-South Fork McKenzie River	OR_WS_170900040301_02_104314	8.4	12.3	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: Cougar Creek-South Fork McKenzie River	OR_WS_170900040308_02_104321	15.0	16.3	0.0	0.0
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: 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: Straight Creek-North Santiam River	OR_WS_170900050202_02_104344	14.2	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: Whitewater Creek	OR_WS_170900050206_02_104348	14.1	18.3	0.0	0.0
HUC12 Name: Sauers Creek-North Santiam River	OR_WS_170900050208_02_104350	15.8	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: Upper Canyon Creek	OR_WS_170900060204_02_104370	17.6	16.3	1.3	7.6
HUC12 Name: Owl Creek	OR_WS_170900060205_02_104371	15.5	16.3	0.0	0.0
HUC12 Name: Lower Quartzville Creek	OR_WS_170900060305_02_104379	23.7	18.3	5.4	22.8
HUC12 Name: McKinney Creek	OR_WS_170900070203_02_104411	26.9	18.3	8.6	32.0
HUC12 Name: Lower Mill Creek	OR_WS_170900070204_02_104412	25.9	18.3	7.6	29.3
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: Glenn Creek-Willamette River	OR_WS_170900070303_02_104415	27.2	18.3	8.9	32.7
HUC12 Name: Canyon Creek	OR_WS_170900090601_02_104482	8.2	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: Last Creek-Pinhead Creek	OR_WS_170900110204_02_104526	10.4	16.3	0.0	0.0
HUC12 Name: Pot Creek-Clackamas River	OR_WS_170900110205_02_104527	10.1	16.3	0.0	0.0
HUC12 Name: Roaring River	OR_WS_170900110402_02_104535	24.0	16.3	7.7	32.1
HUC12 Name: Fish Creek	OR_WS_170900110403_02_104536	16.0	16.3	0.0	0.0
HUC12 Name: South Fork Clackamas River	OR_WS_170900110404_02_104537	12.8	16.3	0.0	0.0
HUC12 Name: North Fork Clackamas River	OR_WS_170900110405_02_104538	17.0	16.3	0.7	4.2
HUC12 Name: Helion Creek-Clackamas River	OR_WS_170900110406_02_104539	16.5	16.3	0.2	1.2
HUC12 Name: Upper Eagle Creek	OR_WS_170900110501_02_104540	17.7	16.3	1.4	8.0
HUC12 Name: North Fork Eagle Creek	OR_WS_170900110502_02_104541	12.8	16.3	0.0	0.0
HUC12 Name: Upper Clear Creek	OR_WS_170900110601_02_104543	13.1	16.3	0.0	0.0
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: 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: 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: 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: Balch Creek-Willamette River	OR_WS_170900120202_02_104555	21.8	18.3	3.5	15.9
HUC12 Name: Multnomah Channel	OR_WS_170900120305_02_104561	18.5	18.3	0.2	1.2

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 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

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

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

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

Table 9.1 Molalla-Pudding Subbasin: Molalla River, Pudding River, Silver Creek, Abiqua Creek, ~~and~~, Mill Creek human use allowance allocations.

Portion of Human Use Allowance (°C)	Source or source category
0.20*	NPDES point sources
0.00	Dam and reservoir operations
0.05	Water management activities and water withdrawals
0.02	Solar loading from existing transportation corridors, existing buildings, and existing utility infrastructure
0.00	Solar loading from other NPS sectors
0.03	Reserve capacity
0.30	**Total**
Note: * NPDES permitted point sources discharging to the Molalla River, Pudding River, Silver Creek, Abiqua Creek, and Mill Creek are allowed up to 0.20°C °cumulatively at the point of maximum impact. The portion of the human use allowance at the point of discharge is described in Table 9.7.	

Table 9.2 Clackamas Subbasin: Eagle Creek human use allowance allocations.

Portion of Human Use Allowance (°C)	Source or source category
0.20*	NPDES point sources
0.00	Dam and reservoir operations
0.05	Water management activities and water withdrawals
0.02	Solar loading from existing transportation corridors, existing buildings, and existing utility infrastructure
0.00	Solar loading from other NPS sectors
0.03	Reserve capacity
0.30	**Total**
Note: * USFW - Eagle Creek National Fish Hatchery is the only individual NPDES ~~permitted~~ point ~~sources~~source discharging to ~~the Molalla River, Pudding River, Silver Creek, Abiqua~~Eagle Creek~~, and Mill~~. As described in Table 9.7, USFW - Eagle Creek ~~are~~National Fish Hatchery is allowed up to 0.20°C ~~°~~at the point of discharge and cumulatively at the point of maximum impact.~~ The portion of the human use allowance at the point of discharge is described in Table 9.3.~~	

Table 9.3~~ Human Use Allowance~~: Upper Willamette Subbasin: Amazon Creek, Calapooia River, Camas Swale Creek, and Marys River human use allowance allocations~~ for all other waters in the Willamette Subbasins~~.

Portion of Human Use Allowance (°C)	Source or source category
0.15*	NPDES point sources

0.00	Dam and reservoir operations
0.05	Water management activities and water withdrawals
0.02	Solar loading from existing transportation corridors, existing buildings, and existing utility infrastructure
0.00	Solar loading from other NPS sectors
0.08	Reserve capacity
0.30	**Total**
NPDES point sourcesNote: * NPDES permitted point sources discharging to the Amazon Creek, Calapooia River, Camas Swale Creek, and Marys River are allowed up to 0.15°C °cumulatively at the point of maximum impact. The portion of the human use allowance at the point of discharge is described in Table 9.7.	

Table 9.4:Lower Willamette Subbasin: Columbia Slough and Mount Scott Creek human use allowance allocations.

Portion of Human Use Allowance (°C)	Source or source category
0.15*	NPDES point sources
0.00	Dam and reservoir operations
0.05	Water management activities and water withdrawals
0.02	Solar loading from existing transportation corridors, existing buildings, and existing utility infrastructure
0.00	Solar loading from other NPS sectors
0.08	Reserve capacity
0.30	**Total**
Note: * NPDES permitted point sources discharging to the Columbia Slough and Mount Scott Creek are allowed up to 0.15°C °cumulatively at the point of maximum impact. The portion of the human use allowance at the point of discharge is described in Table 9.7.	

Table 9.5:Middle Willamette Subbasin: Rickreall Creek human use allowance allocations.

Portion of Human Use Allowance (°C)	Source or source category
0.15*	NPDES point sources
0.00	Dam and reservoir operations
0.05	Water management activities and water withdrawals
0.02	Solar loading from existing transportation corridors, existing buildings, and existing utility infrastructure
0.00	Solar loading from other NPS sectors
0.08	Reserve capacity
0.30	**Total**
Note: * NPDES permitted point sources discharging to Rickreall Creek are allowed up to 0.15°C °cumulatively at the point of maximum impact. The portion of the human use allowance at the point of discharge is described in Table 9.7.	

Table 9.6 Human Use Allowance allocations for all other waters in the Willamette Subbasins

Portion of Human Use Allowance (°C)	Source or source category
0.075	NPDES point sources
0.00	Dam and reservoirs operations
0.05	Water management activities and water withdrawals
0.02	Solar loading from existing transportation corridors, existing buildings, and existing utility infrastructure
0.00	Solar loading from other nonpoint sectors
0.~~13~~155	Reserve capacity
0.30	**Total**

Note: * NPDES permitted point sources are allowed up to 0.~~10~~075°C cumulatively at the point of maximum impact. The portion of the human use allowance at the point of discharge is described in Table 9.~~3~~7.

9.1.1. Thermal wasteload allocations for point sources

Waste load allocations for the NPDES permitted point sources listed in Table 9.~~3~~7 were calculated using **Equation 2**.

The wasteload allocation for registrants under the general stormwater permits (MS4, 1200-A, 1200-C and 1200-Z) and general permit registrants not identified in Table 9.3 is equal to any existing thermal load authorized under the current permit. More specific wasteload allocations can be considered, if subsequent data and evaluation demonstrates a need and if capacity is available.

$$WLA = (\Delta T) \cdot (Q_E + Q_R) \cdot C_F$$ **Equation 2**

where,

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

$\Delta T =$ The maximum temperature increase (°C) above the applicable river temperature criterion using 100% of river flow not to be exceeded by each individual source from all outfalls combined. 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) covert 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 cubic feet per second (cfs): 2,446,665

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

The effluent discharge used to calculate the waste load allocations presented in Table 9.7 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. Average dry weather facility design flows were obtained from the current NPDES permits or permit evaluation reports.

Wasteload allocations in Table 9.~~3~~7 may be implemented in NPDES permits in any of the following ways: 1) incorporating the minimum wasteload allocation as a static numeric limit. Permit writers may recalculate the limit using ~~using~~ different values for 7Q10 (Q_R), and effluent flow (Q_E), if better estimates are available. 2) incorporating **Equation 2** directly into the permit with effluent flow (Q_E), river flow (Q_R), and the wasteload allocation (WLA) being dynamic and calculated on a daily basis.

Table 9.7 Thermal waste load allocations for point sources

NPDES Permittee WQ File# : EPA Number	Allocated Human Use Allowance (°C)	WLA period start	WLA period end	Annual 7Q10 River flow (cfs)	Effluent discharge (cfs)	Minimum WLA (kcals/day)
Albany Water Treatment Plant 66584 : ORG383501~~Arclin 16037 : OR0021857~~	0.~~10~~075	5/1	10/31	~~0~~24	~~1.55~~0.77	~~378,555~~4,545,955
~~Forrest Paint Co. 100684 : ORG253508~~Alpine Community 100101 : OR0032387	0.~~05~~00	5/1	10/31	0.4	0.~~77~~03	~~94,639~~0
~~Georgia-Pacific Chemicals LLC 32864 : OR0002101~~Americold Logistics, LLLC 87663 : ORG253544	0.~~00~~075	5/1	10/31	0	0.~~0~~77	~~0~~141,958
Arclin 16037 : OR0021857	0.075	5/1	10/31	0	1.55	283,916
~~SFPP 103159 : OR0044661~~Arclin 81714 : OR0000892	0.~~05~~075	5/1	10/31	0.0	0.~~02~~93	~~2,839~~170,350
ATI Albany Operations 64300 : OR0001716~~J.H. Baxter & Co 6553 : OR0021911~~	0.~~10~~075	5/1	10/31	~~0.6~~1.4	0.~~12~~46	~~175,909~~342,075
Aumsville STP 4475 : OR0022721	0.00	5/1	10/31	0.7	0.52	0
Aurora STP 110020 : OR0043991~~Albany Water Treatment Plant 66584 : ORG383501~~	0.~~10~~00	5/1	10/31	~~24~~10.1	0.~~77~~1	~~6,061,274~~0

Blount Oregon Cutting Systems Division 63545 : OR0032298	0.075	5/1	10/31	0	0.19	34,070
Boeing Of Portland - Fabrication Division 9269 : OR0031828	0.075	5/1	10/31	0	0.46	85,175
Brownsville STP 11770 : OR0020079	0.00	5/1	10/31	14.4	0.0	0
City of Silverton Drinking WTP 81398 : ORG383527~~Tangent STP 87425 : OR0031917~~	0.~~00~~20	5/1	10/31	~~20.3~~5	0.~~17~~095	~~0~~2,493,152
Coburg Wastewater Treatment Plant 115851 : OR0044628	0.075	5/1	10/31	0	0.68	124,923
Coffin Butte Landfill 104176 : OR0043630	0.075	5/1	10/31	0	0.0	0.0
Columbia Helicopters 100541 : OR0033391	0.075	5/1	10/31	0	0.01	2,129
Corvallis Rock Creek WTP 20160 : ORG383513	0.075	5/1	10/31	0	0.77	141,958
Creswell STP 20927 : OR0027545	0.00	5/1	10/31	0	0.31	0
Dallas STP 22546 : OR0020737~~Foster Farms 97246 : OR0026450~~	0.~~00~~075	5/1	10/31	~~0~~4.2	3.09~~0.0~~	~~0~~1,338,532
Dallas WTP 22550 : ORG383529	0.075	5/1	10/31	3.3	0.77	747,508
Duraflake 97047 : OR0000426	0.075	5/1	10/31	0	0.55	101,317
Estacada STP 27866 : OR0020575	0.~~05~~075	5/1	10/31	317	0.84	~~38,881,850~~58,322,775
EWEB Carmen-Smith (Outfalls 001A and 001B) 28393 : OR0000680	0.075	5/1	10/31	146	2.68	27,282,157
EWEB Carmen-Smith (Outfalls 002A and 002B) 28393 : OR0000680	0.075	5/1	10/31	497.5	0.93	91,461,538
~~Timberlake~~Falls City STP ~~90948 : OR0023167~~ 28830 : OR0032701	0.~~05~~00	5/1	10/31	~~254~~5.34	0.~~22~~0	~~31,099,901~~0
~~Americold Logistics, LLLC 87663 : ORG253544~~First Premier Properties 110603 : ORG253511	0.~~10~~075	5/1	10/31	0	0.77	~~189,278~~141,958
Forrest Paint Co. 100684 : ORG253508	0.075	5/1	10/31	0	0.77	141,958
Foster Farms 97246 : OR0026450	0.00	5/1	10/31	0	0.0	0

Fujimi Corporation - SW Commerce Circle 107178 : OR0040339	0.~~10~~075	5/1	10/31	0	0.2	~~47,221~~35,415
Georgia-Pacific Chemicals LLC 32864 : OR0002101	0.075	5/1	5/31	0	0.0	0
	0.00	6/1	10/31	0	0.0	0
Gervais STP 33060 : OR0027391	0.00	5/1	10/31	7.3	0.34	0
GP Millersburg Resin Plant 32650 : OR0032107	0.00	5/1	10/31	0	0.0	0
Halsey STP 36320 : OR0022390	0.00	5/1	10/31	5.0	0.30	0
Herbert Malarkey Roofing Company 52638 : ORG250024	0.~~10~~075	5/1	10/31	0	0.77	~~189,278~~141,958
Holiday Retirement Corp 108298 : ORG253504	0.075	5/1	10/31	0	0.77	141,958
Hubbard STP 40494 : OR0020591	0.00	5/1	10/31	0	0.53	0
Hull-Oakes Lumber Co. 107228 : OR0038032	0.075	5/1	10/31	0	0.08	14,196
~~Portland~~ International ~~Airport~~ ~~107220 : OR0040291~~Paper - Springfield (Outfall 003)** 96244 : OR0000515	0.~~00~~075	5/1	10/31	0	~~0.0~~3.09	~~0~~567,833
~~Seneca Sawmill Company~~ ~~80207 : OR0022985~~	~~0.00~~	~~5/1~~	~~10/31~~	~~0~~	~~1.19~~	~~0~~
J.H. Baxter & Co 6553 : OR0021911~~USFW - Eagle Creek National Fish Hatchery~~ ~~91035 : OR0000710~~	0.~~20*~~075	5/1	10/31	~~21.3~~0.6	~~52.6~~0.12	131,932~~36,161,709~~
~~Norpac Foods - Brooks Plant No. 5~~ ~~84791 : OR0021261~~JLR 32536 : OR0001015	0.~~00~~01	5/1	10/31	~~0~~6.7	0.~~0~~5	176,160~~0~~
Junction City STP 44509 : OR0026565	0.00	5/1	10/31	0	0.0	0
Kingsford Manufacturing Company - Springfield Plant 46000 : OR0031330~~ODFW - Marion Forks Hatchery~~ ~~64495 : OR0027847~~	0.~~10*~~075	5/1	~~10~~5/31	~~6.3~~0	~~18.6~~0.08	~~6,082,409~~14,680

~~Row River Valley Water District 100075 : ORG383534~~	~~0.10~~	~~5/1~~	~~10/31~~		~~0.77~~	~~189,278~~
~~Falls City STP 28830 : OR0032701~~	~~0.00~~	~~5/1~~	~~10/31~~	~~5.34~~	~~0.0~~	~~0~~
~~Sherman Bros. Trucking 36646 : OR0021954~~	~~0.00~~	~~5/1~~	~~10/31~~	~~0.2~~	~~0.02~~	~~0~~
~~Veneta STP 92762 : OR0020532~~	~~0.10~~	~~5/1~~	~~10/31~~	~~6.3~~	~~0.81~~	~~1,739,762~~
~~Corvallis Rock Creek WTP 20160 : ORG383513~~	~~0.05~~	~~5/1~~	~~10/31~~		~~0.77~~	~~94,639~~
~~Philomath WTP 100048 : ORG383536~~	~~0.05~~	~~5/1~~	~~10/31~~	~~11~~	~~0.77~~	~~1,440,305~~
~~Philomath WWTP 103468 : OR0032441~~	0.00	~~5~~6/1	10/31	~~6.6~~0	0.0	0
~~EWEB Carmen-Smith 28393 : OR0000680~~	~~0.10~~	~~5/1~~	~~10/31~~	~~500.6~~	~~3.61~~	~~123,362,083~~
~~Oakridge STP 62886 : OR0022314~~	~~0.10~~	~~5/1~~	~~10/31~~	~~449.8~~	~~0.73~~	~~110,228,913~~
~~Sunstone Circuits 26788 : OR0031127~~	~~0.04~~	~~5/1~~	~~10/31~~	~~10.5~~	~~0.065~~	~~1,033,961~~
~~Hubbard STP 40494 : OR0020591~~Knoll Terrace Mhc 46990 : OR0026956	0.00	5/1	10/31	0	0.~~53~~09	0
Lakewood Utilities, Ltd 96110 : OR0027570	0.00	5/1	10/31	0	0.0	0
Lane Community College 48854 : OR0026875~~Norpac Foods-Plant #1, Stayton 84820 : OR0001228~~	0.~~05~~00	5/1	10/31	0	~~6.19~~0.22	~~757,110~~0
~~ODC - Oregon State Penitentiary 109727 : OR0043770~~Mcfarland Cascade Pole & Lumber Co 54370 : OR0031003	0.~~05~~00	5/1	10/31	~~6.53~~0	~~2.48~~0.0	~~1,101,680~~0
Miller Paint Co Inc 103774 : ORG250040	0.075	5/1	10/31	0	0.77	141,958
Molalla Municipal Drinking WTP 109846 : ORG380014	0.02	5/1	10/31	55.5	0.08	~~3,915~~2,719,713
Molalla STP 57613 : OR0022381	0.10	5/1	10/31	55.8	3.46	14,498,083

Blount Oregon Cutting Systems Division 63545 : OR0032298	0.05	5/1	10/31	0	0.19	22,713
PCC Structurals, Inc. 71920 : ORG250015	0.05	5/1	10/31	0	0.77	94,639
Knoll Terrace Mhc 46990 : OR0026956	0.00	5/1	10/31	0	0.09	0
Alpine Community 100101 : OR0032387	0.00	5/1	10/31	0.4	0.03	0
Coburg Wastewater Treatment Plant 115851 : OR0044628	0.10	5/1	10/31	0	0.68	166,564
Halsey STP 36320 : OR0022390	0.00	5/1	10/31	5.0	0.30	0
Duraflake 97047 : OR0000426	0.05	5/1	10/31	0	0.55	67,544
GP Millersburg Resin Plant 32650 : OR0032107	0.00	5/1	10/31	0	0.0	0
Westfir STP 94805 : OR0028282	0.10	5/1	10/31	174	0.05	42,583,328
WES - Boring STP 16592 : OR0031399	0.10	5/1	10/31	0.65	0.03	166,373
ATI Albany Operations 64300 : OR0001716	0.10	5/1	10/31	1.4	0.46	456,100
Hull-Oakes Lumber Co. 107228 : OR0038032	0.10	5/1	10/31	0	0.08	18,928
Boeing Of Portland - Fabrication Division 9269 : OR0031828	0.10	5/1	10/31	0	0.46	113,567
Kingsford Manufacturing Company - Springfield Plant 46000 : OR0031330	0.10	5/1	10/31	0	0.08	19,573
Aurora STP 110020 : OR0043991	0.00	5/1	10/31	10.1	0.1	0
Gervais STP 33060 : OR0027391	0.00	5/1	10/31	7.3	0.34	0
JLR 32536 : OR0001015	0.01	5/1	10/31	6.7	0.5	176,160
Mt. Angel STP 58707 : OR0028762	0.00	5/1	10/31	7.3	0.87	0
Murphy Veneer, Foster Division 97070 : OR0021741	0.075	5/1	10/31	4.2	1.11	974,267
Norpac Foods - Brooks Plant No. 5 84791 : OR0021261	0.00	5/1	10/31	0	0.0	0

Norpac Foods- Plant #1, Stayton 84820 : OR0001228Woodburn WWTP 98815 : OR0020001	0.20075	5/1	10/31	6.70	7.796.19	1,135,6657,092,094
DallasOakridge STP 62886 : OR002231422546 : OR0020737	0.10075	5/1	10/31	449.84.2	0.733.09	1,784,70982,671,684
ODC - Oregon State Penitentiary 109727 : OR0043770	0.075	5/1	10/31	6.53	2.48	1,652,520
ODFW - Marion Forks Hatchery 64495 : OR0027847Dallas WTP 22550 : ORG383529	0.10075*	5/1	10/31	36.3	18.60.77	996,6774,561,807
Coffin Butte Landfill 104176 : OR0043630	0.10	5/1	10/31	0	0.0	0.0
ODFW - Roaring River Hatchery 64525 : ORG133506	0.10075*	5/1	10/31	0.5	14.2	3,596,5982,697,448
Lane Community College 48854 : OR0026875	0.00	5/1	10/31	0	0.22	0
ODFW - Willamette Fish Hatchery 64585 : ORG133507	0.10075*	5/1	10/31	110	79.0	46,241,96934,681,476
Owens-Brockway Glass Container Inc. 65610 : ORG250029	0.075	5/1	10/31	0	0.77	141,958
PCC Structurals, Inc. 71920 : ORG250015	0.075	5/1	10/31	0	0.77	141,958
City of Silverton Drinking WTP Philomath WTP 100048 : ORG38353681398 : ORG383527	0.20075	5/1	10/31	56.55	0.09577	2,493,1521,343,882
Philomath WWTP 103468 : OR0032441	0.00	5/1	10/31	6.6	0.0	0
Portland International Airport 107220 : OR0040291	0.00	5/1	10/31	0	0.0	0
Row River Valley Water District 100075 : ORG383534	0.075	5/1	10/31	11.5	0.77	2,252,207
RSG Forest Products – Liberal 72596 : OR0021300	0.16	5/1	10/31	0	1.24	484,550
Sandy WWTP 78615 : OR0026573	0.00	5/1	10/31	0	0.00	0

