Modeling Quality Assurance Project Plan for the Middle Willamette Subbasins Temperature Total Maximum Daily Load

December 2021

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State of Oregon
Department of Environmental Quality

Last Updated: 12/09/2021
DEQ21-LAB-0051-QAPP
Version 1.0

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Abbreviations

AWQMS	Ambient Water Quality Monitoring System
BLM	United States Bureau of Land Management
DEQ	Oregon Department of Environmental Quality
DMR	Discharge Monitoring Report
EQC	Oregon Environmental Quality Commission
NCDC	National Climatic Data Center
NPDES	National Pollutant Discharge Elimination System
NWS	National Weather Service
OAR	Oregon Administrative Rule
OWRD	Oregon Water Resources Department
QAPP	Quality Assurance Project Plan
RAWS	Remote Automatic Weather Stations
STP	Sewage Treatment Plant
SWCD	Soil and Water Conservation District
TIR	Thermal Infrared Radiometry
TMDL	Total Maximum Daily Load
USBR	United States Bureau of Reclamation
USEPA	United States Environmental Protection Agency
USFS	United States Forest Service
USGS	United States Geological Survey
WRIS	Water Rights Information System
WWTP	Waste water treatment plant

1 Introduction

This Quality Assurance Project Plan (QAPP) summarizes the modeling approach to be used for the temperature TMDL replacement project applicable within the Middle Willamette Subbasin (17090007), the Molalla-Pudding Subbasin (17090009), the North Santiam Subbasin (17090005), and the South Santiam Subbasin (17090006), which collectively make up the project area called the Middle Willamette Subbasins. This QAPP project area excludes the Willamette River, the Santiam River, the North Santiam River downstream of Detroit Dam, and the South Santiam River downstream of Foster Dam. These waterbodies are included in the Willamette River and Major Tributaries QAPP.

A TMDL is a water quality restoration plan and the calculation of the maximum amount of a pollutant that a waterbody can receive while still meeting water quality standards for that particular pollutant. The maximum amount of loading a waterbody can receive is called the loading capacity. Loading from all pollutant sources must not exceed the loading capacity (TMDL) of a waterbody, including an appropriate margin of safety.

Load allocations are portions of the loading capacity that are allocated to background sources or non-point sources, such as urban, rural agriculture, or forestry activities. Wasteload allocations are portions of the total load, which are allocated to NPDES permitted sources, such as wastewater treatment plants or industries. Wasteload allocations are used to establish effluent limits in NPDES discharge permits. Allocations may also be reserved for future uses, called reserve capacity. Allocations are quantified measures that assure water quality standards will be met and may distribute the pollutant loads between nonpoint and point sources. This general TMDL concept is represented by Equation 1.

$$TMDL = \sum WLA + \sum LA + \text{Reserve Capacity} + MOS \qquad \text{Equation 1}$$

Where $\sum WLA$ is the sum of wasteload allocations (NPDES permitted sources), $\sum LA$ is the sum of load allocations (nonpoint sources and background), Reserve Capacity is allocations reserved for future uses, and MOS is a margin-of-safety to account for uncertainty. For a temperature TMDL, these elements establish the maximum thermal loads that a waterbody may receive without exceeding applicable water quality standards for temperature designed to protect aquatic life and other beneficial uses.

The Clean Water Act requires TMDLs be developed for waterbodies that do not meet water quality standards and are listed as water quality impaired on the State's 303(d) list. The Middle Willamette Subbasins include several waterbodies listed on the Oregon 2018/2020 Section 303(d) Category 5 list as water quality limited for temperature (Table 1). TMDLs were previously developed for the Middle Willamette Subbasins (DEQ, 2006 and DEQ, 2008) but they must be replaced due to recent litigation.

In 2013, the United States Environmental Protection Agency (USEPA) disapproved the Natural Conditions Criterion contained in Oregon's water quality standard for temperature due to the 2012 U.S. District Court decision for NWEA v. EPA, 855 F. Supp. 2d 1199 (D. Or., 2012). This portion of the temperature water quality standard was used in most temperature TMDLs issued from 2003 through 2012. On October 4, 2019, the U.S. District Court issued a judgment for NWEA v. EPA, No. 3:12-cv-01751-HZ (D. Or., Oct. 4, 2019) and required DEQ and USEPA to replace 15 Oregon temperature TMDLs that were based on the Natural Conditions Criterion and to reissue the temperature TMDLs based on the remaining elements of the temperature water quality standard.

This QAPP is consistent with DEQ's and USEPA's modeling QAPP guidance (DEQ, 2017; EPA, 2016) and documents the analysis and numerical modeling approach that will support the updated Middle

Willamette Subbasins TMDL as well as other project details. In particular, this QAPP details the following:

- Definition of the issue and objectives, including the spatial and temporal extents of the water quality impairments (Section 2);
- A high-level description of the key processes and variables for temperature (Section 3);
- The overarching technical approach, including the appropriate modeling and analytical tools to be used (Section 4);
- The data sources for defining and creating inputs to the model, including data that were used in the modeling for the original TMDL. Examples of these inputs include meteorological data, stream flow and temperature, point sources and vegetation characteristics (Sections 5 and 6);
- How the analysis and modeling will be evaluated for acceptability (Sections 7 and 9);
- Scenarios for evaluating management strategies for reducing anthropogenic thermal loads (Section 10);
- Various aspects for managing the TMDL development project, including documentation (Section 8), the project team (Section 11), data and records management (Sections 12 and 13); and
- Aspects relating to this QAPP and its role in the project (Sections 14 and 15).

2 Problem definition and management objectives

Multiple waterbodies in the Middle Willamette Subbasins do not meet the water quality standards for temperature and are listed as Category 5, water quality limited on Oregon's 2018/2020 Section 303(d) list (Table 1). The temperature water quality standards are set at a level to protect the most sensitive beneficial uses. The beneficial uses most sensitive to water temperature are fish and aquatic life. The temperature water quality standards in the Middle Willamette Subbasins include the numeric criteria identified below. The numeric temperature criteria are based on a seven-day average daily maximum continuous measurement of temperature.

- Salmon and Steelhead Spawning: 13.0 deg-C (OAR 340-041-0028(4)(a))
- Core Cold Water Habitat: 16.0 deg-C (OAR 340-041-0028(4)(b))
- Salmon and Trout Rearing and Migration: 18.0 deg-C (OAR 340-041-0028(4)(c))

Where and when the applicable criteria apply are based on the designated fish uses maps in OAR 340-041-0340 Figure 340A and Figure 340B. The fish use designations and applicable criteria are shown in the HTML interactive map that accompanies this QAPP and is referenced in Appendix D.

The temperature standard authorizes insignificant additions of heat from human sources in waters that exceed the applicable temperature criteria as follows: Following a temperature TMDL or other

cumulative effects analysis, the Human Use Allowance (HUA) will restrict all NPDES point sources and nonpoint sources to a cumulative increase of no greater than 0.3 deg-C (OAR 340-041-0028(12)(b)).

As described in Chapter 1, the U.S. Environmental Protection Agency (USEPA) and State of Oregon (OR) are required to revise the water temperature TMDL for the Middle Willamette Subbasins. In revising the TMDL, all of the allocations will be updated to target the applicable biologically-based numeric criteria (BBNC) and Human Use Allowance (HUA) water quality temperature standards.

Since the issuance of the original TMDL, the extent and number of waterbodies that are identified as water quality limited for temperature has changed. As part of the TMDL update, DEQ will address all current temperature listings based on the most recent integrated report list. The current listings, as they pertain to the Middle Willamette Subbasins QAPP project area, were obtained from Oregon's 2018/2020 Integrated Report and are summarized in Table 1. The listings are also shown in the HTML interactive map that accompanies this QAPP and referenced in Appendix D.

To the extent existing data and information allow, the primary analysis and modeling objectives for this TMDL include:

1) Complete a source assessment and cumulative effects analysis to characterize or identify:

    a. Anthropogenic sources of stream temperature warming;
    b. How much warming comes from background sources;
    c. How much warming comes from each anthropogenic source or source category;
    d. The cumulative warming from all anthropogenic sources combined;
    e. Where along the stream anthropogenic warming occurs;
    f. Where the point of maximum stream warming is located; and
    g. The amount of stream warming that exceeds the human use allowance and applicable water quality standards.

2) Determine TMDL elements and allocations that attain the applicable temperature criteria by identifying:

    a. The thermal loading capacity for each temperature listed waterbody;
    b. The excess thermal load exceeding the loading capacity for each temperature listed waterbody;
    c. The thermal load and wasteload allocations necessary to meet the applicable water quality standards for each listed waterbody;
    d. Any surrogate measures;
    e. Any reserve capacity;
    f. Any margin of safety; and
    g. The seasonal variation and critical conditions corresponding to the time period when the applicable temperature criteria are exceeded.

3) Support development of the TMDL Water Quality Management Plan and evaluate implementation options.

    a. Evaluate existing land management plans, TMDL implementation plans, or rules for sufficiency in minimizing anthropogenic warming to the level established by the TMDL allocations.

b. Identify additional management strategies or surrogate measures.
c. Identify under what timeline and where management strategies need to be implemented.

The effort currently described in the QAPP includes use of existing models and the development of new models or new model scenarios.

Table 1: Middle Willamette Subbasins assessment units that are classified as water quality limited category 5 for temperature based on the Section 303(d) 2018/2020 Integrated Report.

Assessment Unit Name	Assessment Unit ID	Year Listed	Use Period
Abernethy Creek	OR_SR_1709000704_02_104017	2010	Year Round
Abernethy Creek	OR_SR_1709000704_02_104594	2010	Year Round
Abiqua Creek	OR_SR_1709000901_02_104062	2018	Year Round
Bear Branch	OR_SR_1709000506_02_103928	2010	Year Round
Bear Creek Watershed	OR_WS_170900090303_02_104470	2010	Year Round
Beaver Creek	OR_SR_1709000606_02_103973	2010	Year Round
Bilyeu Creek	OR_SR_1709000607_02_103986	2010	Year Round
Bilyeu Creek	OR_SR_1709000607_02_103989	2010	Year Round
Blowout Creek	OR_SR_1709000503_02_103907	2018	Year Round
Blowout Creek	OR_SR_1709000503_02_103909	2018	Year Round
Boulder Creek	OR_SR_1709000502_02_103902	2018	Year Round
Brandy Creek-Pudding River Watershed	OR_WS_170900090204_02_104467	2010	Year Round
Butte Creek	OR_SR_1709000902_02_104070	2010	Year Round
Butte Creek	OR_SR_1709000902_02_104072	2018	Year Round
Canyon Creek	OR_SR_1709000602_02_103949	2018	Year Round
Chehalem Creek Watershed	OR_WS_170900070306_02_104417	2010	Year Round
Chehulpum Creek	OR_SR_1709000506_02_103926	2010	Year Round
Cougar Creek-Middle Santiam River Watershed	OR_WS_170900060102_02_104364	2010	Year Round
Crabtree Creek	OR_SR_1709000606_02_103978	2010	Spawning, Year Round
Croisan Creek-Willamette River Watershed	OR_WS_170900070301_02_104413	2010	Year Round
Croisan Creek-Willamette River Watershed	OR_WS_170900070301_02_104413	2018	Spawning
Drift Creek	OR_SR_1709000901_02_104069	2010	Year Round
Drift Creek	OR_SR_1709000901_02_104069	2018	Spawning
Elkhorn Creek	OR_SR_1709000505_02_103923	2010	Year Round
Foster Lake	OR_LK_1709000604_02_100772	2010	Year Round
Glenn Creek-Willamette River Watershed	OR_WS_170900070303_02_104415	2018	Year Round

Assessment Unit Name	Assessment Unit ID	Year Listed	Use Period
Green Peter Lake	OR_LK_1709000603_02_100771	2010	Year Round
Hamilton Creek	OR_SR_1709000608_02_103993	2010	Spawning, Year Round
Hamilton Creek	OR_SR_1709000608_02_103996	2010	Spawning, Year Round
Hamilton Creek Watershed	OR_WS_170900060804_02_104398	2010	Year Round
Headwaters Pudding River Watershed	OR_WS_170900090101_02_104454	2010	Year Round
Lambert Slough-Willamette River Watershed	OR_WS_170900070304_02_104599	2010	Year Round
Latiwi Creek	OR_SR_1709000602_02_103955	2018	Year Round
Little North Santiam River	OR_SR_1709000505_02_104564	2010	Year Round
Little North Santiam River	OR_SR_1709000505_02_104564	2018	Spawning
Little Wiley Creek Watershed	OR_WS_170900060501_02_104384	2010	Year Round
Lower Mill Creek Watershed	OR_WS_170900070204_02_104412	2018	Year Round
Lower Thomas Creek Watershed	OR_WS_170900060705_02_104394	2010	Year Round
Marion Creek-North Santiam River Watershed	OR_WS_170900050603_02_104361	2010	Spawning, Year Round
Marion Creek Watershed	OR_WS_170900050203_02_104345	2010	Year Round
McDowell Creek	OR_SR_1709000608_02_103994	2010	Year Round
McDowell Creek Watershed	OR_WS_170900060802_02_104396	2010	Year Round
McKinney Creek Watershed	OR_WS_170900070203_02_104411	2018	Year Round
Middle Butte Creek Watershed	OR_WS_170900090202_02_104465	2010	Year Round
Middle Little North Santiam River Watershed	OR_WS_170900050504_02_104563	2010	Year Round
Middle Santiam River	OR_SR_1709000601_02_103934	2010	Year Round
Middle Santiam River	OR_SR_1709000601_02_103936	2010	Year Round
Middle Santiam River	OR_SR_1709000601_02_103938	2010	Year Round
Middle Santiam River	OR_SR_1709000603_02_103965	2010	Year Round
Middle Santiam River	OR_SR_1709000604_02_103969	2018	Spawning
Mill Creek	OR_SR_1709000703_02_104007	2010	Spawning, Year Round
Molalla River	OR_SR_1709000904_02_104086	2010	Spawning, Year Round
Moose Creek	OR_SR_1709000602_02_103954	2010	Spawning, Year Round
Owl Creek	OR_SR_1709000602_02_103941	2018	Year Round

Assessment Unit Name	Assessment Unit ID	Year Listed	Use Period
Pine Creek-Molalla River Watershed	OR_WS_170900090403_02_104474	2010	Year Round
Pudding River	OR_SR_1709000905_02_104088	2010	Year Round
Pudding River	OR_SR_1709000901_02_104067	2018	Year Round
Pyramid Creek	OR_SR_1709000601_02_103935	2018	Year Round
Quartzville Creek	OR_SR_1709000603_02_103960	2010	Year Round
Quartzville Creek	OR_SR_1709000603_02_103957	2018	Year Round
Rickreall Creek	OR_SR_1709000701_02_104591	2010	Year Round
Scott Creek	OR_SR_1709000608_02_103997	2010	Year Round
Sheep Creek	OR_SR_1709000602_02_103953	2018	Year Round
Silver Creek	OR_SR_1709000901_02_104595	2010	Year Round
Soda Fork	OR_SR_1709000602_02_103947	2018	Year Round
South Fork Neal Creek	OR_SR_1709000607_02_103985	2010	Year Round
South Fork Neal Creek Watershed	OR_WS_170900060704_02_104393	2010	Year Round
South Fork Silver Creek	OR_SR_1709000901_02_104066	2010	Year Round
South Santiam River	OR_SR_1709000604_02_103968	2010	Spawning, Year Round
South Santiam River	OR_SR_1709000602_02_103950	2018	Spawning, Year Round
Stout Creek	OR_SR_1709000506_02_103929	2010	Year Round
Table Rock Fork	OR_SR_1709000904_02_104087	2010	Spawning, Year Round
Thomas Creek	OR_SR_1709000607_02_103988	2010	Year Round
Thomas Creek	OR_SR_1709000607_02_103991	2010	Spawning, Year Round
Trout Creek	OR_SR_1709000602_02_103942	2018	Year Round
Two Girls Creek	OR_SR_1709000602_02_103948	2018	Year Round
Upper Blowout Creek Watershed	OR_WS_170900050301_02_104351	2018	Year Round
Upper Little North Santiam River Watershed	OR_WS_170900050503_02_104567	2010	Year Round
Wiley Creek	OR_SR_1709000605_02_103971	2010	Spawning, Year Round
Wiley Creek	OR_SR_1709000605_02_103972	2010	Spawning, Year Round
Willamette Slough	OR_LK_1709000703_02_100792	2010	Year Round
Zollner Creek	OR_LK_1709000902_02_100830	2010	Year Round

3 Conceptual model: key processes and variables

The current theory to explain the nature of heat is called the kinetic-molecular theory. The modern version of this theory was developed in the mid-19th century by Rudolf Clausis, James Clerk Maxwell, and Ludwig Boltzmann. The theory is based on the assumption that all matter is composed of a tiny population of molecules that are always in motion. The molecules in hot objects are moving faster and hence have greater kinetic energy than the molecules in cold objects. Individual molecules have a certain amount of kinetic energy based on their mass and velocity. The thermal energy of an object is determined by adding up the kinetic energy of all the molecules in that object. When a hot and cold object come into contact with each other, the molecules collide and the kinetic energy flows from the molecules with more kinetic energy to molecules with less kinetic energy. This type of flow of kinetic energy is called heat.

Temperature is an intensive property and much like concentration measures the "strength" rather than "quantity" of kinetic energy. The temperature of an object is the measure of the average kinetic energy of all the molecules in that object. Hot water has greater average kinetic energy than cold water but may not have greater total kinetic energy. For example, a small pot of water with a temperature near the boiling point has a higher average kinetic energy than a swimming pool at room temperature. The swimming pool has a much larger quantity of molecules and therefore a higher total kinetic energy than the pot of water.

Temperature is the water quality parameter of concern, but heat, in particular heat from human activities or anthropogenic sources, is the pollutant of concern. Water temperature change (ΔTw) is a function of the heat transfer in a discrete volume and may be described in terms of changes in heat per unit volume. Conversely, a change in volume can result in water temperature change for a defined amount of heat exchange. With this basic conceptual framework of water temperature change, it is possible to discuss stream temperature change as a function of two variables: heat and mass transfer.

Water Temperature Change as a Function of Heat Exchange and Volume,

$$\Delta Tw = \frac{\Delta Heat}{Density \times \text{Specific Heat} \times \Delta Volume} \qquad \text{Equation 2}$$

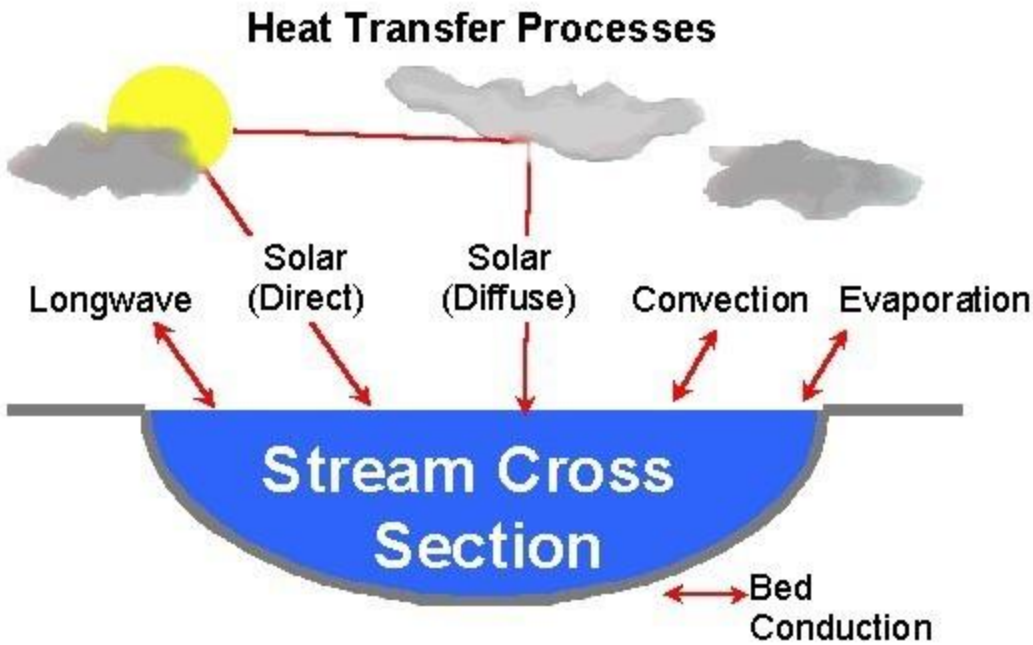

Figure 1: Major heat transfer processes.

Heat transfer relates to processes that change heat in a defined water volume. There are several thermodynamic pathways that can introduce or remove heat from a stream. These different processes are shown in Figure 1. For any given stream reach heat exchange is closely related to the season, time of day and the surrounding environment and the stream characteristics. Heat transfer can be dynamic and change over relatively small distances and time periods. Equation 3 describes the several heat transfer processes that change stream temperature (Wunderlich, 1972; Jobson and Keefer, 1979; Beschta and Weatherred, 1984; Sinokrot and Stefan, 1993; Boyd, 1996; Johnson, 2004; Hannah et al., 2008; Benyahya et al., 2012).

$$\Phi_{total} = \Phi_{solar} + \Phi_{longwave} + \Phi_{streambed} + \Phi_{convection} + \Phi_{evaporation} \qquad \text{Equation 3}$$

Where,
Φ_{total} = Net heat energy flux (+/-)
Φ_{solar} = Shortwave direct and diffuse solar radiation (+ only)
$\Phi_{longwave}$ = Longwave (thermal) radiation (+/-)
$\Phi_{streambed}$ = Streambed conduction (+/-)
$\Phi_{convection}$ = Stream/air convection[1] (+/-)
$\Phi_{evaporation}$ = Evaporation (+/-)

[1]Air/Water convection includes both turbulent and free surface conduction.

Mass transfer relates to transport of flow volume downstream, instream mixing and the introduction or removal of water from a stream. For instance, flow from a tributary will cause a temperature change if the temperature is different from the receiving water. Mass transfer commonly occurs in stream systems as a result of:

- Advection,
- Dispersion,
- Groundwater exchange,
- Hyporheic flows,
- Surface water exchange (e.g. tributary input, precipitation), and
- Other human related activities that alter stream flow volume.

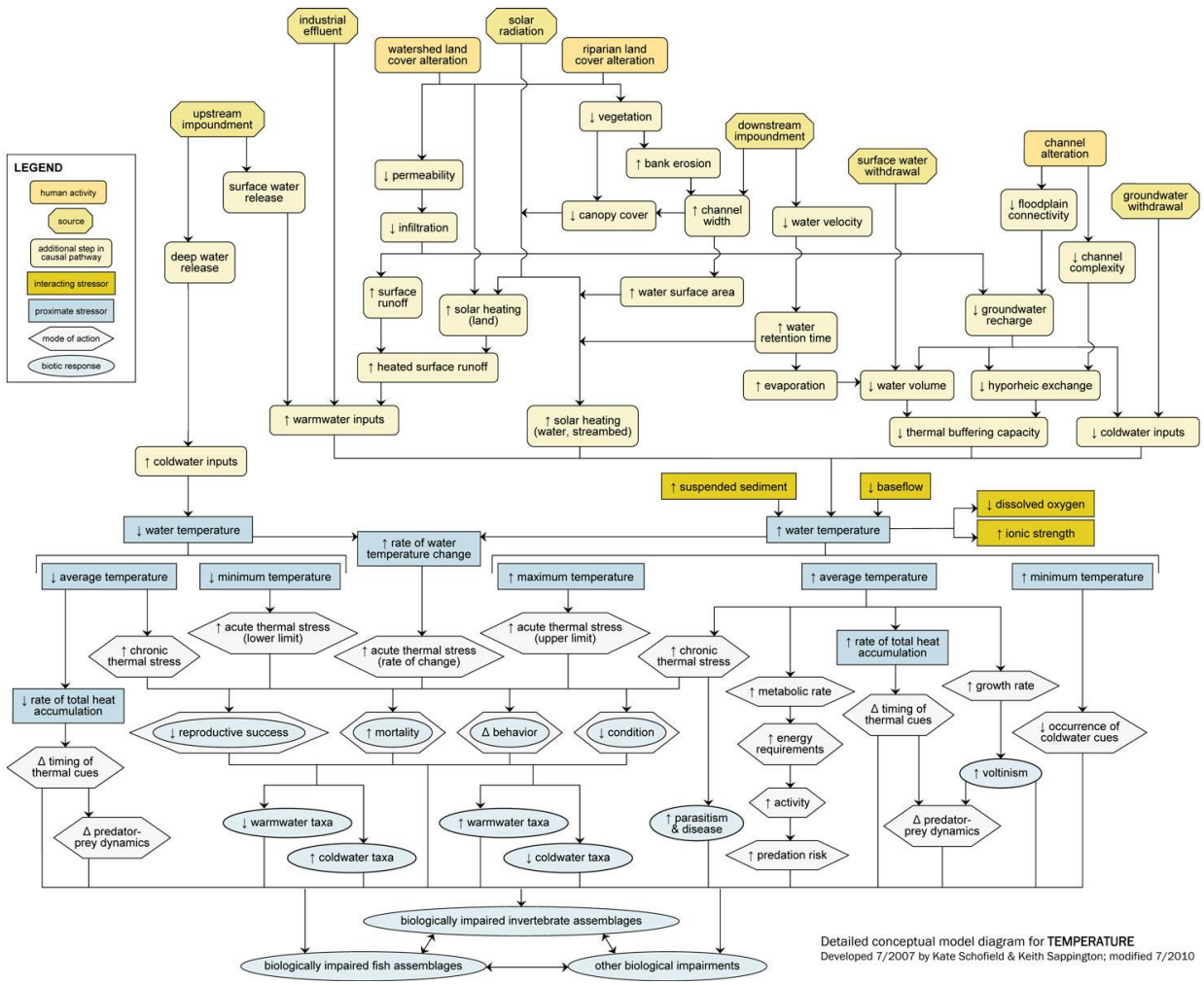

Figure 2: Conceptual diagram that identifies the key processes and variables that drive stream temperature changes and the biological responses (Schofield and Sappington, 2010).

Stream temperature is influenced by both human and natural factors. Figure 2 is a conceptual diagram that identifies the key process and variables that drive stream temperature. Human sources and natural sources are identified. Near the bottom of the diagram the biological responses are identified.

Anthropogenic Nonpoint Sources: Temperature increases from human-caused nonpoint sources are caused by increases in solar radiation loading to the stream network from the disturbance or removal of near-stream vegetation, channel modification and widening, reductions to the stream flow rate or volume,

changes in hyporheic flows and channel connectivity, reductions in cold groundwater inflows, and changes to meteorological conditions, such as those caused by climate change.

Background Sources: Background sources include all sources of pollution or pollutants not originating from human activities. In the context of a TMDL, background sources may also include anthropogenic sources of a pollutant that DEQ or another Oregon state agency does not have authority to regulate, such as pollutants emanating from another state, tribal lands, or sources otherwise beyond the jurisdiction of the state (OAR 340-042-0030(1)). Additionally, effective shade levels on smaller streams are more sensitive to riparian disturbances and so the differences between current condition solar flux and background solar flux can be larger.

Anthropogenic Point Sources: Temperature increases from point sources are those caused by warm water discharges from NPDES permitted facilities, such as industrial outfalls, municipal waste water treatment plants (WWTP), and other point sources.

4 Technical approach

4.1 Overview

Stream temperature TMDLs are generally scaled to a subbasin or basin scale since stream temperatures are affected by cumulative interactions between upstream and local sources. For this reason the TMDL considers all surface waters that affect the temperatures of 303(d) listed waterbodies. For example, the Pudding River is water quality limited for temperature. To address this listing in the TMDL, all upstream waterbodies are considered in the TMDL analysis and TMDL allocations are applied throughout the entire stream network and include all waters of the state.

An important step in the TMDL is to perform a source assessment which quantifies the background and anthropogenic contributions to stream heating. Models provide a way to evaluate potential sources of stream warming and, to the extent existing data allow, the amount of pollutant loading from these sources. The model that is selected for the TMDL analysis should support the needs of the project. Section 4.2 describes the model framework needs for this project and the models that will be used to support the TMDL.

TMDLs also require identification of seasonal variation and critical conditions. The TMDL analysis will determine seasonal variation by including a statistical summary and visual plots summarizing the instream temperatures and flow rates observed at various monitoring locations. The time period when the applicable temperature criteria are exceeded will be described in relation to the critical conditions.

The TMDL will establish a loading capacity which specifies the amount of a pollutant or pollutants that a waterbody can receive and still meet water quality standards. The pollutant addressed in the temperature TMDL is heat. The TMDL will divide the loading capacity into thermal wasteload allocations for NPDES permittees and load allocations for background and nonpoint sources of heat to ensure that the applicable temperature standards are achieved. Anthropogenic nonpoint and NPDES permitted point sources are not permitted to heat a waterbody more than 0.3 deg-C above the applicable criteria, cumulatively at the point of maximum impact. The portion of the human use allowance allocated to each source will be determined in the TMDL with the modeling approach supporting assessment of different allocation options. The modeling approach may also be used to support development of TMDL surrogate measures such as effective shade targets. Nonpoint source allocations can be translated into surrogate measures when a

pollutant is difficult to measure, highly variable, or difficult to monitor (OAR 340-042-0040(5)(b)). Thermal load allocations for nonpoint sources can be difficult to measure and monitor. Attainment of the surrogate measures ensures compliance with the nonpoint source allocations.

Stream temperatures for the Molalla-Pudding Subbasin TMDL and WQMP (DEQ, 2008) and Willamette Basin TMDL and WQMP (DEQ, 2006) were simulated using the computer models (Heat Source version 6 temperature model, Heat Source version 7 temperature model, and Heat Source version 8 temperature model). The models extents include some of the main rivers in the project area that contain or influence primary fish habitat. These models also are tributaries to the series of CE-QUAL-W2 models that are proposed to be used for the Willamette Mainstem and major tributaries temperature TMDL project area. The heat source and CE-QUAL-W2 models will not be linked directly since the model years are different, but the temperature outputs of the heat source models may be used to develop the boundary conditions temperatures for some of the Wilmette mainstem project area management scenarios.

Site-specific load allocations will be developed for the streams that are simulated. Other streams are assigned generalized load allocations based on effective shade surrogate measures that target site potential or restored vegetation types. Numeric or narrative wasteload allocations will be developed for all NPDES permittees.

4.2 Model selection

The modeling framework needs for this project include:

1) Prediction of hourly stream temperatures over a period of months and at a no greater than 500 meter longitudinal resolution.

2) Prediction of hourly solar radiation flux and daily effective shade at a no greater than 100 meter longitudinal resolution.

3) Ability to evaluate hourly stream temperature response from changes in streamside vegetation.

4) Ability to evaluate hourly stream temperature response from changes in water withdrawals and tributary stream flow within the upstream catchment.

5) Ability to evaluate hourly stream temperature response from changes in channel morphology within the upstream catchment.

6) Ability to evaluate hourly stream temperature response from changes in effluent temperature and flow discharge from NPDES permitted facilities.

The Heat Source stream thermodynamics model (Boyd and Kasper, 2003) meets all these model framework needs and was selected for stream temperature simulation in the project area. The Heat Source model was originally developed at Oregon State University as a master's thesis where it was evaluated and approved by an academic committee (Boyd, 1996). Development of the model continued and in 1999 DEQ submitted the model equations and methodology for peer review (DEQ, 1999) and again in 2004 to the Independent Multidisciplinary Science Team (IMST, 2004) where the model was found to be scientifically sound.

The Heat Source model has been used in numerous stream temperature related studies including Loheide and Gorelick (2006), Diabat et al. (2013), Holzapfel et al. (2013), Lawrence et al. (2014), Bond et al. (2015), Woltemade and Hawkins (2016), Justice et al. (2017), and Wondzell et al. (2019). Heat Source

has also been used in numerous Oregon TMDLs (DEQ, 2001, 2002, 2003, 2005, 2006, 2007, 2008, 2010, 2018, 2019).

4.3 Software Development Quality Assessment

We do not anticipate any new software development or model code changes as part of this project.

5 Data availability and quality

This chapter describes the data that is available to support the TMDL project and the quality assurance procedures used when collecting or reviewing the available data.

5.1 Meteorology

Meteorological data includes air temperature, sky conditions, cloudiness, relative humidity, and wind speed. Table 38 through Table 41 in Appendix A list the stations where meteorological data available in the Middle Willamette Subbasins, including 165 stations from National Oceanic and Atmospheric Association (NOAA)'s National Climatic Data Center (NCDC), 1 station from National Interagency Fire Center's Remote Automatic Weather Stations (RAWS), 3 stations from Bureau of Reclamation Cooperative Agricultural Weather Network (AgriMet), and 139 stations from University of Utah MesoWest database. The meteorological monitoring stations are also shown in the HTML interactive map that accompanies this QAPP and is referenced in Appendix D. The station IDs in Table 38 are the NCDC ID, which may differ from the station identifiers used by other sources.

The meteorological data obtained from the NCDC includes the Local Climatological Dataset (NOAA, 2005) and the Global Integrated Surface Dataset (NOAA, 2001). The Local Climatological Dataset includes quality controlled meteorological data from airports and other prominent weather stations managed by the National Weather Service, Federal Aviation Administration, and the U.S. Department of Defense. The Global Integrated Surface Dataset provides a long-term record of hourly, sub-hourly and synoptic weather observations from a variety of meteorological networks around the world. The dataset includes observations from the World Meteorological Organization, Automated Surface Observing System, Automated Weather Observing Stations, U.S. Climate Reference Network, and others.

5.2 Thermal Infrared Radiometry (TIR) data

DEQ contracted with Watershed Sciences, Inc. to provide airborne Thermal Infrared Radiometry (TIR) imagery of spatial temperature patterns within the Middle Willamette Subbasins (Watershed Sciences, 2001, Watershed Sciences, 2005). TIR data is used to characterize the thermal regime of the streams and habitat quality. All streams and the TIR collection dates are summarized in Table 2.

Table 2: Streams and the TIR collection dates in the Middle Willamette Subbasins.

Stream	Survey Extent	Date	Time	Survey Distance
Beverly Creek	Mouth to headwaters	2000-08-02	15:24-15:31	2.3 mi

Stream	Survey Extent	Date	Time	Survey Distance
Bonnie Creek	Mouth to headwaters	2000-08-03	14:38-14:41	2 mi
Boulder Creek	Mouth to headwaters	2000-08-02	14:51-14:57	2.9 mi
Canal Creek	Mouth to Elk Creek	2000-08-02	15:59-16:04	2.7 mi
Crabtree Creek	River mile 30.6 to downstream of Crabtree Lake	2000-08-02	16:13-16:25	6.1 mi
Elkhorn Creek	Mouth to river mile 3.3	2000-08-01	15:04-15:10	3.3 mi
Hamilton Creek	Deer Creek to headwaters	2000-08-03	13:38-13:51	3.8 mi
Hamilton Creek South Branch	Mouth to headwaters	2000-08-03	13:54-14:05	2.5 mi
Little North Fork Santiam River	Mouth to Henline Creek	2000-08-01	14:33-15:00	16.8 mi
Molalla River	Mouth to headwaters	2004-07-26	14:36-16:23	47.1 mi
Packers Gulch	Mouth to headwaters	2000-08-02	15:05-15:14	3 mi
Pat Creek	Mouth to headwaters	2000-08-02	15:34-15:37	1.4 mi
Pudding River	Mouth to Little Pudding River	2004-08-11	16:01-17:59	36.7 mi
Pudding River	Little Pudding River to heatwaters	2004-08-12	14:07-15:48	26.8 mi
Quartzville Creek	Green Peter Reservoir to Canal Creek	2000-08-02	15:43-15:59	8.9 mi
Schafer Creek	Mouth to headwaters	2000-08-02	16:13-16:25	1.2 mi
South Fork Packers Gulch	Mouth to headwaters	2000-08-02	15:01-15:05	1.8 mi
South Fork Scott Creek	Mouth to headwaters	2000-08-03	13:22-13:33	5.3 mi
South Santiam River	Confluence with the North Santiam River to Foster Reservoir	2000-08-01	15:32 - 16:16	35.9 mi
Thomas Creek	Mouth to Neal Creek	2000-08-03	16:16-16:43	16 mi
Thomas Creek	River mile 22.2 to River mile 35.8	2000-08-03	16:50-17:08	10 mi

Stream	Survey Extent	Date	Time	Survey Distance
Unnamed Tributary to Crabtree Creek	Mouth to headwaters	2000-08-03	14:11-14:18	2.6 mi
Unnamed Tributary to Quartzville Ck	Mouth to headwaters	2000-08-02	14:19-14:22	1.1 mi
Unnamed Tributary to Unnamed Trib of Crabtree Creek	Mouth to headwaters	2000-08-03	14:20-14:24	1.1 mi
Unnamed Tributary to Yellowstone Creek	Mouth to headwaters	2000-08-02	14:35-14:37	0.7 mi
Unnamed Tributary to Yellowstone Creek	Mouth to headwaters	2000-08-02	14:40-14:48	1.5 mi
West Fork Packers Gulch	Mouth to headwaters	2000-08-02	15:14-15:19	1.5 mi
White Rock Creek	Mouth to headwaters	2000-08-03	14:26-14:35	2.7 mi
Yellowstone Creek	Mouth to headwaters	2000-08-02	14:27-14:34	3 mi

5.3 Continuous stream temperature data

All available continuous stream temperature data were retrieved from DEQ's Ambient Water Quality Monitoring System (AWQMS), USGS's National Water Information System (NWIS), or were obtained during the data solicitation for DEQ's Temperature TMDL Replacement Project. Some temperature data presented in this QAPP were retrieved from DEQ's files and were not available in AWQMS or USGS's database.

The data retrieval period for continuous stream temperature data is from January 1, 1990 to December 31, 2020. Data retrieved from the AWQMS database has a Data Quality Level (DQL) of A, B or E and a result status of "Final" or "Provisional". The data quality level criteria are outlined in DEQ's Data Quality Matrix for Field Parameters (DEQ, 2013). The TMDL program uses waterbody results with a data quality level of A, B, or E (DEQ, 2021). Data of unknown quality are used after careful review.

Appendix B summarizes 263 locations where continuous stream temperature data were collected in the Middle Willamette Subbasins and the organizations that collected that data in Table 42, and when data were collected at each location in Table 43. The location of these stations is shown in the HTML interactive map that accompanies this QAPP and referenced in Appendix D.

5.4 Stream flow data

Table 44 through Table 45 in Appendix C list the stations where continuous and instantaneous flow volume data were available in the Middle Willamette Subbasins, including 26 stations from USGS and 13 stations from DEQ's files. The location of these stations is shown in the HTML interactive map that accompanies this QAPP and referenced in Appendix D. DEQ relies upon the quality control checks implemented by USGS and OWRD. DEQ-collected stream flow measurements utilize field and quality control methods outlined in DEQ's Mode of Operations Manual (DEQ, 2020).

5.5 Point source discharges

Table 3 identifies all the active individual NPDES permittees in the Middle Willamette Subbasins (including individual MS4 permittees). Table 4 lists the registrants covered under the general NPDES GEN01, GEN03, and GEN40 (MS4) permits in the Middle Willamette Subbasins. This group of general permits are highlighted because the permits require temperature monitoring at a frequency of at least one grab sample per month. The location of these NPDES permittees is shown in the HTML interactive map that accompanies this QAPP and is referenced in Appendix D. Many of these permittees submit Discharge Monitoring Reports (DMRs) as a condition of their permit. Depending on the monitoring requirements in the permit, some permittees are required to report effluent temperature and effluent flow rates in the DMR. The frequency and type of reporting varies by permit and permit type. Some permits only require monthly, weekly, or daily grab samples while others require summary statistics such as daily maximum, daily mean, or seven-day average daily maximum. The NPDES permits require data be collected and reported on the DMR using appropriate methods based on a quality assurance and quality control plan. Where possible, DEQ will utilize any continuous effluent data that has been provided to DEQ. When continuous data is not available, DMR data will be utilized to characterize point source discharges. Table 5 lists the current number of registrants for all the other general NPDES permits in the Middle Willamette Subbasins that are not listed in Table 4.

Table 3: Summary of individual NPDES permitted discharges in the Middle Willamette Subbasins.

Facility Name (Facility Number)	Latitude/Longitude	Permit Type and Description	Stream River Mile
Aumsville STP (4475)	44.8542/-122.875	NPDES-DOM-Db: Sewage - less than 1 MGD with discharging lagoons	Beaver Creek RM 2.5
Aurora STP (110020)	45.22/-122.8	NPDES-DOM-Db: Sewage - less than 1 MGD with discharging lagoons	Pudding River RM 8.8
Columbia Helicopters (100541)	45.2587/-122.765	NPDES-IW-B16: All facilities not elsewhere classified which dispose of non-process wastewaters	Pudding River RM 2
Dallas STP (22546)	44.9204/-123.255	NPDES-DOM-C1a: Sewage - 2 MGD or more but less than 5 MGD	Rickreall Creek RM 10.5
Fujimi Corporation - Sw Commerce Circle (107178)	45.336/-122.777	NPDES-IW-B15: All facilities not elsewhere classified which dispose of process wastewater (includes remediated groundwater) - Tier 2 sources	Coffee Lake Creek RM 1.8
Gervais STP (33060)	45.1129/-122.89	NPDES-DOM-Db: Sewage - less than 1 MGD with discharging lagoons	Pudding River RM 28.2
Hubbard STP (40494)	45.1872/-122.812	NPDES-DOM-Da: Sewage - less than 1 MGD	Mill Creek RM 5.3
Jlr, Llc (32536)	45.1328/-122.841	NPDES-IW-B05: Food/beverage processing - Large and complex. Flow greater than or equal to 1 MGD for 180 days/year or more	Pudding River RM 27

Facility Name (Facility Number)	Latitude/Longitude	Permit Type and Description	Stream River Mile
Lakewood Utilities, Ltd (96110)	45.2037/-122.789	NPDES-DOM-Da: Sewage - less than 1 MGD	Mill Creek RM 3.9
Molalla STP (57613)	45.1552/-122.611	NPDES-DOM-Db: Sewage - less than 1 MGD with discharging lagoons	Molalla River RM 8.2
Mt. Angel STP (58707)	45.074/-122.821	NPDES-DOM-Da: Sewage - less than 1 MGD	Pudding River RM 37.5
Murphy Veneer, Foster Division (97070)	44.4082/-122.665	NPDES-IW-B20: Timber and Wood Products - Hardboard, veneer, plywood, particle board, pressboard manufacturing, wood products.	Wiley Creek RM 0.9
Norpac Foods-Plant #1, Stayton (84820)	44.8003/-122.801	NPDES-IW-B04: Food/beverage processing - Medium. Flow between 0.1 MGD and 1 MGD, or flow greater than or equal to 1 MGD for less than 180 days/year	Mill Creek RM 18.5
Norpac Foods - Brooks Plant No. 5 (84791)	45.0586/-122.961	NPDES-IW-B04: Food/beverage processing - Medium. Flow between 0.1 MGD and 1 MGD, or flow greater than or equal to 1 MGD for less than 180 days/year	Fitzpatrick Creek RM 1
ODC - Oregon State Penitentiary (109727)	44.9321/-123.005	NPDES-IW-B15: All facilities not elsewhere classified which dispose of process wastewater (includes remediated groundwater) - Tier 2 sources	Mill Creek RM 2.5
ODFW - Marion Forks Hatchery (64495)	44.6125/-121.949	NPDES-IW-B17: Dairies, fish hatcheries and other confined feeding operations on individual permits	Horn Creek RM 72.1
Rsg Forest Products - Liberal (72596)	45.1904/-122.587	NPDES-IW-B19: Timber and Wood Products - Sawmills, log storage, instream log storage.	Molalla River RM 9.8
Scio STP (79633)	44.7/-122.853	NPDES-DOM-Db: Sewage - less than 1 MGD with discharging lagoons	Thomas Creek RM 7.2
Silverton STP (81395)	45.0095/-122.801	NPDES-DOM-C1a: Sewage - 2 MGD or more but less than 5 MGD	Silver Creek RM 2.4
Sunstone Circuits (26788)	45.2286/-122.587	NPDES-IW-B15: All facilities not elsewhere classified which dispose of process wastewater (includes remediated groundwater) - Tier 2 sources	Milk Creek RM 5.3
Turner Municipal Stormwater, MS4 (113607)	44.8458/-122.958	NPDES-DOM-MS4-2: Municipal Separate Storm Sewer System - Phase II	Multiple discharge locations

Facility Name (Facility Number)	Latitude/Longitude	Permit Type and Description	Stream River Mile
Woodburn WWTP (98815)	45.1542/-122.802	NPDES-DOM-C1a: Sewage - 2 MGD or more but less than 5 MGD	Pudding River RM 21.4

Table 4: Summary of current registrants under the general NPDES GEN01, GEN03, and GEN40 (MS4) permits in the Middle Willamette Subbasins.

