UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 10
1200 Sixth Avenue, Suite 155
Seattle, WA 98101-3188

WATER
DIVISION

Total Maximum Daily Load (TMDL) for Temperature in the Columbia and Lower Snake Rivers

May 18, 2020 TMDL for Public Comment

In compliance with the provisions of the Clean Water Act, 33 U.S.C. 1251 et seq., as amended by the Water Quality Act of 1987, P.L. 1004, the Environmental Protection Agency is today establishing a TMDL to address temperature loading in the mainstems of the Columbia and lower Snake Rivers in Washington and Oregon.

The Regional Administrator is concurrently seeking public comment on this TMDL. Consistent with EPA's regulations in 40 C.F.R. 130.7(d)(2), EPA will issue a public notice seeking comment on this TMDL established by EPA. EPA will begin a 60-day public process on May 21, 2020. Comments should be provided to ColumbiaRiverTMDL@epa.gov by 5:00 pm Pacific time on July 21, 2020.

After considering public comment and making any revisions deemed appropriate, the Regional Administrator intends to transmit this TMDL to the States of Oregon and Washington for incorporation into their current water quality management plans.

/s/ May 18, 2020
Daniel Opalski, Director

Columbia and Lower Snake Rivers Temperature Total Maximum Daily Load

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May 18, 2020 TMDL for Public Comment

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ACRONYMS/ABBREVIATIONS

Acronyms/Abbreviations	Definition
7-DADM	7-day average daily maximum
BMPs	Best management practices
°C	Degrees Celsius
CFR	Code of Federal Regulations
CRSO	Columbia River System Operations
CTCR	Confederated Tribes of the Colville Reservation
CWA	Clean Water Act
CWR	Cold water refuge
DART	(Columbia River) Data Access in Real Time
DM	Daily maximum
Ecology	Washington Department of Ecology
EIS	Environmental Impact Statement
EPA	U.S. Environmental Protection Agency
FCRPS	Federal Columbia River Power System
kcfs	Kilo cubic feet per second
LA	Load allocation
LC	Loading capacity
MOS	Margin of safety
MS4	Municipal Separated Storm Sewer System
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
OAR	Oregon Administrative Rules
ODEQ	Oregon Department of Environmental Quality
POTW	Publicly owned treatment works
PUD	Public Utility District
RM	River mile
STP	Sewage treatment plan
TMDL	Total Maximum Daily Load

Acronyms/Abbreviations	Definition
USACE	U.S. Army Corps of Engineers
WAC	Washington Administrative Code
WLA	Wasteload allocation
WQC	Water quality criteria
WQS	Water quality standards
WWTP	Wastewater treatment plant

1.0 INTRODUCTION

This document establishes a total maximum daily load (TMDL)[1] for temperature for the Columbia and lower Snake Rivers as required by Section 303(d) of the Clean Water Act (CWA) and its implementing regulations at Title 40 of the Code of Federal Regulations (CFR) Section 130.7. The TMDL is required because the States of Washington and Oregon have identified portions of the Columbia and lower Snake Rivers as impaired because of temperatures that exceed the numeric criteria portion of the States' water quality standards (WQS).

The temperature WQS are designed to protect the beneficial uses in those waters, the most sensitive of which are salmon migration and spawning. Within the framework of the CWA, TMDLs are designed to assess, and provide information needed to address, water quality impairments. Spanning almost 900 river miles, this TMDL examines sources of temperature impairments on the Columbia River, from the Canadian border to the Pacific Ocean; and on the lower Snake River in Washington, from its confluence with the Clearwater River at the Idaho border to its confluence with the Columbia River. See ***Figure 2-1***. The U.S. Environmental Protection Agency (EPA) agreed in a 2000 Memorandum of Agreement with the States of Washington, Oregon, and Idaho to develop the Columbia and Snake River temperature TMDL. On October 17, 2018, a district court found that Washington and Oregon had made a "constructive" submission to EPA of no TMDL to address the temperature impairments, triggering a mandatory duty for EPA to approve or disapprove, and if disapproving, to issue the TMDL. On November 16, 2018, EPA disapproved the constructive submission of no TMDL. The district court decision was upheld on appeal, and EPA is therefore establishing this TMDL.

In developing this TMDL, EPA evaluated the temperature impacts from the following source categories of heat loading: (1) point source discharges of heat subject to National Pollutant Discharge Elimination System (NPDES) permits; (2) nonpoint source heat loading from dams and reservoirs that increase or decrease water temperatures within their reservoirs and in downstream river reaches; (3) tributaries to the mainstems of the Columbia and lower Snake Rivers that are affected by upstream point and nonpoint sources; (4) increasing air temperatures and other factors associated with climate change; and (5) elevated water temperatures in the mainstems of the Columbia and lower Snake Rivers where they enter into Washington from Canada and Idaho, respectively.

1.1 TOTAL MAXIMUM DAILY LOADS AND CLEAN WATER ACT

Section 303(c) of the CWA requires states to establish water quality standards that identify each waterbody's designated uses and the criteria needed to support those uses. CWA section 303(d) requires states to develop lists of impaired waters that fail to meet the standards set by jurisdictions even after implementing technology-based and other pollution controls.

A TMDL specifies the maximum amount of a pollutant that a waterbody can receive and still meet applicable WQS. A mathematical definition of a TMDL is written as the sum of the individual wasteload allocations (WLAs) for point sources, the load allocations (LAs) for

[1] EPA has in the past referred to a "TMDL" in the singular to refer to a single combination of one water quality limited segment and one pollutant. The term "TMDL" in the singular also sometimes refers to a single TMDL *document* that includes multiple TMDLs. This TMDL document is referred to in the singular although it includes multiple TMDLs, i.e., for each of the stream segments addressed in it.

nonpoint sources and natural background, and a margin of safety (MOS). [CWA § 303(d)(1)(C); 40 CFR 130.2(i)]:

TMDL = ΣWLA + ΣLA + MOS

where

WLA = wasteload allocation, or the portion of the TMDL allocated to existing and/or future point sources.

LA = load allocation, or the portion of the TMDL attributed to existing and/or future nonpoint sources and natural background.

MOS = margin of safety, or the portion of the TMDL that accounts for any lack of knowledge concerning the relationship between effluent limitations and water quality, such as uncertainty about the relationship between pollutant loads and receiving water quality, which can be provided implicitly by applying conservative analytical assumptions or explicitly by reserving a portion of loading capacity.

Even if all the allocations in this TMDL are implemented and the temperature reductions envisioned are fully realized, it is unlikely that the numeric criteria portion of the WQS will be met at all times and all places. Sources outside the allocation structure of this TMDL contribute to warmer temperatures. These sources include increased air temperatures throughout the study area and upstream human activities in Idaho and Canada, resulting in Columbia and Snake River water temperatures that already exceed the numeric criteria portion of the WQS when those rivers enter the geographic area covered by this TMDL. Although the TMDL cannot ensure that the applicable criteria will be met at all times and places, this TMDL restricts the identified point and nonpoint sources to the increases that can be allocated under Washington and Oregon WQS (0.3°C above WQC), as discussed below, consistent with those existing WQS.

One option for addressing the conflict created by the inability to achieve applicable water quality criteria at all times and all places is for the States to make changes to their applicable designated uses. The federal regulation at 40 CFR 131.10(g) provides requirements for establishing, modifying, and removing designated uses. A state may designate a use or remove a use that is not an existing use, if the state conducts a “use attainability analysis” that demonstrates that attaining the use is not feasible because of one of the six factors listed in 40 CFR 131.10(g). A use attainability analysis is a structured scientific assessment of the factors affecting the attainment of the use which may include physical, chemical, biological, and economic factors as described in section 131.10(g). If a state adopts a new or revised water quality standard based on a required use attainability analysis, the state also must adopt the highest attainable use. The decision to modify or remove a designated use rests with the state.

1.2 TOTAL MAXIMUM DAILY LOAD GEOGRAPHIC SCOPE AND WATER QUALITY IMPAIRMENTS

The geographic scope of this temperature TMDL includes State waters within the mainstem of the Columbia River from the Canadian border (River Mile [RM] 745) to the Pacific Ocean; and within the mainstem of the lower Snake River in Washington from its confluence with the Clearwater River at the Idaho border (RM 139) to its confluence with the Columbia River. The stream segments and associated waterbody identification numbers of the Columbia and lower

Snake Rivers that are identified as impaired for temperature pursuant to CWA section 303(d) are listed in ***Table 1-1*** and illustrated in ***Figure 1-1***. The Oregon Department of Environmental Quality (DEQ) included the entire Oregon portions of the Columbia River mainstem on its 2012 Section 303(d) list. The Washington Department of Ecology (Ecology) included 49 different segments of the two rivers on its 2012 CWA section 303(d) list.

As detailed in Section 6.0, EPA has completed TMDLs for all 50 segments listed in ***Table 1-1*** by establishing allocations for sources of pollution, including NPDES point sources, tributaries, and dams. EPA also has identified 12 tributaries that provide critical cold water refuge for fish, as explained in Section 5.0.

Table 1-1 Washington and Oregon 303(d) temperature impairments on the Columbia and lower Snake Rivers

Waterbody	Assessment Unit	River Mile (RM)
	Washington	
Columbia River	170800030900_01_02	38.6 – 47.5
Columbia River	170800030900_01_04	53.6 – 57.9
Columbia River	170800030900_01_05	57.9 – 68.1
Columbia River	170800030900_01_06	68.1 – 73.1
Columbia River	170800030900_01_07	73.1 – 76.1
Columbia River	170800030200_01_01	86.6 – 101.4
Columbia River	170800030200_01_02	101.4 – 120.5
Columbia River	170800010804_01_01	120.5 – 131.5
Columbia River	170800010802_01_01	136.8 – 142.4
Columbia River	170701051204_01_01	146.1 – 154.7
Columbia River	170701051106_01_01	154.7 – 168.9
Columbia River	170701051105_01_01	168.9 – 180.4
Columbia River	170701050406_01_01	180.4 – 191.8
Columbia River	170701050401_01_01	191.8 – 202.7
Columbia River	170701050103_01_01	202.7 – 215.6
Columbia River	170701011408_01_01	215.6 – 227.7
Columbia River	170701010601_01_01	286.5 – 292.0
Columbia River	170701010207_01_01	292.0 – 294.8
Columbia River	170701010201_01_01	305.2 – 309.3
Columbia River	170701010103_01_01	314.4 – 317.4
Columbia River	170200160604_01_01	324.5 – 338.1
Columbia River	170200160106_01_01	387.9 – 397.2
Columbia River	170200160105_01_01	397.2 – 404.4
Columbia River	170200100507_01_01	410.7 – 415.8
Columbia River	170200100506_01_01	415.8 – 421.7
Columbia River	170200100401_01_01	450.1 – 453.4
Columbia River	170200100313_01_01	453.4 – 464.1
Columbia River	170200100308_01_01	464.1 – 468.4
Columbia River	170200100307_01_01	468.4 – 473.7

Waterbody	Assessment Unit	River Mile (RM)
Columbia River	170200100306_01_01	473.7 – 483.7
Columbia River	170200050507_01_01	503.4 – 515.6
Columbia River	170200050505_01_01	515.6 – 523.8
Columbia River	170200050405_01_01	533.6 – 545.2
Columbia River	170200050404_01_01	545.2 - 554.8
Columbia River	170200050203_01_01	589.3 – 596.7
Columbia River (Roosevelt Lake)	48117J7B8	
Columbia River (Roosevelt Lake)	48117J7C7	
Columbia River (Roosevelt Lake)	47118J6D8	
Columbia River (Roosevelt Lake)	48118F1G1	
Columbia River (Roosevelt Lake)	48118F1J2	
Snake River	170601100404_01_01	0.3 – 9.8
Snake River	170601100403_01_01	9.8 – 21.1
Snake River	170601100106_01_01	29.8 – 41.6
Snake River	170601100103_01_01	41.6 – 51.8
Snake River	170601070807_01_01	67.4 – 70.3
Snake River	170601070804_01_01	77.9 – 91.8
Snake River	170601070802_01_01	91.8 – 107.3
Snake River	170601030307_01_01	139.3 – 150.3
Snake River	170601030303_01_01	157.6 – 168.8
Oregon		
Mid and lower Columbia	1240480000000	0 – 303.9

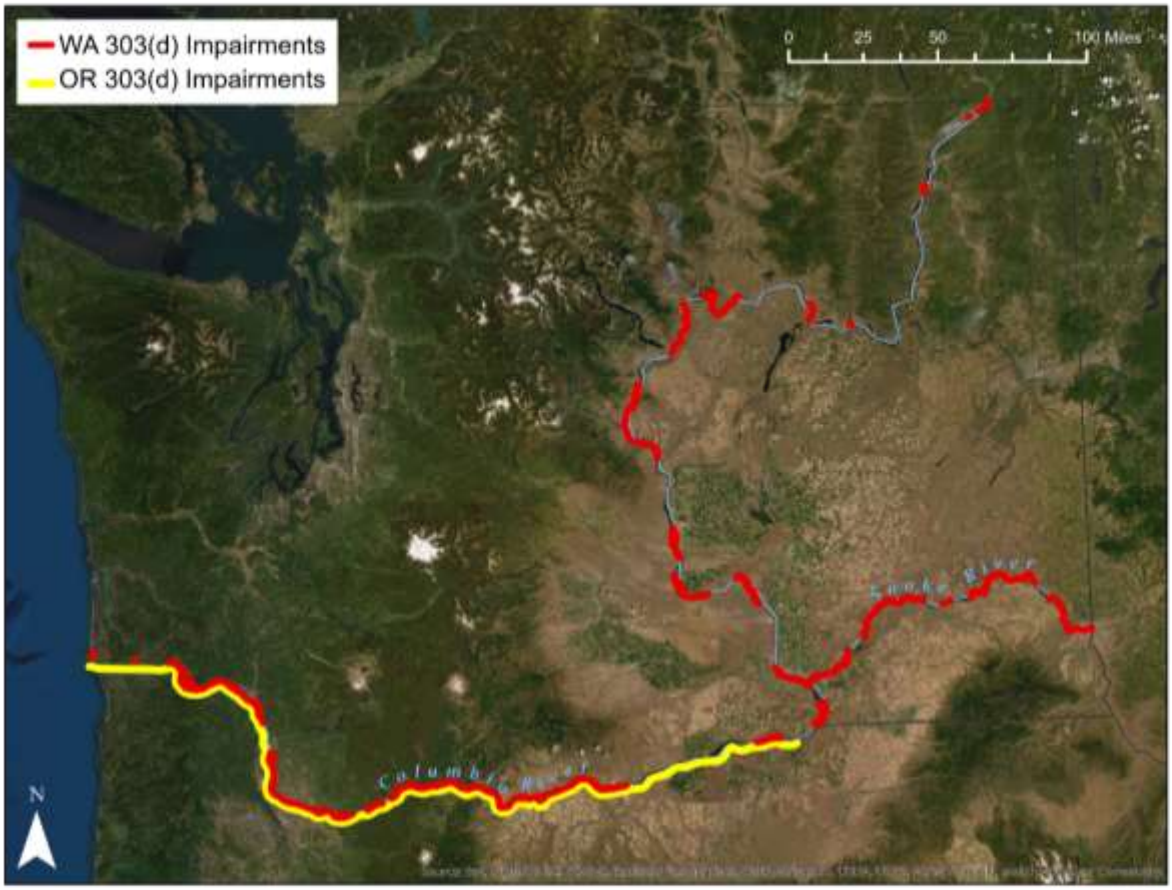

Figure 1-1 Washington and Oregon waterbodies in the Columbia and lower Snake Rivers identified as impaired for temperature pursuant to CWA 303(d)

2.0 WATER QUALITY STANDARDS

This Section identifies the applicable temperature WQS for the mainstems of the Columbia and lower Snake Rivers, including those WQS that have been federally promulgated or adopted by the four governments with jurisdiction over these rivers and approved by EPA: Confederated Tribes of the Colville Reservation (CTCR), Spokane Tribe of Indians, Oregon, and Washington. These States and Tribes developed the temperature WQS to protect the most sensitive aquatic life uses in the Columbia and lower Snake Rivers, such as salmonid spawning, rearing, and migration.

The CTCR standards were promulgated by EPA in 1989 (40 CFR Part 131.35) and apply within the reservation boundaries along a more than 150-mile section of the upper Columbia River, from RM 534 - 690. The Spokane Tribe of Indians standards were approved by EPA in 2013 and apply to a 7-mile stretch of the Columbia River within Lake Roosevelt to protect fish and shellfish, including salmonid migration, rearing, spawning, and harvesting. The CTCR and Spokane Tribe of Indians criteria are summarized in ***Table 2-1***. In this TMDL, the EPA has not relied upon the CTCR or the Spokane WQS for temperature; this TMDL does not establish allocations for Tribal waters.

EPA has compiled and organized the temperature WQS (which include the designated uses and the numeric water quality criteria (WQC)) into 10 different jurisdictional reaches (Reaches A through J) for the purposes of understanding the geographic areas covered by each of the applicable standards. These reaches are illustrated in ***Figure 2-1*** and summarized in ***Table 2-2***. EPA used the most protective of these criteria to develop the TMDL. A more detailed compilation of the WQS can be found in Appendix A.

