# Modeling Quality Assurance Project Plan for the Sandy Subbasin Temperature Total Maximum Daily Load

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**TMDL Program**
**Water Quality Division**
700 NE Multnomah St.
Suite 600
Portland, OR 97232
Phone: 503-229-5696
800-452-4011
Fax: 503-229-6124
Contact: Ryan Michie

www.oregon.gov/DEQ

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This report prepared by:

Erin Costello, Yuan Grund, and Ryan Michie

Oregon Department of Environmental Quality
700 NE Multnomah Street, Suite 600
Portland, OR 97232
1-800-452-4011
www.oregon.gov/deq

In cooperation with:

USEPA Region 10

and

Tetra Tech, Inc.

Contact:
Ryan Michie
503-229-6162

DEQ can provide documents in an alternate format or in a language other than English upon request. Call DEQ at 800-452-4011 or email deqinfo@deq.state.or.us.

# Approval Sheet

| | | | |
|---|---|---|---|
| Approved By: | Gene Foster<br>Gene Foster (Dec 21, 2021 10:12 PST)<br>Gene Foster, Watershed Management Section Manager, DEQ | Date: | 12/21/2021 |
| Approved By: | Ryan Michie<br>Ryan Michie (Dec 21, 2021 09:39 PST)<br>Ryan Michie, Senior Water Quality Analyst DEQ | Date: | 12/21/2021 |
| Approved By: | Erin Costello<br>Erin Costello (Dec 21, 2021 09:40 PST)<br>Erin Costello, Water Quality Analyst DEQ | Date: | 12/21/2021 |
| Approved By: | David Fairbairn<br>David Fairbairn (Dec 21, 2021 09:41 PST)<br>David Fairbairn, Water Quality Analyst DEQ | Date: | 12/21/2021 |
| Approved By: | Roxann Nayar<br>Roxann Nayar (Dec 22, 2021 16:22 PST)<br>Roxy Nayar, Sandy Basin Coordinator DEQ | Date: | 12/22/2021 |
| Approved By: | Chris Moore<br>Chris Moore (Dec 21, 2021 09:35 PST)<br>Chris Moore, QA Officer DEQ | Date: | 12/21/2021 |
| Approved By: | Ben Cope<br>Ben Cope (Dec 21, 2021 10:49 PST)<br>Ben Cope, Environmental Engineer USEPA, Region 10 | Date: | 12/21/2021 |
| Approved By: | Teresa Rafi<br>Teresa Rafi (Dec 21, 2021 14:36 EST)<br>Teresa Rafi, Task Order Leader Tetra Tech | Date: | 12/21/2021 |
| Approved By: | Sen Bai<br>Sen Bai (Jan 4, 2022 14:36 EST)<br>Sen Bai, Project Manager Tetra Tech | Date: | 01/04/2022 |
| Approved By: | Mustafa S. Faizullabhoy<br>Mustafa S. Faizullabhoy (Jan 4, 2022 14:35 EST)<br>Mustafa Faizullabhoy, Technical Lead Tetra Tech | Date: | 01/04/2022 |

Approved By: ______________________________ Date: 01/05/2022

John O'Donnell, Quality Assurance Officer
Tetra Tech

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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 |
| EMSWCD | East Multnomah Soil & Water Conservation District |
| EQC | Oregon Environmental Quality Commission |
| NCDC | National Climatic Data Center |
| NPDES | National Pollutant Discharge Elimination System |
| OAR | Oregon Administrative Rule |
| OWRD | Oregon Water Resources Department |
| QAPP | Quality Assurance Project Plan |
| RAWS | Remote Automatic Weather Stations |
| STP | Sewage Treatment Plant |
| TIR | Thermal Infrared Radiometry |
| TMDL | Total Maximum Daily Load |
| 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 Lower Columbia-Sandy Subbasin (17080001).

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.

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

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 Sandy Subbasin includes several waterbodies listed on the Oregon 2018/2020 Section 303(d) Category 5 list as water quality limited for temperature (Table 1). A TMDL was previously developed for the Sandy Subbasin (DEQ, 2005) but it 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 Sandy Subbasin 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 Sandy Subbasin 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 Sandy Subbasin 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 340-041-0286 Figure 286A and Figure 286B. 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 Sandy Subbasin. 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 Sandy Subbasin 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: Sandy Subbasin 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 |
|---|---|---|---|
| Beaver Creek | OR_SR_1708000107_02_103612 | 2004 | Year Round |
| Benson Lake | OR_LK_1708000108_15_100639 | 2018 | Year Round |
| Bridal Veil Creek-Columbia River Watershed | OR_WS_170800010803_15_103654 | 2018 | Year Round |
| Bull Run River | OR_SR_1708000105_11_103611 | 2004 | Spawning, Year Round |
| Bull Run River | OR_SR_1708000105_11_103688 | 2004 | Year Round |
| Cedar Creek | OR_SR_1708000104_02_103607 | 2004 | Year Round |
| Cedar Creek-Sandy River Watershed | OR_WS_170800010402_02_103644 | 2004 | Year Round |
| Clear Creek | OR_SR_1708000101_02_103597 | 2004 | Spawning, Year Round |
| Clear Fork | OR_SR_1708000101_02_103596 | 2018 | Spawning |
| Gordon Creek | OR_SR_1708000107_02_103617 | 2004 | Spawning |
| Headwaters Sandy River Watershed | OR_WS_170800010101_02_103635 | 2010 | Year Round |
| Little Sandy River | OR_SR_1708000105_11_103609 | 2004 | Spawning, Year Round |
| Little Sandy River Watershed | OR_WS_170800010505_11_103669 | 2018 | Year Round |
| Lower Bull Run River Watershed | OR_WS_170800010506_11_103650 | 2004 | Year Round |
| Lower Salmon River Watershed | OR_WS_170800010304_02_103642 | 2004 | Year Round |
| Middle Bull Run River Watershed | OR_WS_170800010503_11_103648 | 2018 | Year Round |
| Salmon River | OR_SR_1708000103_02_103606 | 2004 | Spawning, Year Round |
| Sandy River | OR_SR_1708000101_02_103595 | 2004 | Year Round |
| Sandy River | OR_SR_1708000101_02_103599 | 2004 | Year Round |
| Sandy River | OR_SR_1708000104_02_103608 | 2004 | Spawning, Year Round |
| Sandy River | OR_SR_1708000107_02_103616 | 2004 | Year Round |
| Sandy River | OR_SR_1708000101_02_103599 | 2018 | Spawning |
| South Fork Bull Run River | OR_SR_1708000105_11_103610 | 2018 | Year Round |
| South Fork Salmon River | OR_SR_1708000103_02_103604 | 2004 | Spawning |
| Still Creek | OR_SR_1708000102_02_103601 | 2004 | Spawning |
| Tanner Creek-Columbia River Watershed | OR_WS_170800010801_15_103707 | 2018 | Spawning, Year Round |

| Assessment Unit Name | Assessment Unit ID | Year Listed | Use Period |
|---|---|---|---|
| Wildcat Creek-Sandy River Watershed | OR_WS_170800010401_02_103643 | 2004 | Spawning |
| Zigzag River | OR_SR_1708000102_02_103600 | 2004 | Spawning |
| Zigzag River | OR_SR_1708000102_02_103602 | 2004 | Spawning |

# 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 ($\Delta Tw$) 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,*

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

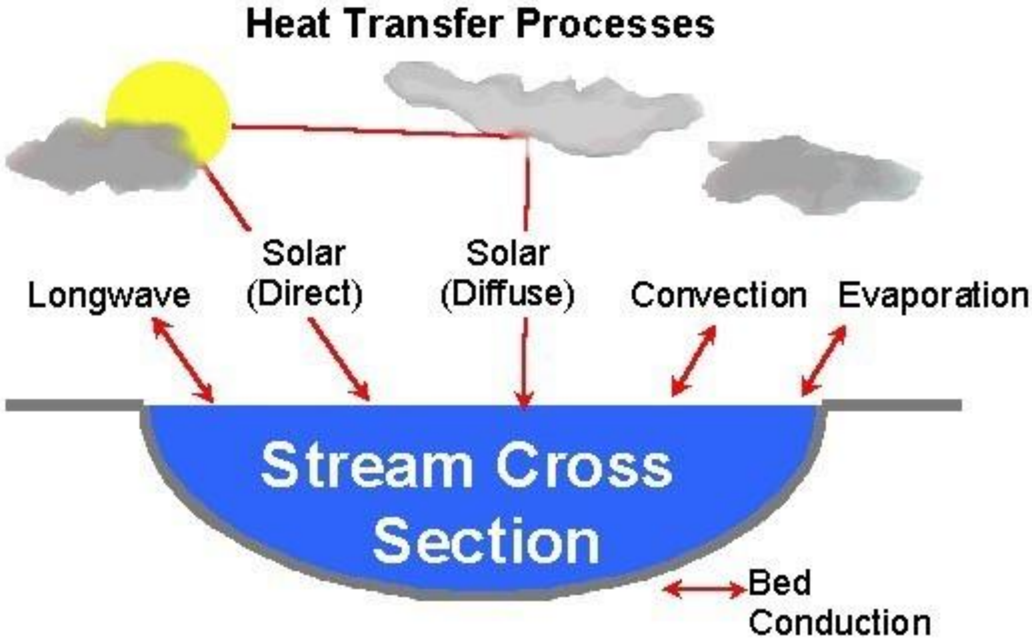


**Figure 1: Major heat transfer processes.**

**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,
$\Phi_{total}$ = Net heat energy flux (+/-)
$\Phi_{solar}$ = 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.

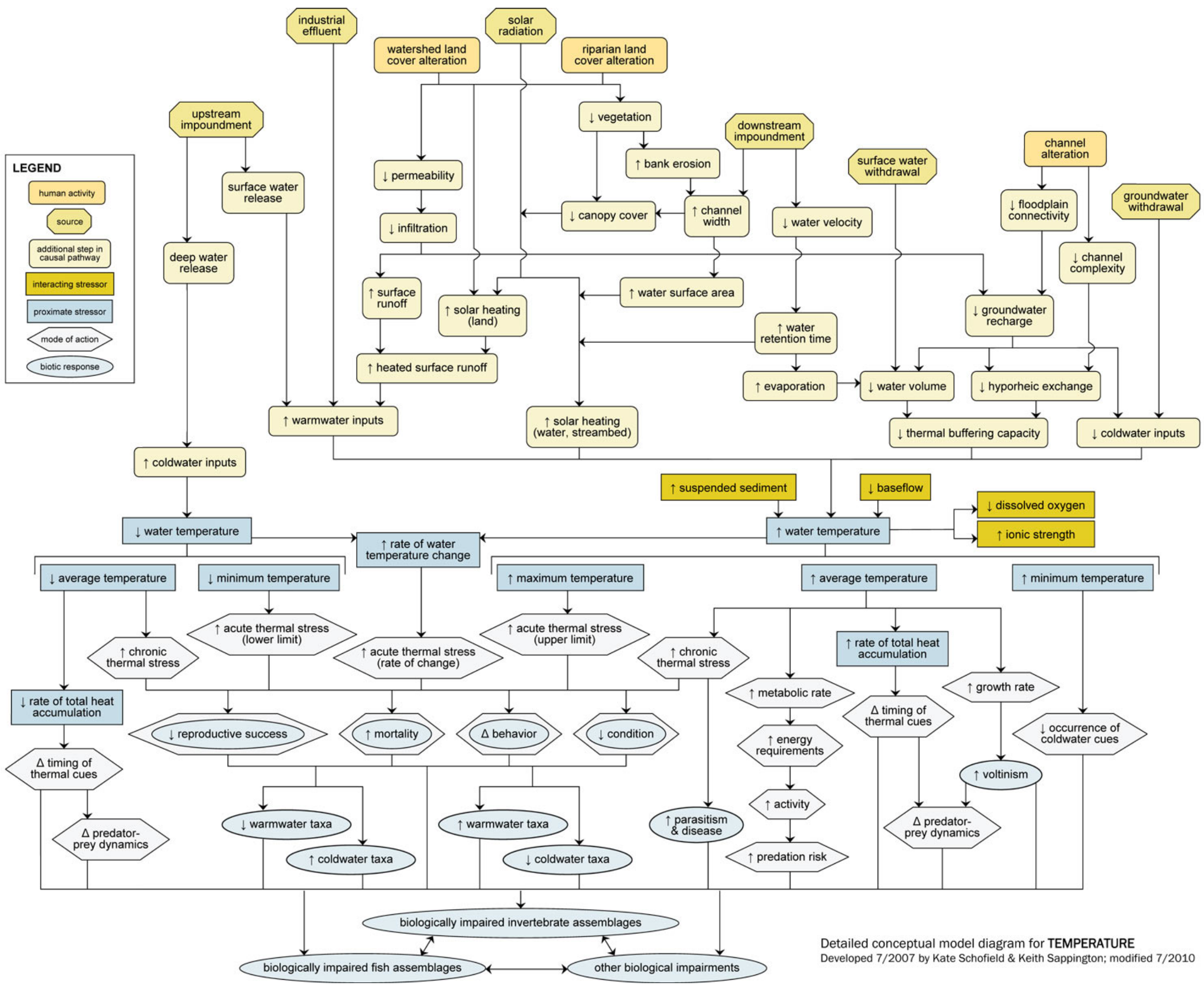


**Figure 2: Conceptual diagram that identifies the key processes and variables that drive stream temperature changes and the biological responses (Schofield and Sappington, 2010).**

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 Sandy 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 2005 Sandy River Basin TMDL (DEQ, 2005) were simulated using a computer model (Heat Source version 6 temperature model). New temperature models are proposed using Heat Source version 8 and potentially CE-QUAL-W2 version 4.2. The models extents include most of the main rivers and their larger tributaries that contain or influence primary fish habitat. 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) was used to model several streams for the development of the 2005 Sandy Basin TMDL. Because these models already exist and meet all the model framework needs, Heat Source 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).

The CE-QUAL-W2 model (Wells, 2019) also meets the model framework needs and has been used by Portland State University and The City of Portland (Annear, et al., 1999, City of Portland, 2004) to model the Bull Run River and reservoirs.

## 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 44 through Table 46 in Appendix A list the stations where meteorological data available in the Sandy Subbasin, including 21 stations from National Oceanic and Atmospheric Association (NOAA)'s National Climatic Data Center (NCDC), 55 stations from University of Utah MesoWest database, and 2 stations from DEQ's files. 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 44 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 Sandy Subbasin (Watershed Sciences, 2001). 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 Sandy Subbasin.**

| Stream | Survey Extent | Date | Time | Survey Distance |
|---|---|---|---|---|
| Bull Run River | Mouth to Bull Run Lake | 2001-08-08 | 13:54-14:36 | 23.42 mi |
| Little Sandy River | Mouth to headwaters | 2001-08-08 | 14:44-14:59 | 15.05 mi |
| Salmon River | Mouth to headwaters | 2001-08-08 | 15:11-16:24 | 32.36 mi |
| Sandy River | Mouth to headwaters | 2001-08-09 | 14:02-14:31 | 53.33 mi |
| South Fork Bull Run River | Mouth to headwaters | 2001-08-09 | 14:38-15:50 | 6.31 mi |
| South Fork Salmon River | Mouth to headwaters | 2001-08-09 | 14:58-15:08 | 5.18 mi |
| Zigzag River | Mouth to headwaters | 2001-08-09 | 15:57-16:19 | 12.38 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 147 locations where continuous stream temperature data were collected in the Sandy Subbasin and the organizations that collected that data in Table 47, and when data were collected at each location in Table 48. 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 49 through Table 51 in Appendix C list the stations where continuous flow volume data were available in the Sandy Subbasin, including 18 stations from USGS, 1 station from OWRD, and 2 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. Table 52 lists the locations where instantaneous flow volume measurements made by DEQ were available. 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 Sandy Subbasin. Table 4 lists the registrants covered under the general NPDES GEN03 and GEN40 (MS4) permits in the Sandy Subbasin. 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 Sandy Subbasin that are not listed in Table 4.

**Table 3: Summary of individual NPDES permitted discharges in the Sandy Subbasin.**

| Facility Name (Facility Number) | Latitude/Longitude | Permit Type and Description | Stream/River Mile |
|---|---|---|---|
| City Of Troutdale Water Pollution Control Facility (89941) | 45.5535/-122.387 | NPDES-DOM-C2a: Sewage - 1 MGD or more but less than 2 MGD | Sandy River RM 2.3 |
| Government Camp STP (34136) | 45.3023/-121.776 | NPDES-DOM-Da: Sewage - less than 1 MGD | Camp Creek RM 6.4 |
| WES (Hoodland STP) (39750) | 45.3464/-121.969 | NPDES-DOM-Da: Sewage - less than 1 MGD | Sandy River RM 41 |

**Table 4: Summary of current registrants under the general NPDES GEN03 and GEN40 (MS4) permits in the Sandy Subbasin.**

| Facility Name (Facility Number) | Latitude/Longitude | Permit Type and Description | Stream/River Mile |
|---|---|---|---|
| ODFW - SANDY RIVER HATCHERY (64550) | 45.407/-122.254 | GEN03: Industrial Wastewater; NPDES fish hatcheries | Cedar Creek RM 0.7 |
| TROUTDALE MUNICIPAL STORMWATER, MS4 (110793) | 45.5282/-122.398 | GEN40: 4000 MS4-Phase 2 General Permit – Water Quality NPDES General Permit | Multiple discharge locations |

**Table 5: Summary of the current number of registrants for all the other general NPDES permits in the Sandy Subbasin that are not listed in Table 4.**

| Permit Type and Description | Current Number of Registrants |
|---|---:|
| GEN12A: Stormwater; NPDES sand & gravel mining | 3 |
| GEN12C(AGENT): Stormwater; NPDES construction more than 1 acre disturbed ground, issued by agent | 3 |
| GEN12C: Stormwater; NPDES construction more than 1 acre disturbed ground | 18 |
| GEN12Z: Stormwater; NPDES specific SIC codes | 2 |

## 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.

## 5.7 Effective shade measurements

Effective shade is the percent of potential daily solar radiation flux that is blocked by vegetation and topography. DEQ and/or partner agency staff used an instrument called a solar pathfinder to collect effective shade measurements in the field. The effective shade measurement methods and quality control procedures used are outlined in the Water Quality Monitoring Technical Guide Book (OWEB, 1999) and the solar pathfinder manual (Solar Pathfinder, 2016). Table 6 lists the locations where effective shade measurements were collected and the effective shade value for August 2021.

**Table 6: Effective shade data collected in the Sandy Subbasin.**

| Station ID | Station | Latitude/Longitude | Effective Shade | Data Source |
|---|---|---|---|---|
| 10676-ORDEQ | Sandy above Salmon near Brightwood | 45.3786/-122.013 | 0% | DEQ |
| 10677-ORDEQ | Salmon River at mouth HWY 26 | 45.3725/-122.021 | 61% | DEQ |
| 11021-ORDEQ | Beaver Creek near Mouth | 45.5414/-122.383 | 55% | DEQ |
| 11025-ORDEQ | Gordon Creek at mouth | 45.4933/-122.277 | 91% | DEQ |
| 26385-ORDEQ | Gordon Creek at NF boundary | 45.5286/-122.125 | 94% | DEQ |
| 26387-ORDEQ | Bull Run at County bridge #160 | 45.4284/-122.233 | 50% | City of Portland |
| 26388-ORDEQ | Bull Run below Little Sandy Bo | 45.4252/-122.217 | 69% | City of Portland |
| 26389-ORDEQ | Little Sandy at mouth | 45.4261/-122.207 | 100% | City of Portland |
| 26390-ORDEQ | Little Sandy above Diversion | 45.4153/-122.171 | 56% | DEQ |
| 26391-ORDEQ | Little Sandy at Road 14 | 45.4037/-122.172 | 69% | DEQ |

| Station ID | Station | Latitude/Longitude | Effective Shade | Data Source |
|---|---|---|---|---|
| 26392-ORDEQ | Bull Run above Little Sandy | 45.4273/-122.207 | 31% | City of Portland |
| 26393-ORDEQ | Bull Run at Larson's bridge | 45.4318/-122.194 | 20% | City of Portland |
| 26394-ORDEQ | Bull Run at Lower BR gage | 45.4375/-122.18 | 68% | City of Portland |
| 26395-ORDEQ | Bull Run below Plunge Pool | 45.4444/-122.16 | 25% | City of Portland |
| 26397-ORDEQ | Bull Run at USGS gage 14138850 | 45.5535/-122.387 | 78% | City of Portland |
| 26398-ORDEQ | Bull Run at RM17.6 above Falls Creek | 45.5086/-121.968 | 5-30% | City of Portland |
| 26399-ORDEQ | Falls Creek at Mouth | 45.5088/-121.968 | 15-40% | City of Portland |
| 26400-ORDEQ | Bull Run below Blazed Alder RM | 45.4965/-121.921 | 0% | City of Portland |
| 26401-ORDEQ | Blazed Alder at Mouth | 45.4964/-121.921 | 9% | City of Portland |
| 26402-ORDEQ | Bull Run above Blazed Alder | 45.4961/-121.921 | 58% | City of Portland |
| 26406-ORDEQ | Cedar Creek at Hwy. 26 | 45.3671/-122.162 | 89% | DEQ |
| 26409-ORDEQ | Alder Creek at mouth | 45.3773/-122.101 | 92% | DEQ |
| 26410-ORDEQ | Wildcat Creek at mouth | 45.3758/-122.083 | 100% | DEQ |
| 26412-ORDEQ | Salmon River at East Bridge Rd. | 45.3207/-121.955 | 65% | DEQ |
| 26413-ORDEQ | S. Fork Salmon River at mouth | 45.2721/-121.939 | 80% | DEQ |
| 26414-ORDEQ | Salmon River above S. Fork | 45.2725/-121.938 | 71% | DEQ |
| 26415-ORDEQ | Salmon R at Hwy. 26/35 USGS gage | 45.2665/-121.719 | 88-94% | DEQ |
| 26416-ORDEQ | Zigzag River at mouth Lolo Pass Rd. | 45.3471/-121.942 | 19% | DEQ |
| 26417-ORDEQ | Still Creek at mouth Still Creek Rd. | 45.3302/-121.916 | 92% | DEQ |
| 26418-ORDEQ | Zigzag River above Still Creek | 45.3297/-121.912 | 72% | DEQ |
| 26419-ORDEQ | Camp Creek at mouth | 45.3035/-121.87 | 88-100% | DEQ |

| Station ID | Station | Latitude/Longitude | Effective Shade | Data Source |
|---|---|---|---|---|
| 26420-ORDEQ | Zigzag River above Camp Creek HWY 26 | 45.311/-121.89 | 95-100% | DEQ |
| 26421-ORDEQ | Clear Creek at mouth at Barlow Tr Rd. | 45.3595/-121.937 | 84% | DEQ |
| 26422-ORDEQ | Sandy above Clear Creek at Lolo Pass Rd. | 45.3565/-121.938 | 61% | DEQ |
| 26423-ORDEQ | Sandy above Lost Creek at Rd 1825 | 45.385/-121.871 | 37% | DEQ |
| 26424-ORDEQ | Camp Creek above Govt. Camp STP | 45.3017/-121.777 | 96% | DEQ |
| 26428-ORDEQ | PGE Bull Run Project Tailrace | 45.4295/-122.234 | 80% | DEQ |
| No Station ID | Sandy River at Troutdale STP | 45.4982/-122.01 | 11% | DEQ |

# 6 Model development and calibration

Waterbodies where model development was initiated for the Sandy River Basin TMDL (DEQ, 2005) are listed in Table 7. The waterbodies listed in Table 8 will have new models developed. 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 7: Waterbodies where a model has already been developed. The model year is identified if another year is proposed for a new model on the same waterbody.**

| Model Version | Model Waterbody |
|---|---|
| Heat Source version 6 temperature model | Bull Run River (2001), Little Sandy River, Salmon River (2001), Sandy River (2001), Zigzag River |

The setup and calibration for the models listed in Table 7 was completed by DEQ and documented in the Sandy River Basin TMDL (DEQ, 2005). 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.

**Table 8: Waterbodies and year for which new models are expected to be developed.**

| Model Version | Model Waterbody |
|---|---|
| Heat Source version 8 temperature model | Bull Run River (2016), Salmon River (2016), Sandy River (2016) |
| CE-QUAL-W2 version 4.2 | Bull Run River (2016) |

The models for the Little Sandy River and Zigzag River were originally developed for the Sandy River Basin TMDL (DEQ, 2005) and will also be used to support the updated TMDL. The models for the Sandy River, Bull Run River, and Salmon River (Table 8) are new and will supplement the models that were developed for the 2005 TMDL.

A new calibrated model is being developed on the Sandy River to characterize the current hydrology and channel morphology conditions post Marmot Dam removal. The existing (2001) calibrated model was developed before the removal of the Marmot Dam. The Bull Run River and Salmon River are major tributaries to the Sandy River. New calibrated models are being setup on these rivers for the same year as the Sandy River (2016) to support development of boundary conditions and model linkage under various management scenarios. The Bull River model will also support estimating background conditions for a longer period of time compared to the 2001 model. The 2001 model only simulated a single day. Separating the background loading from anthropogenic loading over the entire season when the applicable criteria are exceeded will support development of appropriate load allocations and potentially surrogate measures for the City of Portland Bull Run Dams and Reservoirs. DEQ considered developing an updated model for the Zigzag River but there are insufficient temperature data to support a new model in 2016.

DEQ will develop effective shade curves for all other waterbodies that were not specifically listed in Table 7 and Table 8. 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 Sandy River Basin TMDL (DEQ, 2005). 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 CE-QUAL-W2 version 4

The CE-QUAL-W2 version 4 model is a 2-dimensional hydrodynamic and water quality model that incorporates temperature (heat) into its hydrodynamic and water quality subroutines. The heat budget model theory for CE-QUAL-W2 is similar to Heat Source, though its implementation in the model and the level of detail are different. CE-QUAL-W2 is two dimensional in the longitudinal and vertical directions, and the vertical dimension allows for modeling temperature profiles as a function of depth in the water column. This feature is critical for deeper water bodies, such as reservoirs, larger rivers and estuaries where light penetration and density profiles are not easily estimated uniformly throughout the water column. Documentation for CE-QUAL-W2, and the inputs used to set up and calibrate the model, are provided in the CE-QUAL-W2 user’s manual (Wells, 2019).

### 6.1.2 Heat Source version 6

Table 9 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 9: 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 |

| Input Type | Input | Units | Calibration Parameter |
|---|---|---|---|
| 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 |
| 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 |

### 6.1.3 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 10 summarizes the list of model parameters that are different between Heat Source version 6 and Heat Source version 8.

**Table 10: 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 |

| Input Type | Input | Units | V6 | V8 | Calibration Parameter |
|---|---|---|---|---|---|
| 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 |
| 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 |

| Input Type | Input | Units | V6 | V8 | Calibration Parameter |
|---|---|---|---|---|---|
| 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 11 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 11: 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. |

| Method | Possible Parameters | Description |
|---|---|---|
| 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). |
| 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). |

| Method | Possible Parameters | Description |
|---|---|---|
| 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 Sandy River Basin TMDL (DEQ, 2005). 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 Sandy River Basin TMDL (DEQ, 2005). The other model inputs are the same as what is described in Table 12.
- Effective shade lookup tables: Model input values to be used for the lookup tables are described in Table 12.

**Table 12: Range of model inputs to be used for effective shade lookup tables.**

| Model Input | Value Range |
|---|---|
| Vegetation height (meters) | 0 - 90 (or expected maximum) |

| Model Input | Value Range |
|---|---|
| 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 Bull Run River (2001)

The Bull Run River (2001) 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 the Bull Run River from the mouth upstream to Bull Run Headworks at Bull Run Reservoir Number 2. 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

For the discussion of source characteristics, see Section 6.5.3 for the updated Bull Run River (2016) model.

### 6.4.4 Time frame of simulation

The model period is for a single day: August 08, 2001.

### 6.4.5 Important assumptions

The effort currently described in the QAPP includes use of existing models and the development of new models to capture post-dam removal conditions. Key calibration assumptions made during the model setup and calibration process were documented in the original TMDL (DEQ, 2005), the Heat Source model user guide (Boyd and Kasper, 2003) or in Section 6 and Section 7 of this document.

### 6.4.6 Model inputs

Table 13 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 13: Boundary condition and tributary inputs to the existing Bull Run River (2001) Heat Source Model.**

| Model Location Name (Station ID) | Model Location (meters) | Input Type | Model Input | Data Source | Note |
|---|---|---|---|---|---|
| Bull Run River at Headworks (26396-ORDEQ) | 0 | Boundary Condition | Water Temperature | City of Portland | Data not in AWQMS. |
| Deer Creek | 8498.36 | Tributary | Flow | Derived data. | Flow input is constant. |
| Bull Run Power House inflow | 7608.64 | Tributary | Flow | Derived data. | Flow input is constant. |
| Little Sandy River | 5154.24 | Tributary | Flow | Derived data. | Flow input is constant. |
| No Name Site at model meter 4417.92 | 4417.92 | Tributary | Flow | Derived data. | Flow input is constant. |
| Spring at model meter 3344.12 | 3344.12 | Tributary | Flow | Derived data. | Flow input is constant. |
| No Name Site at model meter 1902.16 | 1902.16 | Tributary | Flow | Derived data. | Flow input is constant. |
| Deer Creek (26410-ORDEQ) | 8498.36 | Tributary | Water Temperature | Derived data. DEQ | Used temperature data from Wildcat Creek (26410-ORDEQ). Data not in AWQMS. |
| Bull Run Power House inflow | 7608.64 | Tributary | Water Temperature | DEQ File | |
| Little Sandy River (26389-ORDEQ) | 5154.24 | Tributary | Water Temperature | City of Portland | Data not in AWQMS. |
| No Name Site at model meter 4417.92 (26410-ORDEQ) | 4417.92 | Tributary | Water Temperature | Derived data. DEQ | Used temperature data from Wildcat Creek (26410-ORDEQ). Data not in AWQMS. |

| Model Location Name (Station ID) | Model Location (meters) | Input Type | Model Input | Data Source | Note |
|---|---|---|---|---|---|
| Spring at model meter 3344.12 (TIR) | 3344.12 | Tributary | Water Temperature | Derived data. Watershed Sciences (2001) | Derived from TIR. Constant temperature of 12.0 deg-C. |
| No Name Site at model meter 1902.16 (26410-ORDEQ) | 1902.16 | Tributary | Water Temperature | Derived data. DEQ | Used temperature data from Wildcat Creek (26410-ORDEQ). Data not in AWQMS. |
| 14140000 | 0, 276, 1350, 3804, 5093, 5983, 7455 | Meteorological | Air Temperature, Relative Humidity, Wind Speed | USGS | |

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 14. The model location in the table below describes the distance of each input from the most upstream model node. Effective shade model calibrations sites are summarized in Table 6. The model inputs and parameters that are expected to be modified to improve model fit are described in Section 6.1.