Facility Name (Facility Number)	Latitude/Longitude	Permit Type and Description	Stream River Mile
AMERICOLD LOGISTICS, LLC (87663)	44.9779/-123.001	GEN01: Industrial Wastewater; NPDES cooling water	Claggett Creek RM 4.9
HOLIDAY PLAZA (108298)	44.9158/-123.014	GEN01: Industrial Wastewater; NPDES cooling water	Unknown RM 0.2
KEIZER MUNICIPAL STORMWATER, MS4 (100032)	44.99/-123.025	GEN40: 4000 MS4-Phase 2 General Permit – Water Quality NPDES General Permit	Multiple discharge locations
MARION COUNTY MUNICIPAL STORMWATER, MS4 (113608)	44.9792/-122.991	GEN40: 4000 MS4-Phase 2 General Permit – Water Quality NPDES General Permit	Multiple discharge locations
ODFW - ROARING RIVER HATCHERY (64525)	44.625/-122.722	GEN03: Industrial Wastewater; NPDES fish hatcheries	Roaring River RM 1.1
POLK COUNTY MUNICIPAL STORMWATER, MS4 (116224)	44.9683/-123.087	GEN40: 4000 MS4-Phase 2 General Permit – Water Quality NPDES General Permit	Multiple discharge locations
SPINNAKER II OFFICE BUILDING (110603)	44.9167/-123.015	GEN01: Industrial Wastewater; NPDES cooling water	Unknown RM 0.8

Table 5: Summary of the current number of registrants for all the other general NPDES permits in the Middle Willamette Subbasins that are not listed in Table 4.

Permit Type and Description	Current Number of Registrants
GEN02: Industrial Wastewater; NPDES filter backwash	5
GEN12A: Stormwater; NPDES sand & gravel mining	27
GEN12C(AGENT): Stormwater; NPDES construction more than 1 acre disturbed ground, issued by agent	1

Permit Type and Description	Current Number of Registrants
GEN12C: Stormwater; NPDES construction more than 1 acre disturbed ground	258
GEN12CA: Stormwater; NPDES government agency construction, more than 1 acre disturbed ground	6
GEN12Z: Stormwater; NPDES specific SIC codes	84
GEN15A: Industrial Wastewater; NPDES petroleum hydrocarbon cleanup	1
GEN17A: Industrial Wastewater; NPDES wash water	5

5.6 Water rights/surface water diversions

Data on surface water diversion rates (usage) and the points of diversion (location) are available from the Oregon Water Resources Department (OWRD). OWRD regulates all commercial, industrial, domestic, and agricultural water use in the state of Oregon through water rights.

Estimates of water diversion rates and location of points of diversion can be derived from the following OWRD sources:

- Water Rights Information System (WRIS) – the WRIS database contains all permitted or certificated water rights. Data in the WRIS corresponding to quantities of water for use are expressed as maximum use allowable, generally as monthly, seasonal or annual rates or volumes. These maximum values may not correspond to actual usage, which will likely vary based on factors such as irrigation application rate or household consumer demand. DEQ may choose to incorporate the maximum amount allowable or some lesser quantity provided sufficient information is available to support those rates in the modeling. Water rights information can also be accessed using their online mapping application (https://apps.wrd.state.or.us/apps/gis/wr/Default.aspx).

- Water Use Reports – some, but not all, water rights holders must monitor and report the water they use to the state, typically on a monthly or yearly basis, as a requirement of their water rights. These water use reports will be used to develop withdrawal time series based on available information.

6 Model development and calibration

Waterbodies where model development was initiated for the Molalla-Pudding Subbasin TMDL and WQMP (DEQ, 2008) and Willamette Basin TMDL and WQMP (DEQ, 2006) are listed in Table 6. The extent and location of these models is shown in the HTML interactive map that accompanies this QAPP and is referenced in Appendix D.

Table 6: Waterbodies where a model has already been developed.

Model Version	Model Waterbody
Heat Source version 6 temperature model	Crabtree Creek, Little North Santiam River, Thomas Creek
Heat Source version 7 temperature model	Molalla River
Heat Source version 8 temperature model	Pudding River

The setup and calibration for the models listed in Table 6 was completed by DEQ and documented in the Molalla-Pudding Subbasin TMDL and WQMP (DEQ, 2008) and Willamette Basin TMDL and WQMP (DEQ, 2006). Adjustments to the existing calibrated models are unlikely to occur as part of this project. However, if it is determined that the model calibration needs to be updated, the model inputs that are expected to be modified are described in Section 6.1. DEQ will follow the model acceptance criteria and model fit statistics described in Chapter 7.2.

DEQ will develop effective shade curves for all other waterbodies that were not specifically listed in Table 6. Effective shade curves represent the maximum possible effective shade for different vegetation types, stream widths, and stream aspect. Every combination of these conditions are modeled in Heat Source to develop the estimated effective shade. The results are summarized in a shade curve plot. The results can also be summarized in a lookup table with additional combinations of vegetation height, density, and buffer width included. Effective shade curves were developed for the original Molalla-Pudding Subbasin TMDL and WQMP (DEQ, 2008) and Willamette Basin TMDL and WQMP (DEQ, 2006). Adjustments to the existing shade curve models are unlikely to occur as part of this project. However, if it is determined that the models need to be updated DEQ will follow the procedures outlined in this QAPP.

6.1 General model inputs and parameters

6.1.1 Heat Source version 6

Table 7 summarizes all of the user entered model inputs required to run Heat Source version 6; and identifies the subset of inputs that could possibly be modified to improve the calibration of the model. It should be noted, it is unlikely all of these will be used as calibration parameters; rather this list identifies the candidate model inputs that will be considered for adjustment through the calibration process. The following bulleted list of input categories and specific inputs describes the general form and function of the inputs, and why the inputs are candidates for adjustment during calibration:

- Morphology – The morphology inputs that could be used as calibration parameters include upstream and downstream channel elevations, Manning's *n*, and rating curve coefficients *a* and *b* for a power function. Channel hydraulics are important for predicting stream temperatures because they govern the surface area of water that could be exposed to solar radiation, the residence time for exposure, and the degree of light penetration into the water column. Field data for these inputs are often difficult to collect over large spatial scales, and values can vary significantly on a small scale. Heat Source is a one-dimensional model and complex channel configurations are represented as a trapezoidal pattern. Adjustments to inputs that affect channel hydraulics are often necessary to calibrate the model.

- Meteorology – The meteorological input modified in calibration is wind speed. Wind speed can vary significantly on a small geographic scale and the distance to the source of the meteorological data is often much greater than the small-scale localized weather. Hence, adjusting wind is an appropriate calibration method to account for more site-specific weather patterns.

- Mass and thermal flux – Mass and thermal inflows and outflows are inputs often adjusted during the calibration process. These inflows of heat and water consist of tributary and groundwater inflows as well as diversions (i.e., water rights withdrawals) and groundwater losses. The temporal and geographic extents of flow gaging and temperature monitoring on tributaries or groundwater are generally sparse. An effective way of improving the calibration is to complete a flow mass balance with available data, and then add, subtract, or adjust flows either globally or in specific locations within the bounds of the flow mass balance and available measurements, and the temperature response predicted by the model.

- Vegetation – Vegetation characteristics input into the model are often derived from aerial imagery or LiDAR. The vegetation characteristics determine the degree to which near-stream vegetation has the capacity to block incidental solar radiation on the surface of the modeled waterbody. Three vegetation inputs incorporated into the model calibration process are the vegetation density, overhang, and height. Field measurements offer a general understanding of vegetation characteristics within the watershed, however variability in these parameters can be significant on smaller geographic scales. To improve the model fit these model inputs may be modified on a global scale for different vegetation classes within the bounds of available data.

Table 7: Summary of model inputs required for Heat Source version 6.

Input Type	Input	Units	Calibration Parameter
General	Model Date	date (mm/dd/yyyy)	NO
General	Longitudinal Stream Sample Distance	meters	NO
General	Number of Tributary Inflow Sites	-	NO
General	Number of Meteorological Data Sites	-	NO
General	Total Longitudinal Distance	meters	NO
General	Stop Distance	meters	NO
General	Latitude	decimal degrees	NO
General	Longitude	decimal degrees	NO
General	Riparian Zone Width	meters	NO
Meteorological Data	Meteorological Data Model Kilometers	kilometers	NO
Meteorological Data	Wind Speed	meters/second	YES
Meteorological Data	Relative Humidity	proportion (0-1)	NO
Meteorological Data	Air Temperature	degrees Celsius	NO
Boundary Condition	Boundary Condition Inflow Rate	cubic meters/second	NO
Boundary Condition	Water Temperature	degrees Celsius	NO
Tributary	Tributary Inflow Model Kilometers	kilometers	NO

Input Type	Input	Units	Calibration Parameter
Tributary	Tributary Inflow Rate	cubic meters/second	YES
Tributary	Water Temperature	degrees Celsius	YES
Land Cover Data	Topographic Shade Angle - West	degrees	NO
Land Cover Data	Topographic Shade Angle - South	degrees	NO
Land Cover Data	Topographic Shade Angle - East	degrees	NO
Land Cover Data	Landcover Code	-	NO
Land Cover Codes	Landcover Height	meters	YES
Land Cover Codes	Canopy Density	proportion (0-1)	YES
Land Cover Codes	Landcover Overhang	meters	YES
Morphology Data	Channel Bed Elevation	meters	NO
Morphology Data	Manning's Roughness Coefficient, n	seconds/meter	YES
Morphology Data	Near-stream Disturbance Zone (NSDZ) Width	meters	NO
Morphology Data	Rating Curve Coefficient, a	unitless	YES
Morphology Data	Rating Curve Coefficient, b	unitless	YES
Morphology Data	Percent Bedrock	proportion (0-1)	NO
Morphology Data	Channel Aspect	degrees	NO
Morphology Data	Channel Incision	meters	NO
Morphology Data	Valley Length (optional)	meters	NO

6.1.2 Heat Source version 7

The model parameters for Heat Source version 7 are similar to Heat Source version 6 with a few notable exceptions:

- Model period can be up to 21 days where Heat Source version 6 only models a single day;
- Star pattern landcover input with variable landcover height, density, and ground elevation inputs;
- allows for variable flow rate time series on the boundary conditions and tributary inputs;
- requires input of latitude, longitude, and aspect for each node of the model;
- uses Manning's equation exclusively to calculate channel hydraulics and omits the ability to specify rating curve coefficients for certain aspects of channel hydraulics;
- includes cloudiness (as a percentage of clear sky) as a meteorological input—Heat Source version 6 assumes the clear sky conditions;
- allows specifically for groundwater (accretion) and diversion inputs to the model; and

- specifies additional morphology data such as bed sediment parameters and channel gradient.

Table 8 summarizes the list of the model parameters that are different between Heat Source version 6 and Heat Source version 7.

Table 8: Summary of the model inputs that are different between Heat Source version 6 and Heat Source version 7.

Input Type	Input	Units	V6	V7	Calibration Parameter
General	Riparian Zone Width	meters	YES	NO	NO
Morphology Data	Percent Bedrock	proportion (0-1)	YES	NO	NO
Morphology Data	Channel Incision	meters	YES	NO	NO
Morphology Data	Valley Length	meters	YES	NO	NO
Meteorological Data	Cloudiness	proportion (0-1)	NO	YES	YES
Accretion	Accretion Inflow Rate	cubic meters/second	NO	YES	YES
Accretion	Water Temperature	degrees Celsius	NO	YES	YES
Accretion	Withdrawal flow rate	cubic meters/second	NO	YES	YES
Morphology Data	Channel Gradient	meters/meters	NO	YES	YES
Morphology Data	Channel Angle z	meters/meters	NO	YES	YES
Morphology Data	Bed Particle Size	milimeters	NO	YES	YES
Morphology Data	Percent Embeddedness	proportion (0-1)	NO	YES	YES
General	Stream Length	kilometers	NO	YES	NO
General	Modeling Start Date	date (mm/dd/yyyy)	NO	YES	NO
General	Simulation Period	days	NO	YES	NO
General	Flush Initial Condition	days	NO	YES	NO
General	Time Zone	-	NO	YES	NO
General	Model Time Step	minutes	NO	YES	NO
General	Model Distance Step	meters	NO	YES	NO
General	Include Evaporation Losses From Flow (True/False)	-	NO	YES	NO
General	Evaporation Method (Mass Transfer/Penman)	-	NO	YES	NO
General	Wind Function Coefficient a	unitless	NO	YES	NO

Input Type	Input	Units	V6	V7	Calibration Parameter
General	Wind Function Coefficient b	unitless	NO	YES	NO
General	Include Deep Alluvium Temperature (True/False)	-	NO	YES	NO
General	Deep Alluvium Temperature	degrees Celsius	NO	YES	NO
General	Distance Between Transect Samples	meters	NO	YES	NO
Accretion	Stream Kilometers	kilometers	NO	YES	NO
Land Cover Codes	Landcover Code	-	NO	YES	NO
Morphology Data	Stream Kilometers	kilometers	NO	YES	NO
Morphology Data	Sediment Thermal Conductivity	watts/meters/degrees Celsius	NO	YES	NO
Morphology Data	Rosgen Level I Stream Type	-	NO	YES	NO
Morphology Data	Width to Depth Ratio	meters	NO	YES	NO
Morphology Data	X Factor	unitless	NO	YES	NO

6.1.3 Heat Source version 8

The model parameters for Heat Source version 8 are similar to Heat Source version 6 with a few notable exceptions:

- Model can simulate an unlimited number of days;
- Star pattern landcover input with variable landcover height, density, and ground elevation inputs;
- allows for variable flow rate time series on the boundary conditions and tributary inputs;
- requires input of latitude, longitude and aspect for each node of the model;
- uses Manning's equation exclusively to calculate channel hydraulics and omits the ability to specify rating curve coefficients for certain aspects of channel hydraulics;
- includes cloudiness (as a percentage of clear sky) as a meteorological input—Heat Source version 6 assumes the clear sky conditions;
- allows specifically for groundwater (accretion) and diversion inputs to the model;

- specifies additional morphology data such as bottom width, bed sediment parameters and channel gradient;
- specifies bed conduction inputs such as hyporheic exchange parameters; and
- allows for the use of LiDAR data to be used for vegetation density and overhang.

Table 9 summarizes the list of model parameters that are different between Heat Source version 6 and Heat Source version 8.

Table 9: Summary of the model inputs that are different between Heat Source version 6 and Heat Source version 8.

Input Type	Input	Units	V6	V8	Calibration Parameter
General	Riparian Zone Width	meters	YES	NO	NO
General	Initial Conditions (assumed/user defined)	-	YES	NO	NO
Land Cover Data	Landcover Source	-	YES	NO	NO
Morphology Data	Flow Volume	cubic meters/second	YES	NO	NO
Morphology Data	Percent Bedrock	proportion (0-1)	YES	NO	NO
Morphology Data	Channel Incision	meters	YES	NO	NO
Morphology Data	Valley Length	meters	YES	NO	NO
Meteorological Data	Cloudiness	proportion (0-1)	NO	YES	YES
Accretion	Accretion Inflow Rate	cubic meters/second	NO	YES	YES
Accretion	Water Temperature	degrees Celsius	NO	YES	YES
Accretion	Withdrawal Flow Rate	cubic meters/second	NO	YES	YES
Morphology Data	Channel Gradient	meters/meters	NO	YES	YES
Morphology Data	Channel Angle z	meters/meters	NO	YES	YES
General	LiDAR Density	proportion (0-1)	NO	YES	YES
General	LiDAR Overhang	meters	NO	YES	YES
Morphology Data	Channel Bottom Width	meters	NO	YES	YES
Morphology Data	Hyporheic Zone Thickness	meters	NO	YES	YES
Morphology Data	Percent Hyporheic Exchange	proportion (0-1)	NO	YES	YES

Input Type	Input	Units	V6	V8	Calibration Parameter
Morphology Data	Porosity	proportion (0-1)	NO	YES	YES
General	Stream Length	kilometers	NO	YES	NO
General	Modeling Start Date	date (mm/dd/yyyy)	NO	YES	NO
General	Flush Initial Condition	days	NO	YES	NO
General	Model Time Step	minutes	NO	YES	NO
General	Model Distance Step	meters	NO	YES	NO
General	Include Evaporation Losses From Flow (True/False)	-	NO	YES	NO
General	Evaporation Method (Mass Transfer/Penman)	-	NO	YES	NO
General	Wind Function Coefficient a	unitless	NO	YES	NO
General	Wind Function Coefficient b	unitless	NO	YES	NO
General	Include Deep Alluvium Temperature (True/False)	-	NO	YES	NO
General	Deep Alluvium Temperature	degrees Celsius	NO	YES	NO
General	Distance Between Transect Samples	meters	NO	YES	NO
Accretion	Stream Kilometers	kilometers	NO	YES	NO
Land Cover Codes	Landcover Code	-	NO	YES	NO
Morphology Data	Stream Kilometers	kilometers	NO	YES	NO
Morphology Data	Sediment Thermal Conductivity	watts/meters/degrees Celsius	NO	YES	NO
General	Time Offset From UTC	hours	NO	YES	NO
General	Number Of Samples Per Transect	-	NO	YES	NO
General	Account For Emergent Veg Shading (True/False)	-	NO	YES	NO
General	Land Cover Sample Method (Point/Zone)	-	NO	YES	NO
General	LiDAR Data Used For Veg Codes (True/False)	-	NO	YES	NO
Morphology Data	Sediment Thermal Diffusivity	square centimeters/second	NO	YES	NO

6.2 Data gaps

Non-steady state stream models typically require a significant amount of data because of the large spatial and temporal extents the models typically encompass. As the model size or modeling period increase, the amount of information needed to parameterize it also increases. Often it is not possible to parameterize a model entirely from field data because it can be resource intensive or impractical to collect everything that is needed. In general, these data gaps may be considered and addressed in a number of ways. Table 10 summarizes methods that are used to derive the data needed to parameterize the model.

To the greatest extent possible, the method used to derive the model parameters for the existing TMDL models have been summarized in the boundary conditions and tributary inputs tables in the sections of model inputs in the current Chapter 6.

Table 10: Methods to derive model parameters for data gaps.

Method	Possible Parameters	Description
Direct surrogate	Tributary temperatures, meteorological inputs, sediment	Often, neighboring or nearby tributary watersheds share climatological and landscape features. Model parameters that have an incomplete record or no data may be parameterized using data from a neighboring or nearby location where data is available.
Calibration adjustment	All inputs	In some instances, a significant input may be required for appropriate representation in the modeling, however little may be known about the nature of that input. An example of this is groundwater influx and temperature. Datasets for these inputs can be estimated by adjusting the necessary values within acceptable ranges during the calibration process.
Literature-based values	All inputs	Literature values are often used for model parameters or unquantified model inputs when little is known about the site-specific nature of those inputs. Examples of these types of parameters include stream bed heat transfer properties, hyporheic characteristics or substrate porosity (Bencala and Walters, 1983; Hart, 1995; Pelletier et al., 2006; Sinokrot and Stefan, 1993).
Mass balance	Tributary temperature and flow	On main stem modeled reaches, tributary stream flow or temperature can be estimated using a mass balance approach assuming either flow or temperature data for the tributary are known. If estimating temperature, flow is required, and if estimating flow, temperature is required. Often TIR data are used to estimate tributary flow because upstream, downstream and tributary temperatures are known, and upstream and tributary flows are known (or estimated).

Method	Possible Parameters	Description
Simple linear regression	Tributary temperature and flow	Parameters such as flow and temperature in neighboring or nearby tributaries often demonstrate similar diurnal patterns or hydrographs which allow for the development of suitable mathematical relationships (simple linear regression) in order to fill the data gaps for those inputs. This method requires at least some data exist for the incomplete dataset in order to develop the relationship.
Drainage area ratio	Tributary flow	For ungaged tributaries, flows can be estimated using the ratio between the watershed drainage areas of the ungaged location and from a nearby gaged tributary (Ries et al., 2017; Risley, 2009; Gianfagna, 2015). For example, if the watershed area upstream of a gaged tributary is 10 square kilometers, and the watershed area of an ungaged tributary is 5, the flows in the ungaged tributary are estimated to be half of those in the gaged tributary. The method is typically used to calculate low flow or flood frequency statistics. In that context a weighting factor is recommended when the drainage area ratio of the two sites is between 0.5 and 1.5. Weighting factors can be evaluated if instantaneous observed flows are available at the ungaged location.
Flow-probability-probability-flow (QPPQ)	Tributary flow	The flow-probability-probability-flow (QPPQ) method makes use of relating flow duration curves between a gaged tributary and an ungaged tributary (Lorenz and Ziegeweid, 2016). The flow duration curve at ungaged sites is estimated using regression approaches (Risley et al., 2008) and the online USGS tool StreamStats (Ries et al., 2017).
Adiabatic adjustment	Air temperature	Air temperature can vary significantly throughout a watershed, particularly with large differences in elevation from headwaters to the mouth of the drainage. To account for these differences, air temperatures can be adjusted using an equation that relates air temperature measured at a meteorological station to a location of a given elevation using the dry adiabatic lapse rate of 9.8 °C/km and the differences in elevation.
GIS Data	Channel position, Channel width, Landcover, Gradient, Elevation, Topographic shade angles	Several landscape scale GIS data sets can be used to derive a number of model parameters. Digital orthophotos quads (DOQs) are used to classify landcover and estimate vegetation type, height, density, and overhang. DOQs can also be used to determine stream position, stream aspect, and channel width. A digital elevation model (DEM) consists of digital information that provides a uniform matrix of terrain elevation values. It provides basic quantitative data for deriving surface elevation, stream gradient, and maximum topographic shade angles.

6.3 Effective shade curves and lookup tables

Effective shade curves are plots that present the maximum possible effective shade as a function of different types of natural near-stream vegetation, active channel widths, and stream aspect. Channel width is plotted on the x-axis, effective shade is on the y-axis, and a separate symbol and/or line color is used for each stream aspect. Separate plots are produced for each type of natural vegetation that is expected in the TMDL project area. The plots are called effective shade curves because the pattern on the plot resembles a gentle downward slopping curve. As channel width increases effective shade gets smaller. The plots are produced from the output of Heat Source version 6 shade models that have been parameterized with every combination of the previously mentioned conditions. The effective shade curve approach can be used almost anywhere in the watershed to quantify the amount of background solar radiation loading and the effective shade necessary to eliminate temperature increases from anthropogenic disturbance or removal of near-stream vegetation.

This model approach can also be used to develop a lookup table to determine the effective shade resulting from other combinations vegetation height, vegetation density, vegetation overhang, and vegetation buffer widths that are different from background conditions. The lookup table provides a convenient way for readers of the TMDL to estimate the effective shade for current conditions without using the model. The lookup table can also be used as a reverse lookup to determine what vegetation height, buffer width, or vegetation density would achieve a certain effective shade.

6.3.1 Model domain

The model domain is not specific to any single waterbody but will be parameterized using a latitude and longitude located in the TMDL watershed to ensure that the modeled solar altitude and sun angles are appropriate for the area.

6.3.2 Spatial and temporal resolution

The model input spatial resolution (*dx*) is 30 meters. Outputs are generated every 100 meters. The spatial resolution is not very meaningful however, since each output distance step will represent a unique combination of the different modeled vegetation and channel conditions. The model time step (*dt*) is 1 minute and outputs are generated every hour.

6.3.3 Source characteristics

The effective shade curve approach can be used almost anywhere in the watershed to quantify the amount of background solar radiation loading and the effective shade necessary to eliminate temperature increases from anthropogenic disturbance or removal of near-stream vegetation.

The lookup tables can be used to estimate existing shade or current solar loading. Other potential sources of thermal loading and the temperature response will not be evaluated by this model.

6.3.4 Time frame of simulation

The model period is a single day in late July or early August. This time frame was chosen to characterize the solar loading when maximum stream temperatures are observed, the sun altitude angle is highest, and the period of solar exposure is longest.

6.3.5 Important assumptions

Models used to develop effective shade curves assume no cloud cover and no topographic shade. The modeled terrain is flat so there is no difference in ground elevation between the stream and the adjacent vegetation buffer area. The vegetation density, vegetation height, vegetation overhang, and vegetation buffer width are assumed to be equal on both sides of the stream. The width of the active channel is assumed to be equal to the distance between near-stream vegetation on either side of the stream.

Effective shade curves were developed for the original Molalla-Pudding Subbasin TMDL and WQMP (DEQ, 2008) and Willamette Basin TMDL and WQMP (DEQ, 2006). Adjustments to the existing shade curve models are unlikely to occur as part of this project. However, if it is determined that the models need to be updated DEQ will follow the procedures outlined in this QAPP.

6.3.6 Model inputs

There are two categories of models each with different sets of inputs:

- Effective shade curves: Model input values for vegetation height, vegetation density, vegetation overhang, and vegetation buffer width correspond to the restored streamside vegetation types expected in areas that are currently lacking streamside vegetation because of anthropogenic disturbance. The specific values will be determined during the TMDL process and will likely be the same or similar to the values presented in the Molalla-Pudding Subbasin TMDL and WQMP (DEQ, 2008) and Willamette Basin TMDL and WQMP (DEQ, 2006). The other model inputs are the same as what is described in Table 11.
- Effective shade lookup tables: Model input values to be used for the lookup tables are described in Table 11.

Table 11: Range of model inputs to be used for effective shade lookup tables.

Model Input	Value Range
Vegetation height (meters)	0 - 90 (or expected maximum)
Vegetation density (percent)	0 -100
Vegetation overhang (meters)	0 - 3 (or expected maximum)
Vegetation buffer width (meters)	0 - 45
Active channel width (meters)	0 - 100 (or expected maximum)
Stream aspect (degrees)	North/South (0/180); Northeast/Southwest (45/225); East/West (90/270); Southeast/Northwest (135/315)
Topographic shade angles (degrees)	0
Cloudiness	0

6.4 Crabtree Creek

The Crabtree Creek model is a temperature model developed using Heat Source 6.5.1. The model was developed by DEQ.

6.4.1 Model domain

The extent of the model domain is Crabtree Creek from the mouth to river mile 35. The model extent is shown in the HTML interactive map that accompanies this QAPP and is referenced in Appendix D.

6.4.2 Spatial and temporal resolution

The model input spatial resolution (*dx*) is 30 meters. Outputs are generated every 100 meters. The model time step (*dt*) is 1 minute and outputs are generated every hour.

A *dx* of 30 meters was chosen to capture the range of solar flux input caused by the varied vegetation conditions along the length of the stream. The high resolution *dx* will allow evaluation of multiple vegetation management scenarios for each designated management agency.

6.4.3 Source characteristics

The primary sources of thermal loading contributing to temperatures exceedances along the Crabtree Creek include increases in solar radiation loading from the disturbance or removal of near-stream vegetation, and background sources (DEQ, 2006). Other potential sources include channel modification and widening, reductions to stream flow rate, and warming caused by climate change. The contribution of these latter potential sources may be investigated as part of the model scenarios.

There are no permitted individual NPDES point sources along the model extent.

The majority land uses along the Crabtree Creek are forestry and agriculture accounting for about 87 percent of the near-stream area. Table 12 summarizes all the land uses within 100 meters of the digitized Crabtree Creek centerline. Land uses were summarized using the 2016 National Land Cover Database (Yang et al 2018). Note that Shrub/Scrub and Herbaceous land uses can be areas where forest clearcuts have occurred and would be classified as forest after regrowth.

Table 12: Summary of land uses within 100 meters of the digitized Crabtree Creek centerline based on the 2016 National Land Cover Database (Yang et al 2018).

2016 NLCD Land Cover	Acres	Percent of Total Acres
Evergreen Forest	972.1	34.9
Hay/Pasture	816.2	29.3
Emergent Herbaceous Wetlands	303.3	10.9
Woody Wetlands	217.9	7.8
Cultivated Crops	131.4	4.7
Shrub/Scrub	127.0	4.6
Mixed Forest	97.4	3.5
Herbaceous	56.3	2
Developed, Open Space	23.8	0.9

2016 NLCD Land Cover	Acres	Percent of Total Acres
Deciduous Forest	16.9	0.6
Developed, Low Intensity	15.1	0.5
Barren Land	5.1	0.2
Developed, Medium Intensity	2.2	0.1
Developed, High Intensity	0.7	<0.05

Anthropogenic related stream warming caused by nonpoint sources is closely associated with the uses, the activities, and the condition of vegetation adjacent to the stream. How activities and uses are managed in these areas is partially determined by a variety of different rules and management plans established by the landowner and any agency with land use authority. To better understand the spatial distribution of different agency rules or management plans along the model extent DEQ mapped known designated management agencies (Table 13).

A designated management agency is defined in OAR 340-042-0030(2) as a federal, state, or local governmental agency that has legal authority over a sector or source contributing pollutants. Typically, persons or designated management agencies that are identified in the TMDL Water Quality Management Plan (WQMP) are responsible for developing TMDL implementation plans and implementing management strategies to reduce pollutant loading. Table 13 summarizes the potential designated management agencies and responsible persons along the Crabtree Creek model extent.

Table 13: Summary of potential designated management agencies (DMAs) or responsible persons within 100 meters of the digitized Crabtree Creek centerline.

DMA or Responsible Person	Acres	Percent of Total Acres
Oregon Department of Agriculture	1504.8	54.1
Oregon Department of Forestry - Private Forestland	1018.8	36.6
Linn County	129.3	4.6
U.S. Bureau of Land Management	126.3	4.5
Oregon Department of Transportation	3	0.1
Albany & Eastern Railroad	1.7	0.1

6.4.4 Time frame of simulation

The model period is for a single day: August 02, 2000.

6.4.5 Important assumptions

The effort currently described in the QAPP includes use of existing models. Key calibration assumptions made during the model setup and calibration process were documented in the original TMDL (DEQ, 2006 and DEQ, 2008), the model user guide (Boyd and Kasper, 2003) or in Section 6 and Section 7 of this document.

6.4.6 Model inputs

Table 14 summarizes the current configuration of the model input parameters and the source of these data. Temperature, flow, and meteorological input parameters are summarized to improve documentation of the TMDL approach.

Table 14: Boundary condition and tributary inputs to the existing Crabtree Creek Heat Source model.

Model Location Name (Station ID)	Model Location (meters)	Input Type	Model Input	Data Source	Note
Crabtree Creek upstream of BLM site	0	Boundary Condition	Water Temperature	DEQ	
Beaver Creek (23770-ORDEQ)	44318	Tributary	Flow	DEQ	Data not in AWQMS.
Roaring River (21834-ORDEQ)	25817	Tributary	Flow	DEQ	Data not in AWQMS.
SF Crabtree Creek	9296	Tributary	Flow	DEQ	
White Rock Creek	1036	Tributary	Flow	BLM	
Beaver Creek (23770-ORDEQ)	44318	Tributary	Water Temperature	DEQ	Data not in AWQMS.
Roaring River (21834-ORDEQ)	25817	Tributary	Water Temperature	DEQ	Data not in AWQMS.
SF Crabtree Creek	9296	Tributary	Water Temperature	DEQ	
White Rock Creek	1036	Tributary	Water Temperature	BLM	
No Station ID	0, 4724, 8230, 14691, 18471, 25786, 34991, 46025, 51603	Meteorological	Air Temperature, Relative Humidity, Wind Speed	DEQ	

Hourly meteorology inputs into the model include air temperature, relative humidity, and wind speed. Air temperature data were modified using the dry adiabatic lapse rate to adjust for differences in elevation between the measurement location and the model input location. Wind speeds were adjusted using a wind-sheltering coefficient to represent difference in wind speed between the measurement location and above the stream within the riparian area.

6.4.7 Model calibration

The expected model calibration sites and data sources are summarized in Table 15. The model location in the table below describes the distance of each input from the most upstream model node. The model inputs and parameters that are expected to be modified to improve model fit are described in Section 6.1.

Table 15: Calibration sites and parameters used in the existing Crabtree Creek Heat Source model.

Model Location Name (Station ID)	Model Location (meters)	Calibration Parameter	Data Source
Crabtree Creek at Riverside School Road (10784-ORDEQ)	51603	Water Temperature, Flow, Effective Shade	DEQ
Crabtree Creek at Hoffman Covered Bridge (23771-ORDEQ)	46025	Water Temperature, Flow, Effective Shade	DEQ
Crabtree Creek at Richardson Gap Road (23769-ORDEQ)	34991	Water Temperature, Flow, Effective Shade	DEQ
Crabtree Creek at Larwood Bridge (23768-ORDEQ)	25786	Water Temperature, Flow, Effective Shade	DEQ
Crabtree Creek at swinging foot bridge (23767-ORDEQ)	18471	Water Temperature, Flow, Effective Shade	DEQ
Crabtree Creek at Willamette Main Line Road (23766-ORDEQ)	14691	Water Temperature, Flow, Effective Shade	DEQ
Crabtree Creek at Road 311 Bridge (23743-ORDEQ)	8230	Water Temperature, Flow, Effective Shade	DEQ
Crabtree Creek at Main Line Bridge (23742-ORDEQ)	4724	Water Temperature, Flow, Effective Shade	DEQ
Crabtree Creek upstream of BLM site	0	Effective Shade	DEQ

6.5 Little North Santiam River

The Little North Santiam River model is a temperature model developed using Heat Source 6.5.1. The model was developed by DEQ.

6.5.1 Model domain

The extent of the model domain is the Little North Santiam River from the mouth to river mile 15. The model extent is shown in the HTML interactive map that accompanies this QAPP and is referenced in Appendix D.

6.5.2 Spatial and temporal resolution

The model input spatial resolution (*dx*) is 30 meters. Outputs are generated every 100 meters. The model time step (*dt*) is 1 minute and outputs are generated every hour.

A *dx* of 30 meters was chosen to capture the range of solar flux input caused by the varied vegetation conditions along the length of the stream. The high resolution *dx* will allow evaluation of multiple vegetation management scenarios for each designated management agency.

6.5.3 Source characteristics

The primary sources of thermal loading contributing to temperatures exceedances along the Little North Santiam River include increases in solar radiation loading from the disturbance or removal of near-stream vegetation, and background sources (DEQ, 2006). Other potential sources include channel modification

and widening, reductions to stream flow rate, and warming caused by climate change. The contribution of these latter potential sources may be investigated as part of the model scenarios.

There are no permitted individual NPDES point sources along the model extent.

The majority land use along the Little North Santiam River is forestry accounting for about 88 percent of the near-stream area. Table 16 summarizes all the land uses within 100 meters of the digitized Little North Santiam River centerline. Land uses were summarized using the 2016 National Land Cover Database (Yang et al 2018). Note that Shrub/Scrub and Herbaceous land uses can be areas where forest clearcuts have occurred and would be classified as forest after regrowth.

Table 16: Summary of land uses within 100 meters of the digitized Little North Santiam River centerline based on the 2016 National Land Cover Database (Yang et al 2018).

2016 NLCD Land Cover	Acres	Percent of Total Acres
Evergreen Forest	1418.4	72.3
Developed, Open Space	189.9	9.7
Shrub/Scrub	107.0	5.5
Mixed Forest	82.5	4.2
Deciduous Forest	39.1	2
Woody Wetlands	35.4	1.8
Herbaceous	34.0	1.7
Hay/Pasture	29.1	1.5
Developed, Low Intensity	9.8	0.5
Barren Land	8.0	0.4
Emergent Herbaceous Wetlands	5.1	0.3
Developed, Medium Intensity	2.7	0.1

Anthropogenic related stream warming caused by nonpoint sources is closely associated with the uses, the activities, and the condition of vegetation adjacent to the stream. How activities and uses are managed in these areas is partially determined by a variety of different rules and management plans established by the landowner and any agency with land use authority. To better understand the spatial distribution of different agency rules or management plans along the model extent DEQ mapped known designated management agencies (Table 17).

A designated management agency is defined in OAR 340-042-0030(2) as a federal, state, or local governmental agency that has legal authority over a sector or source contributing pollutants. Typically, persons or designated management agencies that are identified in the TMDL Water Quality Management Plan (WQMP) are responsible for developing TMDL implementation plans and implementing management strategies to reduce pollutant loading. Table 17 summarizes the potential designated management agencies and responsible persons along the Little North Santiam River model extent.

Table 17: Summary of potential designated management agencies (DMAs) or responsible persons within 100 meters of the digitized Little North Santiam River centerline.

DMA or Responsible Person	Acres	Percent of Total Acres
U.S. Forest Service	714.4	32.7
Oregon Department of Forestry - Private Forestland	593	27.1

DMA or Responsible Person	Acres	Percent of Total Acres
Marion County	510.8	23.4
U.S. Bureau of Land Management	285.9	13.1
Oregon Department of Forestry - State Forestland	37.3	1.7
Oregon Department of Agriculture	34.9	1.6
Oregon Department of Transportation	4.1	0.2
City of Lyons	3.4	0.2
Oregon Department of State Lands - Waterway	1	<0.05

6.5.4 Time frame of simulation

The model period is for a single day: August 01, 2000.

6.5.5 Important assumptions

The effort currently described in the QAPP includes use of existing models. Key calibration assumptions made during the model setup and calibration process were documented in the original TMDL (DEQ, 2006 and DEQ, 2008), the model user guide (Boyd and Kasper, 2003) or in Section 6 and Section 7 of this document.

6.5.6 Model inputs

Table 18 summarizes the current configuration of the model input parameters and the source of these data. Temperature, flow, and meteorological input parameters are summarized to improve documentation of the TMDL approach.

Table 18: Boundary condition and tributary inputs to the existing Little North Santiam River Heat Source model.

Model Location Name (Station ID)	Model Location (meters)	Input Type	Model Input	Data Source	Note
Little North Santiam at Fawn Creek (S68509)	0	Boundary Condition	Water Temperature	Watershed Sciences, 2001d	Data not in AWQMS.
Little North Santiam at Fawn Creek (S68509)	0	Boundary Condition	Flow	Derived data.	Derived from flow mass balance
Cox Creek	17374	Tributary	Flow	Derived data.	Derived from TIR using flow mass balance

Model Location Name (Station ID)	Model Location (meters)	Input Type	Model Input	Data Source	Note
Beaver Creek	15728	Tributary	Flow	Derived data.	Derived from TIR using flow mass balance
Canyon Creek	11217	Tributary	Flow	BLM	
Cougar Creek	8108	Tributary	Flow	Derived data.	Derived from TIR using flow mass balance
Big Creek	7559	Tributary	Flow	Derived data.	Derived from TIR using flow mass balance
Wonder Creek	7498	Tributary	Flow	Derived data.	Derived from TIR using flow mass balance
Sinker Creek	5304	Tributary	Flow	BLM	
Elkhorn Creek	2560	Tributary	Flow	BLM	
Fish Creek	2195	Tributary	Flow	Derived data.	Derived from TIR using flow mass balance
Cox Creek	17374	Tributary	Water Temperature	DEQ	Data not in AWQMS.
Beaver Creek	15728	Tributary	Water Temperature	DEQ	Data not in AWQMS.
Canyon Creek	11217	Tributary	Water Temperature	BLM	Data not in AWQMS.
Cougar Creek	8108	Tributary	Water Temperature	DEQ	Data not in AWQMS.
Big Creek	7559	Tributary	Water Temperature	DEQ	Data not in AWQMS.
Wonder Creek	7498	Tributary	Water Temperature	DEQ	Data not in AWQMS.
Sinker Creek	5304	Tributary	Water Temperature	BLM	Data not in AWQMS.
Elkhorn Creek	2560	Tributary	Water Temperature	BLM	Data not in AWQMS.

Model Location Name (Station ID)	Model Location (meters)	Input Type	Model Input	Data Source	Note
Fish Creek	2195	Tributary	Water Temperature	DEQ	Data not in AWQMS.
KSLE - McNary Field Airport	0, 7802.88, 11216.64, 17251.68, 20452.08, 21854.16	Meteorological	Wind Speed	AirNav	Wind speed reduced by 25%.
KSLE - McNary Field Airport	0, 7802.88, 11216.64, 17251.68, 20452.08, 21854.16	Meteorological	Air Temperature, Relative Humidity	AirNav	

Hourly meteorology inputs into the model include air temperature, relative humidity, and wind speed. Air temperature data were modified using the dry adiabatic lapse rate to adjust for differences in elevation between the measurement location and the model input location. Wind speeds were adjusted using a wind-sheltering coefficient to represent difference in wind speed between the measurement location and above the stream within the riparian area.

6.5.7 Model calibration

The expected model calibration sites and data sources are summarized in Table 19. The model location in the table below describes the distance of each input from the most upstream model node. The model inputs and parameters that are expected to be modified to improve model fit are described in Section 6.1.

Table 19: Calibration sites and parameters used in the existing Little North Santiam River Heat Source model.

Model Location Name (Station ID)	Model Location (meters)	Calibration Parameter	Data Source
Little North Santiam River near Mehama (14182500)	21854.16	Water Temperature	USGS
North Fork County Park	20452.08	Water Temperature, Flow, Effective Shade	BLM
Node 4 (S88442)	17251.68	Water Temperature	Watershed Sciences, 2001d
Node 3 (S349766)	11216.64	Water Temperature	Watershed Sciences, 2001d
Elk Horn Park	7802.88	Water Temperature, Flow, Effective Shade	BLM

6.6 Molalla River

The Molalla River model is a temperature model developed using Heat Source 7.0. The model was developed by DEQ.

6.6.1 Model domain

The extent of the model domain is the Molalla River from the mouth to river mile 44. The model extent is shown in the HTML interactive map that accompanies this QAPP and is referenced in Appendix D.

6.6.2 Spatial and temporal resolution

The model input spatial resolution (*dx*) is 30 meters. Outputs are generated every 100 meters. The model time step (*dt*) is 1 minute and outputs are generated every hour.

A *dx* of 30 meters was chosen to capture the range of solar flux input caused by the varied vegetation conditions along the length of the stream. The high resolution *dx* will allow evaluation of multiple vegetation management scenarios for each designated management agency.

6.6.3 Source characteristics

The primary sources of thermal loading contributing to temperatures exceedances along the Molalla River include increases in solar radiation loading from the disturbance or removal of near-stream vegetation, point source discharges, reductions to the stream flow rate or volume, and background sources (DEQ, 2008). Other potential sources include channel modification and widening, and warming caused by climate change. The contribution of these latter potential sources may be investigated as part of the model scenarios.

There are two permitted individual NPDES point sources along the model extent. Detail about each point source is summarized in Table 20.

Table 20: Summary of individual NPDES permitted discharges in the Molalla River.

Facility Name (Facility Number)	Latitude/Longitude	Permit Type and Description	Stream/River Mile
Molalla STP (57613)	45.1552/-122.611	NPDES-DOM-Db: Sewage - less than 1 MGD with discharging lagoons	Molalla River RM 8.2
Rsg Forest Products - Liberal (72596)	45.1904/-122.587	NPDES-IW-B19: Timber and Wood Products - Sawmills, log storage, instream log storage.	Molalla River RM 9.8

The majority land use along the Molalla River is forestry accounting for about 72 percent of the near-stream area. Table 21 summarizes all the land uses within 100 meters of the digitized Molalla River centerline. Land uses were summarized using the 2016 National Land Cover Database (Yang et al 2018). Note that Shrub/Scrub and Herbaceous land uses can be areas where forest clearcuts have occurred and would be classified as forest after regrowth.