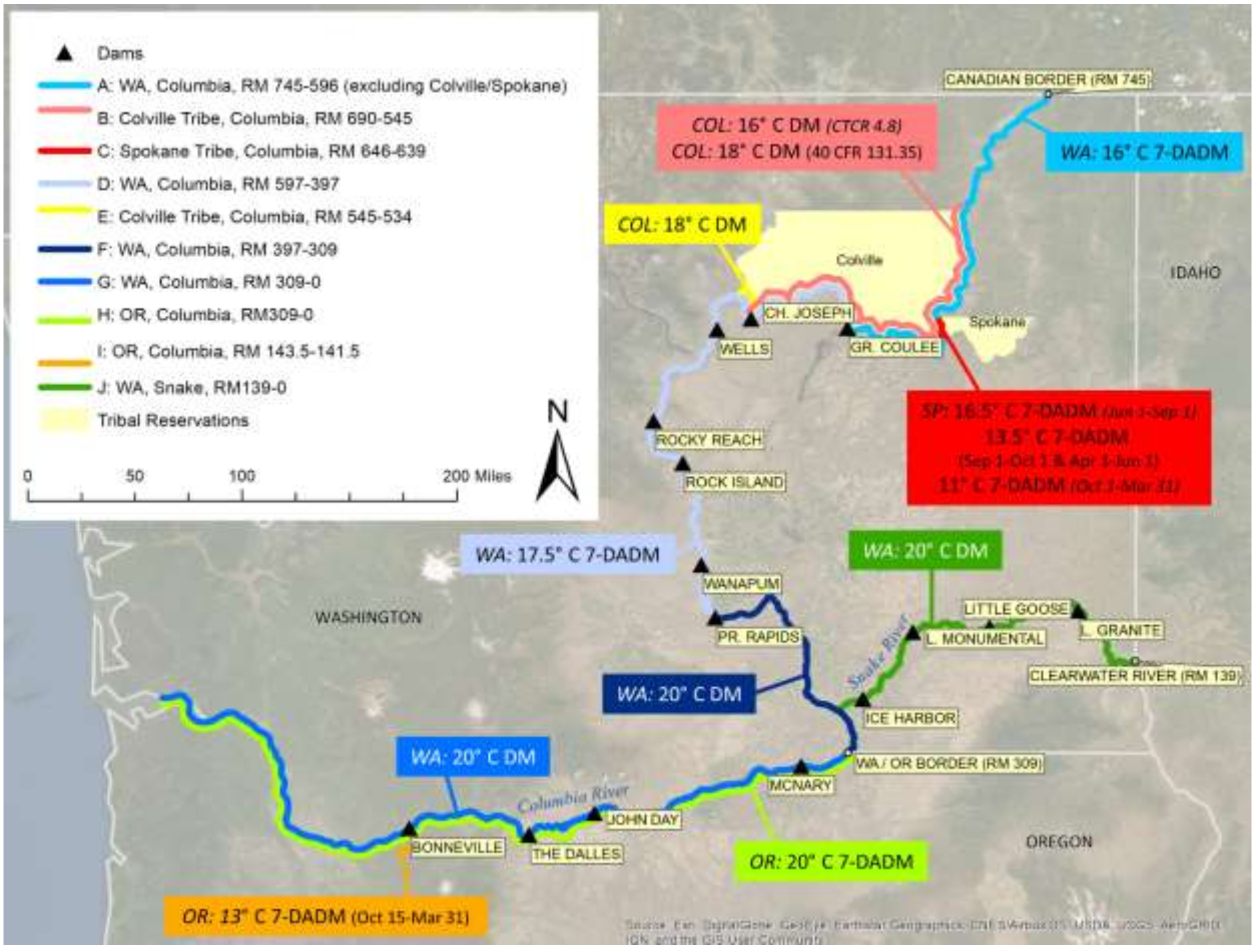

Figure 2-1 Columbia and lower Snake River temperature WQS, jurisdictions, river miles, and numeric criteria

Table 2-1 Summary of temperature criteria and aquatic life uses for the Columbia and lower Snake Rivers

Map	Jurisdiction	RMs	Criterion (°C)	Aquatic Life Use
Columbia River				
A	Washington	Canadian Border (745) to Grand Coulee Dam (596) (excluding RM 646.5-639)	16 7-DADM[2]	Core summer salmonid habitat
B	CTCR	CTCR Reservation Boundary (690) To Chief Joseph Dam (545)	18 DM[3] (40 CFR 131.35)	Salmonid migration, rearing, spawning, and harvesting
C	Spokane Tribe	Reservation Boundary (646.5) to Reservation Boundary (639)	16.5 7-DADM (June 1 - Sept 1); 13.5 7-DADM (Sept 1 – Oct 1 & April 1 – June 1); 11 7-DADM (Oct 1 – March 31)	Fish and shellfish, including salmonid migration, rearing, spawning, and harvesting
D	Washington	Grand Coulee Dam (596) to Priest Rapids Dam (397)	17.5 7-DADM	Salmonid spawning, rearing, and migration
E	CTCR	Chief Joseph Dam (545) to Okanogan River (534)	18 1-DM (40 CFR 131.35 & CTCR 4-8)	Salmonid migration, rearing, spawning, and harvesting
F	Washington	Priest Rapids Dam (397) to WA/OR Border (309)	20 DM	Salmonid spawning, rearing, and migration
G	Washington	WA/OR Border (309) to Pacific Ocean (0)	20 DM	Salmonid spawning, rearing, and migration
H	Oregon	WA/OR Border (309) to Pacific Ocean (0)	20 7-DADM	Salmon and steelhead migration corridors
I	Oregon	Ives Island (143.5) to Beacon Rock (141.5)	13 7-DADM (Oct 15th – Mar 31st)	Salmon and steelhead spawning through fry emergence
Snake River				
J	Washington	Clearwater River (139) to Snake Mouth (0)	20 DM	Salmonid spawning, rearing, and migration

[2] 7-DADM is the 7-day average of the daily maximum temperature.
[3] DM is the daily maximum; averaging period not provided.

2.1 WASHINGTON

Washington's numeric water quality criteria (WQC) are set either as daily maximum temperatures (DM) or as 7-day averages of the daily maximum temperatures (7-DADM) occurring in a waterbody. In developing the temperature standards, Washington recognizes that aquatic species need access to cold water refuges (CWRs), where individual migrating aquatic species sometimes seek refuge to avoid maximum temperatures. The maximum temperature criterion assumes that colder temperatures are available to protect fish at night (Ecology 2002).

In the WQS, aquatic life use categories are described using key species (e.g., salmonid or char versus warm-water species) and life-stage conditions (e.g., spawning versus rearing) (Washington Administrative Code [WAC] 173-201A-200). The temperature criteria established to protect the uses in the Columbia and lower Snake Rivers include 16°C 7-DADM for core summer salmonid habitat and either 17.5°C 7-DADM or 20°C DM for salmonid spawning, rearing, and migration (depending on geographic location), all of which are effective throughout the entire year. Temperatures are not to exceed the criteria at a probability frequency of more than once every 10 years on average (WAC 173-201A-200 (1)(c)(iii)).

In addition to the above numeric temperature WQC, the following narrative criteria also apply to the Columbia and lower Snake Rivers in Washington:

- *Upstream actions must be conducted in manners that meet downstream water body criteria [WAC 173-201A-260(3)(b)]*
- *At the boundary between water bodies protected for different uses, the more stringent criteria apply [WAC 173-201A-260(3)(d)].*

Washington WQS define "measurable change" as *a temperature increase of 0.3°C or greater* (WAC 173-201A-320 [3][a]). EPA interprets and implements this definition as establishing a threshold for *de minimis* changes in water temperature.

2.2 OREGON

The mainstem Columbia River serves as the border between Washington and Oregon from the Pacific Ocean upstream to RM 309 (***Table 2-2***). Oregon's designated uses for the mainstem include salmon and steelhead migration (20°C 7-DADM) for the entire reach, with one relatively small segment that is also seasonally designated for salmon and steelhead spawning through fry emergence (13°C 7-DADM). The criterion for salmon and steelhead spawning through fry emergence applies from October 15 – March 31 for RM 141 to 143 (Reach I).

In addition to the above numeric temperature WQC, the following narrative criteria also apply to the Columbia River basin in Oregon:

- *The seasonal thermal pattern in Columbia and Snake Rivers must reflect the natural seasonal thermal pattern [Oregon Administrative Rules [OAR] 340-041-0028(4)(d)]*
- *Cold Water Refugia. These waterbodies must have cold water refugia that are sufficiently distributed so as to allow salmon and steelhead migration without significant adverse effects from higher water temperatures elsewhere in the waterbody [OAR 340-041-0028(4)(d)].*
- *Oregon water quality standards define cold water refugia as "those portions of a water body where, or times during the diel temperature cycle when, the water temperature is at*

least 2 degrees Celsius colder than the daily maximum temperature of the adjacent well mixed flow of the water body." [OAR 340-041-0002(10)]

Finally, Oregon WQS include a supplementary provision for a "human use allowance" that authorizes insignificant additions of heat in water that exceeds the applicable temperature criteria, as follows:

- *Following a temperature TMDL or other cumulative effects analysis, wasteload and load allocations will restrict all NPDES point sources and nonpoint sources to a cumulative increase of no greater than 0.3 degrees Celsius (0.5 degrees Fahrenheit) above the applicable criteria after complete mixing in the water body, and at the point of maximum impact [OAR 340-041-0028(12)(b)(B)].*

2.3 STANDARDS FOR UPSTREAM WATERS

The temperature of water entering the TMDL study area at the Canadian and Idaho borders affects the temperature of the portions of the Columbia and lower Snake Rivers within the TMDL study area (additional information provided in Section 6.4). Guidelines and standards applicable to the waters in these upstream areas protect key aquatic species, although the guidelines and standards are not always met.

The provincial government of British Columbia, Canada has established water quality guidelines for temperature using key species and life stage conditions. Because site-specific guidelines have not been established for the Columbia River, the province-wide ambient temperature guidelines apply to the Canadian waters of the Columbia River. The applicable guidelines include a mean weekly maximum temperature of 18°C, a maximum daily temperature of 19°C, and an hourly rate of change not to exceed 1°C, as well as a maximum incubation temperature of 12°C in the spring and the fall (British Columbia Ministry of Environment 2019). Downstream of the Canadian border, the Washington water quality standard for the Columbia River is 16°C 7-DADM.

Upstream from the lower Snake River TMDL study area, the Idaho WQS established to protect cold water aquatic life are a daily maximum of 22°C and a maximum daily average of 19°C. The Washington water quality standard for the Snake River is 19°C daily maximum.

2.4 WATER QUALITY STANDARDS USED TO DEVELOP THIS TOTAL MAXIMUM DAILY LOAD

EPA identified the numeric water quality criteria (within the States' water quality standards) applicable to the waters of the two States in the Columbia and lower Snake Rivers in ***Table 2-2***. The table identifies 10 reaches in the Columbia River and one reach in the lower Snake River. For each reach, the applicable Washington and Oregon temperature criteria are identified for each month of the year because the most protective criterion changes at different times of the year based on the designated uses and the criteria established by each State for those aquatic uses.

EPA used the most protective criteria in ***Table 2-2*** to evaluate the frequency and time period associated with criteria exceedances, which occur from July – October. At Grand Coulee Dam and Priest Rapids Dam data collection sites, a change in Washington temperature criteria occurs. The criterion at the tailrace is higher (less stringent) than the criterion upstream of each dam. In this TMDL, at both of these locations, the more protective criterion is used to protect uses and target attainment of the criterion that applies in the reservoirs immediately upstream of these dams. EPA used the more protective criterion to implement the State's narrative water quality standard at WAC 173-201A-260(3)(d). During those time periods and at those locations where exceedances occur, LAs and WLAs have been developed which, if and when implemented, will result in water quality improvements, as discussed in detail in Section 6.0.

Although Washington and Oregon have developed numerous temperature TMDLs using the "natural condition" provisions of the States' WQS, those provisions were not used to develop his TMDL. These existing "natural condition" TMDLs attempted to estimate the instream water quality conditions that occurred prior to human development. For this TMDL, EPA has not attempted to estimate the natural conditions of the mainstems of the Columbia and lower Snake Rivers for two reasons. First, Oregon WQS do not currently include a natural condition provision. Consequently, for the lower Columbia River, where the border between Oregon and Washington divides the River, EPA developed the TMDL using the existing numeric criteria, relying on the more protective aspects of the two States' criteria to determine the total load from bank-to-bank. Secondly, there is no functional basin-wide water quality model for estimating the natural conditions of the Columbia and lower Snake Rivers. An appropriate basin-wide model would incorporate the upper portions of the watershed in Canada and Idaho and would estimate the natural flow and temperature regime that existed prior to construction of dams and irrigation diversions. For these reasons, EPA relied on the existing numeric criteria to develop this TMDL.

Table 2-2 Water quality criteria used to evaluate water quality exceedances in the Columbia and lower Snake River TMDL (July – October)

RMs	Jurisdiction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	WQC Applied[4]
Columbia River														
745 – 646.5	WA	16°C 7-DADM (WA)												**16°C 7-DADM**
639 – 596	WA	16°C 7-DADM (WA)												**16°C 7-DADM**
596 – 545	WA	17.5°C 7-DADM (WA)												**16°C 7-DADM[5]**
545 – 534	WA	17.5°C 7-DADM (WA)												**17.5°C 7-DADM**
534 – 397	WA	17.5°C 7-DADM (WA)												**17.5°C 7-DADM**
397 – 309	WA	20°C DM (WA)												**17.5°C DM**
309 – 143.5	WA, OR	20°C DM (WA) – 20°C 7-DADM (OR)												**20°C DM**
143.5 – 141.5	WA, OR	20°C DM (WA) 13°C 7-DADM (OR)			20°C DM (WA) 20°C 7-DADM (OR)						20°C DM (WA) 13°C 7-DADM (OR) (after Oct 15th)			**20°C DM and 13°C 7-DADM**
141.5 – 0	WA, OR	20°C DM (WA) – 20°C 7-DADM (OR)												**20°C DM**
Snake River														
139 – 0	WA	20°C DM (WA)												**20°C DM**

[4] These water quality criteria are used to evaluate water quality exceedances from July – October.
[5] At the tailrace of Grand Coulee Dam (RM 596) and Priest Rapids Dam (RM 397), the temperature criterion is higher (less stringent) than the criterion upstream of the dam. At both of these locations, the more stringent criterion is used to develop the target temperatures, which are discussed further in Section 6.1, in order to protect the State's designated uses and to target attainment of the criterion in the reservoirs immediately upstream of these dams. Washington WQS at WAC 173-201A-260(3)(d) explain that, at the boundary between water bodies protected for different uses, the more stringent criteria apply.

3.0 CURRENT CONDITIONS

In this section, EPA examines current temperature conditions in the Columbia and lower Snake Rivers basin within the geographic scope of the TMDL. EPA used, as the current conditions regime, calendar years 2011 – 2016 in order to align with the planned timeframe for the Environmental Impact Statement (EIS) assessment being developed by the U.S. Army Corps of Engineers, Bureau of Reclamation, and Bonneville Power Administration. This multi-year period includes a range of temperature conditions and provides robust estimates of current conditions. EPA relied on this timeframe for all current condition analyses used to develop this TMDL. All data were accessed through the Columbia Basin Research website administered by the University of Washington's School of Aquatic & Fishery Sciences. The website features the Columbia River Data Access in Real Time (DART) database. River temperatures were evaluated at 18 DART stations (***Figure 3-1*** and ***Table 3-1***).

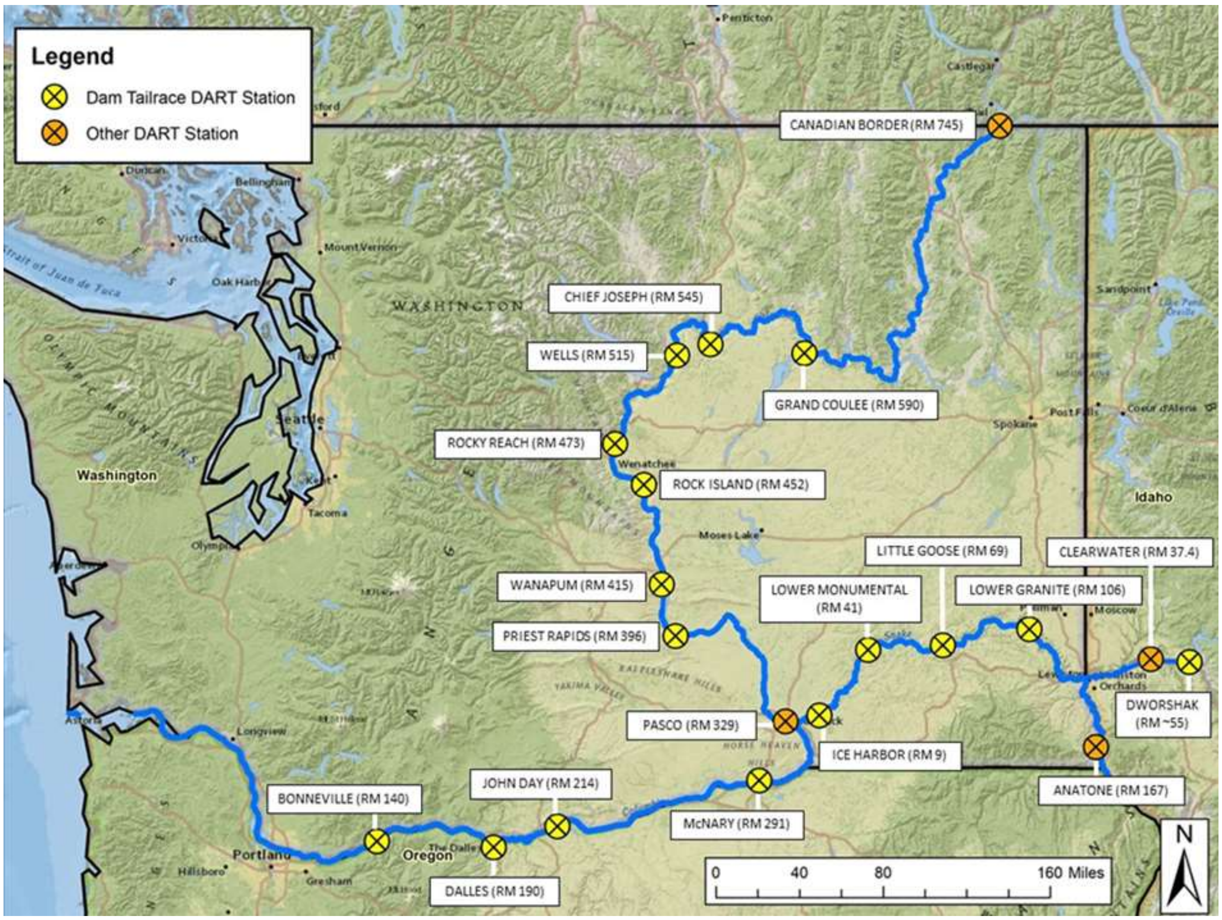

Figure 3-1 DART stations on the Columbia and lower Snake Rivers

Table 3-1 DART data locations

Monitoring Station	DART ID	RM
Columbia River		
Canadian Border	CIBW	745
Grand Coulee Dam tailrace (6 miles downstream)	GCGW	591
Chief Joseph Dam tailrace	CHQW	544
Wells Dam forebay (no tailrace data)	WEL	512
Rocky Reach Dam tailrace	RRDW	472
Rock Island Dam tailrace	RIGW	453
Wanapum Dam tailrace	WANW	413
Priest Rapids Dam tailrace	PRXW	396
Pasco, WA	PAQW	329
McNary Dam tailrace	MCPW	291
John Day Dam tailrace	JHAW	214
The Dalles Dam tailrace	TDDO	190
Bonneville (Warrendale; 6 miles downstream)	WRNO	140
Snake River		
Anatone, WA	ANQW	168
Lower Granite Dam tailrace	LGNW	107
Little Goose Dam tailrace	LGSW	70
Lower Monumental Dam tailrace	LMNW	40
Ice Harbor Dam tailrace	IDSW	6

3.1 COLUMBIA AND LOWER SNAKE TEMPERATURE DATA AND WATER QUALITY EXCEEDANCES

EPA used river temperatures from DART stations located at tailraces of each of the dams on the Columbia and lower Snake Rivers in order to derive the annual and monthly (July - October) average daily mean and daily maximum temperatures for each year of the current condition regime (2011 – 2016). The DART stations generate hourly temperature data in well-mixed areas at the tailraces of dams, and therefore represent the average river temperature at that location. The results for each year were then used to calculate a single average value for annual and monthly (July – October) average mean and maximum temperatures. Observed temperatures were compared to applicable State temperature criteria to assess whether current conditions exceed the criteria.

In ***Table 3-2***, water quality exceedances were calculated as the number of days exceeding the temperature criteria and the percentage of days exceeding the criteria annually and monthly (July – October). The average and maximum magnitude of exceedances were calculated for each year in the current condition regime. The annual and monthly (July – October) current condition regime was then calculated for the average number of days with exceedances, average percentage of days with exceedances, and average mean and maximum temperature exceedance magnitudes.

EPA conducted an extensive quality assurance review of the temperature data and identified numerous data gaps in the available data (detailed in Appendix B). Consistent with applicable temperature WQC, the hourly temperature data were translated into the averaging period(s) corresponding to the temperature WQC that apply at that location.[6]

Table 3-2 through ***Table 3-7*** display current water temperature conditions (2011-2016) within the TMDL study area along with water quality exceedance statistics, based on EPA's review of existing data. EPA's review of available data indicates that temperatures in the mainstems of the Columbia and lower Snake Rivers are at their annual minima in February; temperatures steadily increase through the spring and early summer, with annual maxima generally occurring in August; and temperatures steadily decrease through the fall and early winter.

Between 2011 and 2016, Columbia River water entering the United States at the Canadian Border (RM 745) frequently exceeded Washington's applicable 7-DADM criterion of 16°C in July, August, and September. On average, water temperatures exceeded the 7-DADM by 1.8°C, and the annual maximum exceedance magnitude averaged 3.2°C.