**Table 14: Calibration sites and parameters used in the existing Bull Run River (2001) Heat Source Model.**

| Model Location Name (Station ID) | Model Location (meters) | Calibration Parameter | Data Source |
|---|---|---|---|
| Bull Run River at County Bridge (26387-ORDEQ) | 7455 | Water Temperature | City of Portland |
| Bull Run River below Little Sandy River (26388-ORDEQ) | 5983 | Water Temperature | City of Portland |
| Bull Run River above Little Sandy River (26392-ORDEQ) | 5093 | Water Temperature | City of Portland |
| Bull Run River at Larsons Bridge (26393-ORDEQ) | 3804 | Water Temperature | City of Portland |
| Bull Run River at lower Bull Run Gage (26394-ORDEQ) | 1350 | Water Temperature | City of Portland |

| Model Location Name (Station ID) | Model Location (meters) | Calibration Parameter | Data Source |
|---|---|---|---|
| Bull Run River below Plunge Pool (26395-ORDEQ) | 276 | Water Temperature | City of Portland |
| Model extent | Model extent | Water Temperature (TIR) | Watershed Sciences (2001) |

# 6.5 Bull Run River (2016)

The Bull Run River (2016) model is a temperature model developed using Heat Source 8.0.8. The model will be developed by DEQ. The City of Portland Water Bureau is also developing a temperature model of the Bull Run River using CE-QUAL-W2 version 4.2 for the full 2016 calendar year. This model is an update to an older CE-QUAL-W2 model originally calibrated to the summer period in1999. The model was developed by Portland State University for the City of Portland (Annear et al 1999, Annear and Wells 2002). DEQ may consider using the updated CE-QUAL-W2 model instead of Heat Source for TMDL development after DEQ has reviewed the model and determined the model setup and calibration results achieve the quality acceptance criteria identified in Chapter 7. Documentation of the model will follow the same procedures outlined in Chapter 8. Except where noted, the model setup and calibration described in this section are applicable to both models.

## 6.5.1 Model domain

The extent of the model domain is the Bull Run River from the mouth upstream to Bull Run Dam 2. 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 Heat Source model input spatial resolution (*dx*) is 50 meters. Outputs are generated every 50 meters. The model time step (*dt*) is 1 minute and outputs are generated every hour.

A *dx* of 50 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.

The spatial and temporal resolution for the CE-QUAL-W2 model is as follows:

- Number of waterbodies in the computational grid [NWB]: 12
- Number of branches in the computational grid [NBR]: 15
- Number of segments in the computational grid [IMX]: 100 (70 active segments, 30 boundary segments)
- Number of layers in the computational grid [KMX]: 19 (17 active segments, 2 boundary segments)
- Layer height (minimum – maximum) [H]: 0.1 meters – 4 meters
- Segment length (minimum – maximum) [DLX]: 45 meters - 248 meters

- Number of timestep intervals [NDT]: 7
- Minimum/Maximum timestep [DLTMIN/DLTMAX]: 0.01 – 0.7 minutes

### 6.5.3 Source characteristics

The majority land use along the Bull Run River (2016) is forestry accounting for about 97 percent of the near-stream area. Table 15 summarizes all the land uses within 100 meters of the digitized Bull Run River (2016) 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.

There are no permitted NPDES point sources in the Bull Run Watershed.

**Table 15: Summary of land uses within 100 meters of the digitized Bull Run River (2016) centerline based on the 2016 National Land Cover Database (Yang et al., 2018).**

| 2016 NLCD Land Cover | Acres | Percent of Total Acres |
|---|---|---|
| Evergreen Forest | 288.0 | 63.1 |
| Mixed Forest | 89.8 | 19.7 |
| Deciduous Forest | 39.6 | 8.7 |
| Shrub/Scrub | 16.0 | 3.5 |
| Developed, Open Space | 10.0 | 2.2 |
| Herbaceous | 7.1 | 1.6 |
| Emergent Herbaceous Wetlands | 3.8 | 0.8 |
| Woody Wetlands | 1.6 | 0.4 |
| Barren Land | 0.2 | <0.05 |
| Hay/Pasture | 0.2 | <0.05 |

The City of Portland's drinking water supply project is the primary source of anthropogenic warming in the Bull Run River (DEQ, 2005). The project consists of two storage reservoirs (Dam Numbers 1 and 2) and a dam structure on Bull Run Lake, a natural water body near the headwaters. In 1929, the City of Portland's Water Bureau completed construction of Bull Run Dam 1, a concrete gravity arch dam, creating Reservoir 1 (also known as Lake Ben Morrow). The maximum capacity for Reservoir 1 is ten billion gallons. Dam 1 has a selective withdrawal structure that allows water to be withdrawn at different elevations in the reservoir allowing some control over stream temperatures. The water surface elevation in Reservoir 1 varies between 970 and 1,045 feet above mean sea level.

Dam 2 is an earthfill dam four miles downstream of Dam 1. Dam 2 was completed in 1962 and the reservoir has a maximum capacity of 6.8 billion gallons. In 2014 a selective withdrawal structure was completed on the intake towers at Dam 2. The city tries to keep the reservoir at Dam 2 as full as possible throughout the year, including the summer months. The surface elevation varies between 840 and 860 feet above mean sea level.

The project has a license to produce electricity (FERC License No. 2821). Most of the time water is routed through the powerhouses, located immediately downstream of the dams before being returned to the Bull Run River. Less frequently, water is routed over the spillways during large winter storms that produce flows that exceed the powerhouse capacities. In 2029 the FERC license is scheduled to expire.

Bull Run Lake is a natural lake above the headwaters of Bull Run River, though a dam structure has been added to increase the elevation by 10 feet and the subsequent storage capacity of the lake. The lake does not have a surface water connection to Bull Run River and was formed from a landslide sometime before European settlement. Seepage through porous geologic features surrounding the lake contributes significant stream flow into the Bull Run River. The U.S. Forest Service issues a special use permit to the City of Portland to withdrawal water from the lake for municipal water supplies. Water from the lake is used for drinking water supply only during dry years. The permit restricts the withdrawal to ensure adequate water is available to support the ecosystem.

Based on modeling completed for the 2005 TMDL (DEQ, 2005), the drinking water supply project results in cooler temperatures downstream of Dam 2 in August compared to temperatures under natural flows. The TMDL model focused on a single day, August 8, 2001, and did not evaluate temperature impacts during other periods. The 2005 TMDL established a surrogate measure temperature target at Larson’s Bridge. This location corresponds to where the model predicted the maximum stream temperatures occur. Based on monitoring information provided by the City of Portland to DEQ, the project typically attains the surrogate measure during the summer period and has more difficulty attaining the target in autumn when the supply of cooler water is diminished and the reservoirs become less thermally stratified.

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 16).

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 16 summarizes the potential designated management agencies and responsible persons along the Bull Run River (2016) model extent.

**Table 16: Summary of potential designated management agencies (DMAs) or responsible persons within 100 meters of the digitized Bull Run River (2016) centerline.**

| DMA or Responsible Person | Acres | Percent of Total Acres |
|---|---|---|
| City of Portland | 311.5 | 61.9 |
| Oregon Department of Forestry - Private Forestland | 93.4 | 18.5 |
| U.S. Forest Service | 65.8 | 13.1 |
| Oregon Department of State Lands - Waterway | 20.8 | 4.1 |
| Clackamas County | 8.5 | 1.7 |
| U.S. Government | 3.6 | 0.7 |

### 6.5.4 Time frame of simulation

The Heat Source model period is June 15, 2016 to October 31, 2016. The CE-QUAL-W2 model period is January 1, 2016 to December 31 2016.

### 6.5.5 Important assumptions

Model development for the Bull Run River relies on deriving temperature or flow inputs from a few small tributaries (Table 17). DEQ plans to use the direct surrogate or linear regression approaches described in Section 6.2 to derive stream temperature, and a combination of a flow mass balance, drainage area ratio, and the flow-probability-probability-flow approaches to estimate stream flow. It assumed that these approaches do a reasonably good job of estimating the tributary temperature or flow. DEQ will assess the goodness of fit for these approaches where measured temperature or flow data are available.

DEQ will review the vegetation conditions at sites where effective shade measurements were made in August of 2001 (Table 6) and compare those conditions to vegetation conditions observed in 2016. If the conditions do not appear to have changed significantly DEQ will use the effective shade measured in 2001 as a rough guide for model calibration purposes with the assumption that the shade will likely be about the same or have increased since 2001 if site conditions look similar.

Other key assumptions about model constants are described in the Heat Source model user guide (Boyd and Kasper, 2003) or in Section 6 and Section 7 of this document.

### 6.5.6 Model inputs

Table 17 summarizes the expected configuration of the model input parameters and the source of these data. Temperature, flow, and meteorological input parameters are summarized.

**Table 17: Boundary condition and tributary inputs to the Bull Run River (2016) Heat Source Model.**

| Model Location Name (Station ID) | Model Location (kilometers) | Input Type | Model Input | Data Source | Note |
|---|---|---|---|---|---|
| Bull Run Dam 2 outflow | 10.5 | Boundary Condition | Flow | City of Portland Water Bureau | |
| Bull Run River immediately upstream of Lamprey Barrier (PWB_D2_LampB) | 10.5 | Boundary Condition | Water Temperature | City of Portland Water Bureau | |
| Unnamed Tributary in TIR image br0252 | 7.9 | Tributary | Flow | Derived data. | |
| Spring (LB) in TIR image br0214 | 6.45 | Tributary | Flow | Derived data. | |
| Little Sandy River (14141500) | 4.8 | Tributary | Flow | USGS | |
| Deer Creek | 1.6 | Tributary | Flow | Derived data. | |

| Model Location Name (Station ID) | Model Location (kilometers) | Input Type | Model Input | Data Source | Note |
|---|---|---|---|---|---|
| Unnamed Tributary in TIR image br0252 (TIR) | 7.9 | Tributary | Water Temperature | Derived data. Watershed Sciences (2001) | Derived from TIR. Constant temperature of 15.0 deg-C. |
| Spring (LB) in TIR image br0214 (TIR) | 6.45 | Tributary | Water Temperature | Derived data. Watershed Sciences (2001) | Derived from TIR. Constant temperature of 12.4 deg-C. |
| Little Sandy River (MHNF-050) | 4.8 | Tributary | Water Temperature | USFS | |
| Deer Creek (PWB_Gordon_Mouth) | 1.6 | Tributary | Water Temperature | Derived data. City of Portland Water Bureau | Use temperature data from Gordon Creek (PWB_Gordon_Mouth) |
| 10009634 - Portland Troutdale Airport | 9.5 | Meteorological | Cloudiness | NCDC | |
| Bull Run Headworks | 9.5 | Meteorological | Air Temperature, Relative Humidity, Wind Speed | City of Portland | |

Hourly meteorology inputs into the model include air temperature, cloudiness, relative humidity, and wind speed. Air temperature data may be modified using the dry adiabatic lapse rate to adjust for differences in elevation between the measurement location and the model input location. Wind speeds may be 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 18. The model location in the table below describes the distance of each input from the most downstream model node. Effective shade model calibrations sites are summarized in Table 6. The model inputs and parameters that are expected to be modified to improve model fit are described in Section 6.1.

**Table 18: Calibration sites and parameters used in the Bull Run River (2016) Heat Source Model.**

| Model Location Name (Station ID) | Model Location (kilometers) | Calibration Parameter | Data Source |
|---|---|---|---|
| Bull Run River Near Bull Run (River Only) (14140000) | 7.55 | Flow | USGS |
| Bull Run River approximately 600 feet downstream of Bull Run Dam 2 spillway plunge pool (PWB_BR_DNSTM_PP) | 9.50 | Water Temperature | City of Portland Water B ureau |
| Bull Run River approximately 60 feet upstream of Rd 14 ( Southside) bridge (PWB_BR_SS_BR) | 7.70 | Water Temperature | City of Portland Water B ureau |
| Bull Run River at Larson's Bridge, Near Bull Run, OR (14140020) | 6.05 | Water Temperature | USGS |
| Bull Run River 20 feet downstream of Bowman's Bridge (PWB_BR_BWMN_BR) | 3.95 | Water Temperature | City of Portland Water B ureau |
| Bull Run River approximately 500 feet upstream of Sandy River confluence (PWB_BR_DODGE) | 0.15 | Water Temperature | City of Portland Water B ureau |

## 6.6 Little Sandy River

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

### 6.6.1 Model domain

The extent of the model domain is the Little Sandy River from the mouth upstream to Road 14. 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 Little Sandy River include increases in solar radiation loading from background sources and the disturbance or removal of near-stream vegetation for a few really short reaches from river miles 1.8 - 1.9 and river miles 9.7 - 10.6 (DEQ, 2005). Other potential sources include warming caused by climate change.

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

The majority land use along the Little Sandy River is forestry accounting for about 100 percent of the near-stream area. Table 19 summarizes all the land uses within 100 meters of the digitized Little Sandy 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 19: Summary of land uses within 100 meters of the digitized Little Sandy 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 | 1128.4 | 88.3 |
| Mixed Forest | 77.2 | 6 |
| Shrub/Scrub | 47.4 | 3.7 |
| Deciduous Forest | 18.5 | 1.4 |
| Developed, Open Space | 2.7 | 0.2 |
| Hay/Pasture | 2.4 | 0.2 |
| Herbaceous | 0.7 | 0.1 |
| Woody Wetlands | 0.2 | <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 20).

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 20 summarizes the potential designated management agencies and responsible persons along the Little Sandy River model extent.

**Table 20: Summary of potential designated management agencies (DMAs) or responsible persons within 100 meters of the digitized Little Sandy River centerline.**

| DMA or Responsible Person | Acres | Percent of Total Acres |
|---|---:|---|
| U.S. Forest Service | 881.4 | 68.4 |
| U.S. Bureau of Land Management | 341.7 | 26.5 |
| Oregon Department of Forestry - Private Forestland | 55.5 | 4.3 |
| City of Portland | 7.5 | 0.6 |
| U.S. Government | 2.2 | 0.2 |
| Oregon Department of Agriculture | 0.5 | <0.05 |

#### 6.6.4 Time frame of simulation

The model period is for a single day: August 09, 2001.

#### 6.6.5 Important assumptions

The effort currently described in the QAPP includes use of existing models with no changes to the models since their previous calibration. Key calibration assumptions made during the model setup and calibration process were documented in the original TMDL (DEQ, 2005) and the Heat Source model user guide (Boyd and Kasper, 2003).

#### 6.6.6 Model inputs

Table 21 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 21: Boundary condition and tributary inputs to the existing Little Sandy River Heat Source Model.**

| Model Location Name (Station ID) | Model Location (meters) | Input Type | Model Input | Data Source | Note |
|---|---|---|---|---|---|
| Little Sandy at Road 14 (26391-ORDEQ) | 0 | Boundary Condition | Water Temperature | DEQ | Data not in AWQMS. |
| Groundwater Accretion | 16368 | Tributary | Flow | Derived data. | Flow input is constant. |
| Groundwater Accretion | 15758 | Tributary | Flow | Derived data. | Flow input is constant. |
| Marmot in flow | 14325.6 | Tributary | Flow | Derived data. | Flow input is constant. |
| No Name Site at model meter 4724.4 | 4724.4 | Tributary | Flow | Derived data. | Flow input is constant. |
| Spring at model meter 4206.24 | 4206.24 | Tributary | Flow | Derived data. | Flow input is constant. |
| Spring at model meter 4084.32 | 4084.32 | Tributary | Flow | Derived data. | Flow input is constant. |
| Spring at model meter 1554.48 | 1554.48 | Tributary | Flow | Derived data. | Flow input is constant. |
| Groundwater Accretion | 16368 | Tributary | Water Temperature | Derived data. | Constant temperature of 13.0. |

| Model Location Name (Station ID) | Model Location (meters) | Input Type | Model Input | Data Source | Note |
|---|---|---|---|---|---|
| Groundwater Accretion | 15758 | Tributary | Water Temperature | Derived data. | Constant temperature of 13.0. |
| Marmot in flow | 14325.6 | Tributary | Water Temperature | Derived data. DEQ | Used temperature data from Sandy River at Marmot Gage (26408-ORDEQ). |
| No Name Site at model meter 4724.4 | 4724.4 | Tributary | Water Temperature | Derived data. DEQ | Used temperature data from Badger Creek at Coleman (26407-ORDEQ) on 8/9. |
| Spring at model meter 4206.24 | 4206.24 | Tributary | Water Temperature | Derived data. | Constant temperature of 12. |
| Spring at model meter 4084.32 (TIR) | 4084.32 | Tributary | Water Temperature | Derived data. Watershed Sciences (2001) | Derived from TIR. Constant temperature of 7.2 deg-C. |
| Spring at model meter 1554.48 (TIR) | 1554.48 | Tributary | Water Temperature | Derived data. Watershed Sciences (2001) | Derived from TIR. Constant temperature of 7.5 deg-C. |
| 14140000 | 0, 14112.2, 17129.8 | Meteorological | Air Temperature, Relative Humidity, Wind Speed | USGS | |

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 22. The model location in the table below describes the distance of each input from the most upstream model node. Effective shade model calibrations sites are summarized in Table 6. The model inputs and parameters that are expected to be modified to improve model fit are described in Section 6.1.

**Table 22: Calibration sites and parameters used in the existing Little Sandy River Heat Source Model.**

| Model Location Name (Station ID) | Model Location (meters) | Calibration Parameter | Data Source |
|---|---|---|---|
| Little Sandy at Mouth (26389-ORDEQ) | 17129.8 | Water Temperature | City of Portland |
| Little Sandy above Diversion (26390-ORDEQ) | 14112.2 | Water Temperature | DEQ |
| Model extent | Model extent | Water Temperature (TIR) | Watershed Sciences (2001) |

## 6.7 Salmon River (2001)

The Salmon River (2001) model is a temperature model developed using Heat Source 6.5.1. The model was developed by DEQ.

### 6.7.1 Model domain

The extent of the model domain is the Salmon River from the mouth to Highway 26/35. 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 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.

### 6.7.3 Source characteristics

For the discussion of source characteristics, see Section 6.8.3 for the updated Salmon River (2016) model.

### 6.7.4 Time frame of simulation

The model period is for a single day: August 09, 2001.

### 6.7.5 Important assumptions

The effort currently described in the QAPP includes use of existing models with no changes to the models since their previous calibration. Key calibration assumptions made during the model setup and calibration process were documented in the original TMDL (DEQ, 2005) and the Heat Source model user guide (Boyd and Kasper, 2003).

### 6.7.6 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 Salmon River (2001) Heat Source Model.**

| Model Location Name (Station ID) | Model Location (meters) | Input Type | Model Input | Data Source | Note |
|---|---|---|---|---|---|
| Salmon River at HWY 26/35 (26415-ORDEQ) | 0 | Boundary Condition | Water Temperature | DEQ | Data not in AWQMS. |
| No Name Site at model meter 46020 (TIR) | 46020 | Tributary | Water Temperature | Derived data. Watershed Sciences (2001) | Derived from TIR. Constant temperature of 13.9 deg-C. |
| Boulder Creek (26410-ORDEQ) | 45651.84 | Tributary | Water Temperature | Derived data. DEQ | Used temperature data from Wildcat Creek (26410-ORDEQ). Data not in AWQMS. |
| No Name Site at model meter 44271.24 (TIR) | 44271.24 | Tributary | Water Temperature | Derived data. Watershed Sciences (2001) | Derived from TIR. Constant temperature of 12 deg-C. |
| No Name Site at model meter 41908.88 (26410-ORDEQ) | 41908.88 | Tributary | Water Temperature | Derived data. DEQ | Used temperature data from Wildcat Creek (26410-ORDEQ). Data not in AWQMS. |
| Spring at model meter 41479.36 (TIR) | 41479.36 | Tributary | Water Temperature | Derived data. Watershed Sciences (2001) | Derived from TIR. Constant temperature of 13.1 deg-C. |
| Spring Brook (26410-ORDEQ) | 40988.48 | Tributary | Water Temperature | Derived data. DEQ | Used temperature data from Wildcat Creek (26410-ORDEQ). Data not in AWQMS. |
| No Name Site at model meter 38227.28 (TIR) | 38227.28 | Tributary | Water Temperature | Derived data. Watershed Sciences (2001) | Derived from TIR. Constant temperature of 15.1 deg-C. |

| Model Location Name (Station ID) | Model Location (meters) | Input Type | Model Input | Data Source | Note |
|---|---|---|---|---|---|
| No Name Site at model meter 37951.16 (TIR) | 37951.16 | Tributary | Water Temperature | Derived data. Watershed Sciences (2001) | Derived from TIR. Constant temperature of 15.1 deg-C. |
| No Name Site at model meter 35772.88 (TIR) | 35772.88 | Tributary | Water Temperature | Derived data. Watershed Sciences (2001) | Derived from TIR. Constant temperature of 17.3 deg-C. |
| Cheeney Creek (26413-ORDEQ) | 35619.48 | Tributary | Water Temperature | Derived data. | Used temperature data from South Fork Salmon River (226413-ORDEQ). |
| No Name Site at model meter 32428.76 (TIR) | 32428.76 | Tributary | Water Temperature | Derived data. Watershed Sciences (2001) | Derived from TIR. Constant temperature of 15.4 deg-C. |
| No Name Site at model meter 31048.16 (TIR) | 31048.16 | Tributary | Water Temperature | Derived data. Watershed Sciences (2001) | Derived from TIR. Constant temperature of 14.8 deg-C. |
| No Name Site at model meter 30894.76 (26413-ORDEQ) | 30894.76 | Tributary | Water Temperature | Derived data. | Used temperature data from South Fork Salmon River (226413-ORDEQ). |
| No Name Site at model meter 29728.92 (26413-ORDEQ) | 29728.92 | Tributary | Water Temperature | Derived data. | Used temperature data from South Fork Salmon River (226413-ORDEQ). |
| South Fork Salmon River (26413-ORDEQ) | 29268.72 | Tributary | Water Temperature | DEQ | |

| Model Location Name (Station ID) | Model Location (meters) | Input Type | Model Input | Data Source | Note |
|---|---|---|---|---|---|
| Spring at model meter 28440.36 (TIR) | 28440.36 | Tributary | Water Temperature | Derived data. Watershed Sciences (2001) | Derived from TIR. Constant temperature of 14 deg-C. |
| Bighorn Creek (TIR) | 27213.16 | Tributary | Water Temperature | Derived data. Watershed Sciences (2001) | Derived from TIR. Constant temperature of 13.9 deg-C. |
| No Name Site at model meter 27151.8 (TIR) | 27151.8 | Tributary | Water Temperature | Derived data. Watershed Sciences (2001) | Derived from TIR. Constant temperature of 13.9 deg-C. |
| No Name Site at model meter 26354.12 (TIR) | 26354.12 | Tributary | Water Temperature | Derived data. Watershed Sciences (2001) | Derived from TIR. Constant temperature of 13.9 deg-C. |
| No Name Site at model meter 26016.64 (TIR) | 26016.64 | Tributary | Water Temperature | Derived data. Watershed Sciences (2001) | Derived from TIR. Constant temperature of 13.9 deg-C. |
| Copper Creek (TIR) | 25280.32 | Tributary | Water Temperature | Derived data. Watershed Sciences (2001) | Derived from TIR. Constant temperature of 15.4 deg-C. |
| No Name Site at model meter 24421.28 (TIR) | 24421.28 | Tributary | Water Temperature | Derived data. Watershed Sciences (2001) | Derived from TIR. Constant temperature of 17.9 deg-C. |
| Goat Creek (TIR) | 23562.24 | Tributary | Water Temperature | Derived data. Watershed Sciences (2001) | Derived from TIR. Constant temperature of 13.2 deg-C. |
| Kinzel Creek (TIR) | 22304.36 | Tributary | Water Temperature | Derived data. Watershed Sciences (2001) | Derived from TIR. Constant temperature of 13.8 deg-C. |

| Model Location Name (Station ID) | Model Location (meters) | Input Type | Model Input | Data Source | Note |
|---|---|---|---|---|---|
| Iron Creek (TIR) | 22150.96 | Tributary | Water Temperature | Derived data. Watershed Sciences (2001) | Derived from TIR. Constant temperature of 14.3 deg-C. |
| Small tributary (TIR) | 20218.12 | Tributary | Water Temperature | Derived data. Watershed Sciences (2001) | Derived from TIR. Constant temperature of 18 deg-C. |
| Linney Creek (TIR) | 19205.68 | Tributary | Water Temperature | Derived data. Watershed Sciences (2001) | Derived from TIR. Constant temperature of 10.9 deg-C. |
| No Name Site at model meter 17272.84 (TIR) | 17272.84 | Tributary | Water Temperature | Derived data. Watershed Sciences (2001) | Derived from TIR. Constant temperature of 13 deg-C. |
| Wolf Creek (TIR) | 16383.12 | Tributary | Water Temperature | Derived data. Watershed Sciences (2001) | Derived from TIR. Constant temperature of 13 deg-C. |
| No Name Site at model meter 15186.6 (TIR) | 15186.6 | Tributary | Water Temperature | Derived data. Watershed Sciences (2001) | Derived from TIR. Constant temperature of 13.1 deg-C. |
| Spring at model meter 14327.56 (TIR) | 14327.56 | Tributary | Water Temperature | Derived data. Watershed Sciences (2001) | Derived from TIR. Constant temperature of 7.8 deg-C. |
| Spring at model meter 14266.2 (TIR) | 14266.2 | Tributary | Water Temperature | Derived data. Watershed Sciences (2001) | Derived from TIR. Constant temperature of 9.6 deg-C. |
| No Name Site at model meter 13407.16 (TIR) | 13407.16 | Tributary | Water Temperature | Derived data. Watershed Sciences (2001) | Derived from TIR. Constant temperature of 12.9 deg-C. |
| Fir Tree Creek (TIR) | 13315.12 | Tributary | Water Temperature | Derived data. Watershed Sciences (2001) | Derived from TIR. Constant temperature of 10.3 deg-C. |

| Model Location Name (Station ID) | Model Location (meters) | Input Type | Model Input | Data Source | Note |
|---|---|---|---|---|---|
| Spring at model meter 12179.96 (TIR) | 12179.96 | Tributary | Water Temperature | Derived data. Watershed Sciences (2001) | Derived from TIR. Constant temperature of 11.1 deg-C. |
| Spring at model meter 11965.2 (TIR) | 11965.2 | Tributary | Water Temperature | Derived data. Watershed Sciences (2001) | Derived from TIR. Constant temperature of 9.6 deg-C. |
| No Name Site at model meter 11719.76 (TIR) | 11719.76 | Tributary | Water Temperature | Derived data. Watershed Sciences (2001) | Derived from TIR. Constant temperature of 11.9 deg-C. |
| Mud Creek (TIR) | 11075.48 | Tributary | Water Temperature | Derived data. Watershed Sciences (2001) | Derived from TIR. Constant temperature of 13.7 deg-C. |
| Spring at model meter 9940.32 (TIR) | 9940.32 | Tributary | Water Temperature | Derived data. Watershed Sciences (2001) | Derived from TIR. Constant temperature of 11.2 deg-C. |
| Spring at model meter 9602.84 (TIR) | 9602.84 | Tributary | Water Temperature | Derived data. Watershed Sciences (2001) | Derived from TIR. Constant temperature of 8.9 deg-C. |
| Spring at model meter 8099.52 (TIR) | 8099.52 | Tributary | Water Temperature | Derived data. Watershed Sciences (2001) | Derived from TIR. Constant temperature of 7.7 deg-C. |
| Ghost Creek (TIR) | 5553.08 | Tributary | Water Temperature | Derived data. Watershed Sciences (2001) | Derived from TIR. Constant temperature of 12.3 deg-C. |
| No Station ID | 0, 29207, 36018, 46020 | Meteorological | Air Temperature, Relative Humidity, Wind Speed | DEQ File | |

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.

### 6.7.7 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 upstream model node. Effective shade model calibrations sites are summarized in Table 6. 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 Salmon River (2001) Heat Source Model.**

| Model Location Name (Station ID) | Model Location (meters) | Calibration Parameter | Data Source |
|---|---|---|---|
| Salmon River at Mouth/ HWY 26 (10677-ORDEQ) | 46020 | Water Temperature | DEQ |
| Salmon River at East Bridge Road (26412-ORDEQ) | 36018 | Water Temperature | DEQ |
| Salmon River above the South Fork (26414-ORDEQ) | 29207 | Water Temperature | DEQ |
| Model extent | Model extent | Water Temperature (TIR) | Watershed Sciences (2001) |

## 6.8 Salmon River (2016)

The Salmon River (2016) model is a temperature model developed using Heat Source 8.0.8. The model will be developed by DEQ.