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	4,259
Sherman Bros. Trucking 36646 : OR0021954	0.00	5/1	10/31	0.2	0.02	0
Silverton STP 81395 : OR0020656	0.20	5/1	10/31	14	3.87	8,743,437
~~Mcfarland Cascade Pole & Lumber Co 54370 : OR0031003~~	~~0.00~~	~~5/1~~	~~10/31~~	~~0~~	~~0.0~~	~~0~~
Sundance Lumber Company, Inc. 107401 : ORG253618	0.~~10~~075	5/1	10/31	0	0.77	~~189,278~~141,958
Sunstone Circuits 26788 : OR0031127	0.04	5/1	10/31	10.5	0.065	1,033,961
Tangent STP 87425 : OR0031917	0.00	5/1	10/31	20.3	0.17	0
Timberlake STP 90948 : OR0023167	0.075	5/1	10/31	254	0.22	46,649,852
USFW - Eagle Creek National Fish Hatchery 91035 : OR0000710	0.20*	5/1	10/31	21.3	52.6	36,161,709
~~Scio~~Veneta STP ~~79633 : OR0029301~~ 92762 : OR0020532	0.~~00~~075	5/1	10/31	6.~~9~~3	0.~~14~~81	~~0~~1,304,821
~~Sandy WWTP 78615 : OR0026573~~Veneta STP 92762 : OR0020532	0.00	5/1	10/31	~~0~~6.3	0.00	0
~~Arclin 81714 : OR0000892~~	~~0.10~~	~~5/1~~	~~10/31~~	~~0.0~~	~~0.93~~	~~227,133~~
~~First Premier Properties 110603 : ORG253511~~Ventura Foods, LLLC 103832 : ORG250005	0.~~10~~075	5/1	10/31	0	0.77	~~189,278~~141,958
~~Holiday Retirement Corp 108298 : ORG253504~~WES - Boring STP 16592 : OR0031399	0.~~10~~075	5/1	10/31	0.65	0.~~77~~03	~~189,278~~124,780
~~RSG Forest Products - Liberal 72596 : OR0021300~~Westfir STP 94805 : OR0028282	0.~~16~~075	5/1	10/31	~~0~~174	~~1.24~~0.05	31,937,496~~484,550~~
~~Columbia Helicopters 100541 : OR0033391~~	~~0.10~~	~~5/1~~	~~10/31~~	~~0~~	~~0.01~~	~~2,839~~

Willamette Leadership Academy 34040 : OR0027235	0.00	5/1	10/31	0	0.01	0
Woodburn WWTP 98815 : OR0020001~~Murphy Veneer, Foster Division 97070 : OR0021741~~	0.~~10~~20	5/1	10/31	~~4.2~~6.7	~~1.11~~7.79	7,092,094~~1,299,023~~
~~Hydro Extrusion Portland, Inc. 3060 :~~	~~0.10~~	~~5/1~~	~~10/31~~	~~0~~	~~0.77~~	~~189,278~~
~~Miller Paint Co Inc 103774 : ORG250040~~	~~0.10~~	~~5/1~~	~~10/31~~	~~0~~	~~0.77~~	~~189,278~~
~~Owens-Brockway Glass Container Inc. 65610 : ORG250029~~	~~0.10~~	~~5/1~~	~~10/31~~	~~0~~	~~0.77~~	~~189,278~~
~~Ventura Foods, LLLC 103832 : ORG250005~~	~~0.10~~	~~5/1~~	~~10/31~~	~~0~~	~~0.77~~	~~189,278~~

Notes: WLA = waste load 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.
** Allocation applies to Outfall 003 only. Outfalls 001 and 002 are addressed in the 2006 Willamette Basin TMDL.

The effluent discharge used to calculate the waste load allocations presented in Table 9.3 are typically based on the average dry weather facility design flow, the maximum effluent discharge characterized from discharge monitoring reports, or assumed maximum values. Average dry weather facility design flows were obtained from the current NPDES permit or permit evaluation reports. More information on the specific source of the effluent discharge flow is described in the technical support document.

9.1.2. Thermal load allocations for nonpoint sources

Load allocations for nonpoint sources were calculated using Equation 3.

$$LA = (\Delta T) \cdot (Q_R) \cdot C_F \qquad \textbf{Equation 3}$$

where,

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

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

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

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

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

Table 9.4 presents the minimum load allocation for background sources on temperature impaired category 5 assessment units that were modeled for the TMDL analysis.

The load allocations to background sources presented in Table 9.4 were calculated based on the 7Q10 low river flows and the minimum applicable criterion in the respective assessment units. Equation 3 may be used to calculate the load allocations when river flows are greater than 7Q10 or at other locations in the Willamette Subbasins.

The allocated portion of the human use allowance (ΔT) presented in Table 9.1 through ~~Table 9.2~~Table 9.6 and Equation 3 shall be used to calculate the load allocation for other nonpoint source or source category for any assessment unit in the Willamette Subbasins.

Equation 3 may also be used to calculate the load allocations for anthropogenic and background nonpoint sources if in the future the applicable temperature criteria are updated and approved by EPA.

Table 9.8 Thermal load allocations for background sources.

AU Name and AU ID	Annual 7Q10 (cfs)	Applicable criterion (°C)	LA period start	LA period end	Minimum Loading Capacity Non-Spawning (kilocalories/day)	Minimum Loading Capacity Spawning (kilocalories/day)
Mosby Creek OR_SR_1709000201_02_103752	10.7	16.0 13.0	5/1	10/31	418,869,048	340,331,102
Coyote Creek OR_SR_1709000301_02_103796	5.9	18.0	5/1	10/31	259,835,823	NA
Luckiamute River OR_SR_1709000305_02_103829	15.9	18.0 13.0	5/1	10/31	699,711,975	505,347,537
Mohawk River OR_SR_1709000406_02_103871	15.7	16.0 13.0	5/1	10/31	612,728,347	497,841,782
Little North Santiam River OR_SR_1709000505_02_104564	19.5	16.0 13.0	5/1	10/31	762,091,245	619,199,137
Crabtree Creek OR_SR_1709000606_02_103978	25.4	16.0 13.0	5/1	10/31	994,324,656	807,888,783
Thomas Creek OR_SR_1709000607_02_103988	6.9	18.0	5/1	10/31	302,179,054	NA
Molalla River OR_SR_1709000904_02_104086	38.1	16.0 13.0	5/1	10/31	1,491,486,984	1,211,833,175
Pudding River OR_SR_1709000905_02_104088	10.4	18.0	5/1	10/31	459,371,266	NA
Johnson Creek OR_SR_1709001201_02_104170	11.1	18.0 13.0	5/1	10/31	489,182,033	353,298,135

9.1.2.1. Surrogate Measures

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

9.1.2.1.1. Dam and reservoir operations

Dam and reservoir operations have been allocated 0.0 °C of the human use allowance (Table 9.1 through Table 9.6.) and the equivalent load allocation as calculated using Equation 3. Monitoring stream temperature, rather than a thermal load, is often a more useful and meaningful approach for reservoir management. For this reason, DEQ is using a surrogate measure to implement the load allocation for dam and reservoir operations. OAR 340-042-0028(12)(a) states that anthropogenic sources are only responsible for controlling the thermal effects of their own discharge or activity in accordance with its overall heat contribution. For dam and reservoir operations, the minimum duties provision means that when 7-day average daily maximum temperatures upstream of the reservoirs exceed the applicable temperature criteria the dam and reservoir operations must not contribute any additional warming above and beyond those upstream temperatures entering the reservoir. DEQ has developed the following surrogate measure temperature approach to implement the load allocation. The 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 the warmer of either:

a) The 7DADM temperatures immediately upstream of the reservoirs plus any warming or cooling that would occur through the reservoir reaches absent the dam and reservoir operations. 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. With DEQ approval, the estimated free flowing (no dam) temperatures may also be calculated using a model.

b) The applicable temperature criteria immediately downstream of the dam. If the applicable temperature criteria immediately downstream of the dam are updated and approved by EPA, the updated criteria shall be used instead.

~~9.1.2.1.1.~~9.1.2.1.2. Site specific effective shade surrogate measure

Effective shade surrogate measure targets shown in Table 9.5, Table 9.6, and Table 9.7 represent the arithmetic mean of the shade values at all model nodes assigned to each designated management agency (**Equation 4**). Following the process and methods outlined in the water quality management plan, current or target site specific shade values shall be calculated using **Equation 4**. Changes in the target effective shade from the values presented in Table 9.5, Table 9.6, and Table 9.7 may result in redistribution of the sector or source responsible for excess load reduction. If the shade target increases, the equivalent portion of the excess load is reassigned from background sources to nonpoint sources. If the shade target decreases, the portion of the excess load is reassigned from nonpoint sources to background sources. The exact portion reassigned can only be determined in locations where temperature models have been developed. In locations without temperature models, the reassignment remains unquantified. Changes to the target effective shade do not impact the loading capacity, human use allowance, or the load allocations. They remain the same as presented in this TMDL.

$$\overline{ES} = \frac{\sum ES_{n_i}}{n_i} \qquad \textbf{Equation 4}$$

Where,

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

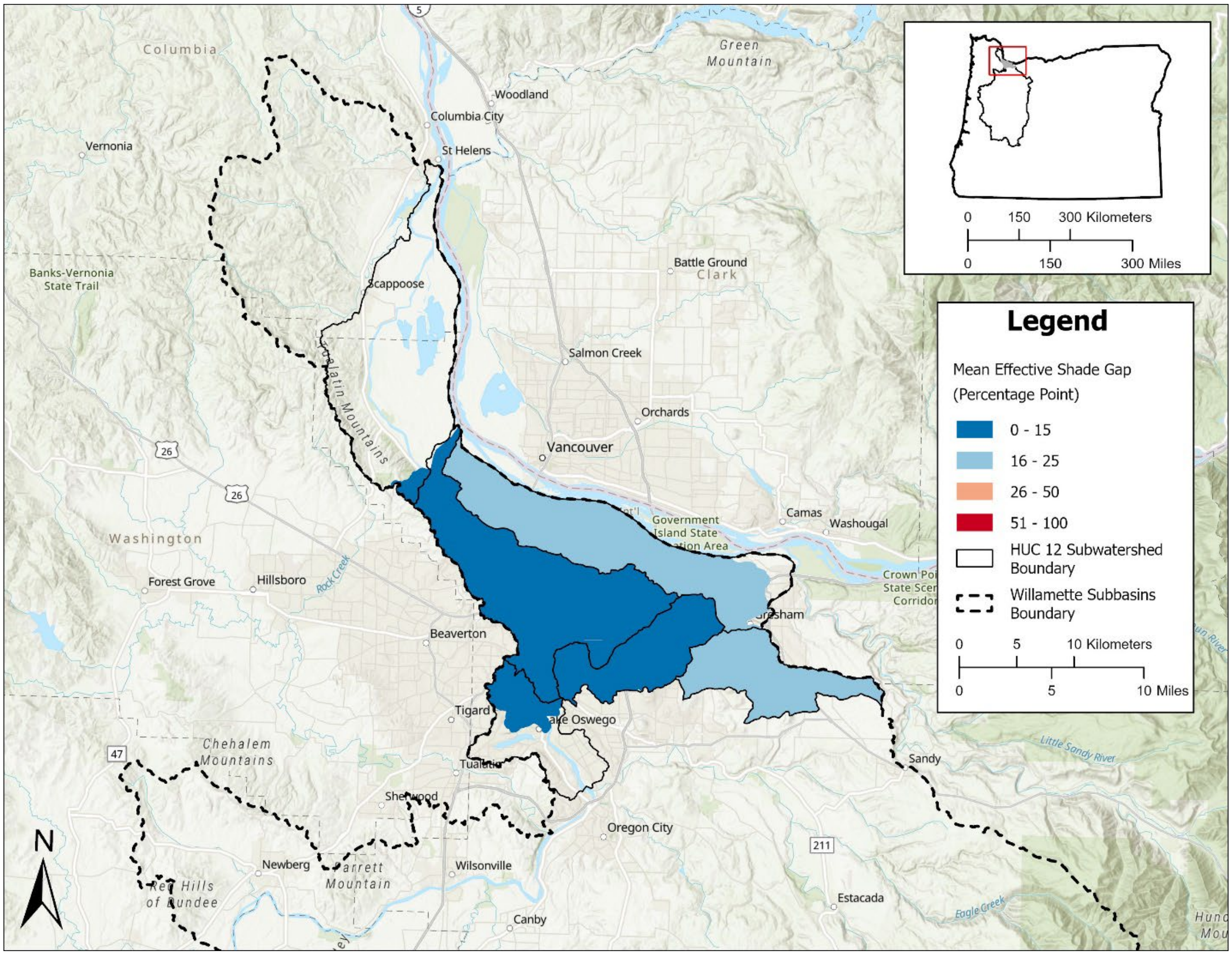


Figure 9.1 Lower Willamette Subbasin model area and mean effective shade gap for each HUC12 subwatershed within the model extent.

Table 9.9 Effective shade surrogate measure targets to meet nonpoint source load allocations for designated management agencies in the Lower Willamette Subbasin model area.

Designated Management Agency	Total Kilometers Assessed	Assessed Effective Shade	TMDL Target Effective Shade	Shade Gap
BNSF	0.1	35	42	7
City of Fairview	0.1	21	54	33
City of Gresham	16	63	81	18
City of Happy Valley	0.8	79	90	11
City of Lake Oswego	5.8	83	90	7
City of Milwaukie	2.9	62	80	18
City of Portland	127.4	61	73	12
Clackamas County	13.3	66	86	20
Multnomah County	9.7	75	90	15
Oregon Department of Agriculture	13.5	65	85	20

Designated Management Agency	Total Kilometers Assessed	Assessed Effective Shade	TMDL Target Effective Shade	Shade Gap
Oregon Department of Forestry - Private	6.6	89	92	3
Oregon Parks and Recreation Department	0.1	91	91	0
Port of Portland	2.1	29	45	16
Portland & Western Railroad	<0.1	82	89	7
Roads	3.1	54	77	23
Union Pacific Railroad	0.1	34	62	28

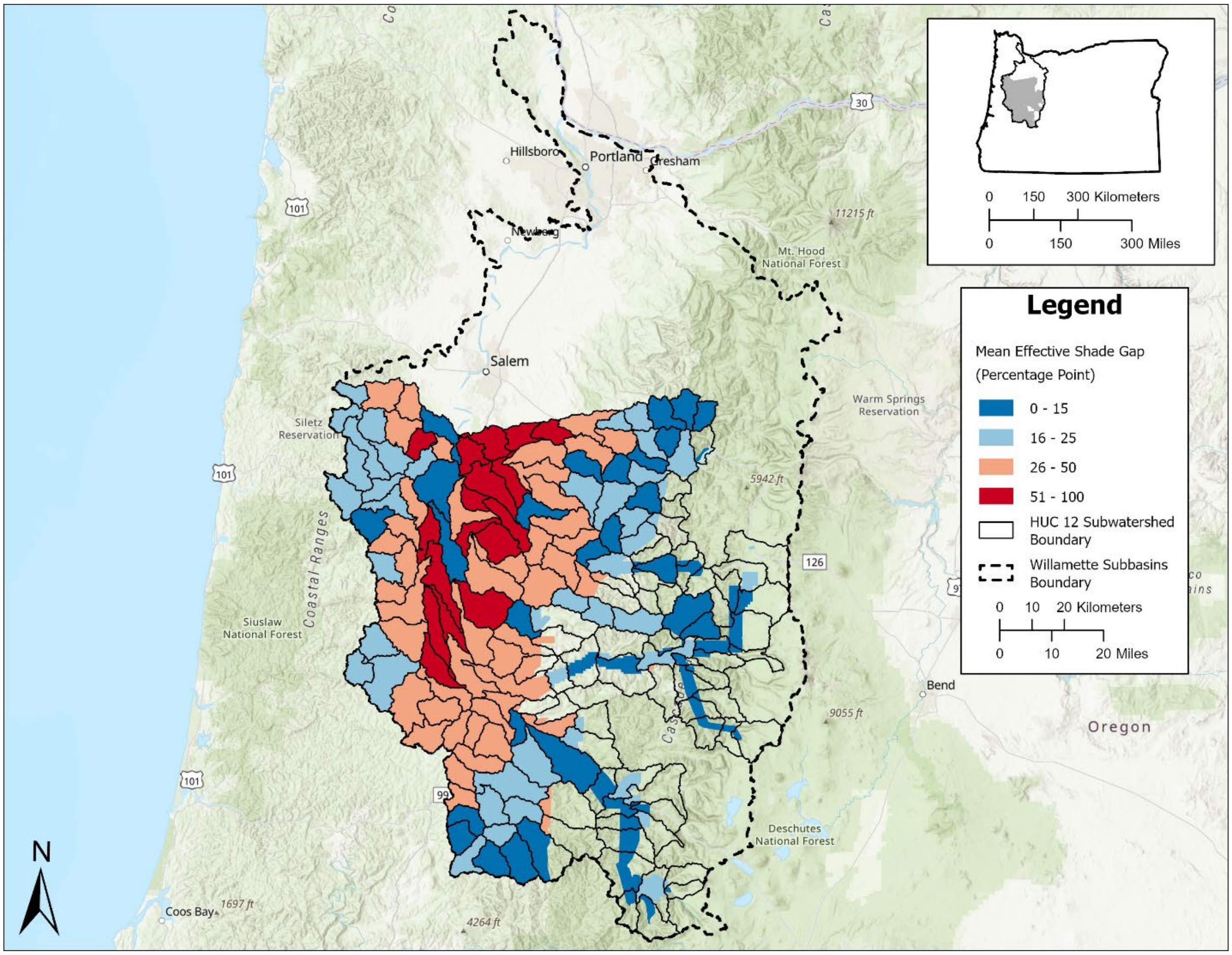


Figure 9.2 Southern Willamette model area and mean effective shade gap for each HUC12 subwatershed within the model extent.

Table 9.10 Shade surrogate measure targets to meet nonpoint source load allocations for designated management agencies in the in the Southern Willamette model area.

Designated Management Agency	Total Kilometers Assessed	Assessed Effective Shade	TMDL Target Effective Shade	Shade Gap
Albany & Eastern Railroad	0.1	96	97	1
Benton County	119.3	59	89	30
Bonneville Power Administration	2.3	35	94	59
Central Oregon & Pacific Railroad	0.2	8	86	78
City of Adair Village	2	29	93	64
City of Albany	47.7	37	76	39
City of Brownsville	4	29	67	38
City of Coburg	2.8	22	91	69
City of Corvallis	63.8	60	87	27
City of Cottage Grove	6.2	40	85	45
City of Creswell	4.6	19	91	72
City of Eugene	128.8	30	84	54
City of Falls City	9	57	97	40
City of Gates	4.7	37	85	48
City of Halsey	1.6	8	87	79
City of Harrisburg	0.8	3	88	85
City of Jefferson	3.2	23	82	59
City of Junction City	11.6	10	86	76
City of Lebanon	16.2	39	85	46
City of Lowell	2.7	34	90	56
City of Lyons	2.3	33	88	55
City of Mill City	2.9	18	76	58
City of Millersburg	17.2	27	78	51
City of Monmouth	0.5	82	89	7
City of Monroe	1.2	27	75	48
City of Oakridge	9.2	29	75	46
City of Philomath	7.6	38	88	50
City of Salem	0.8	25	45	20
City of Scio	1.7	53	59	6
City of Springfield	42.3	33	88	55
City of Stayton	3.9	43	86	43
City of Sweet Home	26.2	35	87	52
City of Tangent	10.9	50	82	32
City of Veneta	8.7	52	95	43
City of Waterloo	0.4	51	94	43
City of Westfir	3.1	30	80	50
Lane County	718.8	53	89	36
Lincoln County	0.2	9	96	87
Linn County	180.7	44	88	44
Marion County	49	44	78	34
Oregon Department of Agriculture	4790.6	33	86	53
Oregon Department of Aviation	0.2	1	92	91
Oregon Department of Fish and Wildlife	13.8	38	73	35
Oregon Department of Forestry - Private	8597.7	71	96	25
Oregon Department of Forestry - Public	526.6	87	97	10
Oregon Department of Geology and Mineral Industries	5	41	93	52
Oregon Department of State Lands	1.4	55	82	27
Oregon Department of Transportation	52.8	37	80	43
Oregon Military Department	0.2	0	86	86
Oregon Parks and Recreation Department	27.8	50	72	22

Designated Management Agency	Total Kilometers Assessed	Assessed Effective Shade	TMDL Target Effective Shade	Shade Gap
Polk County	64.9	52	93	41
Port of Coos Bay	1.9	58	94	36
Portland & Western Railroad	1.9	48	74	26
State of Oregon	2.5	64	68	4
U.S. Army Corps of Engineers	73.4	61	82	21
U.S. Bureau of Land Management	2569.5	90	97	7
U.S. Department of Agriculture	0.8	36	54	18
U.S. Department of Defense	1.5	49	85	36
U.S. Fish and Wildlife Service	39.7	49	77	28
U.S. Forest Service	2973.9	85	96	11
U.S. Government	10.1	62	84	22
Union Pacific Railroad	5.4	66	90	24

Table 9.11 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
Pudding River	85.55	44	52	8
Molalla River	75.36	27	41	14