In the portion of the Columbia River above Priest Rapids Dam, the majority of criteria exceedances occur in the months of August and September. In the mid-Columbia, from Wells Dam to Wanapum Dam, water temperatures exceed the criterion more frequently, for a longer average duration and by a higher average magnitude. The lower mainstem Columbia, below McNary Dam, has a higher criterion (20°C) but exhibits only slightly fewer criteria exceedances.

[6] The 7-DADM temperatures were calculated by averaging the daily maximum temperature for a given day with the daily maximum temperature values of the previous three days and the following three days, as specified in the Washington WQS.

Table 3-2 Current conditions regime (2011 – 2016) observed annual, July, August, September, and October average and average maximum temperatures

RM	Location	River	Annual		July		August		September		October	
			Mean (°C)	Max (°C)	Mean (°C)	Max (°C)	Mean (°C)	Max (°C)	Mean (°C)	Max (°C)	Mean (°C)	Max (°C)
745	Canadian Border	Columbia	9.9	19.6	16.3	18.3	17.8	19.5	16.4	18.5	13.0	15.4
590	Grand Coulee Dam tailrace	Columbia	11.3	19.4	15.7	17.7	18.0	19.2	18.4	19.3	16.9	18.3
545	Chief Joseph Dam tailrace	Columbia	N/A	19.3	15.9	17.7	18.2	19.1	18.5	19.0	17.6	18.1
515	Wells Dam forebay	Columbia	11.6	19.7	16.5	18.3	18.7	19.5	18.8	19.7	16.4	18.0
473	Rocky Reach Dam tailrace	Columbia	11.8	20.3	16.7	18.5	18.9	20.1	18.8	19.6	16.7	18.1
452	Rock Island Dam tailrace	Columbia	11.8	20.7	16.8	19.1	19.0	20.6	18.6	20.4	16.4	18.4
415	Wanapum Dam tailrace	Columbia	11.3	20.2	17.2	19.0	19.4	20.1	18.9	19.8	16.3	17.9
396	Priest Rapids Dam tailrace	Columbia	11.2	20.2	16.8	18.7	19.3	20.1	19.0	20.1	16.2	18.2
329	Pasco, WA	Columbia	N/A	21.2	18.3	20.1	20.3	21.1	N/A	N/A	N/A	N/A
291	McNary Dam tailrace	Columbia	12.5	21.8	19.2	20.7	21.0	21.7	19.7	21.3	16.2	18.2
214	John Day Dam tailrace	Columbia	12.5	22.6	19.7	21.2	21.5	22.4	20.2	21.6	16.8	18.7
190	The Dalles Dam tailrace	Columbia	12.6	22.6	19.8	21.2	21.5	22.4	20.1	21.4	16.6	18.7
140	Bonneville Dam (downstream)	Columbia	12.5	22.6	19.7	21.4	21.3	22.5	19.8	21.5	16.3	18.5
167	Anatone, WA	Snake	N/A	24.2	21.1	23.6	22.4	23.9	N/A	22.3	N/A	N/A
37	Clearwater Station	Clearwater	7.5	15.3	11.5	14.2	10.7	12.5	11.6	14.4	10.4	13.0
55	Dworshak Dam tailrace	Clearwater	6.9	10.8	7.1	8.0	8.1	9.1	9.3	10.4	9.7	10.5
106	Lower Granite Dam tailrace	Snake	11.3	20.4	18.6	20.1	19.0	20.1	18.3	19.2	15.7	18.4
69	Little Goose Dam tailrace	Snake	11.7	21.1	19.2	20.7	20.0	21.0	18.9	20.2	16.4	18.1
41	Lower Monumental Dam tailrace	Snake	12.0	21.4	19.5	21.0	20.5	21.2	19.2	20.5	16.5	18.1
9	Ice Harbor Dam tailrace	Snake	12.3	22.3	20.0	21.8	21.4	22.1	19.7	21.3	16.5	18.4

Note: Orange cells indicate that the regime value was tabulated with three yearly values missing. Red cells with a value of N/A indicates that the regime value had four or more missing values, so a regime value was not established.

Table 3-3 Current conditions regime (2011 – 2016) observed annual river temperature exceedances (average number of days, average percent of time, average magnitude, and average maximum magnitude)

RM	Location	River	WQC (°C)	Annual			
				Days	Percent (%)	Mean (°C)	Max (°C)
745	Canadian Border	Columbia	Washington 16 7-DADM	78	21	1.8	3.2
590	Grand Coulee Dam tailrace	Columbia	Colville Tribe 18 DM	45	12	0.7	1.3
			Washington 17.5 7-DADM	62	17	1.1	1.6
545	Chief Joseph Dam tailrace	Columbia	Colville Tribe 18 DM	50	14	0.7	1.3
			Washington 17.5 7-DADM	64	18	1.0	1.6
515	Wells Dam forebay	Columbia	Washington 17.5 7-DADM	83	23	1.4	2.4
473	Rocky Reach Dam tailrace	Columbia	Washington 17.5 7-DADM	81	22	1.3	2.4
452	Rock Island Dam tailrace	Columbia	Washington 17.5 7-DADM	78	21	1.4	2.4
415	Wanapum Dam tailrace	Columbia	Washington 17.5 7-DADM	80	22	1.5	2.5
396	Priest Rapids Dam tailrace	Columbia	Washington 20 DM	16	4	0.3	0.4
329	Pasco, WA	Columbia	Washington 20 DM	34	9	0.6	1.2
291	McNary Dam tailrace	Columbia	Washington 20 DM	49	13	1.0	1.8
			Oregon 20 7-DADM	49	13	1.0	1.7
214	John Day Dam tailrace	Columbia	Washington 20 DM	62	17	1.4	2.6
			Oregon 20 7-DADM	65	18	1.3	2.3
190	The Dalles Dam tailrace	Columbia	Washington 20 DM	63	17	1.4	2.6
			Oregon 20 7-DADM	65	18	1.3	2.3
140	Bonneville Dam tailrace	Columbia	Washington 20 DM	61	17	1.3	2.6
			Oregon 20 7-DADM	63	17	1.3	2.3
167	Anatone, WA	Snake	Idaho 22 DM	45	12	1.0	2.2
			Washington 20 DM	68	19	2.4	4.2
37	Clearwater Station (on Clearwater River)	Clearwater	Idaho 22 DM	0	0	N/A	N/A
			Washington 20 DM	0	0	N/A	N/A
55	Dworshak Dam tailrace (on Clearwater River)	Clearwater	Washington 20 DM	0	0	N/A	N/A
106	Lower Granite Dam tailrace	Snake	Washington 20 DM	5	1	0.3	0.5
69	Little Goose Dam tailrace	Snake	Washington 20 DM	42	11	0.5	1.1
41	Lower Monumental Dam tailrace	Snake	Washington 20 DM	54	15	0.7	1.4
9	Ice Harbor Dam tailrace	Snake	Washington 20 DM	64	17	1.4	2.3

Note: Orange cells indicate that the regime value was tabulated with three yearly values missing. Red cells with a value of N/A indicates that the regime value had four or more missing values, so a regime value was not established.

Table 3-4 Current conditions regime (2011– 2016) observed July river temperature exceedances (average number of days, average percent of time, average magnitude, and average maximum magnitude)

RM	Location	River	WQC (°C)	July			
				Days	Percent (%)	Mean (°C)	Max (°C)
745	Canadian Border	Columbia	Washington 16 7-DADM	22	70	1.2	2.0
590	Grand Coulee Dam tailrace	Columbia	Colville Tribe 18 DM	2	8	0.1	0.3
			Washington 17.5 7-DADM	5	16	0.2	0.4
545	Chief Joseph Dam tailrace	Columbia	Colville Tribe 18 DM	2	8	0.1	0.2
			Washington 17.5 7-DADM	6	18	0.3	0.4
515	Wells Dam forebay	Columbia	Washington 17.5 7-DADM	10	33	0.5	0.8
473	Rocky Reach Dam tailrace	Columbia	Washington 17.5 7-DADM	12	38	0.6	1.0
452	Rock Island Dam tailrace	Columbia	Washington 17.5 7-DADM	12	39	0.7	1.1
415	Wanapum Dam tailrace	Columbia	Washington 17.5 7-DADM	16	50	0.7	1.3
396	Priest Rapids Dam tailrace	Columbia	Washington 20 DM	0	0	N/A	N/A
329	Pasco, WA	Columbia	Washington 20 DM	8	25	0.3	0.5
291	McNary Dam tailrace	Columbia	Washington 20 DM	11	36	0.6	1.0
			Oregon 20 7-DADM	11	35	0.6	0.9
214	John Day Dam tailrace	Columbia	Washington 20 DM	16	51	0.9	1.4
			Oregon 20 7-DADM	16	52	0.8	1.3
190	The Dalles Dam tailrace	Columbia	Washington 20 DM	16	52	0.9	1.4
			Oregon 20 7-DADM	16	52	0.9	1.3
140	Bonneville Dam tailrace	Columbia	Washington 20 DM	16	51	0.9	1.5
			Oregon 20 7-DADM	16	51	0.9	1.3
167	Anatone, WA	Snake	Idaho 22 DM	16	52	0.9	1.6
			Washington 20 DM	23	73	2.4	3.6
37	Clearwater Station (on Clearwater River)	Clearwater	Idaho 22 DM	0	0	N/A	N/A
			Washington 20 DM	0	0	N/A	N/A
55	Dworshak Dam tailrace (on Clearwater River)	Clearwater	Washington 20 DM	0	0	N/A	N/A
106	Lower Granite Dam tailrace	Snake	Washington 20 DM	2	5	0.2	0.3
69	Little Goose Dam tailrace	Snake	Washington 20 DM	16	52	0.4	0.9
41	Lower Monumental Dam tailrace	Snake	Washington 20 DM	18	57	0.7	1.0
9	Ice Harbor Dam tailrace	Snake	Washington 20 DM	18	58	1.3	1.8

Note: Red cells with a value of N/A indicates that the regime value had four or more missing values, so a regime value was not established.

Table 3-5 Current conditions regime (2011 – 2016) observed August river temperature exceedances (average number of days, average percent of time, average magnitude, and average maximum magnitude)

RM	Location	River	WQC (°C)	August			
				Days	Percent (%)	Mean (°C)	Max (°C)
745	Canadian Border	Columbia	Washington 16 7-DADM	31	99	2.5	3.1
590	Grand Coulee Dam tailrace	Columbia	Colville Tribe 18 DM	16	53	0.6	1.0
			Washington 17.5 7-DADM	20	66	0.9	1.2
545	Chief Joseph Dam tailrace	Columbia	Colville Tribe 18 DM	20	64	0.7	1.1
			Washington 17.5 7-DADM	27	85	1.0	1.5
515	Wells Dam forebay	Columbia	Washington 17.5 7-DADM	29	93	1.4	1.9
473	Rocky Reach Dam tailrace	Columbia	Washington 17.5 7-DADM	30	96	1.6	2.1
452	Rock Island Dam tailrace	Columbia	Washington 17.5 7-DADM	30	97	1.6	2.2
415	Wanapum Dam tailrace	Columbia	Washington 17.5 7-DADM	30	96	2.0	2.4
396	Priest Rapids Dam tailrace	Columbia	Washington 20 DM	12	40	0.2	0.4
329	Pasco, WA	Columbia	Washington 20 DM	21	67	0.7	1.1
291	McNary Dam tailrace	Columbia	Washington 20 DM	27	86	1.2	1.7
			Oregon 20 7-DADM	27	87	1.2	1.6
214	John Day Dam tailrace	Columbia	Washington 20 DM	30	95	1.7	2.4
			Oregon 20 7-DADM	30	97	1.7	2.2
190	The Dalles Dam tailrace	Columbia	Washington 20 DM	30	96	1.7	2.4
			Oregon 20 7-DADM	30	96	1.7	2.2
140	Bonneville Dam tailrace	Columbia	Washington 20 DM	29	95	1.6	2.5
			Oregon 20 7-DADM	30	97	1.6	2.2
167	Anatone, WA	Snake	Idaho 22 DM	25	80	1.2	1.9
			Washington 20 DM	28	91	3.0	3.9
37	Clearwater Station (on Clearwater River)	Clearwater	Idaho 22 DM	0	0	N/A	N/A
			Washington 20 DM	0	0	N/A	N/A
55	Dworshak Dam tailrace (on Clearwater River)	Clearwater	Washington 20 DM	0	0	N/A	N/A
106	Lower Granite Dam tailrace	Snake	Washington 20 DM	2	8	0.1	0.2
69	Little Goose Dam tailrace	Snake	Washington 20 DM	20	65	0.4	1.0
41	Lower Monumental Dam tailrace	Snake	Washington 20 DM	29	94	0.7	1.2
9	Ice Harbor Dam tailrace	Snake	Washington 20 DM	31	100	17	2.1

Note: Red cells with a value of N/A indicates that the regime value had four or more missing values, so a regime value was not established.

Table 3-6 Current conditions regime (2011 – 2016) observed September river temperature exceedances (average number of days, average percent of time, average magnitude, and average maximum magnitude)

RM	Location	River	WQC (°C)	September			
				Days	Percent (%)	Mean (°C)	Max (°C)
745	Canadian Border	Columbia	Washington 16 7-DADM	22	72	1.3	2.2
590	Grand Coulee Dam tailrace	Columbia	Colville Tribe 18 DM	19	63	0.7	1.1
			Washington 17.5 7-DADM	25	82	1.3	1.5
545	Chief Joseph Dam tailrace	Columbia	Colville Tribe 18 DM	25	82	0.7	1.0
			Washington 17.5 7-DADM	29	97	1.1	1.4
515	Wells Dam forebay	Columbia	Washington 17.5 7-DADM	30	98	1.5	2.0
473	Rocky Reach Dam tailrace	Columbia	Washington 17.5 7-DADM	30	100	1.3	1.8
452	Rock Island Dam tailrace	Columbia	Washington 17.5 7-DADM	29	96	1.5	2.0
415	Wanapum Dam tailrace	Columbia	Washington 17.5 7-DADM	30	100	1.5	2.1
396	Priest Rapids Dam tailrace	Columbia	Washington 20 DM	4	13	0.2	0.3
329	Pasco, WA	Columbia	Washington 20 DM	6	21	0.4	0.5
291	McNary Dam tailrace	Columbia	Washington 20 DM	12	40	0.7	1.3
			Oregon 20 7-DADM	12	41	0.7	1.1
214	John Day Dam tailrace	Columbia	Washington 20 DM	16	52	0.9	1.6
			Oregon 20 7-DADM	17	57	0.8	1.4
190	The Dalles Dam tailrace	Columbia	Washington 20 DM	16	52	0.8	1.4
			Oregon 20 7-DADM	17	57	0.8	1.4
140	Bonneville Dam tailrace	Columbia	Washington 20 DM	14	46	0.8	1.5
			Oregon 20 7-DADM	15	49	0.7	1.4
167	Anatone, WA	Snake	Idaho 22 DM	3	11	0.3	0.3
			Washington 20 DM	13	43	1.5	2.3
37	Clearwater Station (on Clearwater River)	Clearwater	Idaho 22 DM	0	0	N/A	N/A
			Washington 20 DM	0	0	N/A	N/A
55	Dworshak Dam tailrace (on Clearwater River)	Clearwater	Washington 20 DM	0	0	N/A	N/A
106	Lower Granite Dam tailrace	Snake	Washington 20 DM	1	3	0.1	0.1
69	Little Goose Dam tailrace	Snake	Washington 20 DM	4	13	0.1	0.3
41	Lower Monumental Dam tailrace	Snake	Washington 20 DM	6	21	0.3	0.5
9	Ice Harbor Dam tailrace	Snake	Washington 20 DM	14	45	0.8	1.3

Note: Red cells with a value of N/A indicates that the regime value had four or more missing values, so a regime value was not established.

Table 3-7 Current conditions regime (2011 – 2016) observed October river temperature exceedances (average number of days, average percent of time, average magnitude, and average maximum magnitude)

RM	Location	River	WQC (°C)	October			
				Days	Percent (%)	Mean (°C)	Max (°C)
745	Canadian Border	Columbia	Washington 16 7-DADM	0	0	0	0
590	Grand Coulee Dam tailrace	Columbia	Colville Tribe 18 DM	7	23	0.36	0.57
			Washington 17.5 7-DADM	24	74	0.54	0.89
545	Chief Joseph Dam tailrace	Columbia	Colville Tribe 18 DM	3	10	0.21	0.30
			Washington 17.5 7-DADM	3	10	0.50	0.52
515	Wells Dam forebay	Columbia	Washington 17.5 7-DADM	5	15	0.23	0.39
473	Rocky Reach Dam tailrace	Columbia	Washington 17.5 7-DADM	5	15	0.29	0.44
452	Rock Island Dam tailrace	Columbia	Washington 17.5 7-DADM	5	15	0.35	0.51
415	Wanapum Dam tailrace	Columbia	Washington 17.5 7-DADM	5	15	0.31	0.46
396	Priest Rapids Dam tailrace	Columbia	Washington 20 DM	0	0	0	0
329	Pasco, WA	Columbia	Washington 20 DM	0	0	0	0
291	McNary Dam tailrace	Columbia	Washington 20 DM	0	0	0	0
			Oregon 20 7-DADM	0	0	0	0
214	John Day Dam tailrace	Columbia	Washington 20 DM	0	0	0	0
			Oregon 20 7-DADM	0	0	0	0
190	The Dalles Dam tailrace	Columbia	Washington 20 DM	0	0	0	0
			Oregon 20 7-DADM	0	0	0	0
140	Bonneville Dam tailrace	Columbia	Washington 20 DM	0	0	0	0
			Oregon 13 7-DADM	17	100	2.6	3.65
167	Anatone, WA	Snake	Idaho 22 DM	0	0	0	0
			Washington 20 DM	0	0	0	0
37	Clearwater Station (on Clearwater River)	Clearwater	Idaho 22 DM	0	0	N/A	N/A
			Washington 20 DM	0	0	N/A	N/A
55	Dworshak Dam tailrace (on Clearwater River)	Clearwater	Washington 20 DM	0	0	N/A	N/A
106	Lower Granite Dam tailrace	Snake	Washington 20 DM	0	0	0	0
69	Little Goose Dam tailrace	Snake	Washington 20 DM	0	0	0	0
41	Lower Monumental Dam tailrace	Snake	Washington 20 DM	0	0	0	0
9	Ice Harbor Dam tailrace	Snake	Washington 20 DM	0	0	0	0

Note: Red cells with a value of N/A indicates that the regime value had four or more missing values, so a regime value was not established.

Between April and August, average daily maximum temperatures in the lower and mid-reaches of the mainstem Columbia are warmer than the upper Columbia as measured from below Grand Coulee (RM 590). During this time, river temperatures below Bonneville Dam can be up to 5°C warmer than below Grand Coulee Dam. However, beginning in late September, Grand Coulee's large storage reservoir inverts this relationship. The impounded water, warmed by solar radiation and warm air temperatures in the summer, cools at a slower rate compared to downstream reaches. As a result, between October – December, observed water temperatures in Grand Coulee's tailrace are warmer than temperatures below Priest Rapids, McNary, and Bonneville (***Figure 3-2***).