### 6.8.1 Model domain

The extent of the model domain is the Salmon River from the mouth to the USFS boundary at MHNF-077. 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 50 meters. Outputs are generated every 50 meters. The model time step (*dt*) is 1 minute and outputs are generated every hour.

A *dx* of 50 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 Salmon River (2016) include increases in solar radiation loading from the disturbance or removal of near-stream vegetation, reductions to the stream flow rate or volume, and background sources. 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 no permitted individual NPDES point sources along the model extent.

The majority land use along the Salmon River (2016) is forestry accounting for about 87 percent of the near-stream area. Table 25 summarizes all the land uses within 100 meters of the digitized Salmon River (2016) 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 25: Summary of land uses within 100 meters of the digitized Salmon River (2016) centerline based on the 2016 National Land Cover Database (Yang et al., 2018).**

| 2016 NLCD Land Cover | Acres | Percent of Total Acres |
|---|---|---|
| Evergreen Forest | 480.6 | 75.5 |
| Developed, Open Space | 78.1 | 12.3 |
| Mixed Forest | 42.0 | 6.6 |
| Shrub/Scrub | 26.5 | 4.2 |
| Developed, Low Intensity | 3.8 | 0.6 |
| Herbaceous | 2.2 | 0.3 |
| Deciduous Forest | 1.6 | 0.3 |
| Developed, Medium Intensity | 0.9 | 0.1 |
| Woody Wetlands | 0.4 | 0.1 |
| Hay/Pasture | 0.2 | <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 26).

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 26 summarizes the potential designated management agencies and responsible persons along the Salmon River (2016) model extent.

**Table 26: Summary of potential designated management agencies (DMAs) or responsible persons within 100 meters of the digitized Salmon River (2016) centerline.**

| DMA or Responsible Person | Acres | Percent of Total Acres |
|---|---|---|
| Clackamas County | 357.1 | 44.8 |
| U.S. Bureau of Land Management | 204.7 | 25.7 |
| Oregon Department of State Lands - Waterway | 105.3 | 13.2 |
| Oregon Department of Forestry - Private Forestland | 75.1 | 9.4 |
| U.S. Forest Service | 38.7 | 4.9 |
| Oregon Department of Transportation | 8.0 | 1 |

| DMA or Responsible Person | Acres | Percent of Total Acres |
|---|---|---|
| U.S. Government | 7.8 | 1 |

### 6.8.4 Time frame of simulation

The model period is July 15, 2016 to September 05, 2016.

### 6.8.5 Important assumptions

Model development for the Salmon River relies on deriving temperature or flow inputs from a few small tributaries (Table 27). DEQ plans to use the direct surrogate or linear regression approaches described in Section 6.2 to derive stream temperature, and a combination of a flow mass balance, drainage area ratio, and the flow-probability-probability-flow approaches to estimate stream flow. It assumed that these approaches do a reasonably good job of estimating the tributary temperature or flow. DEQ will assess the goodness of fit for these approaches where measured temperature or flow data are available.

DEQ will review the vegetation conditions at sites where effective shade measurements were made in August of 2001 (Table 6) and compare those conditions to vegetation conditions observed in 2016. If the conditions do not appear to have changed significantly DEQ will use the effective shade measured in 2001 as a rough guide for model calibration purposes with the assumption that the shade will likely be about the same or have increased since 2001 if site conditions look similar.

Other key assumptions about model constants are described in the Heat Source model user guide (Boyd and Kasper, 2003) or in Section 6 and Section 7 of this document.

### 6.8.6 Model inputs

Table 27 summarizes the expected configuration of the model input parameters and the source of these data. Temperature, flow, and meteorological input parameters are summarized.

**Table 27: Boundary condition and tributary inputs to the Salmon River (2016) Heat Source Model.**

| Model Location Name (Station ID) | Model Location (kilometers) | Input Type | Model Input | Data Source | Note |
|---|---|---|---|---|---|
| Salmon River at Forest Boundary_LTWT | 13 | Boundary Condition | Flow | Derived data. | Based on drainage area ratio or QPPQ method using OWRD gage 14134000 |
| Salmon River at Forest Boundary_LTWT (MHNF-077) | 13 | Boundary Condition | Water Temperature | USFS | |
| Cheeney Creek | 11.45 | Tributary | Flow | Derived data. | |
| Lymp Creek | 7.85 | Tributary | Flow | Derived data. | |

| Model Location Name (Station ID) | Model Location (kilometers) | Input Type | Model Input | Data Source | Note |
|---|---|---|---|---|---|
| Spring Brook (LB) from TIR image sfsa0215 | 6.05 | Tributary | Flow | Derived data. | |
| Spring in TIR image sfsa0199 (LB) | 5.6 | Tributary | Flow | Derived data. | |
| Unnamed Stream (LB) | 2.85 | Tributary | Flow | Derived data. | |
| Boulder Creek | 1.5 | Tributary | Flow | Derived data. | |
| Cheeney Creek | 11.45 | Tributary | Water Temperature | Derived data. | Use MHNF-048 as a surrogate |
| Lymp Creek | 7.85 | Tributary | Water Temperature | Derived data. | Use MHNF-048 as a surrogate |
| Spring Brook (LB) from TIR image sfsa0215 (TIR) | 6.05 | Tributary | Water Temperature | Derived data. Watershed Sciences (2001) | Derived from TIR. Constant temperature of 15.9 deg-C. |
| Spring in TIR image sfsa0199 (LB) (TIR) | 5.6 | Tributary | Water Temperature | Derived data. Watershed Sciences (2001) | Derived from TIR. Constant temperature of 13.3 deg-C. |
| Unnamed Stream (LB) | 2.85 | Tributary | Water Temperature | Derived data. | |
| Boulder Creek | 1.5 | Tributary | Water Temperature | Derived data. | Linear regression method using 26411-ORDEQ and USGS 14139800 or another site with data in 2001 and 2016. |

| Model Location Name (Station ID) | Model Location (kilometers) | Input Type | Model Input | Data Source | Note |
|---|---|---|---|---|---|
| 10009634 - Portland Troutdale Airport | 13 | Meteorological | Cloudiness | NCDC | |
| EW6654 Rhododendron | 13 | Meteorological | Air Temperature, Relative Humidity, Wind Speed | MesoWest, APRSWXNET/CWOP | |

Hourly meteorology inputs into the model include air temperature, cloudiness, relative humidity, and wind speed. Air temperature data may be modified using the dry adiabatic lapse rate to adjust for differences in elevation between the measurement location and the model input location. Wind speeds may be 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 28. The model location in the table below describes the distance of each input from the most downstream model node. Effective shade model calibrations sites are summarized in Table 6. The model inputs and parameters that are expected to be modified to improve model fit are described in Section 6.1.

**Table 28: Calibration sites and parameters used in the Salmon River (2016) Heat Source Model.**

| Model Location Name (Station ID) | Model Location (kilometers) | Calibration Parameter | Data Source |
|---|---|---|---|
| Salmon River trap WT site (MHNF-078) | 3.25 | Water Temperature | USFS |
| Salmon River above Sandy Brightwood Bridge (Salmon_0.5) | 1.00 | Water Temperature | PSU |

## 6.9 Sandy River (2001)

The Sandy River (2001) model is a temperature model developed using Heat Source 6.5.1. The model was developed by DEQ.

### 6.9.1 Model domain

The extent of the model domain is the Sandy River from the mouth at the Columbia River upstream to just above Lost Creek. The model extent is shown in the HTML interactive map that accompanies this QAPP and is referenced in Appendix D.

### 6.9.2 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.

### 6.9.3 Source characteristics

For the discussion of source characteristics, see Section 6.10.3 for the updated Sandy River (2016) model.

### 6.9.4 Time frame of simulation

The model period is for a single day: August 08, 2001.

### 6.9.5 Important assumptions

The effort currently described in the QAPP includes use of existing models with no changes to the models since their previous calibration. Key calibration assumptions made during the model setup and calibration process were documented in the original TMDL (DEQ, 2005) and the Heat Source model user guide (Boyd and Kasper, 2003).

### 6.9.6 Model inputs

Table 29 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 29: Boundary condition and tributary inputs to the existing Sandy River (2001) Heat Source Model.**

| Model Location Name (Station ID) | Model Location (meters) | Input Type | Model Input | Data Source | Note |
|---|---|---|---|---|---|
| Sandy River Above Lost Creek (26423-ORDEQ) | 0 | Boundary Condition | Water Temperature | DEQ | Data not in AWQMS. |
| Beaver Creek | 74031 | Tributary | Flow | Derived data. | Flow input is constant. |
| Buck Creek | 57770 | Tributary | Flow | Derived data. | Flow input is constant. |
| Gordon Creek | 57188 | Tributary | Flow | Derived data. | Flow input is constant. |
| Trout Creek | 56513 | Tributary | Flow | Derived data. | Flow input is constant. |
| Spring at model meter 51573 | 51573 | Tributary | Flow | Derived data. | Flow input is constant. |

| Model Location Name (Station ID) | Model Location (meters) | Input Type | Model Input | Data Source | Note |
|---|---|---|---|---|---|
| Unnamed tributary at model meter 49518 | 49518 | Tributary | Flow | Derived data. | Flow input is constant. |
| Walker Creek | 48843 | Tributary | Flow | Derived data. | Flow input is constant. |
| Bull Run | 48045 | Tributary | Flow | Derived data. | Flow input is constant. |
| Cedar Creek | 43075 | Tributary | Flow | Derived data. | Flow input is constant. |
| Badger Creek | 35650 | Tributary | Flow | Derived data. | Flow input is constant. |
| Alder Creek | 23716 | Tributary | Flow | Derived data. | Flow input is constant. |
| Unnamed tributary or Spring at model meter 22949 | 22949 | Tributary | Flow | Derived data. | Flow input is constant. |
| Wildcat Creek | 22734 | Tributary | Flow | Derived data. | Flow input is constant. |
| Salmon River | 17334 | Tributary | Flow | Derived data. | Flow input is constant. |
| Bear Creek | 8744 | Tributary | Flow | Derived data. | Flow input is constant. |
| Zigzag River | 8406 | Tributary | Flow | Derived data. | Flow input is constant. |
| Clear Creek | 7302 | Tributary | Flow | Derived data. | Flow input is constant. |
| Horseshoe Creek | 3283 | Tributary | Flow | Derived data. | Flow input is constant. |
| No Name Trib at model meter 3007 | 3007 | Tributary | Flow | Derived data. | Flow input is constant. |
| Lost Creek | 2424 | Tributary | Flow | Derived data. | Flow input is constant. |
| Beaver Creek (11021-ORDEQ) | 74031 | Tributary | Water Temperature | DEQ | Data not in AWQMS. |

| Model Location Name (Station ID) | Model Location (meters) | Input Type | Model Input | Data Source | Note |
|---|---|---|---|---|---|
| Buck Creek (11024-ORDEQ) | 57770 | Tributary | Water Temperature | DEQ | Data not in AWQMS. |
| Gordon Creek (11025-ORDEQ) | 57188 | Tributary | Water Temperature | DEQ | Data not in AWQMS. |
| Trout Creek | 56513 | Tributary | Water Temperature | Derived data. | Used temperature data from Gordon Creek (11025-ORDEQ). |
| Spring at model meter 51573 (TIR) | 51573 | Tributary | Water Temperature | Derived data. Watershed Sciences (2001) | Derived from TIR. Constant temperature input of 12.0 deg-C. |
| Unnamed tributary at model meter 49518 (26405-ORDEQ) | 49518 | Tributary | Water Temperature | Derived data. DEQ | Used temperature from Cedar Creek (26405-ORDEQ). Data not in AWQMS. |
| Walker Creek (26405-ORDEQ) | 48843 | Tributary | Water Temperature | Derived data. DEQ | Used temperature from Cedar Creek (26405-ORDEQ). Data not in AWQMS. |
| Bull Run | 48045 | Tributary | Water Temperature | Derived data. | Calibrated Bull Run Heat Source model output. |
| Cedar Creek (26405-ORDEQ) | 43075 | Tributary | Water Temperature | DEQ | Data not in AWQMS. |
| Badger Creek (26407-ORDEQ) | 35650 | Tributary | Water Temperature | DEQ | Data not in AWQMS. |
| Alder Creek (26409-ORDEQ) | 23716 | Tributary | Water Temperature | DEQ | Data not in AWQMS. |
| Unnamed tributary or Spring at model meter 22949 (26410-ORDEQ) | 22949 | Tributary | Water Temperature | Derived data. DEQ | Used temperature data from Wildcat Creek (26410-ORDEQ). Data not in AWQMS. |

| Model Location Name (Station ID) | Model Location (meters) | Input Type | Model Input | Data Source | Note |
|---|---|---|---|---|---|
| Wildcat Creek (26410-ORDEQ) | 22734 | Tributary | Water Temperature | DEQ | Data not in AWQMS. |
| Salmon River | 17334 | Tributary | Water Temperature | Derived data. | Calibrated Salmon River Heat Source model output. |
| Bear Creek (TIR) | 8744 | Tributary | Water Temperature | Derived data. | Set to constant temperature of 12.0 deg-C. |
| Zigzag River | 8406 | Tributary | Water Temperature | Derived data. | Calibrated Zigzag Heat Source model output. |
| Clear Creek (26421-ORDEQ) | 7302 | Tributary | Water Temperature | DEQ | Data not in AWQMS. |
| Horseshoe Creek (TIR) | 3283 | Tributary | Water Temperature | Derived data. Watershed Sciences (2001) | Derived from TIR. Constant temperature of 12.0 deg-C. |
| No Name Trib at model meter 3007 (TIR) | 3007 | Tributary | Water Temperature | Derived data. Watershed Sciences (2001) | Derived from TIR. Constant temperature of 12.0 deg-C. |
| Lost Creek (26423-ORDEQ) | 2424 | Tributary | Water Temperature | Derived data. DEQ | Used temperature data from Sandy River above Lost Creek (26423-ORDEQ). Data not in AWQMS. |
| No Station ID | 0, 7118, 15677, 28962, 47861, 64704, 68938 | Meteorological | Air Temperature, Relative Humidity, Wind Speed | DEQ File | |

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.

### 6.9.7 Model calibration

The expected model calibration sites and data sources are summarized in Table 30. The model location in the table below describes the distance of each input from the most upstream model node. Effective shade model calibrations sites are summarized in Table 6. The model inputs and parameters that are expected to be modified to improve model fit are described in Section 6.1.

**Table 30: Calibration sites and parameters used in the existing Sandy River (2001) Heat Source Model.**

| Model Location Name (Station ID) | Model Location (meters) | Calibration Parameter | Data Source |
|---|---|---|---|
| Sandy River at Dabney Bridge (11780-ORDEQ) | 68938 | Water Temperature | DEQ |
| Sandy River at Oxbow Park (11782-ORDEQ) | 64704 | Water Temperature | DEQ |
| Sandy River Above Bull Run (26404-ORDEQ) | 47861 | Water Temperature | DEQ |
| Sandy River at Marmot Gage (26408-ORDEQ) | 28962 | Water Temperature | DEQ |
| Sandy River Above Salmon River (10676-ORDEQ) | 15677 | Water Temperature | DEQ |
| Sandy River Above Clear Creek (26422-ORDEQ) | 7118 | Water Temperature | DEQ |
| Model extent | Model extent | Water Temperature (TIR) | Watershed Sciences (2001) |

## 6.10 Sandy River (2016)

The Sandy River (2016) model is a temperature model developed using Heat Source 8.0.8. The model will be developed by DEQ and Tetra Tech.

### 6.10.1 Model domain

The extent of the model domain is the Sandy River from the mouth at the Columbia River to just upstream of Clear Creek. The model extent is shown in the HTML interactive map that accompanies this QAPP and is referenced in Appendix D.

### 6.10.2 Spatial and temporal resolution

The model input spatial resolution (*dx*) is 50 meters. Outputs are generated every 50 meters. The model time step (*dt*) is 1 minute and outputs are generated every hour.

A *dx* of 50 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.

### 6.10.3 Source characteristics

The primary sources of thermal loading contributing to temperatures exceedances along the Sandy River (2016) 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, 2005). 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 31.

**Table 31: Summary of individual NPDES permitted discharges in the Sandy River (2016).**

| Facility Name (Facility Number) | Latitude/Longitude | Permit Type and Description | Stream/River Mile |
|---|---|---|---|
| City Of Troutdale Water Pollution Control Facility (89941) | 45.5535/-122.387 | NPDES-DOM-C2a: Sewage - 1 MGD or more but less than 2 MGD | Sandy River RM 2.3 |
| WES (Hoodland STP) (39750) | 45.3464/-121.969 | NPDES-DOM-Da: Sewage - less than 1 MGD | Sandy River RM 41 |

The majority land use along the Sandy River (2016) is forestry accounting for about 81 percent of the near-stream area. Table 32 summarizes all the land uses within 100 meters of the digitized Sandy River (2016) 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 32: Summary of land uses within 100 meters of the digitized Sandy River (2016) centerline based on the 2016 National Land Cover Database (Yang et al., 2018).**

| 2016 NLCD Land Cover | Acres | Percent of Total Acres |
|---|---:|---|
| Evergreen Forest | 1162.7 | 45.2 |
| Mixed Forest | 357.8 | 13.9 |
| Woody Wetlands | 211.5 | 8.2 |
| Developed, Open Space | 159.7 | 6.2 |
| Emergent Herbaceous Wetlands | 152.3 | 5.9 |
| Shrub/Scrub | 144.6 | 5.6 |
| Deciduous Forest | 115.2 | 4.5 |
| Herbaceous | 81.4 | 3.2 |
| Barren Land | 48.5 | 1.9 |
| Developed, Low Intensity | 44.5 | 1.7 |
| Hay/Pasture | 42.7 | 1.7 |
| Developed, Medium Intensity | 20.5 | 0.8 |
| Cultivated Crops | 16.5 | 0.6 |
| Developed, High Intensity | 14.7 | 0.6 |

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 33).

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 33 summarizes the potential designated management agencies and responsible persons along the Sandy River (2016) model extent.

**Table 33: Summary of potential designated management agencies (DMAs) or responsible persons within 100 meters of the digitized Sandy River (2016) centerline.**

| DMA or Responsible Person | Acres | Percent of Total Acres |
|---|---|---|
| Oregon Department of State Lands - Waterway | 1178.9 | 31.5 |
| Oregon Department of Forestry - Private Forestland | 839.1 | 22.4 |
| Clackamas County | 702.3 | 18.8 |
| U.S. Bureau of Land Management | 538.6 | 14.4 |
| City of Troutdale | 136.5 | 3.6 |
| Oregon Department of Agriculture | 70.8 | 1.9 |
| Oregon Department of Fish and Wildlife | 56.3 | 1.5 |
| Multnomah County | 52.6 | 1.4 |
| Oregon Parks and Recreation Department | 38.4 | 1 |
| U.S. Forest Service | 27.5 | 0.7 |
| City of Sandy | 25.3 | 0.7 |
| Oregon Department of Transportation | 19.2 | 0.5 |
| City of Portland | 17.9 | 0.5 |
| Port of Portland | 14.6 | 0.4 |
| State of Oregon | 11.6 | 0.3 |
| U.S. Government | 10.7 | 0.3 |
| Union Pacific Railroad | 1.1 | <0.05 |

### 6.10.4 Time frame of simulation

The model period is July 15, 2016 to September 05, 2016.

### 6.10.5 Important assumptions

Model development for the Sandy River relies on deriving temperature or flow inputs from a few small tributaries (Table 34). DEQ plans to use the direct surrogate or linear regression approaches described in Section 6.2 to derive stream temperature, and a combination of a flow mass balance, drainage area ratio, and the flow-probability-probability-flow approaches to estimate stream flow. It assumed that these approaches do a reasonably good job of estimating the tributary temperature or flow. DEQ will assess the goodness of fit for these approaches where measured temperature or flow data are available.

DEQ will review the vegetation conditions at sites where effective shade measurements were made in August of 2001 (Table 6) and compare those conditions to vegetation conditions observed in 2016. If the conditions do not appear to have changed significantly DEQ will use the effective shade measured in 2001 as a rough guide for model calibration purposes with the assumption that the shade will likely be about the same or have increased since 2001 if site conditions look similar.

Other key assumptions about model constants are described in the Heat Source model user guide (Boyd and Kasper, 2003) or in Section 6 and Section 7 of this document.

### 6.10.6 Model inputs

Table 34 summarizes the expected configuration of the model input parameters and the source of these data. Temperature, flow, and meteorological input parameters are summarized.

**Table 34: Boundary condition and tributary inputs to the Sandy River (2016) Heat Source Model.**

| Model Location Name (Station ID) | Model Location (kilometers) | Input Type | Model Input | Data Source | Note |
|---|---|---|---|---|---|
| Sandy River upstream of Clear Creek | 70.2 | Boundary Condition | Flow | Derived data. | |
| Sandy River upstream of Clear Creek (MHNF-080) | 70.2 | Boundary Condition | Water Temperature | USFS | |
| Clear Creek | 70.15 | Tributary | Flow | Derived data. | |
| Zigzag River | 69 | Tributary | Flow | Derived data. | |
| Bear Creek | 68.6 | Tributary | Flow | Derived data. | |
| WES (Hoodland STP) (39750) | 66.6 | Tributary | Flow | 2016 Discharge Monitoring Report | |
| Salmon River | 60.05 | Tributary | Flow | Derived data. | |
| Wildcat Creek | 54.75 | Tributary | Flow | Derived data. | |
| Alder Creek | 53.7 | Tributary | Flow | Derived data. | |
| Whiskey Creek | 50.9 | Tributary | Flow | Derived data. | |
| Badger Creek | 41.65 | Tributary | Flow | Derived data. | |
| Cedar Creek | 34.45 | Tributary | Flow | Derived data. | |
| Bull Run (14140000 plus 14141500) | 29.35 | Tributary | Flow | Derived data. USGS | Derived by the sum of USGS 14140000 plus 14141500 |

| Model Location Name (Station ID) | Model Location (kilometers) | Input Type | Model Input | Data Source | Note |
|---|---|---|---|---|---|
| Walker Creek | 28.55 | Tributary | Flow | Derived data. | |
| Spring on TIR image san0681 | 26 | Tributary | Flow | Derived data. | |
| Gordon Creek and Buck Creek | 19.9 | Tributary | Flow | Derived data. | Gordon and Buck combined |
| Big Creek | 15.45 | Tributary | Flow | Derived data. | |
| Smith Creek | 10.85 | Tributary | Flow | Derived data. | |
| Beaver Creek (14142800) | 3.7 | Tributary | Flow | USGS | |
| City Of Troutdale Water Pollution Control Facility (89941) | 2.3 | Tributary | Flow | 2016 Discharge Monitoring Report | |
| Clear Creek (MHNF-024) | 70.15 | Tributary | Water Temperature | USFS | |
| Zigzag River (MHNF-099) | 69 | Tributary | Water Temperature | USFS | |
| Bear Creek | 68.6 | Tributary | Water Temperature | Derived data. | Constant temperature input of 12.0 deg-C. (same as DEQ 2005) |
| WES (Hoodland STP) (39750) | 66.6 | Tributary | Water Temperature | 2016 Discharge Monitoring Report | |
| Salmon River (Salmon_0.5) | 60.05 | Tributary | Water Temperature | PSU | |
| Wildcat Creek | 54.75 | Tributary | Water Temperature | Derived data. | |
| Alder Creek | 53.7 | Tributary | Water Temperature | Derived data. | |
| Whiskey Creek | 50.9 | Tributary | Water Temperature | Derived data. | |
| Badger Creek | 41.65 | Tributary | Water Temperature | Derived data. | |

| Model Location Name (Station ID) | Model Location (kilometers) | Input Type | Model Input | Data Source | Note |
|---|---|---|---|---|---|
| Cedar Creek | 34.45 | Tributary | Water Temperature | ODFW | Includes mixed temperature from Sandy River Fish Hatchery effluent and Cedar Creek above outfall. |
| Bull Run (PWB_BR_DODG) | 29.35 | Tributary | Water Temperature | City of Portland Water Bureau | |
| Walker Creek | 28.55 | Tributary | Water Temperature | Derived data. | |
| Spring on TIR image san0681 (TIR) | 26 | Tributary | Water Temperature | Derived data. Watershed Sciences (2001) | Derived from TIR. Constant temperature of 15.4 deg-C. |
| Gordon Creek and Buck Creek (PWB_Gordon_Mouth) | 19.9 | Tributary | Water Temperature | City of Portland Water Bureau | Using the temperature of Gordon downstream of Buck |
| Big Creek (EMSWCD_Big_Black) | 15.45 | Tributary | Water Temperature | EMSWCD | |
| Smith Creek (EMSWCD_Smith_Murphy) | 10.85 | Tributary | Water Temperature | EMSWCD | |
| Beaver Creek (Beaver_0.0) | 3.7 | Tributary | Water Temperature | PSU | |
| City Of Troutdale Water Pollution Control Facility (89941) | 2.3 | Tributary | Water Temperature | 2016 Discharge Monitoring Report | |
| 10009634 - Portland Troutdale Airport | 70.2 | Meteorological | Cloudiness | NCDC | |

| Model Location Name (Station ID) | Model Location (kilometers) | Input Type | Model Input | Data Source | Note |
|---|---|---|---|---|---|
| D4118 - DW4118 Sandy | 70.2 | Meteorological | Air Temperature, Relative Humidity, Wind Speed | MesoWest, APRSWXNET/ CWOP | |

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

### 6.10.7 Model calibration

The expected model calibration sites and data sources are summarized in Table 35. The model location in the table below describes the distance of each input from the most downstream model node. Effective shade model calibrations sites are summarized in Table 6. The model inputs and parameters that are expected to be modified to improve model fit are described in Section 6.1.

**Table 35: Calibration sites and parameters used in the Sandy River (2016) Heat Source Model.**

| Model Location Name (Station ID) | Model Location (kilometers) | Calibration Parameter | Data Source |
|---|---:|---|---|
| Sandy River Near Marmot (14137000) | 47.60 | Flow | USGS |
| Sandy River Below Bull Run River, Near Bull Run (14142500) | 28.90 | Flow | USGS |
| Sandy River upstream of Zigzag River (Sandy_42.5) | 69.20 | Water Temperature | PSU |
| Sandy River at Barlow Trail bridge below Salmon River (Sandy_36.1) | 58.55 | Water Temperature | PSU |
| Sandy River at Marmot Dam Site (Sandy_29.6) | 47.80 | Water Temperature | PSU |
| Sandy River below Marmot Dam (Sandy_29.4) | 47.45 | Water Temperature | PSU |
| Sandy River Above Beaver Creek (Sandy_3.0) | 4.06 | Water Temperature | PSU |

## 6.11 Zigzag River

The Zigzag River model is a temperature model developed using Heat Source 6.5.1. The model was developed by DEQ.

#### 6.11.1 Model domain

The extent of the model domain is the Zigzag River from the mouth to just upstream of Camp Creek at Highway 26. The model extent is shown in the HTML interactive map that accompanies this QAPP and is referenced in Appendix D.

#### 6.11.2 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.

#### 6.11.3 Source characteristics

The primary sources of thermal loading contributing to temperatures exceedances along the Zigzag River include increases in solar radiation loading from the disturbance or removal of near-stream vegetation and background sources (DEQ, 2005). Other potential sources include channel modification and widening, reductions to stream flow rate, and warming caused by climate change.

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

The majority land use along the Zigzag River is forestry accounting for about 80 percent of the near-stream area. Table 36 summarizes all the land uses within 100 meters of the digitized Zigzag 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 36: Summary of land uses within 100 meters of the digitized Zigzag 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 | 269.5 | 74.3 |
| Developed, Open Space | 66.1 | 18.2 |
| Deciduous Forest | 7.3 | 2 |
| Mixed Forest | 5.6 | 1.5 |
| Shrub/Scrub | 4.9 | 1.4 |
| Herbaceous | 4.2 | 1.2 |
| Developed, Low Intensity | 2.9 | 0.8 |
| Developed, Medium Intensity | 2.2 | 0.6 |
| Developed, High Intensity | 0.2 | 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 37).

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 37 summarizes the potential designated management agencies and responsible persons along the Zigzag River model extent.

**Table 37: Summary of potential designated management agencies (DMAs) or responsible persons within 100 meters of the digitized Zigzag River centerline.**

| DMA or Responsible Person | Acres | Percent of Total Acres |
|---|---|---|
| U.S. Forest Service | 316.8 | 68.2 |
| Clackamas County | 99.0 | 21.3 |
| Oregon Department of State Lands - Waterway | 20.4 | 4.4 |
| Oregon Department of Transportation | 17.8 | 3.8 |
| Oregon Department of Forestry - Private Forestland | 4.4 | 0.9 |
| U.S. Bureau of Land Management | 4.1 | 0.9 |
| U.S. Government | 2.1 | 0.5 |

### 6.11.4 Time frame of simulation

The model period is for a single day: August 09, 2001.

### 6.11.5 Important assumptions

The effort currently described in the QAPP includes use of existing models with no changes to the models since their previous calibration. Key calibration assumptions made during the model setup and calibration process were documented in the original TMDL (DEQ, 2005) and the Heat Source model user guide (Boyd and Kasper, 2003).