Table 21: Summary of land uses within 100 meters of the digitized Molalla River centerline based on the 2016 National Land Cover Database (Yang et al 2018).

2016 NLCD Land Cover	Acres	Percent of Total Acres
Evergreen Forest	1586.8	46.8
Woody Wetlands	583.6	17.2
Emergent Herbaceous Wetlands	406.1	12
Hay/Pasture	376.1	11.1

2016 NLCD Land Cover	Acres	Percent of Total Acres
Mixed Forest	110.8	3.3
Shrub/Scrub	76.1	2.2
Developed, Open Space	68.3	2
Herbaceous	51.8	1.5
Cultivated Crops	40.0	1.2
Developed, Low Intensity	33.4	1
Deciduous Forest	22.2	0.7
Barren Land	21.3	0.6
Developed, Medium Intensity	13.1	0.4
Developed, High Intensity	2.4	0.1

Anthropogenic related stream warming caused by nonpoint sources is closely associated with the uses, the activities, and the condition of vegetation adjacent to the stream. How activities and uses are managed in these areas is partially determined by a variety of different rules and management plans established by the landowner and any agency with land use authority. To better understand the spatial distribution of different agency rules or management plans along the model extent DEQ mapped known designated management agencies (Table 22).

A designated management agency is defined in OAR 340-042-0030(2) as a federal, state, or local governmental agency that has legal authority over a sector or source contributing pollutants. Typically, persons or designated management agencies that are identified in the TMDL Water Quality Management Plan (WQMP) are responsible for developing TMDL implementation plans and implementing management strategies to reduce pollutant loading. Table 22 summarizes the potential designated management agencies and responsible persons along the Molalla River model extent.

Table 22: Summary of potential designated management agencies (DMAs) or responsible persons within 100 meters of the digitized Molalla River centerline.

DMA or Responsible Person	Acres	Percent of Total Acres
U.S. Bureau of Land Management	1336.3	33.4
Oregon Department of Agriculture	1171.5	29.3
Oregon Department of Forestry - Private Forestland	668.7	16.7
Oregon Department of State Lands - Waterway	384.8	9.6
Clackamas County	185.3	4.6
City of Canby	105.4	2.6
Oregon Parks and Recreation Department	90.4	2.3
State of Oregon	33.3	0.8
Union Pacific Railroad	7.8	0.2
Oregon Department of Transportation	6.2	0.2
City of Molalla	4.7	0.1
U.S. Government	4.7	0.1
Oregon Pacific Railroad	2.8	0.1

6.6.4 Time frame of simulation

The model period is July 20, 2004 to August 02, 2004.

6.6.5 Important assumptions

The effort currently described in the QAPP includes use of existing models. Key calibration assumptions made during the model setup and calibration process were documented in the original TMDL (DEQ, 2006 and DEQ, 2008), the model user guide (Boyd and Kasper, 2003) or in Section 6 and Section 7 of this document.

6.6.6 Model inputs

Table 23 summarizes the current configuration of the model input parameters and the source of these data. Temperature, flow, and meteorological input parameters are summarized to improve documentation of the TMDL approach.

Table 23: Boundary condition and tributary inputs to the existing Molalla River Heat Source model.

Model Location Name (Station ID)	Model Location (kilometers)	Input Type	Model Input	Data Source	Note
Molalla at Locked Gate HW	75.36	Boundary Condition	Flow	Derived data.	Flow input is constant.
Molalla at Locked Gate HW	75.36	Boundary Condition	Water Temperature	DEQ	
Copper Creek	75.33	Tributary	Flow	Derived data.	
Spring at model kilometer 75.3	75.3	Tributary	Flow	Derived data.	
unnamed tributary 6	74.6	Tributary	Flow	Derived data.	
Spring at model kilometer 74.2	74.2	Tributary	Flow	Derived data.	
Spring at model kilometer 73.77	73.77	Tributary	Flow	Derived data.	
Spring at model kilometer 73.4	73.4	Tributary	Flow	Derived data.	
Minette Creek	72.69	Tributary	Flow	Derived data.	

Model Location Name (Station ID)	Model Location (kilometers)	Input Type	Model Input	Data Source	Note
Table Rock Fork	66.54	Tributary	Flow	Derived data.	
Horse Creek	64.65	Tributary	Flow	Derived data.	
Spring at model kilometer 63.33	63.33	Tributary	Flow	Derived data.	
Gawley Creek	62.52	Tributary	Flow	Derived data.	
Spring at model kilometer 60.84	60.84	Tributary	Flow	Derived data.	
unnamed tributary 5	59.91	Tributary	Flow	Derived data.	
North Fork Molalla	44.94	Tributary	Flow	DEQ	
Spring at model kilometer 39.12	39.12	Tributary	Flow	Derived data.	
Seep at model kilometer 38.16	38.16	Tributary	Flow	Derived data.	
Seep/Spring at model kilometer 35.88	35.88	Tributary	Flow	Derived data.	
Spring at model kilometer 35.07	35.07	Tributary	Flow	Derived data.	
Spring at model kilometer 32.7	32.7	Tributary	Flow	Derived data.	
Spring at model kilometer 30.63	30.63	Tributary	Flow	Derived data.	

Model Location Name (Station ID)	Model Location (kilometers)	Input Type	Model Input	Data Source	Note
Spring at model kilometer 30.54	30.54	Tributary	Flow	Derived data.	
Seep at model kilometer 29.88	29.88	Tributary	Flow	Derived data.	
Spring at model kilometer 25.59	25.59	Tributary	Flow	Derived data.	
Spring at model kilometer 22.29	22.29	Tributary	Flow	Derived data.	
Spring at model kilometer 18.33	18.33	Tributary	Flow	Derived data.	
Spring at model kilometer 16.89	16.89	Tributary	Flow	Derived data.	
unnamed tributary 2	15.75	Tributary	Flow	Derived data.	
Spring at model kilometer 13.71	13.71	Tributary	Flow	Derived data.	
Milk Creek	12.9	Tributary	Flow	Derived data.	
Spring at model kilometer 12.69	12.69	Tributary	Flow	Derived data.	
Spring at model kilometer 12.03	12.03	Tributary	Flow	Derived data.	
unnamed tributary 1	11.88	Tributary	Flow	Derived data.	

Model Location Name (Station ID)	Model Location (kilometers)	Input Type	Model Input	Data Source	Note
Spring at model kilometer 11.58	11.58	Tributary	Flow	Derived data.	
Spring at model kilometer 11.19	11.19	Tributary	Flow	Derived data.	
Spring at model kilometer 10.59	10.59	Tributary	Flow	Derived data.	
Gribble Creek	8.46	Tributary	Flow	Derived data.	
Spring at model kilometer 2.67	2.67	Tributary	Flow	Derived data.	
Pudding River	2.55	Tributary	Flow	Derived data.	
Spring at model kilometer 0.87	0.87	Tributary	Flow	Derived data.	
Copper Creek (32047-ORDEQ)	75.33	Tributary	Water Temperature	DEQ	
Spring at model kilometer 75.3 (TIR)	75.3	Tributary	Water Temperature	Derived data. Watershed Sciences (2005)	Derived from TIR. Constant temperature of 14.3 deg-C.
unnamed tributary 6 (TIR)	74.6	Tributary	Water Temperature	Derived data. Watershed Sciences (2005)	Derived from TIR. Constant temperature of 15.5 deg-C.
Spring at model kilometer 74.2 (TIR)	74.2	Tributary	Water Temperature	Derived data. Watershed Sciences (2005)	Derived from TIR. Constant temperature of 15.3 deg-C.

Model Location Name (Station ID)	Model Location (kilometers)	Input Type	Model Input	Data Source	Note
Spring at model kilometer 73.77 (TIR)	73.77	Tributary	Water Temperature	Derived data. Watershed Sciences (2005)	Derived from TIR. Constant temperature of 14.7 deg-C.
Spring at model kilometer 73.4 (TIR)	73.4	Tributary	Water Temperature	Derived data. Watershed Sciences (2005)	Derived from TIR. Constant temperature of 9.3 deg-C.
Minette Creek (TIR)	72.69	Tributary	Water Temperature	Derived data. Watershed Sciences (2005)	Derived from TIR. Constant temperature of 13.2 deg-C.
Table Rock Fork (32048-ORDEQ)	66.54	Tributary	Water Temperature	DEQ	
Horse Creek (TIR)	64.65	Tributary	Water Temperature	Derived data. Watershed Sciences (2005)	Derived from TIR. Constant temperature of 17.1 deg-C.
Spring at model kilometer 63.33 (TIR)	63.33	Tributary	Water Temperature	Derived data. Watershed Sciences (2005)	Derived from TIR. Constant temperature of 14.7 deg-C.
Gawley Creek (TIR)	62.52	Tributary	Water Temperature	Derived data. Watershed Sciences (2005)	Derived from TIR. Constant temperature of 16.3 deg-C.
Spring at model kilometer 60.84 (TIR)	60.84	Tributary	Water Temperature	Derived data. Watershed Sciences (2005)	Derived from TIR. Constant temperature of 18.9 deg-C.
unnamed tributary 5 (TIR)	59.91	Tributary	Water Temperature	Derived data. Watershed Sciences (2005)	Derived from TIR. Constant temperature of 18.9 deg-C.

Model Location Name (Station ID)	Model Location (kilometers)	Input Type	Model Input	Data Source	Note
North Fork Molalla	44.94	Tributary	Water Temperature	DEQ	
Spring at model kilometer 39.12 (TIR)	39.12	Tributary	Water Temperature	Derived data. Watershed Sciences (2005)	Derived from TIR. Constant temperature of 20.3 deg-C.
Seep at model kilometer 38.16 (TIR)	38.16	Tributary	Water Temperature	Derived data. Watershed Sciences (2005)	Derived from TIR. Constant temperature of 19.3 deg-C.
Seep/Spring at model kilometer 35.88 (TIR)	35.88	Tributary	Water Temperature	Derived data. Watershed Sciences (2005)	Derived from TIR. Constant temperature of 21.1 deg-C.
Spring at model kilometer 35.07 (TIR)	35.07	Tributary	Water Temperature	Derived data. Watershed Sciences (2005)	Derived from TIR. Constant temperature of 22.2 deg-C.
Spring at model kilometer 32.7 (TIR)	32.7	Tributary	Water Temperature	Derived data. Watershed Sciences (2005)	Derived from TIR. Constant temperature of 16.9 deg-C.
Spring at model kilometer 30.63 (TIR)	30.63	Tributary	Water Temperature	Derived data. Watershed Sciences (2005)	Derived from TIR. Constant temperature of 20.7 deg-C.
Spring at model kilometer 30.54 (TIR)	30.54	Tributary	Water Temperature	Derived data. Watershed Sciences (2005)	Derived from TIR. Constant temperature of 21 deg-C.
Seep at model kilometer 29.88 (TIR)	29.88	Tributary	Water Temperature	Derived data. Watershed Sciences (2005)	Derived from TIR. Constant temperature of 20.8 deg-C.

Model Location Name (Station ID)	Model Location (kilometers)	Input Type	Model Input	Data Source	Note
Spring at model kilometer 25.59 (TIR)	25.59	Tributary	Water Temperature	Derived data. Watershed Sciences (2005)	Derived from TIR. Constant temperature of 22.2 deg-C.
Spring at model kilometer 22.29 (TIR)	22.29	Tributary	Water Temperature	Derived data. Watershed Sciences (2005)	Derived from TIR. Constant temperature of 22.5 deg-C.
Spring at model kilometer 18.33 (TIR)	18.33	Tributary	Water Temperature	Derived data. Watershed Sciences (2005)	Derived from TIR. Constant temperature of 19.7 deg-C.
Spring at model kilometer 16.89 (TIR)	16.89	Tributary	Water Temperature	Derived data. Watershed Sciences (2005)	Derived from TIR. Constant temperature of 18.2 deg-C.
unnamed tributary 2 (TIR)	15.75	Tributary	Water Temperature	Derived data. Watershed Sciences (2005)	Derived from TIR. Constant temperature of 23.2 deg-C.
Spring at model kilometer 13.71 (TIR)	13.71	Tributary	Water Temperature	Derived data. Watershed Sciences (2005)	Derived from TIR. Constant temperature of 21.3 deg-C.
Milk Creek (TIR)	12.9	Tributary	Water Temperature	Derived data. Watershed Sciences (2005)	Derived from TIR. Constant temperature of 23.5 deg-C.
Spring at model kilometer 12.69 (TIR)	12.69	Tributary	Water Temperature	Derived data. Watershed Sciences (2005)	Derived from TIR. Constant temperature of 22.6 deg-C.

Model Location Name (Station ID)	Model Location (kilometers)	Input Type	Model Input	Data Source	Note
Spring at model kilometer 12.03 (TIR)	12.03	Tributary	Water Temperature	Derived data. Watershed Sciences (2005)	Derived from TIR. Constant temperature of 19.8 deg-C.
unnamed tributary 1 (TIR)	11.88	Tributary	Water Temperature	Derived data. Watershed Sciences (2005)	Derived from TIR. Constant temperature of 24.4 deg-C.
Spring at model kilometer 11.58 (TIR)	11.58	Tributary	Water Temperature	Derived data. Watershed Sciences (2005)	Derived from TIR. Constant temperature of 19.8 deg-C.
Spring at model kilometer 11.19 (TIR)	11.19	Tributary	Water Temperature	Derived data. Watershed Sciences (2005)	Derived from TIR. Constant temperature of 19.8 deg-C.
Spring at model kilometer 10.59 (TIR)	10.59	Tributary	Water Temperature	Derived data. Watershed Sciences (2005)	Derived from TIR. Constant temperature of 24.7 deg-C.
Gribble Creek (TIR)	8.46	Tributary	Water Temperature	Derived data. Watershed Sciences (2005)	Derived from TIR. Constant temperature of 19.1 deg-C.
Spring at model kilometer 2.67 (TIR)	2.67	Tributary	Water Temperature	Derived data. Watershed Sciences (2005)	Derived from TIR. Constant temperature of 13.8 deg-C.
Pudding River at Arndt Road (Barlow) (10362-ORDEQ)	2.55	Tributary	Water Temperature	DEQ	

Model Location Name (Station ID)	Model Location (kilometers)	Input Type	Model Input	Data Source	Note
Spring at model kilometer 0.87 (TIR)	0.87	Tributary	Water Temperature	Derived data. Watershed Sciences (2005)	Derived from TIR. Constant temperature of 19.1 deg-C.
No Station ID	0.3, 3.18, 4.8, 10.41, 13.65, 20.49, 24.4, 32.16, 45, 54.45, 64.8, 75.36	Meteorological	Air Temperature, Relative Humidity, Wind Speed	DEQ	

Hourly meteorology inputs into the model include air temperature, relative humidity, and wind speed. Air temperature data were modified using the dry adiabatic lapse rate to adjust for differences in elevation between the measurement location and the model input location. Wind speeds were adjusted using a wind-sheltering coefficient to represent difference in wind speed between the measurement location and above the stream within the riparian area.

6.6.7 Model calibration

The expected model calibration sites and data sources are summarized in Table 24. The model location in the table below describes the distance of each input from the most downstream model node. The model inputs and parameters that are expected to be modified to improve model fit are described in Section 6.1.

Table 24: Calibration sites and parameters used in the existing Molalla River Heat Source model.

Model Location Name (Station ID)	Model Location (kilometers)	Calibration Parameter	Data Source
Molalla at Locked Gate HW	75.36	Water Temperature	DEQ
Molalla above Horse Cr (32049-ORDEQ)	64.8	Water Temperature	DEQ
Molalla above Pine Cr USGS (32051-ORDEQ)	54.45	Water Temperature	DEQ
Molalla abv N. Fork	45	Water Temperature	DEQ
Molalla at HWY 211	32.16	Water Temperature	DEQ
Molalla at HWY 213 (10881-ORDEQ)	24.4	Water Temperature	DEQ
Molalla at Kraxberger	20.49	Water Temperature	DEQ
Molalla abv Milk Cr (32061-ORDEQ)	13.65	Water Temperature	DEQ

Model Location Name (Station ID)	Model Location (kilometers)	Calibration Parameter	Data Source
Molalla at Goods Br. USGS (32058-ORDEQ)	10.41	Water Temperature	DEQ
Molalla River at Knights Bridge Road (Canby) (10637-ORDEQ)	4.8	Water Temperature	DEQ
Molalla at 22nd (32059-ORDEQ)	3.18	Water Temperature	DEQ
Molalla at mouth (10636-ORDEQ)	0.3	Water Temperature	DEQ
Model extent	Model extent	Water Temperature (TIR)	Watershed Sciences (2005)

6.7 Pudding River

The Pudding River model is a temperature model developed using Heat Source 8.0. The model was developed by DEQ.

6.7.1 Model domain

The extent of the model domain is the Pudding River from the mouth to upstream of the confluence with Drift Creek at river kilometer 84.5. The model extent is shown in the HTML interactive map that accompanies this QAPP and is referenced in Appendix D.

6.7.2 Spatial and temporal resolution

The model input spatial resolution (*dx*) is 30 meters. Outputs are generated every 100 meters. The model time step (*dt*) is 4 minute and outputs are generated every hour.

A *dx* of 30 meters was chosen to capture the range of solar flux input caused by the varied vegetation conditions along the length of the stream. The high resolution *dx* will allow evaluation of multiple vegetation management scenarios for each designated management agency.

6.7.3 Source characteristics

The primary sources of thermal loading contributing to temperatures exceedances along the Pudding River include increases in solar radiation loading from the disturbance or removal of near-stream vegetation, point source discharges, reductions to the stream flow rate or volume, and background sources (DEQ, 2008). Other potential sources include channel modification and widening, and warming caused by climate change. The contribution of these latter potential sources may be investigated as part of the model scenarios.

There are six permitted individual NPDES point sources along the model extent. Detail about each point source is summarized in Table 25.

Table 25: Summary of individual NPDES permitted discharges in the Pudding River.

Facility Name (Facility Number)	Latitude/Longitude	Permit Type and Description	Stream/River Mile
Aurora STP (110020)	45.22/-122.8	NPDES-DOM-Db: Sewage - less than 1 MGD with discharging lagoons	Pudding River RM 8.8
Columbia Helicopters (100541)	45.2587/-122.765	NPDES-IW-B16: All facilities not elsewhere classified which dispose of non-process wastewaters	Pudding River RM 2
Gervais STP (33060)	45.1129/-122.89	NPDES-DOM-Db: Sewage - less than 1 MGD with discharging lagoons	Pudding River RM 28.2
Jlr, Llc (32536)	45.1328/-122.841	NPDES-IW-B05: Food/beverage processing - Large and complex. Flow greater than or equal to 1 MGD for 180 days/year or more	Pudding River RM 27
Mt. Angel STP (58707)	45.074/-122.821	NPDES-DOM-Da: Sewage - less than 1 MGD	Pudding River RM 37.5
Woodburn WWTP (98815)	45.1542/-122.802	NPDES-DOM-C1a: Sewage - 2 MGD or more but less than 5 MGD	Pudding River RM 21.4

The majority land uses along the Pudding River are agriculture and forestry accounting for about 88 percent of the near-stream area. Table 26 summarizes all the land uses within 100 meters of the digitized Pudding River centerline. Land uses were summarized using the 2016 National Land Cover Database (Yang et al 2018). Note that Shrub/Scrub and Herbaceous land uses can be areas where forest clearcuts have occurred and would be classified as forest after regrowth.

Table 26: Summary of land uses within 100 meters of the digitized Pudding River centerline based on the 2016 National Land Cover Database (Yang et al 2018).

2016 NLCD Land Cover	Acres	Percent of Total Acres
Hay/Pasture	1398.0	31.2
Woody Wetlands	1296.8	29
Cultivated Crops	911.6	20.4
Emergent Herbaceous Wetlands	420.1	9.4
Evergreen Forest	189.5	4.2
Shrub/Scrub	88.5	2
Developed, Low Intensity	86.1	1.9
Developed, Open Space	45.6	1
Mixed Forest	26.5	0.6
Developed, Medium Intensity	7.1	0.2
Herbaceous	5.3	0.1
Barren Land	1.6	<0.05
Developed, High Intensity	0.7	<0.05
Deciduous Forest	0.7	<0.05

Anthropogenic related stream warming caused by nonpoint sources is closely associated with the uses, the activities, and the condition of vegetation adjacent to the stream. How activities and uses are managed in these areas is partially determined by a variety of different rules and management plans established by the landowner and any agency with land use authority. To better understand the spatial distribution of different agency rules or management plans along the model extent DEQ mapped known designated management agencies (Table 27).

A designated management agency is defined in OAR 340-042-0030(2) as a federal, state, or local governmental agency that has legal authority over a sector or source contributing pollutants. Typically, persons or designated management agencies that are identified in the TMDL Water Quality Management Plan (WQMP) are responsible for developing TMDL implementation plans and implementing management strategies to reduce pollutant loading. Table 27 summarizes the potential designated management agencies and responsible persons along the Pudding River model extent.

Table 27: Summary of potential designated management agencies (DMAs) or responsible persons within 100 meters of the digitized Pudding River centerline.

DMA or Responsible Person	Acres	Percent of Total Acres
Oregon Department of Agriculture	3919.3	86.3
Oregon Department of State Lands - Waterway	466.2	10.3
Oregon Parks and Recreation Department	57.7	1.3
Marion County	34.4	0.8
Clackamas County	28.4	0.6
Oregon Department of Transportation	23.1	0.5
City of Aurora	4.6	0.1
Union Pacific Railroad	3.1	0.1
Willamette Valley Railway	2.9	0.1
State of Oregon	2.1	<0.05
City of Woodburn	0.3	<0.05
Oregon Department of Forestry - Private Forestland	<0.05	<0.05

6.7.4 Time frame of simulation

The model period is August 01, 2004 to August 14, 2004.

6.7.5 Important assumptions

The effort currently described in the QAPP includes use of existing models. Key calibration assumptions made during the model setup and calibration process were documented in the original TMDL (DEQ, 2006 and DEQ, 2008), the model user guide (Boyd and Kasper, 2003) or in Section 6 and Section 7 of this document.

6.7.6 Model inputs

Table 28 summarizes the current configuration of the model input parameters and the source of these data. Temperature, flow, and meteorological input parameters are summarized to improve documentation of the TMDL approach.

Table 28: Boundary condition and tributary inputs to the existing Pudding River Heat Source model.

Model Location Name (Station ID)	Model Location (kilometers)	Input Type	Model Input	Data Source	Note
Pudding River upstream of Drift Creek	84.6	Boundary Condition	Flow	Derived data. OWRD	
Pudding River at State Street (32055-ORDEQ)	84.6	Boundary Condition	Water Temperature	DEQ	
POD at Original Node 148 (OWRD)	84.1	Point of Diversion	Flow	DEQ	
POD at Original Node 153 (OWRD)	83.6	Point of Diversion	Flow	DEQ	
POD at Original Node 158 (OWRD)	83.1	Point of Diversion	Flow	DEQ	
POD at Original Node 165 (OWRD)	82.4	Point of Diversion	Flow	DEQ	
POD at Original Node 176 (OWRD)	81.3	Point of Diversion	Flow	DEQ	
POD at Original Node 200 (OWRD)	78.9	Point of Diversion	Flow	DEQ	
POD at Original Node 214 (OWRD)	77.5	Point of Diversion	Flow	DEQ	
POD at Original Node 224 (OWRD)	76.5	Point of Diversion	Flow	DEQ	
POD at Original Node 233 (OWRD)	75.6	Point of Diversion	Flow	DEQ	
POD at Original Node 249 (OWRD)	74	Point of Diversion	Flow	DEQ	
POD at Original Node 265 (OWRD)	72.4	Point of Diversion	Flow	DEQ	

Model Location Name (Station ID)	Model Location (kilometers)	Input Type	Model Input	Data Source	Note
POD at Original Node 281 (OWRD)	70.8	Point of Diversion	Flow	DEQ	
POD at Original Node 294 (OWRD)	69.5	Point of Diversion	Flow	DEQ	
POD at Original Node 320 (OWRD)	66.9	Point of Diversion	Flow	DEQ	
POD at Original Node 335 (OWRD)	65.4	Point of Diversion	Flow	DEQ	
POD at Original Node 367 (OWRD)	62.2	Point of Diversion	Flow	DEQ	
POD at Original Node 394 (OWRD)	59.5	Point of Diversion	Flow	DEQ	
POD at Original Node 418 (OWRD)	57.1	Point of Diversion	Flow	DEQ	
POD at Original Node 452 (OWRD)	53.7	Point of Diversion	Flow	DEQ	
POD at Original Node 469 (OWRD)	52	Point of Diversion	Flow	DEQ	
POD at Original Node 495 (OWRD)	49.4	Point of Diversion	Flow	DEQ	
POD at Original Node 536 (OWRD)	45.3	Point of Diversion	Flow	DEQ	
POD at Original Node 550 (OWRD)	43.9	Point of Diversion	Flow	DEQ	
POD at Original Node 576 (OWRD)	41.3	Point of Diversion	Flow	DEQ	
POD at Original Node 598 (OWRD)	39.1	Point of Diversion	Flow	DEQ	

Model Location Name (Station ID)	Model Location (kilometers)	Input Type	Model Input	Data Source	Note
POD at Original Node 625 (OWRD)	36.4	Point of Diversion	Flow	DEQ	
POD at Original Node 649 (OWRD)	34	Point of Diversion	Flow	DEQ	
POD at Original Node 683 (OWRD)	30.6	Point of Diversion	Flow	DEQ	
POD at Original Node 708 (OWRD)	28.1	Point of Diversion	Flow	DEQ	
POD at Original Node 732 (OWRD)	25.7	Point of Diversion	Flow	DEQ	
POD at Original Node 779 (OWRD)	21	Point of Diversion	Flow	DEQ	
POD at Original Node 808 (OWRD)	18.1	Point of Diversion	Flow	DEQ	
POD at Original Node 832 (OWRD)	15.7	Point of Diversion	Flow	DEQ	
POD at Original Node 890 (OWRD)	9.9	Point of Diversion	Flow	DEQ	
POD at Original Node 911 (OWRD)	7.8	Point of Diversion	Flow	DEQ	
POD at Original Node 956 (OWRD)	3.3	Point of Diversion	Flow	DEQ	
POD at Original Node 969 (OWRD)	2	Point of Diversion	Flow	DEQ	
JLR, LLC	44.15	Point Source	Flow	DEQ	Agripac/Brucepac WWTP
Woodburn WWTP	38.3	Point Source	Flow	DEQ	
JLR, LLC	44.15	Point Source	Water Temperature	DEQ	Agripac/Brucepac WWTP

Model Location Name (Station ID)	Model Location (kilometers)	Input Type	Model Input	Data Source	Note
Woodburn WWTP	38.3	Point Source	Water Temperature	DEQ	
Drift Creek (DC1)	84.5	Tributary	Flow	Marion SWCD	
Lower Pudding R / Howell Prairie Catchment 1 (blw Drift Cr)	82.3	Tributary	Flow	Derived data.	
Silver Creek	81.2	Tributary	Flow	Derived data.	
Lower Pudding R / Howell Prairie Catchment 2 (Silver to Abiqua) Node 180	80.9	Tributary	Flow	Derived data.	
Abiqua Creek (AC1)	75.1	Tributary	Flow	Marion SWCD	
Lower Pudding R / Howell Prairie Catchment 3 (u/s Mt. Angel gage) Node 278	71.1	Tributary	Flow	Derived data.	
Howell Prairie Cr Node 360	62.9	Tributary	Flow	Derived data.	
Little Pudding River (LPR1)	60.4	Tributary	Flow	Marion SWCD	
Unnamed Trib (Sacred Heart Cr) to the Pudding at Monitor-McKee Rd Node 478	51.1	Tributary	Flow	Derived data.	

Model Location Name (Station ID)	Model Location (kilometers)	Input Type	Model Input	Data Source	Note
Zollner Creek at USGS Gage (14201300)	47.6	Tributary	Flow	USGS	
Unnmd Trib Node 580 inflow (19% of 6th field)	40.9	Tributary	Flow	Derived data.	
Butte Creek (BC1)	32.9	Tributary	Flow	Marion SWCD	
Brandy Creek Node 703	28.6	Tributary	Flow	Derived data.	
Rock Creek	24.9	Tributary	Flow	Derived data.	
DA between Mill Cr and Pudding R to Node 794	19.5	Tributary	Flow	Derived data.	
DA Rt side Pudding u/s Mill to Node 837	15.2	Tributary	Flow	Derived data.	
Mill Creek	10.8	Tributary	Flow	Derived data.	
DA Lt side Pudding ds Mill to Arndt Rd Node 894	9.5	Tributary	Flow	Derived data.	
DA Rt side Pudding ds Mill to Arndt Rd Node 907	8.2	Tributary	Flow	Derived data.	
DA Rt side ds Arndt Rd Node 967	2.2	Tributary	Flow	Derived data.	
DA Lt side ds Arndt Rd Node 971	1.8	Tributary	Flow	Derived data.	

Model Location Name (Station ID)	Model Location (kilometers)	Input Type	Model Input	Data Source	Note
Drift Cr (DC2, 32057-ODEQ)	84.5	Tributary	Water Temperature	Derived data. Marion SWCD, DEQ	Temperature data derived from a linear interpolation of data from Marion County SWCD and DEQ temperatue station 32057.
Lower Pudding R / Howell Prairie Catchment 1 (blw Drift Cr)	82.3	Tributary	Water Temperature	Derived data.	Temperature data from a mix of Mill Creek (31876-ODEQ), Zollner Creek (ZC1-72-Marion SWCD), Upper Pudding Creek and groundwater data.
Silver Creek (10646-ORDEQ)	81.2	Tributary	Water Temperature	DEQ	
Lower Pudding R / Howell Prairie Catchment 2 (Silver to Abiqua) Node 180	80.9	Tributary	Water Temperature	Derived data.	Temperature data from a mix of Mill Creek (31876-ODEQ), Zollner Creek (ZC1-72-Marion SWCD), Upper Pudding Creek and groundwater data.
Abiqua Creek (AC1-5406)	75.1	Tributary	Water Temperature	Marion SWCD	
Lower Pudding R / Howell Prairie Catchment 3 (u/s Mt. Angel gage) Node 278	71.1	Tributary	Water Temperature	Derived data.	Temperature data from a mix of Mill Creek (31876-ODEQ), Zollner Creek (ZC1-72-Marion SWCD), Upper Pudding Creek and groundwater data.
Howell Prairie Cr Node 360	62.9	Tributary	Water Temperature	Derived data.	Temperature data from a mix of Mill Creek (31876-ODEQ), Zollner Creek (ZC1-72-Marion SWCD), Upper Pudding Creek and groundwater data.

Model Location Name (Station ID)	Model Location (kilometers)	Input Type	Model Input	Data Source	Note
Little Pudding R Node 385 (LPR1-71)	60.4	Tributary	Water Temperature	Marion SWCD	
Unnamed Trib (Sacred Heart Cr) to the Pudding at Monitor-McKee Rd Node 478	51.1	Tributary	Water Temperature	Derived data.	Temperature data from a mix of Mill Creek (31876-ODEQ), Zollner Creek (ZC1-72-Marion SWCD), Upper Pudding Creek and groundwater data.
Zollner Creek (ZC1-72)	47.6	Tributary	Water Temperature	Marion SWCD	
Unnmd Trib Node 580 inflow (19% of 6th field)	40.9	Tributary	Water Temperature	Derived data.	Temperature data from a mix of Mill Creek (31876-ODEQ), Zollner Creek (ZC1-72-Marion SWCD), Upper Pudding Creek and groundwater data.
Butte Creek (BC1-67)	32.9	Tributary	Water Temperature	Marion SWCD	
Brandy Creek Node 703	28.6	Tributary	Water Temperature	Derived data.	Temperature data from a mix of Mill Creek (31876-ODEQ), Zollner Creek (ZC1-72-Marion SWCD), Upper Pudding Creek and groundwater data.
Rock Creek (RC1-70)	24.9	Tributary	Water Temperature	Marion SWCD	
DA between Mill Cr and Pudding R to Node 794	19.5	Tributary	Water Temperature	Derived data.	Temperature data from a mix of Mill Creek (31876-ODEQ), Zollner Creek (ZC1-72-Marion SWCD), Upper Pudding Creek and groundwater data.

Model Location Name (Station ID)	Model Location (kilometers)	Input Type	Model Input	Data Source	Note
DA Rt side Pudding u/s Mill to Node 837	15.2	Tributary	Water Temperature	Derived data.	Temperature data from a mix of Mill Creek (31876-ODEQ), Zollner Creek (ZC1-72-Marion SWCD), Upper Pudding Creek and groundwater data.
Mill Creek (31876-ORDEQ)	10.8	Tributary	Water Temperature	DEQ	
DA Lt side Pudding ds Mill to Arndt Rd Node 894	9.5	Tributary	Water Temperature	Derived data.	Temperature data from a mix of Mill Creek (31876-ODEQ), Zollner Creek (ZC1-72-Marion SWCD), Upper Pudding Creek and groundwater data.
DA Rt side Pudding ds Mill to Arndt Rd Node 907	8.2	Tributary	Water Temperature	Derived data.	Temperature data from a mix of Mill Creek (31876-ODEQ), Zollner Creek (ZC1-72-Marion SWCD), Upper Pudding Creek and groundwater data.
DA Rt side ds Arndt Rd Node 967	2.2	Tributary	Water Temperature	Derived data.	Temperature data from a mix of Mill Creek (31876-ODEQ), Zollner Creek (ZC1-72-Marion SWCD), Upper Pudding Creek and groundwater data.
DA Lt side ds Arndt Rd Node 971	1.8	Tributary	Water Temperature	Derived data.	Temperature data from a mix of Mill Creek (31876-ODEQ), Zollner Creek (ZC1-72-Marion SWCD), Upper Pudding Creek and groundwater data.
arao - Aurora	7.7, 12.4, 36.2, 43.7, 51.7, 66.3, 79.6	Meteorological	Air Temperature, Relative Humidity, Wind Speed	Oregon AgriMet Weather Station	

Model Location Name (Station ID)	Model Location (kilometers)	Input Type	Model Input	Data Source	Note
KUAO - Aurora State Airport	7.7, 12.4, 36.2, 43.7, 51.7, 66.3, 79.6	Meteorological	Cloudiness	NWS	

Hourly meteorology inputs into the model include air temperature, cloudiness, relative humidity, and wind speed. Air temperature data were modified using the dry adiabatic lapse rate to adjust for differences in elevation between the measurement location and the model input location. Wind speeds were adjusted using a wind-sheltering coefficient to represent difference in wind speed between the measurement location and above the stream within the riparian area.

6.7.7 Model calibration

The expected model calibration sites and data sources are summarized in Table 29. The model location in the table below describes the distance of each input from the most downstream model node. The model inputs and parameters that are expected to be modified to improve model fit are described in Section 6.1.

Table 29: Calibration sites and parameters used in the existing Pudding River Heat Source model.

Model Location Name (Station ID)	Model Location (kilometers)	Calibration Parameter	Data Source
Pudding River at Hazel Green Rd. (PR1-5808)	79.6	Water Temperature	Marion SWCD
Pudding River at Saratoga Road (31877-ORDEQ)	66.3	Water Temperature	DEQ
Pudding River at Monitor-McKee Road (11530-ORDEQ)	51.7	Water Temperature	DEQ
Pudding River at Hwy 214 (downstream of cannery outfall) (10641-ORDEQ)	43.7	Water Temperature	DEQ
Pudding River at Hwy 211 (Woodburn) (10640-ORDEQ)	36.2	Water Temperature	DEQ
Pudding River at Hwy 99 (Aurora) (10917-ORDEQ)	12.4	Water Temperature	DEQ
Pudding River at Arndt Road (Barlow) (10362-ORDEQ)	7.7	Water Temperature	DEQ
Model extent	Model extent	Water Temperature (TIR)	Watershed Sciences (2005)

6.8 Thomas Creek

The Thomas Creek model is a temperature model developed using Heat Source 6.5.1. The model was developed by DEQ.

6.8.1 Model domain

The extent of the model domain is Thomas Creek from the mouth to river mile 32. The model extent is shown in the HTML interactive map that accompanies this QAPP and is referenced in Appendix D.

6.8.2 Spatial and temporal resolution

The model input spatial resolution (*dx*) is 30 meters. Outputs are generated every 100 meters. The model time step (*dt*) is 1 minute and outputs are generated every hour.

A *dx* of 30 meters was chosen to capture the range of solar flux input caused by the varied vegetation conditions along the length of the stream. The high resolution *dx* will allow evaluation of multiple vegetation management scenarios for each designated management agency.

6.8.3 Source characteristics

The primary sources of thermal loading contributing to temperatures exceedances along the Thomas Creek include increases in solar radiation loading from the disturbance or removal of near-stream vegetation, point source discharges, and background sources (DEQ, 2006). Other potential sources include channel modification and widening, reductions to stream flow rate, and warming caused by climate change. The contribution of these latter potential sources may be investigated as part of the model scenarios.

There is one permitted individual NPDES point source along the model extent. Detail about the point source is summarized in Table 30.

Table 30: Summary of individual NPDES permitted discharges in the Thomas Creek.

Facility Name (Facility Number)	Latitude/Longitude	Permit Type and Description	Stream/River Mile
Scio STP (79633)	44.7/-122.853	NPDES-DOM-Db: Sewage - less than 1 MGD with discharging lagoons	Thomas Creek RM 7.2

The majority land uses along the Thomas Creek are forestry and agriculture accounting for about 86 percent of the near-stream area. Table 31 summarizes all the land uses within 100 meters of the digitized Thomas Creek centerline. Land uses were summarized using the 2016 National Land Cover Database (Yang et al 2018). Note that Shrub/Scrub and Herbaceous land uses can be areas where forest clearcuts have occurred and would be classified as forest after regrowth.

Table 31: Summary of land uses within 100 meters of the digitized Thomas Creek centerline based on the 2016 National Land Cover Database (Yang et al 2018).

2016 NLCD Land Cover	Acres	Percent of Total Acres
Evergreen Forest	915.2	36.8
Hay/Pasture	625.2	25.1

2016 NLCD Land Cover	Acres	Percent of Total Acres
Woody Wetlands	257.8	10.4
Emergent Herbaceous Wetlands	186.4	7.5
Cultivated Crops	161.9	6.5
Developed, Open Space	95.2	3.8
Mixed Forest	83.6	3.4
Developed, Low Intensity	55.4	2.2
Shrub/Scrub	48.7	2
Herbaceous	29.8	1.2
Developed, Medium Intensity	13.8	0.6
Deciduous Forest	6.7	0.3
Barren Land	5.1	0.2
Developed, High Intensity	2.4	0.1

Anthropogenic related stream warming caused by nonpoint sources is closely associated with the uses, the activities, and the condition of vegetation adjacent to the stream. How activities and uses are managed in these areas is partially determined by a variety of different rules and management plans established by the landowner and any agency with land use authority. To better understand the spatial distribution of different agency rules or management plans along the model extent DEQ mapped known designated management agencies (Table 32).

A designated management agency is defined in OAR 340-042-0030(2) as a federal, state, or local governmental agency that has legal authority over a sector or source contributing pollutants. Typically, persons or designated management agencies that are identified in the TMDL Water Quality Management Plan (WQMP) are responsible for developing TMDL implementation plans and implementing management strategies to reduce pollutant loading. Table 32 summarizes the potential designated management agencies and responsible persons along the Thomas Creek model extent.

Table 32: Summary of potential designated management agencies (DMAs) or responsible persons within 100 meters of the digitized Thomas Creek centerline.

DMA or Responsible Person	Acres	Percent of Total Acres
Oregon Department of Agriculture	1423.8	55.6
Oregon Department of Forestry - Private Forestland	701.3	27.4
U.S. Bureau of Land Management	215.8	8.4
Linn County	111.5	4.4
City of Scio	68.1	2.7
Oregon Department of Transportation	39.1	1.5

6.8.4 Time frame of simulation

The model period is for a single day: August 03, 2000.

6.8.5 Important assumptions

The effort currently described in the QAPP includes use of existing models. Key calibration assumptions made during the model setup and calibration process were documented in the original TMDL (DEQ, 2006 and DEQ, 2008), the model user guide (Boyd and Kasper, 2003) or in Section 6 and Section 7 of this document.

6.8.6 Model inputs

Table 33 summarizes the current configuration of the model input parameters and the source of these data. Temperature, flow, and meteorological input parameters are summarized to improve documentation of the TMDL approach.

Table 33: Boundary condition and tributary inputs to the existing Thomas Creek Heat Source model.

Model Location Name (Station ID)	Model Location (meters)	Input Type	Model Input	Data Source	Note
Upper Thomas Creek BLM Site (tho31a01)	0	Boundary Condition	Water Temperature	BLM	Data not in AWQMS.
Upper Thomas Creek BLM Site (tho31a01)	0	Boundary Condition	Flow	DEQ	
Sucker Slough at Robinson Road	46817.28	Tributary	Flow	Derived data.	
Small Trib	39288.72	Tributary	Flow	Derived data.	
Peters Ditch	38374.32	Tributary	Flow	Derived data.	
Mill Creek	30297.12	Tributary	Flow	Derived data.	
Small Trib	29992.32	Tributary	Flow	Derived data.	
Neal Creek at Lulay Bridge near Hannah Covered Bridge	23652.48	Tributary	Flow	DEQ	
Jordon Creek	20543.52	Tributary	Flow	Derived data.	
Spring Brook	20330.16	Tributary	Flow	Derived data.	
Bear Creek	13776.96	Tributary	Flow	Derived data.	
Criminal Creek	9174.48	Tributary	Flow	BLM	

Model Location Name (Station ID)	Model Location (meters)	Input Type	Model Input	Data Source	Note
Avery Creek	7040.88	Tributary	Flow	Derived data.	
Indian Prairie / Devils Den	5760.72	Tributary	Flow	Derived data.	
Ella Creek	4815.84	Tributary	Flow	Derived data.	
Hortense Creek	1920.24	Tributary	Flow	Derived data.	
Sucker Slough at Robinson Road (23787-ORDEQ)	46817.28	Tributary	Water Temperature	DEQ	Data not in AWQMS.
Small Trib	39288.72	Tributary	Water Temperature	Derived data.	Temp determined from Heat Source 6.5.1.
Peters Ditch	38374.32	Tributary	Water Temperature	Derived data.	Temp determined from Heat Source 6.5.1.
Mill Creek	30297.12	Tributary	Water Temperature	Derived data.	Temp determined from Heat Source 6.5.1.
Small Trib	29992.32	Tributary	Water Temperature	Derived data.	Temp determined from Heat Source 6.5.1.
Neal Creek at Lulay Bridge near Hannah Covered Bridge (23782-ORDEQ)	23652.48	Tributary	Water Temperature	DEQ	Data not in AWQMS.
Jordon Creek	20543.52	Tributary	Water Temperature	Derived data.	Temp determined from Heat Source 6.5.1.
Spring Brook (TIR)	20330.16	Tributary	Water Temperature	Derived data. Watershed Sciences (2001)	Derived from TIR. Constant temperature of 18.8 deg-C.

Model Location Name (Station ID)	Model Location (meters)	Input Type	Model Input	Data Source	Note
Bear Creek	13776.96	Tributary	Water Temperature	Derived data.	Temp determined from Heat Source 6.5.1.
Criminal Creek	9174.48	Tributary	Water Temperature	Derived data.	Temp determined from Heat Source 6.5.1.
Avery Creek	7040.88	Tributary	Water Temperature	Derived data.	Temp determined from Heat Source 6.5.1.
Indian Prairie / Devils Den	5760.72	Tributary	Water Temperature	Derived data.	Temp determined from Heat Source 6.5.1.
Ella Creek	4815.84	Tributary	Water Temperature	Derived data.	Temp determined from Heat Source 6.5.1.
Hortense Creek	1920.24	Tributary	Water Temperature	Derived data.	Temp determined from Heat Source 6.5.1.
crvo - Corvallis	0, 7681, 12223, 20940, 23987, 27706, 31699, 38039, 46787	Meteorological	Air Temperature, Relative Humidity, Wind Speed	Oregon AgriMet Weather Station	

Hourly meteorology inputs into the model include air temperature, relative humidity, and wind speed. Air temperature data were modified using the dry adiabatic lapse rate to adjust for differences in elevation between the measurement location and the model input location. Wind speeds were adjusted using a wind-sheltering coefficient to represent difference in wind speed between the measurement location and above the stream within the riparian area.