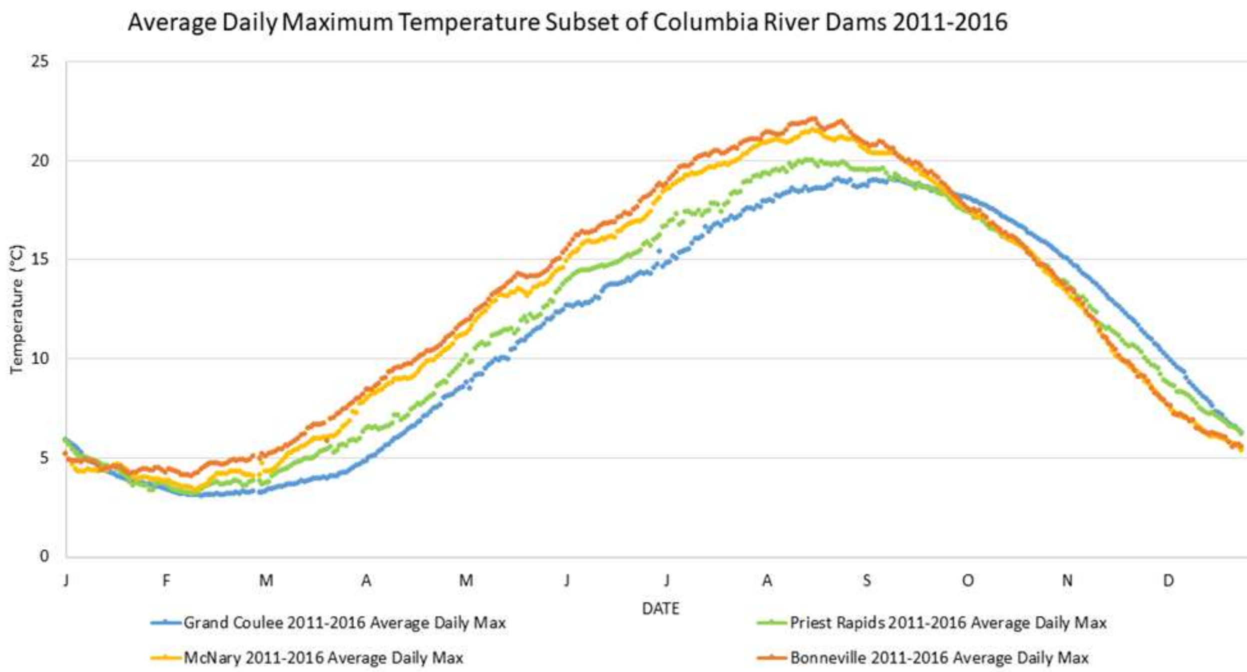

Figure 3-2 Columbia River warming as it flows downstream from Grand Coulee (blue) to Bonneville (orange)

The annual temperature profile of the lower Snake River mirrors that of the mainstem Columbia River. Average annual minima occur in February, and water temperatures steadily rise through the early spring and summer, generally reaching an average maximum temperature of 19°C-22°C in August. Water temperatures decline in the fall and winter, reaching the coldest temperatures in February (***Figure 3-2***).

The lower Snake River enters the TMDL study area at the confluence with the Clearwater River, 139 river miles upstream of its confluence with the Columbia River. Between 2011 and 2016, observed water temperatures upstream of the TMDL boundary in Anatone, WA exceed Washington's temperature criterion (20°C DM) for 68 days per year and by 1.5°C, on average. Managed releases from Dworshak Dam on the Clearwater River, a major tributary to the lower Snake River at the TMDL boundary, deliver cold water to help meet Washington's numeric criterion of 20°C DM at Lower Granite Dam (RM 106), the most upstream of the four dams on the lower Snake River. As a result, exceedances at the Lower Granite tailrace occur for only five days per year by 0.3°C, on average. However, the influence of Dworshak Dam's cold-water releases decreases steadily as the lower Snake River flows through the three downstream dams: Little Goose Dam (RM 69), Lower Monumental Dam (RM 41), and Ice Harbor Dam (RM 9).

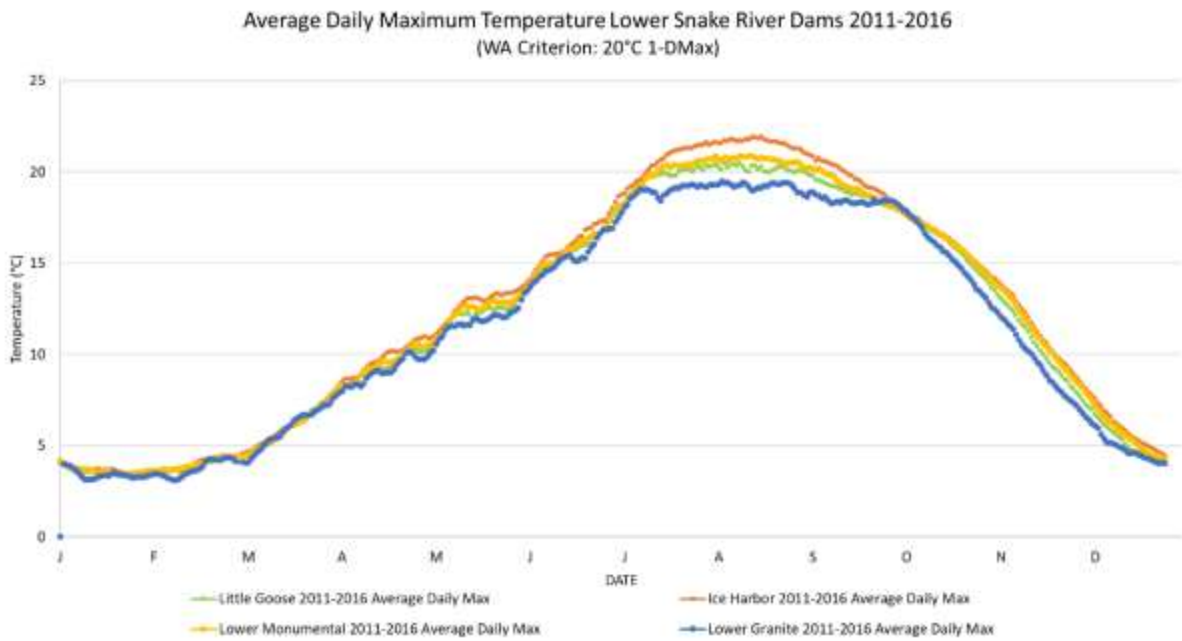

Figure 3-3 Snake River warming as it flows downstream from Lower Granite Dam (blue) to Ice Harbor Dam (orange)

Based on EPA's evaluation of available data from 2011-2016, temperature criterion exceedances at the Little Goose, Lower Monumental, and Ice Harbor Dams generally begin to occur in mid-July, ranging between 16-18 days, on average (***Table 3-4***). In August, water temperatures exceed the WQC for an average of 20 days below Little Goose Dam, 29 days below Lower Monumental Dam, and 31 days below Ice Harbor Dam (***Table 3-5***). In September, exceedances at Little Goose and Lower Monumental Dams drop significantly, averaging 4 and 6 days, respectively. At Ice Harbor Dam, however, water temperatures exceed the criterion for an average of 14 days by an average magnitude of 0.8°C in September (***Table 3-6***).

3.2 TRIBUTARY TEMPERATURE

EPA evaluated the temperatures of Columbia River tributaries by comparing tributary and mainstem temperatures at the confluences. Mainstem Columbia River mean monthly temperatures were obtained from the DART website from 2011 through 2015. Current mean monthly water temperatures for tributaries at their confluences with the Columbia River (***Figure 3-5***) were obtained from the USFS "NorWeST" Stream Temperature Modeling website, which provides the most comprehensive datasets and statistical estimates of monthly average stream temperature across the Pacific Northwest.

Based on its review of available information, EPA found temperature differences between the Columbia River mainstem and tributaries to be highly variable throughout the spring and summer period. Tributary temperatures are generally cooler than the mainstem in the fall (***Table 3-8***, Appendix E). In August, most tributaries that were significantly cooler than the mainstem (green and purple dots in ***Figure 3-5***) had very low flows proportional to the mainstem flows, and their cold water benefits were offset by the large flows associated with the largest tributaries. Large tributary temperatures were often similar to those of the Columbia River mainstem at their confluences. Table 3-8 presents the tributaries relative flow and temperature contributions to the mainstem.

Table 3-8 Tributary temperatures relative to mainstem Columbia River temperatures at their confluences from June – September. Negative differences indicate tributary temperatures are colder than the mainstem, positive differences indicate temperatures are warmer than the mainstem.

	Proportion of Total Tributary Flow	Tributary Temperature Difference (°C)
June		
Flow Weighted Average of all Tributaries (N=202)	**100.0%**	**1.2**
Snake River (N=1)	52.6%	2.8
Willamette River (N=1)	8.6%	0.4
Deschutes River (N=1)	4.9%	0.9
Cowlitz River (N=1)	4.7%	-0.9
Okanogan River (N=1)	4.4%	-1.1
Flow Weighted Average of other 197 Tributaries	24.8%	-1.0
July		
Flow Weighted Average of all Tributaries (N=202)	**100.0%**	**1.0**
Snake River (N=1)	47.0%	1.7
Willamette River (N=1)	9.7%	1.3
Deschutes River (N=1)	6.5%	-1.4
Cowlitz River (N=1)	4.7%	0.5
Okanogan River (N=1)	4.7%	0.7
Flow Weighted Average of other 197 Tributaries	27.4%	0.4
August		
Flow Weighted Average of all Tributaries (N=202)	**100.0%**	**-0.3**
Snake River (N=1)	44.7%	0.9
Willamette River (N=1)	14.8%	0.9
Deschutes River (N=1)	7.7%	-2.3
Cowlitz River (N=1)	6.2%	-4.9
Okanogan River (N=1)	3.2%	2.0
Flow Weighted Average of other 197 Tributaries	23.4%	-1.9
September		
Flow Weighted Average of all Tributaries (N=202)	**100.0%**	**-1.6**
Snake River (N=1)	44.2%	-0.4
Willamette River (N=1)	18.8%	-0.2
Deschutes River (N=1)	7.4%	-4.1
Cowlitz River (N=1)	6.2%	-5.4
Okanogan River (N=1)	4.0%	-3.6
Flow Weighted Average of other 197 Tributaries	19.5%	-3.2

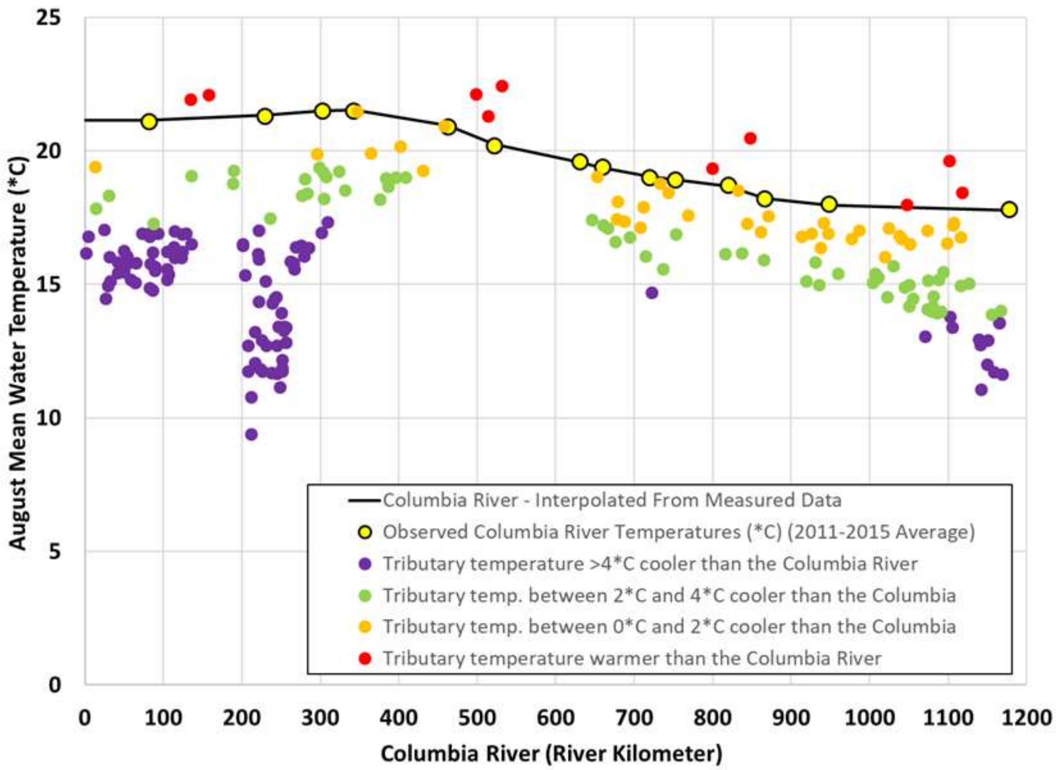

Figure 3-5 Columbia River and tributary monthly mean temperatures – August

As discussed further in Section 6.5.5, EPA used data for 23 major tributaries to the Columbia and lower Snake Rivers to develop this TMDL. ***Table 3-9*** summarizes the estimated current temperatures for these tributaries for 2011-2016. These temperatures are calculated from measured temperatures, with measurement gaps filled using interpolation and/or substitution of long-term average temperatures (EPA 2019a).

Table 3-9 Estimated mean monthly temperature in 23 major tributaries

Tributary Name	Confluence Location (RM)	Estimated Mean Temperature (2011 2016) (°C)			
		July	August	September	October
Columbia River					
Kettle	706	19.0	20.5	16.0	9.8
Colville	700	19.5	19.8	15.2	9.9
Spokane	639	20.4	19.6	17.5	12.1
Okanogan	534	20.7	21.9	17.4	11.1
Methow	524	16.0	17.0	14.6	9.3
Chelan	503	19.9	21.6	18.7	13.7
Entiat	484	14.2	16.5	13.6	7.9
Wenatachee	468	16.5	19.0	15.7	10.2
Crab Creek	411	22.7	21.1	17.8	12.0
Yakima	335	21.1	21.2	17.9	12.5
Walla Walla	315	23.1	20.8	17.0	12.1
Umatilla	289	19.9	20.1	17.0	13.0
John Day	218	24.3	22.9	19.1	12.4
Deschutes	204	19.1	18.5	15.9	12.9
Klickitat	180	16.0	16.8	13.0	8.3
Hood	169	19.1	18.5	15.9	12.9
Sandy	121	19.1	18.5	15.9	12.9
Willamette	102	22.0	22.7	19.1	14.2
Lewis	87	11.4	12.5	12.9	14.3
Kalama	73	19.1	18.5	15.9	12.9
Cowlitz	69	15.7	15.9	13.9	11.1
Snake River					
Tucannon	62	21.2	20.2	16.4	11.6
Palouse	60	23.7	22.0	16.9	11.3

4.0 SOURCE ASSESSMENT

Stream temperature is influenced by natural factors such as climate, geomorphology, hydrology, and vegetation. In this TMDL, EPA considered the temperature impacts from the following source categories: (1) point sources discharges subject to NPDES permits, including municipal, industrial,[7] and stormwater dischargers; (2) nonpoint source heat loading from dams and reservoirs that increase or decrease water temperatures within their reservoirs and in downstream river reaches;[8] (3) tributaries to the mainstems of the Columbia and lower Snake Rivers, which are affected by upstream point and nonpoint sources; (4) increasing air temperatures and other factors associated with climate change; and (5) elevated water temperatures in the Columbia and lower Snake Rivers where they enter into Washington from Canada and Idaho, respectively.

The thermal regime of a river is continually changing over space and time in response to the natural factors and human sources listed above. To identify source impacts, EPA distinguishes the effect of human sources from the effects of natural variation in the system using mathematical models. Mathematical models, such as the RBM10 model of the Columbia and lower Snake Rivers, are commonly used by EPA and state agencies in TMDL analyses. By tracking the time-varying factors influencing river temperatures, the RBM10 model estimates the thermal loading capacity and source impacts across time and space. EPA extensively evaluated and tested the RBM10 temperature model, ensuring that the model is capable of performing this source assessment. The model development report is provided in Appendix C.

The TMDL source assessment methodology for this TMDL presented unique technical features and challenges. With the TMDL study area spanning almost 900 river miles, the scale of modeling and analysis of the mainstem Columbia and lower Snake Rivers is the largest in any Pacific Northwest TMDL. The assessment addresses the cumulative impacts from NPDES permitted point sources (see Section 6.5.2); 23 major tributaries; and 15 hydroelectric dams (see ***Table 6-4***) and incorporates the impact of cold water releases from Dworshak Dam via the Clearwater River to the Snake River. The full modeling source assessment is provided in Appendix D.

A growing body of research has produced and is continuing to produce evidence that changes to regional climate are contributing to an increase in instream temperatures in the Columbia and Snake Rivers. In addition to the RBM10 modeling assessment, EPA reviewed and synthesized available information and data on climate and projected future trends (Appendix G).

4.1 WATER QUALITY MODELING FRAMEWORK

Temperatures in streams naturally fluctuate over the day and year in response to changes in solar energy, air temperature, wind, river flows, groundwater flows, and other factors. This

[7]Industrial discharge facilities are facilities discharging process water, cooling water, and other contaminated waters from industrial or commercial activities.

[8]Although temperature TMDLs typically identify loss of riparian shade as a nonpoint source of heat, they are not a source on the mainstem Columbia and Snake rivers. The width of these large rivers results in the surfaces of the rivers being directly exposed to full solar radiation during daylight hours. The presence or absence of trees on the banks does not create any measurable instream temperature effects. In contrast, shade restoration in tributary watersheds can improve tributary temperatures.

natural variability in river temperatures is an important factor in the water quality status of a waterbody.

In order to support TMDL development, EPA used the RBM10 water quality model to replicate and predict the temperature fluctuations in the Columbia and lower Snake Rivers. RBM10 is a one-dimensional mathematical temperature model that simulates the thermal energy budget of the mainstem Columbia and lower Snake Rivers. Appendix C provides detailed documentation for RBM10.

The version of RBM10 used for this TMDL is an updated version of the model code and database that has been used to estimate conditions in the Columbia and Snake rivers since 2001 (Yearsley et al. 2001). A model update report (EPA 2019a) that documents all aspects of the updated version of the model is included as Appendix C, which includes a description of the model update process, model structure and limitations, data inputs, model calibration, and evaluation of model performance. A summary of the information in Appendix C is presented below.

Spatial Representation

RBM10 simulates the daily heat budget and resulting instream temperature of the Columbia River from the Canadian border (Columbia RM 745.0) to the mouth at Astoria, Oregon; the Snake River from Anatone, Washington (Snake RM 168) to its confluence with the Columbia River near Pasco, Washington; and the Clearwater River from Orofino, Idaho (Clearwater RM 44.6) to its confluence with the Snake River near Lewiston, Idaho (Snake RM 139.3). The Clearwater River is included in the model domain to represent the cold water releases from Dworshak Dam, which have a cooling effect on the Snake River. All other major tributaries are represented as model boundary inputs, represented by their flow and temperature at their confluences with the mainstem Columbia and lower Snake Rivers (i.e., the tributaries listed in ***Table 3-9***).

Temporal Resolution

RBM10 simulates daily average temperatures in the Columbia and Snake Rivers from 1970 through 2016. The simulation period was constrained by the timeframe of the completion of the hydroelectric system and the availability of publicly available data necessary to set up and run the model. The full simulation period is used for long term trend analysis, and the period 2011—2016 is used to represent current conditions for the TMDL.