### 6.11.6 Model inputs

Table 38 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 38: Boundary condition and tributary inputs to the existing Zigzag River Heat Source Model.**

| Model Location Name (Station ID) | Model Location (meters) | Input Type | Model Input | Data Source | Note |
|---|---|---|---|---|---|
| Zigzag above Camp Creek/ HWY 26 (26420-ORDEQ) | 0 | Boundary Condition | Water Temperature | DEQ | Data not in AWQMS. |
| Spring at model meter 6187.44 (TIR) | 6187.44 | Tributary | Water Temperature | Derived data. Watershed Sciences (2001) | Derived from TIR. Constant temperature of 13.7 deg-C. |
| No Name Site at model meter 5943.6 (TIR) | 5943.6 | Tributary | Water Temperature | Derived data. Watershed Sciences (2001) | Derived from TIR. Constant temperature of 17.4 deg-C. |
| Spring at model meter 5882.64 (TIR) | 5882.64 | Tributary | Water Temperature | Derived data. Watershed Sciences (2001) | Derived from TIR. Constant temperature of 13.1 deg-C. |
| Spring at model meter 5547.36 (TIR) | 5547.36 | Tributary | Water Temperature | Derived data. Watershed Sciences (2001) | Derived from TIR. Constant temperature of 11.7 deg-C. |
| Henry/No Name (TIR) | 4389.12 | Tributary | Water Temperature | Derived data. Watershed Sciences (2001) | Derived from TIR. Constant temperature of 12.9 deg-C. |
| Still Creek (26417-ORDEQ) | 3870.96 | Tributary | Water Temperature | DEQ | Data not in AWQMS. |
| Camp Creek (26419-ORDEQ) | 792.48 | Tributary | Water Temperature | DEQ | Data not in AWQMS. |
| 14140000 | 0, 3475, 7010 | Meteorological | Air Temperature, Relative Humidity, Wind Speed | USGS | |

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.

#### 6.11.7 Model calibration

The expected model calibration sites and data sources are summarized in Table 39. The model location in the table below describes the distance of each input from the most upstream model node. Effective shade model calibrations sites are summarized in Table 6. The model inputs and parameters that are expected to be modified to improve model fit are described in Section 6.1.

**Table 39: Calibration sites and parameters used in the existing Zigzag River Heat Source Model.**

| Model Location Name (Station ID) | Model Location (meters) | Calibration Parameter | Data Source |
|---|---|---|---|
| Zigzag River at mouth/ Lolo Pass Road (26416-ORDEQ) | 7010 | Water Temperature | DEQ |
| Zigzag River above Still Creek (26418-ORDEQ) | 3475 | Water Temperature | DEQ |
| Model extent | Model extent | Water Temperature (TIR) | Watershed Sciences (2001) |

# 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 any additional uncertainty or sensitivity analyses will be performed on the calibrated models originally developed for the 2005 Sandy Temperature TMDL (DEQ, 2005).

## 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 or because the management scenario is not applicable to the specific waterbody. 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 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. On the Bull Run River, the background scenario will incorporate the elements of the no dam 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.

## 10.2 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 Sandy River Basin TMDL (DEQ, 2005).
- 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.

## 10.3 Protected vegetation

This scenario evaluates the stream temperature response from only streamside vegetation along the stream 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.

# 10.4 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.

# 10.5 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.

# 10.6 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.

## 10.7 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.

## 10.8 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 Sandy River model including adjustments to the Cedar Creek tributary temperatures to remove the ODFW Sandy River Fish Hatchery.
- All other model inputs will be the same as the current condition model.

## 10.9 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.

# 10.10 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.
- Modifying the temperature and outflow from Bull Run Dam One to evaluate different management options and the temperature response in the Bull Run River.
- 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.

# 10.11 No dams

This scenario is specific to the Bull Run River and Sandy River. This scenario estimates the stream temperatures on the Bull Run River without Bull Run Dam and Reservoir Number One and Bull Run Dam and Reservoir Number Two. The model extent will be from the Bull Run River mouth to just upstream of Bull Run Reservoir Number One at USGS Gage 14138850. No changes are proposed on the Sandy River model except for setting the Bull Run River input to the no dam temperature outputs. The stream temperature warming or cooling caused by the dams is evaluated by comparing the results of this scenario to the current condition model run.

This scenario will also be used to estimate the background rate of warming that occurs within the reaches where the reservoirs and dams are currently located. This warming rate may be used, in conjunction with data collected at the various gages in the Bull Run and Little Sandy Rivers to develop management targets for the Bull Run Reservoirs similar to the current temperature target surrogate measures in the 2005 Sandy TMDL (DEQ, 2005).

To complete this scenario, DEQ anticipates extending the 2016 current condition Heat Source model upstream through the reservoir reaches but may also consider using a CE-QUAL-W2 model developed by Portland State University for The City of Portland (Annear, et al., 1999, City of Portland, 2004). The CE-QUAL-W2 model was developed as a no dam scenario for the 2001 model year. Use of this model at minimum would require updates to the boundary conditions and meteorological inputs. At the current time the CE-QUAL-W2 model is not available to DEQ. Should this model become available DEQ will review the model to make a determination on its use considering the current model setup, data availability, and the amount of time and work required to update the model.

Development of a riverine model in place of the Bull Run Reservoirs will require information about channel position, width, slope, substrate, and Manning's roughness coefficients. Existing bathymetry and any pre-dam channel measurements, if available, will be used to develop the model setup. Table 40 summarizes the various data sources to be used for the boundary conditions, tributary, and meteorological inputs for the no dam scenario. All other inputs downstream of Bull Run Dam Number Two will be the same as the current condition model.

**Table 40: Boundary condition and tributary inputs to the no dam scenario on the Bull Run River.**

| Model Location Name (Station ID) | Input Type | Model Input | Data Source |
|---|---|---|---|
| Bull Run River Near Multnomah Falls, OR (14138850) | Boundary Condition | Flow, Water Temperature | USGS |
| Fir Creek (14138870) | Tributary | Flow, Water Temperature | USGS |
| North Fork Bull Run River (14138900) | Tributary | Flow, Water Temperature | USGS |
| South Fork Bull Run River (14139800) | Tributary | Flow, Water Temperature | USGS |
| Bull Run Headworks or Log Creek (LFG03) | Meteorological | Air Temperature, Relative Humidity, Wind Speed, Solar Radiation | City of Portland, MesoWest, and USFS/BLM |

# 11 Project organization

## 11.1 Project team/roles

Project roles and responsibilities are described in Table 41.

**Table 41: 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<br>1. Provide guidance to team and project manager<br>2. Approve project plan and changes to the project, scope, budget, and schedule (pending manager elevation as necessary)<br>3. Sustain support of decision makers at their level, all stakeholders<br>4. Remove roadblocks<br>5. Communicate progress to other managers |

| Name | Position | Role and Responsibilities |
|---|---|---|
| | | and WQ Director<br>6. Review project status<br>7. Manage resistance<br>8. Ensure communication with employees affected by changes<br>9. Provide forum to listen to concerns |
| Gene Foster | Manager, Watershed Management, Oregon DEQ | Manager<br>1. Review and approve team work products<br>2. Communicate progress to other managers<br>3. Approve project plan, changes to the project, and any changes that affect scope and schedule<br>4. Approve development and finalization of solutions to issues that occur during the project<br>5. Decide measures of project success |
| Michele Martin | Project Manager, Water Quality, Oregon DEQ | Project Manager<br>1. Facilitate meetings, effective meeting management<br>2. Provide feedback and leadership in the development of meeting agendas, activities during meetings, and tasks.<br>3. Provide feedback on project planning and design<br>4. Keep sponsor informed<br>5. Develop project charter<br>6. Develop project plan (including major tasks, milestones, project schedule, communication plan, risk analysis, etc.)<br>7. Develop team meeting agendas<br>8. Keep track of meeting decisions and notes (very brief), and team ideas<br>9. Ensure team's work drives towards outcomes and deliverables<br>10. Sustain engagement of team members and team performance<br>11. Control project scope (with Technical Lead)<br>12. Coordinate team communication: Emails, SharePoint, shared drives<br>13. Closeout project and document lessons learned |
| Ryan Michie | Senior Water Quality Analyst, Watershed Management, Oregon DEQ | Project Technical Lead<br>1. Lead, oversee, and direct development of the project QAPP<br>2. Lead, oversee, and direct the public data solicitation process<br>3. Coordination with EPA and Contractor |

| Name | Position | Role and Responsibilities |
|---|---|---|
| | | 4. Lead, oversee, and direct DEQ technical staff<br>5. Perform model calibration/evaluation<br>6. Run model scenarios<br>7. Analyze and interpret model results<br>8. Lead, oversee, and direct TMDL document writing<br>9. Participate and present at TMDL public meetings<br>10. Respond to public comments |
| Jim Bloom | Senior Water Quality Analyst, Watershed Management, Oregon DEQ | 1. Develop and configure models<br>2. Perform model calibration/evaluation<br>3. Run model scenarios<br>4. Analyze and interpret model results<br>5. Write TMDL<br>6. Participate and present at TMDL public meetings<br>7. Respond to public comments |
| Erin Costello | Water Quality Analyst, Watershed Management, Oregon DEQ | 1. Write QAPP<br>2. Develop and configure models<br>3. Perform model calibration/evaluation<br>4. Run model scenarios<br>5. Analyze and interpret model results<br>6. Write TMDL<br>7. Participate and present at TMDL public meetings<br>8. Respond to public comments |
| David Fairbarin | Water Quality Analyst, Watershed Management, Oregon DEQ | 1. Write QAPP<br>2. Develop and configure models<br>3. Perform model calibration/evaluation<br>4. Run model scenarios<br>5. Analyze and interpret model results<br>6. Write TMDL<br>7. Participate and present at TMDL public meetings<br>8. Respond to public comments |
| Yuan Grund | Water Quality Analyst, Watershed Management, Oregon DEQ | 1. Write QAPP<br>2. Perform data evaluation<br>3. Run model scenarios<br>4. Analyze and interpret model results |
| Roxy Nayar | Basin Coordinator, Oregon DEQ | 1. Review QAPP and TMDL<br>2. Write WQMP<br>3. TMDL Advisory Committee coordinator<br>4. Participate and present at TMDL public |

| Name | Position | Role and Responsibilities |
|---|---|---|
| | | meetings<br>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<br>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<br>1. Review QAPPs<br>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<br>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 Sandy Subbasin 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 42.

**Table 42: 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 43: QAPP revision history.**

| Revision | Date | Changes | Editor |
|---|---|---|---|
| 1.0 | 7/12/2021 | New QAPP | R. Michie |
| 1.1 | 12/09/2021 | Approval Sheet: Add additional signatories. Chapters 1-4, 8-15: Improve narrative for clarity. Fix grammar and spelling errors. Chapter 5: Move long list of station tables to appendix. Improve narrative for clarity. Fix grammar and spelling errors. Add improved description of quality and field methods. Update or add method references. Chapter 6: Add improved description of Bull Run River (2016) CE-QUAL-W2 model and effective shade curves. Improve narrative for clarity. Fix grammar and spelling errors. Fix a few station source reference errors. Chapter 7: Update DEQ MOMs and add TMDL QAPP references. Add coefficient of determination as a goodness of fit statistic. Chapter 16: Add new cited references, remove old references, fix minor errors. Appendix A – D: Add long station tables previously in Chapter 4. Update tables with most recent information retrieved from the water quality databases | R. Michie |

# Appendix A Meteorology data summary

**Table 44: Meteorological stations and data available in the National Climatic Data Center (NCDC) database in the Sandy Subbasin.**

| Station ID | Station | Latitude/Longitude |
|---|---|---|
| 10009634 | PORTLAND TROUTDALE AIRPORT | 45.5511/-122.409 |
| 20016316 | GOVERNMENT CAMP | 45.3014/-121.741 |
| 20016332 | BRIGHTWOOD 1 WNW | 45.3853/-122.046 |
| 20016363 | HEADWORKS PTLD WTR BUR | 45.45/-122.154 |
| 20016388 | TROUTDALE 1 ESE | 45.5378/-122.377 |
| 20016413 | ROOSTER ROCK STATE PARK | 45.545/-122.247 |
| 20016427 | BONNEVILLE DAM | 45.6354/-121.952 |
| 20016529 | MULTNOMAH FALLS | 45.5794/-122.116 |
| 30026907 | SANDY 6.6 NNE | 45.4838/-122.203 |
| 30027866 | RHODODENDRON 3.8NW | 45.3596/-121.974 |
| 30033463 | TROUTDALE 4.2 ESE | 45.5109/-122.313 |
| 30035145 | TROUTDALE 5.0 E | 45.5276/-122.288 |
| 30075019 | MT HOOD TEST SITE | 45.32/-121.72 |
| 30075286 | LOG CREEK OREGON | 45.51/-121.903 |
| 30075862 | BLAZED ALDER | 45.43/-121.86 |
| 30075946 | SOUTH FORK BULL RUN | 45.45/-122.03 |
| 30076096 | MUD RIDGE | 45.25/-121.74 |
| 30076424 | NORTH FORK | 45.55/-122 |
| 30085287 | MOUNT HOOD VILLAGE 1.7 ESE | 45.3483/-121.947 |
| 30109665 | SANDY 1.4 NE | 45.4142/-122.245 |
| 30121133 | MOUNT HOOD VILLAGE 0.6 NNE | 45.3639/-121.976 |

**Table 45: Meteorological stations and data, including air temperature, precipitation, relative humidity, wind speed and wind direction, available in the MesoWest database in the Sandy Subbasin.**

| Station ID | Station | Latitude/Longitude |
|---|---|---|
| 2021P | CORBETT | 45.5253/-122.23 |
| 2024P | REVENUE BRIDGE | 45.4071/-122.233 |
| 3691P | SANDEE PALISADES - TROUTDALE | 45.527/-122.378 |
| AR969 | KB7PGV GRESHAM | 45.4787/-122.387 |
| AT638 | KK7N TROUTDALE | 45.5243/-122.375 |
| AU658 | N7CVZ CORBETT | 45.5295/-122.271 |

| Station ID | Station | Latitude/Longitude |
|---|---|---|
| C2654 | CW2654 CORBETT | 45.5/-122.2 |
| C2664 | CW2664 CORBETT | 45.5313/-122.292 |
| C6318 | CW6318 WELCHES | 45.3558/-121.968 |
| C8562 | CW8562 SANDY | 45.3637/-122.161 |
| C9149 | CW9149 CORBETT | 45.5145/-122.3 |
| C9303 | CW9303 RHODODENDRON | 45.3414/-121.932 |
| COOPHDWO3 | HEADWORKS PORTLAND WATER BUREAU | 45.45/-122.15 |
| COOPTTDO3 | SANDY RIVER NR TROUTDALE | 45.54/-122.38 |
| D3605 | DW3605 CORBETT | 45.5211/-122.161 |
| D4118 | DW4118 SANDY | 45.3915/-122.108 |
| D6006 | DW6006 TROUTDALE | 45.5277/-122.39 |
| D6193 | DW6193 CROWN POINT | 45.5388/-122.244 |
| D9126 | DW9126 BRIGHTWOOD | 45.3641/-121.978 |
| D9403 | DW9403 CORBETT | 45.504/-122.27 |
| DSRO3 | NRAWS 3 (DODSON) | 45.6043/-122.043 |
| E6654 | EW6654 RHODODENDRON | 45.3463/-121.951 |
| E8038 | EW8038 CORBETT AIMS | 45.4745/-122.271 |
| F0409 | FW0409 TROUTDALE | 45.5275/-122.384 |
| F1967 | FW1967 CORBETT MENUCHA RETREAT | 45.5372/-122.266 |
| F4477 | FW4477 CORBETT | 45.48/-122.268 |
| F6341 | FW6341 GRESHAM | 45.4907/-122.388 |
| F8434 | FW8434 CORBETT | 45.5095/-122.297 |
| GVT36 | SKIBOWL BASE | 45.3016/-121.772 |
| GVT50 | SKIBOWL SUMMIT | 45.2886/-121.783 |
| LGFO3 | LOG CREEK | 45.4967/-121.895 |
| OD155 | US26 WB AT RUN AWAY TRUCK RAMP MP49.95 | 45.305/-121.817 |
| OD160 | US26 WB AT GOVERNMENT CAMP LOOP RD EAST END MP53.93 | 45.3022/-121.748 |
| OD161 | US26 EB AT USFS RD 35 (KIWANIS) MP47.83 | 45.3069/-121.854 |
| OD162 | US26 EB AT SKI BOWL WEST MP52.44 | 45.3029/-121.779 |
| OD165 | US26 AT ZIGZAG - HOODLAND FIRE MP41.43 | 45.3446/-121.948 |
| ODE02 | MT. HOOD VISIBILITY | 45.2884/-121.783 |
| ODT15 | US26 EB AT BRIGHTWOOD SCALES MP36.51 | 45.3763/-122.035 |
| ODT29 | I84 WB AT SANDY RIVER MP17.5 | 45.5448/-122.388 |
| ODT75 | US26 EB AT GOVERNMENT CAMP MAINT MP54.13 | 45.3018/-121.744 |
| ODT83 | US26 EB AT FIRWOOD RD MP27.04 | 45.3761/-122.223 |
| ODT84 | US26 EB AT CHERRYVILLE DR MP31 | 45.3669/-122.143 |

| Station ID | Station | Latitude/Longitude |
|---|---|---|
| ODT85 | US26 WB AT E ARLIE MITCHELL RD MP44 | 45.3313/-121.913 |
| ODT88 | US26 NB AT FROG LAKE MP61.96 | 45.2288/-121.7 |
| ODT91 | US26 EB AT TRILLIUM LAKE MP55.99 | 45.2841/-121.725 |
| RDSPN | RHODODENDRON SUBSTATION | 45.3128/-121.892 |
| RRWO3 | ROOSTER ROCK | 45.5422/-122.291 |
| SRMO3 | SANDY RIVER BELOW MARMOT DAM NEAR MARMOT NEAR SANDY | 45.3997/-122.136 |
| TARO3 | NRAWS 4 (TANNER) | 45.6126/-121.943 |
| TIM59 | TIMBERLINE LODGE | 45.33/-121.711 |
| TIM70 | TIMBERLINE - MAGIC MILE | 45.3454/-121.712 |
| TR320 | ZIGZAG PORTABLE | 45.3453/-121.939 |
| UP112 | BRIDAL | 45.5414/-122.238 |
| UP220 | DODSON | 45.6294/-121.966 |
| WRNO3 | WARRENDALE WATER QUALITY STATION | 45.6/-122.053 |

**Table 46: Meteorological data provided to DEQ from the various sources for the Sandy Subbasin.**

| Source | Latitude/Longitude | Available Data |
|---|---|---|
| 14140000, USGS | 45.4373/-122.18 | Air Temperature, Relative Humidity, Wind Speed |
| BULL RUN HEADWORKS, CITY OF PORTLAND | 45.4484/-122.154 | Air Temperature, Relative Humidity, Wind Speed |

# Appendix B Continuous stream temperature data summary

**Table 47: Continuous temperature monitoring stations in the Sandy Subbasin currently available in public databases and DEQ files.**

| Station ID | Station | Latitude/Longitude | Organization |
|---|---|---|---|
| 10676-ORDEQ | Sandy River Above Salmon River | 45.3786/-122.013 | DEQ |
| 10677-ORDEQ | Salmon River at Mouth/ HWY 26 | 45.3725/-122.021 | DEQ |
| 11021-ORDEQ | Beaver Creek | 45.5414/-122.383 | DEQ |
| 11024-ORDEQ | Buck Creek | 45.4971/-122.277 | DEQ |
| 11025-ORDEQ | Gordon Creek | 45.4933/-122.277 | DEQ |
| 11780-ORDEQ | Sandy River at Dabney Bridge | 45.5157/-122.36 | DEQ |
| 11782-ORDEQ | Sandy River at Oxbow Park | 45.497/-122.28 | DEQ |
| 21854-ORDEQ | Zigzag River | 45.3384/-121.922 | DEQ |
| 26390-ORDEQ | Little Sandy above Diversion | 45.4153/-122.171 | DEQ |
| 26391-ORDEQ | Little Sandy at Road 14 | 45.4037/-122.172 | DEQ |
| 26404-ORDEQ | Sandy River Above Bull Run | 45.4456/-122.25 | DEQ |
| 26405-ORDEQ | Cedar Creek | 45.3991/-122.246 | DEQ |
| 26407-ORDEQ | Badger Creek | 45.3746/-122.152 | DEQ |
| 26408-ORDEQ | Sandy River at Marmot Gage | 45.3986/-122.128 | DEQ |
| 26409-ORDEQ | Alder Creek | 45.3773/-122.101 | DEQ |
| 26410-ORDEQ | Wildcat Creek | 45.3758/-122.083 | DEQ |
| 26411-ORDEQ | Boulder Creek at mouth (Salmon River, Sandy River tributary) | 45.3687/-122.023 | DEQ |

| Station ID | Station | Latitude/Longitude | Organization |
|---|---|---|---|
| 26412-ORDEQ | Salmon River at East Bridge Road | 45.3207/-121.955 | DEQ |
| 26413-ORDEQ | South Fork Salmon River | 45.2723/-121.938 | DEQ |
| 26414-ORDEQ | Salmon River above the South Fork | 45.2725/-121.938 | DEQ |
| 26415-ORDEQ | Salmon River at HWY 26/35 | 45.2665/-121.719 | DEQ |
| 26416-ORDEQ | Zigzag River at mouth/ Lolo Pass Road | 45.3471/-121.942 | DEQ |
| 26417-ORDEQ | Still Creek | 45.3302/-121.916 | DEQ |
| 26418-ORDEQ | Zigzag River above Still Creek | 45.3297/-121.912 | DEQ |
| 26419-ORDEQ | Camp Creek | 45.3035/-121.87 | DEQ |
| 26420-ORDEQ | Zigzag above Camp Creek/ HWY 26 | 45.311/-121.89 | DEQ |
| 26421-ORDEQ | Clear Creek | 45.3595/-121.937 | DEQ |
| 26422-ORDEQ | Sandy River Above Clear Creek | 45.3565/-121.938 | DEQ |
| 26423-ORDEQ | Sandy River Above Lost Creek | 45.385/-121.871 | DEQ |
| 30354-ORDEQ | Little Sandy Creek | 45.411/-121.948 | DEQ |
| 30362-ORDEQ | Lost Creek | 45.385/-121.848 | DEQ |
| 30628-ORDEQ | Tanner Creek | 45.622/-121.952 | DEQ |
| 31358-ORDEQ | Alder Creek tributary near Cherryville | 45.3316/-122.04 | DEQ |
| 31359-ORDEQ | Hickman Creek tributary by Thunder Rock | 45.4394/-121.884 | DEQ |
| 31377-ORDEQ | Big Creek | 45.5106/-122.285 | DEQ |
| 31389-ORDEQ | Gordon Creek | 45.5108/-122.135 | DEQ |
| 31393-ORDEQ | Cedar Creek | 45.3936/-122.228 | DEQ |
| 31396-ORDEQ | Salmon River | 45.2683/-121.931 | DEQ |
| 31408-ORDEQ | Bull Run River | 45.5042/-121.929 | DEQ |

| Station ID | Station | Latitude/Longitude | Organization |
|---|---|---|---|
| 31480-ORDEQ | Rushing Water Creek, LC reference site | 45.3718/-121.778 | DEQ |
| 31481-ORDEQ | Muddy Fork Sandy River, LC reference site | 45.3962/-121.792 | DEQ |
| 39750 | WES (Hoodland STP) | 45.3464/-121.969 | 2016 Discharge Monitoring Report |
| 89941 | City Of Troutdale Water Pollution Control Facility | 45.5535/-122.387 | 2016 Discharge Monitoring Report |
| COG_ArrowMouth | Arrow Creek at mouth at Division | 45.4972/-122.378 | City of Gresham |
| COG_BCI1 | Beaver Creek at Canyon footbridge | 45.5312/-122.381 | City of Gresham |
| COG_BCI2 | Beaver Creek at Division Street and Troutdale Road | 45.4973/-122.378 | City of Gresham |
| COG_BeaveratCoch | Beaver Creek at Cochran Road | 45.5101/-122.39 | City of Gresham |
| COG_BeaveratGlenO | Beaver Creek at Glen Otto park | 45.5374/-122.379 | City of Gresham |
| COG_BeaveratStark | Beaver Creek at Stark Street | 45.5187/-122.389 | City of Gresham |
| COG_BeaverDSKelly | Beaver Creek downstream of confluence with Kelly Creek | 45.5143/-122.391 | City of Gresham |
| COG_BeaverUSKelly | Beaver Creek upstream of confluence with Kelly Creek | 45.5136/-122.391 | City of Gresham |
| COG_BeDSBeavDamA | Beaver Creek on MHCC campus downstram of beaver dam | 45.5157/-122.391 | City of Gresham |
| COG_BeUSBeavDamA | Beaver Creek on MHCC campus upstream of beaver dam | 45.5154/-122.391 | City of Gresham |
| COG_Burl@Culvert | Burlingame Creek at ditch from culvert on Hogan | 45.5077/-122.414 | City of Gresham |
| COG_Burl@Golf | Burlingame Creek on Gresham Golf Course upstream of Kelly Creek | 45.5111/-122.403 | City of Gresham |

| Station ID | Station | Latitude/Longitude | Organization |
|---|---|---|---|
| COG_Burl@Hogan | Burlingame Creek at Hogan Road | 45.509/-122.414 | City of Gresham |
| COG_BurlatHogan | Burlingame Creek at Hogan Road | 45.509/-122.414 | City of Gresham |
| COG_KCI1 | Kelly Creek downstream of MHCC pond | 45.5135/-122.395 | City of Gresham |
| COG_KCI2 | Kelly Creek upstream MHCC pond | 45.5124/-122.399 | City of Gresham |
| COG_KCI3 | Kelly Creek downstream of Kelley Creek detention pond | 45.4868/-122.383 | City of Gresham |
| COG_KCI4 | Kelly Creek at Ironwood Drive | 45.4846/-122.378 | City of Gresham |
| COG_KellyatKane | Kelly Creek at Kane Drive | 45.5121/-122.401 | City of Gresham |
| COG_KellyUSGolf | Kelly Creek upstream of Gresham Golf Course | 45.5094/-122.402 | City of Gresham |
| 26387-ORDEQ | Bull Run River at County Bridge | 45.4284/-122.233 | City of Portland |
| 26388-ORDEQ | Bull Run River below Little Sandy River | 45.4252/-122.217 | City of Portland |
| 26389-ORDEQ | Little Sandy River | 45.4261/-122.207 | City of Portland |
| 26389-ORDEQ | Little Sandy at Mouth | 45.4261/-122.207 | City of Portland |
| 26392-ORDEQ | Bull Run River above Little Sandy River | 45.4273/-122.207 | City of Portland |
| 26393-ORDEQ | Bull Run River at Larsons Bridge | 45.4318/-122.194 | City of Portland |
| 26394-ORDEQ | Bull Run River at lower Bull Run Gage | 45.4375/-122.18 | City of Portland |
| 26395-ORDEQ | Bull Run River below Plunge Pool | 45.4444/-122.16 | City of Portland |
| 26396-ORDEQ | Bull Run River at Headworks | 45.4464/-122.156 | City of Portland |
| PWB_BR_DODG | Bull Run | 45.4444/-122.248 | City of Portland Water Bureau |
| No Station ID | Bull Run Power House inflow | 45.4289/-122.233 | DEQ File |

| Station ID | Station | Latitude/Longitude | Organization |
|---|---|---|---|
| EMSWCD_BCB | Beaver Creek North Fork at 302nd Ave | 45.4972/-122.353 | EMSWCD |
| EMSWCD_BCC | Beaver Creek South Fork at 302nd Ave | 45.4888/-122.353 | EMSWCD |
| EMSWCD_Beaver_Cory | Beaver Creek at confluence of North and South Forks | 45.4958/-122.366 | EMSWCD |
| EMSWCD_Beaver_Freuler | Beaver Creek South Fork downstream of BCC | 45.4895/-122.357 | EMSWCD |
| EMSWCD_Big_Black | Big Creek at Hurlburt Rd. | 45.5084/-122.287 | EMSWCD |
| EMSWCD_Big_Fishel_Howard | Howard Creek upstream up Littlepage Rd. | 45.5135/-122.282 | EMSWCD |
| EMSWCD_Big_Fishel_Main | Big Creek downstream of confluence of all major tributaries. | 45.5124/-122.284 | EMSWCD |
| EMSWCD_Big_Fishel_Pounder | Pounder Creek at Pounder Rd. | 45.5139/-122.283 | EMSWCD |
| EMSWCD_Smith_Guebert | Smith Creek by Hurlburt Rd. | 45.5101/-122.313 | EMSWCD |
| EMSWCD_Smith_Murphy | Smith Creek downstream of Christensen Rd. | 45.5154/-122.326 | EMSWCD |
| EMSWCD_Smith_Spencer | Smith Creek downstream of Northway Rd. | 45.515/-122.333 | EMSWCD |
| Beaver_0.0 | Beaver Creek at Mouth | 45.541/-122.383 | Portland State University |
| Salmon_0.5 | Salmon River above Sandy Brightwood Bridge | 45.373/-122.021 | Portland State University |
| Salmon_27.8 | Salmon River near Government Camp | 45.265/-121.717 | Portland State University |
| Sandy_29.4 | Sandy River below Marmot Dam | 45.3988/-122.139 | Portland State University |
| Sandy_29.6 | Sandy River at Marmot Dam Site | 45.399/-122.135 | Portland State University |
| Sandy_3.0 | Sandy River Above Beaver Creek | 45.5398/-122.379 | Portland State University |
| Sandy_36.1 | Sandy River at Barlow Trail bridge below Salmon River | 45.3839/-122.046 | Portland State University |