~~Designated Management Agency~~	~~Stream Name~~	~~Current Shade~~	~~TMDL Target~~	~~Shade Gap~~
~~Clackamas County~~	~~Salmon River~~	~~24~~	~~37~~	~~13~~
~~Oregon Department of Forestry - Private~~	~~Salmon River~~	~~26~~	~~40~~	~~14~~
~~Oregon Department of Transportation~~	~~Salmon River~~	~~10~~	~~48~~	~~38~~
~~U.S. Bureau of Land Management~~	~~Salmon River~~	~~26~~	~~35~~	~~9~~
~~U.S. Forest Service~~	~~Salmon River~~	~~49~~	~~59~~	~~10~~
~~*Water*~~	~~*Salmon River*~~	~~*26*~~	~~*40*~~	~~*14*~~
~~City of Portland~~	~~Sandy River~~	~~8~~	~~12~~	~~4~~
~~City of Sandy~~	~~Sandy River~~	~~23~~	~~25~~	~~2~~
~~City of Troutdale~~	~~Sandy River~~	~~13~~	~~18~~	~~5~~
~~Clackamas County~~	~~Sandy River~~	~~18~~	~~27~~	~~9~~
~~Multnomah County~~	~~Sandy River~~	~~16~~	~~19~~	~~3~~
~~Oregon Department of Agriculture~~	~~Sandy River~~	~~24~~	~~28~~	~~4~~
~~Oregon Department of Fish and Wildlife~~	~~Sandy River~~	~~22~~	~~26~~	~~4~~
~~Oregon Department of Forestry - Private~~	~~Sandy River~~	~~19~~	~~23~~	~~4~~
~~Oregon Parks and Recreation Department~~	~~Sandy River~~	~~6~~	~~7~~	~~1~~

~~Port of Portland~~	~~Sandy River~~	~~3~~	~~9~~	~~6~~
~~State of Oregon~~	~~Sandy River~~	~~13~~	~~17~~	~~4~~
~~U.S. Bureau of Land Management~~	~~Sandy River~~	~~25~~	~~29~~	~~4~~
~~U.S. Forest Service~~	~~Sandy River~~	~~3~~	~~6~~	~~3~~
~~U.S. Government~~	~~Sandy River~~	~~16~~	~~18~~	~~2~~

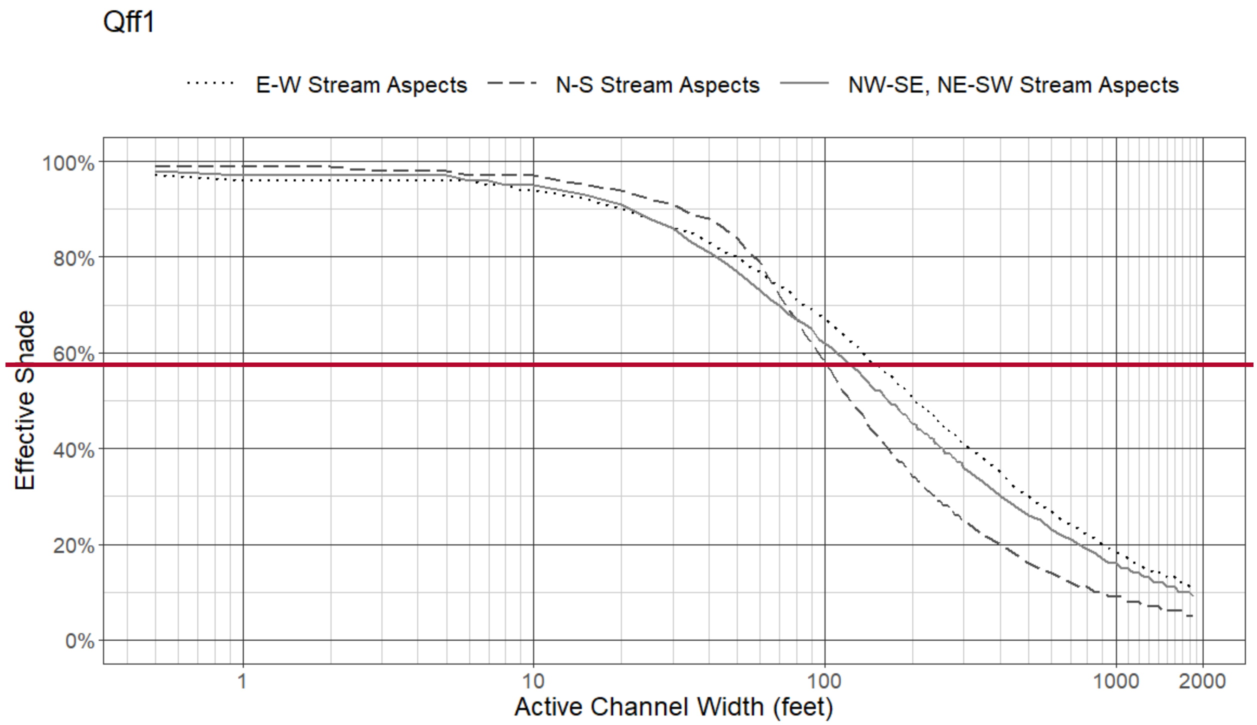
9.1.2.1.1. Effective shade curve surrogate measure

Effective shade curves are applicable to any stream that does not have site specific shade targets (Section 9.1.2.1.1). Effective shade curves represent the maximum possible effective shade for a given vegetation type. The values presented within the effective shade curves (Figure 9.1 to Figure 9.22) 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 9.8. See the technical support document, for additional details on the methodologies used to determine vegetation characteristics. ~~The technical support document~~Section 12 provides tables of the plotted shade curve values.

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 9.12. 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 (feet)	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



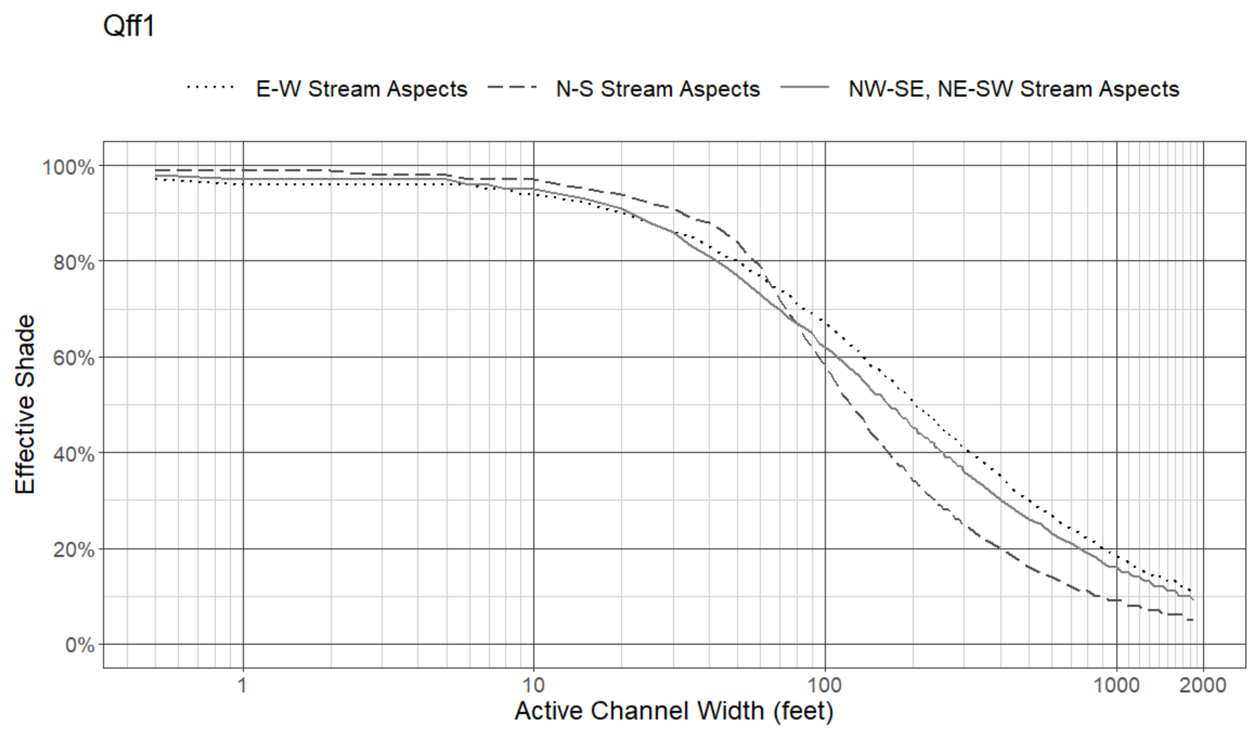
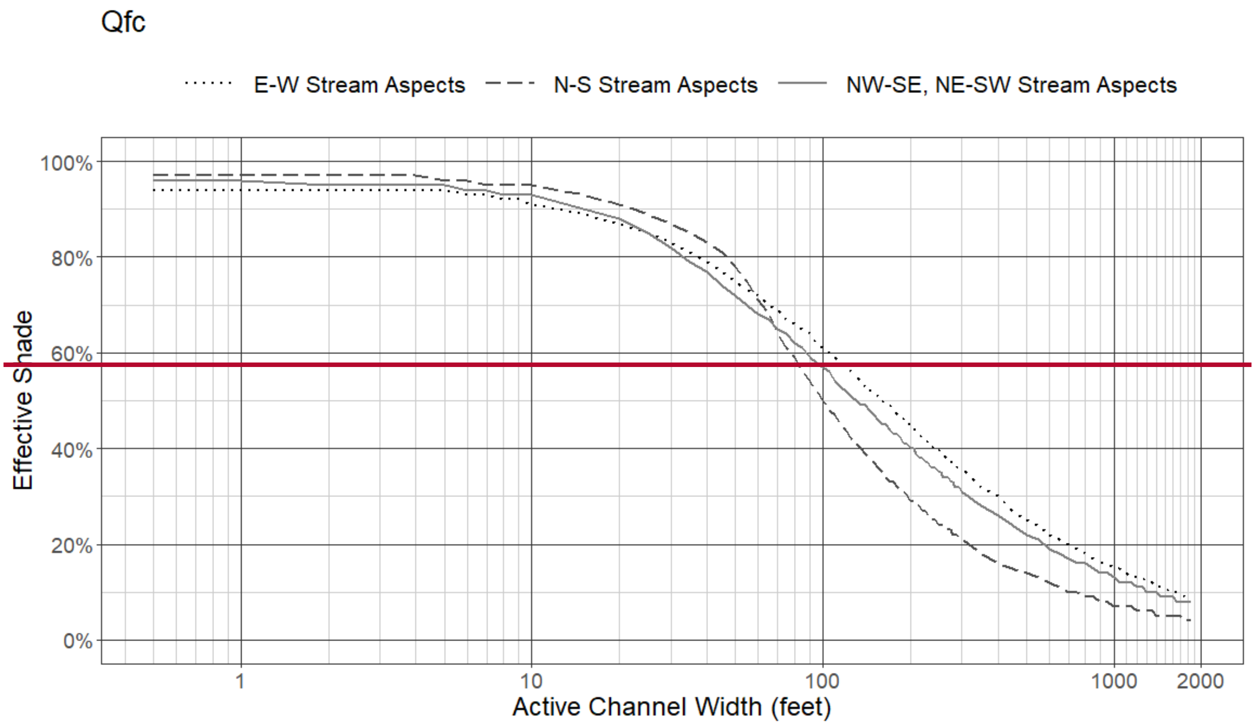


Figure 9.3 Effective shade targets for stream sites in the Qff1 mapping unit.



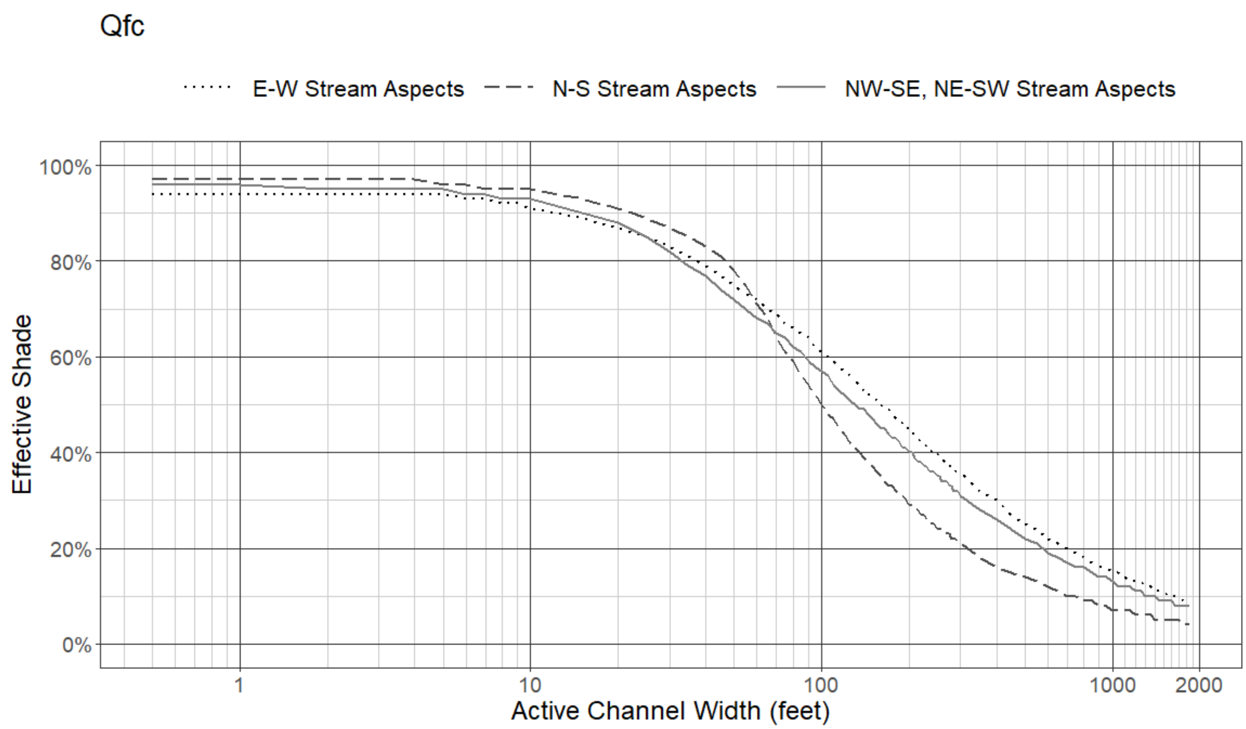
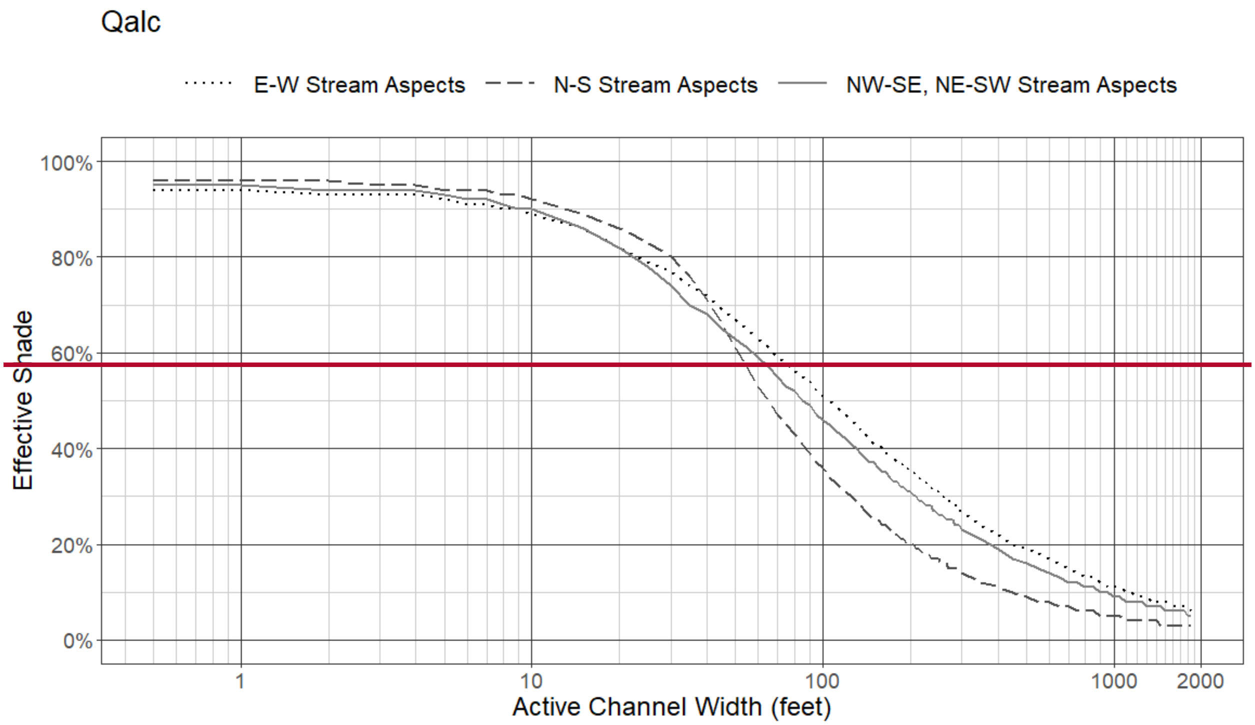


Figure 9.4 Effective shade targets for stream sites in the Qfc mapping unit.



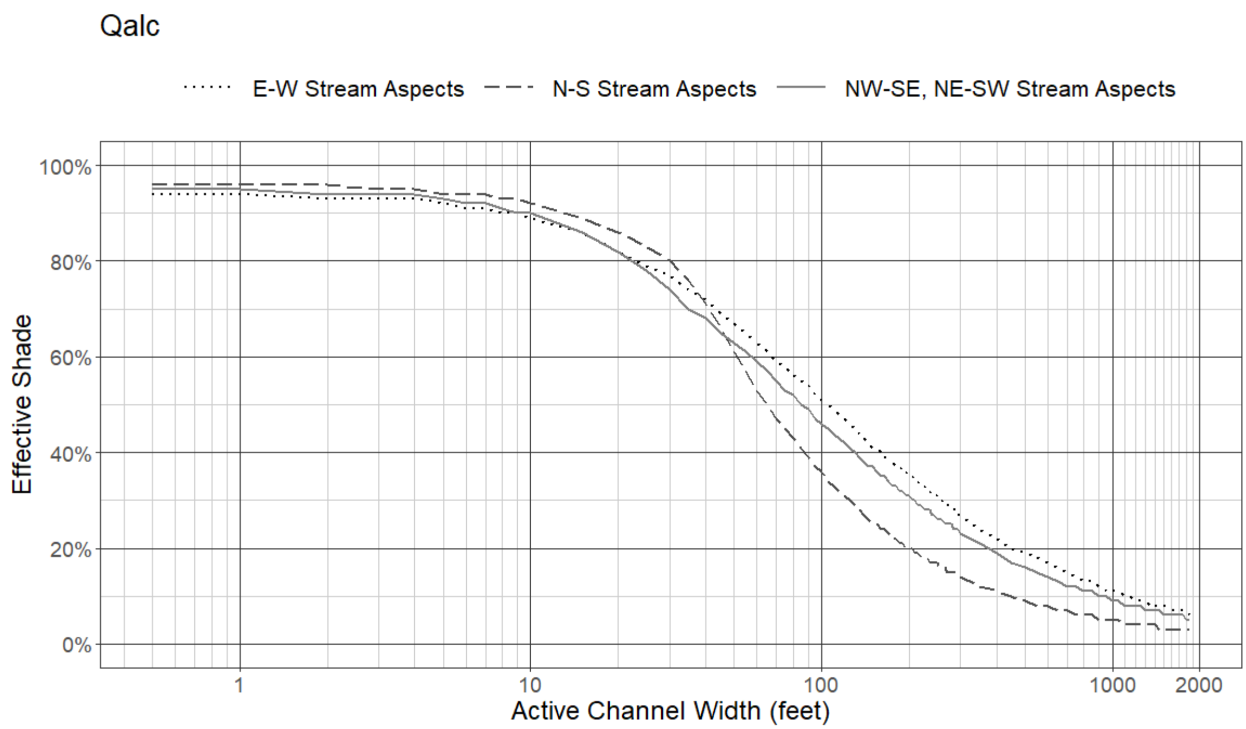


Figure 9.5 Effective shade targets for stream sites in the Qalc mapping unit.