The use of daily average temperature simulations for the TMDL presents a challenge when comparing daily average modeling results to the water quality temperature criteria, which are expressed as daily maximum or 7-DADM values. Because the daily average time step does not capture the peak daily temperature, EPA could not compare the model results directly to criteria values. As discussed further in Section 6.5.1, however, EPA relied on the model only for source assessment, where the focus of the methodology was changes in temperature rather than the baseline temperature. Moreover, EPA used actual temperature measurements obtained from the DART site (not modeling estimates) to confirm the States' impairment determinations and to develop the TMDL, and then to calculate the temperature reductions needed to meet the relevant criterion. The use of one-dimensional, daily average simulations carries benefits as well. The modeling approach allows for an efficient, long-term simulation (over a 47-year period) that captures the overall range of variation and long-term trends

4.2 MODEL SCENARIOS AND RESULTS

EPA's conceptual approach for assessing source impacts begins by using the calibrated model results (current conditions) as the baseline for source scenario comparisons. The individual model inputs are then modified in a prescribed manner to investigate impacts of sources, leaving all other inputs of the model unchanged. The model is run with the modified inputs (e.g., a source or set of sources is removed or altered), and results from the model scenario runs are compared to the modeled baseline condition. Any changes in the simulated temperature output are the result of the change made to the model inputs for the scenario run.

EPA estimated the temperature impacts of dams by altering (in the model) the river geometry within the TMDL study area to reflect the free-flowing river conditions that could occur in the absence of the existing dams. EPA's evaluation does not consider or reflect free-flowing conditions upstream of the TMDL study area boundaries in Canada or Idaho.

The modeling scenarios and subsequent RBM10 assessment estimated the impacts of dams, Dworshak Dam cold water releases, tributaries, boundary conditions, NPDES point sources (including a reserve allocation, as discussed in Section 6.5.4), and the Banks Lake pump storage project. A summary of the modeling results is presented in ***Table 4-1*** and detailed results are provided in the model scenario report (Appendix D).

Table 4-1 Estimated range of current source impacts on Columbia and lower Snake River mainstems from July to October across RBM10 model domain

River	Point Sources (Δ C)	Tributaries (Δ C)	Dworshak Dam Cooling (Δ C)	Dams (Δ C)	Climate Change (Δ C)
Columbia River	0.0 – 0.1	0.0 – 0.1	(-0.2) – 0.0	(-0.9) – 4.5	1.0 – 2.0
Snake River	0.0 – 0.1	0.0 – 0.1	(-3.8) – 0.0	0.3 – 3.2	1.0 – 2.0

4.3 EFFECTS OF CHANGES IN CLIMATE

EPA conducted a technical review of available research on the impacts of regional climate change, particularly increasing air temperatures, on Columbia and lower Snake River temperatures, with data and information dating back to 1960 (Appendix G). EPA synthesized available information on river warming that is estimated to have occurred to date, as well as warming that is projected to occur in the future. Because this TMDL evaluates current sources of heat, the estimated current impacts to the rivers (i.e., river warming to-date) are most relevant to this TMDL source assessment.

Based on EPA's technical review (Appendix G), predicted trends in river temperatures since a baseline of 1960 vary between sites, as shown by the analysis of historical data, and there is considerable variation at the sites themselves (which is expected given the influence of the El Niño – Southern Oscillation and the Pacific-North American pattern). Amid this variation there is evidence of a warming trend in Pacific Northwest waters and in the Columbia River mainstem since 1960, as indicated by literature and the analyses conducted by EPA (Appendix G). Based on available information, the estimated increase in river temperatures since 1960 ranges from 0.2°C to 0.4°C per decade, for a total water temperature increase to date of 1.5°C ± 0.5°C.

4.4 ACCOUNTING FOR UNCERTAINTY

Uncertainty is inherent for both model-based and measurement-based assessments. Models and measurements (data) are complementary information sources used to assess the condition of the environment. Models are often developed and used to address gaps and limitations in our measurement systems because measurement at every location at every time across a large-scale watershed is infeasible. At the same time, measurement data are critical inputs for model development, and gaps and/or imprecision in data affect the accuracy of a model.

EPA relies on the RBM10 model (Appendix D) and the climate change assessment (Appendix G) as the best available estimates of the temperature changes in the Columbia and lower Snake Rivers. The analysis is limited and influenced by the following sources of uncertainty:

- Measurement gaps and errors: Monitoring is not seamless, and gaps must be filled. Quality assurance checks cannot identify all measurement and recording errors.
- Model uncertainty: Models are simplifications of the natural system, and predictions do not perfectly match field observations and monitoring data. The model report for RBM10 documents the simplifications and assumptions of the model, as well as the differences between simulated and measured temperatures.
- System variability: Assessments attempt to identify source impacts in a dynamic and variable environment. Methods and considerations are discussed in Section 6.2.
- Synthesis challenges: Climate change estimates are based on a synthesis of available information that may employ different kinds of observations, statistics, models, and assumptions.

As with any scientific endeavor, the results in this assessment may be reviewed and reevaluated over time as new information and analyses about this topic are produced by EPA and others.

5.0 COLD WATER REFUGE

The Oregon WQS include a narrative cold water refuge (CWR) criterion for the lower Columbia River that supplements the numeric criteria by providing additional protection for migrating salmon and steelhead in the lower Columbia River. The CWR criterion stipulates that the lower Columbia River "must have cold water refugia that are sufficiently distributed so as to allow salmon and steelhead migration without significant adverse effects from higher water temperatures elsewhere in the water body" (OAR 340-041-0028(4)(d)).

EPA cooperated with the States of Oregon and Washington, National Oceanic and Atmospheric Administration (NOAA) Fisheries, Tribal governments, local watershed groups, and other experts and stakeholders to identify and assess the sufficiency of cold water refuges in the lower Columbia River, from the mouth to its confluence with the Snake River at river mile 325. EPA has developed a draft *Columbia River Cold Water Refuges Plan* (EPA 2019b). The draft is currently under review, but its preliminary findings provide a framework for the discussion of CWR in this TMDL.

Approximately two to three million adult salmon and steelhead currently return from the ocean and migrate up the Columbia River system each year. To minimize exposure to warm temperatures in the Columbia River, salmon and steelhead temporarily transit into CWRs during migration. In the lower Columbia River, CWRs occur primarily where cooler tributary rivers flow into the Columbia River.

The University of Idaho found that migrating steelhead begin to use CWRs when the Columbia River temperature reaches 19°C (USACE 2013, Keefer). One individual steelhead tagged by University of Idaho researchers remained in a CWR for approximately three weeks. When temperatures are 20°C or higher, approximately 60 - 80% of the steelhead use CWRs. Fall Chinook start to occupy CWRs at slightly warmer temperatures (20 - 21°C) and about 40% use cold water refuges when temperatures reach 21 - 22°C (Goniea et al. 2006).

As described in EPA's draft *Cold Water Refuge Plan* (EPA 2019b), EPA identified 12 tributaries as primary CWR areas based on CWR volume, stream temperatures, and documented or presumed use by salmon and steelhead. The 12 primary CWRs are identified in ***Table 5-1*** and illustrated in ***Figure 5-1***. EPA calculated that these 12 CWRs constitute 97% of available CWR in the lower Columbia River. In ***Figure 5-1***, primary CWR tributaries that are >4°C cooler than the Columbia are highlighted in purple, and two primary CWR tributaries with temperatures 2-4°C cooler than the Columbia are highlighted in green. The availability of these CWRs contribute to attainment of the designated uses, particularly for adult migration,

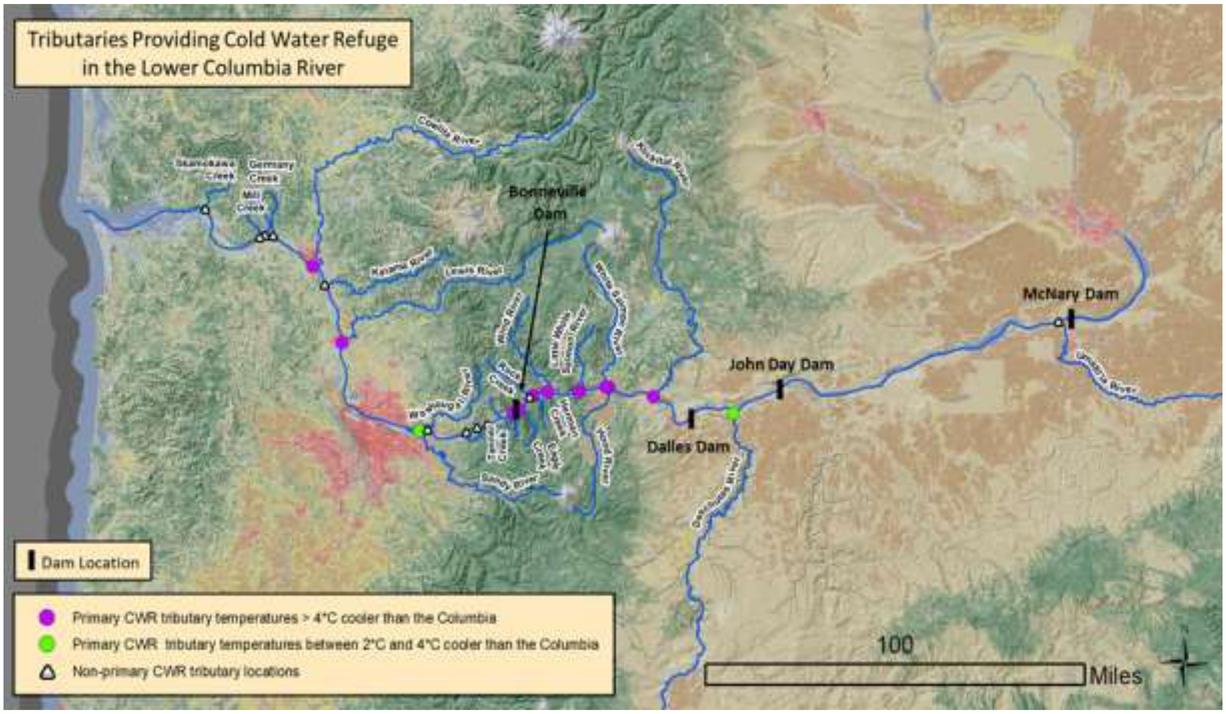

Figure 5-1 Tributaries providing cold water refuge

Table 5-1 Twelve primary cold water refuges

Tributary Name	RM	August Mean Mainstem Temperature (DART)	August Mean Tributary Temperature (NorWeST)	August Mean Temperature Difference	Plume CWR Volume (> 2°C Δ)	Stream CWR Volume (> 2°C Δ)	Total CWR Volume (> 2°C Δ)
		°C	°C	°C	m^3	m^3	m^3
Cowlitz River, WA	65.2	21.3	16.0	-5.4	870,000	684,230	1,554,230
Lewis River, WA	84.4	21.3	16.6	-4.8	120,000	493,455	613,455
Sandy River, OR	117.1	21.3	18.8	-2.5	9,900	22,015	31,915
Tanner Creek, OR	140.9	21.3	11.7	-9.6	1,300	413	1,713
Eagle Creek, OR	142.7	21.2	15.1	-6.1	2,100	888	2,988
Herman Creek, OR	147.5	21.2	12.0	-9.2	168,000	1,698	169,698
Wind River, WA	151.1	21.2	14.5	-6.7	60,800	44,420	105,220
Little White Salmon River, WA	158.7	21.2	13.3	-7.9	1,097,000	4,126	1,101,126
White Salmon River, WA	164.9	21.2	15.7	-5.5	72,000	81,529	153,529
Hood River, OR	165.7	21.4	15.5	-5.9	28,000	0	28,000
Klickitat River, WA	176.8	21.4	16.4	-5.0	73,000	149,029	222,029
Deschutes River, OR	200.8	21.4	19.2	-2.2	300,000	580,124	880,124

6.0 TOTAL MAXIMUM DAILY LOAD ANALYSIS

6.1 TEMPERATURE TARGETS

6.1.1 Target Sites

In this TMDL, EPA assesses and allocates heat loads to almost 900 river miles of study area. As part of this relatively large, basin-scale assessment, EPA selected a reasonable number of target sites that span the study area. Target sites are locations in the river where EPA quantified river temperatures and source impacts based on both measured and simulated temperature data.

All of the TMDL's target sites are at the tailraces of dams. The water temperature monitoring system for the Columbia and Snake rivers has been conducted for several decades by the operators of federal and PUD dams, using monitoring stations located at each dam site. The temperatures are monitored in the forebay (upstream) and tailrace (downstream) of each dam. Because the rivers are relatively well-mixed at the tailraces, these data provide a better estimate of the cross-sectional average river temperature than the forebay, where flow is less will-mixed. Selection of the tailrace as the target location also aligns with EPA's application of the one-dimensional RBM10 model, which assumes complete mixing within the water column and simulates the cross-sectional average temperature of the rivers. The model is also calibrated to the measured tailrace temperature.

To address specific source impacts, EPA has also used model estimates at sites that are not monitored target sites. For example, the source assessment modeling includes simulation results for RM 42. This location is downstream of the Bonneville target site in the vicinity of large point source discharges and is the location of modeled maximum point source impacts. Water quality data are not available at RM 42, but EPA used the model to estimate the cumulative impacts of upstream heat loads (from point sources and tributaries) at this location. EPA also considered model temperature estimates above and below the lower Snake River confluence on the Columbia River. EPA included these sites (labeled Hanford Reach and Snake Confluence) in the dam impact assessment to evaluate the extent to which the lower Snake River dams are contributing to downstream warming of the mainstem Columbia River.

EPA recognizes that there are limitations to any set of temperature data used to characterize an assessment area of this size, including the use of data from fifteen target site locations in a TMDL area that spans nearly 900 river miles. The limitations and advantages in the temperature data analysis are outlined above and in Appendix B.

6.1.2 Target Temperatures

At each target site, EPA used the most stringent water quality criteria identified in Section 2.0 to develop target temperatures. Sections 2.1 and 2.2 explain EPA's reasons for applying the additional 0.3°C above criteria temperatures for Washington and Oregon. The additional 0.3°C increment, when combined with other criteria, establish the maximum allowable temperature allowed by the Washington and Oregon water quality standards. The criteria + 0.3°C are therefore the temperature targets for the TMDL, and future monitoring programs should compare temperature data to these target temperatures to determine whether target criteria are attained. The numeric criteria and TMDL target temperatures at each target site are included in ***Table 6-1***. As described in detail in Appendix D, EPA compared these target temperatures to water quality data at each target site to determine the level of temperature above the target occurring at each site.

Although the criteria averaging-periods vary (e.g. 7-DADM, DM), EPA evaluated the targets in ***Table 6-1*** as daily maxima. As explained in Appendix H, analysis of the differences between 7-DADM and DM values indicates minor differences in the impact of using either metric. At two locations in the Columbia River — Grand Coulee Dam and Priest Rapids Dam — the applicable Washington temperature criteria changes at the dam. At both of these locations, the TMDL uses the more stringent criteria as the target temperature (***Table 6-1***) in order to protect uses and to target attainment of criteria in the reservoirs upstream of these dams.

Table 6-1 TMDL target temperatures

Location (Tailrace)	RM	Water Quality Criterion (C) (See Table 2 2)	TMDL Target Temperature (°C) (July Sept.)	TMDL Target Temperature (°C) (October)
Columbia River				
Grand Coulee	591	16.0 7-DADM /17.5 7-DADM	16.3 DM	16.3 DM
Chief Joseph	544	17.5 7-DADM	17.8 DM	17.8 DM
Wells	512	17.5 7-DADM	17.8 DM	17.8 DM
Rocky Reach	472	17.5 7-DADM	17.8 DM	17.8 DM
Rock Island	453	17.5 7-DADM	17.8 DM	17.8 DM
Wanapum	413	17.5 7-DADM	17.8 DM	17.8 DM
Priest Rapids	396	17.5 DADM / 20.0 DM	17.8 DM	17.8 DM
McNary	291	20.0 DM	20.3 DM	20.3 DM
John Day	215	20.0 DM	20.3 DM	20.3 DM
Dalles	189	20.0 DM	20.3 DM	20.3 DM
Bonneville	140	20.0 DM (July-Sept) 13.0 7-DADM (Oct)	20.3 DM	13.3 DM[9]
Snake River				
Lower Granite	107	20.0 DM	20.3 DM	20.3 DM
Little Goose	70	20.0 DM	20.3 DM	20.3 DM
Lower Monumental	40	20.0 DM	20.3 DM	20.3 DM
Ice Harbor	6	20.0 DM	20.3 DM	20.3 DM

EPA used available hourly data to calculate the mean of the measured maximum monthly temperature at each target site for July – October over a six-year period (2011-2016). EPA used the maximum monthly temperatures to estimate the magnitude of temperature exceedances that occur at each target site during the critical time periods for the TMDL. The exceedance values in ***Table 6-2*** are estimates, based on available data, of the extent to which the mean maximum monthly temperatures are predicted to exceed the target temperatures at most

[9] Oregon's 20°C is the applicable WQC until October 15, when the 13°C WQC takes effect.

locations throughout the summer and fall, including the upstream borders of the TMDL study area (at the Canadian Border and at Anatone, at the Idaho border).

Table 6-2 Summary of maximum monthly temperature and target temperature exceedance

Location	Target (°C)	Mean of Measured Maximum Monthly Temperature for 2011 2016 (°C)				Exceedance (°C)			
	Year Round	July	August	Sept	Oct	July	August	Sept	Oct
Columbia River									
Canadian Border	16.3	18.3	19.5	18.5	15.4	2.0	3.2	2.2	0
Grand Coulee	16.3	17.7	19.2	19.3	18.3	1.4	2.9	3.0	2.0
Chief Joseph	17.8	17.7	19.1	19.0	18.1	0.0	1.3	1.2	0.3
Wells	17.8	18.3	19.5	19.7	18.0	0.5	1.7	1.9	0.2
Rocky Reach	17.8	18.5	20.1	19.6	18.1	0.7	2.3	1.8	0.3
Rock Island	17.8	19.1	20.6	20.4	18.4	1.3	2.8	2.6	0.6
Wanapum	17.8	19.0	20.1	19.8	17.9	1.2	2.3	2.0	0.1
Priest Rapids	17.8	18.7	20.1	20.1	18.2	0.9	2.3	2.3	0.4
McNary	20.3	20.7	21.7	21.3	18.2	0.4	1.4	1.0	0
John Day	20.3	21.2	22.4	21.6	18.7	0.9	2.1	1.3	0
Dalles	20.3	21.2	22.4	21.4	18.7	0.9	2.1	1.1	0
Bonneville	20.3 / 13.3[10]	21.4	22.5	21.5	18.5	1.1	2.2	1.2	5.2
Snake River									
Anatone	20.3	23.6	23.9	22.3	18.5	3.3	3.6	2.0	0
Lower Granite	20.3	20.1	20.1	19.2	18.4	0.0	0.0	0.0	0
Little Goose	20.3	20.7	21.0	20.2	18.4	0.4	0.7	0.0	0
Lower Mon	20.3	21.0	21.2	20.5	17.9	0.7	0.9	0.2	0
Ice Harbor	20.3	21.8	22.1	21.3	18.4	1.5	1.8	1.0	0

[10] Targets are July – September (20.3°C) and October (13.3°C).

6.2 SEASONAL VARIATION AND CRITICAL CONDITIONS

The critical time periods for this TMDL are July – October for all locations. Available data indicate that temperature criteria exceedances occur during this time period. Seasonal variability is illustrated in ***Figure 3-2*** and ***Figure 3-3***. EPA used RBM10 to incorporate seasonal variation of river temperature into the TMDL evaluation.