6.8.7 Model calibration

The expected model calibration sites and data sources are summarized in Table 34. The model location in the table below describes the distance of each input from the most upstream model node. The model inputs and parameters that are expected to be modified to improve model fit are described in Section 6.1.

Table 34: Calibration sites and parameters used in the existing Thomas Creek Heat Source model.

Model Location Name (Station ID)	Model Location (meters)	Calibration Parameter	Data Source
Thomas Creek at Kelly Road (10783-ORDEQ)	46787	Water Temperature, Flow, Effective Shade	DEQ
Thomas Creek at 0.6 miles west of Scio off of NW 1st (23785-ORDEQ)	38039	Water Temperature, Flow, Effective Shade	DEQ
Thomas Creek at Shimanek Covered Bridge (23784-ORDEQ)	31699	Water Temperature, Flow, Effective Shade	DEQ
Thomas Creek at USGS Gauge at Shindler Bridge Dr. (23783-ORDEQ)	27706	Water Temperature	DEQ
Thomas Creek at Hannah Covered Bridge (23781-ORDEQ)	23987	Water Temperature, Flow, Effective Shade	DEQ
Downstream Jordon Creek (23780-ORDEQ)	20940	Water Temperature, Flow, Effective Shade	DEQ
Thomas Creek at bridge at Willamette Industries Gate (23779-ORDEQ)	12223	Water Temperature, Flow, Effective Shade	DEQ
Lower Thomas Creek BLM Site (tho25a01)	7681	Water Temperature, Flow, Effective Shade	BLM and DEQ
Upper Thomas Creek BLM Site (tho31a01)	0	Effective Shade	DEQ

7 Model evaluation and acceptance

7.1 Model uncertainty and sensitivity

Model uncertainty can arise from a number of sources including error associated with measuring field parameters used for model input or calibration, lack of knowledge on the appropriate value to use for model parameters or constants, or an imperfect mathematical formulation in the model of real world physical processes. A model's sensitivity is the degree to which predictions are affected by changes in a single or multiple input parameters.

In many cases, the major source of uncertainty is due to uncertainty in spatial representation of the river channel and adjacent landcover (e.g., bathymetry, vegetation height and density) from lack of data or simplification, configuration of the boundary conditions (e.g., uncertainty in estimation of ungaged tributary flows or temperatures), and uncertainty from limited amount or spatial distribution of observed data used for calibration. These sources of uncertainty are largely unavoidable, but do not invalidate the use of the model for decision purposes.

During the calibration process, it is good practice to evaluate and minimize uncertainty associated with the model parameters to the greatest extent practical (Beck, 1987; EPA, 2009). During the model calibration process, the responsiveness of the model predictions to various assumptions and rate constants

should be evaluated. The model setup should include parameters based on literature recommendations and best professional judgment.

Reducing uncertainty in measured field parameters used for model input and calibration is accomplished in the following ways:

- Data used for the TMDL must have been collected based on a project plan with quality assurance and quality control protocols for collecting and analyzing samples.
- The sampling and laboratory analysis must follow widely accepted scientific methods and protocols. These may include DEQ's Mode of Operations Manual (DEQ, 2020), USEPA's methods (EPA, 1983), USGS's published techniques of water-resources investigations, the USGS National Field Manual, or Standard Methods for the Examination of Water and Wastewater. All acceptable methods include applicable precision and accuracy checks.
- When possible, accuracy and precision should be evaluated using DEQ's data validation criteria as outlined in DEQ Data Quality Matrix for Field Parameters (DEQ, 2013). The TMDL program uses waterbody results that demonstrate a data quality level of A, B, or E with careful review (DEQ, 2021). For continuous temperature data a data quality of A or B corresponds to an absolute accuracy 1.0 deg-C and absolute precision 2.0 deg-C. Data of unknown quality lacking audit and pre and post accuracy checks may also be used following a careful review where it is determined the results appear reasonable and free of issues based on professional judgment.

Uncertainties in the mathematical formulation are addressed by using open source models that allow free and transparent inspection of model code, and models that have had their methodologies peer reviewed and evaluated.

It is not anticipated that additional uncertainty or sensitivity analyses will be performed on the existing calibrated models.

7.2 Model acceptance

This section identifies the model acceptance criteria. Model acceptance relies on satisfying seven (7) conditions:

1) Incorporation of all available field observations of the system (e.g., geometry, flow, boundary inputs/withdrawals, and meteorology) for the time period simulated.
2) Model parameters and unmeasured boundary conditions that are within literature-supported and physically defensible ranges.
3) Model predicted results have been compared with the associated observed measurements using graphical presentations. Visual comparisons are useful in evaluating model performance over the appropriate temporal or spatial scales.
4) Goodness of fit statistics have been calculated comparing the model predicted results to the associated observed measurements. The calibration goodness of fit statistics are shown in Equation 4 through Equation 8.
5) Goodness of fit statistics have been used to inform the appropriate use of the model. Where a model achieves an excellent or good fit it can generally assume a strong role in decision making about appropriate management options. Conversely, where a model achieves only a fair or poor

fit it should assume a much less prominent role in decision making about appropriate management options. If a desired level of quality is not achieved on some or all measures, the model might still be useful; however, a detailed description of its potential range of applicability will be provided.

6) Written documentation of all important elements in the model, including model setup, model parameterization, key assumptions, and known areas of uncertainty.

7) Peer review as described in Section 9.

Equation 5 through Equation 8 are the goodness of fit statistics to be calculated for each calibrated temperature model. Equation 4 through Equation 7 are the goodness of fit statistics to be calculated for each calibrated shade model.

Coefficient of Determination – R squared (R^2): A coefficient of determination, or R^2, of one indicates a perfect fit. R^2 is a measure of how well predicted values fit the observed data. It compares the variations in the residuals to the variation of the observed data.

$$R^2 = 1 - \frac{\sum(X_{obs} - X_{mod})^2}{\sum\left(X_{obs} - \overline{X_{obs}}\right)^2} \qquad \text{Equation 4}$$

Mean Error (ME): A mean error of zero indicates a perfect fit. A positive value indicates on average the model predicted values are less than the observed data. A negative value indicates on average the model predicted values are greater than the observed data. The mean error statistic may give a false ideal value of zero (or near zero) if the average of the positive deviations between predictions and observations is about equal to the average of the negative deviations in a data set. Because of this, the mean absolute error (MAE) statistic should be used in conjunction with mean error to evaluate model performance.

$$ME = \frac{1}{n}\sum(X_{mod} - X_{obs}) \qquad \text{Equation 5}$$

Mean Absolute Error (MAE): A mean absolute error of zero indicates a perfect fit. The magnitude of the mean absolute error indicates the average deviation between model predicted values and observed data. The mean absolute error cannot give a false zero.

$$MAE = \frac{1}{n}\sum|X_{mod} - X_{obs}| \qquad \text{Equation 6}$$

Root Mean Square Error (RMSE): A root mean square error of zero indicates a perfect fit. Root mean square error is a measure of the magnitude of the difference between model predicted values and observed data.

$$RMSE = \sqrt{\frac{1}{n}\sum(X_{mod} - X_{obs})^2} \qquad \text{Equation 7}$$

Nash-Sutcliffe efficiency coefficient (NS): Nash-Sutcliffe efficiencies can range from -∞ to 1. An efficiency of 1 corresponds to a perfect match of modeled predicted value to the observed data. An efficiency of 0 indicates that the model predictions are as accurate as the mean of the observed data, whereas an efficiency less than zero occurs when the observed mean is a better predictor than the model.

$$NS = 1 - \frac{\sum(X_{mod} - X_{obs})^2}{\sum\left(X_{mod} - \overline{X_{obs}}\right)^2} \qquad \text{Equation 8}$$

where,
X_{mod} = The model predicted results;
X_{obs} = The observed or measured results;
$\overline{X}_{obs}$ = The mean of the observed or measured temperature;
n = The sample size.

8 Documentation in model reports

Model documentation will consist of a series of TMDL technical appendices describing the model setup, model calibration results, model scenario setup, and model scenario results.

The model setup and calibration documentation will include details on the calibrated model domain and layout; spatial and temporal resolution; timeframe of simulation; summary of data used for model inputs; summary of methods used to fill data gaps; summary of data used for calibration; time series plots comparing observed and model predicted temperatures and other parameters as appropriate; goodness-of-fit statistics, and plots and tables summarizing temperature and effective shade model results.

The model scenario setup and scenario results documentation will include a description of the scenario, what model elements were modified for the scenario; tables, plots, or narrative summarizing the final values for any modified inputs or parameters; methods or data sources used to setup the scenario; and plots and tables that summarize the scenario results.

When no changes or minor changes are made to the existing TMDL models, the existing TMDL technical appendices will be amended as necessary to document any changes to the existing calibration or management scenarios. For more extensive changes or entirely new models new technical appendices may need to be developed to document the models and results.

9 Peer review

Peer review of the models and model results will be conducted in the following ways:

DEQ will conduct internal peer review during the modeling process with input from USEPA Region 10 as needed. For models being developed by USEPA's contractor, Tetra Tech, USEPA and DEQ will peer review all contractor developed models and model documentation.

DEQ will consider feedback on model scenarios and results from the TMDL advisory group and make changes as appropriate.

DEQ will review and respond to any public comments received on the model and model results, and make changes as appropriate.

10 Management scenarios

Management scenarios described in this section summarize the means by which the current conditions and other alternatives will be evaluated. Some of these model scenarios may not be developed due to lack of sufficient data and information, because the management scenario is not applicable to the specific waterbody, or because it is determined the scenario will require an effort and timeline that does not align with the project schedule or available resources. In some cases, the management scenario has already been developed as part of the previous TMDL and does not need further adjustment. DEQ will review all available data and information during model development and document final model scenario decisions, setup, and results in the TMDL technical appendix.

10.1 Current conditions

This scenario evaluates the stream temperature response under current existing conditions. This scenario is similar to the calibrated model except that some sources conditions will be modified, may be removed, or new ones added to reflect the current conditions or discharge loads if they are significantly different from the calibrated model. Elements of this scenario or scenarios may include:

- Updating the Molalla River model to include current discharges from RSG Forest Products.
- Updating the Pudding River model to include current discharges from the Aurora STP, Columbia Helicopters, the Woodburn WWTP, and the Mt. Angel STP.

10.2 Background

This scenario evaluates the stream temperature response from background sources only. Background sources include all sources of pollution or pollutants not originating from human activities. Background sources may also include anthropogenic sources of a pollutant that DEQ or another Oregon state agency does not have authority to regulate, such as pollutants emanating from another state, tribal lands, or sources otherwise beyond the jurisdiction of the state (OAR 340-042-0030(1)). This scenario essentially combines the following model scenarios: restored vegetation, restored stream flow, improvements to channel morphology, and potentially elements of the climate scenario. The background scenario will be compared to the current conditions model scenario to determine the point of maximum impact, and the amount of cumulative warming originating from human activities that DEQ or another Oregon state agency have authority to regulate.

10.3 Restored vegetation

This scenario evaluates the stream temperature response with streamside vegetation at restored conditions. The stream temperature warming or cooling contributed by removal of streamside vegetation is evaluated by comparing this scenario to the current condition model. Elements of this scenario or scenarios may include:

- Restoring streamside vegetation in areas along the model extent that are currently characterized as lacking streamside vegetation because of anthropogenic disturbance. The restored vegetation type, height, density, and overhang values will be determined during the TMDL process and will likely be the same or similar to the values presented in the Molalla-Pudding Subbasin TMDL and WQMP (DEQ, 2008) and Willamette Basin TMDL and WQMP (DEQ, 2006).

- Model inputs for land cover height, canopy density, and overhang will be modified to reflect the restored conditions.
- All other model inputs will be the same as the current condition model.

10.4 Protected vegetation

This scenario evaluates the stream temperature response from only streamside vegetation along the Molalla and Pudding Rivers that is currently protected by statue, rule, ordinance, or some other approved management plan (voluntary or regulatory). The purpose of this scenario is to determine the stream temperature warming or cooling contributed by removal of streamside vegetation in unprotected areas and if existing management strategies are sufficient to achieve allocations and surrogate measure effective shade targets. This scenario may be a subset of the TMDL implementation scenario. The stream temperature warming or cooling is evaluated by comparing this scenario to the current condition model. Attainment of the effective shade targets and allocations assigned to riparian management nonpoint sources are evaluated by comparing this scenario to the background model scenario. Elements of this scenario or scenarios may include:

- Identifying streamside vegetation areas along the model extent that are protected and will not be removed. The exact definition of a protected area will be determined during the TMDL process.
- Model inputs for land cover height, density, and overhang outside protected areas will be set to zero.
- Model inputs for land cover height, density, and overhang inside protected areas will be set to current conditions.
- All other model inputs will be the same as the current condition model.

10.5 Restored stream flow

This scenario evaluates stream temperature response by changing permitted water withdrawals to instream flow. The stream temperature warming or cooling from keeping permitted water withdrawals as instream flow is evaluated by comparing this scenario to the current conditions model scenario. Assumptions and methods used to estimate restored stream flow will be documented in the TMDL. Elements of this scenario or scenarios may include:

- Maintaining all currently permitted water withdrawals as instream flow in order to increase the thermal loading capacity and reduce stream warming.
- Model boundary and tributary flows will be set to reflect the additional instream flows.
- All other model inputs will be the same as the current condition model.

10.6 Tributary temperatures

This scenario evaluates the stream temperature response from restoration actions on tributaries. The stream temperature warming or cooling contributed by removal of streamside vegetation on tributaries is evaluated by comparing this scenario to the current condition model. Assumptions and methods used to

estimate restored tributary conditions will be documented in the TMDL. Elements of this scenario or scenarios may include:

- Tributary inputs will be set to reflect restored temperature and flow conditions. The tributary flow will reflect maintaining all currently permitted water withdrawals as instream flow.
- All other model inputs will be the same as the current condition model.

10.7 Climate

This scenario evaluates the stream temperature response from changes in air temperature and relative humidity connected to human caused changes to global or micro climate conditions. Warming or cooling from climate related impacts will be evaluated by comparing this scenario to the current conditions model scenario. Assumptions and methods used to develop this scenario will be documented in the TMDL. Elements of this scenario or scenarios may include:

- Model inputs for air temperature and relative humidity may be modified to reflect potential conditions or conditions without climate change impacts assuming enough information exists that would allow downscaling to the site specific conditions in model extent.
- Model inputs for groundwater or stream flow may also be modified if sufficient information exists that would allow downscaling to the site specific conditions in model extent.
- All other model inputs will be the same as the current condition model.

10.8 Channel morphology

This scenario evaluates stream temperature response from improvements to channel morphology, including projects to restore cold water refuges. The warming or cooling from channel morphology improvements is evaluated by comparing this scenario to the current conditions model scenario. Assumptions and methods used to develop this scenario will be documented in the TMDL. Elements of this scenario or scenarios may include:

- Modifying channel width and/or depth to reflect locations where improvements to channel morphology are needed. The location of channel morphology projects will be determined during the TMDL process.
- Model configurations for channel width, bank angle, channel position, Manning's *n*, gradient, elevation, porosity, percent hyporheic flow, hyporheic zone thickness, land cover height, density, and overhang may be modified in areas with improved channel morphology.
- All other model inputs will be the same as the current condition model.

10.9 No point sources

This scenario evaluates the stream temperature response from removing point source heat load. The stream temperature warming or cooling from permitted NPDES point sources is evaluated by comparing this scenario to the current conditions model scenario. Elements of this scenario or scenarios may include:

- Removal of all point sources from the model.

- All other model inputs will be the same as the current condition model.

10.10 TMDL wasteload allocations

This scenario evaluates stream temperature warming or cooling from the TMDL wasteload allocations. These scenarios will be compared to the background model scenario to evaluate attainment of the human use allowance allocations. Numeric or narrative wasteload allocations will be developed for all NPDES permittees but some of the permittees may not be included in this model scenario due to availability of effluent data, lack of discharge, or because the discharge is not a significant source or thermal loading. Elements of this scenario or scenarios may include:

- Modifying point source discharges to reflect proposed or existing TMDL wasteload allocations.
- All other model inputs will be the same as the current condition model.

10.11 TMDL implementation plans

This set of scenarios evaluate the stream temperature response from proposed or existing DMA and responsible person management plans, TMDL implementation plans, or rules. These scenarios will be compared to the background model scenario to evaluate attainment of the human use allowance allocations or surrogate measures. It is likely that multiple model scenarios will be developed evaluating a single implementation plan or multiple implementation plans together. Assumptions and methods used to develop this scenario will be documented in the TMDL. Elements of this scenario or scenarios may include:

- Modifying streamside vegetation, instream flow, and/or channel morphology to reflect the proposed or existing implementation plan. Translating the plan elements to the modeled landscape conditions will be determined during the TMDL process.
- Model inputs for land cover height, density, overhang, boundary condition flow and temperature, channel width, bank angle, Manning's *n*, porosity, percent hyporheic flow, and hyporheic zone thickness, may be modified.
- All other model inputs will be the same as the current calibrated model.

DEQ may also rely upon the results of relevant studies, reports, or published articles to supplement the model scenario; or as the primary source of information for locations or situations where the model results are not applicable.

11 Project organization

11.1 Project team/roles

Project roles and responsibilities are described in Table 35.

Table 35: The roles and responsibilities of each team member involved in the temperature TMDL replacement project.

Name	Position	Role and Responsibilities
Jennifer Wigal	Deputy Water Quality Administrator, Oregon DEQ	Sponsor 1. Provide guidance to team and project manager 2. Approve project plan and changes to the project, scope, budget, and schedule (pending manager elevation as necessary) 3. Sustain support of decision makers at their level, all stakeholders 4. Remove roadblocks 5. Communicate progress to other managers and WQ Director 6. Review project status 7. Manage resistance 8. Ensure communication with employees affected by changes 9. Provide forum to listen to concerns
Gene Foster	Manager, Watershed Management, Oregon DEQ	Manager 1. Review and approve team work products 2. Communicate progress to other managers 3. Approve project plan, changes to the project, and any changes that affect scope and schedule 4. Approve development and finalization of solutions to issues that occur during the project 5. Decide measures of project success
Michele Martin	Project Manager, Water Quality, Oregon DEQ	Project Manager 1. Facilitate meetings, effective meeting management 2. Provide feedback and leadership in the development of meeting agendas, activities during meetings, and tasks. 3. Provide feedback on project planning and design 4. Keep sponsor informed 5. Develop project charter 6. Develop project plan (including major tasks, milestones, project schedule, communication plan, risk analysis, etc.) 7. Develop team meeting agendas 8. Keep track of meeting decisions and notes (very brief), and team ideas 9. Ensure team's work drives towards outcomes and deliverables 10. Sustain engagement of team members and team performance 11. Control project scope (with Technical

Name	Position	Role and Responsibilities
		Lead) 12. Coordinate team communication: Emails, SharePoint, shared drives 13. Closeout project and document lessons learned
Ryan Michie	Senior Water Quality Analyst, Watershed Management, Oregon DEQ	Project Technical Lead 1. Lead, oversee, and direct development of the project QAPP 2. Lead, oversee, and direct the public data solicitation process 3. Coordination with EPA and Contractor 4. Lead, oversee, and direct DEQ technical staff 5. Perform model calibration/evaluation 6. Run model scenarios 7. Analyze and interpret model results 8. Lead, oversee, and direct TMDL document writing 9. Participate and present at TMDL public meetings 10. Respond to public comments
Jim Bloom	Senior Water Quality Analyst, Watershed Management, Oregon DEQ	1. Develop and configure models 2. Perform model calibration/evaluation 3. Run model scenarios 4. Analyze and interpret model results 5. Write TMDL 6. Participate and present at TMDL public meetings 7. Respond to public comments
Erin Costello	Water Quality Analyst, Watershed Management, Oregon DEQ	1. Write QAPP 2. Develop and configure models 3. Perform model calibration/evaluation 4. Run model scenarios 5. Analyze and interpret model results 6. Write TMDL 7. Participate and present at TMDL public meetings 8. Respond to public comments
David Fairbarin	Water Quality Analyst, Watershed Management, Oregon DEQ	1. Write QAPP 2. Develop and configure models 3. Perform model calibration/evaluation 4. Run model scenarios 5. Analyze and interpret model results 6. Write TMDL 7. Participate and present at TMDL public

Name	Position	Role and Responsibilities
		meetings 8. Respond to public comments
Yuan Grund	Water Quality Analyst, Watershed Management, Oregon DEQ	1. Write QAPP 2. Perform data evaluation 3. Run model scenarios 4. Analyze and interpret model results
Nancy Gramlich	Basin Coordinator, Oregon DEQ	1. Review QAPP and TMDL 2. Write WQMP 3. TMDL Advisory Committee coordinator 4. Participate and present at TMDL public meetings 5. Respond to public comments
Roxy Nayar	Basin Coordinator, Oregon DEQ	1. Review QAPP and TMDL 2. Write WQMP 3. TMDL Advisory Committee coordinator 4. Participate and present at TMDL public meetings 5. Respond to public comments
Chris Moore	DEQ QAPP Officer, Oregon DEQ	Review QAPP
Dianne Lloyd	Oregon Department of Justice	Legal Counsel
Rob Burkhardt	Water Quality Specialist, Oregon DEQ	Project team point of contact to NPDES permit program and permittees Review wasteload allocations
Tetra Tech	Contractor	TMDL development support
Claire Schary	EPA Region 10	Non-technical TMDL reviewer
Ben Cope	EPA Region 10 QAPP Officer for Modeling Projects	EPA Modeling Lead 1. Review QAPPs 2. Review EPA Contractor work products
Jayshika Ramrakha	EPA Region 10 EPA Task Order Manager	Direct EPA Contractor
TMDL Advisory Committee	Each TMDL will have a local, public advisory committee	1. Participate in TMDL Advisory Committee Meetings 2. Provide input to DEQ on TMDL and WQMP elements

11.2 Expertise and special training requirements

Additional expertise or special training is not necessary at this time.

DEQ staff involved in developing and configuring models, performing model calibration, running model scenarios, and analyzing and interpreting model results have experience in these tasks from numerous other modeling projects. The Project Manager has extensive experience managing large complex projects and will ensure strict adherence to the project protocols.

11.3 Reports to management

The DEQ Project Manager (or designee) will provide progress reports to DEQ Management and USEPA as needed based on new project information. As appropriate, these reports will provide information on the following:

- Adherence to project schedule and/or budget.
- Deviations from approved QAPP, as determined from project assessment and oversight activities.
- The impact of any deviations on model application quality and uncertainty.
- The need for and results of response actions to correct any deviations.
- Potential uncertainties in decisions based on model predictions and data.
- Data quality assessment findings regarding model input data and model outputs.

11.4 Project schedule

The project schedule for the Middle Willamette Subbasins TMDL is scheduled to occur in two phases. The pre TMDL project phase, and the TMDL and WQMP development phase.

Pre TMDL project phase

The pre TMDL project phase will generally occur between January 2020 through the end of August 2022. In this phase most of the planning and technical work occurs. Specific tasks include:

Task P1 Data gathering and project organization.

P1.1 Organize and gather effluent data from all active NPDES permittees in the temperature TMDL replacement project area.

P1.2 Organize and gather all available and relevant river temperature, stream flow, habitat, effective shade, and channel morphology.

P1.3 Complete an open data solicitation. During the solicitation period, the public may submit continuous stream temperature data and NPDES effluent data to DEQ in the watersheds subject to the temperature TMDL replacements.

P1.4 Review data collected. Data submitted to DEQ will be screened for completeness and quality, and whether the results are within the typical range expected for that season and time of day.

P1.5 Stream temperature data will be made available in DEQ's Ambient Water Quality Monitoring System database (AWQMS).

Task P2 Develop modeling Quality Assurance Project Plans (QAPPs). The modeling QAPPs will identify the available data and overall technical approach to be taken for each TMDL project.

Task P3 Mapping of Designated Management Agencies (DMAs) and Responsible Persons for counties that are within the project area. All Oregon counties are within the project area except Tillamook, Clatsop, and Deschutes counties.

Task P4 Development of computer code to streamline analysis tasks and TMDL document production.

Task P5 Development of template TMDL and WQMP section outlines and language.

Task P6 Implement Modeling QAPPs. This task is a follow-up to Task P2. Gathering of new data and completion of new technical work described in the modeling QAPPs.

TMDL and WQMP development phase

The TMDL and WQMP development phase is scheduled to begin in 2022 with USEPA's final agency action approving or disapproving of the TMDL no later than January 15, 2024. In this phase, the draft TMDL and WQMP documents will be written; a TMDL advisory committee will be convened to discuss the updated TMDL allocations, any revisions to the WQMP, and potential fiscal impacts in the case of a rulemaking process; and finally DEQ will conduct a public comment period. DEQ will respond to all public comments received, revise the TMDL and WQMP as necessary, and issue the final TMDL to USEPA for their action.

12 Data management

DEQ does not anticipate collecting additional field samples. Water quality data gathered and used for this project will be managed in DEQ's AWQMS database or the project files.

The modeling software to be used for this project is available on DEQ's TMDL program website (https://www.oregon.gov/deq/wq/tmdls/Pages/TMDLs-Tools.aspx).

Model-generated data resulting from testing, calibration, and scenarios will be stored in spreadsheets and text files by DEQ in the TMDL project directory. Metadata describing the content, date, and personnel involved in modeling will be documented alongside raw and summarized data.

Secondary data developed as part of this task will be maintained as hardcopy only, both hardcopy and electronic, or electronic only, depending on their nature.

All electronic data will be maintained on DEQ's computers and servers. DEQ's computers are serviced by in-house specialists. When a problem with DEQ's computers and servers occurs, in-house computer specialists diagnose the problem and correct it if possible. When outside assistance is necessary, the computer specialists call the appropriate vendor. For other computer equipment requiring outside repair and not covered by a service contract, local computer service companies are used on a time-and-materials basis.

Routine maintenance of DEQ's computers and servers is performed by in-house computer specialists. Electric power to each computer flows through a surge suppressor to protect electronic components from potentially damaging voltage spikes. All computer users have been instructed on the importance of

routinely archiving work assignment data files from hard drive to server storage. The office network server is backed up on tape nightly during the week. Screening for viruses on electronic files loaded on DEQ's computers or the network is standard policy. Automated screening systems have been placed on all computer systems and are updated regularly to ensure that viruses are identified and destroyed. Annual maintenance of software is performed to keep up with evolutionary changes in computer storage, media, and programs.

13 Recordkeeping and archiving

All data and documents generated during the course of the TMDL project will be archived according to the current Oregon State Archives Records Retention Schedules. Generally TMDL documents will be retained until 15 years after the TMDL is no longer operational.

Records that are stored in electronic format will be located in either the TMDL project folder or Master TMDL folder located on DEQ's TMDL server. The TMDL project folder will contain at minimum the following subfolders: "Project Plans", "Data", "Models", and "Meetings". Alternative names and additional subfolders can be used as appropriate. The Master TMDL folder will contain the written TMDL documents (Word, PDF) along with supporting written documents that support the public comment period and TMDL issuance. The contents and organization of these subfolders is described below.

Project Plans: All documents related to project planning, project proposals, project schedules, and the modeling QAPPs. Each will reside in their relevant subfolders. The final versions of documents will be clearly identified from drafts and ideally located in separate folders.

Data: All field data organized or collected in support of the TMDL project. This may include water quality samples, NPDES effluent data, field sheets, photos, monitoring metadata, sampling project plans, or other documentation. The data should be organized by parameter and data source if possible.

Models: All models used for the TMDL project including calibration and scenario models. The models should be organized into subfolders for each model domain and model scenario. Draft models and the final TMDL models will be clearly identified and ideally saved in separate folders. The model folders should include:

- The model with all input and output files and any executable code used;
- Copy of all raw and summarized data (including GIS files) used for model input with data source and location metadata included;
- Scripts or spreadsheets used to transform raw data or used to derive model inputs;
- Key assumptions and documentation for the model setup and parameterization;
- Documentation of newly developed model code or modifications to the existing model; and
- Identification of staff that completed the model.

Meetings: All documents produced for external meetings including agendas, presentations, posters, and meeting handouts. Material for each meeting will be saved in a subfolder organized by date and meeting type. For example the folder name for the first meeting of the TMDL advisory group would be "2022-08-

15 Temperature AG 1". Draft documents and final documents will be clearly identified and ideally saved in separate folders.

TMDL documents: At each key stage of TMDL and WQMP development copies of the following documents will be saved in separate subfolders within the project folder on the Master TMDL directory. The final versions of documents will be clearly identified from drafts and ideally saved in separate folders.

- Public Comment Draft:
  - Briefing memo to DEQ Water Quality Division Administrator or Director on public comment draft
  - Draft TMDL and WQMP Report (Both Word and PDF)
  - Draft TMDL Appendices (Both Word and PDF)
  - Public Notice document
  - TMDL Summary Fact Sheet
  - News release
  - GovDelivery Notice and email
  - Other public notification emails
  - Mailing List (if used)
  - Public Comments Errata
- Public Comments Received: Copy of all public comments received
- Final TMDL and WQMP documents:
  - Briefing memo to DEQ Water Quality Division Administrator or Director on final TMDL
  - Signed TMDL order (both Word and PDF)
  - TMDL issuance letter to USEPA (both Word and PDF)
  - USEPA approval letter (USEPA)
  - Response to Comment Document (both Word and PDF)
  - TMDL and WQMP Report (both Word and PDF)
  - TMDL Appendices (both Word and PDF)
  - TMDL Summary Fact Sheet
  - News release
  - GovDelivery Notice and email
  - Other public notification emails
  - Relevant EQC agenda documents
  - Designated Management Agency/Responsible Person notification letters (both Word and PDF)
  - Addendums
  - Errata
  - Petitions
  - Director's Petition Action (acceptance or rejection of petition)
  - Response to Petition
  - ATTAINS upload files

14 QAPP review and approval

The DEQ Project Technical Lead will distribute the draft QAPP to the respective DEQ and USEPA project team members for review. Comments will be provided to the Project Technical Lead for further discussion. When possible, revision and submittal of the final plan will be made within 10 business days of receipt of comments. Following approval, the Project Technical Lead will distribute the final, signed copy to the respective DEQ and USEPA project team members.

USEPA has an independent responsibility for this QAPP and must complete a separate approval protocol. USEPA approval is necessary for USEPA contractors to begin any modeling work.

Official copies of the final, approved QAPP will be retained in DEQ's document control system. If any change(s) to the QAPP are required during the project, they must be described in a memorandum and approved by the signatories to this QAPP and attached to the QAPP.

15 Implementation and adaptive management

DEQ plans to develop a Risk Management Plan to identify project constraints, the risks that may arise during project implementation, and potential solutions. Identified project constraints include the abbreviated project schedule with hard deadlines established via court order, limited resources, uncertain funding from USEPA, and a complex TMDL technical effort which may require additional time and public process. Projects risks from these constraints and proposed solutions are described in Table 36.

Table 36: Projects risks and proposed solutions.

Risk Description	Solution
Extended public process for complex TMDLs	Communication to DEQ manager and external contacts as deemed necessary by the manager
Team member availability: Inadequate resources to effectively produce the TMDL	Dedicate additional resources to support the effort from internal staff
Delivery commitment	Designate the projects as priority and dedicate additional resources to support the effort from internal staff or contractor (depending on contractor funding)
Scope creep: Working on the TMDLs could be an opportunity for attempts to add additional technical work that are outside the project scope	Sponsor and Manager to address scope creep with stakeholders as necessary

Should a situation arise that requires a significant change in the technical approach, the project team will update the QAPP as needed through revisions or addenda.

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17 Revision history

Table 37: QAPP revision history.

Revision	Date	Changes	Editor
1.0	12/09/2021	New QAPP	R. Michie

Appendix A Meteorology data summary

Table 38: Meteorological stations and data available in the National Climatic Data Center (NCDC) database in the Middle Willamette Subbasins.

Station ID	Station	Latitude/Longitude
20016118	CASCADIA	44.4/-122.483
20016120	FOSTER DAM	44.4167/-122.667
20016137	WATERLOO	44.5/-122.817
20016162	MARION FRKS FISHHATCH	44.6125/-121.949
20016163	LACOMB 3 NNE	44.6333/-122.717
20016186	JEFFERSON	44.7167/-123.017
20016189	DETROIT DAM	44.7167/-122.25
20016199	MEHAMA	44.7889/-122.617
20016200	STAYTON	44.7894/-122.814
20016217	SILVER CREEK FALLS	44.8667/-122.65
20016219	MONMOUTH	44.85/-123.233
20016230	SALEM MCNARY FIELD	44.9078/-122.995
20016231	DALLAS 2 NE	44.95/-122.3
20016239	SCOTTS MILLS 9 SE	44.9472/-122.525
20016241	SALEM	44.9444/-123.042
20016246	SILVERTON	45.005/-122.775
20016265	MOLALLA 2 ESE	45.1392/-122.533
20016271	COLTON	45.1667/-122.433
20016283	AURORA	45.2333/-122.749
20016300	CANBY	45.25/-122.683
20016302	N WILLAMETTE EXPSTN	45.2833/-122.75
20016304	AURORA STATE AP	45.25/-122.75
20016305	NEWBERG 1 SE	45.2847/-122.959
20016318	WILSONVILLE	45.3/-122.767
20016320	REX 1 S	45.3036/-122.914
20016334	OREGON CITY 1 E	45.3603/-122.573
20016336	OREGON CITY LOCKS	45.3514/-122.633
20016337	OREGON CITY	45.3553/-122.605
30002669	MOLALLA 7NE	45.1783/-122.506
30014771	LEBANON	44.5328/-122.901
30015007	LYONS 3N	44.7939/-122.595

Station ID	Station	Latitude/Longitude
30015057	COLTON 2SW	45.135/-122.464
30015582	CANBY 2 N	45.2989/-122.693
30016253	LACOMB 1 W	44.5757/-122.776
30017010	GATES 1.1 SE	44.7443/-122.403
30018108	COLTON 1 E	45.1725/-122.438
30018590	MONMOUTH 0.9 ESE	44.8433/-123.212
30019696	SWEET HOME 1.0 ESE	44.3968/-122.684
30019840	SALEM 3.6 SSW	44.8756/-123.045
30020540	MOLALLA 0.6 SE	45.1432/-122.569
30021140	LYONS 11.4 ENE	44.8271/-122.384
30021301	CANBY 0.2 S	45.2008/-122.638
30021575	SWEET HOME 2.0 NE	44.4192/-122.671
30021805	LEBANON 4.8 E	44.544/-122.807
30022300	DALLAS 3.5 W	44.9189/-123.383
30023795	KEIZER 1.3 SW	44.9919/-123.043
30025558	SALEM 3.5 NW	44.9529/-123.081
30026063	JEFFERSON 5.2 NNW	44.7903/-123.032
30026080	LEBANON 1.0 S	44.5204/-122.9
30026492	LYONS 2.1 S	44.7475/-122.607
30026722	AUMSVILLE 2.5 N	44.8814/-122.877
30026852	SWEET HOME 2.6 E	44.4077/-122.65
30028299	SALEM 2.2 SW	44.9039/-123.056
30028952	INDEPENDENCE 5.2SE	44.7925/-123.133
30031506	STAYTON 0.7 ENE	44.8048/-122.783
30031588	LYONS 3.4 ESE	44.7659/-122.539
30032067	KEIZER 1.0 NW	45.0146/-123.034
30032941	DALLAS 1.0 WSW	44.9183/-123.333
30033943	MILL CITY 0.4 WSW	44.7485/-122.484
30034886	SALEM 3.3 SSW	44.879/-123.042
30036051	CANBY 0.2 N	45.2691/-122.692
30036421	DALLAS 0.3 NE	44.9245/-123.308
30036901	DALLAS 1.0 W	44.9203/-123.332
30041248	SALEM 5 NE	44.9881/-122.987
30041863	SALEM 1.0 S	44.9131/-123.042
30043808	SCIO 4.2 SW	44.6694/-122.918
30044409	DALLAS 3 WNW	44.9392/-123.367
30044590	SALEM 1.1 WSW	44.9161/-123.041

Station ID	Station	Latitude/Longitude
30044808	AUMSVILLE 1.4 N	44.8651/-122.872
30045922	SALEM 2 W	44.9253/-123.049
30045992	SALEM 5 SE	44.885/-122.932
30046138	DALLAS 1.3 NNW	44.9374/-123.325
30046286	OREGON CITY 5.5 ESE	45.3131/-122.493
30048038	LYONS 1.6 SSW	44.7571/-122.624
30052645	SALEM 2.7 NW	44.9529/-123.06
30053284	CANBY 5.4 SE	45.2039/-122.625
30053359	TURNER 6.6 S	44.7504/-122.936
30053926	AUMSVILLE 5.4 S	44.7672/-122.879
30055634	SALEM 3.2 WNW	44.9402/-123.084
30056882	OREGON CITY 1.0 NNW	45.3411/-122.563
30058972	SCIO 2.3 SW	44.6833/-122.883
30060263	KEIZER 1.4 N	45.0242/-123.018
30060627	INDEPENDENCE 0.3NNW	44.8592/-123.195
30062503	SALEM 4.5 ENE	44.9436/-122.934
30065798	STAYTON 6 ENE	44.8353/-122.684
30066088	SALEM 3.2 ENE	44.9419/-122.961
30067556	MOLALLA 6.4 SW	45.0787/-122.662
30067711	SALEM 3.7 SSW	44.8768/-123.058
30070095	AUMSVILLE 2.0 NNW	44.8729/-122.878
30074323	MOLALLA 5.8 SSE	45.0694/-122.54
30074931	MARION FORKS	44.59/-121.97
30074965	ROCK HOUSE OREGON	44.9/-123.5
30075074	BOULDER CREEK OREGON	44.7219/-122.003
30075779	DALY LAKE	44.52/-122.09
30075807	STAYTON OREGON	44.75/-122.867
30076178	LITTLE MEADOWS	44.61/-122.23
30076186	JUMP OFF JOE	44.39/-122.17
30076227	YELLOWSTONE MOUNTAIN OREGON	44.5922/-122.428
30076438	HORSE CREEK OREGON	44.9406/-122.4
30078131	SCIO 2.2 N	44.7372/-122.842
30078985	MILL CITY 0.8 W	44.7524/-122.494
30078990	MEHAMA 0.7 ESE	44.7869/-122.605
30079040	LEBANON 0.5 SE	44.5304/-122.897
30079122	SILVERTON 9.1 SE	44.9138/-122.651
30079129	DALLAS 1.3 WSW	44.9121/-123.336

Station ID	Station	Latitude/Longitude
30079317	SALEM 4.0 NE	44.9649/-122.964
30079442	SCIO 5.1 SSE	44.6366/-122.811
30079486	SALEM 4.0 NW	44.9699/-123.074
30079494	MOUNT ANGEL 0.2 E	45.0691/-122.79
30084811	FALLS CREEK FOREST	44.3961/-122.373
30084813	FALLS CREEK OPEN	44.3964/-122.377
30084816	MOOSE MOUNTAIN FOREST	44.4146/-122.394
30084818	MOOSE MOUNTAIN OPEN	44.4113/-122.398
30084819	MIDDLE SANTIAM FOREST	44.5144/-122.258
30084820	SOAPGRASS FOREST	44.3482/-122.292
30084822	SOAPGRASS OPEN	44.3452/-122.294
30084953	SHERWOOD 3.3 SE	45.3283/-122.791
30094353	LEBANON 6.0 SE	44.4815/-122.808
30094459	MOLALLA 7.5 S	45.0424/-122.601
30094486	TURNER 6.0 SSE	44.7647/-122.906
30094545	LEBANON 10.6 ENE	44.5924/-122.705
30094821	SCIO 7.2 SSE	44.6153/-122.775
30094828	OREGON CITY 7.5 SSE	45.2503/-122.522
30094930	LEBANON 2.3 E	44.535/-122.858
30101323	SALEM 2.9 NW	44.9485/-123.069
30101614	MOLALLA 7.4 S	45.0423/-122.59
30101708	LEBANON 11.5 ESE	44.4511/-122.704
30101780	KEIZER 1.4 NNW	45.0231/-123.027
30101970	CANBY 0.5 ENE	45.2693/-122.683
30102568	NEWBERG 0.3 N	45.3103/-122.961
30103178	SILVERTON 4.8 ESE	44.9931/-122.685
30103215	SALEM 1.2 W	44.9239/-123.046
30103654	SALEM 4.0 SSW	44.8678/-123.041
30103669	MONMOUTH 0.9 SE	44.8419/-123.215
30103737	SALEM 4.5 E	44.9364/-122.931
30106927	RICKREALL 3.9 NE	44.9712/-123.179
30106993	DALLAS 1.2 WSW	44.9127/-123.333
30107262	LEBANON 11.3 ESE	44.4484/-122.711
30107365	SILVERTON 1.0 SSW	44.995/-122.789
30107636	INDEPENDENCE 0.6WSW	44.8517/-123.204
30108022	SILVERTON 0.6 SE	45.0003/-122.774
30108035	SCIO 7.3 SSE	44.616/-122.771

Station ID	Station	Latitude/Longitude
30108108	SALEM 2.2 WNW	44.9394/-123.062
30108109	KEIZER 1.4 SSW	44.9867/-123.034
30108544	SWEET HOME 1.0 E	44.404/-122.682
30108701	LEBANON 7.9 SSE	44.4343/-122.829
30109564	LEBANON 5.1 NE	44.5848/-122.827
30111995	OREGON CITY 2.5 SE	45.315/-122.568
30112059	SWEET HOME 2.2 E	44.3982/-122.658
30112217	MILL CITY 0.9 ESE	44.7467/-122.46
30112347	LEBANON 5.4 E	44.5245/-122.797
30112353	SALEM 2.5 WNW	44.9438/-123.066
30112459	STAYTON 8.4 E	44.7903/-122.626
30112741	SWEET HOME 1.7 WSW	44.388/-122.732
30112842	GATES 1.4 SW	44.7406/-122.438
30113064	DALLAS 1.5 WNW	44.9319/-123.339
30113792	SILVERTON 0.7 SE	45.0004/-122.77
30114206	SALEM 3.4 S	44.8759/-123.035
30115312	SALEM 4.3 NNE	44.9817/-122.99
30120676	SWEET HOME 0.2 SE	44.3997/-122.698
30120699	MOLALLA 7.1 SSE	45.0515/-122.533
30121001	LEBANON 0.7 N	44.5455/-122.902
30121413	SALEM 1.9 ENE	44.9357/-122.986
30123322	WOODBURN 1.8 ENE	45.1552/-122.819
30124556	LYONS 0.8 WNW	44.7828/-122.62

Table 39: Meteorological stations and data, including humidity, precipitation, temperature, wind direction, and wind speed, available in the Remote Automatic Weather Station (RAWS) database in the Middle Willamette Subbasins.

Station ID	Station	Latitude/Longitude	Agency
orOJOR	JORDAN	44.7169/-122.692	S&PF

Table 40: Meteorological stations and data, including air temperature, precipitation, relative humidity and wind, available in the USBR AgriMet database in the Middle Willamette Subbasins.

Station ID	Station	Latitude/Longitude
ARAO	AURORA, OREGON AGRIMET WEATHER STATION	45.2819/-122.75
CRVO	CORVALLIS, OREGON AGRIMET WEATHER STATION	44.6342/-123.19
DTRO	DETROIT LAKE, OREGON AGRIMET WEATHER STATION	44.73/-122.179

Table 41: Meteorological stations and data, including air temperature, precipitation, relative humidity, wind speed and wind direction, available in the MesoWest database in the Middle Willamette Subbasins.