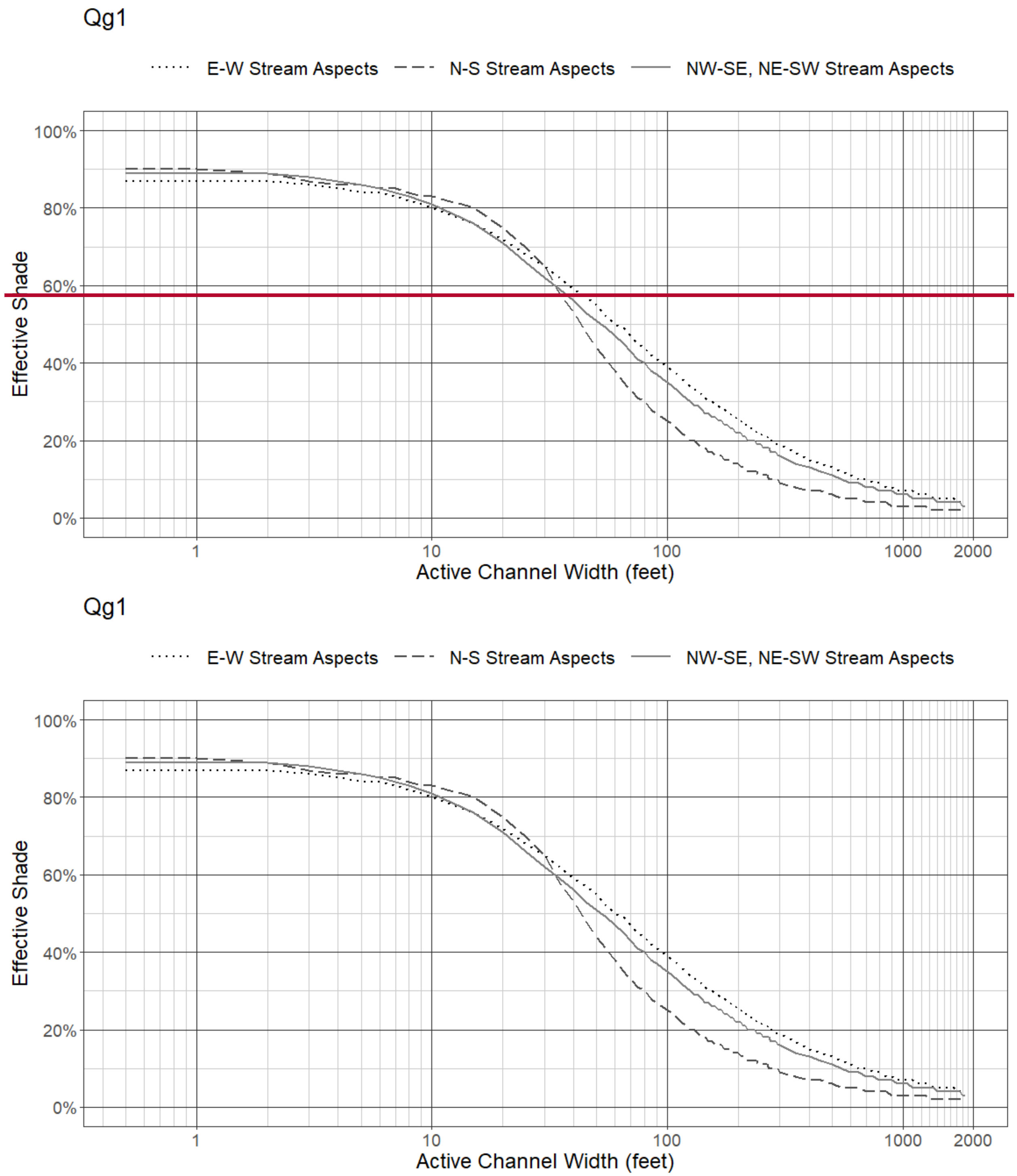
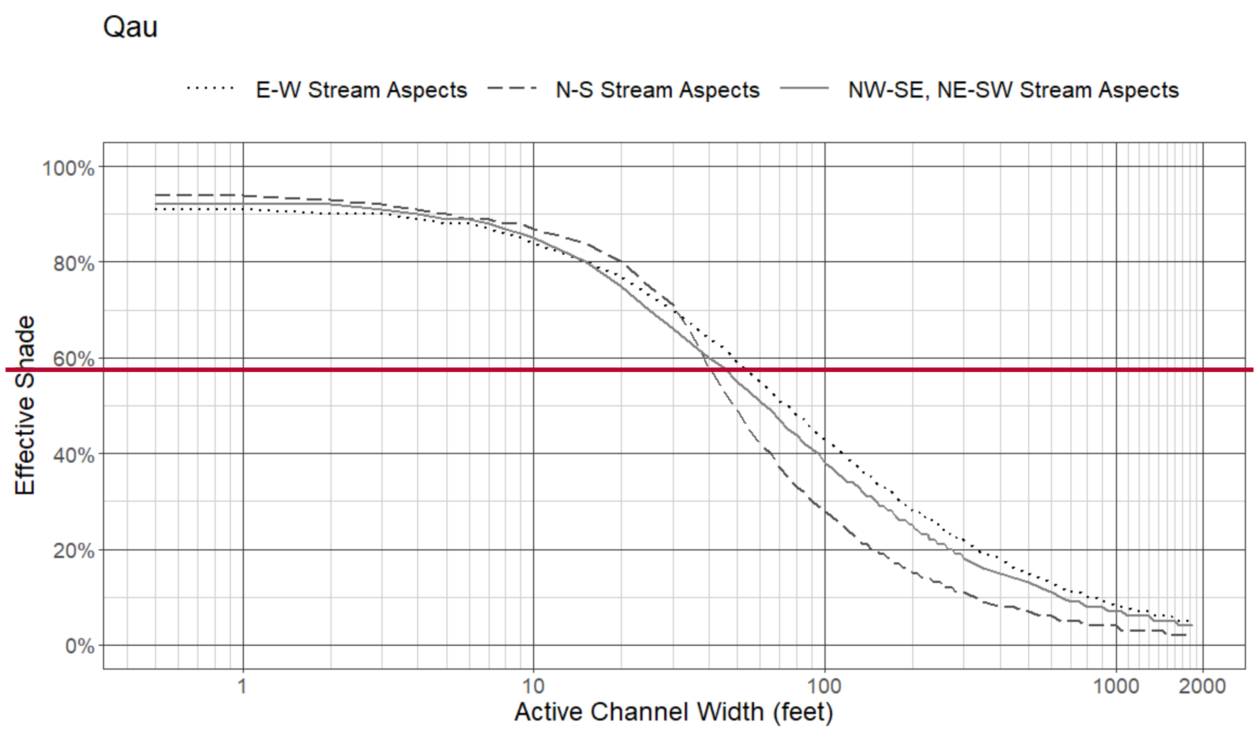


Figure 9.6 Effective shade targets for stream sites in the Qg1 mapping unit.



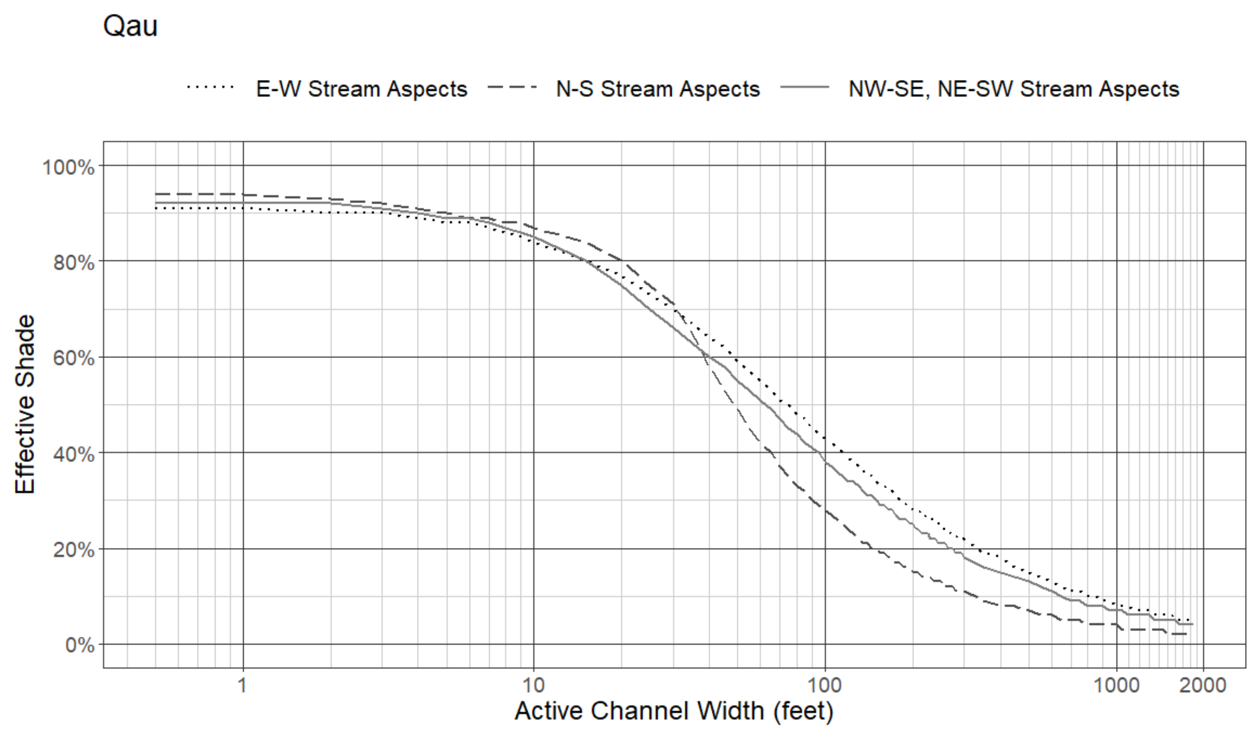
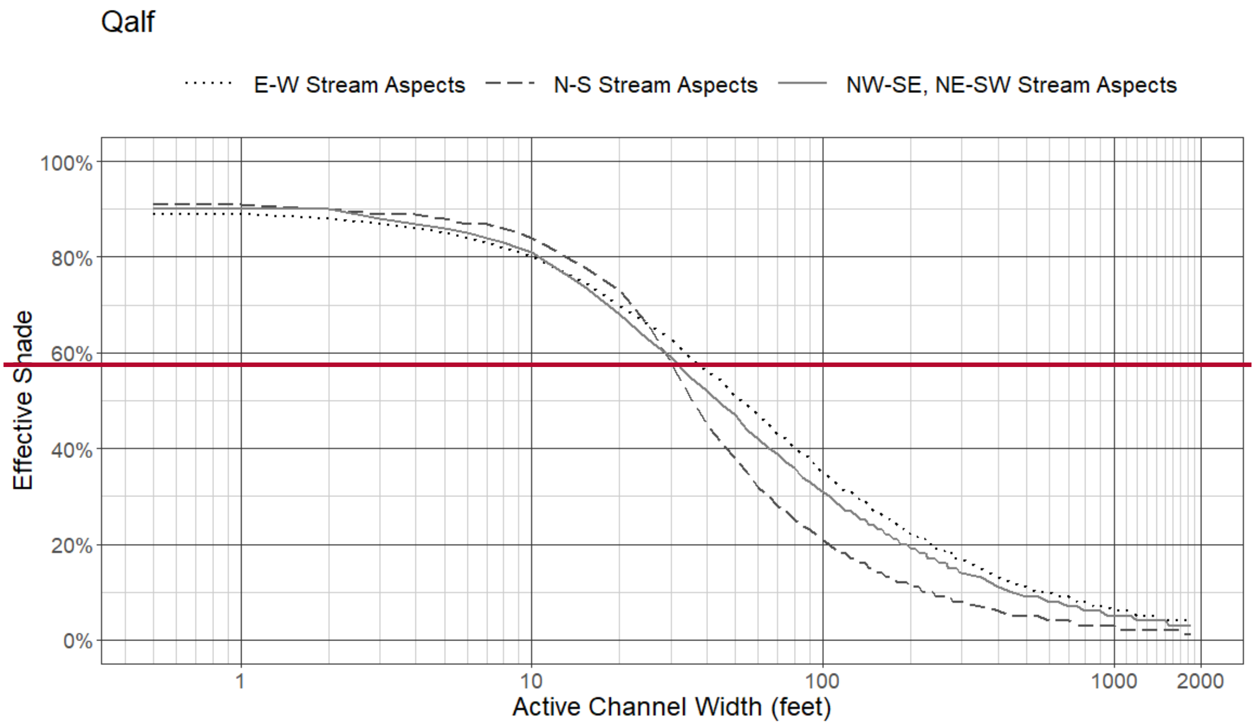


Figure 9.7 Effective shade targets for stream sites in the Qau mapping unit.



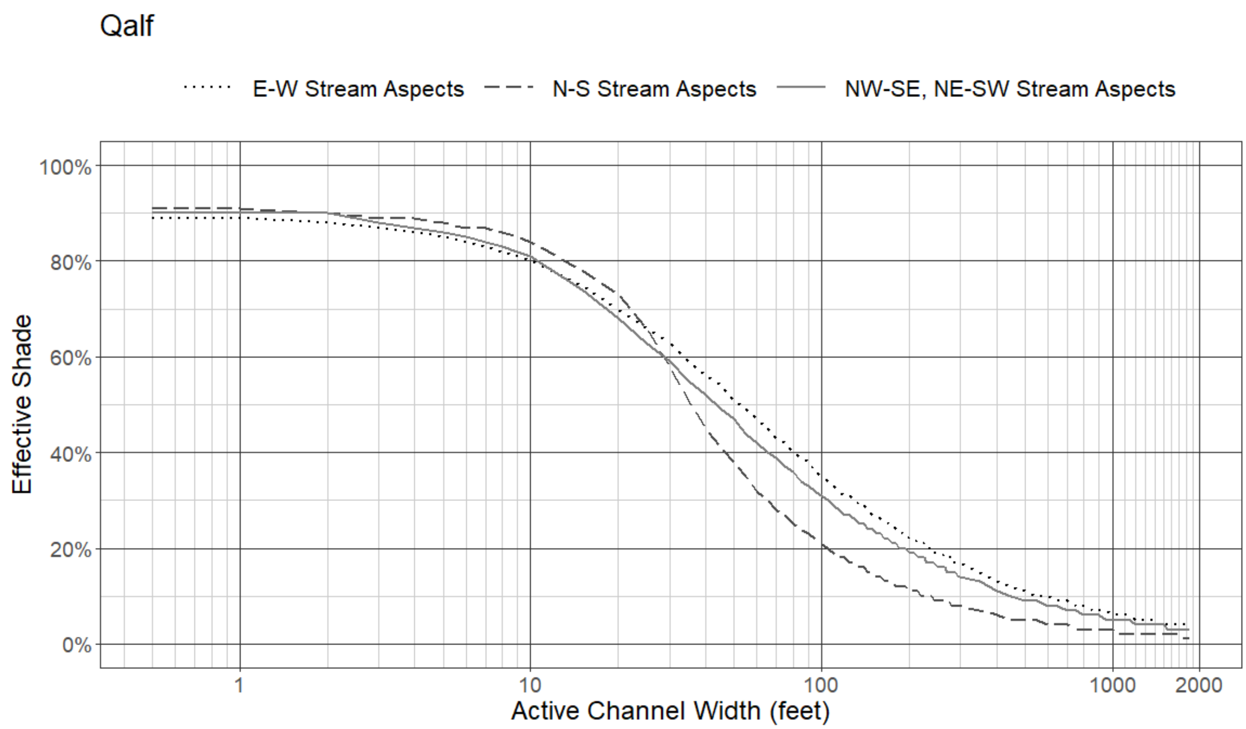


Figure 9.8 Effective shade targets for stream sites in the Qalf mapping unit.

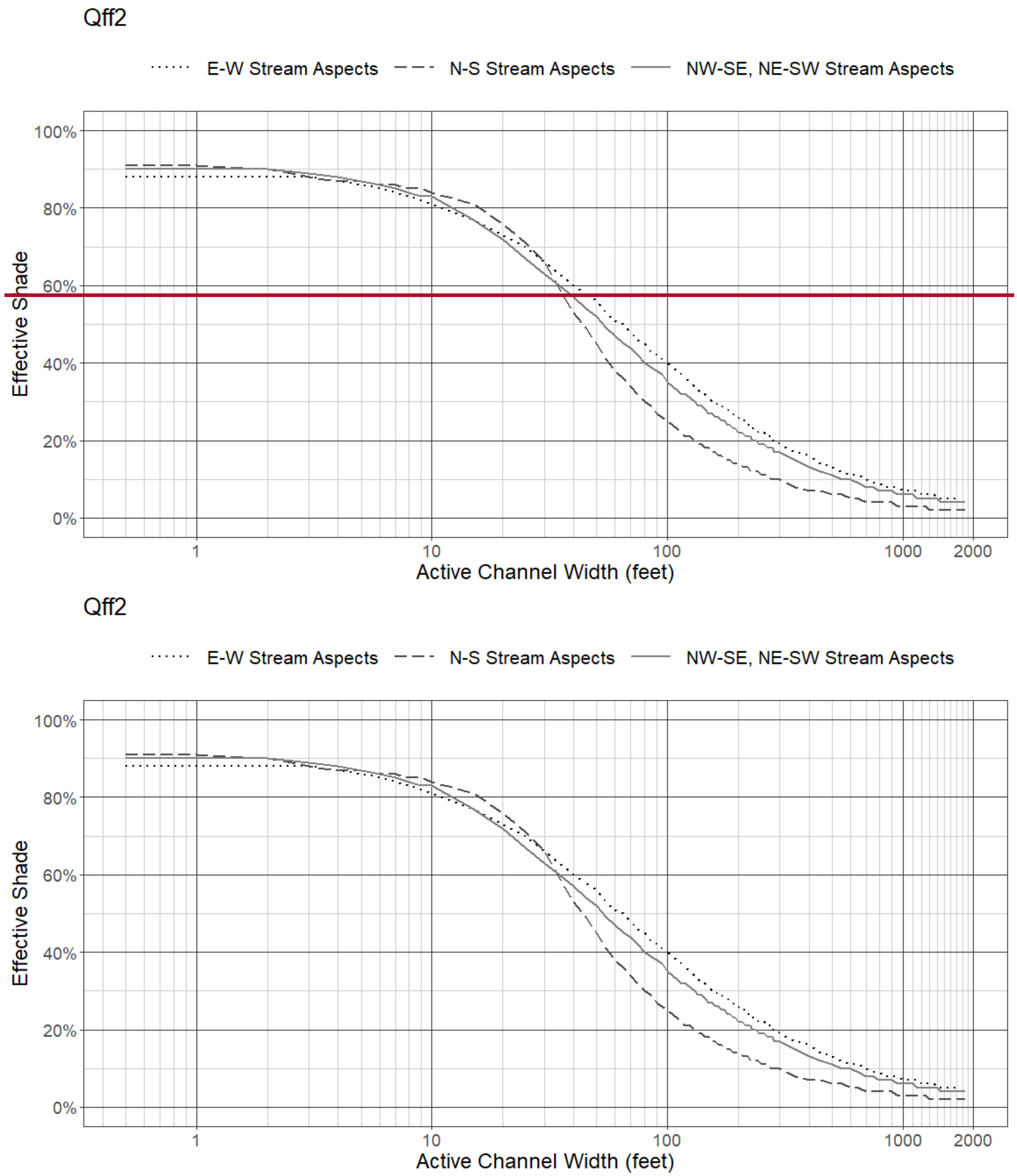


Figure 9.9 Effective shade targets for stream sites in the Qff2 mapping unit.

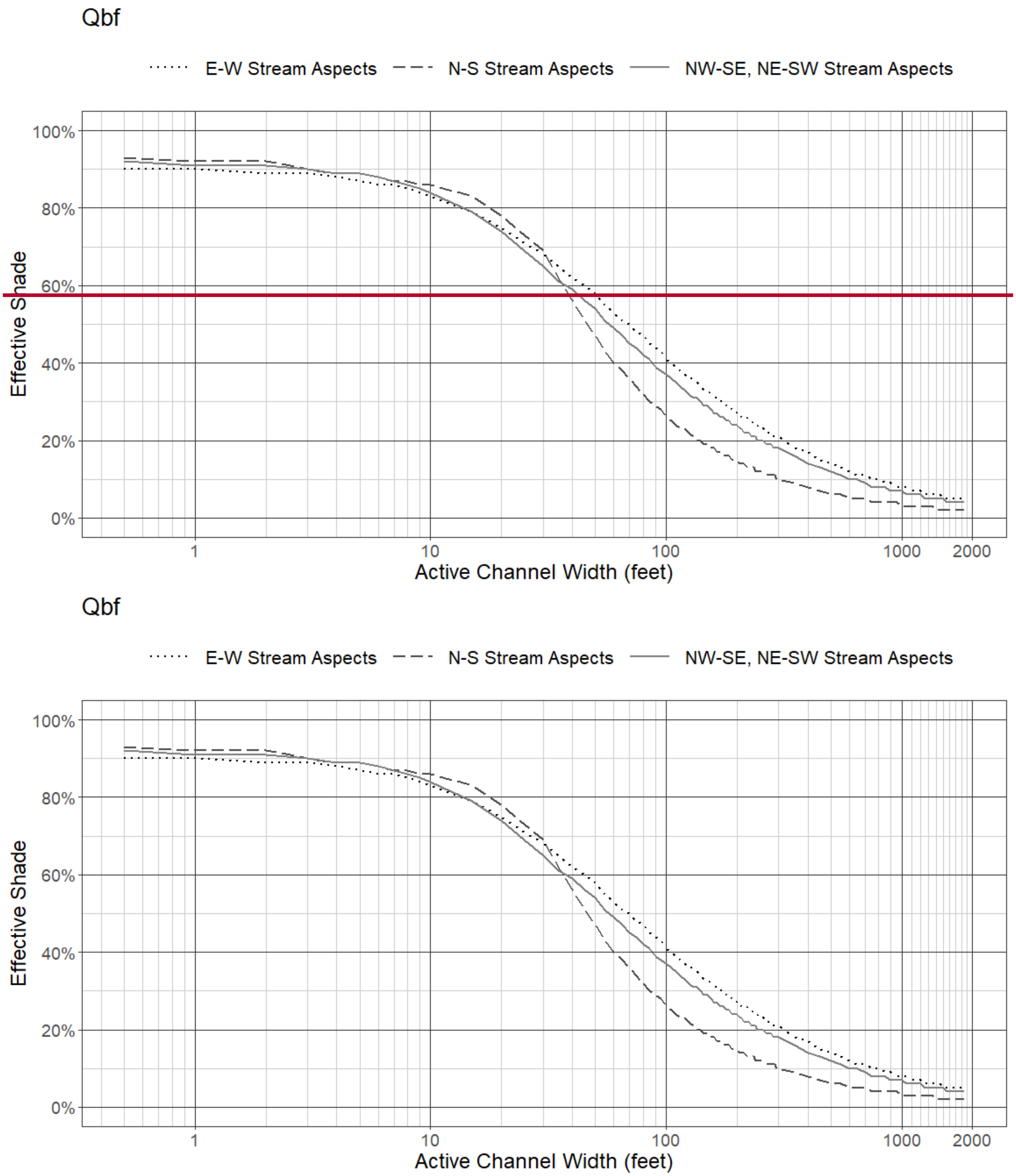
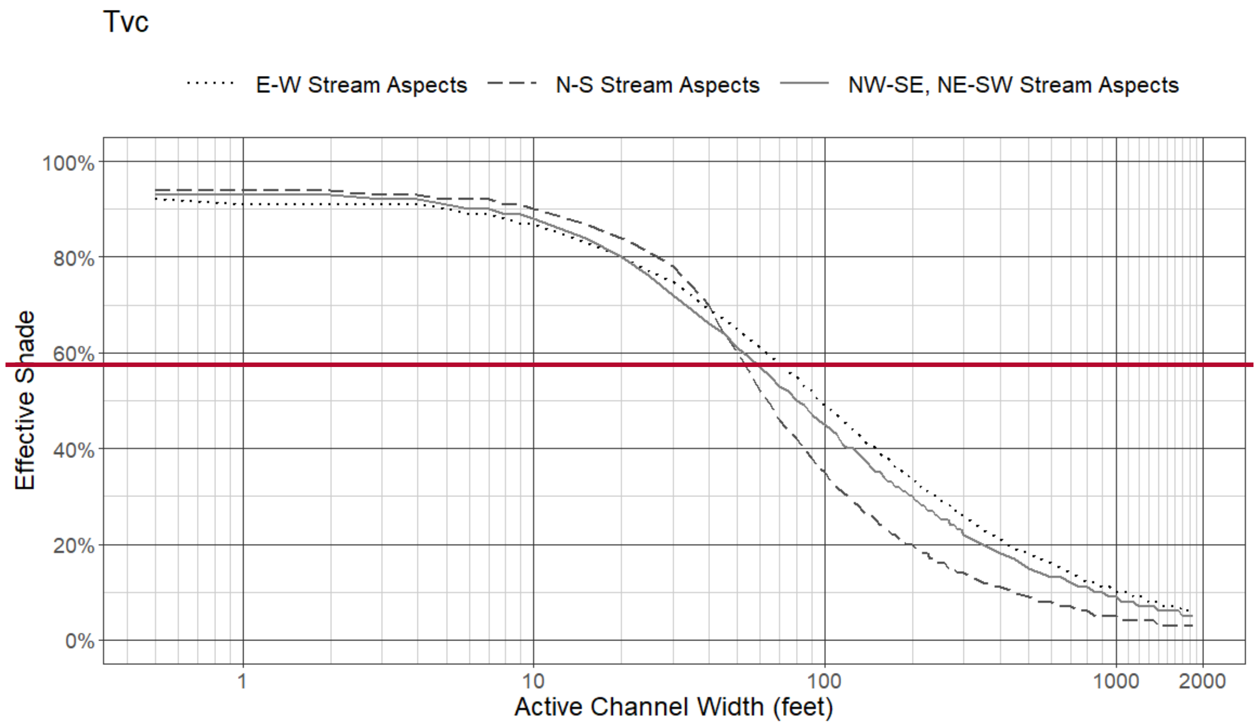


Figure 9.10 Effective shade targets for stream sites in the Qbf mapping unit.