| Station ID | Station | Latitude/Longitude | Organization |
|---|---|---|---|
| Sandy_42.5 | Sandy River upstream of Zigzag River | 45.3497/-121.944 | Portland State University |
| Sandy_43.4 | Sandy River upstream of Clear Creek | 45.3576/-121.937 | Portland State University |
| PWB_Beavr_Canyn | In Beaver Creek Canyon near site of old upstream footbridge | 45.5289/-122.378 | Portland Water Bureau |
| PWB_BR_BWMN_BR | 20 feet downstream of Bowman’s Bridge | 45.4252/-122.217 | Portland Water Bureau |
| PWB_BR_DNSTM_PP | Approximately 600 feet downstream of Bull Run Dam 2 spillway plunge pool | 45.4444/-122.159 | Portland Water Bureau |
| PWB_BR_DODGE | Approximately 500 feet upstream of Sandy River confluence | 45.4444/-122.248 | Portland Water Bureau |
| PWB_BR_SS_BR | Aproximately 60 feet upstream of Rd 14 (Southside) bridge | 45.4379/-122.179 | Portland Water Bureau |
| PWB_D2_LampB | Immediately upstream of Lamprey Barrier | 45.449/-122.155 | Portland Water Bureau |
| PWB_Gordon_Bonner | Downstream edge of Bonner property | 45.4939/-122.218 | Portland Water Bureau |
| PWB_Gordon_LoggingBridge | Under logging bridge on Frank Timber property | 45.5037/-122.174 | Portland Water Bureau |
| PWB_Gordon_Mouth | Approximately 600 feet upstream of Gordon Creek Rd bridge | 45.4915/-122.274 | Portland Water Bureau |
| PWB_SR_US_BR | Approximately 1,900 ft upstream of Bull Run River confluence | 45.4444/-122.254 | Portland Water Bureau |
| CRGNSA-001 | Benson Lake_be20_LTWT | 45.5779/-122.127 | USFS |
| CRGNSA-002 | Bridal Veil Temp Monitor | 45.5561/-122.183 | USFS |
| CRGNSA-007 | Horsetail Water Temp Probe | 45.5905/-122.069 | USFS |
| CRGNSA-008 | McCord Water Temp Monitor | 45.6144/-121.997 | USFS |
| CRGNSA-009 | Moffett Water Temperature Monitor | 45.623/-121.977 | USFS |

| Station ID | Station | Latitude/Longitude | Organization |
|---|---|---|---|
| CRGNSA-011 | Multnomah Creek mu15_LTWT | 45.5787/-122.13 | USFS |
| CRGNSA-012 | Multnomah Creek Upper mu40_LTWT | 45.5778/-122.12 | USFS |
| CRGNSA-013 | Oneonta Water Temp Probe | 45.5899/-122.075 | USFS |
| CRGNSA-015 | Wahkeena Creek wa20_LTWT | 45.5779/-122.13 | USFS |
| MHNF-010 | Alder Cr. Water Temp Probe #1 | 45.377/-122.101 | USFS |
| MHNF-015 | Camp Creek Temp. Monitor | 45.3112/-121.896 | USFS |
| MHNF-016 | Cedar Cr. Water Temp Probe #1 | 45.399/-122.246 | USFS |
| MHNF-024 | Clear Creek trap HOBO temperature site | 45.3581/-121.938 | USFS |
| MHNF-025 | Clear Fork Trap Site WT | 45.3942/-121.859 | USFS |
| MHNF-042 | Goodfellows outlet WT site | 45.4219/-121.966 | USFS |
| MHNF-043 | Gordon Cr_LTWT | 45.5189/-122.116 | USFS |
| MHNF-048 | LinneyCr_LTWT | 45.2189/-121.859 | USFS |
| MHNF-049 | Little Sandy at waterfall WT site | 45.4171/-121.968 | USFS |
| MHNF-050 | Little Sandy R at Bull Run_LTWT | 45.426/-122.207 | USFS |
| MHNF-051 | Little Sandy R at Rd1228_LTWT | 45.4186/-121.961 | USFS |
| MHNF-052 | Little Sandy R Homestead_LTWT | 45.4036/-122.022 | USFS |
| MHNF-053 | Little Sandy Water Temp Monitor | 45.4234/-122.212 | USFS |
| MHNF-054 | Lost Creek Trap Site WT | 45.3794/-121.866 | USFS |
| MHNF-062 | Mud Creek WT site | 45.2618/-121.751 | USFS |
| MHNF-074 | Ramona Cr. R6 Water Temp Monitor | 45.3919/-121.807 | USFS |
| MHNF-077 | Salmon R at Forest Boundary_LTWT | 45.3072/-121.944 | USFS |

| Station ID | Station | Latitude/Longitude | Organization |
|---|---|---|---|
| MHNF-078 | Salmon River trap WT site | 45.3623/-122.011 | USFS |
| MHNF-079 | SalmonRatLinneyCr_LTWT | 45.2209/-121.859 | USFS |
| MHNF-080 | Sandy R at Forest Boundary_LTWT | 45.3563/-121.938 | USFS |
| MHNF-084 | Still Creek 20 Bridge WT | 45.3156/-121.908 | USFS |
| MHNF-085 | Still Creek_LTWT | 45.3273/-121.913 | USFS |
| MHNF-099 | Zigzag River at Forest Boundary_LTWT | 45.3388/-121.923 | USFS |
| MHNF-100 | Zigzag River trap site HOBO | 45.3119/-121.896 | USFS |
| 14133400 | Bear Creek Near Rhododendron, OR. | 45.3401/-121.931 | USGS |
| 14137002 | Sandy River Below Marmot Dam, Near Marmot, OR | 45.3996/-122.137 | USGS |
| 14138720 | Bull Run River At Lower Flume Nr Brightwood, OR | 45.471/-121.865 | USGS |
| 14138850 | Bull Run River Near Multnomah Falls, OR | 45.4982/-122.012 | USGS |
| 14138870 | Fir Creek Near Brightwood, OR | 45.4801/-122.026 | USGS |
| 14138900 | North Fork Bull Run River Near Multnomah Falls, OR | 45.4943/-122.036 | USGS |
| 14139800 | South Fork Bull Run River Near Bull Run, OR | 45.4446/-122.11 | USGS |
| 14140000 | Bull Run River Near Bull Run (River Only), OR | 45.4373/-122.18 | USGS |
| 14140020 | Bull Run R At Larson’s Bridge, Near Bull Run, OR | 45.4318/-122.195 | USGS |
| 14141500 | Little Sandy River Near Bull Run, OR | 45.4154/-122.171 | USGS |

**Table 48: Summary of existing temperature data in the Sandy Subbasin. Columns Jan – Dec indicate the number of daily maximum temperature results in each month. Data from the DEQ files 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1990 | 14138850 | Bull Run River Near Multnomah Falls, OR | 31 | 28 | 31 | 7 | 31 | 30 | 31 | 31 | 30 | | | |
| 1990 | 14138870 | Fir Creek Near Brightwood, OR | 31 | 13 | 30 | 30 | 31 | 30 | 26 | 23 | 29 | 31 | 30 | 31 |
| 1990 | 14138900 | North Fork Bull Run River Near Multnomah Falls, OR | 31 | 28 | 31 | 30 | 31 | 29 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1990 | 14139800 | South Fork Bull Run River Near Bull Run, OR | 31 | 28 | 31 | 25 | 31 | 30 | 29 | 31 | 30 | 31 | 30 | 31 |
| 1991 | 14138850 | Bull Run River Near Multnomah Falls, OR | | | | | | | | | | 31 | 30 | 31 |
| 1991 | 14138870 | Fir Creek Near Brightwood, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1991 | 14138900 | North Fork Bull Run River Near Multnomah Falls, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 28 | 31 | 23 | 31 |
| 1991 | 14139800 | South Fork Bull Run River Near Bull Run, OR | 27 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1992 | 14138850 | Bull Run River Near Multnomah Falls, OR | 31 | 19 | 24 | | 19 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1992 | 14138870 | Fir Creek Near Brightwood, OR | 31 | 26 | 26 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1992 | 14138900 | North Fork Bull Run River Near Multnomah Falls, OR | 31 | 12 | 31 | 22 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1992 | 14139800 | South Fork Bull Run River Near Bull Run, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 29 | 30 | 31 |
| 1993 | 14138850 | Bull Run River Near Multnomah Falls, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1993 | 14138870 | Fir Creek Near Brightwood, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 30 | 30 | 31 | 30 | 31 |
| 1993 | 14138900 | North Fork Bull Run River Near Multnomah Falls, OR | 31 | 28 | 31 | 30 | 26 | | 17 | 31 | 30 | 31 | 30 | 31 |
| 1993 | 14139800 | South Fork Bull Run River Near Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1994 | 14138850 | Bull Run River Near Multnomah Falls, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 16 | 30 | 24 | 30 | 31 |

| Year | Station ID | Station | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1994 | 14138870 | Fir Creek Near Brightwood, OR | 31 | 28 | 24 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 29 | 31 |
| 1994 | 14138900 | North Fork Bull Run River Near Multnomah Falls, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1994 | 14139800 | South Fork Bull Run River Near Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 28 | 26 |
| 1995 | 14138720 | Bull Run River At Lower Flume Nr Brightwood, OR | | | | | | | | | 1 | 31 | 30 | 31 |
| 1995 | 14138850 | Bull Run River Near Multnomah Falls, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1995 | 14138870 | Fir Creek Near Brightwood, OR | 31 | 24 | 31 | 30 | 31 | 30 | 31 | 31 | 28 | 31 | 27 | 31 |
| 1995 | 14138900 | North Fork Bull Run River Near Multnomah Falls, OR | 31 | 28 | 31 | 30 | 30 | 29 | 31 | 31 | 30 | 31 | 28 | 8 |
| 1995 | 14139800 | South Fork Bull Run River Near Bull Run, OR | 29 | 27 | 31 | 30 | 29 | 11 | 31 | 31 | 30 | 31 | 29 | 31 |
| 1996 | 14138720 | Bull Run River At Lower Flume Nr Brightwood, OR | 31 | 29 | 31 | 30 | 31 | 24 | 31 | 31 | 30 | 25 | 30 | 31 |
| 1996 | 14138850 | Bull Run River Near Multnomah Falls, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1996 | 14138870 | Fir Creek Near Brightwood, OR | 31 | 6 | 7 | 30 | 29 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1996 | 14138900 | North Fork Bull Run River Near Multnomah Falls, OR | 31 | 29 | 31 | 27 | 31 | 30 | 31 | 31 | 30 | 26 | 30 | 31 |
| 1996 | 14139800 | South Fork Bull Run River Near Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 27 | 18 | 31 |
| 1997 | 14138720 | Bull Run River At Lower Flume Nr Brightwood, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1997 | 14138850 | Bull Run River Near Multnomah Falls, OR | 31 | 28 | 30 | 30 | 31 | 30 | 31 | 31 | 30 | 29 | 5 | 8 |
| 1997 | 14138870 | Fir Creek Near Brightwood, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1997 | 14138900 | North Fork Bull Run River Near Multnomah Falls, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1997 | 14139800 | South Fork Bull Run River Near Bull Run, OR | 30 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 29 |

| Year | Station ID | Station | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1998 | 14133400 | Bear Creek Near Rhododendron, OR. | | | | | | | | | | | 6 | 31 |
| 1998 | 14138720 | Bull Run River At Lower Flume Nr Brightwood, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1998 | 14138850 | Bull Run River Near Multnomah Falls, OR | 31 | 26 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1998 | 14138870 | Fir Creek Near Brightwood, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1998 | 14138900 | North Fork Bull Run River Near Multnomah Falls, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1998 | 14139800 | South Fork Bull Run River Near Bull Run, OR | 24 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1999 | 14133400 | Bear Creek Near Rhododendron, OR. | 31 | 27 | 31 | 13 | | | | | | | | |
| 1999 | 14138720 | Bull Run River At Lower Flume Nr Brightwood, OR | 31 | 28 | 9 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1999 | 14138850 | Bull Run River Near Multnomah Falls, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1999 | 14138870 | Fir Creek Near Brightwood, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 25 | 31 |
| 1999 | 14138900 | North Fork Bull Run River Near Multnomah Falls, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 27 | 31 |
| 1999 | 14139800 | South Fork Bull Run River Near Bull Run, OR | 27 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1999 | 21854-ORDEQ | Zigzag River | | | | | | | 31 | 31 | 26 | | | |
| 2000 | 14138720 | Bull Run River At Lower Flume Nr Brightwood, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2000 | 14138850 | Bull Run River Near Multnomah Falls, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2000 | 14138870 | Fir Creek Near Brightwood, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2000 | 14138900 | North Fork Bull Run River Near Multnomah Falls, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2000 | 14139800 | South Fork Bull Run River Near Bull Run, OR | 31 | 29 | 27 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2000 | 14140000 | Bull Run River Near Bull Run (River Only), OR | | | | | | | | | | | | 13 |

| Year | Station ID | Station | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2001 | 14138720 | Bull Run River At Lower Flume Nr Brightwood, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2001 | 14138850 | Bull Run River Near Multnomah Falls, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2001 | 14138870 | Fir Creek Near Brightwood, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2001 | 14138900 | North Fork Bull Run River Near Multnomah Falls, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2001 | 14139800 | South Fork Bull Run River Near Bull Run, OR | 31 | 24 | 31 | 30 | 27 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2001 | 14140000 | Bull Run River Near Bull Run (River Only), OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2001 | 26411-ORDEQ | Boulder Creek at mouth (Salmon River, Sandy River tributary) | | | | | | 29 | 31 | 20 | 22 | 1 | | |
| 2002 | 14138720 | Bull Run River At Lower Flume Nr Brightwood, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2002 | 14138850 | Bull Run River Near Multnomah Falls, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2002 | 14138870 | Fir Creek Near Brightwood, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2002 | 14138900 | North Fork Bull Run River Near Multnomah Falls, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 25 | 31 |
| 2002 | 14139800 | South Fork Bull Run River Near Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2002 | 14140000 | Bull Run River Near Bull Run (River Only), OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2003 | 14138720 | Bull Run River At Lower Flume Nr Brightwood, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2003 | 14138850 | Bull Run River Near Multnomah Falls, OR | 28 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2003 | 14138870 | Fir Creek Near Brightwood, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2003 | 14138900 | North Fork Bull Run River Near Multnomah Falls, 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2003 | 14139800 | South Fork Bull Run River Near Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2003 | 14140000 | Bull Run River Near Bull Run (River Only), OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2003 | 30362-ORDEQ | Lost Creek | | | | | | 6 | 31 | 25 | | | | |
| 2003 | 30628-ORDEQ | Tanner Creek | | | | | | | | 29 | | | | |
| 2004 | 14138720 | Bull Run River At Lower Flume Nr Brightwood, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2004 | 14138850 | Bull Run River Near Multnomah Falls, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2004 | 14138870 | Fir Creek Near Brightwood, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2004 | 14138900 | North Fork Bull Run River Near Multnomah Falls, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2004 | 14139800 | South Fork Bull Run River Near Bull Run, OR | 31 | 24 | 26 | 30 | 28 | 27 | 31 | 30 | 30 | 31 | 30 | 31 |
| 2004 | 14140000 | Bull Run River Near Bull Run (River Only), OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2004 | 30354-ORDEQ | Little Sandy Creek | | | | | | | 24 | 31 | 28 | | | |
| 2004 | 30628-ORDEQ | Tanner Creek | | | | | | 23 | 31 | 31 | 20 | | | |
| 2004 | 31358-ORDEQ | Alder Creek tributary near Cherryville | | | | | | | 7 | | | | | |
| 2004 | 31359-ORDEQ | Hickman Creek tributary by Thunder Rock | | | | | | | 23 | 31 | 23 | | | |
| 2004 | 31377-ORDEQ | Big Creek | | | | | | 8 | 31 | 31 | 26 | | | |
| 2004 | 31389-ORDEQ | Gordon Creek | | | | | | 19 | 31 | 31 | 26 | | | |
| 2004 | 31393-ORDEQ | Cedar Creek | | | | | | | 25 | 31 | 30 | 14 | | |
| 2004 | 31396-ORDEQ | Salmon River | | | | | | | 24 | 31 | 27 | | | |
| 2004 | 31408-ORDEQ | Bull Run River | | | | | | | 24 | 31 | 22 | | | |
| 2004 | 31480-ORDEQ | Rushing Water Creek, LC reference site | | | | | | | | | 30 | 8 | | |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2004 | 31481-ORDEQ | Muddy Fork Sandy River, LC reference site | | | | | | 24 | 31 | 31 | 30 | 4 | | |
| 2004 | MHNF-043 | Gordon Cr_LTWT | | | | | | | 11 | 31 | 30 | 19 | | |
| 2004 | MHNF-048 | LinneyCr_LTWT | | | | | | | 14 | 31 | 30 | 17 | | |
| 2004 | MHNF-050 | Little Sandy R at Bull Run_LTWT | | | | | | | 29 | 31 | 22 | 19 | | |
| 2004 | MHNF-051 | Little Sandy R at Rd1228_LTWT | | | | | | | 30 | 31 | 30 | 19 | | |
| 2004 | MHNF-052 | Little Sandy R Homestead_LTWT | | | | | | | 31 | 31 | 30 | 19 | | |
| 2004 | MHNF-062 | Mud Creek WT site | | | | | | | 21 | 31 | 30 | 17 | | |
| 2004 | MHNF-077 | Salmon R at Forest Boundary_LTWT | | | | | | | 20 | 31 | 30 | 18 | | |
| 2004 | MHNF-079 | SalmonRatLinneyCr_LTWT | | | | | | | 14 | 31 | 30 | 17 | | |
| 2004 | MHNF-080 | Sandy R at Forest Boundary_LTWT | | | | | | | 21 | 31 | 30 | 25 | | |
| 2005 | 14138720 | Bull Run River At Lower Flume Nr Brightwood, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2005 | 14138850 | Bull Run River Near Multnomah Falls, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2005 | 14138870 | Fir Creek Near Brightwood, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2005 | 14138900 | North Fork Bull Run River Near Multnomah Falls, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2005 | 14139800 | South Fork Bull Run River Near Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2005 | 14140000 | Bull Run River Near Bull Run (River Only), OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2006 | 14138720 | Bull Run River At Lower Flume Nr Brightwood, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2006 | 14138850 | Bull Run River Near Multnomah Falls, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 27 | 31 |
| 2006 | 14138870 | Fir Creek Near Brightwood, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2006 | 14138900 | North Fork Bull Run River Near Multnomah Falls, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 21 | 20 |
| 2006 | 14139800 | South Fork Bull Run River Near Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 29 | 31 |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2006 | 14140000 | Bull Run River Near Bull Run (River Only), OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | | | |
| 2006 | 14140020 | Bull Run R At Larson’s Bridge, Near Bull Run, OR | | | | | 7 | 27 | 31 | 31 | 30 | 31 | 14 | 31 |
| 2006 | 14141500 | Little Sandy River Near Bull Run, OR | | | | | 6 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2006 | MHNF-050 | Little Sandy R at Bull Run_LTWT | | | | | | | 24 | 31 | 30 | 5 | | |
| 2006 | MHNF-051 | Little Sandy R at Rd1228_LTWT | | | | | | 9 | 31 | 31 | 30 | 1 | | |
| 2006 | MHNF-052 | Little Sandy R Homestead_LTWT | | | | | | 9 | 31 | 31 | 30 | 1 | | |
| 2006 | MHNF-077 | Salmon R at Forest Boundary_LTWT | | | | | 21 | 30 | 31 | 31 | 20 | | | |
| 2006 | MHNF-079 | SalmonRatLinneyCr_LTWT | | | | | | 8 | 31 | 31 | 30 | 1 | | |
| 2006 | MHNF-080 | Sandy R at Forest Boundary_LTWT | | | | | 21 | 30 | 31 | 31 | 30 | 15 | | |
| 2006 | MHNF-099 | Zigzag River at Forest Boundary_LTWT | | | | | 21 | 30 | 31 | 31 | 30 | 15 | | |
| 2007 | 14137002 | Sandy River Below Marmot Dam, Near Marmot, OR | | | | | | 29 | 31 | 31 | 30 | 1 | | |
| 2007 | 14138720 | Bull Run River At Lower Flume Nr Brightwood, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2007 | 14138850 | Bull Run River Near Multnomah Falls, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2007 | 14138870 | Fir Creek Near Brightwood, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2007 | 14138900 | North Fork Bull Run River Near Multnomah Falls, OR | 31 | 28 | 31 | 30 | 31 | 30 | | | 29 | 31 | 30 | 25 |
| 2007 | 14139800 | South Fork Bull Run River Near Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2007 | 14140020 | Bull Run R At Larson’s Bridge, Near Bull Run, OR | 20 | 14 | 31 | 25 | 23 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2007 | 14141500 | Little Sandy River Near Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2007 | MHNF-043 | Gordon Cr_LTWT | | | | | | 7 | 31 | 31 | 30 | 16 | | |
| 2007 | MHNF-048 | LinneyCr_LTWT | | | | | | 4 | 31 | 31 | 30 | 10 | | |
| 2007 | MHNF-050 | Little Sandy R at Bull Run_LTWT | | | | | | 9 | 31 | 31 | 30 | 16 | | |
| 2007 | MHNF-051 | Little Sandy R at Rd1228_LTWT | | | | | | 9 | 31 | 31 | 30 | 16 | | |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2007 | MHNF-052 | Little Sandy R Homestead_LTWT | | | | | | 9 | 31 | 31 | 30 | 16 | | |
| 2007 | MHNF-077 | Salmon R at Forest Boundary_LTWT | | | | | | 17 | 31 | 31 | 30 | 16 | | |
| 2007 | MHNF-079 | SalmonRatLinneyCr_LTWT | | | | | | 4 | 31 | 31 | 30 | 10 | | |
| 2007 | MHNF-080 | Sandy R at Forest Boundary_LTWT | | | | | | 21 | 31 | 31 | 30 | 16 | | |
| 2007 | MHNF-099 | Zigzag River at Forest Boundary_LTWT | | | | | | 21 | 31 | 31 | 30 | 14 | | |
| 2008 | 14138720 | Bull Run River At Lower Flume Nr Brightwood, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2008 | 14138850 | Bull Run River Near Multnomah Falls, OR | 28 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2008 | 14138870 | Fir Creek Near Brightwood, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2008 | 14138900 | North Fork Bull Run River Near Multnomah Falls, OR | 29 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2008 | 14139800 | South Fork Bull Run River Near Bull Run, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2008 | 14140020 | Bull Run R At Larson’s Bridge, Near Bull Run, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 27 | 31 |
| 2008 | 14141500 | Little Sandy River Near Bull Run, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2008 | COG_KCI1 | Kelly Creek downstream of MHCC pond | | | | | | | 16 | 31 | 29 | | | |
| 2008 | COG_KCI4 | Kelly Creek at Ironwood Drive | | | | | | | 16 | 31 | 29 | | | |
| 2008 | CRGNSA-001 | Benson Lake_be20_LTWT | | | | | | 6 | 31 | 5 | | | | |
| 2008 | CRGNSA-011 | Multnomah Creek mu15_LTWT | | | | | | 6 | 31 | 31 | 30 | 5 | | |
| 2008 | CRGNSA-012 | Multnomah Creek Upper mu40_LTWT | | | | | 3 | 30 | 31 | 31 | 30 | 5 | | |
| 2008 | CRGNSA-015 | Wahkeena Creek wa20_LTWT | | | | | | 6 | 31 | 31 | 30 | 5 | | |
| 2008 | MHNF-043 | Gordon Cr_LTWT | | | | | | 14 | 31 | 31 | 29 | | | |
| 2008 | MHNF-048 | LinneyCr_LTWT | | | | | | | 23 | 31 | 23 | | | |
| 2008 | MHNF-050 | Little Sandy R at Bull Run_LTWT | | | | | | | 17 | 31 | 30 | 1 | | |
| 2008 | MHNF-051 | Little Sandy R at Rd1228_LTWT | | | | | | | 21 | 31 | 30 | | | |
| 2008 | MHNF-052 | Little Sandy R Homestead_LTWT | | | | | | 27 | 31 | 31 | 30 | | | |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2008 | MHNF-077 | Salmon R at Forest Boundary_LTWT | | | | | | 27 | 31 | 31 | 30 | 12 | | |
| 2008 | MHNF-079 | SalmonRatLinneyCr_LTWT | | | | | | | 23 | 31 | 23 | | | |
| 2008 | MHNF-080 | Sandy R at Forest Boundary_LTWT | | | | | | 28 | 31 | 31 | 28 | | | |
| 2008 | MHNF-085 | Still Creek_LTWT | | | | | 23 | 30 | 31 | 31 | 30 | 31 | 11 | |
| 2008 | MHNF-099 | Zigzag River at Forest Boundary_LTWT | | | | | | 28 | 31 | 31 | 29 | | | |
| 2009 | 14138720 | Bull Run River At Lower Flume Nr Brightwood, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2009 | 14138850 | Bull Run River Near Multnomah Falls, OR | 31 | 26 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2009 | 14138870 | Fir Creek Near Brightwood, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2009 | 14138900 | North Fork Bull Run River Near Multnomah Falls, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2009 | 14139800 | South Fork Bull Run River Near Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2009 | 14140020 | Bull Run R At Larson’s Bridge, Near Bull Run, OR | 2 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2009 | 14141500 | Little Sandy River Near Bull Run, OR | 14 | 17 | 31 | 30 | 31 | 18 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2009 | COG_BCI2 | Beaver Creek at Division Street and Troutdale Road | | | | | 12 | 30 | 31 | 31 | 30 | 31 | 2 | |
| 2009 | COG_KCI1 | Kelly Creek downstream of MHCC pond | | | | | 12 | 19 | | 25 | 30 | 31 | 2 | |
| 2009 | COG_KCI4 | Kelly Creek at Ironwood Drive | | | | | 12 | 30 | 31 | 31 | 30 | 31 | 2 | |
| 2009 | MHNF-043 | Gordon Cr_LTWT | | | | | | 12 | 31 | 31 | 28 | | | |
| 2009 | MHNF-050 | Little Sandy R at Bull Run_LTWT | | | | | | 15 | 31 | 31 | 30 | 13 | | |
| 2009 | MHNF-051 | Little Sandy R at Rd1228_LTWT | | | | | | 27 | 31 | 31 | 23 | | | |
| 2009 | MHNF-052 | Little Sandy R Homestead_LTWT | | | | | | 27 | 31 | 31 | 23 | | | |
| 2009 | MHNF-077 | Salmon R at Forest Boundary_LTWT | | | | | | 27 | 31 | 31 | 30 | 13 | | |
| 2009 | MHNF-080 | Sandy R at Forest Boundary_LTWT | | | | | | 25 | 31 | 31 | 30 | 13 | | |
| 2009 | MHNF-085 | Still Creek_LTWT | | | | | 17 | 30 | 31 | 31 | 30 | 19 | | |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2009 | MHNF-099 | Zigzag River at Forest Boundary_LTWT | | | | | | 26 | 31 | 31 | 30 | 6 | | |
| 2010 | 14138720 | Bull Run River At Lower Flume Nr Brightwood, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2010 | 14138850 | Bull Run River Near Multnomah Falls, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2010 | 14138870 | Fir Creek Near Brightwood, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2010 | 14138900 | North Fork Bull Run River Near Multnomah Falls, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2010 | 14139800 | South Fork Bull Run River Near Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2010 | 14140020 | Bull Run R At Larson’s Bridge, Near Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2010 | 14141500 | Little Sandy River Near Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2010 | CRGNSA-002 | Bridal Veil Temp Monitor | | | | | | 7 | 31 | 31 | 22 | | | |
| 2010 | CRGNSA-011 | Multnomah Creek mu15_LTWT | | | | | 3 | 30 | 31 | 31 | 30 | 19 | | |
| 2010 | MHNF-025 | Clear Fork Trap Site WT | | | | 3 | 31 | 30 | 31 | 31 | 19 | 10 | 29 | 31 |
| 2010 | MHNF-043 | Gordon Cr_LTWT | | | | | | 14 | 31 | 31 | 23 | | | |
| 2010 | MHNF-048 | LinneyCr_LTWT | | | | | | 15 | 31 | 31 | 30 | 3 | | |
| 2010 | MHNF-050 | Little Sandy R at Bull Run_LTWT | | | | | | 14 | 31 | 31 | 30 | 6 | | |
| 2010 | MHNF-051 | Little Sandy R at Rd1228_LTWT | | | | | | 23 | 31 | 30 | 20 | 12 | 30 | 31 |
| 2010 | MHNF-052 | Little Sandy R Homestead_LTWT | | | | | | 23 | 31 | 31 | 20 | 12 | 30 | 31 |
| 2010 | MHNF-053 | Little Sandy Water Temp Monitor | | | | | | | 30 | 31 | 22 | | | |
| 2010 | MHNF-077 | Salmon R at Forest Boundary_LTWT | | | | | | 23 | 31 | 31 | 29 | | | |
| 2010 | MHNF-079 | SalmonRatLinneyCr_LTWT | | | | | | 15 | 31 | 31 | 30 | 3 | | |
| 2010 | MHNF-080 | Sandy R at Forest Boundary_LTWT | | | | | | 24 | 31 | 31 | 30 | 12 | | |
| 2010 | MHNF-085 | Still Creek_LTWT | | | | 3 | 31 | 30 | 31 | 31 | 19 | 11 | 30 | 31 |
| 2010 | MHNF-099 | Zigzag River at Forest Boundary_LTWT | | | | | | 24 | 31 | 31 | 29 | | | |
| 2010 | MHNF-100 | Zigzag River trap site HOBO | | | | 3 | 31 | 30 | 31 | 31 | 19 | | | |