Station ID	Station	Latitude/Longitude
1952P	COLLEGE PARK	45.3103/-122.967
1970P	775 1/2 E MILTON ST	44.5332/-122.896
1987P	ROBSON ACRES	45.1949/-122.639
1988P	KC HOME	45.2232/-122.679
2015P	WILSONVILLE MEADOWS	45.313/-122.749
2029P	CASCADE 17 OUTSIDE	44.8078/-122.915
2038P	COUNTRYGLEN KEIZER	45.0175/-123.017
2050P	SUNSET AIR	45.3576/-122.629
2081P	WOU ATHLETICS	44.8502/-123.239
2084P	MARKS RIDGE-SWEET HOME	44.4341/-122.702
2097P	WILLAMETTE UNIVERSITY - SPARKS CENTER	44.9347/-123.03
2105P	GEORGE FOX UNIVERSITY	45.3052/-122.968
3168P	WEST LINN -DOWNTOWN	45.3441/-122.65
3675P	RIDGEWOOD RANCH	44.8094/-122.711
3878P	CANBY AIR STATION 1C	45.2614/-122.675
A3795	PORTLAND - SPANGLER ROAD	45.2593/-122.588
A3804	TURNER - CJHS	44.8103/-122.915
A4216	SWEET HOME - FIRE DEPARTMENT	44.3958/-122.731
A4217	LYONS	44.7787/-122.617
A4219	SALEM - STATE HOSPITAL	44.9431/-123.006
A4719	MILL CITY	44.7521/-122.48
A4741	DALLAS LACREOLE MIDDLE SCHOOL	44.9226/-123.302
AR136	N6TW SILVERTON	45.0145/-122.774
AS522	W7OBH CANBY	45.2567/-122.685
AT321	W7BDB SALEM	45.0078/-123.009
AT482	KD6WAB SALEM	44.9582/-122.964
AT595	K7JKM KEIZER	45.0172/-123.017
AU187	KD7SYS-1 DALLAS	44.9345/-123.325
AU381	AF7U AUMSVILLE	44.8287/-122.862
AU524	W7APD KEIZER	44.9885/-123.024
AU615	KB5LNT SALEM	44.877/-123.056
AU732	K7LWV DALLAS	44.916/-123.333
AU762	WA7SHP-13 SALEM	44.9153/-123.057
AV095	WB6RDV-13 BREITENBUSH	44.772/-121.968
AV613	WB6RDV-3 GATES	44.7542/-122.392
AV707	K5VP NEWBERG	45.3458/-122.984

Station ID	Station	Latitude/Longitude
AV725	KI7JYE NEWBERG	45.3121/-122.943
BRBO3	BREITENBUSH RIVER ABOVE FRENCH CREEK NEAR DETROIT 1NE	44.7525/-122.129
C0493	CW0493 DALLAS	44.9337/-123.327
C0825	CW0825 SWEET HOME	44.3957/-122.702
C1092	CW1092 MCMINNVILLE	45.0333/-123.05
C1250	CW1250 SALEM	44.9842/-123.002
C1855	CW1855 LIBERAL	45.186/-122.587
C2188	CW2188 AUMSVILLE	44.8167/-122.867
C3745	CW3745 SALEM	44.9342/-122.972
C5404	CW5404 DALLAS	44.918/-123.296
C5416	CW5416 CANBY	45.2797/-122.688
C7076	CW7076 SALEM	44.9324/-122.978
C7745	CW7745 OREGON CITY	45.3385/-122.53
C8892	CW8892 SWEET HOME	44.3929/-122.722
C9093	CW9093 AURORA	45.287/-122.771
C9230	CW9230 STAYTON	44.8091/-122.804
C9266	CW9266 SALEM	44.9777/-123.083
C9399	CW9399 JEFFERSON	44.7352/-123.002
C9654	CW9654 CANBY	45.2692/-122.692
C9982	CW9982 OREGON CITY	45.3287/-122.61
CANO3	MOLALLA RIVER NEAR CANBY 1S	45.2444/-122.686
COOPDTTO3	DETROIT DAM PRECIP STN	44.72/-122.25
COOPFSTO3	FOSTER DAM PRECIP	44.41/-122.67
COOPLABO3	LACOMB	44.63/-122.72
COOPLAMO3	LAUREL MOUNTAIN	44.92/-123.58
COOPMNFO3	MARION FORKS FISH HATCHERY	44.61/-121.95
COOPORYO3	FIRE STATION	45.36/-122.61
COOPREXO3	COOP STN NAME = REX 1 S	45.3/-122.91
COOPSCMO3	SCOTTS MILLS	44.95/-122.52
COOPSICO3	SILVER FALLS ST PK, AKA SILVER CRK FALLS	44.87/-122.65
COOPSLE	SALEM ARPT (MCNARY FIELD)	44.91/-123
COOPSTYO3	CITY TREATMENT PLANT	44.79/-122.81
COOPSVTO3	WATER PURIFICATION PLANT	45.01/-122.77
D0160	DW0160 TURNER	44.7507/-122.935
D0475	DW0475 CANBY	45.2455/-122.648
D0603	DW0603 AURORA	45.2955/-122.774

Station ID	Station	Latitude/Longitude
D3664	DW3664 HILLSBORO	45.1117/-122.931
D4147	DW4147 DUNDEE	45.2933/-123.005
D5901	DW5901 STAYTON	44.7517/-122.81
D6048	DW6048 LEBANON	44.5045/-122.716
D6349	DW6349 NEWBERG	45.3052/-122.978
D6393	DW6393 TUALATIN	45.3597/-122.791
D6452	DW6452 RUSSELLVILLE	45.0693/-122.54
D6659	DW6659 COLTON	45.18/-122.403
D7719	DW7719 STAYTON	44.7987/-122.793
D7980	DW7980 OREGON CITY	45.3662/-122.519
D8407	DW8407 LACOMB	44.5915/-122.769
D9524	DW9524 LEBANON	44.5388/-122.902
D9680	DW9680 YAMHILL	45.3712/-123.109
E0062	EW0062 DUNDEE	45.2923/-123.06
E1284	EW1284 OREGON CITY	45.3492/-122.596
E1702	EW1702 AUMSVILLE	44.8445/-122.858
E3257	EW3257 KEIZER	45.005/-123.04
E3720	EW3720 LEBANON	44.6115/-122.758
E5920	EW5920 SALEM	44.9023/-123.026
E6055	EW6055 OREGON CITY	45.3408/-122.611
E6204	EW6204 SCOTTS MILLS	45.0427/-122.663
E6414	EW6414 MILL CITY	44.7574/-122.466
E7604	EW7604 SALEM	44.9618/-123.107
E7700	EW7700 SWEET HOME	44.4025/-122.702
E8347	EW8347 SWEET HOME	44.4345/-122.703
E8461	EW8461 COLTON	45.1773/-122.442
E8660	EW8660 KEIZER	45/-123.011
E9538	EW9538 WILSONVILLE	45.312/-122.774
F0539	FW0539 SILVERTON	44.9257/-122.657
F0653	FW0653 NEWBERG	45.3253/-122.982
F0666	FW0666 NEWBERG	45.3005/-123.046
F1740	FW1740 COLTON	45.1642/-122.475
F1747	FW1747 SALEM	44.8648/-123
F2474	FW2474 SALEM	44.9458/-123.021
F2822	FW2822 SALEM	44.9063/-123.075
F3199	FW3199 HUBBARD	45.1823/-122.808
F3961	FW3961 TURNER	44.8462/-122.95

Station ID	Station	Latitude/Longitude
F5406	FW5406 OREGON CITY	45.3542/-122.598
F5845	FW5845 NEWBERG	45.3017/-122.946
F6328	FW6328 SALEM	44.9962/-122.974
F6494	FW6494 OREGON CITY	45.3487/-122.606
F6522	FW6522 STAYTON	44.7892/-122.815
F8313	FW8313 SALEM	44.9578/-123.057
F8540	FW8540 WOODBURN	45.1938/-122.867
H0024	12S CORNELIUS	45.338/-123.096
H0220	HILLSBORO	45.32/-122.58
H0227	TURNER	44.75/-122.94
HSFO3	HORSE CREEK	44.9408/-122.401
KSLE	SALEM - MCNARY FIELD	44.9049/-123.001
KUAO	AURORA STATE AIRPORT	45.2466/-122.771
MRRO3	MOMPANO RESRVOIR ON ABERNATHY CREEK NEAR REDLAND 2S	45.3142/-122.505
NS089	MITCHELL	44.5819/-122.179
OD119	OR22 AT SANTIAM PARK MP25.44	44.7765/-122.563
OD147	OR22 WB AT OSCI HILL MP5.34	44.8862/-122.921
OD179	I205 NB AT WILLAMETTE VIEWPOINT MP7.61	45.3512/-122.628
OD190	OR22 AT EOLA EB MP21.93	44.9307/-123.114
ODA01	SILVERTON (OREGON GARDEN)	44.9954/-122.791
ODA02	BASKETT SLOUGH WILDLIFE REFUGE	44.9439/-123.26
ODE05	SILVERTON N JAMES ST AND WESTERN AVE	45.015/-122.79
ODT47	I5 NB AT ENCHANTED WAY MP246.99	44.8245/-123.016
ODT63	OR99E NB AT CANEMAH MP14.2	45.3423/-122.635
ORCO3	WILLAMETTE RIVER BELOW OREGON CITY FALLS	45.3578/-122.61
TS627	WEST ZONE PORTABLE	44.9496/-123.255
UP335	HUBBRD	45.1703/-122.822
UR047	BROOKS	45.0278/-122.978
UR053	MILRBG	44.7079/-123.037
WLOOX	WLOO LEBANON	44.5234/-122.738

Appendix B Continuous stream temperature data summary

Table 42: Continuous temperature monitoring stations in the Middle Willamette Subbasins currently available in public databases and DEQ files.

Station ID	Station	Latitude/Longitude	Organization
10362-ORDEQ	Pudding River at Arndt Road (Barlow)	45.2596/-122.739	DEQ
10636-ORDEQ	Molalla River at mouth	45.2996/-122.721	DEQ
10637-ORDEQ	Molalla River at Knights Bridge Road (Canby)	45.2675/-122.71	DEQ
10640-ORDEQ	Pudding River at Hwy 211 (Woodburn)	45.1505/-122.793	DEQ
10641-ORDEQ	Pudding River at Hwy 214 (downstream of cannery outfall)	45.1262/-122.82	DEQ
10646-ORDEQ	Silver Creek at Brush Creek Road	45.0063/-122.825	DEQ
10647-ORDEQ	Silver Creek upstream of Silverton	44.9899/-122.769	DEQ
10783-ORDEQ	Thomas Creek at Kelly Road	44.6907/-122.937	DEQ
10784-ORDEQ	Crabtree Creek at Riverside School Road	44.6734/-122.918	DEQ
10787-ORDEQ	Mcdowell Creek at Bench Mark 456	44.461/-122.768	DEQ
10791-ORDEQ	Quartsville Creek at USGS Gage	44.54/-122.436	DEQ
10881-ORDEQ	Molalla River at Hwy 213 Bridge (Mulino)	45.1999/-122.581	DEQ
10886-ORDEQ	Mill Creek at Ehuen Road Bridge (Aurora)	45.2334/-122.757	DEQ
10896-ORDEQ	Butte Creek at Hwy 211	45.1476/-122.78	DEQ
10899-ORDEQ	Zollner Creek at Monitor-McKee Road Bridge	45.1003/-122.822	DEQ
10917-ORDEQ	Pudding River at Hwy 99E (Aurora)	45.2337/-122.75	DEQ
11102-ORDEQ	Rickreall Creek at State Farm Road	44.9308/-123.129	DEQ
11514-ORDEQ	South Fork Bochsler Creek at Hwy 214	45.0959/-122.785	DEQ
11528-ORDEQ	Pudding River at Bernard Road (Whiskey Hill)	45.1803/-122.753	DEQ
11530-ORDEQ	Pudding River at Monitor-McKee Road	45.1005/-122.831	DEQ
11535-ORDEQ	Pudding River at Hazel Green Road	45.0095/-122.843	DEQ
11536-ORDEQ	Pudding River at Nusom Road	45.038/-122.834	DEQ
12210-ORDEQ	Silver Creek at James Street Bridge (Silverton)	45.0095/-122.79	DEQ
21834-ORDEQ	Roaring River	44.6303/-122.738	DEQ
21835-ORDEQ	Dead Horse Creek at River Mile 1.26	44.7839/-122.104	DEQ
21838-ORDEQ	Glenn Creek at River Mile 5.45	44.9475/-123.103	DEQ
23742-ORDEQ	Crabtree Creek at Main Line Bridge	44.5945/-122.557	DEQ

Station ID	Station	Latitude/Longitude	Organization
23743-ORDEQ	Crabtree Creek at Road 311 Bridge	44.5781/-122.582	DEQ
23766-ORDEQ	Crabtree Creek at Willamette Main Line Road	44.5883/-122.637	DEQ
23767-ORDEQ	Crabtree Creek at swinging foot bridge	44.5983/-122.687	DEQ
23768-ORDEQ	Crabtree Creek at Larwood Bridge	44.6294/-122.741	DEQ
23769-ORDEQ	Crabtree Creek at Richardson Gap Road	44.6581/-122.804	DEQ
23770-ORDEQ	Beaver Creek	44.6336/-122.855	DEQ
23771-ORDEQ	Crabtree Creek at Hoffman Covered Bridge	44.6534/-122.89	DEQ
23774-ORDEQ	Hamilton Creek at Upper Berlin Road near Berlin Ridge Road	44.4974/-122.75	DEQ
23775-ORDEQ	Hamilton Creek at Belinger Scale Road at golf course	44.5135/-122.798	DEQ
23777-ORDEQ	McDowell Creek at 5.7 miles up McDowell Creek Road	44.461/-122.717	DEQ
23779-ORDEQ	Thomas Creek at bridge at Willamette Industries Gate	44.7122/-122.609	DEQ
23780-ORDEQ	Downstream Jordon Creek	44.7265/-122.7	DEQ
23781-ORDEQ	Thomas Creek at Hannah Covered Bridge	44.7122/-122.718	DEQ
23782-ORDEQ	Neal Creek at Lulay Bridge near Hannah Covered Bridge	44.7076/-122.712	DEQ
23783-ORDEQ	Thomas Creek at USGS Gauge at Shindler Bridge Dr.	44.711/-122.767	DEQ
23784-ORDEQ	Thomas Creek at Shimanek Covered Bridge	44.7162/-122.804	DEQ
23785-ORDEQ	Thomas Creek at 0.6 miles west of Scio off of NW 1st	44.7038/-122.859	DEQ
23787-ORDEQ	Sucker Slough at Robinson Road	44.7059/-122.917	DEQ
23805-ORDEQ	Middle Santiam River at gague upstream of Green Peter Reservoir	44.5152/-122.372	DEQ
23847-ORDEQ	Moose Creek at River Mile 4.5 (South Santaim, Santiam, Willamette)	44.4275/-122.386	DEQ
23851-ORDEQ	North Santiam River at River Mile 78.0 ODQW99-0009	44.5699/-122	DEQ
23858-ORDEQ	Little North Fork Silver Creek at River Mile 0.30 (Silver, Pudding, Willamette)	44.8815/-122.595	DEQ
24572-ORDEQ	Chehulpum Creek at Interstate 5, Talbot Road, exit (Santiam)	44.7582/-123.049	DEQ
24574-ORDEQ	Marion Creek at Jefferson-Marion Road Bridge, next to Pletzer Road (Santiam)	44.7358/-122.947	DEQ
25356-ORDEQ	Coal Creek	44.9733/-122.508	DEQ
25374-ORDEQ	Tincup Creek	44.8629/-122.281	DEQ

Station ID	Station	Latitude/Longitude	Organization
25381-ORDEQ	Chehalem Creek tributary	45.337/-123.055	DEQ
25385-ORDEQ	Drift Creek	44.9659/-122.796	DEQ
25975-ORDEQ	Stout Creek at mouth (North Santiam, Willamette)	44.7805/-122.66	DEQ
25981-ORDEQ	Bear Branch at Shelburn Drive (North Santiam, Willamette)	44.753/-122.85	DEQ
26751-ORDEQ	North Santiam River at River Mile 47.6 - Detroit Lake Tailrace	44.7255/-122.255	DEQ
26759-ORDEQ	Mill Creek at River Mile 2.2 at State Street, Salem	44.9345/-123.017	DEQ
26860-ORDEQ	Table Rock Fork	44.9613/-122.41	DEQ
28157-ORDEQ	Divide Creek	44.6442/-122.112	DEQ
28159-ORDEQ	Blowout Creek	44.638/-122.114	DEQ
28160-ORDEQ	Boulder Creek	44.7042/-122.09	DEQ
28161-ORDEQ	North Santiam River Bruno Mountain Road 2242 bridge	44.6914/-121.987	DEQ
28162-ORDEQ	North Santiam River downstream of Marion Creek confluence	44.6216/-121.948	DEQ
28163-ORDEQ	North Santiam River Hwy 22 bridge, Big Meadows	44.5008/-122.003	DEQ
28164-ORDEQ	Straight Creek at mouth across from Hwy 22	44.572/-121.999	DEQ
28165-ORDEQ	Lynx Creek	44.5658/-122.001	DEQ
28171-ORDEQ	East Humbug Creek	44.8006/-122.058	DEQ
28175-ORDEQ	Mansfield Creek	44.7875/-121.977	DEQ
28468-ORDEQ	Springbrook Creek upstream of Wilsonville Road	45.2903/-122.941	DEQ
28485-ORDEQ	Chehalem Creek upstream of Dopp Road	45.3237/-123.068	DEQ
28486-ORDEQ	Chehalem Creek upstream of Ewing Young Park	45.2897/-122.98	DEQ
28615-ORDEQ	South Santiam River above Foster Reservoir at River Mile 40.6	44.4007/-122.586	DEQ
28616-ORDEQ	Middle Santiam River below Green Peter Reservoir at Old Fish Facility	44.4482/-122.55	DEQ
28713-ORDEQ	Mill Creek at Turner Road (tributary to Willamette River at River Mile 84)	44.8812/-122.978	DEQ
28901-ORDEQ	Hess Creek upstream of Fulton Street (Yamhill, Willamette)	45.3069/-122.966	DEQ
28961-ORDEQ	Mill Creek at Front Street NE, Salem (tributary to Willamette River at River Mile 84)	44.9507/-123.037	DEQ

Station ID	Station	Latitude/Longitude	Organization
28964-ORDEQ	Clark Creek at mouth (tributary to Pringle Creek at River Mile 1.05)	44.9269/-123.033	DEQ
29457-ORDEQ	Pine Creek 110	45.0156/-122.449	DEQ
31403-ORDEQ	Abernethy Creek	45.3255/-122.508	DEQ
31872-ORDEQ	Abiqua Creek at Gallon House Bridge	45.0321/-122.798	DEQ
31874-ORDEQ	Butte Creek at Butte Creek Road LD	45.0327/-122.637	DEQ
31875-ORDEQ	Little Pudding River at Rambler Road	45.0454/-122.895	DEQ
31876-ORDEQ	Mill Creek Ehlen Road	45.2333/-122.757	DEQ
31877-ORDEQ	Pudding River at Saratoga Road	45.063/-122.83	DEQ
31878-ORDEQ	Pudding River below Drift Creek	44.9843/-122.834	DEQ
31879-ORDEQ	Silver Creek at Silverton, OR	45.009/-122.796	DEQ
31880-ORDEQ	Zollner Creek at Monitor-McKee Road Bridge	45.1003/-122.822	DEQ
32046-ORDEQ	Molalla River at River Mile 44	44.9145/-122.329	DEQ
32047-ORDEQ	Copper Creek at mouth (Molalla River)	44.9242/-122.339	DEQ
32048-ORDEQ	Table Rock Fork Molalla River at River Mile 1	44.9681/-122.404	DEQ
32049-ORDEQ	Molalla River upstream of Horse Creek	44.9622/-122.432	DEQ
32050-ORDEQ	Pine Creek at mouth (Molalla River)	45.0154/-122.482	DEQ
32051-ORDEQ	Molalla River upstream of Pine Creek	45.0121/-122.485	DEQ
32054-ORDEQ	Drift Creek at Victor Point Road	44.9241/-122.756	DEQ
32055-ORDEQ	Pudding River at State Street	44.9142/-122.819	DEQ
32056-ORDEQ	Pudding River at Sunnyview Road	44.9563/-122.867	DEQ
32057-ORDEQ	Drift Creek at Hibbard Road (Pudding River)	44.9765/-122.83	DEQ
32058-ORDEQ	Molalla River at Canby-Marquam Hwy (Goods Bridge)	45.2443/-122.688	DEQ
32059-ORDEQ	Molalla River at 22nd Avenue	45.2805/-122.711	DEQ
32060-ORDEQ	Mill Creek upstream of Hubbard STP (Pudding River)	45.186/-122.814	DEQ
32061-ORDEQ	Molalla River upstream of Milk Creek	45.2377/-122.658	DEQ
32062-ORDEQ	Molalla River North of Oak Grove Road	45.2189/-122.605	DEQ
33192-ORDEQ	South Fork Pudding River 0.5 miles upstream of highway	44.8865/-122.79	DEQ
33193-ORDEQ	North Fork Silver Creek at Silver Falls Drive	44.8841/-122.62	DEQ
33194-ORDEQ	Abiqua Creek downstream of South Abiqua Road bridge	45.0081/-122.678	DEQ
33195-ORDEQ	Silver Creek at River Mile 6.4 (Pudding River)	44.9825/-122.748	DEQ

Station ID	Station	Latitude/Longitude	Organization
33199-ORDEQ	Powers Creek at mouth (Abiqua, Pudding)	45.0163/-122.7	DEQ
33200-ORDEQ	South Fork Pudding River at Cascade Hwy	44.8895/-122.799	DEQ
33201-ORDEQ	Abiqua Creek upstream of Cascade Hwy (Pudding)	45.0274/-122.734	DEQ
33202-ORDEQ	Rock Creek at South Meridian Road (Pudding)	45.1884/-122.744	DEQ
33203-ORDEQ	Little Pudding River 200 yards downstream of Waldo Lake	44.8961/-122.892	DEQ
33204-ORDEQ	Little Pudding River at Conifer Road	44.945/-122.912	DEQ
33207-ORDEQ	Butte Creek at ODF Campground (Pudding)	44.9203/-122.495	DEQ
33208-ORDEQ	Coal Creek at the end of Butte Creek Road (Butte, Pudding)	44.9898/-122.54	DEQ
33233-ORDEQ	Brush Creek at Cascade Hwy downstream of Oregon Garden outfall (Silver Creek, Pudding)	44.9918/-122.802	DEQ
33234-ORDEQ	Brush Creek at Cascade Hwy upstream of Oregon Garden outfall (Silver Creek, Pudding)	44.9918/-122.802	DEQ
33235-ORDEQ	Albiqua Creek at River Mile 19.6 (Pudding)	44.9308/-122.571	DEQ
33236-ORDEQ	Kirk Creek upstream of Forest Road 400 (Butte Creek, Pudding)	44.9175/-122.507	DEQ
33485-ORDEQ	Croisan Creek	44.8771/-123.085	DEQ
33488-ORDEQ	Claggett Creek	44.9904/-123.015	DEQ
33490-ORDEQ	Little Pudding River tributary	44.9276/-122.956	DEQ
33496-ORDEQ	Willamette tributary near Wilsonville	45.3144/-122.747	DEQ
33512-ORDEQ	Clark Creek, Salem	44.9204/-123.035	DEQ
33523-ORDEQ	Abernathy Creek	45.3626/-122.593	DEQ
33859-ORDEQ	Breitenbush River at River Mile 9.6	44.7827/-122.045	DEQ
34289-ORDEQ	Abiqua Creek DS Homestead Creek (Pudding, Willamette)	44.9227/-122.562	DEQ
35587-ORDEQ	Battle Creek at RM 3.64	44.8602/-123.017	DEQ
35913-ORDEQ	Clark Creek at Ewald Ave (Pringle Cr Trib)	44.9011/-123.051	DEQ
35914-ORDEQ	Pringle Creek at Pringle Park (Willamette)	44.9343/-123.038	DEQ
35916-ORDEQ	East Fork of Pringle Creek at Trelstad Ave. (Willamette)	44.8853/-122.987	DEQ
35917-ORDEQ	Mill Creek at North Salem High School	44.9423/-123.024	DEQ
35923-ORDEQ	Glenn Creek at Wallace Rd.	44.9655/-123.058	DEQ
35933-ORDEQ	Battle Creek above Jory Creek	44.861/-123.049	DEQ

Station ID	Station	Latitude/Longitude	Organization
37229-ORDEQ	Bear Branch at Huntley Rd	44.7677/-122.745	DEQ
40069-ORDEQ	McDowell Creek at Berlin Road	44.4709/-122.744	DEQ
40070-ORDEQ	Hamilton Creek at Upper Berlin Rd	44.5009/-122.729	DEQ
40122-ORDEQ	Butte Cr at Woodburn Monitor Rd	45.1016/-122.746	DEQ
40126-ORDEQ	Fruitland Ck 0.2 RM downstream of Lardon Road	44.9717/-122.93	DEQ
40613-ORDEQ	Unnamed Tributary A above Big Creek	44.7981/-122.426	DEQ
40622-ORDEQ	Packers Gulch Creek	44.5894/-122.392	DEQ
40623-ORDEQ	South Fork Neal Creek	44.6789/-122.665	DEQ
40791-ORDEQ	McDowell Ck at Speasl Rd	44.458/-122.707	DEQ
40792-ORDEQ	Hamilton Ck at 1170m upstream of Bellinger Scale Rd	44.51/-122.789	DEQ
No Station ID	White Rock Creek		BLM
No Station ID	Elk Horn Park		BLM
No Station ID	North Fork County Park		BLM
No Station ID	Elkhorn Creek	44.8028/-122.439	BLM
No Station ID	Sinker Creek	44.8093/-122.417	BLM
No Station ID	Canyon Creek	44.8016/-122.479	BLM
tho25a01	Lower Thomas Creek BLM Site	44.7025/-122.559	BLM
tho31a01	Upper Thomas Creek BLM Site	44.6823/-122.483	BLM
BAT12	Battle Creek at Lone Oak Rd.	44.8611/-123.049	City of Salem
BAT3	Battle Creek at Commercial Ave.	44.8603/-123.017	City of Salem
CGT1	Claggett Creek at Mainline Dr NE	44.9822/-123.009	City of Salem
CGT5	Claggett Creek at Hawthorne St NE	44.9793/-122.993	City of Salem
CLK1	Clark Creek at Bush Park	44.9268/-123.034	City of Salem
CLK12	Clark Creek at Ewald Ave.	44.9012/-123.052	City of Salem
CRO1	Croisan Creek at Courthouse Athletic Club	44.9134/-123.069	City of Salem
CRO10	Croisan Creek at Ballantyne Rd S	44.8797/-123.083	City of Salem
GIB1	Gibson Creek at Wallace Rd NW	44.9748/-123.069	City of Salem
GIB15	Gibson Creek at Brush College Rd NW	44.9758/-123.092	City of Salem
GLE12	Glenn Creek at Hidden Valley Rd.	44.9475/-123.102	City of Salem
GLE3	Glenn Creek at Wallace Rd.	44.9653/-123.058	City of Salem
MIC12	Mill Creek at Turner Rd.	44.8813/-122.977	City of Salem
MIC3	Mill Creek at North Salem High School	44.9424/-123.024	City of Salem
MRA1	Mill Race at High St SE	44.9373/-123.039	City of Salem
MRA10	Mill Race at Mill Race Park	44.9337/-123.018	City of Salem
PRI12	East Fork of Pringle Creek at Trelstad Ave.	44.8853/-122.987	City of Salem
PRI3	Pringle Creek at Pringle Park	44.9341/-123.038	City of Salem

Station ID	Station	Latitude/Longitude	Organization
SHE1	Shelton Ditch at Church St SE	44.9348/-123.038	City of Salem
SHE10	Shelton Ditch at State Printing Office	44.9245/-123	City of Salem
WLN-MA	Waln Creek at Mitigation Area	44.8634/-123.023	City of Salem
WLN1	Waln Creek at Wiltsey Rd SE	44.8695/-123.024	City of Salem
No Station ID	SF Crabtree Creek		DEQ
No Station ID	Fish Creek		DEQ
No Station ID	Wonder Creek		DEQ
No Station ID	Big Creek		DEQ
No Station ID	Cougar Creek		DEQ
No Station ID	Beaver Creek		DEQ
No Station ID	Cox Creek		DEQ
No Station ID	Molalla at Locked Gate HW		DEQ
No Station ID	Molalla at Kraxberger		DEQ
No Station ID	Molalla at HWY 211		DEQ
No Station ID	Molalla abv N. Fork		DEQ
No Station ID	North Fork Molalla		DEQ
No Station ID	Crabtree Creek upstream of BLM site		DEQ
AC1-5406	Abiqua Creek	45.0323/-122.798	Marion SWCD
BC1-67	Butte Creek	45.1477/-122.78	Marion SWCD
LPR1-71	Little Pudding R Node 385	45.0458/-122.895	Marion SWCD
PR1-5808	Pudding River at Hazel Green Rd.	45.0094/-122.843	Marion SWCD
RC1-70	Rock Creek	45.1879/-122.745	Marion SWCD
ZC1-72	Zollner Creek	45.1004/-122.823	Marion SWCD
MHNF-007	060600006_Canyon_Creek	45.1288/-122.314	USFS
WNF-006	Blowout_Creek-mid-lo-USGS_LTWT	44.653/-122.131	USFS
WNF-007	Blowout_Creek-mid-upstrm_IvyCr_LTWT	44.6383/-122.115	USFS
WNF-008	Boulder_Creek-mouth_LTWT	44.7043/-122.09	USFS
WNF-010	Breitenbush_River-lo-USGS_LTWT	44.751/-122.133	USFS
WNF-011	Breitenbush_River-upper-dnstrm_HotSprings_LTWT	44.778/-121.997	USFS
WNF-013	Canal Creek	44.6152/-122.326	USFS
WNF-014	CanyonLower_LTWT	44.3906/-122.441	USFS
WNF-015	CanyonUpper_LTWT	44.3255/-122.342	USFS
WNF-027	Divide_Creek-lower_LTWT	44.6447/-122.113	USFS
WNF-028	East_Humbug_Creek-lo-USGS_LTWT	44.8006/-122.058	USFS
WNF-059	Latiwi	44.3729/-122.219	USFS
WNF-071	Middle Santiam	44.5021/-122.169	USFS

Station ID	Station	Latitude/Longitude	Organization
WNF-074	MooseLower_LTWT	44.4089/-122.435	USFS
WNF-075	MooseMid	44.4113/-122.43	USFS
WNF-076	MooseUpper_LTWT	44.4264/-122.387	USFS
WNF-081	North_Santiam_River-lower-USGS_LTWT	44.7077/-122.103	USFS
WNF-082	North_Santiam_River-mid-RiversideCG_LTWT	44.6348/-121.94	USFS
WNF-084	Owl Ck Upper	44.3058/-122.371	USFS
WNF-085	Owl_Lower_LTWT	44.3307/-122.365	USFS
WNF-091	Pyramid Ck	44.5035/-122.168	USFS
WNF-094	Quartzville Creek	44.5753/-122.296	USFS
WNF-103	Seven Mile	44.3734/-122.218	USFS
WNF-108	Sheep_LTWT	44.3936/-122.243	USFS
WNF-115	So Santiam lower (below Falls Ck)	44.4017/-122.385	USFS
WNF-116	SodaFork_LTWT	44.4105/-122.276	USFS
WNF-117	SouthSantiamUpper	44.383/-122.232	USFS
WNF-123	Trout_LTWT	44.3996/-122.348	USFS
WNF-125	Two Girls Upper	44.3404/-122.295	USFS
WNF-126	TwoGirlsLow	44.3302/-122.328	USFS
WNF-131	Battle Axe Creek-mouth-JawboneFlats	44.8475/-122.208	USFS
WNF-132	Battle Axe Crk-WT	44.8483/-122.207	USFS
WNF-134	Bugaboo Creek-lo Rd2234-290X	44.5997/-121.973	USFS
WNF-136	Cedar Creek-mouth-ShadyCove	44.8454/-122.296	USFS
WNF-138	Elkhorn Creek-upper-blw private	44.8003/-122.27	USFS
WNF-139	Grizzly Creek-mouth	44.655/-121.91	USFS
WNF-142	Mackey Creek-lo-abv Hwy22X	44.7278/-122.137	USFS
WNF-143	Marion Creek-lo abv Hwy22X-LTWT	44.6128/-121.947	USFS
WNF-145	Milk Creek-mouth Rd2246X	44.6597/-121.904	USFS
WNF-148	Minto Creek-Hwy22X	44.6272/-121.942	USFS
WNF-149	Minto Creek-mid Rd2253X	44.6146/-121.907	USFS
WNF-150	North Santiam River-upper-blw Hwy22X-LTWT	44.5013/-122.004	USFS
WNF-151	North Santiam River-upstrm of Marion Fks	44.615/-121.95	USFS
WNF-153	Opal Creek-mouth-JawboneFlats	44.845/-122.207	USFS
WNF-154	Pamelia Creek-lo abv Hwy22X	44.6638/-121.956	USFS
WNF-155	Puzzle Creek-lo abv Rd2255X	44.5884/-121.918	USFS
WNF-156	Red Creek-lo Rd2246X	44.66/-121.919	USFS
WNF-157	Russel Creek-mouth	44.6948/-121.892	USFS
WNF-159	Straight Creek-up-Rd1164X	44.576/-122.05	USFS

Station ID	Station	Latitude/Longitude	Organization
WNF-162	Whitewater Creek-mid-Rd2243-440X	44.695/-121.924	USFS
WNF-163	Whitewater Creek-mouth abv Hwy22X	44.6885/-121.971	USFS
14178000	No Santiam R Blw Boulder Crk, Nr Detroit, OR	44.7068/-122.101	USGS
14179000	Breitenbush R Abv French Cr Nr Detroit, OR.	44.7526/-122.129	USGS
14179100	French Creek Near Detroit, OR	44.7604/-122.168	USGS
14180300	Blowout Creek Near Detroit, OR	44.6529/-122.131	USGS
14181750	Rock Creek Near Mill City, OR	44.7121/-122.428	USGS
14182400	Little N Santiam R Blw Canyon Ck, Near Mehama, OR	44.7935/-122.493	USGS
14182500	Little North Santiam River Near Mehama, OR	44.7915/-122.579	USGS
14185000	South Santiam River Below Cascadia, OR	44.3918/-122.498	USGS
14185800	Middle Santiam R Near Cascadia, OR	44.5151/-122.372	USGS
14185900	Quartzville Creek Near Cascadia, OR	44.5401/-122.436	USGS
14186200	Middle Santiam R Blw Green Peter Dam Nr Foster, OR	44.4482/-122.55	USGS
14200400	Little Abiqua Creek Near Scotts Mills, OR	44.9557/-122.628	USGS
14201300	Zollner Creek Near Mt Angel, OR	45.1004/-122.822	USGS
14202000	Pudding River At Aurora, OR	45.2332/-122.75	USGS
S349766	Node 3		Watershed Sciences (2001)
S68509	Node 1		Watershed Sciences (2001)
S88442	Node 4		Watershed Sciences (2001)
MFMOLALLA	Monitoring location takes place in the upper Molalla River watershed on the middle fork roughly 6.5 miles above confluence with South Fork Molalla river on Weyerhaeuser ownership.	44.9924/-122.321	Weyerhaeuser

Table 43: Summary of existing temperature data in the Middle Willamette Subbasins. Columns Jan – Dec indicate the number of daily maximum temperature results in each month. Data from the DEQ file that are not in the databases were not summarized in the table.

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1993	14200400	Little Abiqua Creek Near Scotts Mills, OR							4	31	30	31	30	31
1993	14201300	Zollner Creek Near Mt Angel, OR							25	31	30	31	30	31
1993	14202000	Pudding River At Aurora, OR								25	30	31	30	31
1994	14200400	Little Abiqua Creek Near Scotts Mills, OR	31	28	31	30	31	30	31	31	30	31	21	31
1994	14201300	Zollner Creek Near Mt Angel, OR	31	28	31	30	31	28	16	31	30	31	30	31
1994	14202000	Pudding River At Aurora, OR	31	28	31	30	18	30	31	31	30	31	30	31
1995	14200400	Little Abiqua Creek Near Scotts Mills, OR	31	11		11	31	30	12			28	30	31
1995	14201300	Zollner Creek Near Mt Angel, OR	31	28	31	30	30	30	31	31	30	31	30	30
1995	14202000	Pudding River At Aurora, OR	31	28	31	30	31	30	31	31	30	31	30	31
1996	14200400	Little Abiqua Creek Near Scotts Mills, OR	31	29	31	30	31	30	31	31	30	31	30	31
1996	14201300	Zollner Creek Near Mt Angel, OR	31	4	20	30	31	28	26	27	9	26	30	30
1996	14202000	Pudding River At Aurora, OR	31	29	31	30	31	30	31	31	30	31	30	31
1997	14200400	Little Abiqua Creek Near Scotts Mills, OR	31	28	31	30	31	30	31	31	30	31	30	31
1997	14201300	Zollner Creek Near Mt Angel, OR	30	28	31	30	31	30	31	31	30	31	30	31
1997	14202000	Pudding River At Aurora, OR	31	28	31	30	31	30	31	31	30			
1998	14178000	No Santiam R Blw Boulder Crk, Nr Detroit, OR										31	30	31
1998	14179000	Breitenbush R Abv French Cr Nr Detroit, OR.									1	31	30	31
1998	14180300	Blowout Creek Near Detroit, OR										23	30	31

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1998	14200400	Little Abiqua Creek Near Scotts Mills, OR	31	28	28	30	31	30	31	31	30	31	30	31
1998	14201300	Zollner Creek Near Mt Angel, OR	27	28	31	30	31	30	31	31	30	31	30	31
1999	14178000	No Santiam R Blw Boulder Crk, Nr Detroit, OR	31	28	31	30	31	30	31	31	30	31	30	31
1999	14179000	Breitenbush R Abv French Cr Nr Detroit, OR.	31	28	31	30	31	30	31	30	30	31	30	31
1999	14180300	Blowout Creek Near Detroit, OR	31	28	31	30	31	30	31	31	30	31	30	31
1999	14200400	Little Abiqua Creek Near Scotts Mills, OR	31	28	31	30	31	30	31	31	7		27	31
1999	14201300	Zollner Creek Near Mt Angel, OR	31	28	31	30	31	30	31	31	30	31	30	31
2000	14178000	No Santiam R Blw Boulder Crk, Nr Detroit, OR	31	29	23	30	31	30	31	31	30	31	30	31
2000	14179000	Breitenbush R Abv French Cr Nr Detroit, OR.	31	29	31	30	31	30	31	31	30	31	30	31
2000	14180300	Blowout Creek Near Detroit, OR	31	29	31	30	31	30	31	31	30	31	30	31
2000	14182500	Little North Santiam River Near Mehama, OR				25	31	29	31	31	30	31	30	31
2000	14200400	Little Abiqua Creek Near Scotts Mills, OR	31	29	31	30	31	30	31	31	30	31	30	31
2000	14201300	Zollner Creek Near Mt Angel, OR	31	29	31	30	31	30	31	31	30	31	30	31
2000	21835-ORDEQ	Dead Horse Creek at River Mile 1.26						23	31	31	17			
2000	23851-ORDEQ	North Santiam River at River Mile 78.0 ODQW99-0009						23	31	31	17			
2000	23858-ORDEQ	Little North Fork Silver Creek at River Mile 0.30 (Silver, Pudding, Willamette)						29	31	31	6			
2000	24572-ORDEQ	Chehulpum Creek at Interstate 5, Talbot Road, exit (Santiam)						28	31	31	28			

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2000	24574-ORDEQ	Marion Creek at Jefferson-Marion Road Bridge, next to Pletzer Road (Santiam)						23	31	31	30	11		
2000	25975-ORDEQ	Stout Creek at mouth (North Santiam, Willamette)						15	31	31	14			
2000	25981-ORDEQ	Bear Branch at Shelburn Drive (North Santiam, Willamette)						22	31	31	14			
2000	28468-ORDEQ	Springbrook Creek upstream of Wilsonville Road							10	31	30	4		
2000	28485-ORDEQ	Chehalem Creek upstream of Dopp Road							12	31	11			
2000	28486-ORDEQ	Chehalem Creek upstream of Ewing Young Park							10	31	30	4		
2000	28901-ORDEQ	Hess Creek upstream of Fulton Street (Yamhill, Willamette)							10	31	28	4		
2000	29457-ORDEQ	Pine Creek 110						17	31	31	30	2		
2000	40622-ORDEQ	Packers Gulch Creek								22	13			
2000	40623-ORDEQ	South Fork Neal Creek						3	31	31	25			
2001	10784-ORDEQ	Crabtree Creek at Riverside School Road						30	31	31	30	31	2	
2001	10917-ORDEQ	Pudding River at Hwy 99E (Aurora)						19	31	31	30	31	4	
2001	11102-ORDEQ	Rickreall Creek at State Farm Road					16	29	31	31	30	22		
2001	14178000	No Santiam R Blw Boulder Crk, Nr Detroit, OR	31	28	31	30	31	30	31	31	30	31	30	31
2001	14179000	Breitenbush R Abv French Cr Nr Detroit, OR.	31	28	3	30	31	30	31	31	30	31	30	31
2001	14179100	French Creek Near Detroit, OR						4	30	31	27	7	30	31
2001	14180300	Blowout Creek Near Detroit, OR	31	28	31	29	30	30	31	31	30	31	30	31

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2001	14182500	Little North Santiam River Near Mehama, OR	31	27	31	30	31	30	31	31	30	31	30	31
2001	14200400	Little Abiqua Creek Near Scotts Mills, OR	31	28	31	30	31	30	31	31	30	31	30	31
2001	14201300	Zollner Creek Near Mt Angel, OR	31	28	31	30	31	30	31	31	27	31	30	31
2001	23847-ORDEQ	Moose Creek at River Mile 4.5 (South Santaim, Santiam, Willamette)						24	31	11	16			
2001	24572-ORDEQ	Chehulpum Creek at Interstate 5, Talbot Road, exit (Santiam)							25	31	30	9		
2001	25356-ORDEQ	Coal Creek							26	20				
2001	25374-ORDEQ	Tincup Creek							5					
2001	25381-ORDEQ	Chehalem Creek tributary						5	16					
2001	25975-ORDEQ	Stout Creek at mouth (North Santiam, Willamette)							31	31	27			
2001	25981-ORDEQ	Bear Branch at Shelburn Drive (North Santiam, Willamette)							31	31	30	10		
2001	26751-ORDEQ	North Santiam River at River Mile 47.6 - Detroit Lake Tailrace						23	28	4	25	31	2	
2001	26759-ORDEQ	Mill Creek at River Mile 2.2 at State Street, Salem						23	31	31	30	31	5	
2001	28157-ORDEQ	Divide Creek								24	9			
2001	28159-ORDEQ	Blowout Creek								24	9			
2001	28160-ORDEQ	Boulder Creek								24	9			
2001	28161-ORDEQ	North Santiam River Bruno Mountain Road 2242 bridge								21	11			
2001	28162-ORDEQ	North Santiam River downstream of Marion Creek confluence								24	11			
2001	28163-ORDEQ	North Santiam River Hwy 22 bridge, Big Meadows								24	11			