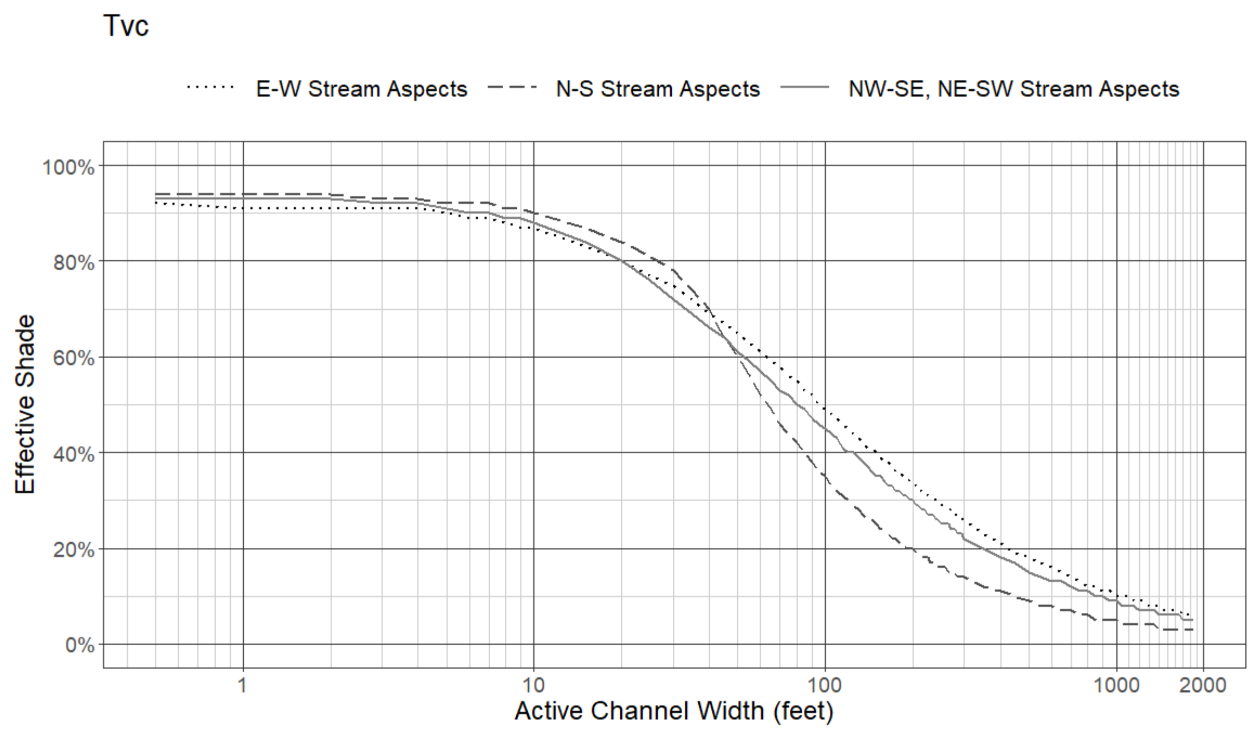


Figure 9.11 Effective shade targets for stream sites in the Tvc mapping unit.

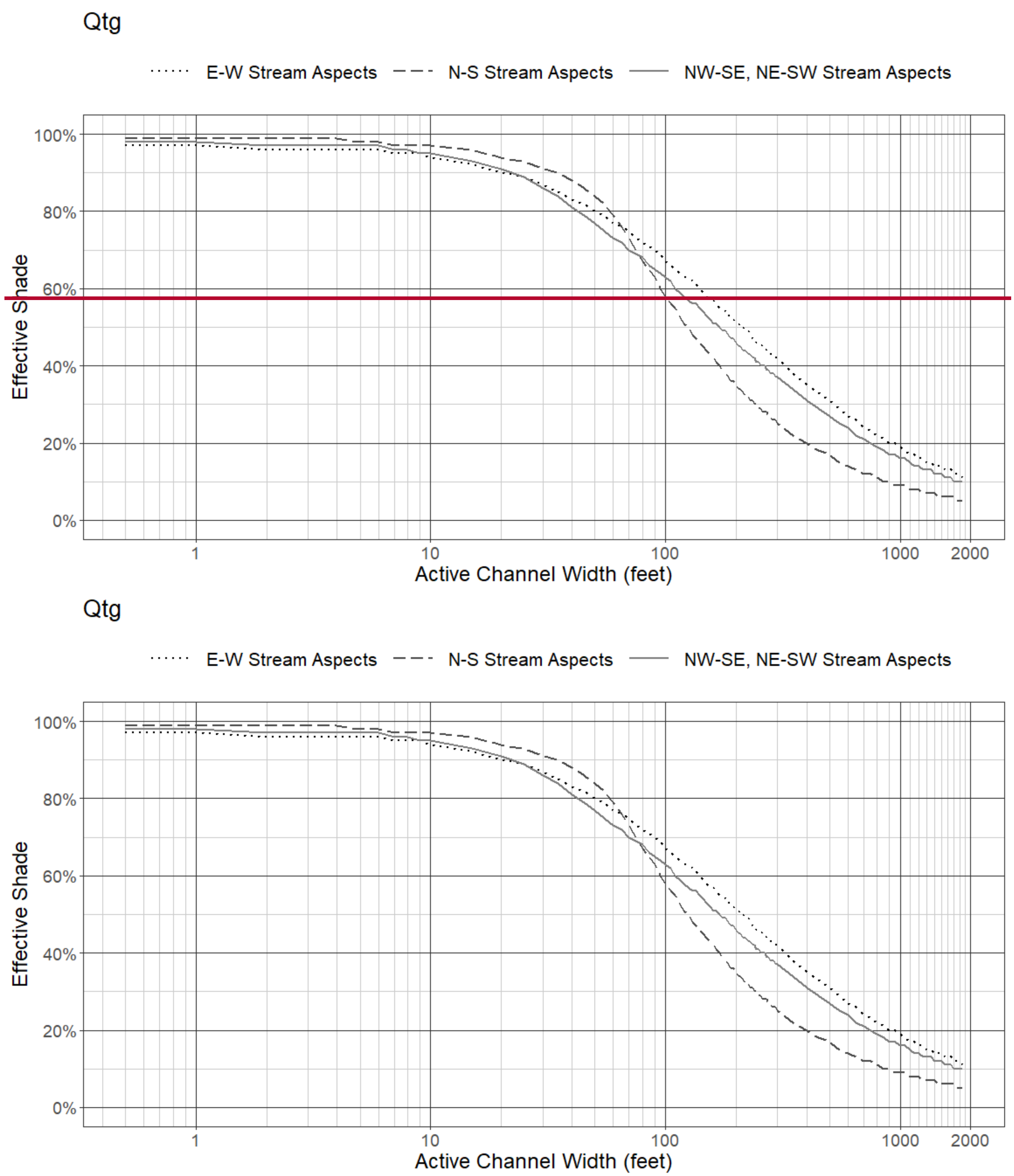


Figure 9.12 Effective shade targets for stream sites in the Qtg mapping unit.

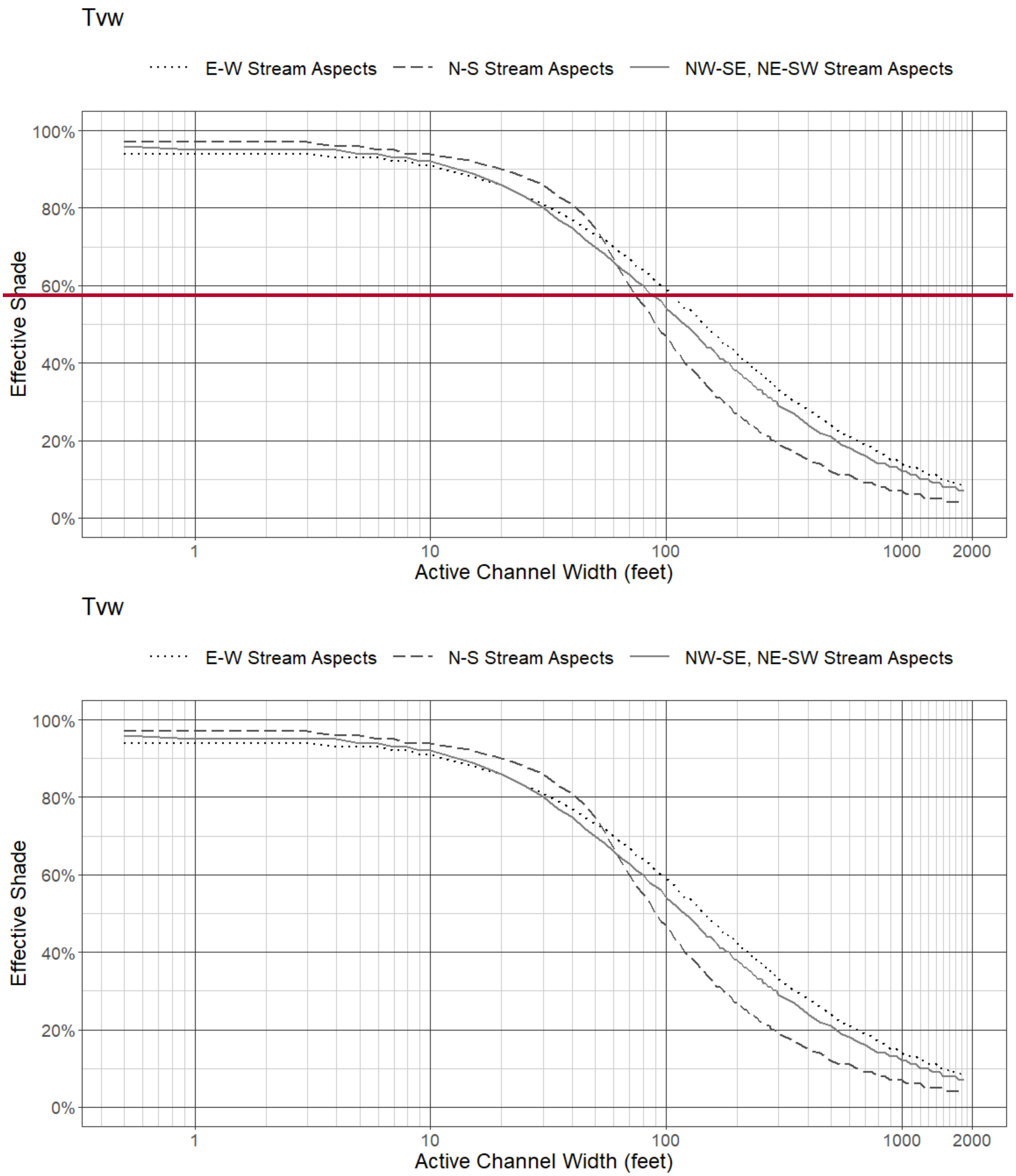
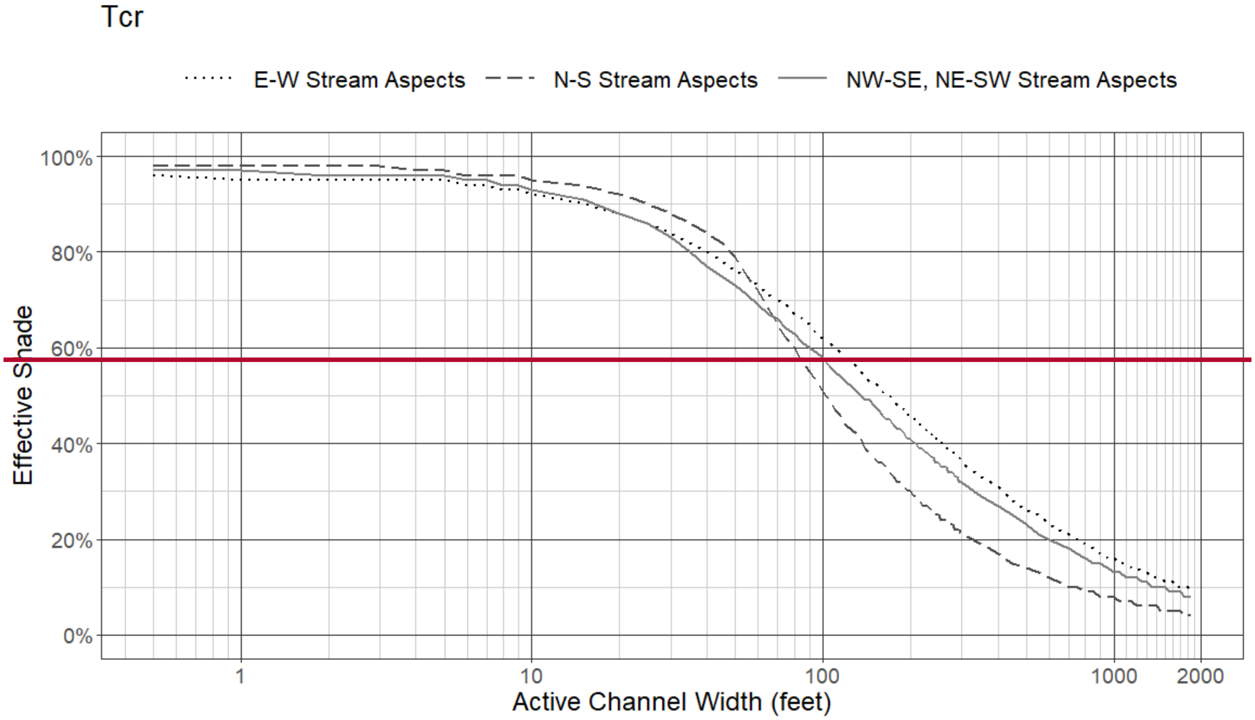


Figure 9.13 Effective shade targets for stream sites in the Tvw mapping unit.



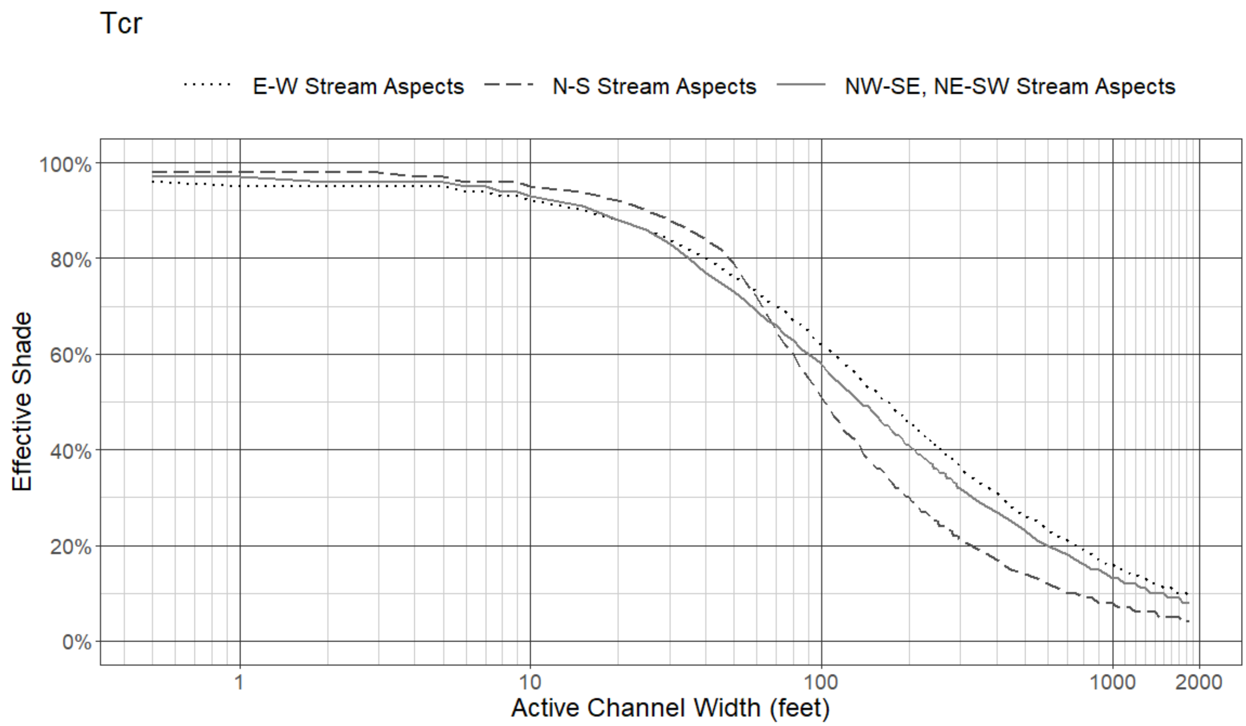
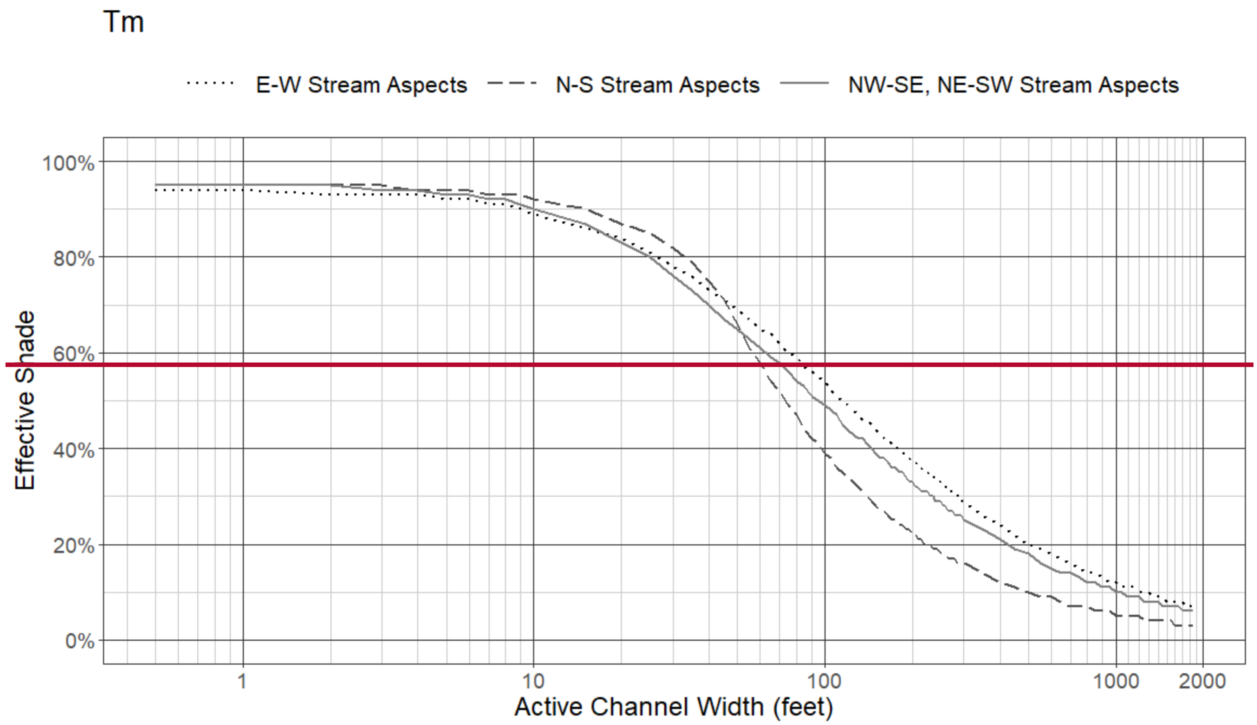


Figure 9.14 Effective shade targets for stream sites in the Tcr mapping unit.