| Year | Station ID | Station | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2011 | 14138720 | Bull Run River At Lower Flume Nr Brightwood, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2011 | 14138850 | Bull Run River Near Multnomah Falls, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2011 | 14138870 | Fir Creek Near Brightwood, OR | 30 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 29 | 31 |
| 2011 | 14138900 | North Fork Bull Run River Near Multnomah Falls, OR | 31 | 28 | 31 | 30 | 31 | 30 | 22 | 31 | 30 | 31 | 30 | 31 |
| 2011 | 14139800 | South Fork Bull Run River Near Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2011 | 14140020 | Bull Run R At Larson’s Bridge, Near Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2011 | 14141500 | Little Sandy River Near Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2011 | COG_BCI1 | Beaver Creek at Canyon footbridge | | | | | 6 | 30 | 31 | 31 | 30 | 19 | | |
| 2011 | COG_KCI1 | Kelly Creek downstream of MHCC pond | | | | | 6 | 30 | 14 | 27 | 30 | 14 | | |
| 2011 | COG_KCI2 | Kelly Creek upstream MHCC pond | | | | | 6 | 30 | 31 | 31 | 30 | 24 | | |
| 2011 | COG_KCI3 | Kelly Creek downstream of Kelley Creek detention pond | | | | | 6 | 30 | 31 | 31 | 30 | 24 | | |
| 2011 | CRGNSA-011 | Multnomah Creek mu15_LTWT | | | | | | | 18 | 30 | 30 | 24 | | |
| 2011 | CRGNSA-015 | Wahkeena Creek wa20_LTWT | | | | | | | 18 | 30 | 30 | 24 | | |
| 2011 | MHNF-015 | Camp Creek Temp. Monitor | | | | | | 8 | 31 | 31 | 30 | 3 | | |
| 2011 | MHNF-025 | Clear Fork Trap Site WT | 31 | 28 | 30 | 30 | 31 | 30 | 31 | 31 | 30 | 29 | 29 | 31 |
| 2011 | MHNF-043 | Gordon Cr_LTWT | | | | | | 1 | 31 | 31 | 30 | 11 | | |
| 2011 | MHNF-048 | LinneyCr_LTWT | | | | | | 1 | 31 | 31 | 30 | 10 | | |
| 2011 | MHNF-050 | Little Sandy R at Bull Run_LTWT | | | | | | 30 | 31 | 31 | 30 | 16 | | |
| 2011 | MHNF-051 | Little Sandy R at Rd1228_LTWT | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 12 | | |
| 2011 | MHNF-052 | Little Sandy R Homestead_LTWT | 31 | 28 | 31 | 30 | 31 | 30 | 35* | 60* | 60* | 39* | 29 | 31 |
| 2011 | MHNF-074 | Ramona Cr. R6 Water Temp Monitor | | | | | | 7 | 31 | 31 | 30 | 3 | | |
| 2011 | MHNF-077 | Salmon R at Forest Boundary_LTWT | | | | | 5 | 30 | 31 | 31 | 30 | 10 | | |
| 2011 | MHNF-078 | Salmon River trap WT site | | | | | | | | | | 12 | 29 | 31 |

| Year | Station ID | Station | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2011 | MHNF-079 | SalmonRatLinneyCr_LTWT | | | | | | 2 | 31 | 31 | 30 | 10 | | |
| 2011 | MHNF-080 | Sandy R at Forest Boundary_LTWT | | | | | 5 | 30 | 31 | 31 | 30 | 10 | | |
| 2011 | MHNF-085 | Still Creek_LTWT | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2011 | MHNF-099 | Zigzag River at Forest Boundary_LTWT | | | | | 5 | 30 | 31 | 31 | 30 | 10 | | |
| 2011 | PWB_Beavr_Canyn | In Beaver Creek Canyon near site of old upstream footbridge | | | | | | | | | | 18 | 29 | 31 |
| 2012 | 14138720 | Bull Run River At Lower Flume Nr Brightwood, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2012 | 14138850 | Bull Run River Near Multnomah Falls, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2012 | 14138870 | Fir Creek Near Brightwood, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2012 | 14138900 | North Fork Bull Run River Near Multnomah Falls, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2012 | 14139800 | South Fork Bull Run River Near Bull Run, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2012 | 14140020 | Bull Run R At Larson’s Bridge, Near Bull Run, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2012 | 14141500 | Little Sandy River Near Bull Run, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2012 | COG_BCI1 | Beaver Creek at Canyon footbridge | | | | | | 23 | 31 | 31 | 30 | 31 | 3 | |
| 2012 | COG_BCI2 | Beaver Creek at Division Street and Troutdale Road | | | | | | 23 | 31 | 31 | 30 | 31 | 3 | |
| 2012 | COG_BurlatHogan | Burlingame Creek at Hogan Road | | | | | | 23 | 31 | 31 | 30 | 31 | 3 | |
| 2012 | COG_KCI2 | Kelly Creek upstream MHCC pond | | | | | | 23 | 31 | 31 | 30 | 31 | 3 | |
| 2012 | CRGNSA-007 | Horsetail Water Temp Probe | | | | | | 18 | 31 | 31 | 30 | 1 | | |
| 2012 | CRGNSA-013 | Oneonta Water Temp Probe | | | | | | 18 | 31 | 31 | 30 | 1 | | |
| 2012 | MHNF-010 | Alder Cr. Water Temp Probe #1 | | | | | | 4 | 31 | 31 | 30 | 3 | | |
| 2012 | MHNF-016 | Cedar Cr. Water Temp Probe #1 | | | | | | 4 | 31 | 31 | 30 | 3 | | |
| 2012 | MHNF-025 | Clear Fork Trap Site WT | 31 | 29 | 30 | 30 | 13 | 28 | 31 | 31 | 28 | 31 | 29 | 31 |
| 2012 | MHNF-043 | Gordon Cr_LTWT | | | | | | 9 | 31 | 31 | 11 | | | |
| 2012 | MHNF-048 | LinneyCr_LTWT | | | | | | 18 | 31 | 31 | 12 | | | |

| Year | Station ID | Station | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2012 | MHNF-050 | Little Sandy R at Bull Run_LTWT | | | | | | 4 | 31 | 31 | 11 | | | |
| 2012 | MHNF-052 | Little Sandy R Homestead_LTWT | 31 | 29 | 30 | 30 | 13 | 28 | 31 | 10 | | 29 | 29 | 31 |
| 2012 | MHNF-077 | Salmon R at Forest Boundary_LTWT | | | | | | 17 | 31 | 31 | 11 | | | |
| 2012 | MHNF-078 | Salmon River trap WT site | 31 | 29 | 30 | 30 | 15 | | 17 | 31 | 30 | 31 | 29 | 6 |
| 2012 | MHNF-079 | SalmonRatLinneyCr_LTWT | | | | | | 18 | 31 | 31 | 12 | | | |
| 2012 | MHNF-080 | Sandy R at Forest Boundary_LTWT | | | | | 1 | 30 | 31 | 31 | 11 | | | |
| 2012 | MHNF-085 | Still Creek_LTWT | 31 | 29 | 31 | 30 | 29 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2012 | MHNF-099 | Zigzag River at Forest Boundary_LTWT | | | | | 1 | 30 | 31 | 31 | 11 | | | |
| 2012 | PWB_Beavr_Canyn | In Beaver Creek Canyon near site of old upstream footbridge | 31 | 29 | 30 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 29 | 31 |
| 2012 | PWB_Gordon_Bonner | Downstream edge of Bonner property | | | | | | 3 | 31 | 31 | 30 | 26 | | |
| 2012 | PWB_Gordon_Mouth | Approximately 600 feet upstream of Gordon Creek Rd bridge | | | | | | | 30 | 31 | 30 | 26 | | |
| 2013 | 14138720 | Bull Run River At Lower Flume Nr Brightwood, OR | 24 | 14 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2013 | 14138850 | Bull Run River Near Multnomah Falls, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 26 |
| 2013 | 14138870 | Fir Creek Near Brightwood, OR | 24 | 28 | 31 | 30 | 31 | 30 | 31 | 30 | 30 | 31 | 30 | 29 |
| 2013 | 14138900 | North Fork Bull Run River Near Multnomah Falls, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 29 | 30 | 31 |
| 2013 | 14139800 | South Fork Bull Run River Near Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2013 | 14140020 | Bull Run R At Larson’s Bridge, Near Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2013 | 14141500 | Little Sandy River Near Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 30 |
| 2013 | COG_BeaveratGlenO | Beaver Creek at Glen Otto park | | | | | | 26 | 4 | 31 | 6 | 23 | | |
| 2013 | COG_BurlatHogan | Burlingame Creek at Hogan Road | | | | | | 29 | 31 | 31 | 20 | | | |
| 2013 | COG_KCI1 | Kelly Creek downstream of MHCC pond | | | | | | 29 | 24 | | | | | |
| 2013 | COG_KCI2 | Kelly Creek upstream MHCC pond | | | | | | 29 | 31 | 31 | 30 | 24 | | |

| Year | Station ID | Station | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2013 | COG_KCI3 | Kelly Creek downstream of Kelley Creek detention pond | | | 5 | 30 | 31 | 30 | 31 | 31 | 30 | 19 | | |
| 2013 | COG_KCI4 | Kelly Creek at Ironwood Drive | | | 5 | 30 | 31 | 30 | 31 | 31 | 30 | 19 | | |
| 2013 | COG_KellyatKane | Kelly Creek at Kane Drive | | | | | | 29 | 31 | 31 | 30 | 24 | | |
| 2013 | EMSWCD_BCB | Beaver Creek North Fork at 302nd Ave | | | | | | 17 | 31 | 31 | 30 | 16 | | |
| 2013 | MHNF-024 | Clear Creek trap HOBO temperature site | | | | | | | | | | 30 | 29 | 31 |
| 2013 | MHNF-025 | Clear Fork Trap Site WT | 31 | 28 | 30 | 30 | 12 | | 21 | 8 | | | | |
| 2013 | MHNF-043 | Gordon Cr_LTWT | | | | | | 19 | 31 | 31 | 24 | | | |
| 2013 | MHNF-048 | LinneyCr_LTWT | | | | | | 20 | 31 | 31 | 18 | | | |
| 2013 | MHNF-050 | Little Sandy R at Bull Run_LTWT | | | | | | 19 | 31 | 31 | 24 | | | |
| 2013 | MHNF-052 | Little Sandy R Homestead_LTWT | 31 | 28 | 30 | 30 | 13 | 12 | 19 | 31 | 17 | | | |
| 2013 | MHNF-077 | Salmon R at Forest Boundary_LTWT | | | | | 16 | 30 | 31 | 31 | 24 | | | |
| 2013 | MHNF-078 | Salmon River trap WT site | | | | | | | 28 | 31 | 24 | | | |
| 2013 | MHNF-080 | Sandy R at Forest Boundary_LTWT | | | | | 17 | 30 | 31 | 31 | 24 | | | |
| 2013 | MHNF-085 | Still Creek_LTWT | 31 | 28 | 31 | 30 | 29 | 30 | 31 | 31 | 24 | 31 | 30 | 31 |
| 2013 | MHNF-099 | Zigzag River at Forest Boundary_LTWT | | | | | | | | | | 31 | 30 | 31 |
| 2013 | PWB_Beavr_Canyn | In Beaver Creek Canyon near site of old upstream footbridge | 31 | 28 | 30 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 29 | 31 |
| 2013 | PWB_Gordon_Bonner | Downstream edge of Bonner property | | | | | | 24 | 31 | 31 | 30 | 4 | | |
| 2013 | PWB_Gordon_Mouth | Approximately 600 feet upstream of Gordon Creek Rd bridge | | | | 11 | 31 | 30 | 31 | 31 | 30 | 31 | 29 | 31 |
| 2014 | 14138720 | Bull Run River At Lower Flume Nr Brightwood, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2014 | 14138850 | Bull Run River Near Multnomah Falls, OR | 31 | 21 | 31 | 30 | 31 | 22 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2014 | 14138870 | Fir Creek Near Brightwood, OR | 31 | 28 | 31 | 30 | 28 | 29 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2014 | 14138900 | North Fork Bull Run River Near Multnomah Falls, 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 | 14139800 | South Fork Bull Run River Near Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2014 | 14140020 | Bull Run R At Larson’s Bridge, Near Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2014 | 14141500 | Little Sandy River Near Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2014 | COG_ArrowMouth | Arrow Creek at mouth at Division | | | | | 3 | 30 | 31 | 31 | 30 | 26 | | |
| 2014 | COG_BCI2 | Beaver Creek at Division Street and Troutdale Road | | | | | 21 | 30 | 31 | 31 | 30 | 26 | | |
| 2014 | COG_BeaveratCoch | Beaver Creek at Cochran Road | | | | | 3 | 30 | 31 | 31 | 30 | 26 | | |
| 2014 | COG_BeaveratStark | Beaver Creek at Stark Street | | | | | 21 | 30 | 31 | 31 | 30 | 26 | | |
| 2014 | COG_KCI2 | Kelly Creek upstream MHCC pond | | | | | 21 | 30 | 31 | 31 | 30 | 26 | | |
| 2014 | COG_KellyatKane | Kelly Creek at Kane Drive | | | | | 21 | 30 | 31 | 31 | 30 | 26 | | |
| 2014 | CRGNSA-008 | McCord Water Temp Monitor | | | | | | | 15 | 31 | 30 | 15 | | |
| 2014 | CRGNSA-009 | Moffett Water Temperature Monitor | | | | | | | 15 | 31 | 30 | 15 | | |
| 2014 | EMSWCD_BCB | Beaver Creek North Fork at 302nd Ave | | | | | 8 | 30 | 31 | 31 | 30 | 8 | | |
| 2014 | EMSWCD_BCC | Beaver Creek South Fork at 302nd Ave | | | | | 8 | 30 | 10 | | | | | |
| 2014 | EMSWCD_Beaver_Cory | Beaver Creek at confluence of North and South Forks | | | | | 8 | 30 | 31 | 31 | 30 | 8 | | |
| 2014 | MHNF-024 | Clear Creek trap HOBO temperature site | 31 | 28 | 30 | 27 | 31 | 30 | 31 | 31 | 21 | | | |
| 2014 | MHNF-025 | Clear Fork Trap Site WT | | | | | | | | | 8 | 31 | 30 | 31 |
| 2014 | MHNF-043 | Gordon Cr_LTWT | | | | | | 21 | 31 | 31 | 30 | 2 | | |
| 2014 | MHNF-048 | LinneyCr_LTWT | | | | | 3 | 30 | 31 | 31 | 14 | | | |
| 2014 | MHNF-050 | Little Sandy R at Bull Run_LTWT | | | | | | 21 | 31 | 31 | 28 | | | |
| 2014 | MHNF-052 | Little Sandy R Homestead_LTWT | | | | 6 | 31 | 30 | 31 | 31 | 25 | | | |
| 2014 | MHNF-054 | Lost Creek Trap Site WT | | | | | | | | | | 21 | 30 | 31 |
| 2014 | MHNF-077 | Salmon R at Forest Boundary_LTWT | | | | 9 | 31 | 30 | 31 | 31 | 17 | | | |
| 2014 | MHNF-078 | Salmon River trap WT site | | | | 1 | 31 | 30 | 31 | 31 | 23 | | | |

| Year | Station ID | Station | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2014 | MHNF-079 | SalmonRatLinneyCr_LTWT | | | | | 3 | 30 | 31 | 31 | 14 | | | |
| 2014 | MHNF-080 | Sandy R at Forest Boundary_LTWT | | | | | | | 22 | 31 | 21 | | | |
| 2014 | MHNF-085 | Still Creek_LTWT | 31 | 28 | 31 | 28 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2014 | MHNF-099 | Zigzag River at Forest Boundary_LTWT | 31 | 28 | 31 | 28 | 31 | 30 | 31 | 31 | 14 | | | |
| 2014 | PWB_Beavr_Canyn | In Beaver Creek Canyon near site of old upstream footbridge | 31 | 28 | 30 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 29 | 31 |
| 2014 | PWB_BR_DNSTM_PP | Approximately 600 feet downstream of Bull Run Dam 2 spillway plunge pool | | | | | | | 21 | 31 | 30 | 8 | | |
| 2014 | PWB_BR_SS_BR | Aproximately 60 feet upstream of Rd 14 (Southside) bridge | | | | | | | 21 | 31 | 30 | 8 | | |
| 2014 | PWB_D2_LampB | Immediately upstream of Lamprey Barrier | | 9 | 30 | 21 | 31 | 30 | 31 | 31 | 30 | 31 | 29 | 31 |
| 2014 | PWB_Gordon_Mouth | Approximately 600 feet upstream of Gordon Creek Rd bridge | 31 | 28 | 30 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 29 | 31 |
| 2015 | 14138720 | Bull Run River At Lower Flume Nr Brightwood, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2015 | 14138850 | Bull Run River Near Multnomah Falls, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2015 | 14138870 | Fir Creek Near Brightwood, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 23 | 31 | 30 | 31 |
| 2015 | 14138900 | North Fork Bull Run River Near Multnomah Falls, OR | 31 | 26 | 24 | 30 | 31 | 30 | 31 | 31 | 30 | 29 | 30 | 31 |
| 2015 | 14139800 | South Fork Bull Run River Near Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 24 | 27 | 31 | 30 | 31 |
| 2015 | 14140020 | Bull Run R At Larson’s Bridge, Near Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 20 |
| 2015 | 14141500 | Little Sandy River Near Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2015 | COG_ArrowMouth | Arrow Creek at mouth at Division | | | | | 9 | 30 | 31 | 31 | 30 | 19 | | |
| 2015 | COG_BCI2 | Beaver Creek at Division Street and Troutdale Road | | | | | 9 | 30 | 31 | 31 | 30 | 19 | | |
| 2015 | COG_BeaveratCoch | Beaver Creek at Cochran Road | | | | | 9 | 30 | 31 | 31 | 30 | 19 | | |

| Year | Station ID | Station | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2015 | COG_BeaveratGlenO | Beaver Creek at Glen Otto park | | | | | 9 | 30 | 31 | 31 | 30 | 19 | | |
| 2015 | COG_BeaveratStark | Beaver Creek at Stark Street | | | | | 9 | 30 | 31 | 31 | 30 | 19 | | |
| 2015 | COG_BeaverDSKelly | Beaver Creek downstream of confluence with Kelly Creek | | | | | 9 | 30 | 31 | 31 | 30 | 19 | | |
| 2015 | COG_BeaverUSKelly | Beaver Creek upstream of confluence with Kelly Creek | | | | | 9 | 30 | 31 | 31 | 30 | 19 | | |
| 2015 | COG_BurlatHogan | Burlingame Creek at Hogan Road | | | | | 9 | 30 | 31 | 31 | 30 | 19 | | |
| 2015 | COG_KCI1 | Kelly Creek downstream of MHCC pond | | | | | 9 | 30 | 31 | 31 | 30 | 19 | | |
| 2015 | COG_KCI2 | Kelly Creek upstream MHCC pond | | | | | 9 | 30 | 31 | 31 | 30 | 19 | | |
| 2015 | COG_KellyatKane | Kelly Creek at Kane Drive | | | | | 9 | 30 | 31 | 31 | 30 | 19 | | |
| 2015 | EMSWCD_BCB | Beaver Creek North Fork at 302nd Ave | | | | | 12 | 30 | 31 | 31 | 30 | 12 | | |
| 2015 | EMSWCD_BCC | Beaver Creek South Fork at 302nd Ave | | | | | 12 | 30 | 31 | 31 | 30 | 12 | | |
| 2015 | EMSWCD_Beaver_Cory | Beaver Creek at confluence of North and South Forks | | | | | 3 | 30 | 31 | 31 | 30 | 31 | 23 | |
| 2015 | MHNF-024 | Clear Creek trap HOBO temperature site | | | | | | | | | 6 | 31 | 30 | 31 |
| 2015 | MHNF-025 | Clear Fork Trap Site WT | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 2 | | | |
| 2015 | MHNF-042 | Goodfellows outlet WT site | | | | | | | 11 | 31 | 20 | | | |
| 2015 | MHNF-043 | Gordon Cr_LTWT | | | | | | 17 | 31 | 31 | 20 | | | |
| 2015 | MHNF-048 | LinneyCr_LTWT | | | | | | 19 | 31 | 31 | 7 | | | |
| 2015 | MHNF-049 | Little Sandy at waterfall WT site | | | | | | | 11 | 31 | 23 | | | |
| 2015 | MHNF-050 | Little Sandy R at Bull Run_LTWT | | | | | | | 31 | 31 | 20 | | | |
| 2015 | MHNF-051 | Little Sandy R at Rd1228_LTWT | | | | | | 26 | 31 | 31 | 20 | | | |
| 2015 | MHNF-052 | Little Sandy R Homestead_LTWT | | | | | | 26 | 31 | 31 | 23 | | | |
| 2015 | MHNF-054 | Lost Creek Trap Site WT | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 7 | | | |
| 2015 | MHNF-062 | Mud Creek WT site | | | | | | 18 | 31 | 31 | 7 | | | |
| 2015 | MHNF-077 | Salmon R at Forest Boundary_LTWT | | | | | | 25 | 31 | 31 | 23 | | | |

| Year | Station ID | Station | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2015 | MHNF-078 | Salmon River trap WT site | | | | | | | | | 6 | 31 | 30 | 31 |
| 2015 | MHNF-079 | SalmonRatLinneyCr_LTWT | | | | | | 19 | 31 | 31 | 7 | | | |
| 2015 | MHNF-085 | Still Creek_LTWT | 31 | 28 | 31 | 30 | 31 | 3 | | 25 | 30 | 31 | 30 | 31 |
| 2015 | MHNF-099 | Zigzag River at Forest Boundary_LTWT | | | | | | 27 | 31 | 31 | 7 | | | |
| 2015 | PWB_Beavr_Canyn | In Beaver Creek Canyon near site of old upstream footbridge | 31 | 28 | 30 | 30 | 31 | 30 | 31 | 31 | 30 | 29 | | |
| 2015 | PWB_BR_BWMN_BR | 20 feet downstream of Bowman's Bridge | | | | | | 8 | 31 | 31 | 23 | | | |
| 2015 | PWB_BR_DNSTM_PP | Approximately 600 feet downstream of Bull Run Dam 2 spillway plunge pool | | | | | | 7 | 31 | 31 | 30 | 20 | | |
| 2015 | PWB_BR_DODGE | Approximately 500 feet upstream of Sandy River confluence | | | | | | | | 20 | 30 | 16 | | |
| 2015 | PWB_BR_SS_BR | Aproximately 60 feet upstream of Rd 14 (Southside) bridge | | | | | | 8 | 31 | 31 | 30 | 20 | | |
| 2015 | PWB_D2_LampB | Immediately upstream of Lamprey Barrier | 30 | 28 | 30 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 27 | 30 |
| 2015 | PWB_Gordon_Bonner | Downstream edge of Bonner property | | | | | | 5 | 31 | 31 | 30 | 21 | | |
| 2015 | PWB_Gordon_LoggingBridge | Under logging bridge on Frank Timber property | | | | | | 3 | 31 | 31 | 30 | 20 | | |
| 2015 | PWB_Gordon_Mouth | Approximately 600 feet upstream of Gordon Creek Rd bridge | | | | | | 14 | 31 | 31 | 30 | 31 | 29 | 31 |
| 2015 | PWB_SR_US_BR | Approximately 1,900 ft upstream of Bull Run River confluence | | | | | | | | 20 | 30 | 19 | | |
| 2016 | 14138720 | Bull Run River At Lower Flume Nr Brightwood, OR | 31 | 29 | 25 | 29 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2016 | 14138850 | Bull Run River Near Multnomah Falls, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2016 | 14138870 | Fir Creek Near Brightwood, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2016 | 14138900 | North Fork Bull Run River Near Multnomah Falls, 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 | 14139800 | South Fork Bull Run River Near Bull Run, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2016 | 14140020 | Bull Run R At Larson's Bridge, Near Bull Run, OR | 28 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2016 | 14141500 | Little Sandy River Near Bull Run, OR | 31 | 27 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2016 | Beaver_0.0 | Beaver Creek at Mouth | | | | | | | 24 | 31 | 21 | | | |
| 2016 | COG_BeaveratGlenO | Beaver Creek at Glen Otto park | | | | | 24 | 30 | 31 | 31 | 30 | 31 | 3 | |
| 2016 | COG_BeaverDSKelly | Beaver Creek downstream of confluence with Kelly Creek | | | | | 24 | 30 | 31 | 31 | 30 | 31 | 3 | |
| 2016 | COG_BeaverUSKelly | Beaver Creek upstream of confluence with Kelly Creek | | | | | 24 | 30 | 31 | 31 | 30 | 31 | 3 | |
| 2016 | COG_KCI2 | Kelly Creek upstream MHCC pond | | | | | 24 | 30 | 31 | 31 | 30 | 31 | 3 | |
| 2016 | COG_KellyUSGolf | Kelly Creek upstream of Gresham Golf Course | | | | | 24 | 30 | 31 | 31 | 30 | 31 | 3 | |
| 2016 | EMSWCD_Beaver_Cory | Beaver Creek at confluence of North and South Forks | | | | | 19 | 30 | 31 | 31 | 30 | 24 | | |
| 2016 | EMSWCD_Beaver_Freuler | Beaver Creek South Fork downstream of BCC | | | | | 19 | 28 | 31 | 31 | 30 | 11 | | |
| 2016 | EMSWCD_Big_Black | Big Creek at Hurlburt Rd. | | | | | 19 | 30 | 31 | 31 | 30 | 10 | | |
| 2016 | EMSWCD_Big_Fishel_Howard | Howard Creek upstream up Littlepage Rd. | | | | | 19 | 30 | 31 | 31 | 30 | 10 | | |
| 2016 | EMSWCD_Big_Fishel_Main | Big Creek downstream of confluence of all major tributaries. | | | | | 19 | 30 | 31 | 31 | 30 | 10 | | |
| 2016 | EMSWCD_Big_Fishel_Pounder | Pounder Creek at Pounder Rd. | | | | | 19 | 30 | 31 | 31 | 30 | 10 | | |
| 2016 | EMSWCD_Smith_Murphy | Smith Creek downstream of Christensen Rd. | | | | | 19 | 30 | 31 | 31 | 30 | 6 | | |
| 2016 | MHNF-024 | Clear Creek trap HOBO temperature site | 31 | 29 | 31 | 28 | 31 | 30 | 31 | 31 | 29 | 31 | 30 | 31 |
| 2016 | MHNF-042 | Goodfellows outlet WT site | | | | | | 22 | 31 | 31 | 8 | | | |
| 2016 | MHNF-043 | Gordon Cr_LTWT | | | | | | 29 | 31 | 31 | 8 | | | |
| 2016 | MHNF-048 | LinneyCr_LTWT | | | | | | 22 | 31 | 31 | | | | |

| Year | Station ID | Station | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2016 | MHNF-049 | Little Sandy at waterfall WT site | | | | | | 22 | 31 | 31 | 8 | | | |
| 2016 | MHNF-050 | Little Sandy R at Bull Run_LTWT | | | | | | 23 | 31 | 31 | 8 | | | |
| 2016 | MHNF-051 | Little Sandy R at Rd1228_LTWT | | | | | | 22 | 31 | 31 | 8 | | | |
| 2016 | MHNF-052 | Little Sandy R Homestead_LTWT | | | | | | 23 | 31 | 31 | 8 | | | |
| 2016 | MHNF-054 | Lost Creek Trap Site WT | | | | | | | | | | 31 | 30 | 31 |
| 2016 | MHNF-062 | Mud Creek WT site | | | | 5 | 31 | 30 | 31 | 31 | 7 | | | |
| 2016 | MHNF-077 | Salmon R at Forest Boundary_LTWT | | | | 5 | 31 | 30 | 31 | 31 | 7 | | | |
| 2016 | MHNF-078 | Salmon River trap WT site | 31 | 29 | 31 | 28 | 31 | 30 | 31 | 31 | 29 | 31 | 30 | 31 |
| 2016 | MHNF-079 | SalmonRatLinneyCr_LTWT | | | | | | 22 | 31 | 31 | | | | |
| 2016 | MHNF-080 | Sandy R at Forest Boundary_LTWT | | | | 18 | 31 | 30 | 31 | 31 | 7 | | | |
| 2016 | MHNF-085 | Still Creek_LTWT | 31 | 29 | 31 | 28 | 31 | 30 | 31 | 31 | 29 | 31 | 30 | 31 |
| 2016 | MHNF-099 | Zigzag River at Forest Boundary_LTWT | | | | 18 | 31 | 30 | 31 | 31 | 7 | | | |
| 2016 | MHNF-100 | Zigzag River trap site HOBO | | | | | | | | | | 31 | 30 | 31 |
| 2016 | PWB_Beavr_Canyn | In Beaver Creek Canyon near site of old upstream footbridge | | | | 29 | 31 | 30 | 31 | 31 | 30 | 31 | 29 | 31 |
| 2016 | PWB_BR_BWMN_BR | 20 feet downstream of Bowman’s Bridge | | | | | | 8 | 31 | 31 | 29 | | | |
| 2016 | PWB_BR_DNSTM_PP | Approximately 600 feet downstream of Bull Run Dam 2 spillway plunge pool | | | | | | 8 | 31 | 31 | 28 | | | |
| 2016 | PWB_BR_DODGE | Approximately 500 feet upstream of Sandy River confluence | | | | | | 8 | 31 | 31 | 29 | | | |
| 2016 | PWB_BR_SS_BR | Aproximately 60 feet upstream of Rd 14 (Southside) bridge | | | | | | 8 | 31 | 31 | 28 | | | |
| 2016 | PWB_D2_LampB | Immediately upstream of Lamprey Barrier | 31 | 29 | 30 | 30 | 31 | 30 | 22 | 31 | 30 | 31 | 29 | 20 |
| 2016 | PWB_Gordon_Bonner | Downstream edge of Bonner property | | | | | 11 | 30 | 31 | 31 | 30 | 12 | | |
| 2016 | PWB_Gordon_LoggingBridge | Under logging bridge on Frank Timber property | | | | | 6 | 30 | 31 | 31 | 30 | 18 | | |