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2001	28164-ORDEQ	Straight Creek at mouth across from Hwy 22								24	11			
2001	28165-ORDEQ	Lynx Creek								30	11			
2001	28171-ORDEQ	East Humbug Creek							5	8				
2001	28175-ORDEQ	Mansfield Creek							5	9				
2001	29457-ORDEQ	Pine Creek 110							4	31	30	14		
2001	40613-ORDEQ	Unnamed Tributary A above Big Creek							13	31	20			
2002	10791-ORDEQ	Quartsville Creek at USGS Gage							19	31	10			
2002	10896-ORDEQ	Butte Creek at Hwy 211						3	31	31	30	6		
2002	11535-ORDEQ	Pudding River at Hazel Green Road						2	31	31	30	2		
2002	14178000	No Santiam R Blw Boulder Crk, Nr Detroit, OR	31	28	31	30	31	30	31	31	30	31	30	31
2002	14179000	Breitenbush R Abv French Cr Nr Detroit, OR.	31	28	31	30	31	30	31	31	30	31	30	31
2002	14179100	French Creek Near Detroit, OR	31	27	25	30	31	27	14	31	30	31	30	31
2002	14180300	Blowout Creek Near Detroit, OR	31	28	31	30	31	30	31	31	30	31	30	31
2002	14182500	Little North Santiam River Near Mehama, OR	31	28	31	30	31	30	31	31	30	31	30	31
2002	14200400	Little Abiqua Creek Near Scotts Mills, OR	31	28	31	30	31	30	31	31	30	31	30	31
2002	14201300	Zollner Creek Near Mt Angel, OR	31	28	31	30	31	30	31	31	30	31	28	24
2002	23805-ORDEQ	Middle Santiam River at gague upstream of Green Peter Reservoir				7	31	30	31	31	10			
2002	26860-ORDEQ	Table Rock Fork						4	31	31	23			
2002	28468-ORDEQ	Springbrook Creek upstream of Wilsonville Road						4	31	31	30	22		
2002	28615-ORDEQ	South Santiam River above Foster Reservoir at River Mile 40.6								25	10			

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2002	28616-ORDEQ	Middle Santiam River below Green Peter Reservoir at Old Fish Facility				5	31	30	31	5				
2002	28901-ORDEQ	Hess Creek upstream of Fulton Street (Yamhill, Willamette)							15	31	30	22		
2002	31872-ORDEQ	Abiqua Creek at Gallon House Bridge						5	31	31	30	2		
2002	31874-ORDEQ	Butte Creek at Butte Creek Road LD						3	31	31	30	2		
2002	31875-ORDEQ	Little Pudding River at Rambler Road						5	31	31	30	22		
2002	31879-ORDEQ	Silver Creek at Silverton, OR							29	31	30	31	6	
2002	33192-ORDEQ	South Fork Pudding River 0.5 miles upstream of highway						2	31	31	30	30		
2002	33193-ORDEQ	North Fork Silver Creek at Silver Falls Drive						5	31		9			
2002	33194-ORDEQ	Abiqua Creek downstream of South Abiqua Road bridge						2	31	31	30	31	5	
2002	33195-ORDEQ	Silver Creek at River Mile 6.4 (Pudding River)						4	30	30	30	2		
2003	10896-ORDEQ	Butte Creek at Hwy 211						26	25	31	29			
2003	11535-ORDEQ	Pudding River at Hazel Green Road						26	8	31	30	9		
2003	14178000	No Santiam R Blw Boulder Crk, Nr Detroit, OR	31	28	31	30	31	30	31	31	30	31	30	31
2003	14179000	Breitenbush R Abv French Cr Nr Detroit, OR.	31	28	31	30	31	30	31	31	30	31	30	31
2003	14179100	French Creek Near Detroit, OR	31	28	31	30	31	26	23	31	30	30	30	31
2003	14180300	Blowout Creek Near Detroit, OR	31	28	31	30	31	30	31	31	30	31	21	31
2003	14182500	Little North Santiam River Near Mehama, OR	31	28	31	30	31	27	18	31	28	27	30	31
2003	14200400	Little Abiqua Creek Near Scotts Mills, OR	31	28	31	30	31	30	31	31	13	31	30	31
2003	14201300	Zollner Creek Near Mt Angel, OR	29	28	31	30	31	30	31	31	30	31	30	31

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2003	28468-ORDEQ	Springbrook Creek upstream of Wilsonville Road							31	31	30	5		
2003	28486-ORDEQ	Chehalem Creek upstream of Ewing Young Park							31	31	30	23		
2003	31874-ORDEQ	Butte Creek at Butte Creek Road LD						26	31	31	30			
2003	31875-ORDEQ	Little Pudding River at Rambler Road						26	31	31	30	1		
2003	31879-ORDEQ	Silver Creek at Silverton, OR						13	31	31	30	1		
2003	33192-ORDEQ	South Fork Pudding River 0.5 miles upstream of highway						19	31	31	30	1		
2003	33193-ORDEQ	North Fork Silver Creek at Silver Falls Drive						26	31	31	30	1		
2003	33194-ORDEQ	Abiqua Creek downstream of South Abiqua Road bridge						12	31	31	30	1		
2004	10362-ORDEQ	Pudding River at Arndt Road (Barlow)										10	12	
2004	10636-ORDEQ	Molalla River at mouth									14	7		
2004	10637-ORDEQ	Molalla River at Knights Bridge Road (Canby)												17
2004	10640-ORDEQ	Pudding River at Hwy 211 (Woodburn)										4		18
2004	10641-ORDEQ	Pudding River at Hwy 214 (downstream of cannery outfall)											9	13
2004	10646-ORDEQ	Silver Creek at Brush Creek Road									12			
2004	10881-ORDEQ	Molalla River at Hwy 213 Bridge (Mulino)							8	31	30	6		12
2004	10896-ORDEQ	Butte Creek at Hwy 211					11	30	31	31	22			
2004	10899-ORDEQ	Zollner Creek at Monitor-McKee Road Bridge					11	30	31	31	22			
2004	10917-ORDEQ	Pudding River at Hwy 99E (Aurora)											17	4

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2004	11528-ORDEQ	Pudding River at Bernard Road (Whiskey Hill)										13	9	
2004	11530-ORDEQ	Pudding River at Monitor-McKee Road										1	21	
2004	11536-ORDEQ	Pudding River at Nusom Road									10			
2004	14178000	No Santiam R Blw Boulder Crk, Nr Detroit, OR	29	29	31	30	31	30	31	31	30	31	30	31
2004	14179000	Breitenbush R Abv French Cr Nr Detroit, OR.	31	29	31	30	31	30	31	31	30	31	30	31
2004	14179100	French Creek Near Detroit, OR	31	21	31	30	31	29	31	29	30	31	30	31
2004	14180300	Blowout Creek Near Detroit, OR	31	28	30	30	31	30	31	30	30	31	30	31
2004	14182500	Little North Santiam River Near Mehama, OR	31	29	31	30	31	30	31	31	29	31	30	31
2004	14200400	Little Abiqua Creek Near Scotts Mills, OR	31	29	31	30	31	30	31	31	29			
2004	14201300	Zollner Creek Near Mt Angel, OR	31	29	31	30	31	30	31	31	30			
2004	21835-ORDEQ	Dead Horse Creek at River Mile 1.26						6	31	31	15			
2004	23847-ORDEQ	Moose Creek at River Mile 4.5 (South Santaim, Santiam, Willamette)						13	31	31	15			
2004	25385-ORDEQ	Drift Creek					6	30	31	31	21			
2004	31403-ORDEQ	Abernethy Creek						20	31	31	30	10		
2004	31872-ORDEQ	Abiqua Creek at Gallon House Bridge					4	30	31	31	30			
2004	31874-ORDEQ	Butte Creek at Butte Creek Road LD					6	30	31	31	28			
2004	31875-ORDEQ	Little Pudding River at Rambler Road					12	30	31	31	21			
2004	31876-ORDEQ	Mill Creek Ehlen Road											21	1
2004	31877-ORDEQ	Pudding River at Saratoga Road									4	15		
2004	31878-ORDEQ	Pudding River below Drift Creek									1			
2004	31879-ORDEQ	Silver Creek at Silverton, OR					3	30	31	31	30	5		

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2004	32046-ORDEQ	Molalla River at River Mile 44									17	4		
2004	32047-ORDEQ	Copper Creek at mouth (Molalla River)									13	8		
2004	32048-ORDEQ	Table Rock Fork Molalla River at River Mile 1					5	30	31	31	30	13		
2004	32049-ORDEQ	Molalla River upstream of Horse Creek									11	8		
2004	32050-ORDEQ	Pine Creek at mouth (Molalla River)									21			
2004	32051-ORDEQ	Molalla River upstream of Pine Creek									7	10		
2004	32054-ORDEQ	Drift Creek at Victor Point Road									2			
2004	32055-ORDEQ	Pudding River at State Street									12			
2004	32056-ORDEQ	Pudding River at Sunnyview Road									7			
2004	32058-ORDEQ	Molalla River at Canby-Marquam Hwy (Goods Bridge)												17
2004	32059-ORDEQ	Molalla River at 22nd Avenue									7			8
2004	32060-ORDEQ	Mill Creek upstream of Hubbard STP (Pudding River)									8		22	2
2004	32061-ORDEQ	Molalla River upstream of Milk Creek									15			
2004	32062-ORDEQ	Molalla River North of Oak Grove Road									17			
2004	33195-ORDEQ	Silver Creek at River Mile 6.4 (Pudding River)					6	30	31	31	28			
2004	33199-ORDEQ	Powers Creek at mouth (Abiqua, Pudding)					6	30	31	31	21			
2004	33200-ORDEQ	South Fork Pudding River at Cascade Hwy					6	30	31	31	17			
2004	33201-ORDEQ	Abiqua Creek upstream of Cascade Hwy (Pudding)					3	30	31	31	30	4		

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2004	33202-ORDEQ	Rock Creek at South Meridian Road (Pudding)						26	31	31	30	17		
2004	33203-ORDEQ	Little Pudding River 200 yards downstream of Waldo Lake					5	30	31	31	30	5		
2004	33204-ORDEQ	Little Pudding River at Conifer Road					6	30	21	31	30			
2004	WNF-008	Boulder_Creek-mouth_LTWT						29	31	31	30			
2004	WNF-081	North_Santiam_River-lower-USGS_LTWT						29	31	31	30			
2004	WNF-082	North_Santiam_River-mid-RiversideCG_LTWT						29	31	31	30			
2004	WNF-136	Cedar Creek-mouth-ShadyCove						25	31	31	30			
2004	WNF-138	Elkhorn Creek-upper-blw private						24	31	31	30			
2004	WNF-143	Marion Creek-lo abv Hwy22X-LTWT						29	31	31	30			
2004	WNF-150	North Santiam River-upper-blw Hwy22X-LTWT						24	31	31	30			
2004	WNF-151	North Santiam River-upstrm of Marion Fks						29	31	31	30			
2005	10886-ORDEQ	Mill Creek at Ehuen Road Bridge (Aurora)						13	31	31	26			
2005	11514-ORDEQ	South Fork Bochsler Creek at Hwy 214						10	31	29	2			
2005	14178000	No Santiam R Blw Boulder Crk, Nr Detroit, OR	31	28	31	30	31	30	31	31	30	31	30	31
2005	14179000	Breitenbush R Abv French Cr Nr Detroit, OR.	31	28	31	30	31	30	31	31	30	31	30	31
2005	14179100	French Creek Near Detroit, OR	28	28	31	30	31	30	31	31	29			
2005	14180300	Blowout Creek Near Detroit, OR	31	28	31	30	31	30	31	31	30	31	30	31
2005	14181750	Rock Creek Near Mill City, OR										31	30	31

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2005	14182500	Little North Santiam River Near Mehama, OR	31	28	31	30	31	30	31	31	30	31	30	31
2005	21835-ORDEQ	Dead Horse Creek at River Mile 1.26						7	31	31	27			
2005	23847-ORDEQ	Moose Creek at River Mile 4.5 (South Santaim, Santiam, Willamette)						7	31		5			
2005	31872-ORDEQ	Abiqua Creek at Gallon House Bridge						21	31	31	22			
2005	31875-ORDEQ	Little Pudding River at Rambler Road						10	31	31	18			
2005	31879-ORDEQ	Silver Creek at Silverton, OR						2	31	31	21			
2005	31880-ORDEQ	Zollner Creek at Monitor-McKee Road Bridge						10	31	31	26			
2005	32054-ORDEQ	Drift Creek at Victor Point Road							20	31	19			
2005	32057-ORDEQ	Drift Creek at Hibbard Road (Pudding River)						16	31	31	19			
2005	33194-ORDEQ	Abiqua Creek downstream of South Abiqua Road bridge						3	31	31	21			
2005	33195-ORDEQ	Silver Creek at River Mile 6.4 (Pudding River)						15	31	31	22			
2005	33199-ORDEQ	Powers Creek at mouth (Abiqua, Pudding)						2	31	31	30	3		
2005	33204-ORDEQ	Little Pudding River at Conifer Road						20	31	9				
2005	33207-ORDEQ	Butte Creek at ODF Campground (Pudding)							23	31	30	3		
2005	33208-ORDEQ	Coal Creek at the end of Butte Creek Road (Butte, Pudding)						22	31	31	30	3		
2005	33233-ORDEQ	Brush Creek at Cascade Hwy downstream of Oregon Garden outfall (Silver Creek, Pudding)						2	31	31	21			
2005	33234-ORDEQ	Brush Creek at Cascade Hwy upstream of Oregon Garden outfall (Silver Creek, Pudding)						2	31	31	21			

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2005	33235-ORDEQ	Albiqua Creek at River Mile 19.6 (Pudding)							23	31	30	3		
2005	33236-ORDEQ	Kirk Creek upstream of Forest Road 400 (Butte Creek, Pudding)							23	31	30	3		
2005	WNF-008	Boulder_Creek-mouth_LTWT						15	31	31	29			
2005	WNF-081	North_Santiam_River-lower-USGS_LTWT							31	31	30			
2005	WNF-082	North_Santiam_River-mid-RiversideCG_LTWT						15	31	31	30			
2005	WNF-136	Cedar Creek-mouth-ShadyCove							31	31	30			
2005	WNF-143	Marion Creek-lo abv Hwy22X-LTWT						15	31	31	30			
2005	WNF-150	North Santiam River-upper-blw Hwy22X-LTWT						15	31	31	30			
2005	WNF-151	North Santiam River-upstrm of Marion Fks							31	31	30			
2006	10647-ORDEQ	Silver Creek upstream of Silverton						9	31	31	28			
2006	10896-ORDEQ	Butte Creek at Hwy 211						28	31	15				
2006	11514-ORDEQ	South Fork Bochsler Creek at Hwy 214						16						
2006	14178000	No Santiam R Blw Boulder Crk, Nr Detroit, OR	31	28	31	30	31	30	31	31	30	31	30	31
2006	14179000	Breitenbush R Abv French Cr Nr Detroit, OR.	29	28	31	30	31	30	31	31	30	31	30	31
2006	14180300	Blowout Creek Near Detroit, OR	31	28	31	30	31	30	31	31	28	31	30	31
2006	14181750	Rock Creek Near Mill City, OR	31	28	31	30	31	30	31	31	26	31	30	31
2006	14182500	Little North Santiam River Near Mehama, OR	31	28	31	30	31	30	31	31	30	31	30	31
2006	25356-ORDEQ	Coal Creek						29	31	31	18			

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2006	28713-ORDEQ	Mill Creek at Turner Road (tributary to Willamette River at River Mile 84)											22	31
2006	28964-ORDEQ	Clark Creek at mouth (tributary to Pringle Creek at River Mile 1.05)										8	30	31
2006	31872-ORDEQ	Abiqua Creek at Gallon House Bridge						29	31	31	18			
2006	31875-ORDEQ	Little Pudding River at Rambler Road						28	31	31	18			
2006	32054-ORDEQ	Drift Creek at Victor Point Road						28	31	31	25			
2006	33199-ORDEQ	Powers Creek at mouth (Abiqua, Pudding)						29	31	31	28			
2006	33207-ORDEQ	Butte Creek at ODF Campground (Pudding)						29	31	31	17			
2006	33236-ORDEQ	Kirk Creek upstream of Forest Road 400 (Butte Creek, Pudding)						29	31	31	17			
2006	33485-ORDEQ	Croisan Creek							26	31	30	3		
2006	33488-ORDEQ	Claggett Creek							25	8	16	3		
2006	33490-ORDEQ	Little Pudding River tributary							25	31	30	3		
2006	33496-ORDEQ	Willamette tributary near Wilsonville							24	31	30	3		
2006	33512-ORDEQ	Clark Creek, Salem							25	31	30	3		
2006	33523-ORDEQ	Abernathy Creek							21	31	30	3		
2006	33859-ORDEQ	Breitenbush River at River Mile 9.6								22	30	3		
2006	34289-ORDEQ	Abiqua Creek DS Homestead Creek (Pudding, Willamette)						29	31	31	17			
2006	35913-ORDEQ	Clark Creek at Ewald Ave (Pringle Cr Trib)										8	30	31
2006	35914-ORDEQ	Pringle Creek at Pringle Park (Willamette)											24	31
2006	35916-ORDEQ	East Fork of Pringle Creek at Trelstad Ave. (Willamette)											13	28
2006	WNF-008	Boulder_Creek-mouth_LTWT						29	31	31	30			

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2006	WNF-081	North_Santiam_River-lower-USGS_LTWT						29	31	31	30			
2006	WNF-082	North_Santiam_River-mid-RiversideCG_LTWT						29	31	31	30			
2006	WNF-143	Marion Creek-lo abv Hwy22X-LTWT						29	31	31	30			
2006	WNF-150	North Santiam River-upper-blw Hwy22X-LTWT						29	31	31	30			
2006	WNF-151	North Santiam River-upstrm of Marion Fks						29	31	31	30			
2007	14178000	No Santiam R Blw Boulder Crk, Nr Detroit, OR	31	28	31	30	31	30	31	31	30	31	30	31
2007	14179000	Breitenbush R Abv French Cr Nr Detroit, OR.	31	28	31	30	31	30	31	31	30	31	30	31
2007	14180300	Blowout Creek Near Detroit, OR	31	28	31	30	31	30	31	31	30	31	30	31
2007	14181750	Rock Creek Near Mill City, OR	31	28	31	30	31	30	31	31	30	31	30	31
2007	14182400	Little N Santiam R Blw Canyon Ck, Near Mehama, OR											15	31
2007	14182500	Little North Santiam River Near Mehama, OR	31	28	31	30	31	30	31	31	30	31	30	31
2007	14186200	Middle Santiam R Blw Green Peter Dam Nr Foster, OR										8	30	31
2007	21838-ORDEQ	Glenn Creek at River Mile 5.45								20	30	25	30	31
2007	28713-ORDEQ	Mill Creek at Turner Road (tributary to Willamette River at River Mile 84)	17	27	31	25			21	29	21	15	30	31
2007	28961-ORDEQ	Mill Creek at Front Street NE, Salem (tributary to Willamette River at River Mile 84)							13	31	30	1		
2007	28964-ORDEQ	Clark Creek at mouth (tributary to Pringle Creek at River Mile 1.05)	7	26	31	24			15	31	30	23	30	31

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2007	35913-ORDEQ	Clark Creek at Ewald Ave (Pringle Cr Trib)	7	27	31	24			15	31	30	25	30	31
2007	35914-ORDEQ	Pringle Creek at Pringle Park (Willamette)	1	26	31	17			13	31	30	15	29	31
2007	35916-ORDEQ	East Fork of Pringle Creek at Trelstad Ave. (Willamette)	2	27	30	25			22	31	30	16	30	31
2007	35917-ORDEQ	Mill Creek at North Salem High School		21	31	16			21	31	30	17	30	31
2007	35923-ORDEQ	Glenn Creek at Wallace Rd.								20	30	26	28	25
2007	WNF-008	Boulder_Creek-mouth_LTWT							31	31	30			
2007	WNF-081	North_Santiam_River-lower-USGS_LTWT							31	31	30			
2007	WNF-082	North_Santiam_River-mid-RiversideCG_LTWT							31	31	30			
2007	WNF-143	Marion Creek-lo abv Hwy22X-LTWT							31	31	30			
2007	WNF-150	North Santiam River-upper-blw Hwy22X-LTWT							31	31	30			
2008	12210-ORDEQ	Silver Creek at James Street Bridge (Silverton)							7	31	30	21	30	31
2008	14178000	No Santiam R Blw Boulder Crk, Nr Detroit, OR	31	29	31	30	31	30	31	31	30	31	30	31
2008	14179000	Breitenbush R Abv French Cr Nr Detroit, OR.	31	29	31	30	31	30	31	31	30	30	30	31
2008	14180300	Blowout Creek Near Detroit, OR	31	29	31	30	31	30	31	31	30	31	30	31
2008	14181750	Rock Creek Near Mill City, OR	31	29	31	30	31	30	31	31	30	31	30	31
2008	14182400	Little N Santiam R Blw Canyon Ck, Near Mehama, OR	31	29	31	30	31	30	31	31	30	29	29	28
2008	14182500	Little North Santiam River Near Mehama, OR	31	29	31	30	31	30	31	31	30	31	30	31

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2008	14185000	South Santiam River Below Cascadia, OR										3	30	31
2008	14185900	Quartzville Creek Near Cascadia, OR										10	30	31
2008	14186200	Middle Santiam R Blw Green Peter Dam Nr Foster, OR	31	29	31	30	31	3						
2008	21838-ORDEQ	Glenn Creek at River Mile 5.45	31	29	30							23	20	2
2008	28961-ORDEQ	Mill Creek at Front Street NE, Salem (tributary to Willamette River at River Mile 84)							26	31	30	14		
2008	28964-ORDEQ	Clark Creek at mouth (tributary to Pringle Creek at River Mile 1.05)	29	29	31				22	31	30	28	30	31
2008	31872-ORDEQ	Abiqua Creek at Gallon House Bridge					16	24	28	31	30	31	27	2
2008	31878-ORDEQ	Pudding River below Drift Creek							21	31	9	30	14	31
2008	32054-ORDEQ	Drift Creek at Victor Point Road												27
2008	32057-ORDEQ	Drift Creek at Hibbard Road (Pudding River)				20	31	30	31	31	30	31	30	31
2008	35587-ORDEQ	Battle Creek at RM 3.64										11	30	31
2008	35933-ORDEQ	Battle Creek above Jory Creek										10	19	30
2008	40122-ORDEQ	Butte Cr at Woodburn Monitor Rd					25	30	31	31	30	31	30	31
2008	BAT12	Battle Creek at Lone Oak Rd.										10	19	30
2008	BAT3	Battle Creek at Commercial Ave.										11	30	31
2008	CLK1	Clark Creek at Bush Park	29	29	31	26	31	30	27	31	30	28	30	31
2008	CLK12	Clark Creek at Ewald Ave.	29	29	31	27	31	30	26	31	30	28	30	31
2008	GLE12	Glenn Creek at Hidden Valley Rd.	31	29	30	19	23	30				23	20	2
2008	GLE3	Glenn Creek at Wallace Rd.	31	26	30	27	31	29	20	31	30	28	30	31
2008	MIC12	Mill Creek at Turner Rd.	26	29	31	28	31	30	26	30	30	26	30	31
2008	MIC3	Mill Creek at North Salem High School	29	29	31	28	31	30	25	31	30	28	30	31

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2008	PRI12	East Fork of Pringle Creek at Trelstad Ave.	29	29	31	28	31	30	26	31	30	26	30	22
2008	PRI3	Pringle Creek at Pringle Park	29	29	31	26	31	30	25	28	30	28	30	27
2008	WNF-007	Blowout_Creek-mid-upstrm_IvyCr_LTWT						1	31	31	30			
2008	WNF-008	Boulder_Creek-mouth_LTWT						1	31	31	30			
2008	WNF-010	Breitenbush_River-lo-USGS_LTWT						1	31	31	30			
2008	WNF-011	Breitenbush_River-upper-dnstrm_HotSprings_LTWT						1	31	31	30			
2008	WNF-014	CanyonLower_LTWT							15	31	21			
2008	WNF-015	CanyonUpper_LTWT							15	31	23			
2008	WNF-028	East_Humbug_Creek-lo-USGS_LTWT						1	31	31	30			
2008	WNF-059	Latiwi							23	31	22			
2008	WNF-071	Middle Santiam							25	33*	25			
2008	WNF-074	MooseLower_LTWT							16	31	21			
2008	WNF-076	MooseUpper_LTWT							16	31	21			
2008	WNF-081	North_Santiam_River-lower-USGS_LTWT						1	31	31	30			
2008	WNF-082	North_Santiam_River-mid-RiversideCG_LTWT						1	31	31	30			
2008	WNF-085	Owl_Lower_LTWT							15	31	23			
2008	WNF-091	Pyramid Ck							24	31	25			
2008	WNF-103	Seven Mile							23	31	23			
2008	WNF-108	Sheep_LTWT							16	31	23			
2008	WNF-115	So Santiam lower (below Falls Ck)							16	31	23			
2008	WNF-116	SodaFork_LTWT							24	31	22			
2008	WNF-117	SouthSantiamUpper							22	31	23			

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2008	WNF-123	Trout_LTWT							16	31	22			
2008	WNF-126	TwoGirlsLow							15	31	21			
2008	WNF-143	Marion Creek-lo abv Hwy22X-LTWT							31	31	30			
2008	WNF-150	North Santiam River-upper-blw Hwy22X-LTWT							31	31	30			
2009	12210-ORDEQ	Silver Creek at James Street Bridge (Silverton)	31	28	31	26	20							
2009	14178000	No Santiam R Blw Boulder Crk, Nr Detroit, OR	31	28	31	30	31	30	31	31	30	31	30	31
2009	14179000	Breitenbush R Abv French Cr Nr Detroit, OR.	31	28	31	30	31	30	31	31	30	31	30	31
2009	14180300	Blowout Creek Near Detroit, OR	31	28	31	30	30	30	31	31	30	31	30	31
2009	14181750	Rock Creek Near Mill City, OR	4											
2009	14182500	Little North Santiam River Near Mehama, OR	31	28	31	30	30	30	30	31	30	31	30	31
2009	14185000	South Santiam River Below Cascadia, OR	31	28	31	30	31	30	31	31	30	25	30	31
2009	14185900	Quartzville Creek Near Cascadia, OR	31	28	31	30	24	28	31	31	29	31	30	31
2009	14186200	Middle Santiam R Blw Green Peter Dam Nr Foster, OR		4	31	30	31	30	31	31	30	31	30	31
2009	21838-ORDEQ	Glenn Creek at River Mile 5.45	6	8	31	5								
2009	28964-ORDEQ	Clark Creek at mouth (tributary to Pringle Creek at River Mile 1.05)	28	28	31	19								
2009	31878-ORDEQ	Pudding River below Drift Creek	31	28	31	8	14							
2009	32054-ORDEQ	Drift Creek at Victor Point Road	31	28	30	28	6							
2009	32057-ORDEQ	Drift Creek at Hibbard Road (Pudding River)	31	28	31	30	25							
2009	35587-ORDEQ	Battle Creek at RM 3.64	31	28	31	7								
2009	35933-ORDEQ	Battle Creek above Jory Creek	28	28	31	7								

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2009	40122-ORDEQ	Butte Cr at Woodburn Monitor Rd	31	28	31	30	24							
2009	40126-ORDEQ	Fruitland Ck 0.2 RM downstream of Lardon Road	2	28	31	22								
2009	BAT12	Battle Creek at Lone Oak Rd.	28	28	31	23	31	30	25	31	30	29	30	31
2009	BAT3	Battle Creek at Commercial Ave.	31	28	31	27	31	30	28	29	30	28	30	31
2009	CLK1	Clark Creek at Bush Park	28	28	31	27	31	30	30	31	30	25	30	30
2009	CLK12	Clark Creek at Ewald Ave.	28	28	31	30	29	30	28	31	30	26	30	31
2009	GLE12	Glenn Creek at Hidden Valley Rd.	6	8	31	30	6		19	5	30	8		
2009	GLE3	Glenn Creek at Wallace Rd.	31	28	31	26	26	15	22	17	30	25	28	31
2009	MIC12	Mill Creek at Turner Rd.	27	28	31	27	31	30	27	31	30	28	30	31
2009	MIC3	Mill Creek at North Salem High School	31	23	5	11		14	28	31	15	29	30	31
2009	PRI12	East Fork of Pringle Creek at Trelstad Ave.	27	28	31	23	31	30	28	31	30	28	30	31
2009	PRI3	Pringle Creek at Pringle Park	28	28	31	30	31	30	28	31	30	19	30	31
2009	WNF-006	Blowout_Creek-mid-lo-USGS_LTWT						17	31	31	30			
2009	WNF-007	Blowout_Creek-mid-upstrm_IvyCr_LTWT						17	31	31	30			
2009	WNF-008	Boulder_Creek-mouth_LTWT						17	31	31	30			
2009	WNF-010	Breitenbush_River-lo-USGS_LTWT						17	31	31	30			
2009	WNF-011	Breitenbush_River-upper-dnstrm_HotSprings_LTWT						17	31	31	30			
2009	WNF-014	CanyonLower_LTWT							18	31	1			
2009	WNF-015	CanyonUpper_LTWT							18	31	1			
2009	WNF-027	Divide_Creek-lower_LTWT						17	31	31	30			
2009	WNF-028	East_Humbug_Creek-lo-USGS_LTWT						17	31	31	30			
2009	WNF-059	Latiwi							15	31	1			

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2009	WNF-074	MooseLower_LTWT							18	31	3			
2009	WNF-076	MooseUpper_LTWT							18	31	1			
2009	WNF-081	North_Santiam_River-lower-USGS_LTWT						17	31	31	30			
2009	WNF-082	North_Santiam_River-mid-RiversideCG_LTWT						17	31	31	30			
2009	WNF-085	Owl_Lower_LTWT							18	31	1			
2009	WNF-103	Seven Mile							14	31	3			
2009	WNF-108	Sheep_LTWT							18	31	2			
2009	WNF-116	SodaFork_LTWT							18	31	2			
2009	WNF-117	SouthSantiamUpper							21	31	2			
2009	WNF-123	Trout_LTWT							18	31	2			
2009	WNF-126	TwoGirlsLow							18	31	1			
2009	WNF-131	Battle Axe Creek-mouth-JawboneFlats							23	31	30			
2009	WNF-132	Battle Axe Crk-WT							23	31	30			
2009	WNF-139	Grizzly Creek-mouth							22	31	30			
2009	WNF-143	Marion Creek-lo abv Hwy22X-LTWT						16	31	31	30			
2009	WNF-145	Milk Creek-mouth Rd2246X							24	31	30			
2009	WNF-153	Opal Creek-mouth-JawboneFlats							23	31	30			
2009	WNF-154	Pamelia Creek-lo abv Hwy22X							24	31	30			
2009	WNF-155	Puzzle Creek-lo abv Rd2255X							22	31	30			
2009	WNF-163	Whitewater Creek-mouth abv Hwy22X							29	31	30			
2010	14178000	No Santiam R Blw Boulder Crk, Nr Detroit, OR	31	28	31	30	31	30	31	31	30	31	30	31
2010	14179000	Breitenbush R Abv French Cr Nr Detroit, OR.	31	28	31	30	31	30	31	31	30	31	30	31

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2010	14180300	Blowout Creek Near Detroit, OR	31	28	31	30	31	30	31	31	30	31	30	31
2010	14182500	Little North Santiam River Near Mehama, OR	31	28	31	30	31	30	31	31	30	31	30	31
2010	14185000	South Santiam River Below Cascadia, OR	31	28	31	30	31	30	31	31	30	31	30	31
2010	14185800	Middle Santiam R Near Cascadia, OR								14	30	31	30	31
2010	14185900	Quartzville Creek Near Cascadia, OR	31	28	31	30	31	30	31	31	30	31	30	31
2010	14186200	Middle Santiam R Blw Green Peter Dam Nr Foster, OR	29	28	31	30	31	30	31	31	30	31	30	31
2010	BAT12	Battle Creek at Lone Oak Rd.	29	28	30	29	31	30	28	31	30	29	30	31
2010	BAT3	Battle Creek at Commercial Ave.	29	28	30	29	31	30	29	30	30	29	30	31
2010	CLK1	Clark Creek at Bush Park	29	22	30	29	31	30	29	31	30	27	30	31
2010	CLK12	Clark Creek at Ewald Ave.	28	28	30	29	31	30	29	31	30	29	30	31
2010	GLE12	Glenn Creek at Hidden Valley Rd.		19	31	29	31	30	29	31	26	29	30	31
2010	GLE3	Glenn Creek at Wallace Rd.	29	14	31	28	31	30	28	31	30	24	30	31
2010	MIC12	Mill Creek at Turner Rd.	29	28	31	26	31	28	31	31	30	29	30	31
2010	MIC3	Mill Creek at North Salem High School	9	28	31	29	31	30	29	29	30	29	30	31
2010	PRI12	East Fork of Pringle Creek at Trelstad Ave.	28	22	31	26	31	27	30	31	30	12		
2010	PRI3	Pringle Creek at Pringle Park	29	28	31	26	31	30	28	31	30	29	30	31
2010	WNF-008	Boulder_Creek-mouth_LTWT						1	31	31	30			
2010	WNF-010	Breitenbush_River-lo-USGS_LTWT						1	31	31	30			
2010	WNF-011	Breitenbush_River-upper-dnstrm_HotSprings_LTWT						1	31	31	30			
2010	WNF-015	CanyonUpper_LTWT							24	31	13			
2010	WNF-027	Divide_Creek-lower_LTWT						1	31	31	30			

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2010	WNF-028	East_Humbug_Creek-lo-USGS_LTWT						1	31	31	29			
2010	WNF-074	MooseLower_LTWT							24	31	14			
2010	WNF-075	MooseMid							30	31	14			
2010	WNF-076	MooseUpper_LTWT							30	31	14			
2010	WNF-081	North_Santiam_River-lower-USGS_LTWT						1	31	31	20			
2010	WNF-082	North_Santiam_River-mid-RiversideCG_LTWT						1	31	31	30			
2010	WNF-085	Owl_Lower_LTWT							24	31	15			
2010	WNF-116	SodaFork_LTWT							23	31	14			
2010	WNF-143	Marion Creek-lo abv Hwy22X-LTWT							31	31	30			
2011	14178000	No Santiam R Blw Boulder Crk, Nr Detroit, OR	31	28	31	30	31	30	31	31	30	31	30	31
2011	14179000	Breitenbush R Abv French Cr Nr Detroit, OR.	31	28	31	30	31	30	31	31	30	31	30	31
2011	14180300	Blowout Creek Near Detroit, OR	31	28	31	30	31	30	31	31	30	31	30	31
2011	14182500	Little North Santiam River Near Mehama, OR	31	28	31	30	31	30	31	31	30	31	30	31
2011	14185000	South Santiam River Below Cascadia, OR	31	28	31	30	31	30	31	31	30	31	30	31
2011	14185800	Middle Santiam R Near Cascadia, OR	31	28	31	30	31	30	31	31	30	31	30	31
2011	14185900	Quartzville Creek Near Cascadia, OR	31	28	31	30	31	30	31	31	30	31	30	31
2011	14186200	Middle Santiam R Blw Green Peter Dam Nr Foster, OR	31	28	31	30	31	30	31	31	30	31	30	31
2011	BAT12	Battle Creek at Lone Oak Rd.	29	28	31	25	31	30	31	28	30	27	30	31
2011	BAT3	Battle Creek at Commercial Ave.	29	28	31	30	31	30	31	31	30	27	30	31
2011	CLK1	Clark Creek at Bush Park	29	28	31	28	31	30	31	30	29	28	29	27

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2011	CLK12	Clark Creek at Ewald Ave.	29	28	31	28	31	30	31	31	30	28	30	31
2011	GLE12	Glenn Creek at Hidden Valley Rd.	31	28	31	20	30	29	26	31	30	28	30	31
2011	GLE3	Glenn Creek at Wallace Rd.	31	28	24	28	30	29		29	30	28	30	31
2011	MIC12	Mill Creek at Turner Rd.	28	28	31	26	31	26	26	31	28	28	30	31
2011	MIC3	Mill Creek at North Salem High School	31	28	31	25	31	30	31	28	30	27	30	31
2011	PRI12	East Fork of Pringle Creek at Trelstad Ave.					27	29	29	31	30	28	30	31
2011	PRI3	Pringle Creek at Pringle Park	29	28	31	28	31	30	31	31	30	28	30	31
2011	WNF-008	Boulder_Creek-mouth_LTWT							31	31	29			
2011	WNF-014	CanyonLower_LTWT								29	19			
2011	WNF-015	CanyonUpper_LTWT								29	19			
2011	WNF-074	MooseLower_LTWT								28	17			
2011	WNF-075	MooseMid								28	18			
2011	WNF-076	MooseUpper_LTWT								28	18			
2011	WNF-081	North_Santiam_River-lower-USGS_LTWT							31	31	29			
2011	WNF-084	Owl Ck Upper								29	19			
2011	WNF-108	Sheep_LTWT								28	19			
2011	WNF-115	So Santiam lower (below Falls Ck)								28	19			
2011	WNF-116	SodaFork_LTWT								28	18			
2011	WNF-117	SouthSantiamUpper								20				
2011	WNF-123	Trout_LTWT								28	18			
2011	WNF-125	Two Girls Upper								29	19			
2011	WNF-126	TwoGirlsLow								17				
2011	WNF-156	Red Creek-lo Rd2246X							31	31	30			

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2012	14178000	No Santiam R Blw Boulder Crk, Nr Detroit, OR	31	29	31	30	31	30	31	31	30	31	30	31
2012	14179000	Breitenbush R Abv French Cr Nr Detroit, OR.	31	29	31	30	31	30	31	31	30	31	30	31
2012	14180300	Blowout Creek Near Detroit, OR	31	29	31	30	31	30	31	31	30	31	30	31
2012	14182500	Little North Santiam River Near Mehama, OR	31	29	31	30	31	30	31	31	30	31	30	31
2012	14185000	South Santiam River Below Cascadia, OR	31	29	31	30	31	30	31	31	30	31	30	31
2012	14185800	Middle Santiam R Near Cascadia, OR	31	29	31	30	31	30	31	31	30	31	30	31
2012	14185900	Quartzville Creek Near Cascadia, OR	31	29	31	30	31	30	31	31	30	31	30	31
2012	14186200	Middle Santiam R Blw Green Peter Dam Nr Foster, OR	31	29	31	30	31	30	31	31	30	31	30	31
2012	BAT12	Battle Creek at Lone Oak Rd.	31	29	31	26	31	30	30	31	27	23	30	31
2012	BAT3	Battle Creek at Commercial Ave.	31	29	31	26	30	22	31	31	30	23	30	31
2012	CLK1	Clark Creek at Bush Park	31	29	29	26	31	30	31	29	30	28	30	31
2012	CLK12	Clark Creek at Ewald Ave.	31	29	31	25	27	30	31	31	30	1	25	31
2012	GLE12	Glenn Creek at Hidden Valley Rd.	31	29	31	25	31	27	29	31	29	28	30	31
2012	GLE3	Glenn Creek at Wallace Rd.	31	29	29	25	31	30	31	25	30	23	30	31
2012	MIC12	Mill Creek at Turner Rd.	31	29	31	26	31	30	31	27	26	27	30	31
2012	MIC3	Mill Creek at North Salem High School	30	29	31	25	31	30	31	22	30	28	30	31
2012	PRI12	East Fork of Pringle Creek at Trelstad Ave.	31	29	31	26	31	30	22	31	28	23	30	31
2012	PRI3	Pringle Creek at Pringle Park	31	29	31	26	26	13	24	24	26	23	10	25
2012	WNF-008	Boulder_Creek-mouth_LTWT							27	31	30			
2012	WNF-014	CanyonLower_LTWT							13	31	10			
2012	WNF-015	CanyonUpper_LTWT							13	31	10			

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2012	WNF-074	MooseLower_LTWT							13	31	10			
2012	WNF-076	MooseUpper_LTWT							13	31	10			
2012	WNF-081	North_Santiam_River-lower-USGS_LTWT						1	31	31	30			
2012	WNF-082	North_Santiam_River-mid-RiversideCG_LTWT							27	31	30			
2012	WNF-084	Owl Ck Upper							13	31	10			
2012	WNF-108	Sheep_LTWT							13	31	10			
2012	WNF-116	SodaFork_LTWT							13	31	10			
2012	WNF-117	SouthSantiamUpper							13	31	10			
2012	WNF-123	Trout_LTWT							13	31	10			
2012	WNF-126	TwoGirlsLow							13	31	10			
2012	WNF-143	Marion Creek-lo abv Hwy22X-LTWT							27	31	30			
2013	14178000	No Santiam R Blw Boulder Crk, Nr Detroit, OR	31	28	31	30	31	30	31	31	30	31	30	31
2013	14179000	Breitenbush R Abv French Cr Nr Detroit, OR.	31	28	31	30	31	30	31	31	30	31	30	31
2013	14180300	Blowout Creek Near Detroit, OR	31	28	31	30	31	30	31	31	30	31	30	31
2013	14182500	Little North Santiam River Near Mehama, OR	31	28	31	30	31	30	31	31	30	31	30	31
2013	14185000	South Santiam River Below Cascadia, OR	31	28	31	30	31	30	31	31	30	31	30	31
2013	14185800	Middle Santiam R Near Cascadia, OR	31	28	31	30	31	30	31	31	30	31	30	31
2013	14185900	Quartzville Creek Near Cascadia, OR	31	28	31	30	31	30	31	31	30	31	30	31
2013	14186200	Middle Santiam R Blw Green Peter Dam Nr Foster, OR	31	28	31	30	31	30	31	31	30	31	30	31
2013	BAT12	Battle Creek at Lone Oak Rd.	31	28	31	27	30	27	31	6		23	30	28
2013	BAT3	Battle Creek at Commercial Ave.	31	28	29	27	31	30	31	31	30	28	30	31

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2013	CGT1	Claggett Creek at Mainline Dr NE					30	30	31	31	30	16		
2013	CLK1	Clark Creek at Bush Park	31	28	31	28	31	30	31	31	30	21		
2013	CLK12	Clark Creek at Ewald Ave.	31	28	31	28	31	30	31	31	30	28	30	31
2013	CRO1	Croisan Creek at Courthouse Athletic Club					30	30	31	31	30	16		
2013	CRO10	Croisan Creek at Ballantyne Rd S					30	30	31	31	30	16		
2013	GIB1	Gibson Creek at Wallace Rd NW					30	30	31	31	30	16		
2013	GIB15	Gibson Creek at Brush College Rd NW					30	30	31	31	30	16		
2013	GLE12	Glenn Creek at Hidden Valley Rd.	31	28	31	24	31	30	31	31	29	28	30	31
2013	GLE3	Glenn Creek at Wallace Rd.	31	28	31	24	31	17	31	31	30	28	30	31
2013	MIC12	Mill Creek at Turner Rd.	30	28	30	22	31	28	31	31	30	28	30	31
2013	MIC3	Mill Creek at North Salem High School	29	28	31	21	26	30	31	31	30	29	30	31
2013	MRA1	Mill Race at High St SE					30	30	31	31	30	16		
2013	MRA10	Mill Race at Mill Race Park					30	30	31	31	30	16		
2013	PRI12	East Fork of Pringle Creek at Trelstad Ave.	31	28	31	27	31	29	31	31	25	17	30	31
2013	PRI3	Pringle Creek at Pringle Park	29	22	4			30	31	31	30	27	30	31
2013	SHE1	Shelton Ditch at Church St SE					30	30	31	31	30	16		
2013	SHE10	Shelton Ditch at State Printing Office					30	30	31	31	30	16		
2013	WNF-008	Boulder_Creek-mouth_LTWT						2	31	31	30			
2013	WNF-014	CanyonLower_LTWT						6	31	31	19			
2013	WNF-076	MooseUpper_LTWT							31	31	19			
2013	WNF-081	North_Santiam_River-lower-USGS_LTWT						2	31	31	30			
2013	WNF-082	North_Santiam_River-mid-RiversideCG_LTWT						2	31	31	29			