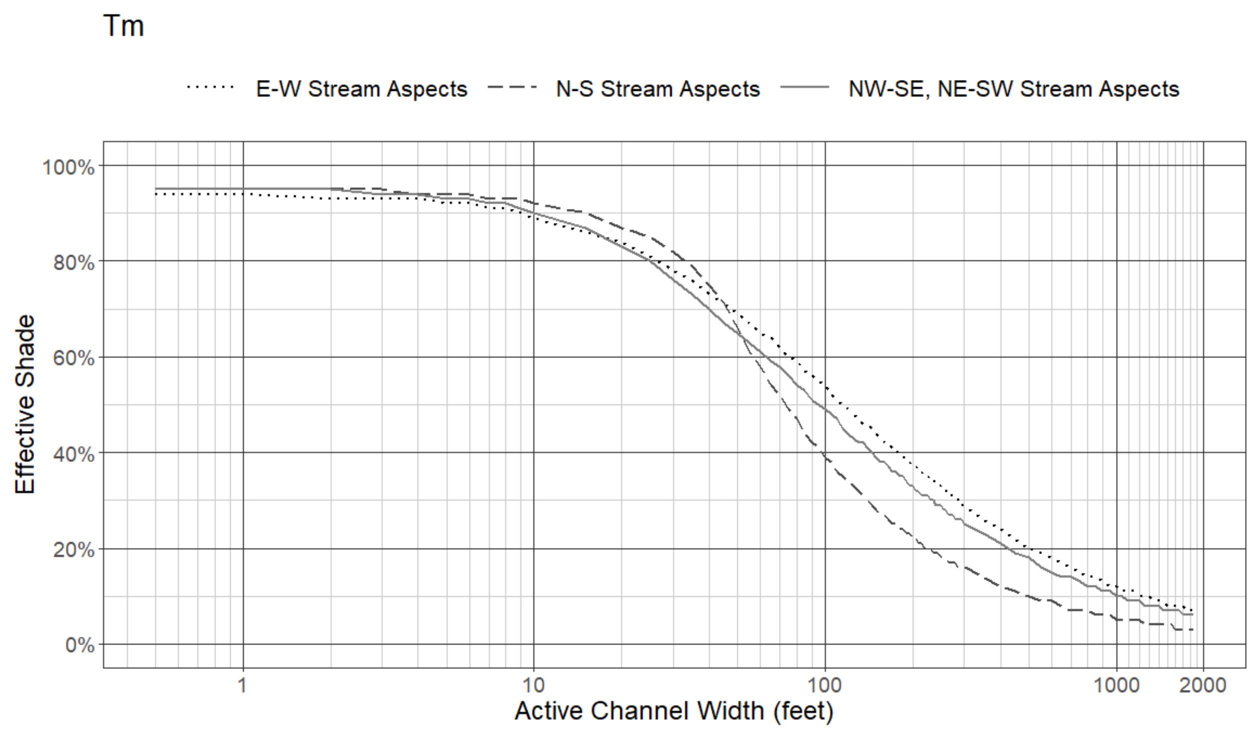


Figure 9.15 Effective shade targets for stream sites in the Tm mapping unit.

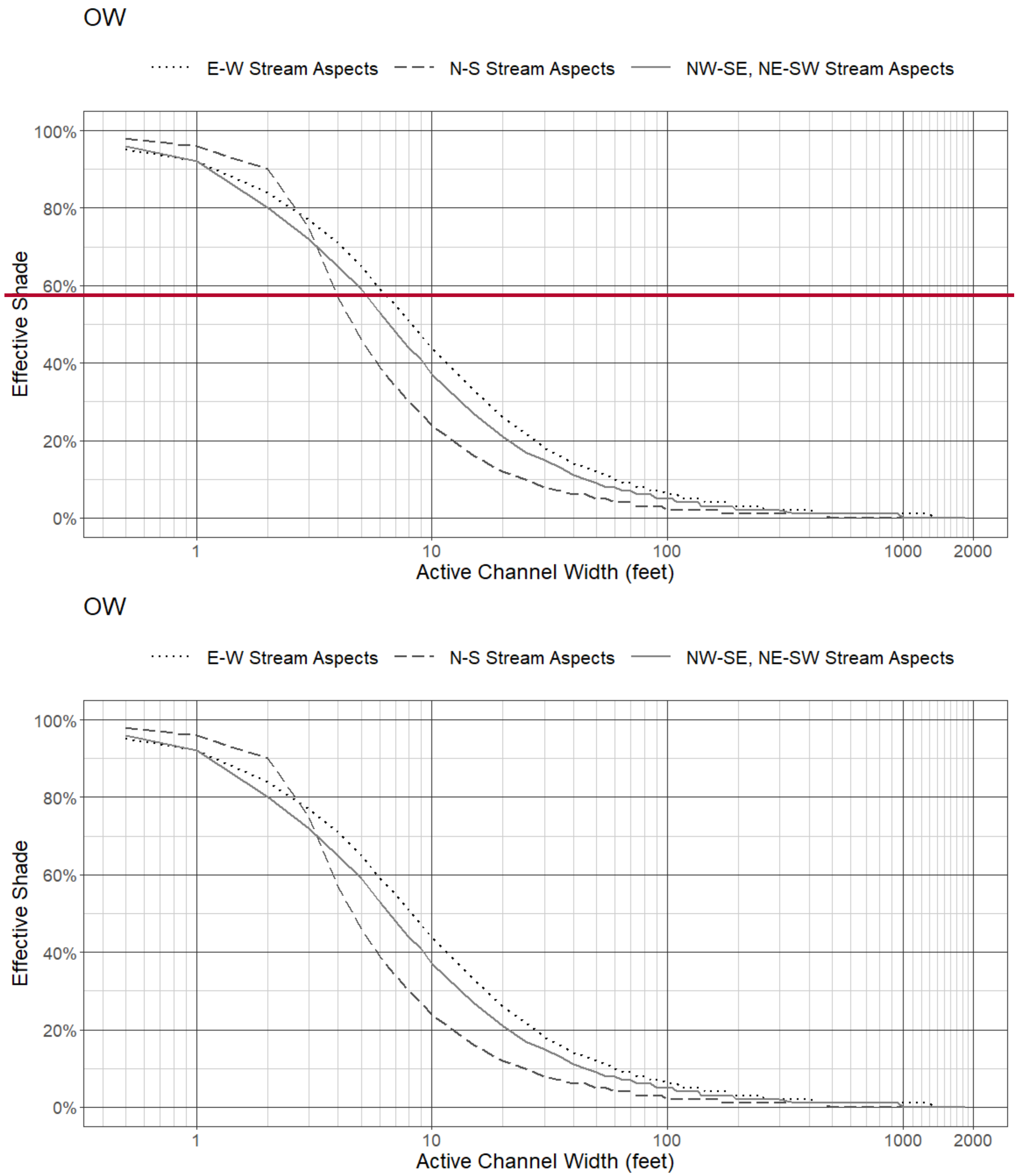


Figure 9.16 Effective shade targets for stream sites in the Open Water (OW) mapping unit.

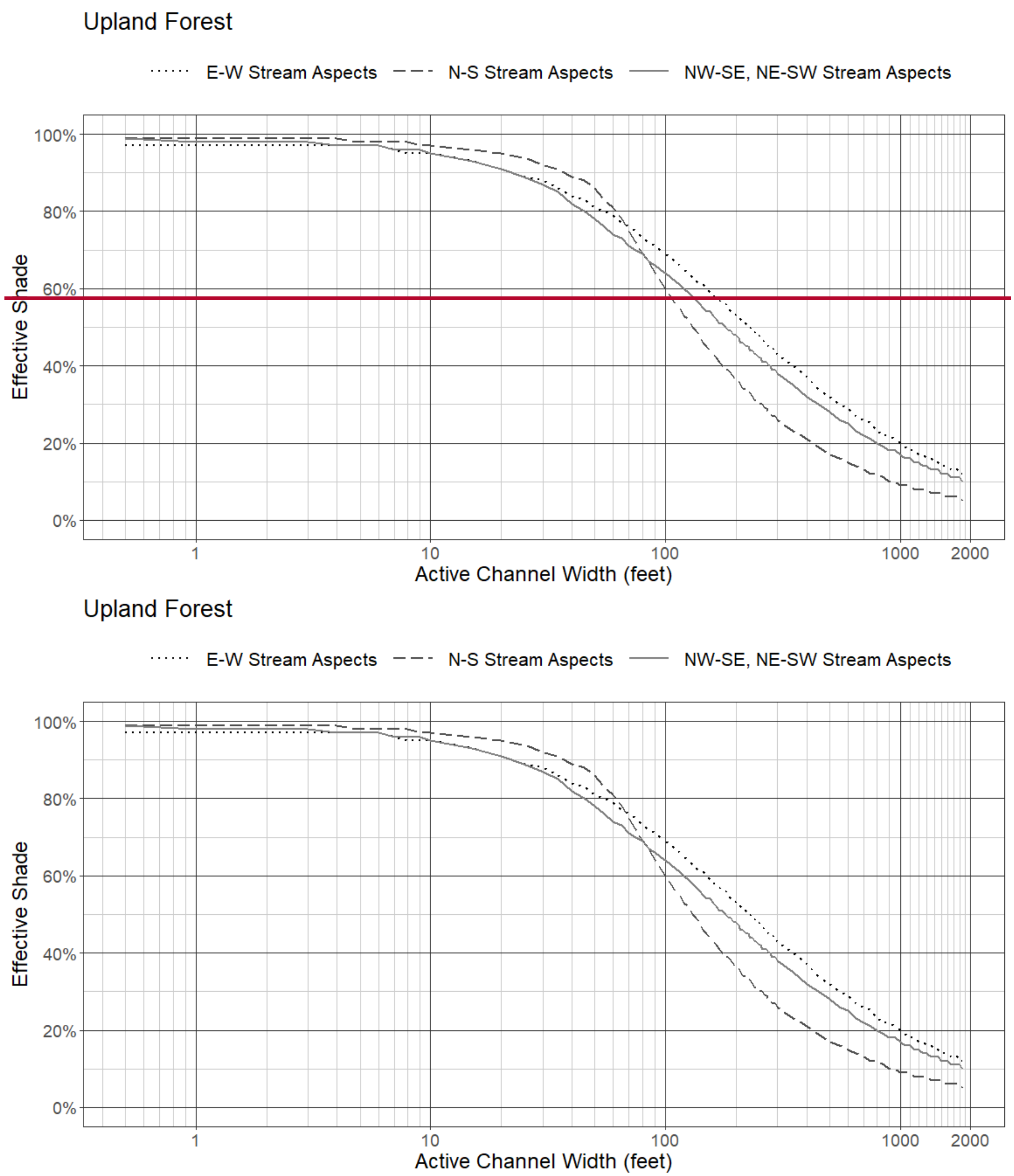


Figure 9.17 Effective shade targets for stream sites in the Upland Forest mapping unit.

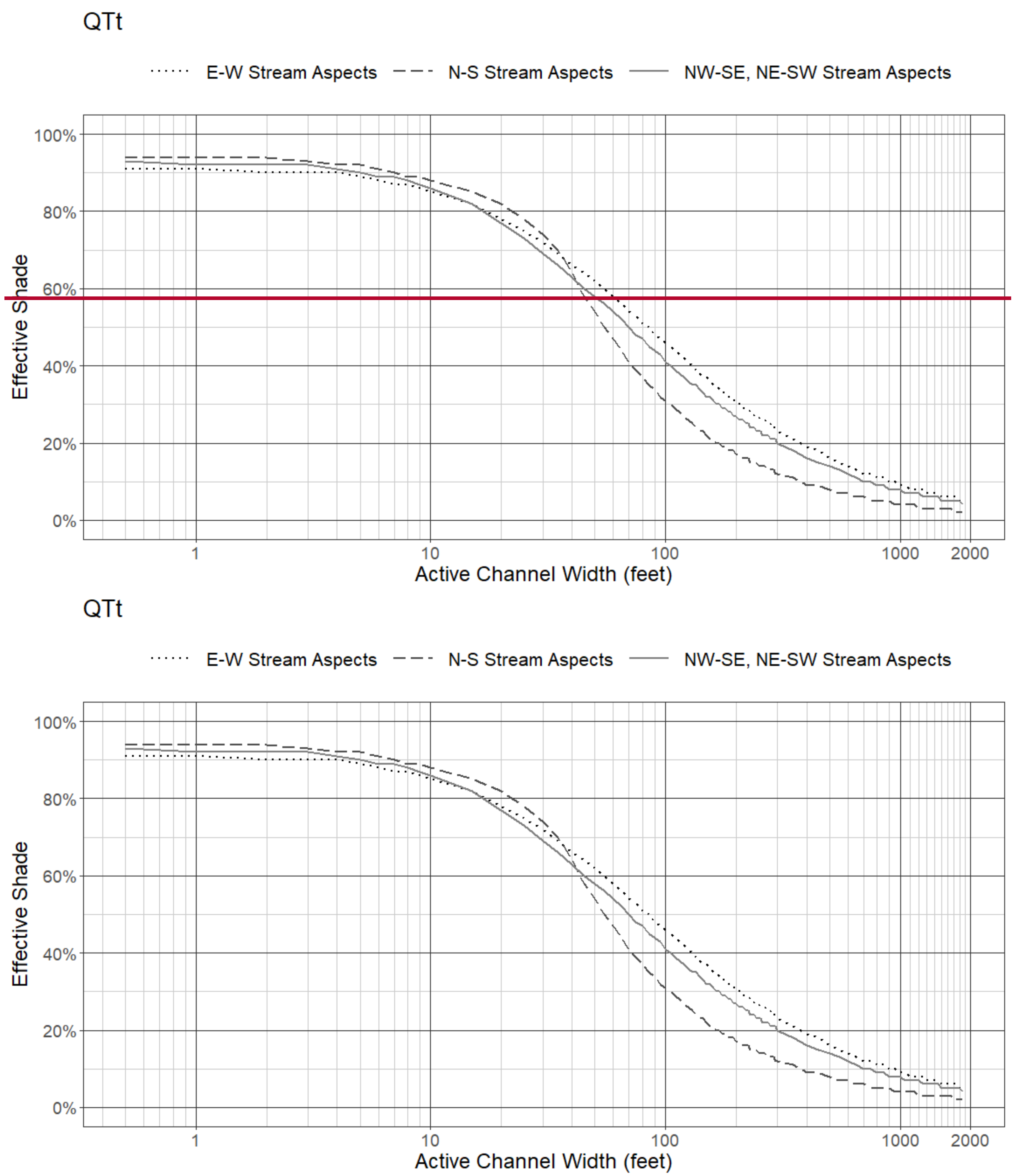
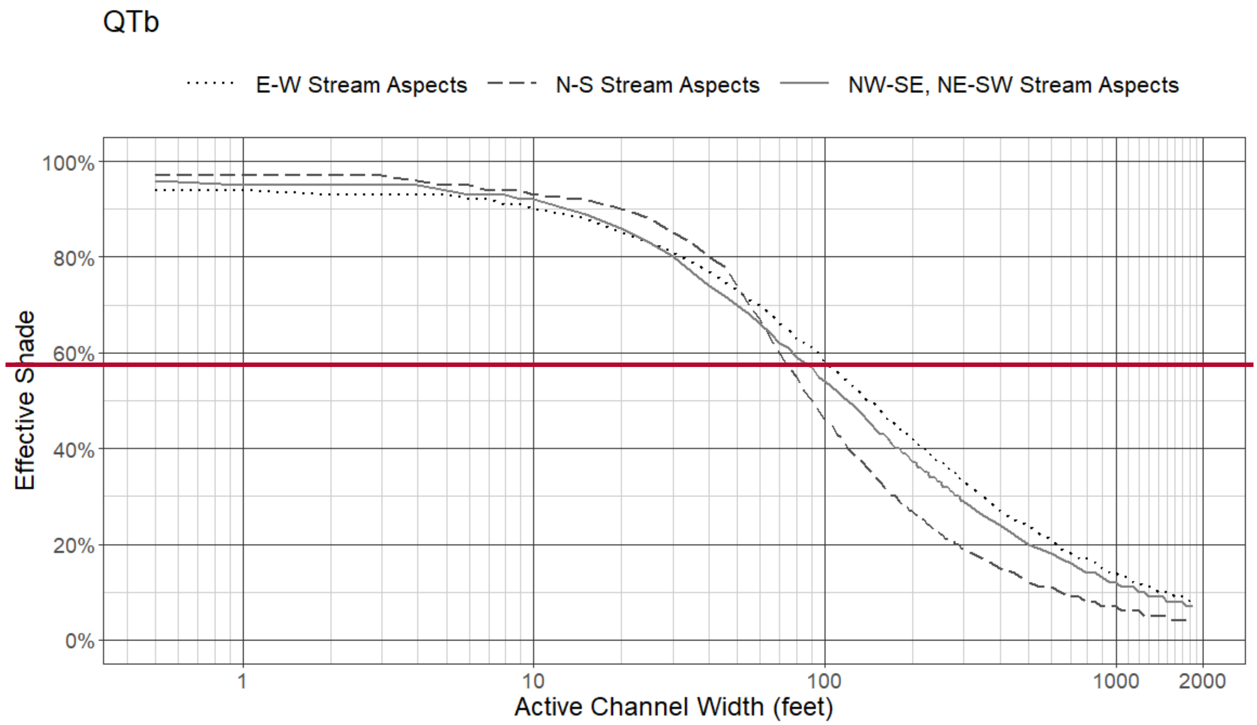


Figure 9.18 Effective shade targets for stream sites in the QTt mapping unit.



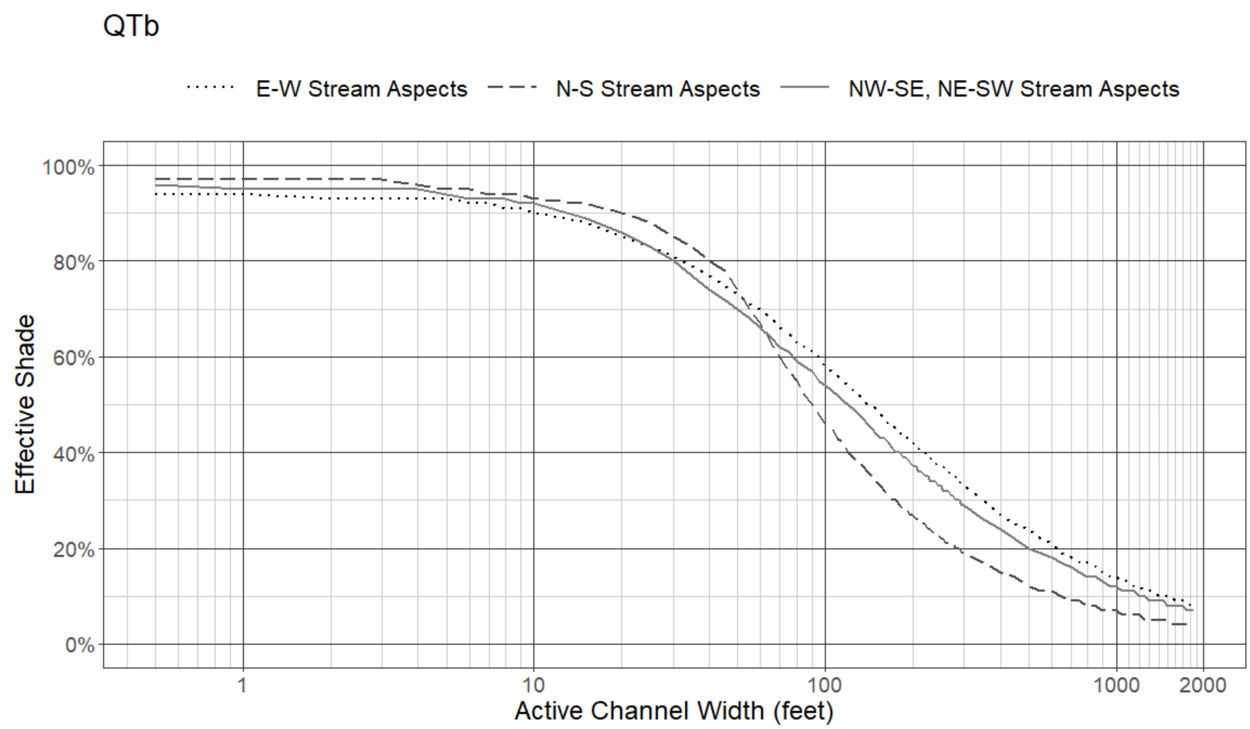
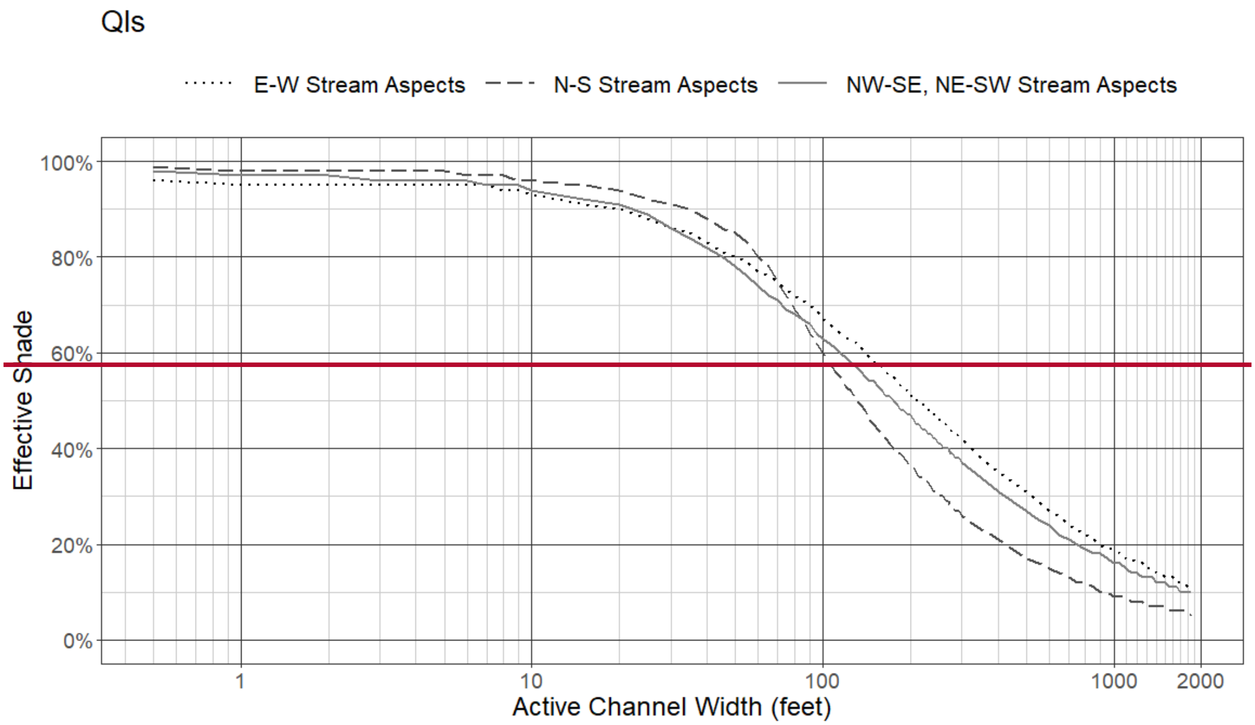


Figure 9.19 Effective shade targets for stream sites in the QTb mapping unit.