| Year | Station ID | Station | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2016 | PWB_Gordon_Mouth | Approximately 600 feet upstream of Gordon Creek Rd bridge | 31 | 29 | 30 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 29 | 31 |
| 2016 | PWB_SR_US_BR | Approximately 1,900 ft upstream of Bull Run River confluence | | | | | | 8 | 31 | 31 | 29 | | | |
| 2016 | Salmon_0.5 | Salmon River above Sandy Brightwood Bridge | | | | | | | 27 | 31 | 22 | | | |
| 2016 | Salmon_27.8 | Salmon River near Government Camp | | | | | | | 27 | 31 | 23 | | | |
| 2016 | Sandy_29.4 | Sandy River below Marmot Dam | | | | | | | 19 | 31 | 21 | | | |
| 2016 | Sandy_29.6 | Sandy River at Marmot Dam Site | | | | | | | 18 | 31 | 21 | | | |
| 2016 | Sandy_3.0 | Sandy River Above Beaver Creek | | | | | | | 22 | 31 | 21 | | | |
| 2016 | Sandy_36.1 | Sandy River at Barlow Trail bridge below Salmon River | | | | | | | 27 | 31 | 22 | | | |
| 2016 | Sandy_42.5 | Sandy River upstream of Zigzag River | | | | | | | 20 | 31 | 22 | | | |
| 2016 | Sandy_43.4 | Sandy River upstream of Clear Creek | | | | | | | 20 | 31 | 22 | | | |
| 2017 | 14138720 | Bull Run River At Lower Flume Nr Brightwood, OR | 8 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2017 | 14138850 | Bull Run River Near Multnomah Falls, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 28 |
| 2017 | 14138870 | Fir Creek Near Brightwood, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2017 | 14138900 | North Fork Bull Run River Near Multnomah Falls, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2017 | 14139800 | South Fork Bull Run River Near Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2017 | 14140020 | Bull Run R At Larson’s Bridge, Near Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2017 | 14141500 | Little Sandy River Near Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2017 | COG_BCI2 | Beaver Creek at Division Street and Troutdale Road | | | | | 18 | 30 | 31 | 31 | 30 | 3 | | |
| 2017 | COG_BeaveratGlenO | Beaver Creek at Glen Otto park | | | | | 18 | 30 | 31 | 31 | 30 | 3 | | |

| Year | Station ID | Station | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2017 | COG_BeaverDSKelly | Beaver Creek downstream of confluence with Kelly Creek | | | | | 18 | 30 | 31 | 31 | 30 | 3 | | |
| 2017 | COG_BeaverUSKelly | Beaver Creek upstream of confluence with Kelly Creek | | | | | 18 | 30 | 31 | 31 | 30 | 3 | | |
| 2017 | COG_BurlatHogan | Burlingame Creek at Hogan Road | | | | | 18 | 30 | 31 | 31 | 30 | 3 | | |
| 2017 | COG_KCI1 | Kelly Creek downstream of MHCC pond | | | | | 18 | 30 | 31 | 31 | 30 | 3 | | |
| 2017 | COG_KCI2 | Kelly Creek upstream MHCC pond | | | | | 18 | 30 | 31 | 31 | 30 | 3 | | |
| 2017 | COG_KellyUSGolf | Kelly Creek upstream of Gresham Golf Course | | | | | 18 | 30 | 31 | 31 | 30 | 3 | | |
| 2017 | CRGNSA-012 | Multnomah Creek Upper mu40_LTWT | | | | | | 22 | 31 | 29 | | | | |
| 2017 | EMSWCD_Beaver_Cory | Beaver Creek at confluence of North and South Forks | | | | | 7 | 30 | 31 | 31 | 30 | 29 | | |
| 2017 | EMSWCD_Beaver_Freuler | Beaver Creek South Fork downstream of BCC | | | | | 8 | 30 | 31 | 31 | 30 | 10 | | |
| 2017 | EMSWCD_Big_Black | Big Creek at Hurlburt Rd. | | | | | 8 | 30 | 31 | 31 | 30 | 10 | | |
| 2017 | EMSWCD_Smith_Guebert | Smith Creek by Hurlburt Rd. | | | | | 8 | 30 | 31 | 31 | 30 | 10 | | |
| 2017 | EMSWCD_Smith_Murphy | Smith Creek downstream of Christensen Rd. | | | | | 7 | 30 | 31 | 31 | 30 | 10 | | |
| 2017 | EMSWCD_Smith_Spencer | Smith Creek downstream of Northway Rd. | | | | | 8 | 30 | 31 | 31 | 30 | 10 | | |
| 2017 | MHNF-024 | Clear Creek trap HOBO temperature site | 31 | 28 | 31 | 30 | 36* | 42* | 42* | 47* | 31 | 31 | 29 | 31 |
| 2017 | MHNF-025 | Clear Fork Trap Site WT | | | | | 19 | 41* | 42* | 42* | 29 | 31 | 29 | 31 |
| 2017 | MHNF-042 | Goodfellows outlet WT site | | | | | 12 | 30 | 31 | 31 | 20 | | | |
| 2017 | MHNF-043 | Gordon Cr_LTWT | | | | | 3 | 30 | 31 | 31 | 26 | | | |
| 2017 | MHNF-048 | LinneyCr_LTWT | | | | | | 25 | 31 | 31 | 20 | | | |
| 2017 | MHNF-049 | Little Sandy at waterfall WT site | | | | | 12 | 30 | 31 | 31 | 30 | 3 | | |
| 2017 | MHNF-050 | Little Sandy R at Bull Run_LTWT | | | | | 3 | 30 | 31 | 31 | 30 | 9 | | |
| 2017 | MHNF-051 | Little Sandy R at Rd1228_LTWT | | | | | 12 | 30 | 31 | 31 | 30 | 3 | | |

| Year | Station ID | Station | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2017 | MHNF-052 | Little Sandy R Homestead_LTWT | | | | | 12 | 30 | 31 | 31 | 24 | | | |
| 2017 | MHNF-054 | Lost Creek Trap Site WT | 31 | 28 | 31 | 30 | 29 | 30 | 31 | 31 | 28 | 31 | 29 | 27 |
| 2017 | MHNF-062 | Mud Creek WT site | | | | | | 24 | 31 | 31 | 20 | | | |
| 2017 | MHNF-077 | Salmon R at Forest Boundary_LTWT | | | | | 17 | 30 | 31 | 31 | 18 | | | |
| 2017 | MHNF-078 | Salmon River trap WT site | 31 | 28 | 31 | 30 | 6 | | | | 24 | 31 | 29 | 31 |
| 2017 | MHNF-079 | SalmonRatLinneyCr_LTWT | | | | | | 25 | 31 | 31 | 20 | | | |
| 2017 | MHNF-080 | Sandy R at Forest Boundary_LTWT | | | | | 19 | 30 | 31 | 31 | 17 | | | |
| 2017 | MHNF-084 | Still Creek 20 Bridge WT | | | | | 17 | 30 | 31 | 31 | 4 | | | |
| 2017 | MHNF-085 | Still Creek_LTWT | 31 | 28 | 31 | 30 | 29 | 30 | 31 | 31 | 4 | | | |
| 2017 | MHNF-099 | Zigzag River at Forest Boundary_LTWT | | | | | 17 | 30 | 31 | 31 | 4 | | | |
| 2017 | MHNF-100 | Zigzag River trap site HOBO | 31 | 28 | 31 | 30 | 30 | 30 | 31 | 31 | 28 | 31 | 29 | 31 |
| 2017 | PWB_Beavr_Canyn | In Beaver Creek Canyon near site of old upstream footbridge | 31 | 28 | 30 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 29 | 31 |
| 2017 | PWB_BR_BWMN_BR | 20 feet downstream of Bowman's Bridge | | | | | | | | 29 | 30 | 9 | | |
| 2017 | PWB_BR_DNSTM_PP | Approximately 600 feet downstream of Bull Run Dam 2 spillway plunge pool | | | | | | | | 29 | 30 | | | |
| 2017 | PWB_BR_DODGE | Approximately 500 feet upstream of Sandy River confluence | | | | | | | | 29 | 30 | 18 | | |
| 2017 | PWB_BR_SS_BR | Aproximately 60 feet upstream of Rd 14 (Southside) bridge | | | | | | | | 29 | 30 | 2 | | |
| 2017 | PWB_D2_LampB | Immediately upstream of Lamprey Barrier | 15 | 27 | 30 | 28 | 31 | 29 | 31 | 31 | 30 | 21 | 2 | |
| 2017 | PWB_Gordon_Bonner | Downstream edge of Bonner property | | | | | 20 | 30 | 31 | 31 | 30 | 26 | | |
| 2017 | PWB_Gordon_LoggingBridge | Under logging bridge on Frank Timber property | | | | | | 10 | 31 | 31 | 30 | 30 | | |
| 2017 | PWB_Gordon_Mouth | Approximately 600 feet upstream of Gordon Creek Rd bridge | 31 | 28 | 30 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 29 | 31 |

| Year | Station ID | Station | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2017 | PWB_SR_US_BR | Approximately 1,900 ft upstream of Bull Run River confluence | | | | | | | | 29 | 30 | 18 | | |
| 2018 | 14138720 | Bull Run River At Lower Flume Nr Brightwood, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2018 | 14138850 | Bull Run River Near Multnomah Falls, OR | 31 | 26 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2018 | 14138870 | Fir Creek Near Brightwood, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2018 | 14138900 | North Fork Bull Run River Near Multnomah Falls, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2018 | 14139800 | South Fork Bull Run River Near Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2018 | 14140020 | Bull Run R At Larson’s Bridge, Near Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2018 | 14141500 | Little Sandy River Near Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2018 | COG_BeaverDSKelly | Beaver Creek downstream of confluence with Kelly Creek | | | | | 23 | 30 | 31 | 31 | 30 | 8 | | |
| 2018 | COG_BeaverUSKelly | Beaver Creek upstream of confluence with Kelly Creek | | | | | 23 | 30 | 31 | 31 | 30 | 8 | | |
| 2018 | COG_BeDSBeavDamA | Beaver Creek on MHCC campus downstram of beaver dam | | | | | | | 10 | 31 | 30 | 8 | | |
| 2018 | COG_BeUSBeavDamA | Beaver Creek on MHCC campus upstream of beaver dam | | | | | | | 10 | 31 | 30 | 8 | | |
| 2018 | COG_KCI1 | Kelly Creek downstream of MHCC pond | | | | 9 | 31 | 30 | 31 | 31 | 30 | 8 | | |
| 2018 | EMSWCD_Beaver_Cory | Beaver Creek at confluence of North and South Forks | | | | 2 | 31 | 30 | 31 | 31 | 30 | 16 | | |
| 2018 | EMSWCD_Smith_Guebert | Smith Creek by Hurlburt Rd. | | | | 5 | 31 | 30 | 31 | 31 | 30 | 14 | | |
| 2018 | EMSWCD_Smith_Murphy | Smith Creek downstream of Christensen Rd. | | | | 5 | 31 | 30 | 31 | 31 | 30 | 14 | | |
| 2018 | EMSWCD_Smith_Spencer | Smith Creek downstream of Northway Rd. | | | | 5 | 31 | 30 | 31 | 31 | 30 | 14 | | |

| Year | Station ID | Station | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2018 | MHNF-024 | Clear Creek trap HOBO temperature site | 31 | 28 | 30 | 30 | 29 | 30 | 31 | 31 | 20 | | | |
| 2018 | MHNF-025 | Clear Fork Trap Site WT | 31 | 28 | 30 | 30 | 27 | 30 | 31 | 31 | 29 | 31 | 29 | 31 |
| 2018 | MHNF-048 | LinneyCr_LTWT | | | | | | 15 | 31 | 31 | 12 | | | |
| 2018 | MHNF-049 | Little Sandy at waterfall WT site | | | | | | 23 | 31 | 31 | 23 | | | |
| 2018 | MHNF-050 | Little Sandy R at Bull Run_LTWT | | | | | 7 | 30 | 31 | 31 | 26 | | | |
| 2018 | MHNF-051 | Little Sandy R at Rd1228_LTWT | | | | | | 23 | 31 | 31 | 29 | 31 | 29 | 31 |
| 2018 | MHNF-052 | Little Sandy R Homestead_LTWT | | | | | | 23 | 31 | 31 | 27 | 31 | 29 | 31 |
| 2018 | MHNF-054 | Lost Creek Trap Site WT | 19 | 28 | 30 | 30 | 28 | 30 | 31 | 31 | 29 | 31 | 29 | 31 |
| 2018 | MHNF-062 | Mud Creek WT site | | | | | | 22 | 31 | 31 | 12 | | | |
| 2018 | MHNF-077 | Salmon R at Forest Boundary_LTWT | | | | | | 28 | 31 | 31 | 10 | | | |
| 2018 | MHNF-078 | Salmon River trap WT site | 31 | 28 | 30 | 30 | 31 | 28 | 31 | 31 | 29 | 31 | 29 | 31 |
| 2018 | MHNF-079 | SalmonRatLinneyCr_LTWT | | | | | | 15 | 31 | 31 | 12 | | | |
| 2018 | MHNF-080 | Sandy R at Forest Boundary_LTWT | | | | | 6 | 30 | 31 | 31 | 20 | | | |
| 2018 | MHNF-084 | Still Creek 20 Bridge WT | | | | | 8 | 30 | 31 | 31 | 11 | | | |
| 2018 | MHNF-085 | Still Creek_LTWT | | | | | 17 | 30 | 31 | 31 | 11 | | | |
| 2018 | MHNF-099 | Zigzag River at Forest Boundary_LTWT | | | | | | 28 | 31 | 31 | 17 | | | |
| 2018 | MHNF-100 | Zigzag River trap site HOBO | 31 | 28 | 30 | 30 | 29 | 30 | 31 | 31 | 29 | 31 | 29 | 31 |
| 2018 | PWB_Beavr_Canyn | In Beaver Creek Canyon near site of old upstream footbridge | 31 | 28 | 30 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 29 | 31 |
| 2018 | PWB_BR_BWMN_BR | 20 feet downstream of Bowman's Bridge | | | | | | | 25 | 31 | 30 | 27 | | |
| 2018 | PWB_BR_DNSTM_PP | Approximately 600 feet downstream of Bull Run Dam 2 spillway plunge pool | | | | | | | 25 | 31 | 30 | 25 | | |
| 2018 | PWB_BR_SS_BR | Aproximately 60 feet upstream of Rd 14 (Southside) bridge | | | | | | | 25 | 31 | 30 | 25 | | |
| 2018 | PWB_D2_LampB | Immediately upstream of Lamprey Barrier | | | | 1 | 1 | | | 16 | 30 | 31 | 29 | 30 |
| 2018 | PWB_Gordon_Bonner | Downstream edge of Bonner property | | | | | 22 | 30 | 31 | 31 | 30 | 28 | | |

| Year | Station ID | Station | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2018 | PWB_Gordon_LoggingBridge | Under logging bridge on Frank Timber property | | | | | 6 | 30 | 31 | 31 | 30 | 29 | | |
| 2018 | PWB_Gordon_Mouth | Approximately 600 feet upstream of Gordon Creek Rd bridge | 31 | 28 | 30 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 29 | 31 |
| 2018 | PWB_SR_US_BR | Approximately 1,900 ft upstream of Bull Run River confluence | | | | | | | 25 | 31 | 30 | 24 | | |
| 2019 | 14138720 | Bull Run River At Lower Flume Nr Brightwood, OR | 31 | 28 | 31 | 30 | 31 | 29 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2019 | 14138850 | Bull Run River Near Multnomah Falls, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2019 | 14138870 | Fir Creek Near Brightwood, OR | 31 | 27 | 31 | 30 | 31 | 28 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2019 | 14138900 | North Fork Bull Run River Near Multnomah Falls, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2019 | 14139800 | South Fork Bull Run River Near Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2019 | 14140020 | Bull Run R At Larson’s Bridge, Near Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2019 | 14141500 | Little Sandy River Near Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2019 | COG_BeaveratGlenO | Beaver Creek at Glen Otto park | | | | | 30 | 30 | 31 | 31 | 30 | | | |
| 2019 | COG_BeaverDSKelly | Beaver Creek downstream of confluence with Kelly Creek | | | | | 30 | 30 | 31 | 31 | 30 | | | |
| 2019 | COG_BeaverUSKelly | Beaver Creek upstream of confluence with Kelly Creek | | | | | 30 | 30 | 31 | 31 | 30 | | | |
| 2019 | COG_BurlatHogan | Burlingame Creek at Hogan Road | | | | | 30 | 30 | 31 | 31 | 30 | | | |
| 2019 | COG_KCI1 | Kelly Creek downstream of MHCC pond | | | | 12 | 31 | 30 | 31 | 31 | 30 | | | |
| 2019 | COG_KCI2 | Kelly Creek upstream MHCC pond | | | | 12 | 31 | 30 | 31 | 31 | 30 | | | |
| 2019 | COG_KellyUSGolf | Kelly Creek upstream of Gresham Golf Course | | | | | 30 | 30 | 31 | 31 | 30 | | | |
| 2019 | EMSWCD_BCB | Beaver Creek North Fork at 302nd Ave | | | | 7 | 31 | 30 | 31 | 31 | 30 | 9 | | |

| Year | Station ID | Station | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2019 | EMSWCD_Beaver_Cory | Beaver Creek at confluence of North and South Forks | | | | 6 | 31 | 30 | 31 | 31 | 30 | 9 | | |
| 2019 | EMSWCD_Beaver_Freuler | Beaver Creek South Fork downstream of BCC | | | | 6 | 31 | 30 | 31 | 31 | 30 | 9 | | |
| 2019 | EMSWCD_Big_Black | Big Creek at Hurlburt Rd. | | | | 7 | 31 | 30 | 31 | 31 | 30 | 9 | | |
| 2019 | EMSWCD_Smith_Guebert | Smith Creek by Hurlburt Rd. | | | | 7 | 31 | 30 | 31 | 31 | 30 | 9 | | |
| 2019 | EMSWCD_Smith_Murphy | Smith Creek downstream of Christensen Rd. | | | | 7 | 31 | 30 | 31 | 31 | 30 | 9 | | |
| 2019 | MHNF-024 | Clear Creek trap HOBO temperature site | | | | | | 24 | 31 | 31 | 28 | 31 | 29 | 31 |
| 2019 | MHNF-025 | Clear Fork Trap Site WT | 31 | 28 | 30 | 29 | 31 | 30 | 31 | 31 | 17 | 31 | 29 | 31 |
| 2019 | MHNF-043 | Gordon Cr_LTWT | | | | | 11 | 30 | 31 | 31 | 21 | | | |
| 2019 | MHNF-048 | LinneyCr_LTWT | | | | | 7 | 30 | 31 | 31 | 20 | | | |
| 2019 | MHNF-049 | Little Sandy at waterfall WT site | | | | | 11 | 30 | 31 | 31 | 20 | | | |
| 2019 | MHNF-050 | Little Sandy R at Bull Run_LTWT | | | | | 10 | 30 | 31 | 31 | 24 | | | |
| 2019 | MHNF-051 | Little Sandy R at Rd1228_LTWT | 31 | 28 | 30 | 30 | 29 | 30 | 31 | 31 | 30 | 31 | 29 | 31 |
| 2019 | MHNF-052 | Little Sandy R Homestead_LTWT | 31 | 28 | 30 | 30 | 29 | 30 | 31 | 31 | 30 | 31 | 29 | 31 |
| 2019 | MHNF-054 | Lost Creek Trap Site WT | 31 | 28 | 30 | 7 | | 24 | 31 | 31 | 29 | 31 | 29 | 31 |
| 2019 | MHNF-062 | Mud Creek WT site | | | | | | 29 | 31 | 31 | 21 | | | |
| 2019 | MHNF-077 | Salmon R at Forest Boundary_LTWT | | | | | 16 | 30 | 31 | 31 | 13 | | | |
| 2019 | MHNF-078 | Salmon River trap WT site | 31 | 28 | 30 | 30 | 31 | 30 | 31 | 31 | 29 | 31 | 29 | 31 |
| 2019 | MHNF-079 | SalmonRatLinneyCr_LTWT | | | | | 7 | 30 | 31 | 31 | 20 | | | |
| 2019 | MHNF-080 | Sandy R at Forest Boundary_LTWT | | | | | | 30 | 31 | 31 | 12 | | | |
| 2019 | MHNF-084 | Still Creek 20 Bridge WT | | | | | 16 | 30 | 31 | 31 | 12 | | | |
| 2019 | MHNF-085 | Still Creek_LTWT | | | | | | 30 | 31 | 31 | 29 | 31 | 29 | 31 |
| 2019 | MHNF-099 | Zigzag River at Forest Boundary_LTWT | | | | | 16 | 30 | 31 | 31 | 12 | | | |
| 2019 | MHNF-100 | Zigzag River trap site HOBO | 31 | 28 | 30 | 30 | 30 | 30 | 31 | 31 | 29 | 31 | 29 | 31 |
| 2019 | PWB_Beavr_Canyn | In Beaver Creek Canyon near site of old upstream footbridge | 31 | 28 | 30 | 30 | 5 | | | | | | | |

| Year | Station ID | Station | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2019 | PWB_D2_LampB | Immediately upstream of Lamprey Barrier | 31 | 27 | 30 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 29 | 31 |
| 2019 | PWB_Gordon_Bonner | Downstream edge of Bonner property | | | | 17 | 27 | 30 | 31 | 31 | 30 | 26 | | |
| 2019 | PWB_Gordon_LoggingBridge | Under logging bridge on Frank Timber property | | | | 28 | 31 | 16 | | | | | | |
| 2019 | PWB_Gordon_Mouth | Approximately 600 feet upstream of Gordon Creek Rd bridge | 31 | 28 | 30 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 6 | |
| 2020 | 14138720 | Bull Run River At Lower Flume Nr Brightwood, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2020 | 14138850 | Bull Run River Near Multnomah Falls, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2020 | 14138870 | Fir Creek Near Brightwood, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2020 | 14138900 | North Fork Bull Run River Near Multnomah Falls, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2020 | 14139800 | South Fork Bull Run River Near Bull Run, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2020 | 14140020 | Bull Run R At Larson’s Bridge, Near Bull Run, OR | 31 | 29 | 30 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 29 |
| 2020 | 14141500 | Little Sandy River Near Bull Run, OR | 30 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2020 | COG_BCI2 | Beaver Creek at Division Street and Troutdale Road | | | | | 31 | 29 | 31 | 31 | 30 | 20 | | |
| 2020 | COG_BeaverDSKelly | Beaver Creek downstream of confluence with Kelly Creek | | | | | 31 | 29 | 31 | 31 | 30 | 20 | | |
| 2020 | COG_BeaverUSKelly | Beaver Creek upstream of confluence with Kelly Creek | | | | | 31 | 29 | 31 | 31 | 30 | 20 | | |
| 2020 | COG_Burl@Culvert | Burlingame Creek at ditch from culvert on Hogan | | | | | 31 | 29 | 31 | 31 | 30 | 20 | | |
| 2020 | COG_Burl@Golf | Burlingame Creek on Gresham Golf Course upstream of Kelly Creek | | | | | 31 | 29 | 31 | 31 | 30 | 20 | | |
| 2020 | COG_Burl@Hogan | Burlingame Creek at Hogan Road | | | | | 31 | 29 | 31 | 31 | 30 | 20 | | |
| 2020 | COG_KCI1 | Kelly Creek downstream of MHCC pond | | | | | 31 | 29 | 31 | 31 | 30 | 20 | | |

| Year | Station ID | Station | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2020 | COG_KCI2 | Kelly Creek upstream MHCC pond | | | | | 31 | 29 | 31 | 25 | 19 | 20 | | |
| 2020 | COG_KellyUSGolf | Kelly Creek upstream of Gresham Golf Course | | | | | 31 | 29 | 31 | 29 | 19 | 20 | | |
| 2020 | MHNF-024 | Clear Creek trap HOBO temperature site | 31 | 29 | 30 | 30 | 31 | 7 | | | | | | |
| 2020 | MHNF-025 | Clear Fork Trap Site WT | 31 | 29 | 30 | 30 | 31 | 7 | | | | | | |
| 2020 | MHNF-049 | Little Sandy at waterfall WT site | | | | | | 7 | 31 | 31 | 30 | 18 | | |
| 2020 | MHNF-050 | Little Sandy R at Bull Run_LTWT | | | | | | 3 | 31 | 31 | 30 | 5 | | |
| 2020 | MHNF-051 | Little Sandy R at Rd1228_LTWT | 31 | 29 | 30 | 30 | 31 | 26 | 31 | 31 | 30 | 18 | | |
| 2020 | MHNF-052 | Little Sandy R Homestead_LTWT | 31 | 6 | | | | 7 | 31 | 31 | 30 | 18 | | |
| 2020 | MHNF-077 | Salmon R at Forest Boundary_LTWT | | | | | | 21 | 31 | 31 | 24 | | | |
| 2020 | MHNF-078 | Salmon River trap WT site | 31 | 29 | 30 | 30 | 31 | 8 | | | | | | |
| 2020 | MHNF-085 | Still Creek_LTWT | 3 | | | | | | | | | | | |
| 2020 | MHNF-099 | Zigzag River at Forest Boundary_LTWT | | | | | | 21 | 31 | 31 | 28 | | | |
| 2020 | MHNF-100 | Zigzag River trap site HOBO | 31 | 29 | 30 | 30 | 31 | 3 | | | | | | |
| 2020 | PWB_D2_LampB | Immediately upstream of Lamprey Barrier | 31 | 29 | 30 | 30 | 31 | 30 | 31 | 31 | 8 | | | |

* 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 49: Continuous flow measurements available from the USGS flow gaging stations in the Sandy Subbasin.**

| Station ID | Station | Latitude/Longitude |
|---|---|---|
| 14131400 | Zigzag River Near Rhododendron, OR. | 45.30873/-121.8598 |
| 14133400 | Bear Creek Near Rhododendron, OR. | 45.34012/-121.9312 |
| 14136500 | Sandy River Below Salmon River Near Brightwood, OR | 45.38317/-122.0456 |
| 14137000 | Sandy River Near Marmot, OR | 45.39956/-122.1373 |
| 14137001 | Sandy River Div Abv Marmot Dam, Nr Marmot, OR | 45.39984/-122.1329 |
| 14137002 | Sandy River Below Marmot Dam, Near Marmot, OR | 45.39956/-122.1373 |
| 14138720 | Bull Run River At Lower Flume Nr Brightwood, OR | 45.47095/-121.8654 |
| 14138800 | Blazed Alder Creek Near Rhododendron, OR | 45.45262/-121.8915 |
| 14138850 | Bull Run River Near Multnomah Falls, OR | 45.49817/-122.0123 |
| 14138870 | Fir Creek Near Brightwood, OR | 45.48012/-122.0256 |
| 14138900 | North Fork Bull Run River Near Multnomah Falls, OR | 45.49429/-122.0359 |
| 14139700 | Cedar Creek Near Brightwood, OR | 45.45817/-122.0317 |
| 14139800 | South Fork Bull Run River Near Bull Run, OR | 45.44456/-122.1095 |
| 14140000 | Bull Run River Near Bull Run (River Only), OR | 45.4373/-122.1797 |
| 14140001 | Bull Run River Near Bull Run, OR | 45.43734/-122.1795 |
| 14141500 | Little Sandy River Near Bull Run, OR | 45.4154/-122.1715 |
| 14142500 | Sandy River Blw Bull Run River, Nr Bull Run, OR | 45.44901/-122.2451 |
| 14142800 | Beaver Creek At Troutdale, OR | 45.51929/-122.389 |

**Table 50: Continuous flow measurements available from the OWRD flow gaging stations in the Sandy Subbasin.**

| Station ID | Station | Latitude/Longitude |
|---|---|---|
| 14134000 | Salmon R Nr Government Camp, OR | 45.2654/-121.718 |

**Table 51: Instantaneous flow measurements made by DEQ in the Sandy Subbasin.**

| Station ID | Station | Date | Flow (cfs) | Latitude/Longitude |
|---|---|---|---|---|
| 10676-ORDEQ | Sandy above Salmon near Brightwood | 2001-08-08 | 258.16 | 45.3786/-122.013 |
| 10677-ORDEQ | Salmon River at mouth HWY 26 | 2001-08-07 | 107.50 | 45.3725/-122.021 |
| 11021-ORDEQ | Beaver Creek at mouth | 2001-08-06 | 0.93 | 45.5414/-122.383 |
| 11024-ORDEQ | Buck Creek at mouth | 2001-08-06 | 2.70 | 45.4971/-122.277 |
| 11025-ORDEQ | Gordon Creek at mouth | 2001-08-06 | 13.82 | 45.4933/-122.277 |
| 11780-ORDEQ | Sandy River at Dabney Bridge | 2001-08-06 | 432.76 | 45.5157/-122.36 |
| 26390-ORDEQ | Little Sandy above Diversion | 2001-08-09 | 31.22 | 45.4153/-122.171 |
| 26391-ORDEQ | Little Sandy at Road 14 | 2001-08-08 | 13.83 | 45.4037/-122.172 |
| 26405-ORDEQ | Cedar Creek at Ten Eyck Rd | 2001-08-07 | 8.68 | 45.3991/-122.246 |
| 26406-ORDEQ | Cedar Creek at Hwy. 26 | 2001-08-07 | 5.61 | 45.3671/-122.162 |
| 26407-ORDEQ | Badger Creek at Coleman Road | 2001-08-07 | 1.08 | 45.3746/-122.152 |
| 26409-ORDEQ | Alder Creek at mouth | 2001-08-07 | 3.28 | 45.3773/-122.101 |
| 26410-ORDEQ | Wildcat Creek at mouth | 2001-08-07 | 0.87 | 45.3758/-122.083 |
| 26411-ORDEQ | Boulder Creek at mouth | 2001-08-07 | 3.80 | 45.3687/-122.023 |
| 26412-ORDEQ | Salmon River at East Bridge Rd. | 2001-08-08 | 127.34 | 45.3207/-121.955 |
| 26413-ORDEQ | S. Fork Salmon River at mouth | 2001-08-07 | 5.41 | 45.2721/-121.939 |
| 26414-ORDEQ | Salmon River above S. Fork Confluence | 2001-08-07 | 105.93 | 45.2725/-121.938 |
| 26415-ORDEQ | Salmon River at Hwy. 26/35 | 2001-08-08 | 14.90 | 45.2665/-121.719 |
| 26416-ORDEQ | Zigzag River at mouth NFD 18 | 2001-08-08 | 97.52 | 45.3471/-121.942 |

| Station ID | Station | Date | Flow (cfs) | Latitude/Longitude |
|---|---|---|---|---|
| 26417-ORDEQ | Still Creek at mouth | 2001-08-07 | 34.77 | 45.3302/-121.916 |
| 26418-ORDEQ | Zigzag River above Still Creek | 2001-08-07 | 80.54 | 45.3297/-121.912 |
| 26419-ORDEQ | Camp Creek at mouth | 2001-08-08 | 16.69 | 45.3035/-121.87 |
| 26420-ORDEQ | Zigzag River above Camp Creek Hwy. 26 | 2001-08-08 | 45.19 | 45.311/-121.89 |
| 26421-ORDEQ | Clear Creek at mouth | 2001-08-08 | 7.54 | 45.3595/-121.937 |
| 26422-ORDEQ | Sandy above Clear Creek NFD 18 | 2001-08-08 | 111.22 | 45.3565/-122.938 |
| 26423-ORDEQ | Sandy above Lost Creek | 2001-08-08 | 91.41 | 45.385/-122.871 |
| 26424-ORDEQ | Camp Creek above Government Camp STP | 2001-08-08 | 6.18 | 45.3017/-121.777 |
| No Station ID | Sandy River at Oxbow Park | 2001-08-06 | 484.00 | |
| No Station ID | Sandy River at Dodge Park | 2001-08-09 | 225.42 | |
| No Station ID | Salmon River Below S. Fork Confluence | 2001-08-07 | 112.69 | |