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2013	WNF-084	Owl Ck Upper							31	31	10			
2013	WNF-116	SodaFork_LTWT							31	31	30	17		
2013	WNF-117	SouthSantiamUpper							31	31	18			
2013	WNF-123	Trout_LTWT							31	31	18			
2013	WNF-126	TwoGirlsLow							31	31	18			
2013	WNF-143	Marion Creek-lo abv Hwy22X-LTWT						2	31	31	30			
2014	14178000	No Santiam R Blw Boulder Crk, Nr Detroit, OR	31	28	31	30	31	30	31	31	30	31	30	31
2014	14179000	Breitenbush R Abv French Cr Nr Detroit, OR.	31	28	31	30	31	30	31	31	30	31	30	31
2014	14180300	Blowout Creek Near Detroit, OR	31	28	31	30	31	30	31	31	30	31	30	31
2014	14182500	Little North Santiam River Near Mehama, OR	31	28	31	30	31	30	30	31	30	31	30	31
2014	14185000	South Santiam River Below Cascadia, OR	31	28	31	30	31	30	31	31	30	31	30	31
2014	14185800	Middle Santiam R Near Cascadia, OR	31	28	31	30	31	30	31	31	30	31	30	31
2014	14185900	Quartzville Creek Near Cascadia, OR	31	28	31	30	31	30	31	31	30	31	30	31
2014	14186200	Middle Santiam R Blw Green Peter Dam Nr Foster, OR	31	28	31	30	31	30	31	31	30	31	30	31
2014	BAT12	Battle Creek at Lone Oak Rd.	31	4	14	30	31	25	30	31	30	31	30	27
2014	BAT3	Battle Creek at Commercial Ave.	31	4	14	28	31	30	31	31	30	31	30	27
2014	CGT1	Claggett Creek at Mainline Dr NE					30	30	31	31	30	16		
2014	CLK1	Clark Creek at Bush Park		1	31	26	31	25	31	31	30	31	27	31
2014	CLK12	Clark Creek at Ewald Ave.	31	28	31	26	31	23	31	31	30	31	27	31
2014	CRO1	Croisan Creek at Courthouse Athletic Club					30	30	31	31	30	16		
2014	CRO10	Croisan Creek at Ballantyne Rd S					30	30	31	31	30	16		
2014	GIB1	Gibson Creek at Wallace Rd NW					30	30	31	31	30	16		

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2014	GIB15	Gibson Creek at Brush College Rd NW					30	30	31	31	30	16		
2014	GLE12	Glenn Creek at Hidden Valley Rd.	31	28	31	28	30	17	29		10	29	30	31
2014	GLE3	Glenn Creek at Wallace Rd.	27	28	31	28	29	27	31	31	30	29	30	31
2014	MHNF-007	060600006_Canyon_Creek							15	31	30	31	5	
2014	MIC12	Mill Creek at Turner Rd.	31	27	27	3	25	27	31	25	13	31	30	31
2014	MIC3	Mill Creek at North Salem High School	31	27	31	26	31	23	31	25	13	31	30	31
2014	MRA1	Mill Race at High St SE					30	30	31	31	30	16		
2014	MRA10	Mill Race at Mill Race Park					30	30	31	31	30	16		
2014	PRI12	East Fork of Pringle Creek at Trelstad Ave.	31	26	31	26	31	26	31	31	30	31	30	1
2014	PRI3	Pringle Creek at Pringle Park	31	28	31	26	31	22	31	31	30	31	27	31
2014	SHE10	Shelton Ditch at State Printing Office					30	30	31	31	30	16		
2014	WNF-008	Boulder_Creek-mouth_LTWT						15	31	31	30			
2014	WNF-014	CanyonLower_LTWT							31	31	1			
2014	WNF-074	MooseLower_LTWT							31	31	1			
2014	WNF-076	MooseUpper_LTWT							31	31	1			
2014	WNF-081	North_Santiam_River-lower-USGS_LTWT						15	31	31	30			
2014	WNF-082	North_Santiam_River-mid-RiversideCG_LTWT						10	31	31	30			
2014	WNF-085	Owl_Lower_LTWT							31	31	1			
2014	WNF-091	Pyramid Ck							29	31	2			
2014	WNF-108	Sheep_LTWT							30	31	1			
2014	WNF-115	So Santiam lower (below Falls Ck)							28					
2014	WNF-116	SodaFork_LTWT							30	31	1			
2014	WNF-117	SouthSantiamUpper							30	31	1			

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2014	WNF-126	TwoGirlsLow							31	31	1			
2014	WNF-143	Marion Creek-lo abv Hwy22X-LTWT						10	31	31	30			
2014	WNF-162	Whitewater Creek-mid-Rd2243-440X						10	31	31	30			
2015	14178000	No Santiam R Blw Boulder Crk, Nr Detroit, OR	31	28	31	30	31	30	31	31	30	31	30	31
2015	14179000	Breitenbush R Abv French Cr Nr Detroit, OR.	31	28	31	30	31	30	31	31	30	31	30	31
2015	14180300	Blowout Creek Near Detroit, OR	31	28	31	30	31	30	31	31	30	31	30	31
2015	14182500	Little North Santiam River Near Mehama, OR	31	28	31	30	31	30	31	31	30	31	30	6
2015	14185000	South Santiam River Below Cascadia, OR	31	28	31	30	31	30	31	31	30	31	30	31
2015	14185800	Middle Santiam R Near Cascadia, OR	31	28	31	30	31	30	31	31	30	31	30	31
2015	14185900	Quartzville Creek Near Cascadia, OR	31	28	31	30	31	30	31	31	30	31	30	31
2015	14186200	Middle Santiam R Blw Green Peter Dam Nr Foster, OR	31	28	31	30	31	30	31	31	30	31	30	31
2015	BAT12	Battle Creek at Lone Oak Rd.	31	28	31	27		25	31	31	30	28	28	31
2015	BAT3	Battle Creek at Commercial Ave.	31	28	31	30	26		30	31	30	28	28	31
2015	CGT5	Claggett Creek at Hawthorne St NE					30	30	31	31	30	31	29	31
2015	CLK1	Clark Creek at Bush Park	31	28	31	30	31	30	31	31	30	28	30	31
2015	CLK12	Clark Creek at Ewald Ave.	31	28	31	30	31	30	31	31	30	21		8
2015	CRO1	Croisan Creek at Courthouse Athletic Club					30	30	31	31	30	12		
2015	CRO10	Croisan Creek at Ballantyne Rd S					30	30	31	31	30	12		
2015	GIB1	Gibson Creek at Wallace Rd NW					30	30	31	31	30	12		
2015	GIB15	Gibson Creek at Brush College Rd NW					30	30	31	31	30	12		
2015	GLE12	Glenn Creek at Hidden Valley Rd.	31	28	31	30	31	30	6			2	30	31

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2015	GLE3	Glenn Creek at Wallace Rd.	31	28	31	30	31	30	31	31	30	27	30	31
2015	MIC12	Mill Creek at Turner Rd.	31	28	31	30	31	30	31	31	30	29	29	31
2015	MIC3	Mill Creek at North Salem High School	31	28	31	30	31	30	31	31	30	28	30	31
2015	MRA1	Mill Race at High St SE					30	30	31	31	30	12		
2015	MRA10	Mill Race at Mill Race Park					30	30	31	31	30	13		
2015	PRI12	East Fork of Pringle Creek at Trelstad Ave.	2	28	22	30	30	28	31	28	30	27	25	31
2015	PRI3	Pringle Creek at Pringle Park	31	28	31	30	31	30	31	28	30	28	30	31
2015	WLN-MA	Waln Creek at Mitigation Area					30	30	31	31	30	14		
2015	WNF-008	Boulder_Creek-mouth_LTWT					10	30	31	31	30			
2015	WNF-015	CanyonUpper_LTWT						12	31	24				
2015	WNF-076	MooseUpper_LTWT						12	31	24				
2015	WNF-081	North_Santiam_River-lower-USGS_LTWT					10	30	31	31	30			
2015	WNF-082	North_Santiam_River-mid-RiversideCG_LTWT					9	30	31	31				
2015	WNF-085	Owl_Lower_LTWT						12	31	31	8			
2015	WNF-091	Pyramid Ck						8	31	31	8			
2015	WNF-108	Sheep_LTWT						7	31	31	1			
2015	WNF-115	So Santiam lower (below Falls Ck)						12	31	31	13			
2015	WNF-116	SodaFork_LTWT						8	31	31	1			
2015	WNF-117	SouthSantiamUpper						12	31	31	13			
2015	WNF-126	TwoGirlsLow						12	31	24				
2015	WNF-143	Marion Creek-lo abv Hwy22X-LTWT					11	30	31	31	30			
2016	14178000	No Santiam R Blw Boulder Crk, Nr Detroit, OR	31	29	31	30	31	30	31	31	30	31	30	31

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2016	14179000	Breitenbush R Abv French Cr Nr Detroit, OR.	31	29	29	30	31	30	31	31	30	31	30	31
2016	14180300	Blowout Creek Near Detroit, OR	31	29	31	30	31	30	31	31	30	31	30	31
2016	14185000	South Santiam River Below Cascadia, OR	31	29	31	30	31	30	31	31	30	31	30	31
2016	14185800	Middle Santiam R Near Cascadia, OR	31	29	31	30	31	30	31	31	30	31	30	31
2016	14185900	Quartzville Creek Near Cascadia, OR	31	29	31	30	31	30	31	31	30	31	30	31
2016	14186200	Middle Santiam R Blw Green Peter Dam Nr Foster, OR	31	29	31	30	31	30	31	31	30	31	30	31
2016	BAT12	Battle Creek at Lone Oak Rd.	31	29	31	28	31	30	31	31	30	23	30	31
2016	BAT3	Battle Creek at Commercial Ave.	31	29	31	28	31	30	31	31	30	29	30	31
2016	CGT1	Claggett Creek at Mainline Dr NE					30	30	31	29	30	1		
2016	CGT5	Claggett Creek at Hawthorne St NE	31	29	28		30	30	25		28	1		
2016	CLK1	Clark Creek at Bush Park	31	29	31	23	31	30	31	31	30	29	29	31
2016	CLK12	Clark Creek at Ewald Ave.	31	29	31	28	31	30	31	31	30	29	30	31
2016	CRO1	Croisan Creek at Courthouse Athletic Club					30	30	31	29	30	1		
2016	CRO10	Croisan Creek at Ballantyne Rd S					30	30	31	29	30	1		
2016	GIB1	Gibson Creek at Wallace Rd NW					30	30	31	29	30			
2016	GIB15	Gibson Creek at Brush College Rd NW					30	30	31	29	30	1		
2016	GLE12	Glenn Creek at Hidden Valley Rd.	31	29	31	29	31	30	31	9		27	30	31
2016	GLE3	Glenn Creek at Wallace Rd.	31	18	31	29	31	30	31	31	30	26	30	31
2016	MFMOLALLA	Monitoring location takes place in the upper Molalla River watershed on the middle fork roughly 6.5 miles above confluence with South Fork Molalla river on Weyerhaeuser ownership.						30	31	31	30	31	30	31
2016	MIC12	Mill Creek at Turner Rd.	31	29	31	28	31	30	31	31	30	26	30	31

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2016	MIC3	Mill Creek at North Salem High School	31	29	31	23	31	30	31	31	30	29	30	31
2016	MRA1	Mill Race at High St SE					30	30	31	29	30	1		
2016	MRA10	Mill Race at Mill Race Park					30	30	31	29	30	1		
2016	PRI12	East Fork of Pringle Creek at Trelstad Ave.	28	29	31	23	31	30	31	31	30	26	30	31
2016	PRI3	Pringle Creek at Pringle Park	31	29	31	23	31	30	31	31	30	29	30	31
2016	SHE1	Shelton Ditch at Church St SE					30	30	31	29	30	1		
2016	SHE10	Shelton Ditch at State Printing Office					30	30	31	29	30	1		
2016	WLN-MA	Waln Creek at Mitigation Area					30	30	31	31	30	1		
2016	WNF-008	Boulder_Creek-mouth_LTWT						29	31	31	30			
2016	WNF-013	Canal Creek							11	31	30	3		
2016	WNF-014	CanyonLower_LTWT							12	31	14			
2016	WNF-015	CanyonUpper_LTWT							12	31	30	2		
2016	WNF-076	MooseUpper_LTWT							12	31	30	2		
2016	WNF-081	North_Santiam_River-lower-USGS_LTWT						29	31	31	30			
2016	WNF-082	North_Santiam_River-mid-RiversideCG_LTWT						29	31	31	30			
2016	WNF-085	Owl_Lower_LTWT							12	31	30	2		
2016	WNF-094	Quartzville Creek							11	31	30	3		
2016	WNF-108	Sheep_LTWT							12	31	30	3		
2016	WNF-115	So Santiam lower (below Falls Ck)							12	31	30	2		
2016	WNF-116	SodaFork_LTWT							12	31	30	3		
2016	WNF-117	SouthSantiamUpper							12	31	30	3		
2016	WNF-126	TwoGirlsLow							12	31	30	2		
2016	WNF-142	Mackey Creek-lo-abv Hwy22X						29	31	31	30			

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2016	WNF-143	Marion Creek-lo abv Hwy22X-LTWT						29	31	31	30			
2017	14178000	No Santiam R Blw Boulder Crk, Nr Detroit, OR	29	28	31	30	31	30	31	31	30	31	30	31
2017	14179000	Breitenbush R Abv French Cr Nr Detroit, OR.	31	16	20	27	16	29	31	26	27	31	30	31
2017	14180300	Blowout Creek Near Detroit, OR	31	28	31	30	31	30	31	31	30	31	30	31
2017	14185000	South Santiam River Below Cascadia, OR	31	28	31	30	31	30	31	31	30	31	30	31
2017	14185800	Middle Santiam R Near Cascadia, OR	31	28	31	30	31	30	31	31	30	31	30	31
2017	14185900	Quartzville Creek Near Cascadia, OR	31	28	31	30	31	30	31	31	30	31	30	31
2017	14186200	Middle Santiam R Blw Green Peter Dam Nr Foster, OR	31	28	31	30	31	30	31	31	30	31	30	31
2017	23775-ORDEQ	Hamilton Creek at Belinger Scale Road at golf course								30	30	4		
2017	23777-ORDEQ	McDowell Creek at 5.7 miles up McDowell Creek Road								30	30	4		
2017	40069-ORDEQ	McDowell Creek at Berlin Road								30	30	5		
2017	40070-ORDEQ	Hamilton Creek at Upper Berlin Rd								30	30	4		
2017	BAT12	Battle Creek at Lone Oak Rd.	31	28	31	30	31	30	31	31	29	25	30	15
2017	BAT3	Battle Creek at Commercial Ave.	31	28	31	30	31	30	31	31	29			
2017	CGT1	Claggett Creek at Mainline Dr NE					30	30	31	31	30	4		
2017	CGT5	Claggett Creek at Hawthorne St NE					30	30	19	17	30	4		
2017	CLK1	Clark Creek at Bush Park	29	5	31	30	31	30	31	31	30	27	5	18
2017	CLK12	Clark Creek at Ewald Ave.	31	28	31	30	31	30	31	31	30	28	30	31
2017	CRO1	Croisan Creek at Courthouse Athletic Club					30	30	31	31	30	4		
2017	CRO10	Croisan Creek at Ballantyne Rd S					30	30	22		12	4		
2017	GIB1	Gibson Creek at Wallace Rd NW					30	30	31	31	30	4		

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2017	GLE12	Glenn Creek at Hidden Valley Rd.	31	28	31	30	31	30	26			26	30	31
2017	GLE3	Glenn Creek at Wallace Rd.	31	28	31	30	31	30	31	31	30	27	30	31
2017	MFMOLALLA	Monitoring location takes place in the upper Molalla River watershed on the middle fork roughly 6.5 miles above confluence with South Fork Molalla river on Weyerhaeuser ownership.	31	28	31	30	31	59*	60*	60*	59*	31	30	31
2017	MIC12	Mill Creek at Turner Rd.	31	28	31	30	30	30	31	31	30	28	30	31
2017	MIC3	Mill Creek at North Salem High School	31	28	31	30	31	30	31	31	30	28	30	31
2017	MRA1	Mill Race at High St SE					30	30	21	7	30	4		
2017	MRA10	Mill Race at Mill Race Park					30	30	31	31	30	4		
2017	PRI12	East Fork of Pringle Creek at Trelstad Ave.	31	28	31	30	31	30	31	31	30	28	30	31
2017	PRI3	Pringle Creek at Pringle Park	31	28	31	30	31	30	31	31	30	27	30	31
2017	SHE1	Shelton Ditch at Church St SE					30	30	31	31	30	4		
2017	SHE10	Shelton Ditch at State Printing Office					29	30	31	31	30	4		
2017	WLN-MA	Waln Creek at Mitigation Area					30	30	31	31	30	4		
2017	WNF-013	Canal Creek						1	31	31	13			
2017	WNF-015	CanyonUpper_LTWT						2	31	31	13			
2017	WNF-074	MooseLower_LTWT						1	31	31	11			
2017	WNF-082	North_Santiam_River-mid-RiversideCG_LTWT						1	31	31	27			
2017	WNF-085	Owl_Lower_LTWT						2	31	31	13			
2017	WNF-094	Quartzville Creek						1	31	31	13			
2017	WNF-108	Sheep_LTWT						2	31	31	11			
2017	WNF-115	So Santiam lower (below Falls Ck)						2	31	31	11			
2017	WNF-116	SodaFork_LTWT						2	31	31	11			

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2017	WNF-117	SouthSantiamUpper						2	31	31	11			
2017	WNF-126	TwoGirlsLow						2	31	31	13			
2017	WNF-142	Mackey Creek-lo-abv Hwy22X							31	31	26			
2017	WNF-143	Marion Creek-lo abv Hwy22X-LTWT						1	31	31	27			
2018	14178000	No Santiam R Blw Boulder Crk, Nr Detroit, OR	31	28	31	30	31	30	31	31	30	31	30	31
2018	14179000	Breitenbush R Abv French Cr Nr Detroit, OR.	31	28	31	30	31	30	31	31	30	31	30	31
2018	14180300	Blowout Creek Near Detroit, OR	31	28	31	30	31	30	31	31	30	31	30	31
2018	14185000	South Santiam River Below Cascadia, OR	31	28	31	30	31	30	31	31	30	31	30	31
2018	14185800	Middle Santiam R Near Cascadia, OR	31	28	31	30	31	30	31	31	30	31	30	31
2018	14185900	Quartzville Creek Near Cascadia, OR	31	28	31	30	31	30	31	31	30	31	30	31
2018	14186200	Middle Santiam R Blw Green Peter Dam Nr Foster, OR	31	28	31	30	31	30	31	31	23	30	30	31
2018	23774-ORDEQ	Hamilton Creek at Upper Berlin Road near Berlin Ridge Road						22	31	31	18			
2018	23775-ORDEQ	Hamilton Creek at Belinger Scale Road at golf course						22	31	31	18			
2018	23777-ORDEQ	McDowell Creek at 5.7 miles up McDowell Creek Road						22	31	31	18			
2018	37229-ORDEQ	Bear Branch at Huntley Rd						5	31	31	30	11		
2018	BAT12	Battle Creek at Lone Oak Rd.	30	28	30	30	31	30	31	31	30	29	29	31
2018	BAT3	Battle Creek at Commercial Ave.	30	24	30	29	29	30	31	31	30	29	29	31
2018	CGT1	Claggett Creek at Mainline Dr NE					30	30	31	31	30	1		
2018	CGT5	Claggett Creek at Hawthorne St NE					30	30	31	31	30	1		
2018	CLK1	Clark Creek at Bush Park	30	28	30	30	31	30	31	31	30	29	29	31
2018	CLK12	Clark Creek at Ewald Ave.	30	28	30	26	17	30	31	31	29	28	29	31

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2018	CRO1	Croisan Creek at Courthouse Athletic Club					30	30	31	31	30	1		
2018	CRO10	Croisan Creek at Ballantyne Rd S					30	30	31	31	30	1		
2018	GIB1	Gibson Creek at Wallace Rd NW					30	30	31	31	30			
2018	GIB15	Gibson Creek at Brush College Rd NW					30	30	31	31	30	1		
2018	GLE12	Glenn Creek at Hidden Valley Rd.	30	28	30	30	31	30	10			12	29	31
2018	GLE3	Glenn Creek at Wallace Rd.	30	28	30	30	31	30	31	31	30	28	29	31
2018	MFMOLALLA	Monitoring location takes place in the upper Molalla River watershed on the middle fork roughly 6.5 miles above confluence with South Fork Molalla river on Weyerhaeuser ownership.	31	28	31	30	31	30	31	31	30			
2018	MIC12	Mill Creek at Turner Rd.	30	28	30	30	31	30	31	31	30	29	29	31
2018	MIC3	Mill Creek at North Salem High School	30	28	30	30	31	30	31	31	30	28	29	31
2018	MRA1	Mill Race at High St SE					30	30	31	31	30	1		
2018	MRA10	Mill Race at Mill Race Park					30	30	31	31	30	1		
2018	PRI12	East Fork of Pringle Creek at Trelstad Ave.	30	28	30	30	31	30	31	31	30	29	29	31
2018	PRI3	Pringle Creek at Pringle Park	30	28	30	30	31	30	31	31	30	28	29	31
2018	SHE1	Shelton Ditch at Church St SE					30	30	31	31	30	1		
2018	SHE10	Shelton Ditch at State Printing Office					30	30	31	31	30	1		
2018	WLN1	Waln Creek at Wiltsey Rd SE					30	30	31	31	30	1		
2018	WNF-013	Canal Creek						3	31	31	5			
2018	WNF-082	North_Santiam_River-mid-RiversideCG_LTWT						24	31	31	30			
2018	WNF-091	Pyramid Ck							26	27				
2018	WNF-134	Bugaboo Creek-lo Rd2234-290X						8	31	31	30			

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2018	WNF-143	Marion Creek-lo abv Hwy22X-LTWT						24	31	31	30			
2018	WNF-148	Minto Creek-Hwy22X						17	31	31	30			
2018	WNF-149	Minto Creek-mid Rd2253X						17	31	31	30			
2018	WNF-159	Straight Creek-up-Rd1164X						2	31	31	30			
2019	14178000	No Santiam R Blw Boulder Crk, Nr Detroit, OR	31	28	31	30	31	30	31	31	30	31	30	31
2019	14179000	Breitenbush R Abv French Cr Nr Detroit, OR.	31	28	31	30	31	30	31	31	30	31	30	31
2019	14180300	Blowout Creek Near Detroit, OR	31	28	31	30	31	30	31	31	30	31	30	31
2019	14185000	South Santiam River Below Cascadia, OR	31	28	31	30	31	30	31	31	30	31	30	31
2019	14185800	Middle Santiam R Near Cascadia, OR	31	28	31	30	31	30	31	31	30	31	30	31
2019	14185900	Quartzville Creek Near Cascadia, OR	31	28	31	30	31	30	31	31	30	31	30	31
2019	14186200	Middle Santiam R Blw Green Peter Dam Nr Foster, OR	31	28	31	30	31	30	31	31	30	31	30	31
2019	14202000	Pudding River At Aurora, OR				28	31	30	31	31	30	31	30	31
2019	23774-ORDEQ	Hamilton Creek at Upper Berlin Road near Berlin Ridge Road					8	30	31	31	30			
2019	23775-ORDEQ	Hamilton Creek at Belinger Scale Road at golf course					7	30	31	31	30	8		
2019	23777-ORDEQ	McDowell Creek at 5.7 miles up McDowell Creek Road					8	30	31	31	30	9		
2019	40069-ORDEQ	McDowell Creek at Berlin Road							14	31	30			
2019	40070-ORDEQ	Hamilton Creek at Upper Berlin Rd					8	30	31	31	30			
2019	40791-ORDEQ	McDowell Ck at Speasl Rd								19	30	9		
2019	40792-ORDEQ	Hamilton Ck at 1170m upstream of Bellinger Scale Rd							23	31	30	8		
2019	BAT12	Battle Creek at Lone Oak Rd.	31	28	30	30	31	28	31	31	30	29	29	31

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2019	BAT3	Battle Creek at Commercial Ave.	31	28	30	25	2	28	26	31	30	29	29	31
2019	CGT1	Claggett Creek at Mainline Dr NE					30	30	31	31	30	10		
2019	CGT5	Claggett Creek at Hawthorne St NE					30	30	31	31	24	10		
2019	CLK1	Clark Creek at Bush Park	31	28	30	21	31	28	31	31	30	31	27	31
2019	CLK12	Clark Creek at Ewald Ave.	31	28	30	30	31	28	31	31	30	31	27	31
2019	CRO1	Croisan Creek at Courthouse Athletic Club					30	30	31	31	30	10		
2019	CRO10	Croisan Creek at Ballantyne Rd S					30	30	31	31	30	10		
2019	GIB1	Gibson Creek at Wallace Rd NW					30	30	31	31	30	10		
2019	GIB15	Gibson Creek at Brush College Rd NW					30	30	31	31	30	10		
2019	GLE12	Glenn Creek at Hidden Valley Rd.	31	28	30	30	29	16	1		19	29	29	30
2019	GLE3	Glenn Creek at Wallace Rd.	31	28	30	30	29	16	31	31	30	29	29	31
2019	MIC12	Mill Creek at Turner Rd.	31	28	30	30	31	28	31	31	30	29	29	31
2019	MIC3	Mill Creek at North Salem High School	31	28	30	29	31	27	31	31	30	31	27	31
2019	MRA1	Mill Race at High St SE					30	30	31	31	30	10		
2019	MRA10	Mill Race at Mill Race Park					30	30	31	31	30	10		
2019	PRI12	East Fork of Pringle Creek at Trelstad Ave.	29	28	30	30	31	28	31	30	30	29	29	31
2019	PRI3	Pringle Creek at Pringle Park	31	28	30	30	31	28	31	31	30	31	27	31
2019	SHE1	Shelton Ditch at Church St SE					30	30	31	31	30	10		
2019	SHE10	Shelton Ditch at State Printing Office					30	30	31	31	30	10		
2019	WLN1	Waln Creek at Wiltsey Rd SE					30	30	31	31	30	10		
2019	WNF-008	Boulder_Creek-mouth_LTWT						24	31	31	30			
2019	WNF-013	Canal Creek						12	31	31	8			
2019	WNF-071	Middle Santiam	30	28	30	30	31	30	31	31	12			

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2019	WNF-082	North_Santiam_River-mid-RiversideCG_LTWT						16	31	31	30			
2019	WNF-091	Pyramid Ck						9	31	31	11			
2019	WNF-094	Quartzville Creek						12	31	31	8			
2019	WNF-157	Russel Creek-mouth						17	31	31	18			
2019	WNF-162	Whitewater Creek-mid-Rd2243-440X						23	31	31	18			
2020	10787-ORDEQ	Mcdowell Creek at Bench Mark 456					4	30	31	27	30	15		
2020	14178000	No Santiam R Blw Boulder Crk, Nr Detroit, OR	31	29	31	30	31	30	31	31	30	29	30	31
2020	14179000	Breitenbush R Abv French Cr Nr Detroit, OR.	31	29	31	30	31	30	31	31	30	31	30	31
2020	14180300	Blowout Creek Near Detroit, OR	31	29	31	30	31	30	31	31	30	31	30	31
2020	14185000	South Santiam River Below Cascadia, OR	31	29	31	30	31	30	31	31	30	31	30	31
2020	14185800	Middle Santiam R Near Cascadia, OR	31	29	31	30	31	30	31	31	30	31	30	31
2020	14185900	Quartzville Creek Near Cascadia, OR	31	29	31	30	31	30	31	31	30	31	30	31
2020	14186200	Middle Santiam R Blw Green Peter Dam Nr Foster, OR	31	29	31	30	31	30	31	31	30	31	30	31
2020	14202000	Pudding River At Aurora, OR	31	29	31	19								
2020	23774-ORDEQ	Hamilton Creek at Upper Berlin Road near Berlin Ridge Road					5	30	31	31	30	13		
2020	23775-ORDEQ	Hamilton Creek at Belinger Scale Road at golf course					3	30	31	31	30	15		
2020	23777-ORDEQ	McDowell Creek at 5.7 miles up McDowell Creek Road					4	30	31	31	30	13		
2020	40070-ORDEQ	Hamilton Creek at Upper Berlin Rd					5	30	31	31	30	13		
2020	40791-ORDEQ	McDowell Ck at Speasl Rd					4	30	31	31	30	13		
2020	40792-ORDEQ	Hamilton Ck at 1170m upstream of Bellinger Scale Rd					5	30	31	31	30	15		

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2020	BAT12	Battle Creek at Lone Oak Rd.	31	29	30	30	31	29						
2020	BAT3	Battle Creek at Commercial Ave.	31	10	13	30	31	29	31	31	30	29	30	30
2020	CLK1	Clark Creek at Bush Park	31	29	30	30	31	29	31	31	30	29	30	30
2020	CLK12	Clark Creek at Ewald Ave.	31	28	30	30	31	29						
2020	GLE12	Glenn Creek at Hidden Valley Rd.	31	29	30	30	31	29						12
2020	GLE3	Glenn Creek at Wallace Rd.	31	29	30	30	31	29				22	17	19
2020	MFMOLALLA	Monitoring location takes place in the upper Molalla River watershed on the middle fork roughly 6.5 miles above confluence with South Fork Molalla river on Weyerhaeuser ownership.						30	31	31	29			
2020	MIC12	Mill Creek at Turner Rd.	31	10	13	30	31	28	30	31	30	29	30	30
2020	MIC3	Mill Creek at North Salem High School	31	29	30	30	31	29						
2020	PRI12	East Fork of Pringle Creek at Trelstad Ave.	31	29	30	30	31	22	21	31	30	29	30	30
2020	PRI3	Pringle Creek at Pringle Park	31	29	30	30	31	29						

* Some stations have more daily maximum results than the number of days in the month due to multiple probes being deployed at the same location or due to duplicate entries in AWQMS. These data are not proposed to support the modeling so we did not investigate these specific situations further.

Appendix C Stream flow data summary

Table 44: Continuous flow measurements available from the USGS flow gaging stations in the Middle Willamette Subbasins.

Station ID	Station	Latitude/Longitude
14178000	No Santiam R Blw Boulder Crk, Nr Detroit, OR	44.70679/-122.1012
14178700	East Humbug Creek Near Detroit, OR	44.79901/-122.059
14179000	Breitenbush R Abv French Cr Nr Detroit, OR.	44.75262/-122.129
14179100	French Creek Near Detroit, OR	44.7604/-122.1684
14180300	Blowout Creek Near Detroit, OR	44.6529/-122.1309
14181750	Rock Creek Near Mill City, OR	44.71207/-122.4276
14182400	Little N Santiam R Blw Canyon Ck, Near Mehama, OR	44.79346/-122.4926
14182500	Little North Santiam River Near Mehama, OR	44.79151/-122.579
14185000	South Santiam River Below Cascadia, OR	44.39179/-122.4976
14185700	Middle Santiam River Near Upper Soda, OR.	44.51235/-122.2656
14185900	Quartzville Creek Near Cascadia, OR	44.54012/-122.4359
14187000	Wiley Creek Near Foster, OR	44.37235/-122.6231
14188610	Schafer Creek Near Lacomb, OR	44.61957/-122.4659
14188800	Thomas Creek Near Scio, OR	44.71207/-122.7701
14198400	Bull Creek Near Wilhoit, OR	44.9609/-122.385
14198500	Molalla R Ab Pc Nr Wilhoit, OR	45.00957/-122.4804
14199704	Nate Creek Tributary Near Colton, OR	45.20523/-122.412
14200000	Molalla River Near Canby, OR	45.24429/-122.6873
14200100	Drift Creek Near Silverton, OR	44.97681/-122.8301
14200300	Silver Creek At Silverton, OR	45.00929/-122.7887
14200400	Little Abiqua Creek Near Scotts Mills, OR	44.95568/-122.6284
14200700	Abiqua Creek At Silverton, OR	45.03145/-122.7908
14201300	Zollner Creek Near Mt Angel, OR	45.1004/-122.8218
14201340	Pudding River Near Woodburn, OR	45.15123/-122.8043
14201500	Butte Creek At Monitor, OR	45.10151/-122.7462
14202000	Pudding River At Aurora, OR	45.23318/-122.7501

Table 45: Instantaneous flow measurements from DEQ and othersin the Middle Willamette Subbasins.

Station ID	Station	Latitude/Longitude	Data Source
No Station ID	Canyon Creek	44.8016/-122.479	BLM
No Station ID	Elkhorn Creek	44.8028/-122.439	BLM
No Station ID	Sinker Creek	44.8093/-122.417	BLM
No Station ID	White Rock Creek		BLM
21834-ORDEQ	Roaring River	44.6303/-122.738	DEQ
23770-ORDEQ	Beaver Creek	44.6336/-122.855	DEQ
No Station ID	Neal Creek at Lulay Bridge near Hannah Covered Bridge		DEQ
No Station ID	North Fork Molalla		DEQ
No Station ID	SF Crabtree Creek		DEQ
AC1	Abiqua Creek	45.0327/-122.797	Marion SWCD
BC1	Butte Creek	45.1065/-122.751	Marion SWCD
DC1	Drift Creek	44.9766/-122.83	Marion SWCD
LPR1	Little Pudding River	45.0458/-122.895	Marion SWCD

Table 46: Summary of existing flow data in the Middle Willamette Subbasins. Columns Jan – Dec indicate the number of daily mean flow results in each month.

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1990	14178000	No Santiam R Blw Boulder Crk, Nr Detroit, OR	31	28	31	30	31	30	31	31	30	31	30	31
1990	14178700	East Humbug Creek Near Detroit, OR	31	28	31	30	31	30	31	31	30	31	30	31
1990	14182500	Little North Santiam River Near Mehama, OR	31	28	31	30	31	30	31	31	30	31	30	31
1990	14185000	South Santiam River Below Cascadia, OR	31	28	31	30	31	30	31	31	30	31	30	31
1990	14185700	Middle Santiam River Near Upper Soda, OR.	31	28	31	30	31	30	31	31	30	31	30	31
1990	14185900	Quartzville Creek Near Cascadia, OR	31	28	31	30	31	30	31	31	30	31	30	31
1990	14187000	Wiley Creek Near Foster, OR	31	28	31	30	31	30	31	31	30	31	30	31
1990	14198500	Molalla R Ab Pc Nr Wilhoit, OR	31	28	31	30	31	30	31	31	30	31	30	31
1991	14178000	No Santiam R Blw Boulder Crk, Nr Detroit, OR	31	28	31	30	31	30	31	31	30	31	30	31
1991	14178700	East Humbug Creek Near Detroit, OR	31	28	31	30	31	30	31	31	30	31	30	31
1991	14182500	Little North Santiam River Near Mehama, OR	31	28	31	30	31	30	31	31	30	31	30	31
1991	14185000	South Santiam River Below Cascadia, OR	31	28	31	30	31	30	31	31	30	31	30	31
1991	14185700	Middle Santiam River Near Upper Soda, OR.	31	28	31	30	31	30	31	31	30	31	30	31
1991	14185900	Quartzville Creek Near Cascadia, OR	31	28	31	30	31	30	31	31	30	31	30	31
1991	14187000	Wiley Creek Near Foster, OR	31	28	31	30	31	30	31	31	30	31	30	31
1991	14198500	Molalla R Ab Pc Nr Wilhoit, OR	31	28	31	30	31	30	31	31	30	31	30	31
1992	14178000	No Santiam R Blw Boulder Crk, Nr Detroit, OR	31	29	31	30	31	30	31	31	30	31	30	31
1992	14178700	East Humbug Creek Near Detroit, OR	31	29	31	30	31	30	31	31	30	31	30	31

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1992	14182500	Little North Santiam River Near Mehama, OR	31	29	31	30	31	30	31	31	30	31	30	31
1992	14185000	South Santiam River Below Cascadia, OR	31	29	31	30	31	30	31	31	30	31	30	31
1992	14185700	Middle Santiam River Near Upper Soda, OR.	31	29	31	30	31	30	31	31	30	31	30	31
1992	14185900	Quartzville Creek Near Cascadia, OR	31	29	31	30	31	30	31	31	30	31	30	31
1992	14187000	Wiley Creek Near Foster, OR	31	29	31	30	31	30	31	31	30	31	30	31
1992	14198500	Molalla R Ab Pc Nr Wilhoit, OR	31	29	31	30	31	30	31	31	30	31	30	31
1993	14178000	No Santiam R Blw Boulder Crk, Nr Detroit, OR	31	28	31	30	31	30	31	31	30	31	30	31
1993	14178700	East Humbug Creek Near Detroit, OR	31	28	31	30	31	30	31	31	30	31	30	31
1993	14182500	Little North Santiam River Near Mehama, OR	31	28	31	30	31	30	31	31	30	31	30	31
1993	14185000	South Santiam River Below Cascadia, OR	31	28	31	30	31	30	31	31	30	31	30	31
1993	14185700	Middle Santiam River Near Upper Soda, OR.	31	28	31	30	31	30	31	31	30	31	30	31
1993	14185900	Quartzville Creek Near Cascadia, OR	31	28	31	30	31	30	31	31	30	31	30	31
1993	14187000	Wiley Creek Near Foster, OR	31	28	31	30	31	30	31	31	30	31	30	31
1993	14188610	Schafer Creek Near Lacomb, OR							17	31	30	31	30	31
1993	14198400	Bull Creek Near Wilhoit, OR			1	30	31	30	31	31	30	31	30	31
1993	14198500	Molalla R Ab Pc Nr Wilhoit, OR	31	28	31	30	31	30	31	31	29			
1993	14200400	Little Abiqua Creek Near Scotts Mills, OR							31	31	30	31	30	31
1993	14201300	Zollner Creek Near Mt Angel, OR							31	31	30	31	30	31
1993	14202000	Pudding River At Aurora, OR						10	31	31	30	31	30	31
1994	14178000	No Santiam R Blw Boulder Crk, Nr Detroit, OR	31	28	31	30	31	30	31	31	30	31	30	31
1994	14178700	East Humbug Creek Near Detroit, OR	31	28	31	30	31	30	10					

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1994	14182500	Little North Santiam River Near Mehama, OR	31	28	31	30	31	30	31	31	30	31	30	31
1994	14185000	South Santiam River Below Cascadia, OR	31	28	31	30	31	30	31	31	30	31	30	31
1994	14185700	Middle Santiam River Near Upper Soda, OR.	31	28	31	30	31							
1994	14185900	Quartzville Creek Near Cascadia, OR	31	28	31	30	31	30	31	31	30	31	30	31
1994	14187000	Wiley Creek Near Foster, OR	31	28	31	30	31	30	31	31	30	31	30	31
1994	14188610	Schafer Creek Near Lacomb, OR	31	28	31	30	31	30	31	31	30	31	30	31
1994	14198400	Bull Creek Near Wilhoit, OR	31	28	31	30	31	30	31	31	30	31	30	31
1994	14200400	Little Abiqua Creek Near Scotts Mills, OR	31	28	31	30	31	30	31	31	30	31	30	31
1994	14201300	Zollner Creek Near Mt Angel, OR	31	28	31	30	31	30	31	31	30	31	30	31
1994	14202000	Pudding River At Aurora, OR	31	28	31	30	31	30	31	31	30	31	30	31
1995	14178000	No Santiam R Blw Boulder Crk, Nr Detroit, OR	31	28	31	30	31	30	31	31	30	31	30	31
1995	14182500	Little North Santiam River Near Mehama, OR	31	28	31	30	31	30	31	31	30	31	30	31
1995	14185000	South Santiam River Below Cascadia, OR	31	28	31	30	31	30	31	31	30	31	30	31
1995	14185900	Quartzville Creek Near Cascadia, OR	31	28	31	30	31	30	31	31	30	31	30	31
1995	14187000	Wiley Creek Near Foster, OR	31	28	31	30	31	30	31	31	30	31	30	31
1995	14188610	Schafer Creek Near Lacomb, OR	31	28	31	30	31	30	31	31	30	31	30	31
1995	14198400	Bull Creek Near Wilhoit, OR	31	28	31	30	31	30	31	31	30	31	30	31
1995	14200400	Little Abiqua Creek Near Scotts Mills, OR	31	28	31	30	31	30	31	31	30	31	30	31
1995	14201300	Zollner Creek Near Mt Angel, OR	31	28	31	30	31	30	31	31	30	31	30	31
1995	14202000	Pudding River At Aurora, OR	31	28	31	30	31	30	31	31	30	31	30	31
1996	14178000	No Santiam R Blw Boulder Crk, Nr Detroit, OR	31	29	31	30	31	30	31	31	30	31	30	31

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1996	14182500	Little North Santiam River Near Mehama, OR	31	29	31	30	31	30	31	31	30	31	30	31
1996	14185000	South Santiam River Below Cascadia, OR	31	29	31	30	31	30	31	31	30	31	30	31
1996	14185900	Quartzville Creek Near Cascadia, OR	31	29	31	30	31	30	31	31	30	31	30	31
1996	14187000	Wiley Creek Near Foster, OR	31	29	31	30	31	30	31	31	30	31	30	31
1996	14188610	Schafer Creek Near Lacomb, OR	31	29	31	30	31	30	31	31	30	31	30	31
1996	14198400	Bull Creek Near Wilhoit, OR	31	29	31	30	31	30	31	31	30	31	30	31
1996	14200400	Little Abiqua Creek Near Scotts Mills, OR	31	29	31	30	31	30	31	31	30	31	30	31
1996	14201300	Zollner Creek Near Mt Angel, OR	31	29	31	30	31	30	31	31	30	31	30	31
1996	14202000	Pudding River At Aurora, OR	31	29	31	30	31	30	31	31	30	31	30	31
1997	14178000	No Santiam R Blw Boulder Crk, Nr Detroit, OR	31	28	31	30	31	30	31	31	30	31	30	31
1997	14182500	Little North Santiam River Near Mehama, OR	31	28	31	30	31	30	31	31	30	31	30	31
1997	14185000	South Santiam River Below Cascadia, OR	31	28	31	30	31	30	31	31	30	31	30	31
1997	14185900	Quartzville Creek Near Cascadia, OR	31	28	31	30	31	30	31	31	30	31	30	31
1997	14187000	Wiley Creek Near Foster, OR	31	28	31	30	31	30	31	31	30	31	30	31
1997	14188610	Schafer Creek Near Lacomb, OR	31	28	31	30	31	30	31	31	30	31	30	31
1997	14198400	Bull Creek Near Wilhoit, OR	31	28	31	30	31	30	31	31	30	31	30	31
1997	14200400	Little Abiqua Creek Near Scotts Mills, OR	31	28	31	30	31	30	31	31	30	31	30	31
1997	14201300	Zollner Creek Near Mt Angel, OR	31	28	31	30	31	30	31	31	30	31	30	31
1997	14201340	Pudding River Near Woodburn, OR										31	30	31
1997	14202000	Pudding River At Aurora, OR	31	28	31	30	31	30	31	31	30			
1998	14178000	No Santiam R Blw Boulder Crk, Nr Detroit, OR	31	28	31	30	31	30	31	31	30	31	30	31
1998	14179000	Breitenbush R Abv French Cr Nr Detroit, OR.										31	30	31

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1998	14180300	Blowout Creek Near Detroit, OR										31	30	31
1998	14182500	Little North Santiam River Near Mehama, OR	31	28	31	30	31	30	31	31	30	31	30	31
1998	14185000	South Santiam River Below Cascadia, OR	31	28	31	30	31	30	31	31	30	31	30	31
1998	14185900	Quartzville Creek Near Cascadia, OR	31	28	31	30	31	30	31	31	30	31	30	31
1998	14187000	Wiley Creek Near Foster, OR	31	28	31	30	31	30	31	31	30	31	30	31
1998	14188610	Schafer Creek Near Lacomb, OR	31	28	31	30	31	30	31	31	30	31	30	31
1998	14198400	Bull Creek Near Wilhoit, OR	31	28	31	30	31	30	31	31	30	31	30	31
1998	14200400	Little Abiqua Creek Near Scotts Mills, OR	31	28	31	30	31	30	31	31	30	31	30	31
1998	14201300	Zollner Creek Near Mt Angel, OR	31	28	31	30	31	30	31	31	30	31	30	31
1998	14201340	Pudding River Near Woodburn, OR	31	28	31	30	31	30	31	31	30	31	30	31
1999	14178000	No Santiam R Blw Boulder Crk, Nr Detroit, OR	31	28	31	30	31	30	31	31	30	31	30	31
1999	14179000	Breitenbush R Abv French Cr Nr Detroit, OR.	31	28	31	30	31	30	31	31	30	31	30	31
1999	14180300	Blowout Creek Near Detroit, OR	31	28	31	30	31	30	31	31	30	31	30	31
1999	14182500	Little North Santiam River Near Mehama, OR	31	28	31	30	31	30	31	31	30	31	30	31
1999	14185000	South Santiam River Below Cascadia, OR	31	28	31	30	31	30	31	31	30	31	30	31
1999	14185900	Quartzville Creek Near Cascadia, OR	31	28	31	30	31	30	31	31	30	31	30	31
1999	14187000	Wiley Creek Near Foster, OR	31	28	31	30	31	30	31	31	30	31	30	31
1999	14188610	Schafer Creek Near Lacomb, OR	31	28	31	30	31	30	31	31	30	31	30	31
1999	14198400	Bull Creek Near Wilhoit, OR	31	28	31	30	31	30	31	31	30	31	30	31
1999	14200400	Little Abiqua Creek Near Scotts Mills, OR	31	28	31	30	31	30	31	31	30	31	30	31
1999	14201300	Zollner Creek Near Mt Angel, OR	31	28	31	30	31	30	31	31	30	31	30	31
1999	14201340	Pudding River Near Woodburn, OR	31	28	31	30	31	30	31	31	30	31	30	31