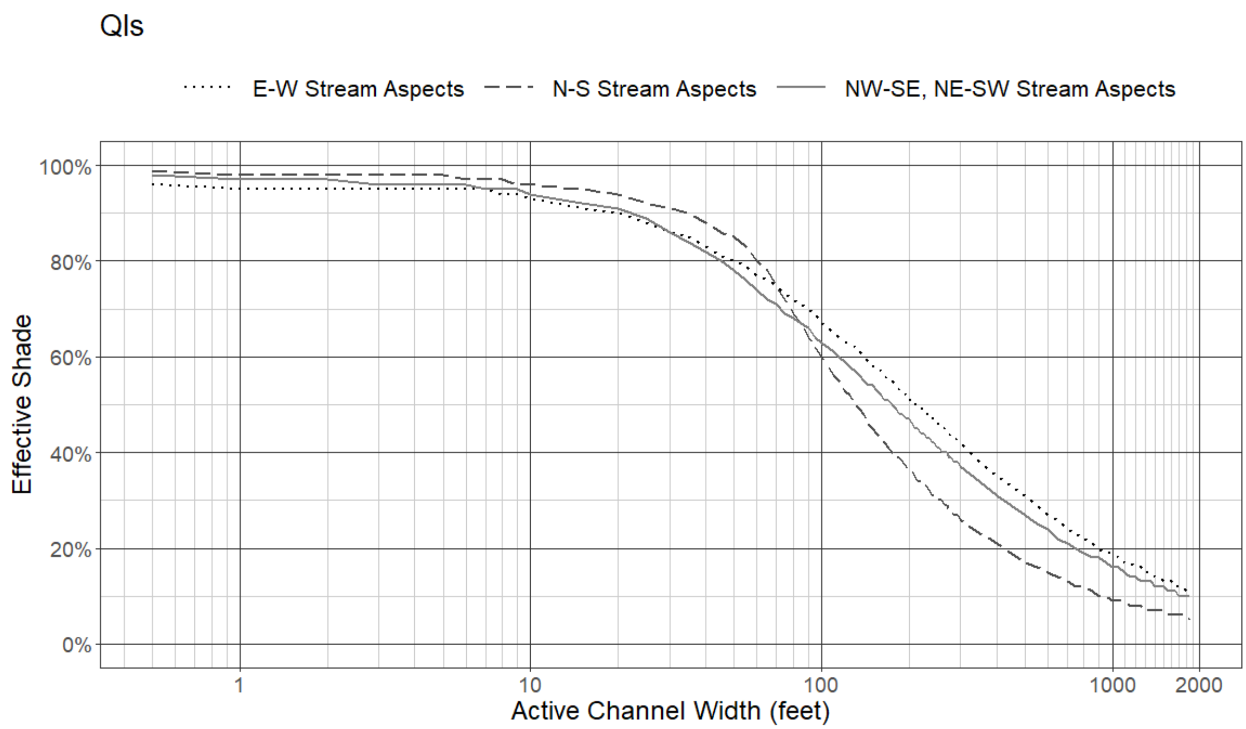
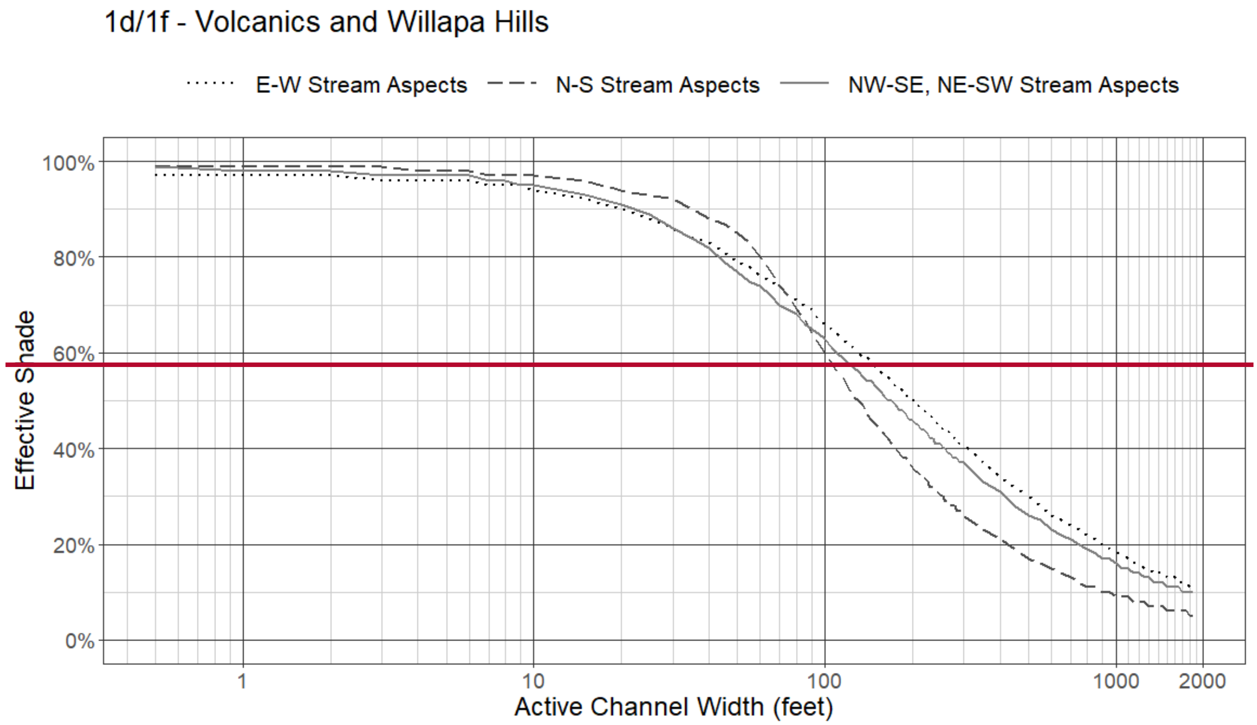


Figure 9.20 Effective shade targets for stream sites in the QIs mapping unit.



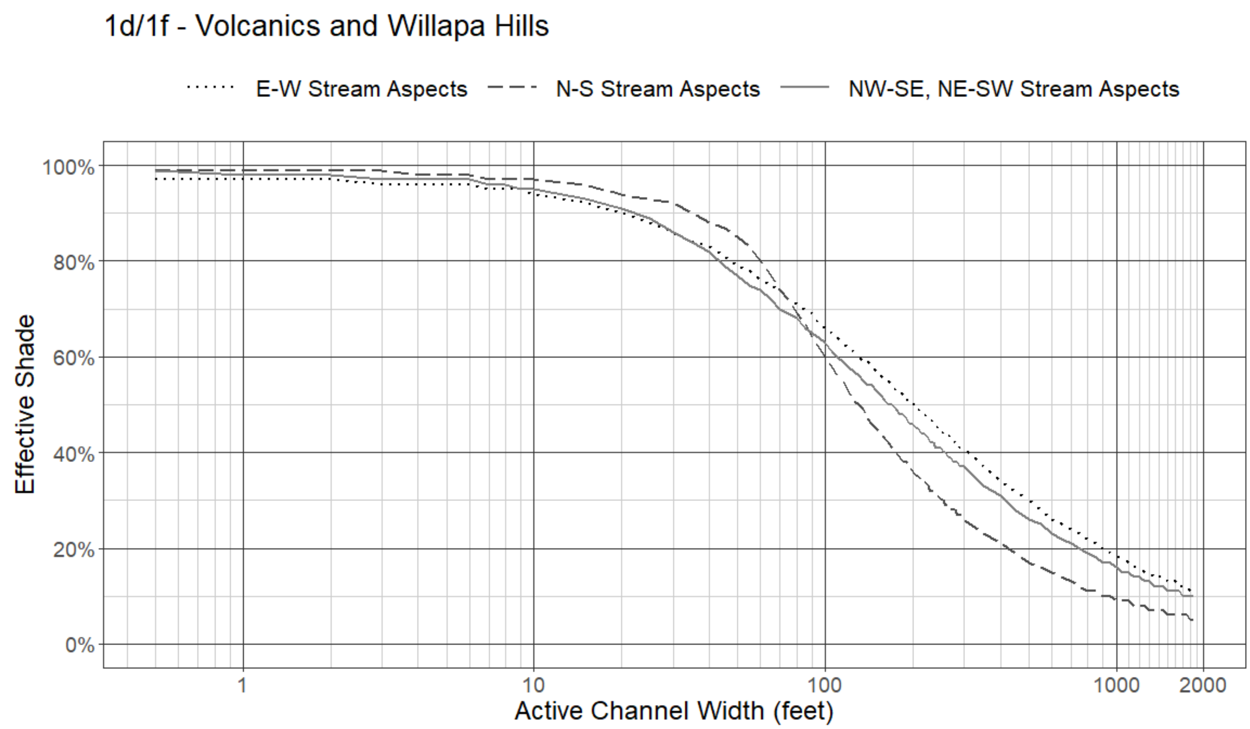
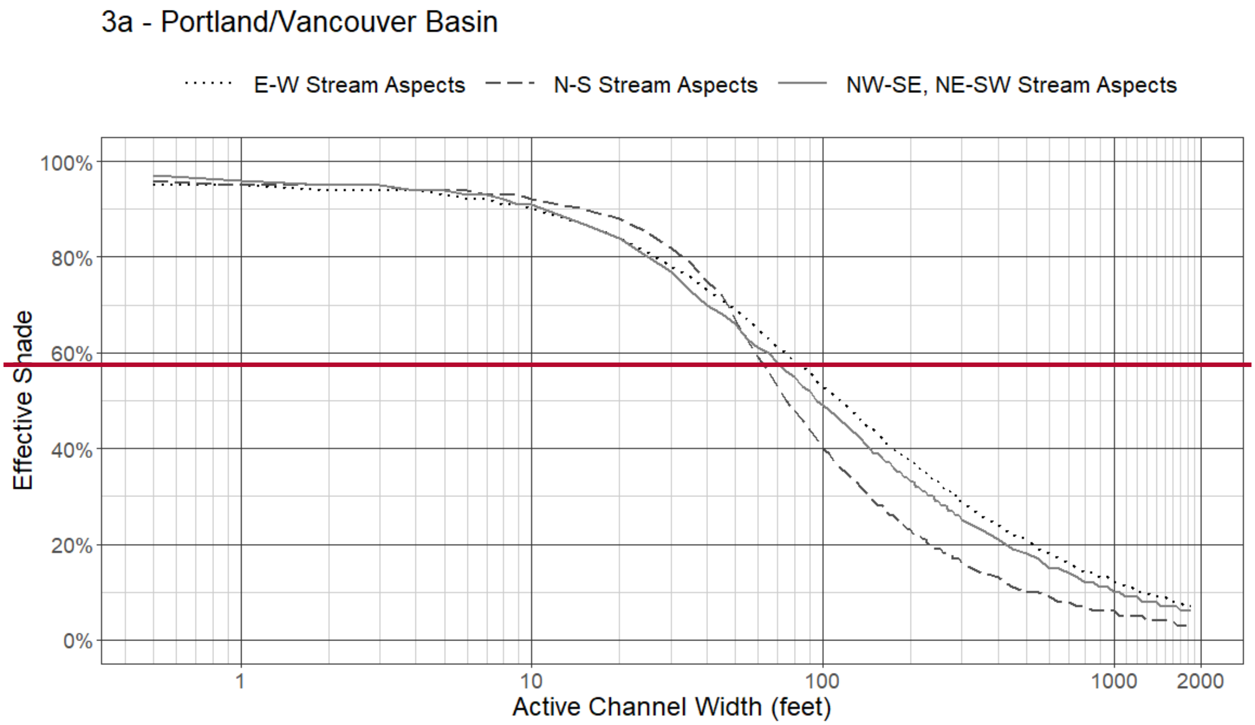


Figure 9.21 Effective shade targets for stream sites in Ecoregion 1d/1f - Volcanics and Willapa Hills.



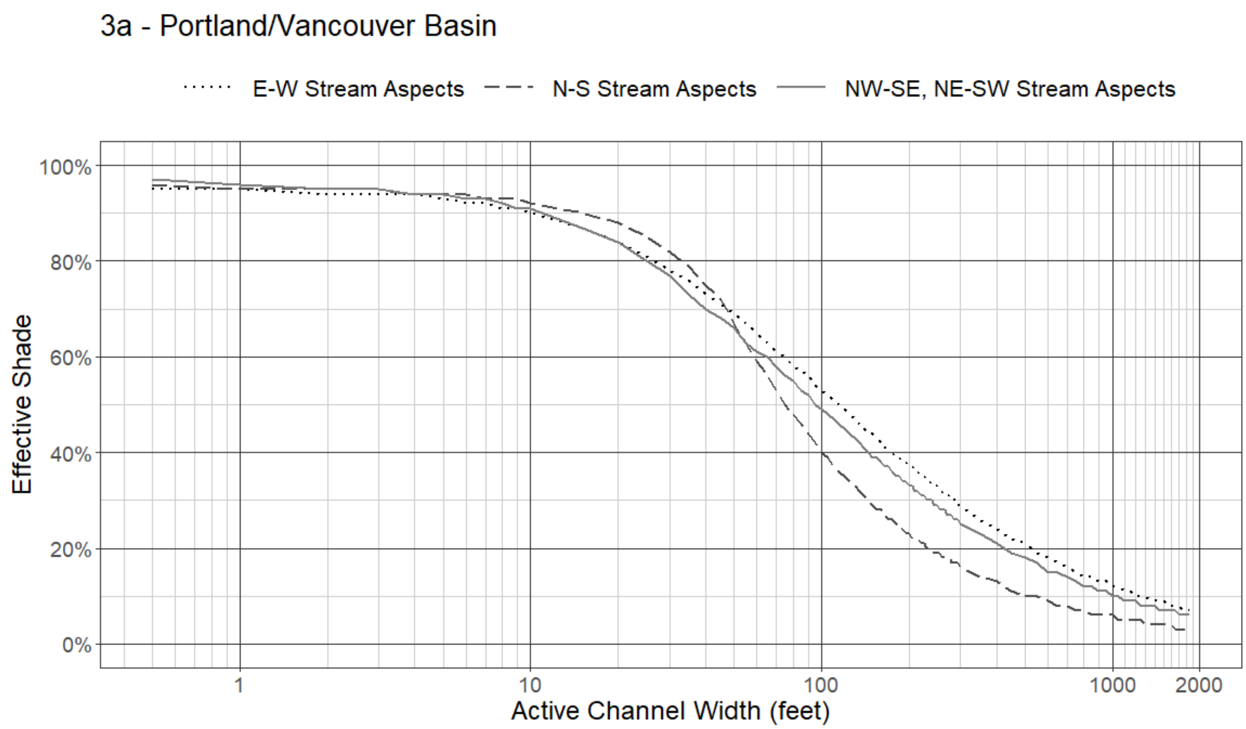
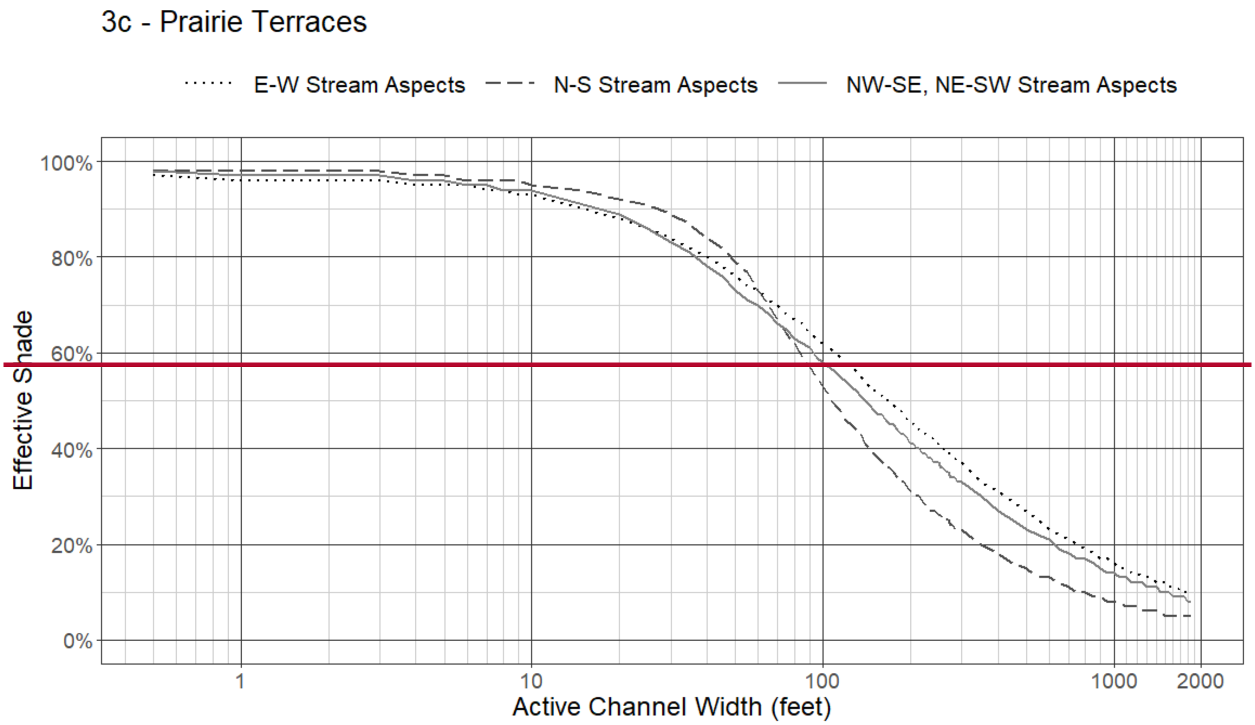


Figure 9.22 Effective shade targets for stream sites in Ecoregion 3a - Portland/Vancouver Basin.



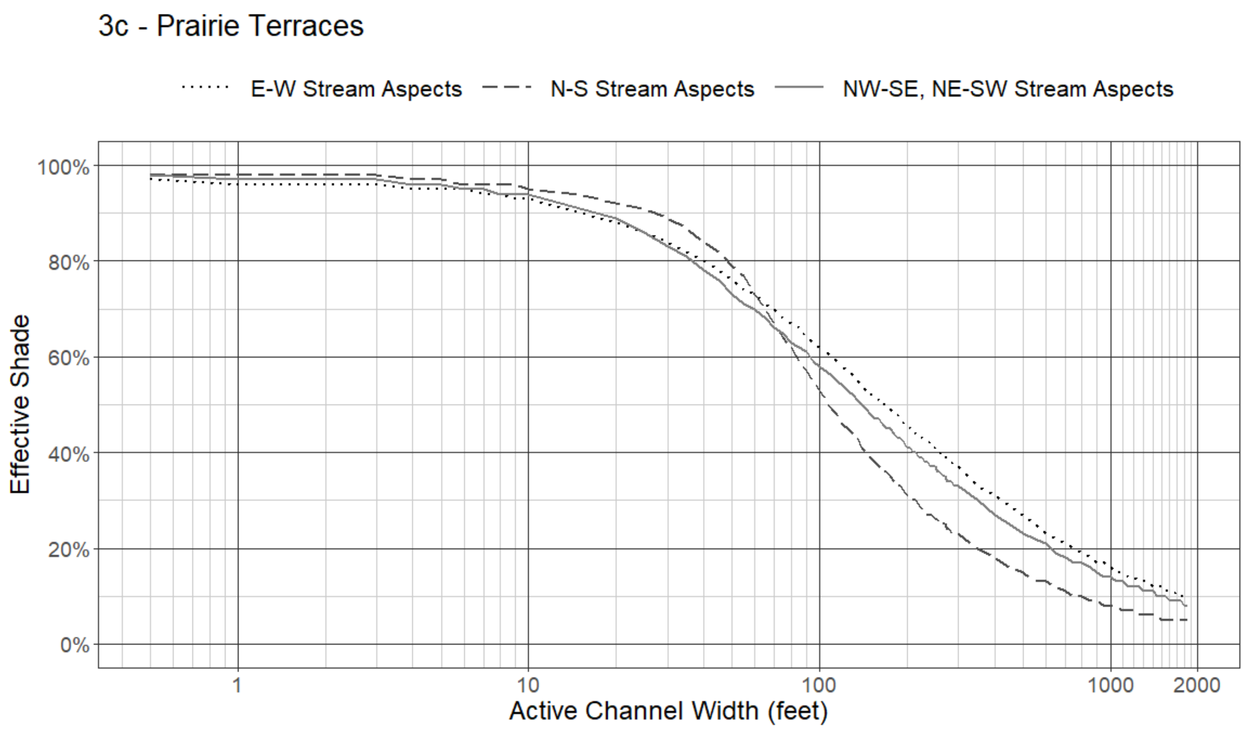


Figure 9.23 Effective shade targets for stream sites in Ecoregion 3c - Prairie Terraces.