EPA's recognition of system variability and inherent model uncertainty (discussed further in Section 4.4) influences how the TMDL is developed and, in turn, how model scenarios are run and outputs are processed to provide information for the TMDL. EPA's goal is to capture central tendencies in the multi-year simulations (e.g., long-term mean conditions) while also considering seasonal variation and critical conditions, in accordance with regulations at 40 CFR 130.7(c)(1). In addition, conservative assumptions are needed to ensure that impacts are not underestimated and to account for uncertainties in the data (see MOS discussion in Section 6.6). Some of the assumptions include:

- Timeframes and magnitudes of impairment are estimated using measured data (DART site) to ensure that times/locations of impairment are fully identified and to provide a uniform analysis. As discussed in Section 6.1, EPA used DM statistics at all locations, even where criteria are expressed as 7-DADM. For each month, the mean of the monthly maxima recorded for the 2011 – 2016 period is used to estimate the exceedance level.
- Model simulations are represented by the aggregated results for 2011 – 2016 to provide robust estimates of temperature conditions.
- Model results are aggregated by month (approximately 30-day periods) to address seasonal variation and provide robust estimates that are not influenced by outlier days/weeks.
- The impacts of point sources are conservatively evaluated at the 90th percentile level.
- Dam impacts are evaluated using daily average temperatures in order to conservatively estimate the impact of these sources.

To ensure that critical temperature locations are identified, model outputs are processed at all dam tailrace sites, major tributary confluences, and at RM42 on the Columbia River, which is located at or downstream of numerous major point source discharges (see

- ***Table 6-12***).
- In order to conservatively estimate critical summer conditions where seasonal low flows result in warmer temperatures, EPA assumed that historical levels of agricultural withdrawals (2011-2016) would continue.

6.3 LOADING CAPACITY

EPA defined the loading capacity as the greatest amount of loading that a waterbody can receive without violating water quality standards (40 CFR 130.2(f)). The regulations governing TMDL development provide for the expression of TMDLs as "either mass per time, toxicity, or other appropriate measure" (40 CFR 130.2(h)). The water quality standards at issue are numeric and narrative temperature criteria. Given the characteristics of the temperature sources in the Columbia and lower Snake Rivers, as discussed below, the loading capacity for this TMDL is most logically and appropriately expressed as a temperature in degrees Celsius (°C).

According to Oregon WQS, when the receiving waters are not attaining standards, the available increase in loading capacity for human-caused sources in the Columbia River is 0.3°C above the criterion. Washington WQS have an analogous 0.3°C allowance, resulting in an available increase in loading capacity for anthropogenic sources of 0.3°C above the criteria at the 15 target sites, and at the Canadian and Idaho borders (see ***Table 6-1***, "TMDL Target"). At the Grand Coulee and Priest Rapids target sites, the criteria differ above and below the target sites. At these locations, the more stringent criterion is used to establish a loading capacity that protects the uses below each target site and in the waters immediately upstream of each target site.

The loading capacities at the TMDL target sites, along with the reductions that would be needed to achieve them, are illustrated in Figure 6-1 through Figure 6-4 for July, August, September, and October. Each figure illustrates the criteria used, the States' allowable temperature increases (0.3°C), and the reduction that needs to be observed at each target site to meet the loading capacity. These figures illustrate the loading capacity increases that occur as the river moves downstream, due in part to changing criteria. The temperature reductions needed at each location to meet the loading capacity are illustrated by the upper, yellow-shaded portion of each bar graph based on the measured temperatures provided in ***Table 6-2***. The temperature reductions needed to achieve the criteria change through the summer (e.g., the most significant reductions are needed in August) and as the river moves downstream.

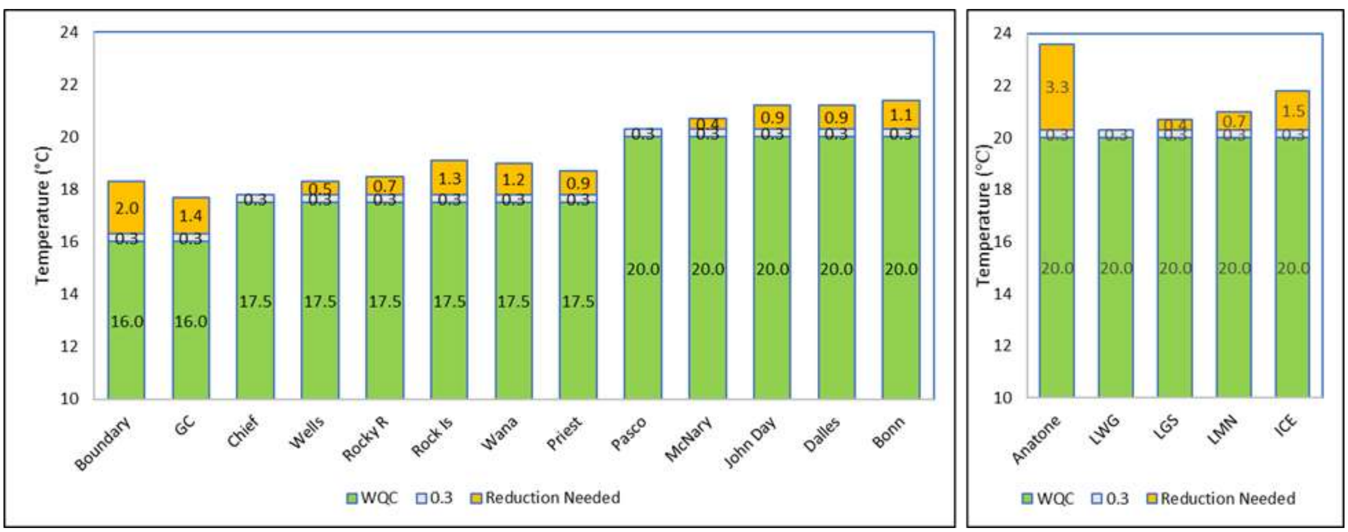

Figure 6-1 Comparing measured maximum monthly temperatures to the target temperatures – July

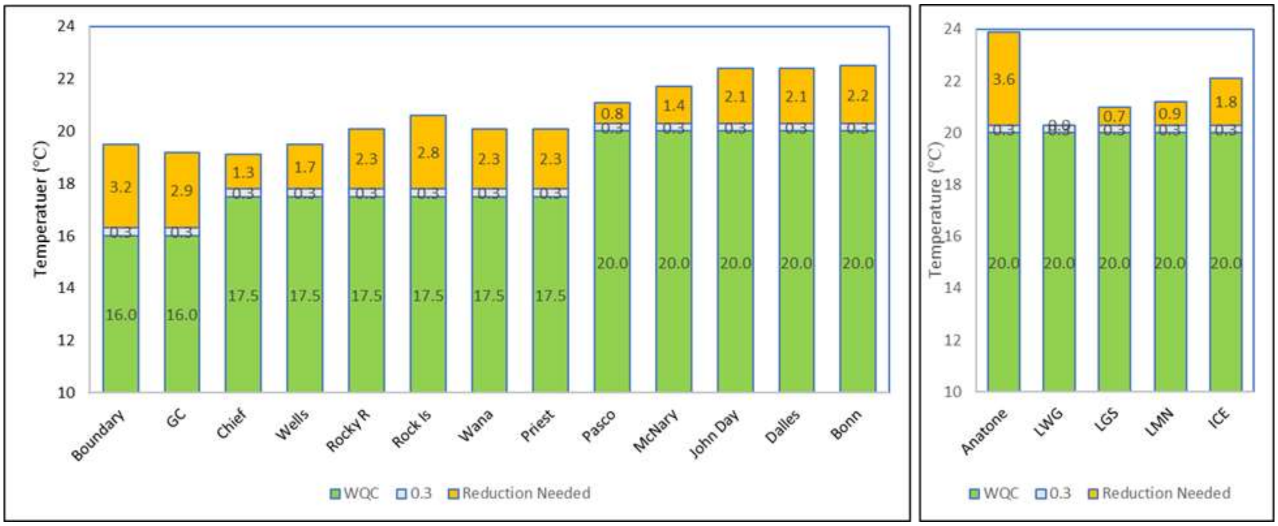

Figure 6-2 Comparing measured maximum monthly temperatures to the target temperatures – August

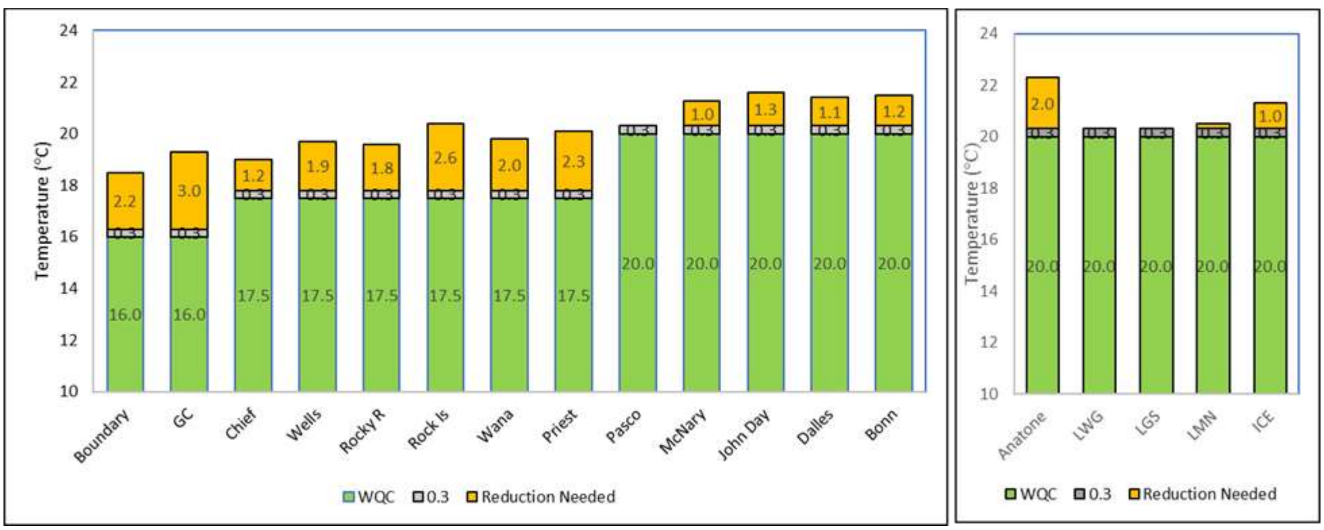

Figure 6-3 Comparing measured maximum monthly temperatures to the target temperatures – September

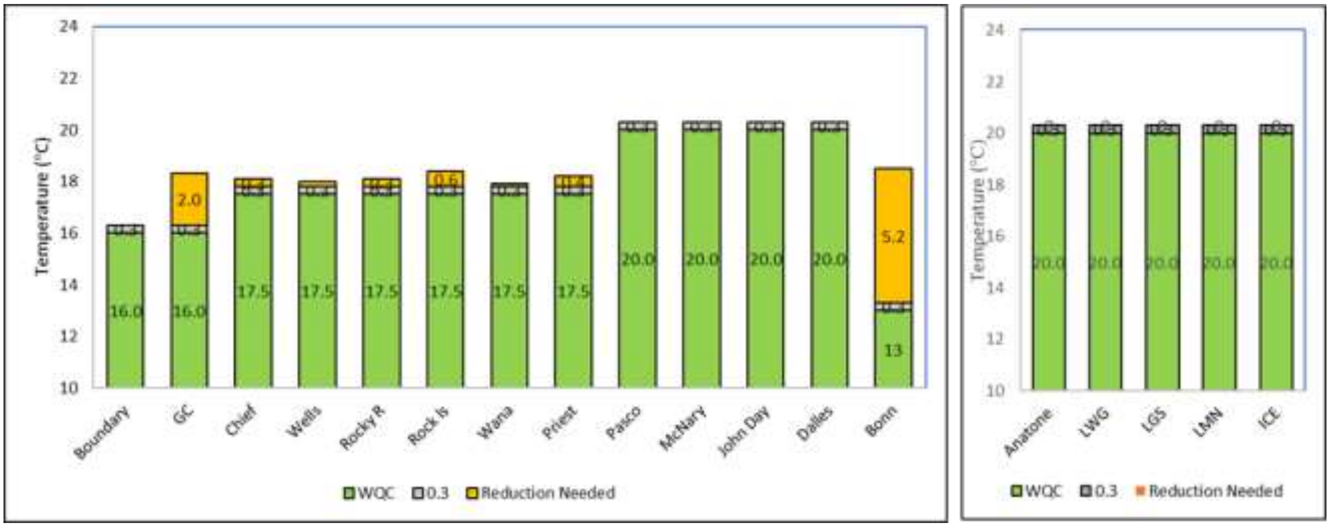

Figure 6-4 Comparing measured maximum monthly temperatures to the target temperatures – October

Temperature is the metric by which loading capacity and TMDL allocations are expressed. In addition, heat loads are provided across the observed range of river flows during the critical period of July – October. These heat loads are calculated as the product of temperature, river flow, and a conversion factor and are expressed in kilocalories per day (kcal/day). The calculated monthly heat loads at each target site are provided in Appendix I. Similarly, heat loads are also provided in Appendix I for the nonpoint source allocations. For individual point sources, wasteload allocations are expressed in the TMDL as heat loads, rather than temperature, because many facilities can manage effluent flow to reduce the impact of their discharge on the receiving water. In expressing the wasteload allocation as heat loads, point sources have the flexibility to manage temperature and/or effluent flow to achieve their wasteload allocations.

6.4 BOUNDARY CONDITIONS

As illustrated in ***Figure 6-1*** through ***Figure 6-3***, the water temperatures as the rivers cross the upstream boundaries of the TMDL study area (Canadian border and the Washington/Idaho border) exceed the Washington water quality criteria by a substantial margin from July through September. The current water quality conditions present a significant challenge to achieving downstream water quality standards in Washington and Oregon. Although EPA used the water quality model RBM10 to examine the potential impacts of colder water temperature inputs at the two boundaries (see Appendix D), this TMDL is established using the *existing* temperature data at both borders because there is inadequate information (e.g., data, water quality models) to evaluate potential future actions that may be taken near these locations and therefore inadequate information to estimate any resulting temperature changes that may occur in the future. A model simulation of source impacts based on an assumption of the achievement of the Washington criteria at the borders would show artificial increases in source impacts downstream of the border. Instead EPA has used an approach grounded in robust estimates of current conditions and impacts. If boundary conditions change substantially in the future, EPA or the States can reexamine the assumptions and resulting allocations of this TMDL.

6.5 ALLOCATIONS

As discussed in Section 6.3, the loading capacity, and therefore the portion available for allocation during the critical period (July – October), is defined by the numeric temperature criteria plus the 0.3°C human use allowance provided in the Washington and Oregon standards. EPA's allocation of heat to all point and nonpoint sources is limited to a cumulative increase of no greater than 0.3°C above the numeric temperature criteria. Climate change trends and heat sources in Canada and Idaho are not allocated a portion of the 0.3°C. Existing data and modeling suggest that these sources of heat cause exceedances of Washington's and Oregon's water quality standards. See Section 6.7 for a discussion of excess temperature.

In establishing this TMDL for the Columbia and lower Snake River mainstems, EPA is dividing the 0.3°C portion of the loading capacity equally among three types of sources: tributaries; current and future NPDES sources; and nonpoint source impacts from dam impoundments (***Table 6-3***).

Table 6-3 Aggregate allocation: allowable 0.3°C

	WLA and LA (°C)	Source Group		
		Dams (Nonpoint source) (°C)	NPDES Point Sources and Reserve (°C)	Major Tributaries (°C)
Aggregate Allocations	0.3	0.1	0.1	0.1

EPA's analysis of NPDES point sources discharging to the Columbia and lower Snake Rivers indicates that the cumulative loading of heat from these point sources is slightly less than 0.1°C. EPA chose to allocate 0.1°C to the point sources because this cumulative temperature impact is achievable by the point sources without imposing a disproportionate burden on other source categories.

A screening analysis using the RBM10 model and available information for tributaries indicates that a 0.1°C allocation is roughly equivalent to the cumulative temperature increase caused by existing riparian shade loss in the tributaries (see Section 3.6 and Appendices D and F). Shade loss is one of the potential source impacts in the tributaries; other sources may include point sources and nonpoint sources such as flow diversions and geomorphological changes. In establishing this 0.1°C allocation, the EPA has not distinguished between anthropogenic and natural heat loading sources in the tributaries. For those tributaries identified as impaired for temperature on the 303(d) list (see ***Table 6-20***), sources of anthropogenic heat will be identified by the States during TMDL development.

EPA's analysis of the cumulative nonpoint source heat loading from dam impoundments shows that the dam impoundments have a greater temperature impact than point sources and tributaries.

6.5.1 Dams

As discussed in Section 4.2 and Appendix D, dams can have a cooling effect or a warming effect on the river, depending on the season and the size of the reservoir. The 15 dams within the TMDL area (***Table 6-4***) have a cumulative warming effect during the summer and early fall. In this TMDL, heat contributed by impounding the river in reservoirs behind the dams is considered a nonpoint source of pollution (and given a load allocation), while discharges from cooling water structures, transformers, and sump pumps are considered point sources (and given wasteload allocations). Wasteload allocations are incorporated in NPDES permits during implementation, as discussed in Section 6.5.2.[11]

Table 6-4 Mainstem Columbia and lower Snake River dams

Name	RM	Operator	Type	Year(s) Completed[12]	Generating Capacity (megawatts)
Columbia River					
Grand Coulee Dam	596.6	Bureau of Reclamation	Storage	1973	6,494
Chief Joseph Dam	545.1	U.S. Army Corps of Engineers (USACE)	Run of River	1961/1973	2,069
Wells Dam	515.8	Douglas County Public Utility District (PUD) No. 1	Run of River	1967	774
Rocky Reach Dam	473.7	Chelan County PUD No. 1	Run of river	1961/1971	1,280
Rock Island Dam	453.4	Chelan County PUD No. 1	Run of River	1932/1953/ 1979	624
Wanapum Dam	415.8	Grant County PUD No. 2	Run of River	1964	1,038
Priest Rapids Dam	397.1	Grant County PUD No. 2	Run of River	1961	955
McNary Dam	292.0	USACE	Run of River	1957	980
John Day Dam	215.6	USACE	Run of River	1971	2,160
The Dalles Dam	191.5	USACE	Run of River	1960/1973	1,780
Bonneville Dam	146.1	USACE	Run of River	1938/1982	1,050
Snake River					
Lower Granite Dam	107.5	USACE	Run of River	1975/1978	810
Little Goose Dam	70.3	USACE	Run of River	1970/1978	810
Lower Monumental Dam	41.6	USACE	Run of River	1970/1978	810

[11] *National Wildlife Federation v. Consumers Power Company*, 862 F.2d 580 (6th Cir. 1988); *National Wildlife Federation v. Gorsuch*, 693 F.2d 156 (D.C. Cir. 1982).
[12] Multiple years indicate initial completion year and subsequent installation of additional hydroelectric turbine year(s).

As explained in Section 6.5, dam impoundments are allocated a cumulative temperature increase to the mainstem Columbia and lower Snake Rivers of 0.1°C, or one third of the 0.3°C allocation available for all sources.

EPA used the RBM10 temperature model to estimate the dams' impacts on river temperature by comparing daily average river temperatures with and without the presence of dams. The target temperatures are daily maxima. Since the diel variation is typically greater in a free-flowing river than when dams are present, the impact of the dams on the daily average temperature is greater than the impact on the daily maximum temperature. The daily average temperature is therefore a more conservative indicator of dam impact. This component of the analysis is considered as a margin of safety (Section 6.6).

EPA used a step-by-step process to estimate the contributions to impairment from dam impoundments. This analysis estimates the cumulative temperature impact in each reach caused by all upstream dam impoundments and estimates when and where this impact exceeds the 0.1°C cumulative dam load allocation. EPA used both RBM10 simulations and monitoring data from 2011 – 2016 for this analysis, starting at the upstream target sites on the Columbia and lower Snake Rivers, and moving downstream. The results of EPA's analyses are included in ***Table 6-6*** through ***Table 6-9***. These tables contain a month by month analysis of the temperature contributions of the dams to address seasonal variation in impacts.