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2000	14178000	No Santiam R Blw Boulder Crk, Nr Detroit, OR	31	29	31	30	31	30	31	31	30	31	30	31
2000	14179000	Breitenbush R Abv French Cr Nr Detroit, OR.	31	29	31	30	31	30	31	31	30	31	30	31
2000	14180300	Blowout Creek Near Detroit, OR	31	29	31	30	31	30	31	31	30	31	30	31
2000	14182500	Little North Santiam River Near Mehama, OR	31	29	31	30	31	30	31	31	30	31	30	31
2000	14185000	South Santiam River Below Cascadia, OR	31	29	31	30	31	30	31	31	30	31	30	31
2000	14185900	Quartzville Creek Near Cascadia, OR	31	29	31	30	31	30	31	31	30	31	30	31
2000	14187000	Wiley Creek Near Foster, OR	31	29	31	30	31	30	31	31	30	31	30	31
2000	14188610	Schafer Creek Near Lacomb, OR	31	29	31	30	31	30	31	31	30	31	30	31
2000	14198400	Bull Creek Near Wilhoit, OR	31	29	31	30	31	30	31	31	30	31	30	31
2000	14200000	Molalla River Near Canby, OR										31	30	31
2000	14200400	Little Abiqua Creek Near Scotts Mills, OR	31	29	31	30	31	30	31	31	30	31	30	31
2000	14201300	Zollner Creek Near Mt Angel, OR	31	29	31	30	31	30	31	31	30	31	30	31
2000	14201340	Pudding River Near Woodburn, OR	31	29	31	30	31	30	31	31	30	31	30	31
2001	14178000	No Santiam R Blw Boulder Crk, Nr Detroit, OR	31	28	31	30	31	30	31	31	30	31	30	31
2001	14179000	Breitenbush R Abv French Cr Nr Detroit, OR.	31	28	31	30	31	30	31	31	30	31	30	31
2001	14179100	French Creek Near Detroit, OR										31	30	31
2001	14180300	Blowout Creek Near Detroit, OR	31	28	31	30	31	30	31	31	30	31	30	31
2001	14182500	Little North Santiam River Near Mehama, OR	31	28	31	30	31	30	31	31	30	31	30	31
2001	14185000	South Santiam River Below Cascadia, OR	31	28	31	30	31	30	31	31	30	31	30	31
2001	14185900	Quartzville Creek Near Cascadia, OR	31	28	31	30	31	30	31	31	30	31	30	31
2001	14187000	Wiley Creek Near Foster, OR	31	28	31	30	31	30	31	31	30	31	30	31

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2001	14188610	Schafer Creek Near Lacomb, OR	31	28	31	30	31	30	31	31	30	31	30	31
2001	14198400	Bull Creek Near Wilhoit, OR	31	28	31	30	31	30	31	31	30	31	30	31
2001	14200000	Molalla River Near Canby, OR	31	28	31	30	31	30	31	31	30	31	30	31
2001	14200400	Little Abiqua Creek Near Scotts Mills, OR	31	28	31	30	31	30	31	31	30	31	30	31
2001	14201300	Zollner Creek Near Mt Angel, OR	31	28	31	30	31	30	31	31	30	31	30	31
2001	14201340	Pudding River Near Woodburn, OR	31	28	31	30	31	30	31	31	30	31	30	31
2002	14178000	No Santiam R Blw Boulder Crk, Nr Detroit, OR	31	28	31	30	31	30	31	31	30	31	30	31
2002	14179000	Breitenbush R Abv French Cr Nr Detroit, OR.	31	28	31	30	31	30	31	31	30	31	30	31
2002	14179100	French Creek Near Detroit, OR	31	28	31	30	31	30	31	31	30	31	30	31
2002	14180300	Blowout Creek Near Detroit, OR	31	28	31	30	31	30	31	31	30	31	30	31
2002	14182500	Little North Santiam River Near Mehama, OR	31	28	31	30	31	30	31	31	30	31	30	31
2002	14185000	South Santiam River Below Cascadia, OR	31	28	31	30	31	30	31	31	30	31	30	31
2002	14185900	Quartzville Creek Near Cascadia, OR	31	28	31	30	31	30	31	31	30	31	30	31
2002	14187000	Wiley Creek Near Foster, OR	31	28	31	30	31	30	31	31	30	31	30	31
2002	14188610	Schafer Creek Near Lacomb, OR	31	28	31	30	31	30	31	31	30	31	30	31
2002	14188800	Thomas Creek Near Scio, OR										31	30	31
2002	14198400	Bull Creek Near Wilhoit, OR	31	28	31	30	31	30	31	31	30	31	30	31
2002	14199704	Nate Creek Tributary Near Colton, OR						24	31	31	30	31	30	31
2002	14200000	Molalla River Near Canby, OR	31	28	31	30	31	30	31	31	30	31	30	31
2002	14200400	Little Abiqua Creek Near Scotts Mills, OR	31	28	31	30	31	30	31	31	30	31	30	31
2002	14201300	Zollner Creek Near Mt Angel, OR	31	28	31	30	31	30	31	31	30	31	30	31
2002	14201340	Pudding River Near Woodburn, OR	31	28	31	30	31	30	31	31	30	31	30	31
2002	14202000	Pudding River At Aurora, OR										31	30	31

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2003	14178000	No Santiam R Blw Boulder Crk, Nr Detroit, OR	31	28	31	30	31	30	31	31	30	31	30	31
2003	14179000	Breitenbush R Abv French Cr Nr Detroit, OR.	31	28	31	30	31	30	31	31	30	31	30	31
2003	14179100	French Creek Near Detroit, OR	31	28	31	30	31	30	31	31	30	31	30	31
2003	14180300	Blowout Creek Near Detroit, OR	31	28	31	30	31	30	31	31	30	31	30	31
2003	14182500	Little North Santiam River Near Mehama, OR	31	28	31	30	31	30	31	31	30	31	30	31
2003	14185000	South Santiam River Below Cascadia, OR	31	28	31	30	31	30	31	31	30	31	30	31
2003	14185900	Quartzville Creek Near Cascadia, OR	31	28	31	30	31	30	31	31	30	31	30	31
2003	14187000	Wiley Creek Near Foster, OR	31	28	31	30	31	30	31	31	30	31	30	31
2003	14188610	Schafer Creek Near Lacomb, OR	31	28	31	30	31	30	31	31	30	31	30	31
2003	14188800	Thomas Creek Near Scio, OR	31	28	31	30	31	30	31	31	30	31	30	31
2003	14198400	Bull Creek Near Wilhoit, OR	31	28	31	30	31	30	31	31	30	31	30	31
2003	14199704	Nate Creek Tributary Near Colton, OR	31	28	31	30	31	30	31	31	30	31	30	31
2003	14200000	Molalla River Near Canby, OR	31	28	31	30	31	30	31	31	30	31	30	31
2003	14200400	Little Abiqua Creek Near Scotts Mills, OR	31	28	31	30	31	30	31	31	30	31	30	31
2003	14201300	Zollner Creek Near Mt Angel, OR	31	28	31	30	31	30	31	31	30	31	30	31
2003	14201340	Pudding River Near Woodburn, OR	31	28	31	30	31	30	31	31	30	31	30	31
2003	14202000	Pudding River At Aurora, OR	31	28	31	30	31	30	31	31	30	31	30	31
2004	14178000	No Santiam R Blw Boulder Crk, Nr Detroit, OR	31	29	31	30	31	30	31	31	30	31	30	31
2004	14179000	Breitenbush R Abv French Cr Nr Detroit, OR.	31	29	31	30	31	30	31	31	30	31	30	31
2004	14179100	French Creek Near Detroit, OR	31	29	31	30	31	30	31	31	30	31	30	31
2004	14180300	Blowout Creek Near Detroit, OR	31	29	31	30	31	30	31	31	30	31	30	31

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2004	14182500	Little North Santiam River Near Mehama, OR	31	29	31	30	31	30	31	31	30	31	30	31
2004	14185000	South Santiam River Below Cascadia, OR	31	29	31	30	31	30	31	31	30	31	30	31
2004	14185900	Quartzville Creek Near Cascadia, OR	31	29	31	30	31	30	31	31	30	31	30	31
2004	14187000	Wiley Creek Near Foster, OR	31	29	31	30	31	30	31	31	30	31	30	31
2004	14188610	Schafer Creek Near Lacomb, OR	31	29	31	30	31	30	31	31	30	31	30	31
2004	14188800	Thomas Creek Near Scio, OR	31	29	31	30	31	30	31	31	30	31	30	31
2004	14198400	Bull Creek Near Wilhoit, OR	31	29	31	30	31	30	31	31	30	31	30	31
2004	14199704	Nate Creek Tributary Near Colton, OR	31	29	31	30	31	30	31	31	30	31	30	31
2004	14200000	Molalla River Near Canby, OR	31	29	31	30	31	30	31	31	30	31	30	31
2004	14200400	Little Abiqua Creek Near Scotts Mills, OR	31	29	31	30	31	30	31	31	30			
2004	14201300	Zollner Creek Near Mt Angel, OR	31	29	31	30	31	30	31	31	30	31	30	31
2004	14201340	Pudding River Near Woodburn, OR	31	29	31	30	31	30	31	31	30	31	30	31
2004	14202000	Pudding River At Aurora, OR	31	29	31	30	31	30	31	31	30	31	30	31
2005	14178000	No Santiam R Blw Boulder Crk, Nr Detroit, OR	31	28	31	30	31	30	31	31	30	31	30	31
2005	14179000	Breitenbush R Abv French Cr Nr Detroit, OR.	31	28	31	30	31	30	31	31	30	31	30	31
2005	14179100	French Creek Near Detroit, OR	31	28	31	30	31	30	31	31	30			
2005	14180300	Blowout Creek Near Detroit, OR	31	28	31	30	31	30	31	31	30	31	30	31
2005	14181750	Rock Creek Near Mill City, OR										31	30	31
2005	14182500	Little North Santiam River Near Mehama, OR	31	28	31	30	31	30	31	31	30	31	30	31
2005	14185000	South Santiam River Below Cascadia, OR	31	28	31	30	31	30	31	31	30	31	30	31
2005	14185900	Quartzville Creek Near Cascadia, OR	31	28	31	30	31	30	31	31	30	31	30	31
2005	14187000	Wiley Creek Near Foster, OR	31	28	31	30	31	30	31	31	30	31	30	31
2005	14188610	Schafer Creek Near Lacomb, OR	31	28	31	30	31	30	31	31	30	31	30	31

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2005	14188800	Thomas Creek Near Scio, OR	31	28	31	30	31	30	31	31	30	31	30	31
2005	14198400	Bull Creek Near Wilhoit, OR	31	28	31	30	31	30	31	31	30	31	30	31
2005	14199704	Nate Creek Tributary Near Colton, OR	31	28	31	30	31	30	31	31	30	31	30	31
2005	14200000	Molalla River Near Canby, OR	31	28	31	30	31	30	31	31	30	31	30	31
2005	14201300	Zollner Creek Near Mt Angel, OR	31	28	31	30	31	30	31	31	30	31	30	31
2005	14201340	Pudding River Near Woodburn, OR	31	28	31	30	31	30	31	31	30	31	30	31
2005	14202000	Pudding River At Aurora, OR	31	28	31	30	31	30	31	31	30	31	30	31
2006	14178000	No Santiam R Blw Boulder Crk, Nr Detroit, OR	31	28	31	30	31	30	31	31	30	31	30	31
2006	14179000	Breitenbush R Abv French Cr Nr Detroit, OR.	31	28	31	30	31	30	31	31	30	31	30	31
2006	14180300	Blowout Creek Near Detroit, OR	31	28	31	30	31	30	31	31	30	31	30	31
2006	14181750	Rock Creek Near Mill City, OR	31	28	31	30	31	30	31	31	30	31	30	31
2006	14182500	Little North Santiam River Near Mehama, OR	31	28	31	30	31	30	31	31	30	31	30	31
2006	14185000	South Santiam River Below Cascadia, OR	31	28	31	30	31	30	31	31	30	31	30	31
2006	14185900	Quartzville Creek Near Cascadia, OR	31	28	31	30	31	30	31	31	30	31	30	31
2006	14187000	Wiley Creek Near Foster, OR	31	28	31	30	31	30	31	31	30	31	30	31
2006	14188610	Schafer Creek Near Lacomb, OR	31	28	31	30	31	30	31	31	30	31	30	31
2006	14188800	Thomas Creek Near Scio, OR	31	28	31	30	31	30	31	31	30	31	30	31
2006	14198400	Bull Creek Near Wilhoit, OR	31	28	31	30	31	30	31	31	30	31	30	31
2006	14199704	Nate Creek Tributary Near Colton, OR	31	28	31	30	31	30	31	31	30	31	30	31
2006	14200000	Molalla River Near Canby, OR	31	28	31	30	31	30	31	31	30	31	30	31
2006	14201300	Zollner Creek Near Mt Angel, OR	31	28	31	30	31	30	31	31	30	31	30	31
2006	14201340	Pudding River Near Woodburn, OR	31	28	31	30	31	30	31	31	30	31	30	31
2006	14202000	Pudding River At Aurora, OR	31	28	31	30	31	30	31	31	30	31	30	31

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2007	14178000	No Santiam R Blw Boulder Crk, Nr Detroit, OR	31	28	31	30	31	30	31	31	30	31	30	31
2007	14179000	Breitenbush R Abv French Cr Nr Detroit, OR.	31	28	31	30	31	30	31	31	30	31	30	31
2007	14180300	Blowout Creek Near Detroit, OR	31	28	31	30	31	30	31	31	30	31	30	31
2007	14181750	Rock Creek Near Mill City, OR	31	28	31	30	31	30	31	31	30	31	30	31
2007	14182400	Little N Santiam R Blw Canyon Ck, Near Mehama, OR									11	31	30	31
2007	14182500	Little North Santiam River Near Mehama, OR	31	28	31	30	31	30	31	31	30	31	30	31
2007	14185000	South Santiam River Below Cascadia, OR	31	28	31	30	31	30	31	31	30	31	30	31
2007	14185900	Quartzville Creek Near Cascadia, OR	31	28	31	30	31	30	31	31	30	31	30	31
2007	14187000	Wiley Creek Near Foster, OR	31	28	31	30	31	30	31	31	30	31	30	31
2007	14188610	Schafer Creek Near Lacomb, OR	31	28	31	30	31	30	31	31	30	31	30	31
2007	14188800	Thomas Creek Near Scio, OR	31	28	31	30	31	30	31	31	30	31	30	31
2007	14198400	Bull Creek Near Wilhoit, OR	31	28	31	30	31	30	31	31	30	31	30	31
2007	14199704	Nate Creek Tributary Near Colton, OR	31	28	31	30	31	30	31	31	30	31	30	31
2007	14200000	Molalla River Near Canby, OR	31	28	31	30	31	30	31	31	30	31	30	31
2007	14201300	Zollner Creek Near Mt Angel, OR	31	28	31	30	31	30	31	31	30	31	30	31
2007	14201340	Pudding River Near Woodburn, OR	31	28	31	30	31	30	31	31	30	31	30	31
2007	14202000	Pudding River At Aurora, OR	31	28	31	30	31	30	31	31	30	31	30	31
2008	14178000	No Santiam R Blw Boulder Crk, Nr Detroit, OR	31	29	31	30	31	30	31	31	30	31	30	31
2008	14179000	Breitenbush R Abv French Cr Nr Detroit, OR.	31	29	31	30	31	30	31	31	30	31	30	31
2008	14180300	Blowout Creek Near Detroit, OR	31	29	31	30	31	30	31	31	30	31	30	31
2008	14181750	Rock Creek Near Mill City, OR	31	29	31	30	31	30	31	31	30	22		

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2008	14182400	Little N Santiam R Blw Canyon Ck, Near Mehama, OR	31	29	31	30	31	30	31	31	30	31	30	31
2008	14182500	Little North Santiam River Near Mehama, OR	31	29	31	30	31	30	31	31	30	31	30	31
2008	14185000	South Santiam River Below Cascadia, OR	31	29	31	30	31	30	31	31	30	31	30	31
2008	14185900	Quartzville Creek Near Cascadia, OR	31	29	31	30	31	30	31	31	30	31	30	31
2008	14187000	Wiley Creek Near Foster, OR	31	29	31	30	31	30	31	31	30	31	30	31
2008	14188610	Schafer Creek Near Lacomb, OR	31	29	31	30	31	30	31	31	30	31	30	31
2008	14188800	Thomas Creek Near Scio, OR	31	29	31	30	31	30	31	31	30	31	30	31
2008	14198400	Bull Creek Near Wilhoit, OR	31	29	31	30	31	30	31	31	30	31	30	31
2008	14199704	Nate Creek Tributary Near Colton, OR	31	29	31	30	31	30	31	31	30	31	30	31
2008	14200000	Molalla River Near Canby, OR	31	29	31	30	31	30	31	31	30	31	30	31
2008	14201300	Zollner Creek Near Mt Angel, OR	31	29	31	30	31	30	31	31	30	31	30	31
2008	14201340	Pudding River Near Woodburn, OR	31	29	31	30	31	30	31	31	30	31	30	31
2008	14202000	Pudding River At Aurora, OR	31	29	31	30	31	30	31	31	30	31	30	31
2009	14178000	No Santiam R Blw Boulder Crk, Nr Detroit, OR	31	28	31	30	31	30	31	31	30	31	30	31
2009	14179000	Breitenbush R Abv French Cr Nr Detroit, OR.	31	28	31	30	31	30	31	31	30	31	30	31
2009	14180300	Blowout Creek Near Detroit, OR	31	28	31	30	31	30	31	31	30	31	30	31
2009	14182500	Little North Santiam River Near Mehama, OR	31	28	31	30	31	30	31	31	30	31	30	31
2009	14185000	South Santiam River Below Cascadia, OR	31	28	31	30	31	30	31	31	30	31	30	31
2009	14185900	Quartzville Creek Near Cascadia, OR	31	28	31	30	31	30	31	31	30	31	30	31
2009	14187000	Wiley Creek Near Foster, OR	31	28	31	30	31	30	31	31	30	31	30	31
2009	14188610	Schafer Creek Near Lacomb, OR	31	28	31	30	31	30	31	31	30	31	30	31
2009	14188800	Thomas Creek Near Scio, OR	31	28	31	30	31	30	31	31	30	31	30	31

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2009	14198400	Bull Creek Near Wilhoit, OR	31	28	31	30	31	30	31	31	30	31	30	31
2009	14199704	Nate Creek Tributary Near Colton, OR	31	28	31	30	31	30	31	31	30	31	30	31
2009	14200000	Molalla River Near Canby, OR	31	28	31	30	31	30	31	31	30	31	30	31
2009	14201300	Zollner Creek Near Mt Angel, OR	31	28	31	30	31	30	31	31	30	31	30	31
2009	14201340	Pudding River Near Woodburn, OR	31	28	31	30	31	30	31	31	30	31	30	31
2009	14202000	Pudding River At Aurora, OR	31	28	31	30	31	30	31	31	30	31	30	31
2010	14178000	No Santiam R Blw Boulder Crk, Nr Detroit, OR	31	28	31	30	31	30	31	31	30	31	30	31
2010	14179000	Breitenbush R Abv French Cr Nr Detroit, OR.	31	28	31	30	31	30	31	31	30	31	30	31
2010	14180300	Blowout Creek Near Detroit, OR	31	28	31	30	31	30	31	31	30	31	30	31
2010	14182500	Little North Santiam River Near Mehama, OR	31	28	31	30	31	30	31	31	30	31	30	31
2010	14185000	South Santiam River Below Cascadia, OR	31	28	31	30	31	30	31	31	30	31	30	31
2010	14185900	Quartzville Creek Near Cascadia, OR	31	28	31	30	31	30	31	31	30	31	30	31
2010	14187000	Wiley Creek Near Foster, OR	31	28	31	30	31	30	31	31	30	31	30	31
2010	14188610	Schafer Creek Near Lacomb, OR	31	28	31	30	31	30	31	31	30	31	30	31
2010	14188800	Thomas Creek Near Scio, OR	31	28	31	30	31	30	31	31	30	31	30	31
2010	14198400	Bull Creek Near Wilhoit, OR	31	28	31	30	31	30	31	31	30	31	30	31
2010	14199704	Nate Creek Tributary Near Colton, OR	31	28	31	30	31	30	31	31	30	31	30	31
2010	14200000	Molalla River Near Canby, OR	31	28	31	30	31	30	31	31	30	31	30	31
2010	14201300	Zollner Creek Near Mt Angel, OR	31	28	31	30	31	30	31	31	30	31	30	31
2010	14201340	Pudding River Near Woodburn, OR	31	28	31	30	31	30	31	31	30	31	30	31
2010	14202000	Pudding River At Aurora, OR	31	28	31	30	31	30	31	31	30	31	30	31
2011	14178000	No Santiam R Blw Boulder Crk, Nr Detroit, OR	31	28	31	30	31	30	31	31	30	31	30	31

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2011	14179000	Breitenbush R Abv French Cr Nr Detroit, OR.	31	28	31	30	31	30	31	31	30	31	30	31
2011	14180300	Blowout Creek Near Detroit, OR	31	28	31	30	31	30	31	31	30	31	30	31
2011	14182500	Little North Santiam River Near Mehama, OR	31	28	31	30	31	30	31	31	30	31	30	31
2011	14185000	South Santiam River Below Cascadia, OR	31	28	31	30	31	30	31	31	30	31	30	31
2011	14185900	Quartzville Creek Near Cascadia, OR	31	28	31	30	31	30	31	31	30	31	30	31
2011	14187000	Wiley Creek Near Foster, OR	31	28	31	30	31	30	31	31	30	31	30	31
2011	14188610	Schafer Creek Near Lacomb, OR	31	28	31	30	31	30	31	31	30	31	30	31
2011	14188800	Thomas Creek Near Scio, OR	31	28	31	30	31	30	31	31	30	31	30	31
2011	14198400	Bull Creek Near Wilhoit, OR	31	28	31	30	31	30	31	31	30	31	30	31
2011	14199704	Nate Creek Tributary Near Colton, OR	31	28	31	30	31	30	31	31	30	31	30	31
2011	14200000	Molalla River Near Canby, OR	31	28	31	30	31	30	31	31	30	31	30	31
2011	14201300	Zollner Creek Near Mt Angel, OR	31	28	31	30	31	30	31	31	30	31	30	31
2011	14201340	Pudding River Near Woodburn, OR	31	28	31	30	31	30	31	31	30	31	30	31
2011	14202000	Pudding River At Aurora, OR	31	28	31	30	31	30	31	31	30	31	30	31
2012	14178000	No Santiam R Blw Boulder Crk, Nr Detroit, OR	31	29	31	30	31	30	31	31	30	31	30	31
2012	14179000	Breitenbush R Abv French Cr Nr Detroit, OR.	31	29	31	30	31	30	31	31	30	31	30	31
2012	14180300	Blowout Creek Near Detroit, OR	31	29	31	30	31	30	31	31	30	31	30	31
2012	14182500	Little North Santiam River Near Mehama, OR	31	29	31	30	31	30	31	31	30	31	30	31
2012	14185000	South Santiam River Below Cascadia, OR	31	29	31	30	31	30	31	31	30	31	30	31
2012	14185900	Quartzville Creek Near Cascadia, OR	31	29	31	30	31	30	31	31	30	31	30	31
2012	14187000	Wiley Creek Near Foster, OR	31	29	31	30	31	30	31	31	30	31	30	31
2012	14188610	Schafer Creek Near Lacomb, OR	31	29	31	30	31	30	31	31	30	31	30	31

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2012	14188800	Thomas Creek Near Scio, OR	31	29	31	30	31	30	31	31	30	31	30	31
2012	14198400	Bull Creek Near Wilhoit, OR	31	29	31	30	31	30	31	31	30	31	30	31
2012	14199704	Nate Creek Tributary Near Colton, OR	31	29	31	30	31	30	31	31	30	31	30	31
2012	14200000	Molalla River Near Canby, OR	31	29	31	30	31	30	31	31	30	31	30	31
2012	14201300	Zollner Creek Near Mt Angel, OR	31	29	31	30	31	30	31	31	30	31	30	31
2012	14201340	Pudding River Near Woodburn, OR	31	29	31	30	31	30	31	31	30	31	30	31
2012	14202000	Pudding River At Aurora, OR	31	29	31	30	31	30	31	31	30	31	30	31
2013	14178000	No Santiam R Blw Boulder Crk, Nr Detroit, OR	31	28	31	30	31	30	31	31	30	31	30	31
2013	14179000	Breitenbush R Abv French Cr Nr Detroit, OR.	31	28	31	30	31	30	31	31	30	31	30	31
2013	14180300	Blowout Creek Near Detroit, OR	31	28	31	30	31	30	31	31	30	31	30	31
2013	14182500	Little North Santiam River Near Mehama, OR	31	28	31	30	31	30	31	31	30	31	30	31
2013	14185000	South Santiam River Below Cascadia, OR	31	28	31	30	31	30	31	31	30	31	30	31
2013	14185900	Quartzville Creek Near Cascadia, OR	31	28	31	30	31	30	31	31	30	31	30	31
2013	14187000	Wiley Creek Near Foster, OR	31	28	31	30	31	30	31	31	30	31	30	31
2013	14188610	Schafer Creek Near Lacomb, OR	31	28	31	30	31	30	31	31	30	31	30	31
2013	14188800	Thomas Creek Near Scio, OR	31	28	31	30	31	30	31	31	30	31	30	31
2013	14198400	Bull Creek Near Wilhoit, OR	31	28	31	30	31	30	31	31	30	31	30	31
2013	14199704	Nate Creek Tributary Near Colton, OR	31	28	31	30	31	30	31	31	30	31	30	31
2013	14200000	Molalla River Near Canby, OR	31	28	31	30	31	30	31	31	30	31	30	31
2013	14201300	Zollner Creek Near Mt Angel, OR	31	28	31	30	31	30	31	31	30	31	30	31
2013	14201340	Pudding River Near Woodburn, OR	31	28	31	30	31	30	31	31	30	31	30	31
2013	14202000	Pudding River At Aurora, OR	31	28	31	30	31	30	31	31	30	31	30	31
2014	14178000	No Santiam R Blw Boulder Crk, Nr Detroit, OR	31	28	31	30	31	30	31	31	30	31	30	31

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2014	14179000	Breitenbush R Abv French Cr Nr Detroit, OR.	31	28	31	30	31	30	31	31	30	31	30	31
2014	14180300	Blowout Creek Near Detroit, OR	31	28	31	30	31	30	31	31	30	31	30	31
2014	14182500	Little North Santiam River Near Mehama, OR	31	28	31	30	31	30	31	31	30	31	30	31
2014	14185000	South Santiam River Below Cascadia, OR	31	28	31	30	31	30	31	31	30	31	30	31
2014	14185900	Quartzville Creek Near Cascadia, OR	31	28	31	30	31	30	31	31	30	31	30	31
2014	14187000	Wiley Creek Near Foster, OR	31	28	31	30	31	30	31	31	30	31	30	31
2014	14188610	Schafer Creek Near Lacomb, OR	31	28	31	30	31	30	31	31	30	31	30	31
2014	14188800	Thomas Creek Near Scio, OR	31	28	31	30	31	30	31	31	30	31	30	31
2014	14198400	Bull Creek Near Wilhoit, OR	31	28	31	30	31	30	31	31	30	31	30	31
2014	14199704	Nate Creek Tributary Near Colton, OR	31	28	31	30	31	30	31	31	30	31	30	31
2014	14200000	Molalla River Near Canby, OR	31	28	31	30	31	30	31	31	30	31	30	31
2014	14200100	Drift Creek Near Silverton, OR					11	30	31	31	30	31	30	31
2014	14200300	Silver Creek At Silverton, OR		23	31	30	31	30	31	31	30	31	30	31
2014	14200700	Abiqua Creek At Silverton, OR						19	31	31	30	31	30	31
2014	14201300	Zollner Creek Near Mt Angel, OR	31	28	31	30	31	30	31	31	30	31	30	31
2014	14201340	Pudding River Near Woodburn, OR	31	28	31	30	31	30	31	31	30	31	30	31
2014	14201500	Butte Creek At Monitor, OR	7	28	31	30	31	30	31	31	30	31	30	31
2014	14202000	Pudding River At Aurora, OR	31	28	31	30	31	30	31	31	30	31	30	31
2015	14178000	No Santiam R Blw Boulder Crk, Nr Detroit, OR	31	28	31	30	31	30	31	31	30	31	30	31
2015	14179000	Breitenbush R Abv French Cr Nr Detroit, OR.	31	28	31	30	31	30	31	31	30	31	30	31
2015	14180300	Blowout Creek Near Detroit, OR	31	28	31	30	31	30	31	31	30	31	30	31
2015	14182500	Little North Santiam River Near Mehama, OR	31	28	31	30	31	30	31	31	30	31	30	31

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2015	14185000	South Santiam River Below Cascadia, OR	31	28	31	30	31	30	31	31	30	31	30	31
2015	14185900	Quartzville Creek Near Cascadia, OR	31	28	31	30	31	30	31	31	30	31	30	31
2015	14187000	Wiley Creek Near Foster, OR	31	28	31	30	31	30	31	31	30	31	30	31
2015	14188610	Schafer Creek Near Lacomb, OR	31	28	31	30	31	30	31	31	30	31	30	31
2015	14188800	Thomas Creek Near Scio, OR	31	28	31	30	31	30	31	31	30	31	30	31
2015	14198400	Bull Creek Near Wilhoit, OR	31	28	31	30	31	30	31	31	30	31	30	31
2015	14199704	Nate Creek Tributary Near Colton, OR	31	28	31	30	31	30	31	31	30	31	30	31
2015	14200000	Molalla River Near Canby, OR	31	28	31	30	31	30	31	31	30	31	30	31
2015	14200100	Drift Creek Near Silverton, OR	31	28	31	30	31	30	31	31	30	31	30	31
2015	14200300	Silver Creek At Silverton, OR	31	28	31	30	31	30	31	31	30	31	30	31
2015	14200700	Abiqua Creek At Silverton, OR	31	28	31	30	31	30	31	31	30	31	30	31
2015	14201300	Zollner Creek Near Mt Angel, OR	31	28	31	30	31	30	31	31	30	31	30	31
2015	14201340	Pudding River Near Woodburn, OR	31	28	31	30	31	30	31	31	30	31	30	31
2015	14201500	Butte Creek At Monitor, OR	31	28	31	30	31	30	31	31	30	31	30	31
2015	14202000	Pudding River At Aurora, OR	31	28	31	30	31	30	31	31	30	31	30	31
2016	14178000	No Santiam R Blw Boulder Crk, Nr Detroit, OR	31	29	31	30	31	30	31	31	30	31	30	31
2016	14179000	Breitenbush R Abv French Cr Nr Detroit, OR.	31	29	31	30	31	30	31	31	30	31	30	31
2016	14180300	Blowout Creek Near Detroit, OR	31	29	31	30	31	30	31	31	30	31	30	31
2016	14182500	Little North Santiam River Near Mehama, OR	31	29	31	30	31	30	31	31	30	31	30	31
2016	14185000	South Santiam River Below Cascadia, OR	31	29	31	30	31	30	31	31	30	31	30	31
2016	14185900	Quartzville Creek Near Cascadia, OR	31	29	31	30	31	30	31	31	30	31	30	31
2016	14187000	Wiley Creek Near Foster, OR	31	29	31	30	31	30	31	31	30	31	30	31
2016	14188610	Schafer Creek Near Lacomb, OR	31	29	31	30	31	30	31	31	30	31	30	31

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2016	14188800	Thomas Creek Near Scio, OR	31	29	31	30	31	30	31	31	30	31	30	31
2016	14198400	Bull Creek Near Wilhoit, OR	31	29	31	30	31	30	31	31	30	31	30	31
2016	14199704	Nate Creek Tributary Near Colton, OR	31	29	31	30	31	30	31	31	30	31	30	31
2016	14200000	Molalla River Near Canby, OR	31	29	31	30	31	30	31	31	30	31	30	31
2016	14200100	Drift Creek Near Silverton, OR	31	29	31	30	31	30	31	31	30	31	30	31
2016	14200300	Silver Creek At Silverton, OR	31	29	31	30	31	30	31	31	30	31	30	31
2016	14200700	Abiqua Creek At Silverton, OR	31	29	31	30	31	30	31	31	30	31	30	31
2016	14201300	Zollner Creek Near Mt Angel, OR	31	29	31	30	31	30	31	31	30	31	30	31
2016	14201340	Pudding River Near Woodburn, OR	31	29	31	30	31	30	31	31	30	31	30	31
2016	14201500	Butte Creek At Monitor, OR	31	29	31	30	31	30	31	31	30	31	30	31
2016	14202000	Pudding River At Aurora, OR	31	29	31	30	31	30	31	31	30	31	30	31
2017	14178000	No Santiam R Blw Boulder Crk, Nr Detroit, OR	31	28	31	30	31	30	31	31	30	31	30	31
2017	14179000	Breitenbush R Abv French Cr Nr Detroit, OR.	31	28	31	30	31	30	31	31	30	31	30	31
2017	14180300	Blowout Creek Near Detroit, OR	31	28	31	30	31	30	31	31	30	31	30	31
2017	14182500	Little North Santiam River Near Mehama, OR	31	28	31	30	31	30	31	31	30	31	30	31
2017	14185000	South Santiam River Below Cascadia, OR	31	28	31	30	31	30	31	31	30	31	30	31
2017	14185900	Quartzville Creek Near Cascadia, OR	31	28	31	30	31	30	31	31	30	31	30	31
2017	14187000	Wiley Creek Near Foster, OR	31	28	31	30	31	30	31	31	30	31	30	31
2017	14188610	Schafer Creek Near Lacomb, OR	31	28	31	30	31	30	31	31	30	31	30	31
2017	14188800	Thomas Creek Near Scio, OR	31	28	31	30	31	30	31	31	30	31	30	31
2017	14198400	Bull Creek Near Wilhoit, OR	31	28	31	30	31	30	31	31	30	31	30	31
2017	14199704	Nate Creek Tributary Near Colton, OR	31	28	31	30	31	30	31	31	30	31	30	31
2017	14200000	Molalla River Near Canby, OR	31	28	31	30	31	30	31	31	30	31	30	31

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2017	14200100	Drift Creek Near Silverton, OR	31	28	31	30	31	30	31	31	30	3		
2017	14200300	Silver Creek At Silverton, OR	31	28	31	30	31	30	31	31	30	31	30	31
2017	14200700	Abiqua Creek At Silverton, OR	31	28	31	30	31	30	31	31	30	31	30	31
2017	14201300	Zollner Creek Near Mt Angel, OR	31	28	31	30	31	30	31	31	30	31	30	31
2017	14201340	Pudding River Near Woodburn, OR	31	28	31	30	31	30	31	31	30	31	30	31
2017	14201500	Butte Creek At Monitor, OR	31	28	31	30	31	30	31	31	30	31	30	31
2017	14202000	Pudding River At Aurora, OR	31	28	31	30	31	30	31	31	30	31	30	31
2018	14178000	No Santiam R Blw Boulder Crk, Nr Detroit, OR	31	28	31	30	31	30	31	31	30	31	30	31
2018	14179000	Breitenbush R Abv French Cr Nr Detroit, OR.	31	28	31	30	31	30	31	31	30	31	30	31
2018	14180300	Blowout Creek Near Detroit, OR	31	28	31	30	31	30	31	31	30	31	30	31
2018	14182500	Little North Santiam River Near Mehama, OR	31	28	31	30	31	30	31	31	30	31	30	31
2018	14185000	South Santiam River Below Cascadia, OR	31	28	31	30	31	30	31	31	30	31	30	31
2018	14185900	Quartzville Creek Near Cascadia, OR	31	28	31	30	31	30	31	31	30	31	30	31
2018	14187000	Wiley Creek Near Foster, OR	31	28	31	30	31	30	31	31	30	31	30	31
2018	14188610	Schafer Creek Near Lacomb, OR	31	28	31	30	31	30	31	31	30	31	30	31
2018	14188800	Thomas Creek Near Scio, OR	31	28	31	30	31	30	31	31	30	31	30	31
2018	14198400	Bull Creek Near Wilhoit, OR	31	28	31	30	31	30	31	31	30	31	30	31
2018	14199704	Nate Creek Tributary Near Colton, OR	31	28	31	30	31	30	31	31	30	31	30	31
2018	14200000	Molalla River Near Canby, OR	31	28	31	30	31	30	31	31	30	31	30	31
2018	14200300	Silver Creek At Silverton, OR	31	5				29	31	31	30	31	30	31
2018	14200700	Abiqua Creek At Silverton, OR	31	28	31	30	31	30	31	31	30	31	30	31
2018	14201300	Zollner Creek Near Mt Angel, OR	31	28	31	30	31	30	31	31	30	31	30	31
2018	14201340	Pudding River Near Woodburn, OR	31	28	31	30	31	30	31	31	30	31	30	31

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2018	14201500	Butte Creek At Monitor, OR	31	28	31	30	31	30	31	31	30	31	30	31
2018	14202000	Pudding River At Aurora, OR	31	28	31	30	31	30	31	31	30	31	30	31
2019	14178000	No Santiam R Blw Boulder Crk, Nr Detroit, OR	31	28	31	30	31	30	31	31	30	31	30	31
2019	14179000	Breitenbush R Abv French Cr Nr Detroit, OR.	31	28	31	30	31	30	31	31	30	31	30	31
2019	14180300	Blowout Creek Near Detroit, OR	31	28	31	30	31	30	31	31	30	31	30	31
2019	14182500	Little North Santiam River Near Mehama, OR	31	28	31	30	31	30	31	31	30	31	30	31
2019	14185000	South Santiam River Below Cascadia, OR	31	28	31	30	31	30	31	31	30	31	30	31
2019	14185900	Quartzville Creek Near Cascadia, OR	31	28	31	30	31	30	31	31	30	31	30	31
2019	14187000	Wiley Creek Near Foster, OR	31	28	31	30	31	30	31	31	30	31	30	31
2019	14188610	Schafer Creek Near Lacomb, OR	31	28	31	30	31	30	31	31	30	31	30	31
2019	14188800	Thomas Creek Near Scio, OR	31	28	31	30	31	30	31	31	30	31	30	31
2019	14198400	Bull Creek Near Wilhoit, OR	31	28	31	30	31	30	31	31	30	31	30	31
2019	14199704	Nate Creek Tributary Near Colton, OR	31	28	31	30	31	30	31	31	30	31	30	31
2019	14200000	Molalla River Near Canby, OR	31	28	31	30	31	30	31	31	30	31	30	31
2019	14200300	Silver Creek At Silverton, OR	31	28	31	30	31	30	31	31	30	31	30	31
2019	14200700	Abiqua Creek At Silverton, OR	31	28	31	30	31	30	31	31	30	31	30	31
2019	14201300	Zollner Creek Near Mt Angel, OR	31	28	31	30	31	30	31	31	30	31	30	31
2019	14201340	Pudding River Near Woodburn, OR	31	28	31	30	31	30	31	31	30	31	30	31
2019	14201500	Butte Creek At Monitor, OR	31	28	31	30	31	30	31	31	30	31	30	31
2019	14202000	Pudding River At Aurora, OR	31	28	31	30	31	30	31	31	30	31	30	31
2020	14178000	No Santiam R Blw Boulder Crk, Nr Detroit, OR	31	29	31	30	31	30	31	31	30	31	30	31
2020	14179000	Breitenbush R Abv French Cr Nr Detroit, OR.	31	29	31	30	31	30	31	31	30	31	30	31

Year	Station ID	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2020	14180300	Blowout Creek Near Detroit, OR	31	29	31	30	31	30	31	31	30	31	30	31
2020	14182500	Little North Santiam River Near Mehama, OR	31	29	31	30	31	30	31	31	30	31	30	31
2020	14185000	South Santiam River Below Cascadia, OR	31	29	31	30	31	30	31	31	30	31	30	28
2020	14185900	Quartzville Creek Near Cascadia, OR	31	29	31	30	31	30	31	31	30	31	30	31
2020	14187000	Wiley Creek Near Foster, OR	31	29	31	30	31	30	31	31	30	31	30	31
2020	14188610	Schafer Creek Near Lacomb, OR	31	29	31	30	31	30	31	31	30	31	30	31
2020	14188800	Thomas Creek Near Scio, OR	31	29	31	30	31	30	31	31	30	31	30	31
2020	14198400	Bull Creek Near Wilhoit, OR	31	29	31	30	31	30	31	31	30	31	30	31
2020	14199704	Nate Creek Tributary Near Colton, OR	31	29	31	30	31	30	31	31	30	31	30	31
2020	14200000	Molalla River Near Canby, OR	31	29	31	30	31	30	31	31	30	31	30	31
2020	14200300	Silver Creek At Silverton, OR	31	29	31	30	31	1						
2020	14200700	Abiqua Creek At Silverton, OR	31	29	31	30	31	30	31	31	30	31	30	31
2020	14201300	Zollner Creek Near Mt Angel, OR	31	29	31	30	31	30	31	31	30	31	30	31
2020	14201340	Pudding River Near Woodburn, OR	31	29	31	30	31	30	31	31	30	31	30	31
2020	14201500	Butte Creek At Monitor, OR	31	29	31	30	31	30	31	31	30	31	30	31
2020	14202000	Pudding River At Aurora, OR	31	29	31	30	31	30	31	31	30	31	30	31

Appendix D HTML map

DEQ prepared an interactive HTML map to display relevant information described in this QAPP. The map will be posted to DEQ's website alongside this QAPP and saved in same location as the QAPP in DEQ's files. The interactive map contains the following layers and location information:

1. OpenStreetMap base map.
2. USGS hydro cache base map that represents hydrologic information of the National Hydrography Dataset (NHD).
3. 2017 and 2018 one foot Oregon Statewide Imagery Program (OSIP) aerial imagery.
4. TMDL project area boundary.
5. Available continuous stream temperature monitoring locations, organizations that collected that data, and the count of days per month for each year when temperature data are available.
6. Available stream flow monitoring locations, organizations that collected that data, and the count of days per month for each year when flow data are available.
7. The location of meteorological monitoring locations and the source of the data.
8. The location of active individual NPDES permitted facilities, the permit type, and DEQ file number.
9. The locations of current registrants covered under the general NPDES GEN01, GEN03, GEN04, GEN05, GEN19, or GEN40 (MS4) permits.
10. The extent of existing calibrated models described in this QAPP.
11. The extent of newly proposed calibrated models described in this QAPP.
12. The location of temperature calibration sites.
13. The location of temperature monitoring used for model boundary conditions and tributary inputs.
14. The location of flow monitoring locations used for model boundary conditions and tributary inputs.
15. Eight-digit hydrologic unit boundaries (HUC8 Subbasins).
16. Ten-digit hydrologic unit boundaries (HUC10 Watersheds).
17. Twelve-digit hydrologic unit boundaries (HUC12 Subwatersheds).
18. 2018/2020 303(d) Integrated Report status that are classified as water quality limited Category 5 and/or Category 4A for temperature.
19. Fish use designations depicted in OAR 340-041-0340 Figure 340A.

20. Salmon and Steelhead spawning use extent and period depicted in OAR 340-041-0340 Figure 340B.

DEQ21-LAB-0051-QAPP

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