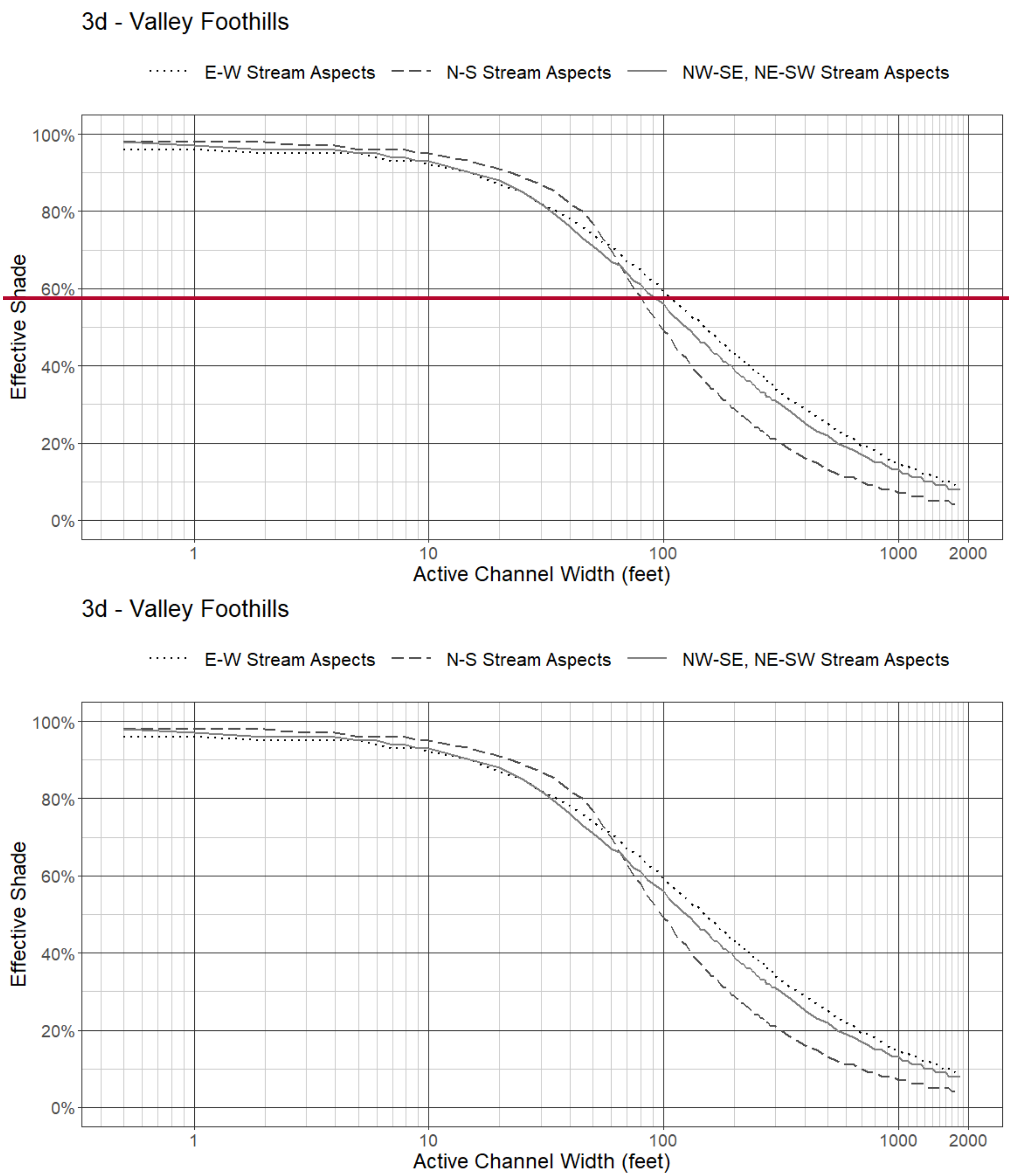


Figure 9.24 Effective shade targets for stream sites in Ecoregion 3d - Valley Foothills.

9.1.3. Reserve capacity

Explicit allocations for reserve capacity have been set aside for use by either point or nonpoint sources. Reserve capacity may be used for an allocation to new or increased thermal loads, or to any existing source that may not have been identified during the development of this TMDL. The portion of the human use allowance associated with the reserve capacity is described in Table 9.1 andthrough Table 9.26.

9.2. Margin of safety

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

In the 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 or a maximum flow obtained from discharge monitoring reports for the model scenario assessing the waste load allocations. It is rare that actual discharges from point sources will reach design flows and sustain that discharge for long periods of time all at the same time.
- Setting effluent temperatures as high as 32 degrees Celsius for the model scenario assessing the waste load allocations. On days when the current thermal load was less than the waste load allocation, the maximum effluent temperatures were increased above the actual temperatures up to either 32 or the effluent temperature that would full utilize the waste load allocation. Actual maximum effluent temperatures are unlikely to get this warm or be sustained over multiple days or weeks.
- The cumulative effects analysis used the maximum increase as the basis for determining attainment of allocations. The maximum increase does not happen more than 5% of the time and the median increase is less. This means that a portion of the loading capacity reserved for human use will go unutilized most of the time.

10. Water quality management plan

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

DEQ sought and considered input from various persons, including DMAs, responsible for TMDL implementation and other interested public and prepared the 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 Oregon Environmental Quality Commission.

11. Reasonable assurance

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

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

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

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

12. Appendix of effective shade curve tables

12.1. Qff1 mapping unit

Table 12.1 Effective shade targets for stream sites in the Qff1 mapping unit.

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

Active Channel Width (m)	Active Channel Width (feet)	Effective Shade Target for E-W Stream Aspects	Effective Shade Target for NW-SE, NE-SW Stream Aspects	Effective Shade Target for N-S Stream Aspects
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%
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%

Active Channel Width (m)	Active Channel Width (feet)	Effective Shade Target for E-W Stream Aspects	Effective Shade Target for NW-SE, NE-SW Stream Aspects	Effective Shade Target for N-S Stream Aspects
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%
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%

12.2. Qfc mapping unit

Table 12.2 Effective shade targets for stream sites in the Qfc Quaternary geologic unit.

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

Active Channel Width (m)	Active Channel Width (feet)	Effective Shade Target for E-W Stream Aspects	Effective Shade Target for NW-SE, NE-SW Stream Aspects	Effective Shade Target for N-S Stream Aspects
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%
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%

Active Channel Width (m)	Active Channel Width (feet)	Effective Shade Target for E-W Stream Aspects	Effective Shade Target for NW-SE, NE-SW Stream Aspects	Effective Shade Target for N-S Stream Aspects
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%
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%

12.3. Qff mapping unit

Table 12.3 Effective shade targets for stream sites in the Qalc geomorphic region.

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

Active Channel Width (m)	Active Channel Width (feet)	Effective Shade Target for E-W Stream Aspects	Effective Shade Target for NW-SE, NE-SW Stream Aspects	Effective Shade Target for N-S Stream Aspects
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%
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%

Active Channel Width (m)	Active Channel Width (feet)	Effective Shade Target for E-W Stream Aspects	Effective Shade Target for NW-SE, NE-SW Stream Aspects	Effective Shade Target for N-S Stream Aspects
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%
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%

Active Channel Width (m)	Active Channel Width (feet)	Effective Shade Target for E-W Stream Aspects	Effective Shade Target for NW-SE, NE-SW Stream Aspects	Effective Shade Target for N-S Stream Aspects
518.2	1700	7%	6%	3%
533.4	1750	7%	6%	3%
548.6	1800	7%	5%	3%
563.9	1850	6%	5%	3%

12.4. Qg1 mapping unit

Table 12.4 Effective shade targets for stream sites in the Qg1 mapping unit.

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

Active Channel Width (m)	Active Channel Width (feet)	Effective Shade Target for E-W Stream Aspects	Effective Shade Target for NW-SE, NE-SW Stream Aspects	Effective Shade Target for N-S Stream Aspects
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%
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%

Active Channel Width (m)	Active Channel Width (feet)	Effective Shade Target for E-W Stream Aspects	Effective Shade Target for NW-SE, NE-SW Stream Aspects	Effective Shade Target for N-S Stream Aspects
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%
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%

12.5. Qau mapping unit

Table 12.5 Effective shade targets for stream sites in the Qau mapping unit.

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

Active Channel Width (m)	Active Channel Width (feet)	Effective Shade Target for E-W Stream Aspects	Effective Shade Target for NW-SE, NE-SW Stream Aspects	Effective Shade Target for N-S Stream Aspects
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%
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%

Active Channel Width (m)	Active Channel Width (feet)	Effective Shade Target for E-W Stream Aspects	Effective Shade Target for NW-SE, NE-SW Stream Aspects	Effective Shade Target for N-S Stream Aspects
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%
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%

Active Channel Width (m)	Active Channel Width (feet)	Effective Shade Target for E-W Stream Aspects	Effective Shade Target for NW-SE, NE-SW Stream Aspects	Effective Shade Target for N-S Stream Aspects
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%

12.6. Qalf mapping unit

Table 12.6 Effective shade targets for stream sites in the Qalf mapping unit.

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

Active Channel Width (m)	Active Channel Width (feet)	Effective Shade Target for E-W Stream Aspects	Effective Shade Target for NW-SE, NE-SW Stream Aspects	Effective Shade Target for N-S Stream Aspects
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%
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%

Active Channel Width (m)	Active Channel Width (feet)	Effective Shade Target for E-W Stream Aspects	Effective Shade Target for NW-SE, NE-SW Stream Aspects	Effective Shade Target for N-S Stream Aspects
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%
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%

12.7. Qaff2 mapping unit

Table 12.7 Effective shade targets for stream sites in the Qff2 mapping unit.

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

Active Channel Width (m)	Active Channel Width (feet)	Effective Shade Target for E-W Stream Aspects	Effective Shade Target for NW-SE, NE-SW Stream Aspects	Effective Shade Target for N-S Stream Aspects
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%
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%

Active Channel Width (m)	Active Channel Width (feet)	Effective Shade Target for E-W Stream Aspects	Effective Shade Target for NW-SE, NE-SW Stream Aspects	Effective Shade Target for N-S Stream Aspects
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%

12.8. Qbf mapping unit

Table 12.8 Effective shade targets for stream sites in the Qbf mapping unit.

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

Active Channel Width (m)	Active Channel Width (feet)	Effective Shade Target for E-W Stream Aspects	Effective Shade Target for NW-SE, NE-SW Stream Aspects	Effective Shade Target for N-S Stream Aspects
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%
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%

Active Channel Width (m)	Active Channel Width (feet)	Effective Shade Target for E-W Stream Aspects	Effective Shade Target for NW-SE, NE-SW Stream Aspects	Effective Shade Target for N-S Stream Aspects
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%
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%

12.9. Tvc mapping unit

Table 12.9 Effective shade targets for stream sites in the Tvc mapping unit.

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

Active Channel Width (m)	Active Channel Width (feet)	Effective Shade Target for E-W Stream Aspects	Effective Shade Target for NW-SE, NE-SW Stream Aspects	Effective Shade Target for N-S Stream Aspects
45.7	150	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%
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%

Active Channel Width (m)	Active Channel Width (feet)	Effective Shade Target for E-W Stream Aspects	Effective Shade Target for NW-SE, NE-SW Stream Aspects	Effective Shade Target for N-S Stream Aspects
274.3	900	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%
518.2	1700	6%	5%	3%
533.4	1750	6%	5%	3%
548.6	1800	6%	5%	3%
563.9	1850	6%	5%	3%

12.10. Qtg mapping unit

Table 12.10 Effective shade targets for stream sites in the Qtg mapping unit.

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

Active Channel Width (m)	Active Channel Width (feet)	Effective Shade Target for E-W Stream Aspects	Effective Shade Target for NW-SE, NE-SW Stream Aspects	Effective Shade Target for N-S Stream Aspects
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%
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%

Active Channel Width (m)	Active Channel Width (feet)	Effective Shade Target for E-W Stream Aspects	Effective Shade Target for NW-SE, NE-SW Stream Aspects	Effective Shade Target for N-S Stream Aspects
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%
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%

Active Channel Width (m)	Active Channel Width (feet)	Effective Shade Target for E-W Stream Aspects	Effective Shade Target for NW-SE, NE-SW Stream Aspects	Effective Shade Target for N-S Stream Aspects
548.6	1800	12%	10%	5%
563.9	1850	11%	10%	5%

12.11. Tvw mapping unit

Table 12.11 Effective shade targets for stream sites in the Tvw mapping unit.

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

Active Channel Width (m)	Active Channel Width (feet)	Effective Shade Target for E-W Stream Aspects	Effective Shade Target for NW-SE, NE-SW Stream Aspects	Effective Shade Target for N-S Stream Aspects
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%
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%

Active Channel Width (m)	Active Channel Width (feet)	Effective Shade Target for E-W Stream Aspects	Effective Shade Target for NW-SE, NE-SW Stream Aspects	Effective Shade Target for N-S Stream Aspects
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%
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%

12.12. Tcr mapping unit

Table 12.12 Effective shade targets for stream sites in the Tcr mapping unit.

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

Active Channel Width (m)	Active Channel Width (feet)	Effective Shade Target for E-W Stream Aspects	Effective Shade Target for NW-SE, NE-SW Stream Aspects	Effective Shade Target for N-S Stream Aspects
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%
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%

Active Channel Width (m)	Active Channel Width (feet)	Effective Shade Target for E-W Stream Aspects	Effective Shade Target for NW-SE, NE-SW Stream Aspects	Effective Shade Target for N-S Stream Aspects
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%
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%

Active Channel Width (m)	Active Channel Width (feet)	Effective Shade Target for E-W Stream Aspects	Effective Shade Target for NW-SE, NE-SW Stream Aspects	Effective Shade Target for N-S Stream Aspects
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%

12.13. Tm mapping unit

Table 12.13 Effective shade targets for stream sites in the Tm mapping unit.

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

Active Channel Width (m)	Active Channel Width (feet)	Effective Shade Target for E-W Stream Aspects	Effective Shade Target for NW-SE, NE-SW Stream Aspects	Effective Shade Target for N-S Stream Aspects
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%
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%

Active Channel Width (m)	Active Channel Width (feet)	Effective Shade Target for E-W Stream Aspects	Effective Shade Target for NW-SE, NE-SW Stream Aspects	Effective Shade Target for N-S Stream Aspects
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%
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%

12.14. QTt mapping unit

Table 12.14 Effective shade targets for stream sites in the QTt mapping unit.

Active Channel Width (m)	Active Channel Width (feet)	Effective Shade Target for E-W Stream Aspects	Effective Shade Target for NW-SE, NE-SW Stream Aspects	Effective Shade Target for N-S Stream Aspects
0.2	0.5	91%	93%	94%
0.3	1	91%	92%	94%

Active Channel Width (m)	Active Channel Width (feet)	Effective Shade Target for E-W Stream Aspects	Effective Shade Target for NW-SE, NE-SW Stream Aspects	Effective Shade Target for N-S Stream Aspects
0.6	2	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%
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%

Active Channel Width (m)	Active Channel Width (feet)	Effective Shade Target for E-W Stream Aspects	Effective Shade Target for NW-SE, NE-SW Stream Aspects	Effective Shade Target for N-S Stream Aspects
54.9	180	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%
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%

Active Channel Width (m)	Active Channel Width (feet)	Effective Shade Target for E-W Stream Aspects	Effective Shade Target for NW-SE, NE-SW Stream Aspects	Effective Shade Target for N-S Stream Aspects
365.8	1200	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%

12.15. QTb mapping unit

Table 12.15 Effective shade targets for stream sites in the QTb mapping unit.

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

Active Channel Width (m)	Active Channel Width (feet)	Effective Shade Target for E-W Stream Aspects	Effective Shade Target for NW-SE, NE-SW Stream Aspects	Effective Shade Target for N-S Stream Aspects
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%
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%

Active Channel Width (m)	Active Channel Width (feet)	Effective Shade Target for E-W Stream Aspects	Effective Shade Target for NW-SE, NE-SW Stream Aspects	Effective Shade Target for N-S Stream Aspects
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%
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%

12.16. Qls mapping unit

Table 12.16 Effective shade targets for stream sites in the Qls mapping unit.

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

Active Channel Width (m)	Active Channel Width (feet)	Effective Shade Target for E-W Stream Aspects	Effective Shade Target for NW-SE, NE-SW Stream Aspects	Effective Shade Target for N-S Stream Aspects
48.8	160	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%
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%

Active Channel Width (m)	Active Channel Width (feet)	Effective Shade Target for E-W Stream Aspects	Effective Shade Target for NW-SE, NE-SW Stream Aspects	Effective Shade Target for N-S Stream Aspects
304.8	1000	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%
548.6	1800	11%	10%	6%
563.9	1850	11%	10%	5%

12.17. Open Water (OW)

Table 12.17 Effective shade targets for stream sites classified as Open Water (OW).

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

Active Channel Width (m)	Active Channel Width (feet)	Effective Shade Target for E-W Stream Aspects	Effective Shade Target for NW-SE, NE-SW Stream Aspects	Effective Shade Target for N-S Stream Aspects
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%
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%

Active Channel Width (m)	Active Channel Width (feet)	Effective Shade Target for E-W Stream Aspects	Effective Shade Target for NW-SE, NE-SW Stream Aspects	Effective Shade Target for N-S Stream Aspects
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%
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%

Active Channel Width (m)	Active Channel Width (feet)	Effective Shade Target for E-W Stream Aspects	Effective Shade Target for NW-SE, NE-SW Stream Aspects	Effective Shade Target for N-S Stream Aspects
548.6	1800	0%	0%	0%
563.9	1850	0%	0%	0%

12.18. Upland Forest

Table 12.18 Effective shade targets for stream sites in the Upland Forest mapping unit.

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

Active Channel Width (m)	Active Channel Width (feet)	Effective Shade Target for E-W Stream Aspects	Effective Shade Target for NW-SE, NE-SW Stream Aspects	Effective Shade Target for N-S Stream Aspects
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%
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%

Active Channel Width (m)	Active Channel Width (feet)	Effective Shade Target for E-W Stream Aspects	Effective Shade Target for NW-SE, NE-SW Stream Aspects	Effective Shade Target for N-S Stream Aspects
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%
396.2	1300	16%	14%	8%
411.5	1350	16%	13%	7%
426.7	1400	15%	13%	7%
442	1450	15%	13%	7%

Active Channel Width (m)	Active Channel Width (feet)	Effective Shade Target for E-W Stream Aspects	Effective Shade Target for NW-SE, NE-SW Stream Aspects	Effective Shade Target for N-S Stream Aspects
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%

12.19. 1d/1f - Volcanics and Willapa Hills

Table 12.19 Effective shade targets for stream sites in Ecoregion 1d/1f - Volcanics and Willapa Hills.

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

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%
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%

12.20. 3a - Portland/Vancouver Basin

Table 12.20 Effective shade targets for stream sites in Ecoregion 3a - Portland/Vancouver Basin.

Active Channel Width (m)	Active Channel Width (feet)	Effective Shade Target for E-W Stream Aspects	Effective Shade Target for NW-SE, NE-SW Stream Aspects	Effective Shade Target for N-S Stream Aspects
0.2	0.5	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%
48.8	160	42%	38%	28%
50.3	165	41%	37%	27%

Active Channel Width (m)	Active Channel Width (feet)	Effective Shade Target for E-W Stream Aspects	Effective Shade Target for NW-SE, NE-SW Stream Aspects	Effective Shade Target for N-S Stream Aspects
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%
304.8	1000	12%	10%	6%
320	1050	12%	10%	5%

Active Channel Width (m)	Active Channel Width (feet)	Effective Shade Target for E-W Stream Aspects	Effective Shade Target for NW-SE, NE-SW Stream Aspects	Effective Shade Target for N-S Stream Aspects
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%

12.21. 3c - Prairie Terraces

Table 12.21 Effective shade targets for stream sites in Ecoregion 3c - Prairie Terraces.

Active Channel Width (m)	Active Channel Width (feet)	Effective Shade Target for E-W Stream Aspects	Effective Shade Target for NW-SE, NE-SW Stream Aspects	Effective Shade Target for N-S Stream Aspects
0.2	0.5	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%
9.1	30	84%	83%	89%
10.7	35	82%	81%	87%

Active Channel Width (m)	Active Channel Width (feet)	Effective Shade Target for E-W Stream Aspects	Effective Shade Target for NW-SE, NE-SW Stream Aspects	Effective Shade Target for N-S Stream Aspects
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%
73.2	240	42%	37%	27%
74.7	245	41%	37%	27%

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

12.22. 3d - Valley Foothills

Table 12.22 Effective shade targets for stream sites in Ecoregion 3d - Valley Foothills.

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

Active Channel Width (m)	Active Channel Width (feet)	Effective Shade Target for E-W Stream Aspects	Effective Shade Target for NW-SE, NE-SW Stream Aspects	Effective Shade Target for N-S Stream Aspects
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%
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%

Active Channel Width (m)	Active Channel Width (feet)	Effective Shade Target for E-W Stream Aspects	Effective Shade Target for NW-SE, NE-SW Stream Aspects	Effective Shade Target for N-S Stream Aspects
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%