Step 1. Use RBM10 to estimate the river temperature with and without dams for each month, at each of the target locations. See columns C (RBM Current) and column D (RBM free flowing) in ***Table 6-6*** through ***Table 6-9***.

Step 2. Identify the estimated temperature change in each reach. As an example: at the John Day tailrace in August (***Table 6-7***), the model predicts a temperature increase of (21.54 - 20.86 =) 0.68°C between the McNary dam tailrace and John Day under current conditions; and a temperature increase of (20.28 - 19.88 =) 0.40° under free flowing (no dams) conditions. The estimated temperature impact in the John Day reach is the difference between these two (0.68 - 0.40 = 0.3) and is identified as the "Reach Impact" (column E). In some months, a dam cools rather than warms the reach that it impounds.

Step 3. Estimate the cumulative temperature impact at each target site. The current temperature (column C) minus the estimated free flowing temperature (column D) equals the cumulative impact (column F).

Step 4. Using existing water quality data, assess whether the estimated cumulative impact of upstream dam(s) exceed the 0.1°C LA at that location. If Column G ("Measured Target Exceedance") is greater than 0.1, then the dams upstream of this location are cumulatively contributing to impairment and the analysis proceeds to Step 5. If no contribution to impairment is identified, the analysis moves to the next target site downstream.

Step 5. Identify the magnitude of the contribution to impairment. If the 0.1°C LA is exceeded, the contribution from dams is calculated one of two ways depending on the level of target exceedance and dam impact. If the measured target exceedance is greater than the cumulative dam impact, the contribution is calculated by subtracting the 0.1°C LA from the cumulative impact of the upstream dams (Column F). If the measured target exceedance is less than the cumulative dam impact, the contribution is calculated by subtracting the 0.1°C LA from the exceedance. The contribution is listed as the "Allocation Exceedance" (Column H).

When dams are estimated as contributing to an exceedance (through Steps 4 and 5 above), the cumulative contribution is identified in Column H ("Allocation Exceedance") of ***Table 6-6*** through ***Table 6-9***. In most cases, multiple upstream dams are contributing to downstream impairments. The dams contributing to downstream impairments are those dams in column E with a reach impact greater than zero.

The "notes" column (Column I) in each of these four tables contains codes that are explained in ***Table 6-5***.

Table 6-5 Explanation of "notes" (Column I) for excess dam impact in ***Table 6-6*** through ***Table 6-9***

Note	Explanation
1	Boundary location for model and/or TMDL. Provided for information only.
2	Load allocation exceedance, and the cumulative dam impact is lower than the target exceedance. The "load allocation exceedance" (Column H) is the source contribution to impairment, and equals the cumulative dam impact (Column F) minus LA (0.1).
3	Load allocation exceedance, and cumulative dam impact is higher than target exceedance. The "load allocation exceedance" (Column H) is source contribution to impairment and equals the measured target exceedance (Column G) minus LA (0.1).
4	The cumulative dam impact (Column F) is equal to the LA.
5	Not exceeding target temperature at target site or supplemental analysis location for dam assessment.
6	Dams do not have a cumulative warming impact at analysis location.
7	No measurements at the analysis location and/or time frame. Model results for lower Snake River show impact due to dams at confluence with Columbia.

Table 6-6 Cumulative excess dam impact on Columbia and lower Snake Rivers temperatures – July

Location	Dam Number	RBM10 Current (C)	RBM10 Free Flowing (C)	RBM10 Reach Impact (∆ C)	RBM10 Cumulative Impact (∆ C)	Measured Target Exceedance (∆ C)	Allocation Exceedance (∆ C)	Notes
A	B	C	D	E	F	G	H	I
Columbia River								
Canadian Border	NA	16.22	16.23	NA	NA	2.0	NA	1
Grand Coulee	1	15.92	16.77	-0.8	-0.8	1.4	None	6
Chief Joseph	2	16.06	16.84	0.1	-0.8	-0.1	None	6
Wells	3	16.43	17.17	0.0	-0.7	0.5	None	6
Rocky Reach	4	17.00	17.37	0.4	-0.4	0.7	None	6
Rock Island	5	17.09	17.41	0.0	-0.3	1.3	None	6
Wanapum	6	17.57	17.53	0.4	0.0	1.2	None	6
Priest Rapids	7	17.85	17.72	0.1	0.1	0.9	None	4
Hanford Reach	NA	18.48	18.31	0.0	0.2	-0.2	None	5
Snake Confluence	NA	18.81	18.50	0.1	0.3	NA	NA	7
McNary	8	19.23	18.73	0.2	0.5	0.4	0.3	3
John Day	9	19.64	19.11	0.0	0.5	0.9	0.4	2
Dalles	10	19.66	19.18	-0.1	0.5	0.9	0.4	2
Bonneville	11	19.68	19.30	-0.1	0.4	1.1	0.3	2
Snake River								
Anatone	NA	21.09	21.09	NA	NA	3.3	NA	1
Clearwater Confluence	NA	17.94	17.91	NA	NA	NA	NA	1
Lower Granite	12	18.73	18.24	0.5	0.5	-0.2	None	5
Little Goose	13	19.21	18.60	0.1	0.6	0.4	0.3	3
Lower Mon	14	19.39	18.84	-0.1	0.6	0.7	0.5	2
Ice Harbor	15	19.89	19.20	0.1	0.7	1.5	0.6	2

Table 6-7 Cumulative excess dam impact on Columbia and lower Snake Rivers temperatures – August

Location	Dam Number	RBM10 Current (C)	RBM10 Free Flowing (C)	RBM10 Reach Impact (Δ C)	RBM10 Cumulative Impact (Δ C)	Measured Target Exceedance (Δ C)	Allocation Exceedance (Δ C)	Notes
A	B	C	D	E	F	G	H	I
Columbia River								
Canadian Border	NA	17.77	17.78	NA	NA	3.2	NA	1
Grand Coulee	1	18.11	18.29	-0.2	-0.2	2.9	None	6
Chief Joseph	2	18.20	18.39	0.0	-0.2	1.3	None	6
Wells	3	18.45	18.66	0.0	-0.2	1.7	None	6
Rocky Reach	4	18.87	18.83	0.2	0.0	2.3	None	6
Rock Island	5	18.98	18.86	0.1	0.1	2.8	None	4
Wanapum	6	19.40	19.05	0.2	0.3	2.3	0.2	2
Priest Rapids	7	19.62	19.15	0.1	0.5	2.3	0.4	2
Hanford Reach	NA	20.02	19.64	-0.1	0.4	0.8	0.3	2
Snake Confluence	NA	20.36	19.69	0.3	0.7	NA	NA	7
McNary	8	20.86	19.87	0.3	1.0	1.4	0.9	2
John Day	9	21.54	20.29	0.3	1.3	2.1	1.2	2
Dalles	10	21.50	20.32	-0.1	1.2	2.1	1.1	2
Bonneville	11	21.57	20.51	-0.1	1.1	2.2	1.0	2
Snake River								
Anatone	NA	22.50	22.50	NA	NA	3.6	NA	1
Clearwater Confluence	NA	18.32	18.28	NA	NA	NA	NA	1
Lower Granite	12	19.47	18.64	0.8	0.8	0.0	None	5
Little Goose	13	20.24	19.05	0.4	1.2	0.7	0.6	3
Lower Mon	14	20.62	19.27	0.2	1.3	0.9	0.8	3
Ice Harbor	15	21.42	19.68	0.4	1.7	1.8	1.6	2

Table 6-8 Cumulative excess dam impact on Columbia and lower Snake Rivers temperatures – September

Location	Dam Number	RBM10 Current (C)	RBM10 Free Flowing (C)	RBM10 Reach Impact (Δ C)	RBM10 Cumulative Impact (Δ C)	Measured Target Exceedance (Δ C)	Allocation Exceedance (Δ C)	Notes
A	B	C	D	E	F	G	H	I
Columbia River								
Canadian Border	NA	16.38	16.38	NA	NA	2.2	NA	1
Grand Coulee	1	18.78	16.69	2.1	2.1	3.0	2.0	2
Chief Joseph	2	18.67	16.70	-0.1	2.0	1.2	1.1	3
Wells	3	18.58	16.85	-0.2	1.7	1.9	1.6	2
Rocky Reach	4	18.61	16.89	0.0	1.7	1.8	1.6	2
Rock Island	5	18.62	16.90	0.0	1.7	2.6	1.6	2
Wanapum	6	18.84	17.01	0.1	1.8	2.0	1.7	2
Priest Rapids	7	18.89	17.03	0.0	1.9	2.3	1.8	2
Hanford Reach	NA	18.76	17.26	-0.4	1.5	NA	NA	7
Snake Confluence	NA	19.06	17.34	0.2	1.7	NA	NA	7
McNary	8	19.47	17.44	0.3	2.0	1.0	0.9	3
John Day	9	20.31	17.78	0.5	2.5	1.3	1.2	3
Dalles	10	20.17	17.90	-0.3	2.3	1.1	1.0	3
Bonneville	11	20.26	18.09	-0.1	2.2	1.2	1.1	3
Snake River								
Anatone	NA	20.19	20.19	NA	NA	2.0	NA	1
Clearwater Confluence	NA	17.81	17.79	NA	NA	NA	NA	1
Lower Granite	12	18.14	17.81	0.3	0.3	-1.1	None	5
Little Goose	13	18.88	17.72	0.8	1.2	-0.1	None	5
Lower Mon	14	19.26	17.63	0.5	1.6	0.2	0.1	3
Ice Harbor	15	19.77	17.58	0.6	2.2	1.0	0.9	3

Table 6-9 Cumulative excess dam impact on Columbia and lower Snake Rivers temperatures – October

Location	Dam Number	RBM10 Current (C)	RBM10 Free Flowing (C)	RBM10 Reach Impact (Δ C)	RBM10 Cumulative Impact (Δ C)	Measured Target Exceedance (Δ C)	Allocation Exceedance (Δ C)	Notes
A	B	C	D	E	F	G	H	I
Columbia River								
Canadian Border	NA	13.01	13.01	NA	NA	0.0	None	1
Grand Coulee	1	17.22	12.78	4.4	4.4	2.0	1.9	3
Chief Joseph	2	17.19	12.72	0.0	4.5	0.9	0.8	3
Wells	3	16.78	12.76	-0.5	4.0	0.2	0.1	3
Rocky Reach	4	16.39	12.75	-0.4	3.6	0.3	0.2	3
Rock Island	5	16.20	12.69	-0.1	3.5	0.6	0.5	3
Wanapum	6	16.13	12.75	-0.1	3.4	0.1	None	4
Priest Rapids	7	15.99	12.72	-0.1	3.3	0.4	0.3	3
Hanford Reach	NA	15.39	12.71	-0.6	2.7	0.0	None	5
Snake Confluence	NA	15.61	12.80	0.1	2.8	0.0	NA	7
McNary	8	15.89	12.79	0.3	3.1	0.0	None	5
John Day	9	16.58	12.98	0.5	3.6	0.0	None	5
Dalles	10	16.41	13.16	-0.4	3.3	0.0	None	5
Bonneville	11	16.39	13.31	-0.2	3.1	5.2	3.0	2
Snake River								
Anatone	NA	14.93	14.93	NA	NA	0.0	NA	1
Clearwater Confluence	NA	13.85	13.84	NA	NA	NA	NA	1
Lower Granite	12	15.20	13.68	1.5	1.5	0.0	None	5
Little Goose	13	15.81	13.43	0.9	2.4	0.0	None	5
Lower Mon	14	16.02	13.19	0.4	2.8	0.0	None	5
Ice Harbor	15	16.21	12.98	0.4	3.2	0.0	None	5

6.5.2 NPDES Permitted Point Sources

The NPDES point sources discharging directly to the mainstems of Columbia and lower Snake Rivers are allocated a temperature increase of 0.1°C, or one third of the 0.3°C available allocation for all sources. EPA used RBM10, with data from 2011 – 2016, to estimate the impacts of current non-stormwater point source discharges at each target site. NPDES permitted stormwater discharges are discussed separately in Section 6.5.3.

Using RBM10, EPA estimates that the greatest cumulative temperature impact of these sources during the critical period, after full dilution with the receiving water, is 0.1°C if current sources continue discharging their existing heat loads, and if relatively small allowances are designated as reserve allocations (discussed in Section 6.5.4) throughout the TMDL area. Specifically, the cumulative impact of the point sources and the reserve allocations in the summer is a 90th percentile temperature increase of 0.1°C, and this impact occurs in September at River Mile 42 of the Columbia River. The maximum impact on the Snake River is a 90th percentile impact of 0.09°C and it occurs in September at Lower Monumental Dam. Model results in ***Table 6-10*** and ***Table 6-11*** show the mean and 90th percentile impacts at each location and time frame. October results are provided for the Columbia River (Bonneville location) where the fall spawning WQC is applicable.

Table 6-10 Estimated impacts of point source wasteload allocations and reserve allocations to the Columbia River (2011 – 2016)

		Estimated Increase in Temperature (C)							
		Mean				90th Percentile			
Location	**RM**	**July**	**Aug**	**Sept**	**Oct**	**July**	**Aug**	**Sept**	**Oct**
Grand Coulee	595	0.00	0.00	0.00	NA	0.01	0.00	0.01	NA
Chief Joseph	546	0.01	0.01	0.01	NA	0.02	0.01	0.02	NA
Wells	515	0.02	0.01	0.02	NA	0.03	0.02	0.04	NA
Rocky Reach	474	0.02	0.02	0.03	NA	0.03	0.03	0.04	NA
Rock Island	453	0.02	0.03	0.03	NA	0.04	0.04	0.06	NA
Wanapum	416	0.03	0.03	0.04	NA	0.04	0.04	0.06	NA
Priest R.	397	0.03	0.03	0.05	NA	0.04	0.04	0.06	NA
McNary	291	0.04	0.04	0.06	NA	0.05	0.05	0.07	NA
John Day	216	0.04	0.03	0.04	NA	0.04	0.04	0.05	NA
Dalles	192	0.04	0.03	0.04	NA	0.04	0.04	0.05	NA
Bonneville	146	0.04	0.03	0.04	0.06	0.04	0.04	0.05	0.07
RM 42	42	0.06	0.06	0.08	NA	0.07	0.07	0.10	NA

Table 6-11 Estimated impacts of point source wasteload allocations and reserve allocations to the Snake River (2011 – 2016)

		Estimated Increase in Temperature (C)					
		Mean			90th Percentile		
Location	**RM**	**July**	**Aug**	**Sept**	**July**	**Aug**	**Sept**
Lower Granite	107	0.03	0.05	0.06	0.05	0.06	0.08
Little Goose	70	0.04	0.05	0.06	0.05	0.06	0.08
Lower Mon	41	0.04	0.05	0.07	0.06	0.06	0.09
Ice Harbor	6	0.05	0.05	0.07	0.06	0.06	0.08

As noted in Section 6.3, wasteload allocations are expressed as heat loads (kcal/day) because many point source facilities can manage effluent flow to reduce the impact of their discharge on the receiving water. In expressing the wasteload allocation as heat loads, the TMDL gives point sources the flexibility to manage temperature and/or effluent flow to achieve their wasteload allocations. The individual WLAs used as inputs to the model and necessary to achieve the 0.1°C aggregate allocation are provided in

Table 6-12 through

Table 6-14. EPA used facility-specific design flow and maximum temperature data (or temperatures representative of the industry sector if effluent data were not available) to derive wasteload allocations for each facility.

Table 6-12 through

Table 6-14 are organized according to the NPDES program designation for major[13] and minor permits (EPA 1990). For discharges to the Columbia River, major facilities are listed in

Table 6-12 and minor facilities are listed in ***Table 6-13***. Discharges to the lower Snake River are listed in ***Table 6-14***. The agency responsible for issuing each NPDES permit is indicated by the permit number (e.g. “WA0020621” was issued by Washington), except for EPA-permitted facilities, which are identified by footnotes. These tables include point sources with existing NPDES permits as well as sources that have applied for and are expected to receive NPDES permits.

Table 6-15 identifies NPDES facilities in the study area that do not discharge heat load during the critical time period or for which there is inadequate information to determine whether the facilities contribute to the impairment. This list includes some facilities authorized to discharge into the TMDL study area under an industrial general permit. Examples of industrial general permits include Confined Animal Feeding Operations (CAFOs), in-stream placer mining, pesticide discharge, fruit packer, seafood processing, net pen aquaculture, and fish hatchery permits. The TMDL does not assign a WLA for these facilities because the type of industry, permit requirements, and/or available data indicate the temperature impacts from these sources are *de minimis*. In the future, if it is determined that these facilities are a heat load source, the permittees will work with the permitting authorities to determine if the reserve allocation or

[13] Major municipal dischargers include all facilities with design flows of greater than one million gallons per day and facilities with EPA/state approved industrial pretreatment programs. Major industrial facilities are determined based on specific ratings criteria developed by EPA or are classified as such by EPA in conjunction with the state (EPA 1996).

additional heat load within the reach is available. The WLA was calculated using the facility design flow and the highest known or estimated temperature of the facility effluent (see Equation 6-1 in Section 6.3). EPA has included the facility design flows in

Table 6-12 through ***Table 6-15*** to enable the NPDES permitting authorities to develop the NPDES permits limitations in a way that is consistent with the assumptions and requirements of the TMDL. [40 CFR 122.44(d)(1)(vii)(B)].

In calculating these WLAs, EPA used the best available data, but in some cases, temperature data from facilities were limited. The reserve allocation is available for situations where the WLAs are based on underestimated discharges, as discussed in Section 6.5.4.

The assumptions of the modeling assessment can be considered in determining how to translate the TMDL wasteload allocations into permit limits. In the model, a point source is input as a continuous heat load, and this is analogous to a source discharging continuously at its monthly average permit limit. Collectively, if all the sources discharge this load on average, the goal of the TMDL for point sources will be achieved.