**Table 52: Summary of existing flow data in the Sandy Subbasin. 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 | 14131400 | Zigzag River Near Rhododendron, OR. | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1990 | 14134000 | Salmon R Nr Government Camp, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1990 | 14137000 | Sandy River Near Marmot, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1990 | 14138800 | Blazed Alder Creek Near Rhododendron, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1990 | 14138850 | Bull Run River Near Multnomah Falls, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1990 | 14138870 | Fir Creek Near Brightwood, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1990 | 14138900 | North Fork Bull Run River Near Multnomah Falls, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1990 | 14139700 | Cedar Creek Near Brightwood, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1990 | 14139800 | South Fork Bull Run River Near Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1990 | 14140000 | Bull Run River Near Bull Run (River Only), OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1990 | 14140001 | Bull Run River Near Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1990 | 14141500 | Little Sandy River Near Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1990 | 14142500 | Sandy River Blw Bull Run River, Nr Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1991 | 14131400 | Zigzag River Near Rhododendron, OR. | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1991 | 14134000 | Salmon R Nr Government Camp, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1991 | 14137000 | Sandy River Near Marmot, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1991 | 14138800 | Blazed Alder Creek Near Rhododendron, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1991 | 14138850 | Bull Run River Near Multnomah Falls, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1991 | 14138870 | Fir Creek Near Brightwood, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1991 | 14138900 | North Fork Bull Run River Near Multnomah Falls, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1991 | 14139700 | Cedar Creek Near Brightwood, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1991 | 14139800 | South Fork Bull Run River Near Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1991 | 14140000 | Bull Run River Near Bull Run (River Only), OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1991 | 14140001 | Bull Run River Near Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1991 | 14141500 | Little Sandy River Near Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1991 | 14142500 | Sandy River Blw Bull Run River, Nr Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1992 | 14131400 | Zigzag River Near Rhododendron, 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 | 14134000 | Salmon R Nr Government Camp, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1992 | 14137000 | Sandy River Near Marmot, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1992 | 14138720 | Bull Run River At Lower Flume Nr Brightwood, OR | | | | | | | | | | 31 | 30 | 31 |
| 1992 | 14138800 | Blazed Alder Creek Near Rhododendron, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1992 | 14138850 | Bull Run River Near Multnomah Falls, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1992 | 14138870 | Fir Creek Near Brightwood, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1992 | 14138900 | North Fork Bull Run River Near Multnomah Falls, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1992 | 14139700 | Cedar Creek Near Brightwood, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1992 | 14139800 | South Fork Bull Run River Near Bull Run, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1992 | 14140000 | Bull Run River Near Bull Run (River Only), OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1992 | 14140001 | Bull Run River Near Bull Run, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1992 | 14141500 | Little Sandy River Near Bull Run, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1992 | 14142500 | Sandy River Blw Bull Run River, Nr Bull Run, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1993 | 14131400 | Zigzag River Near Rhododendron, OR. | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 29 | | | |
| 1993 | 14134000 | Salmon R Nr Government Camp, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1993 | 14137000 | Sandy River Near Marmot, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1993 | 14138720 | Bull Run River At Lower Flume Nr Brightwood, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1993 | 14138800 | Blazed Alder Creek Near Rhododendron, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1993 | 14138850 | Bull Run River Near Multnomah Falls, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1993 | 14138870 | Fir Creek Near Brightwood, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1993 | 14138900 | North Fork Bull Run River Near Multnomah Falls, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1993 | 14139700 | Cedar Creek Near Brightwood, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1993 | 14139800 | South Fork Bull Run River Near Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1993 | 14140000 | Bull Run River Near Bull Run (River Only), OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1993 | 14140001 | Bull Run River Near Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1993 | 14141500 | Little Sandy River Near Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1993 | 14142500 | Sandy River Blw Bull Run River, Nr Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1994 | 14134000 | Salmon R Nr Government Camp, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1994 | 14137000 | Sandy River Near Marmot, 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1994 | 14138720 | Bull Run River At Lower Flume Nr Brightwood, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1994 | 14138800 | Blazed Alder Creek Near Rhododendron, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1994 | 14138850 | Bull Run River Near Multnomah Falls, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1994 | 14138870 | Fir Creek Near Brightwood, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1994 | 14138900 | North Fork Bull Run River Near Multnomah Falls, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1994 | 14139700 | Cedar Creek Near Brightwood, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1994 | 14139800 | South Fork Bull Run River Near Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1994 | 14140000 | Bull Run River Near Bull Run (River Only), OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1994 | 14140001 | Bull Run River Near Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1994 | 14141500 | Little Sandy River Near Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1994 | 14142500 | Sandy River Blw Bull Run River, Nr Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1995 | 14134000 | Salmon R Nr Government Camp, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | | | |
| 1995 | 14137000 | Sandy River Near Marmot, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1995 | 14138720 | Bull Run River At Lower Flume Nr Brightwood, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1995 | 14138800 | Blazed Alder Creek Near Rhododendron, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1995 | 14138850 | Bull Run River Near Multnomah Falls, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1995 | 14138870 | Fir Creek Near Brightwood, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1995 | 14138900 | North Fork Bull Run River Near Multnomah Falls, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1995 | 14139700 | Cedar Creek Near Brightwood, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1995 | 14139800 | South Fork Bull Run River Near Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1995 | 14140000 | Bull Run River Near Bull Run (River Only), OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1995 | 14140001 | Bull Run River Near Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1995 | 14141500 | Little Sandy River Near Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1995 | 14142500 | Sandy River Blw Bull Run River, Nr Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1996 | 14137000 | Sandy River Near Marmot, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1996 | 14138720 | Bull Run River At Lower Flume Nr Brightwood, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1996 | 14138800 | Blazed Alder Creek Near Rhododendron, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1996 | 14138850 | Bull Run River Near Multnomah Falls, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1996 | 14138870 | Fir Creek Near Brightwood, 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 | 14138900 | North Fork Bull Run River Near Multnomah Falls, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1996 | 14139700 | Cedar Creek Near Brightwood, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1996 | 14139800 | South Fork Bull Run River Near Bull Run, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1996 | 14140000 | Bull Run River Near Bull Run (River Only), OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1996 | 14140001 | Bull Run River Near Bull Run, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1996 | 14141500 | Little Sandy River Near Bull Run, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1996 | 14142500 | Sandy River Blw Bull Run River, Nr Bull Run, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1997 | 14137000 | Sandy River Near Marmot, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1997 | 14138720 | Bull Run River At Lower Flume Nr Brightwood, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1997 | 14138800 | Blazed Alder Creek Near Rhododendron, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1997 | 14138850 | Bull Run River Near Multnomah Falls, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1997 | 14138870 | Fir Creek Near Brightwood, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1997 | 14138900 | North Fork Bull Run River Near Multnomah Falls, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1997 | 14139700 | Cedar Creek Near Brightwood, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1997 | 14139800 | South Fork Bull Run River Near Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1997 | 14140000 | Bull Run River Near Bull Run (River Only), OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1997 | 14140001 | Bull Run River Near Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1997 | 14141500 | Little Sandy River Near Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1997 | 14142500 | Sandy River Blw Bull Run River, Nr Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1998 | 14133400 | Bear Creek Near Rhododendron, OR. | | | | | | | | | | | 6 | 31 |
| 1998 | 14137000 | Sandy River Near Marmot, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1998 | 14138720 | Bull Run River At Lower Flume Nr Brightwood, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1998 | 14138800 | Blazed Alder Creek Near Rhododendron, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1998 | 14138850 | Bull Run River Near Multnomah Falls, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1998 | 14138870 | Fir Creek Near Brightwood, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1998 | 14138900 | North Fork Bull Run River Near Multnomah Falls, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1998 | 14139700 | Cedar Creek Near Brightwood, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1998 | 14139800 | South Fork Bull Run River Near Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1998 | 14140000 | Bull Run River Near Bull Run (River Only), 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1998 | 14140001 | Bull Run River Near Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1998 | 14141500 | Little Sandy River Near Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1998 | 14142500 | Sandy River Blw Bull Run River, Nr Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1999 | 14133400 | Bear Creek Near Rhododendron, OR. | 31 | 28 | 31 | 11 | | | | | | | | |
| 1999 | 14137000 | Sandy River Near Marmot, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1999 | 14138720 | Bull Run River At Lower Flume Nr Brightwood, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1999 | 14138800 | Blazed Alder Creek Near Rhododendron, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1999 | 14138850 | Bull Run River Near Multnomah Falls, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1999 | 14138870 | Fir Creek Near Brightwood, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1999 | 14138900 | North Fork Bull Run River Near Multnomah Falls, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1999 | 14139700 | Cedar Creek Near Brightwood, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1999 | 14139800 | South Fork Bull Run River Near Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1999 | 14140000 | Bull Run River Near Bull Run (River Only), OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1999 | 14140001 | Bull Run River Near Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1999 | 14141500 | Little Sandy River Near Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1999 | 14142500 | Sandy River Blw Bull Run River, Nr Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 1999 | 14142800 | Beaver Creek At Troutdale, OR | | | | | | | | | | 31 | 30 | 31 |
| 2000 | 14137000 | Sandy River Near Marmot, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2000 | 14138720 | Bull Run River At Lower Flume Nr Brightwood, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2000 | 14138800 | Blazed Alder Creek Near Rhododendron, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2000 | 14138850 | Bull Run River Near Multnomah Falls, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2000 | 14138870 | Fir Creek Near Brightwood, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2000 | 14138900 | North Fork Bull Run River Near Multnomah Falls, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2000 | 14139700 | Cedar Creek Near Brightwood, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2000 | 14139800 | South Fork Bull Run River Near Bull Run, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2000 | 14140000 | Bull Run River Near Bull Run (River Only), OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2000 | 14140001 | Bull Run River Near Bull Run, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2000 | 14141500 | Little Sandy River Near Bull Run, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2000 | 14142500 | Sandy River Blw Bull Run River, Nr Bull Run, 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2000 | 14142800 | Beaver Creek At Troutdale, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2001 | 14137000 | Sandy River Near Marmot, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2001 | 14138720 | Bull Run River At Lower Flume Nr Brightwood, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2001 | 14138800 | Blazed Alder Creek Near Rhododendron, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2001 | 14138850 | Bull Run River Near Multnomah Falls, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2001 | 14138870 | Fir Creek Near Brightwood, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2001 | 14138900 | North Fork Bull Run River Near Multnomah Falls, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2001 | 14139700 | Cedar Creek Near Brightwood, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2001 | 14139800 | South Fork Bull Run River Near Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2001 | 14140000 | Bull Run River Near Bull Run (River Only), OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2001 | 14140001 | Bull Run River Near Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2001 | 14141500 | Little Sandy River Near Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2001 | 14142500 | Sandy River Blw Bull Run River, Nr Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2001 | 14142800 | Beaver Creek At Troutdale, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2002 | 14137000 | Sandy River Near Marmot, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2002 | 14137001 | Sandy River Div Abv Marmot Dam, Nr Marmot, OR | | | | | | | | | | 31 | 30 | 31 |
| 2002 | 14137002 | Sandy River Below Marmot Dam, Near Marmot, OR | | | 25 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2002 | 14138720 | Bull Run River At Lower Flume Nr Brightwood, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2002 | 14138800 | Blazed Alder Creek Near Rhododendron, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2002 | 14138850 | Bull Run River Near Multnomah Falls, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2002 | 14138870 | Fir Creek Near Brightwood, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2002 | 14138900 | North Fork Bull Run River Near Multnomah Falls, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2002 | 14139700 | Cedar Creek Near Brightwood, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2002 | 14139800 | South Fork Bull Run River Near Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2002 | 14140000 | Bull Run River Near Bull Run (River Only), OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2002 | 14140001 | Bull Run River Near Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2002 | 14141500 | Little Sandy River Near Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2002 | 14142500 | Sandy River Blw Bull Run River, Nr Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2002 | 14142800 | Beaver Creek At Troutdale, 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2003 | 14134000 | Salmon R Nr Government Camp, OR | | | | | | | | | | 31 | 30 | 31 |
| 2003 | 14137000 | Sandy River Near Marmot, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2003 | 14137001 | Sandy River Div Abv Marmot Dam, Nr Marmot, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2003 | 14137002 | Sandy River Below Marmot Dam, Near Marmot, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2003 | 14138720 | Bull Run River At Lower Flume Nr Brightwood, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2003 | 14138800 | Blazed Alder Creek Near Rhododendron, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2003 | 14138850 | Bull Run River Near Multnomah Falls, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2003 | 14138870 | Fir Creek Near Brightwood, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2003 | 14138900 | North Fork Bull Run River Near Multnomah Falls, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2003 | 14139700 | Cedar Creek Near Brightwood, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 29 | | | |
| 2003 | 14139800 | South Fork Bull Run River Near Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2003 | 14140000 | Bull Run River Near Bull Run (River Only), OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2003 | 14140001 | Bull Run River Near Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2003 | 14141500 | Little Sandy River Near Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2003 | 14142500 | Sandy River Blw Bull Run River, Nr Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2003 | 14142800 | Beaver Creek At Troutdale, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2004 | 14134000 | Salmon R Nr Government Camp, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2004 | 14137000 | Sandy River Near Marmot, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2004 | 14137001 | Sandy River Div Abv Marmot Dam, Nr Marmot, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2004 | 14137002 | Sandy River Below Marmot Dam, Near Marmot, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2004 | 14138720 | Bull Run River At Lower Flume Nr Brightwood, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2004 | 14138800 | Blazed Alder Creek Near Rhododendron, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2004 | 14138850 | Bull Run River Near Multnomah Falls, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2004 | 14138870 | Fir Creek Near Brightwood, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2004 | 14138900 | North Fork Bull Run River Near Multnomah Falls, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2004 | 14139800 | South Fork Bull Run River Near Bull Run, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2004 | 14140000 | Bull Run River Near Bull Run (River Only), OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2004 | 14140001 | Bull Run River Near Bull Run, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2004 | 14141500 | Little Sandy River Near Bull Run, 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 | 14142500 | Sandy River Blw Bull Run River, Nr Bull Run, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2004 | 14142800 | Beaver Creek At Troutdale, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2005 | 14134000 | Salmon R Nr Government Camp, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2005 | 14137000 | Sandy River Near Marmot, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2005 | 14137001 | Sandy River Div Abv Marmot Dam, Nr Marmot, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2005 | 14137002 | Sandy River Below Marmot Dam, Near Marmot, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2005 | 14138720 | Bull Run River At Lower Flume Nr Brightwood, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2005 | 14138800 | Blazed Alder Creek Near Rhododendron, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2005 | 14138850 | Bull Run River Near Multnomah Falls, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2005 | 14138870 | Fir Creek Near Brightwood, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2005 | 14138900 | North Fork Bull Run River Near Multnomah Falls, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2005 | 14139800 | South Fork Bull Run River Near Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2005 | 14140000 | Bull Run River Near Bull Run (River Only), OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2005 | 14140001 | Bull Run River Near Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2005 | 14141500 | Little Sandy River Near Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2005 | 14142500 | Sandy River Blw Bull Run River, Nr Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2005 | 14142800 | Beaver Creek At Troutdale, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2006 | 14134000 | Salmon R Nr Government Camp, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2006 | 14137000 | Sandy River Near Marmot, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2006 | 14137001 | Sandy River Div Abv Marmot Dam, Nr Marmot, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2006 | 14137002 | Sandy River Below Marmot Dam, Near Marmot, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2006 | 14138720 | Bull Run River At Lower Flume Nr Brightwood, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2006 | 14138800 | Blazed Alder Creek Near Rhododendron, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2006 | 14138850 | Bull Run River Near Multnomah Falls, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2006 | 14138870 | Fir Creek Near Brightwood, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2006 | 14138900 | North Fork Bull Run River Near Multnomah Falls, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2006 | 14139800 | South Fork Bull Run River Near Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2006 | 14140000 | Bull Run River Near Bull Run (River Only), OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2006 | 14140001 | Bull Run River Near Bull Run, 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2006 | 14141500 | Little Sandy River Near Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2006 | 14142500 | Sandy River Blw Bull Run River, Nr Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2006 | 14142800 | Beaver Creek At Troutdale, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2007 | 14134000 | Salmon R Nr Government Camp, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2007 | 14136500 | Sandy River Below Salmon River Near Brightwood, OR | | | | | | | | | 4 | 31 | 30 | 31 |
| 2007 | 14137000 | Sandy River Near Marmot, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2007 | 14137001 | Sandy River Div Abv Marmot Dam, Nr Marmot, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | | | |
| 2007 | 14137002 | Sandy River Below Marmot Dam, Near Marmot, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | | | |
| 2007 | 14138720 | Bull Run River At Lower Flume Nr Brightwood, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2007 | 14138800 | Blazed Alder Creek Near Rhododendron, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2007 | 14138850 | Bull Run River Near Multnomah Falls, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2007 | 14138870 | Fir Creek Near Brightwood, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2007 | 14138900 | North Fork Bull Run River Near Multnomah Falls, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2007 | 14139800 | South Fork Bull Run River Near Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2007 | 14140000 | Bull Run River Near Bull Run (River Only), OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2007 | 14140001 | Bull Run River Near Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2007 | 14141500 | Little Sandy River Near Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2007 | 14142500 | Sandy River Blw Bull Run River, Nr Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2007 | 14142800 | Beaver Creek At Troutdale, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2008 | 14134000 | Salmon R Nr Government Camp, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2008 | 14136500 | Sandy River Below Salmon River Near Brightwood, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 9 |
| 2008 | 14137000 | Sandy River Near Marmot, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2008 | 14138720 | Bull Run River At Lower Flume Nr Brightwood, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2008 | 14138800 | Blazed Alder Creek Near Rhododendron, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2008 | 14138850 | Bull Run River Near Multnomah Falls, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2008 | 14138870 | Fir Creek Near Brightwood, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2008 | 14138900 | North Fork Bull Run River Near Multnomah Falls, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2008 | 14139800 | South Fork Bull Run River Near Bull Run, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2008 | 14140000 | Bull Run River Near Bull Run (River Only), 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 | 14140001 | Bull Run River Near Bull Run, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2008 | 14141500 | Little Sandy River Near Bull Run, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2008 | 14142500 | Sandy River Blw Bull Run River, Nr Bull Run, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2008 | 14142800 | Beaver Creek At Troutdale, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2009 | 14134000 | Salmon R Nr Government Camp, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2009 | 14137000 | Sandy River Near Marmot, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2009 | 14138720 | Bull Run River At Lower Flume Nr Brightwood, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2009 | 14138800 | Blazed Alder Creek Near Rhododendron, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2009 | 14138850 | Bull Run River Near Multnomah Falls, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2009 | 14138870 | Fir Creek Near Brightwood, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2009 | 14138900 | North Fork Bull Run River Near Multnomah Falls, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2009 | 14139800 | South Fork Bull Run River Near Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2009 | 14140000 | Bull Run River Near Bull Run (River Only), OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2009 | 14140001 | Bull Run River Near Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2009 | 14141500 | Little Sandy River Near Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2009 | 14142500 | Sandy River Blw Bull Run River, Nr Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2009 | 14142800 | Beaver Creek At Troutdale, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2010 | 14134000 | Salmon R Nr Government Camp, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2010 | 14137000 | Sandy River Near Marmot, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2010 | 14138720 | Bull Run River At Lower Flume Nr Brightwood, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2010 | 14138800 | Blazed Alder Creek Near Rhododendron, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2010 | 14138850 | Bull Run River Near Multnomah Falls, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2010 | 14138870 | Fir Creek Near Brightwood, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2010 | 14138900 | North Fork Bull Run River Near Multnomah Falls, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2010 | 14139800 | South Fork Bull Run River Near Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2010 | 14140000 | Bull Run River Near Bull Run (River Only), OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2010 | 14140001 | Bull Run River Near Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2010 | 14141500 | Little Sandy River Near Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2010 | 14142500 | Sandy River Blw Bull Run River, Nr Bull Run, 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 | 14142800 | Beaver Creek At Troutdale, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2011 | 14134000 | Salmon R Nr Government Camp, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2011 | 14137000 | Sandy River Near Marmot, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2011 | 14138720 | Bull Run River At Lower Flume Nr Brightwood, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2011 | 14138800 | Blazed Alder Creek Near Rhododendron, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2011 | 14138850 | Bull Run River Near Multnomah Falls, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2011 | 14138870 | Fir Creek Near Brightwood, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2011 | 14138900 | North Fork Bull Run River Near Multnomah Falls, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2011 | 14139800 | South Fork Bull Run River Near Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2011 | 14140000 | Bull Run River Near Bull Run (River Only), OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2011 | 14140001 | Bull Run River Near Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2011 | 14141500 | Little Sandy River Near Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2011 | 14142500 | Sandy River Blw Bull Run River, Nr Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2011 | 14142800 | Beaver Creek At Troutdale, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2012 | 14134000 | Salmon R Nr Government Camp, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2012 | 14137000 | Sandy River Near Marmot, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2012 | 14138720 | Bull Run River At Lower Flume Nr Brightwood, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2012 | 14138800 | Blazed Alder Creek Near Rhododendron, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2012 | 14138850 | Bull Run River Near Multnomah Falls, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2012 | 14138870 | Fir Creek Near Brightwood, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2012 | 14138900 | North Fork Bull Run River Near Multnomah Falls, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2012 | 14139800 | South Fork Bull Run River Near Bull Run, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2012 | 14140000 | Bull Run River Near Bull Run (River Only), OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2012 | 14140001 | Bull Run River Near Bull Run, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2012 | 14141500 | Little Sandy River Near Bull Run, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2012 | 14142500 | Sandy River Blw Bull Run River, Nr Bull Run, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2012 | 14142800 | Beaver Creek At Troutdale, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2013 | 14134000 | Salmon R Nr Government Camp, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2013 | 14137000 | Sandy River Near Marmot, 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2013 | 14138720 | Bull Run River At Lower Flume Nr Brightwood, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2013 | 14138800 | Blazed Alder Creek Near Rhododendron, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2013 | 14138850 | Bull Run River Near Multnomah Falls, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2013 | 14138870 | Fir Creek Near Brightwood, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2013 | 14138900 | North Fork Bull Run River Near Multnomah Falls, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2013 | 14139800 | South Fork Bull Run River Near Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2013 | 14140000 | Bull Run River Near Bull Run (River Only), OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2013 | 14140001 | Bull Run River Near Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2013 | 14141500 | Little Sandy River Near Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2013 | 14142500 | Sandy River Blw Bull Run River, Nr Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2013 | 14142800 | Beaver Creek At Troutdale, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2014 | 14134000 | Salmon R Nr Government Camp, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2014 | 14137000 | Sandy River Near Marmot, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2014 | 14138720 | Bull Run River At Lower Flume Nr Brightwood, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2014 | 14138800 | Blazed Alder Creek Near Rhododendron, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2014 | 14138850 | Bull Run River Near Multnomah Falls, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2014 | 14138870 | Fir Creek Near Brightwood, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2014 | 14138900 | North Fork Bull Run River Near Multnomah Falls, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2014 | 14139800 | South Fork Bull Run River Near Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2014 | 14140000 | Bull Run River Near Bull Run (River Only), OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2014 | 14140001 | Bull Run River Near Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2014 | 14141500 | Little Sandy River Near Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2014 | 14142500 | Sandy River Blw Bull Run River, Nr Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2014 | 14142800 | Beaver Creek At Troutdale, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2015 | 14134000 | Salmon R Nr Government Camp, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2015 | 14137000 | Sandy River Near Marmot, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2015 | 14138720 | Bull Run River At Lower Flume Nr Brightwood, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2015 | 14138800 | Blazed Alder Creek Near Rhododendron, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2015 | 14138850 | Bull Run River Near Multnomah Falls, 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 | 14138870 | Fir Creek Near Brightwood, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2015 | 14138900 | North Fork Bull Run River Near Multnomah Falls, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2015 | 14139800 | South Fork Bull Run River Near Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2015 | 14140000 | Bull Run River Near Bull Run (River Only), OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2015 | 14140001 | Bull Run River Near Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | | | |
| 2015 | 14141500 | Little Sandy River Near Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2015 | 14142500 | Sandy River Blw Bull Run River, Nr Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2015 | 14142800 | Beaver Creek At Troutdale, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2016 | 14134000 | Salmon R Nr Government Camp, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2016 | 14137000 | Sandy River Near Marmot, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2016 | 14138720 | Bull Run River At Lower Flume Nr Brightwood, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2016 | 14138800 | Blazed Alder Creek Near Rhododendron, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2016 | 14138850 | Bull Run River Near Multnomah Falls, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2016 | 14138870 | Fir Creek Near Brightwood, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2016 | 14138900 | North Fork Bull Run River Near Multnomah Falls, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2016 | 14139800 | South Fork Bull Run River Near Bull Run, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2016 | 14140000 | Bull Run River Near Bull Run (River Only), OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2016 | 14141500 | Little Sandy River Near Bull Run, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2016 | 14142500 | Sandy River Blw Bull Run River, Nr Bull Run, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2016 | 14142800 | Beaver Creek At Troutdale, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2017 | 14134000 | Salmon R Nr Government Camp, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2017 | 14137000 | Sandy River Near Marmot, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2017 | 14138720 | Bull Run River At Lower Flume Nr Brightwood, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2017 | 14138800 | Blazed Alder Creek Near Rhododendron, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2017 | 14138850 | Bull Run River Near Multnomah Falls, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2017 | 14138870 | Fir Creek Near Brightwood, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2017 | 14138900 | North Fork Bull Run River Near Multnomah Falls, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2017 | 14139800 | South Fork Bull Run River Near Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2017 | 14140000 | Bull Run River Near Bull Run (River Only), 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 | 14141500 | Little Sandy River Near Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2017 | 14142500 | Sandy River Blw Bull Run River, Nr Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2017 | 14142800 | Beaver Creek At Troutdale, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2018 | 14134000 | Salmon R Nr Government Camp, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2018 | 14137000 | Sandy River Near Marmot, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2018 | 14138720 | Bull Run River At Lower Flume Nr Brightwood, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2018 | 14138800 | Blazed Alder Creek Near Rhododendron, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2018 | 14138850 | Bull Run River Near Multnomah Falls, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2018 | 14138870 | Fir Creek Near Brightwood, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2018 | 14138900 | North Fork Bull Run River Near Multnomah Falls, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2018 | 14139800 | South Fork Bull Run River Near Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2018 | 14140000 | Bull Run River Near Bull Run (River Only), OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2018 | 14140001 | Bull Run River Near Bull Run, OR |  |  |  |  |  | 21 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2018 | 14141500 | Little Sandy River Near Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2018 | 14142500 | Sandy River Blw Bull Run River, Nr Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2018 | 14142800 | Beaver Creek At Troutdale, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2019 | 14134000 | Salmon R Nr Government Camp, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2019 | 14137000 | Sandy River Near Marmot, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2019 | 14138720 | Bull Run River At Lower Flume Nr Brightwood, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2019 | 14138800 | Blazed Alder Creek Near Rhododendron, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2019 | 14138850 | Bull Run River Near Multnomah Falls, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2019 | 14138870 | Fir Creek Near Brightwood, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2019 | 14138900 | North Fork Bull Run River Near Multnomah Falls, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2019 | 14139800 | South Fork Bull Run River Near Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2019 | 14140000 | Bull Run River Near Bull Run (River Only), OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2019 | 14140001 | Bull Run River Near Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2019 | 14141500 | Little Sandy River Near Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2019 | 14142500 | Sandy River Blw Bull Run River, Nr Bull Run, OR | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2019 | 14142800 | Beaver Creek At Troutdale, 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2020 | 14134000 | Salmon R Nr Government Camp, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2020 | 14137000 | Sandy River Near Marmot, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 30 |
| 2020 | 14138720 | Bull Run River At Lower Flume Nr Brightwood, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2020 | 14138800 | Blazed Alder Creek Near Rhododendron, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2020 | 14138850 | Bull Run River Near Multnomah Falls, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2020 | 14138870 | Fir Creek Near Brightwood, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2020 | 14138900 | North Fork Bull Run River Near Multnomah Falls, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2020 | 14139800 | South Fork Bull Run River Near Bull Run, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2020 | 14140000 | Bull Run River Near Bull Run (River Only), OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2020 | 14140001 | Bull Run River Near Bull Run, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2020 | 14141500 | Little Sandy River Near Bull Run, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2020 | 14142500 | Sandy River Blw Bull Run River, Nr Bull Run, OR | 31 | 29 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 |
| 2020 | 14142800 | Beaver Creek At Troutdale, 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 340-041-0286 Figure 286A.

20. Salmon and Steelhead spawning use extent and period depicted in OAR 340-041-0286 Figure 286B.

# DEQ21-HQ-0028-QAPP

Final Audit Report 2022-01-05

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