Table 6-12 WLAs for “Major facility” NPDES permitted facilities on the Columbia River

Facility Name	Permit Number	Location (RM)	Flow (MGD)	Temp (C)	WLA (kcal/day)
Wenatchee	WA0023949	466.6	5.5	26.2	5.44E+08
E Wenatchee Sewage Treatment Plant (STP)	WA0020621	465.7	3.0	26.2	2.97E+08
Alcoa Wenatchee	WA0000680	455.2	5.5	25.6	5.31E+08
Columbia Generating Sta / Energy Northwest	WA0025151	351.8	9.4	35.9	1.27E+09
Richland STP	WA0020419	337.1	11.4	29.4	1.27E+09
Kennewick Wastewater Treatment Plant	WA0044784	328.0	12.2	27.0	1.24E+09
Pasco	WA0044962	327.6	10.8	27.3	1.11E+09
Agrium Hedges	WA0003699	323.3	0.03	17.2	1.95E+06
Agrium Kennewick	WA0003671	322.6	22.6	23.1	1.97E+09
Agrium Finley	WA0003727	321.5	14.0	27.2	1.44E+09
Packaging Corporation of America	WA0003697	316.0	28.2	37.1	3.95E+09
The Dalles STP	OR0020885	186.5	4.2	27.0	4.23E+08
Hydro Extrusion USA, LLC	OR0001708	186.0	6.0	34.0	7.70E+08
Hood River OR STP	OR0020788	165.0	2.0	25.7	1.94E+08
Georgia Pacific / GP Consumer Operations LLC	WA0000256	120.0	76.0	37.7	1.08E+10
Gresham OR Waste Water Treatment Plant (WWTP)	OR0026131	117.5	15.0	23.9	1.35E+09
Marine Park / Vancouver Marine Park Reclamation Facility	WA0024368	109.5	16.1	25.1	1.53E+09
Vancouver Westside STP	WA0024350	105.0	28.3	26.0	2.78E+09
Salmon Creek STP	WA0023639	103.2	17.0	23.3	1.50E+09
Portland STP OR	OR0026905	102.5	130.0	24.9	1.22E+10

Facility Name	Permit Number	Location (RM)	Flow (MGD)	Temp (C)	WLA (kcal/day)
Boise/St Helens OR STP	OR0020834	86.0	12.7	28.5	1.37E+09
Dyno Nobel Inc.	OR0001635	82.0	24.6	34.0	3.16E+09
Emerald Kalama Chemical	WA0000281	74.0	15.0	34.7	1.97E+09
Steelscape, Inc.	WA0040851	72.2	0.2	35.0	2.38E+07
Westrock Longview	WA0000078	67.4	57.0	38.4	8.28E+09
Three Rivers Regional	WA0037788	66.0	26.0	32.5	3.19E+09
Nippon Dynawave Packaging Corporation	WA0000124	64.0	79.6	45.0	1.35E+10
Millenium Bulk Terminals	WA0000086	63.0	6.6	28.9	7.25E+08
Port of St. Helens	OR0034231	53.0	3.3	32.0	3.99E+08
GP Wauna OR Mill	OR0000795	42.0	39.6	35.4	5.29E+09
Astoria OR STP	OR0027561	18.0	6.2	25.0	5.85E+08

There are no major NPDES facilities on the lower Snake River within the TMDL boundary. Three NPDES facilities, however, are located upstream of the TMDL boundary in Idaho. Loading assumptions for these facilities are included in the model scenarios for estimation of point source impact and allocation (0.1°C gross impact) to ensure that the boundary conditions account for these nearby sources (see Appendix D).

Table 6-13 WLAs for "Minor facility" NPDES permitted facilities located on the Columbia River

Facility Name	Permit Number	Location (RM)	Flow (MGD)	Temp (C)	WLA (kcal/day)
Avista – Kettle Falls	WA0045217	702.4	0.34	32.2	4.12E+07
Coulee Dam Electric Facility (WA)[14,15]	WA0026867	596	178.0	16.8	1.13E+10
Grand Coulee WWTP[14]	WA0044857	596.6	0.3	24.1	2.73E+07
City of Coulee Dam[14]	WA0020281	596.0	0.5	23.9	4.51E+07
Interior, Reclamation[14]	WA0024163	596.0	0.018	24.7	1.68E+06
Colville Confederated Tribes[14]	WAG130016	580.0	4.86	25.4	4.65E+08
Confederated Tribes of the Colville Reservation[14]	WAG130025	580.0	25.4	25.4	2.43E+09
Chief Joseph Dam[14, 15]	EPA	545	92.5	18.2	6.36E+09
Chelan Fruit Cooperative Pateros South Plant	WAG435265	--	0.2	18.8	1.42E+07
Well Fish Hatchery	WAG135009	--	36.2	17.7	2.42E+09
Bridgeport STP	WA0024066	543.7	0.36	24.2	3.33E+07
Brewster	WA0021008	529.8	0.61	26.0	5.99E+07
Pateros STP	WA0020559	524.1	0.10	24.0	8.91E+06

[14] EPA is the NPDES permitting agency.
[15] The NPDES permit application has been submitted.

Facility Name	Permit Number	Location (RM)	Flow (MGD)	Temp (C)	WLA (kcal/day)
Wells Dam	WA0991031	515.5	28.5	35.4	3.81E+09
Chelan Fruit Cooperative Beebe Plant	WAG435270	--	0.2	23.7	1.79E+07
Chelan POTW	WA0020605	503.5	2.6	25.0	2.49E+08
Entiat STP	WA0051276	485.0	0.15	26.0	1.47E+07
Rocky Reach Dam	WA0991033	473.5	17.6	21.3	1.42E+09
Stemlit Growers Euclid	WAG435172	--	0.1	26.1	9.87E+06
Stemlit Growers Olds Station 2	WAG435157	--	0.1	21.3	8.05E+06
Eastbank Hatchery	WAG135011	--	27.1	16.8	1.78E+09
Chelan Hatchery	WAG135006	--	6.7	16.8	4.25E+08
Tree Top Inc Wenatchee	WA0051527	470.8	0.18	26.6	7.03E+07
Naumes Processing / Keyes Fibre Corp	WA0051811	470.5	1.4	24.7	1.32E+08
Lineage Logistics	WA0052400	466.8	1.9	24.7	1.74E+08
KB Alloys/ AMG Al North Amer.	WA0002976	458.5	0.3	40.0	4.53E+07
Specialty Chemical	WA0002861	456.3	0.35	16.1	2.13E+07
Rock Island Dam	WA0501487	455.9	0.34	20.5	2.62E+07
Rock Island Dam	WA0991032	453.5	14.1	22.8	1.21E+09
Crescent Bart WWTP	WA0991013	440	0.16	23.9	1.48E+07
Vantage STP	WA0050474	420.6	0.09	26.1	8.57E+06
Wanapum Dam	WA0991028	416	17.8	18.1	1.22E+09
Priest Rapids Dam	WA0991029	397	15.9	20.5	1.23E+09
Twin City Foods Kennewick	WA0021768	328.3	0.01	24.4	7.37E+05
Agrium Bowles Road	WA0003671	322.6	15.0	30.8	1.74E+09
Agrium Game Farm Road	WA0003727	321.0	14.1	27.2	1.45E+09
Sanvik Metals	WA0003701	321.0	0.24	37.8	3.45E+07
McNary Lock and Dam (WA) [14, 15]	WA0026824	291	0.9	19.7	6.70E+07
McNary Dam (OR) [15]	ODEQ	291	15.9	22.0	1.32E+09
Richland Water Treatment Plant	WAG645000	--	0.8	23.9	7.23E+07
Umatilla STP	OR0022306	285.0	1.1	26.1	1.08E+08
Oregon Fish and Wildlife	ORG137011	275	7.1	17.5	4.71E+08
Oregon Fish and Wildlife	ORG137017	275	18.1	16.6	1.13E+09
Arlington STP	OR0020192	238.0	0.13	25.0	1.18E+07
Goldendale	WA0021121	216.7	2.4	23.3	2.11E+08
John Day Project (WA) [14,15]	WA0026832	214	52.0	19.3	3.79E+09
John Day Dam (OR) [15]	ODEQ	214	100.0	22.6	8.53E+09

Facility Name	Permit Number	Location (RM)	Flow (MGD)	Temp (C)	WLA (kcal/day)
Biggs OR WWTP	OR0041246	205.5	0.039	26.1	3.79E+06
Wishram POTW	WA0051292	200.9	0.10	23.9	8.75E+06
The Dalles Dam (WA) [14,15]	WA0026701	190	56.0	20.0	4.23E+09
Underwood Fruit & Warehouse	WAG435043	--	0.0014	12.7	6.72E+04
Dalles/Oregon Cherry OR	OR0000736	189.5	0.74	23.0	6.43E+07
Lyle POTW	WA0050482	183.2	0.098	23.9	8.84E+06
Mosier OR	OR0028045	174.5	0.085	25.6	8.22E+06
SDS Lumber	WA0051152	170.2	25.0	29.4	2.78E+09
Bingen STP	WA0022373	170.2	0.8	24.0	7.25E+07
Spring Crk Natl Fish Hatchery[14]	WAG130006	165.0	5.1	16.8	3.25E+08
Cascade Locks OR STP	OR0041271	148.2	0.49	28.0	5.21E+07
Stevenson STP	WA0020672	150.0	0.45	27.4	4.66E+07
Oregon Fish and Wildlife	ORG130001	143	32.0	15.5	1.87E+09
Tanner Creek Wastewater Treatment Plant – USACE	OR0022624	146.1	0.1	22.0	8.31E+06
North Bonneville STP	WA0023388	144.0	0.25	20.1	1.90E+07
Bonneville Dam (OR) [15]	OR0034355	141.5	0.86	23.6	7.70E+07
Bonneville Project (WA) [14,15]	WA0026778	141.5	26.0	21.1	2.07E+09
Multnomah Falls OR Lodge STP	OR0040410	135.9	0.5	31.6	5.97E+07
Exterior Wood, Inc. / Taiga Building Products USA	WA0040711	123.8	0.5	24.7	4.66E+07
Washougal STP	WA0037427	123.5	2.2	24.1	2.04E+08
Camas STP	WA0020249	121.2	6.1	25.5	5.87E+08
Toyo Tanso USA OR	OR0034916	118.1	0.2	25.3	1.91E+07
Port of Portland	OR0000060	116.9	3.0	20.0	2.27E+08
Knife River Corporation – NW	OR0044652	116.7	9.0	25.0	8.50E+08
Sundial Marine Construction & Repair, Inc.	OR0044601	116.7	0.022	24.7	2.01E+06
Portland Water Bureau	OR0031135	115.0	4.2	20.0	3.13E+08
River Road Generating Plant	WA0040932	105	0.7	38.5	9.45E+07
Columbia River Carbonates	WA0039721	83.5	0.31	14.1	1.67E+07
Kalama STP	WA0020320	75.0	0.8	23.9	7.22E+07
Port of Kalama	WA0040843	72.2	0.02	24.7	1.86E+06
Riverwood OR Mobile Home Park / Magar E Mager	OR0031143	70.6	0.013	24.0	1.18E+06
Rainier OR STP	OR0020389	67.0	1.0	25.0	9.35E+07
Stella STP	WA0039152	56.4	0.0035	23.9	3.16E+05
PGE Beaver OR	OR0027430	53.0	1.4	35.0	1.90E+08

Facility Name	Permit Number	Location (RM)	Flow (MGD)	Temp (C)	WLA (kcal/day)
Cathlamet STP	WA0022667	32.0	0.38	24.0	3.47E+07
Bio-Oregon Protein	OR0000612	10.8	0.52	28.0	5.50E+07
Pacific Surimi Co., Inc.	OR0034657	10.0	0.38	24.7	3.54E+07
Fort Columbia State Park	WA0038709	10.0	0.005	20.5	3.87E+05
Point Adams Packing Co. / California Shellfish Co.	OR0000868	6.6	0.68	12.8	3.31E+07
Bell Buoy Crab Co. (Now South Bend Products LLC)	WA0000159	6.0	0.2	18.4	1.39E+07
Ilwaco STP	WA0023159	2.0	1.0	23.0	8.77E+07
Jessies Ilwaco Fish Co.	WA0000361	2.0	0.75	18.3	5.18E+07

Table 6-14 WLAs for "Minor facility" NPDES permitted facilities located on the lower Snake River

Facility Name	Permit Number	Location (RM)	Flow (MGD)	Temp (C)	WLA (kcal/day)
Clarkston STP	WA0021113	138.0	2.2	27.4	2.28E+08
Lower Granite Dam and Locks (WA)[16, 17]	WA0026794	106	29.0	20.2	2.21E+09
Little Goose Lock and Dam (WA)[16,17]	WA0026786	69	40.1	19.4	2.94E+09
Lyon's Ferry (hatchery)	WAG137006	59.1	91.9	16.8	5.84E+09
Lower Monumental Lock and Dam (WA)[16,17]	WA0026808	41	27.8	17.1	1.80E+09
Ice Harbor Lock and Dam (WA)[16,17]	WA0026816	9	39.8	21.4	3.22E+09

Table 6-15 NPDES permitted facilities not receiving WLAs

Facility Name	Permit Number	Additional Information
Pacific Aquaculture Incorporated[17]	WA0026328	Net pen aquaculture general permit; Not believed to discharge heat
Pacific Aquaculture Incorporated[17]	WA0026336	Net pen aquaculture general permit; Not believed to discharge heat
Faith Frontier Ministries[17]	WA0026379	Net pen aquaculture general permit; Not believed to discharge heat
Pacific Aquaculture Incorporated[17]	WA0026719	Net pen aquaculture general permit; Not believed to discharge heat
Piezometer Installation and Hyporheic Studies, U.S. Department of Energy[17]	WA0026859	Not believed to discharge heat
Pacific Aquaculture Incorporated[17]	WAG130027	Net pen aquaculture general permit; Not believed to discharge heat
PCL Construction Services[17]	WAR12AO9I	Not believed to discharge heat
Chelan Fruit Cooperative Chelan Station	WAG435269	Fruit packer general permit; Have not been discharging
Gee Whiz II, LLX Orondo Plant	WAG435162	Fruit packer general permit; Have not been discharging

[16] The NPDES permit application has been submitted.
[17] EPA is the NPDES permitting agency.

Facility Name	Permit Number	Additional Information
Chelan Falls Rearing Facility Hatchery	WAG137019	Upland fish hatchery general permit; Operates in Mid-Winter to mid-April during non-critical time period
Oregon Parks and Recreation Department	ORG387007	Filter backwash permit; No flow information
City of Dalles	ORG387005	Filter backwash permit; No flow information
Pacific Coast Seafoods Company LLC	ORG520001	Seafood processing general permit; No flow information
Astoria Pacific Seafoods LLC	ORG520007	Seafood processing general permit; No flow information
Fishhawk Fisheries, Incorporated	ORG520011	Seafood processing general permit; No flow information
Bornstein Seafoods, Incorporated	ORG520014	Seafood processing general permit; No flow information
Flint Group Packaging Inks North America LLC	ORG250003	Cooling water permit; No flow information

6.5.3 NPDES Permitted Stormwater

Stormwater discharges designated as point sources to the Columbia and lower Snake Rivers are regulated by the NPDES programs at ODEQ, Ecology, and EPA. Each of these three agencies has issued NPDES general stormwater permits for municipal, industrial and construction stormwater discharges. Because the estimated temperature impacts from these sources is so minimal, as explained below, EPA has not assigned a WLA to point source stormwater discharges in this TMDL. The permits and number of facilities covered by each general permit are summarized in ***Table 6-16*** and ***Table 6-17*** fall into these categories:

- Municipal Separate Storm Sewer System (MS4) Permits. Municipalities that need to obtain an MS4 permit are classified as either "Phase I" or "Phase II." Phase I MS4s cover areas with populations greater than 100,000 while regulated Phase II (or "small") MS4s typically serve populations less than 100,000 that are located fully, or partially, within an Urbanized Area as defined by a Decennial Census conducted by the U.S. Bureau of Census. There are multiple MS4 permits within the TMDL area that may drain directly to the Columbia and lower Snake Rivers. (see ***Table 6-16***).
- Industrial stormwater permits are used to authorize stormwater discharges from specific industrial activities. There are approximately 334 industrial stormwater permittees in the TMDL area that may drain directly to the Columbia and lower Snake Rivers.
- Construction stormwater permits are used to authorize stormwater discharges for construction projects that disturb one or more acres. Because construction projects are transitory, the number and location of construction stormwater permittees varies from year to year. The issuing agency and number of open permits (as of January 2020) are listed in ***Table 6-17***. Please refer to the following databases for current permit information:

  ODEQ: www.deq.state.or.us/wq/sisdata/sisdata.asp
  Ecology: apps.ecology.wa.gov/paris/PermitLookup.aspx

Table 6-16 MS4 NPDES permits on the Columbia and lower Snake River

City	Permittee	Type	Permit Number
Columbia River			
Pasco, WA	Pasco City	Municipal SW Phase II Eastern WA General Permit (GP)	WAR046503
Kennewick, WA	Kennewick City	Phase II Eastern WA GP	WAR046005
Richland, WA	City of Richland	Phase II Eastern WA GP	WAR046006
	Port of Benton	Phase II Eastern WA GP	WAR046203
	WSU Tri Cities	Phase II Eastern WA GP	WAR046207
	West Richland City	Phase II Eastern WA GP	WAR046007
Wenatchee, WA	Chelan County	Phase II Eastern WA GP	WAR046002
	Chelan County PUD No 1	Phase II Eastern WA GP	WAR046208
	Wenatchee City	Phase II Eastern WA GP	WAR046011
	Wenatchee Valley College	Phase II Eastern WA GP	WAR303571
East Wenatchee, WA	East Wenatchee City	Phase II Eastern WA GP	WAR046012
	Eastmont Metropolitan Park District	Phase II Eastern WA GP	WAR046200
Washougal, WA	Clark County	Phase I GP	WAR044001
	Washougal City	Phase II Western WA GP	WAR045023
Camas, WA	Clark County	Phase I GP	WAR044001
	Camas City	Phase II Western WA GP	WAR045004
Vancouver, WA	Clark County	Phase I GP	WAR044001
	Clark College	Phase II Western WA GP	WAR045212
	Port of Vancouver	Phase II Western WA GP	WAR045201
	Vancouver City	Phase II Western WA GP	WAR045022
	WSU Vancouver	Phase II Western WA GP	WAR045716
Longview, WA	Cowlitz County Consolidated Diking 1	Phase II Western WA GP	WAR045204
	Longview City	Phase II Western WA GP	WAR046208
	Longview School District	Phase II Western WA GP	WAR046012
	Lower Columbia College	Phase II Western WA GP	WAR046200
Portland, OR	Portland, City of	Individual Phase I MS4	ORS108015
Fairview, OR	Multnomah County	Individual Phase I MS4	ORS120542
	Gresham, City of; Fairview, City of	Individual Phase I MS4	ORS108013
Gresham, OR	Gresham, City of; Fairview, City of	Individual Phase I MS4	ORS108013
Troutdale, OR	Multnomah County	Individual Phase I MS4	ORS120542
	Troutdale, City of	Phase II GP	ORS110793
Wood Village, OR	Multnomah County	Individual Phase I MS4	ORS120542
	Wood Village, City of	Phase II GP	ORS098909
Snake River			
Clarkston, WA	Clarkston City	Phase II Eastern WA GP	WAR046502

Table 6-17 Construction and industrial stormwater NPDES permits on the Columbia and lower Snake Rivers

Agency Issuing Permit	Permit Name & Description	Approximate Number of Permittees within TMDL area
EPA	Construction General Permit (as modified June 2019) covers Indian Country within Washington (WAR10I000) and Oregon (ORR10I000); and areas in Washington subject to construction activity by a Federal Operator (WAR10F000)	16
Oregon	Construction General Permits covers activity on Oregon lands (1200-C, 1200-CA, and 1200-C(AGENT))	232
Washington	Construction General Permit covers activity on Washington lands, excluding activity by a Federal Operator (WAR300000)	17
Oregon	Industrial Stormwater Permits (1200-Z and 1200-A)	298
Washington	Industrial Stormwater Permit (WAR1200000)	36

Temperature data collection is not typically required by general stormwater permits, so it was not possible for EPA to characterize the potential temperature impacts from stormwater discharges by assessing existing data as EPA did for the individual NPDES permits discussed in Section 6.5.2. Consequently, EPA evaluated impacts from stormwater on heat using analyses similar to those conducted for other temperature TMDLS in the Pacific Northwest (e.g. ODEQ's Upper Klamath and Lost Subbasins Temperature TMDLs, 2019).

Temperature TMDLs developed by ODEQ and Ecology have not considered stormwater discharges a significant source of heat load during the summer critical period, primarily because of minimal precipitation in most of the Pacific Northwest - including the TMDL area - during the summer and early fall. For example, in the Klamath River temperature TMDL, ODEQ estimated that stormwater discharge from one industrial facility results in a change in temperature of 0.0001°C or less (ODEQ 2019).

As discussed in Appendix D, EPA estimated the heat loading from stormwater for each of the reaches in the TMDL area. The most urbanized portions of the TMDL are in and around the Tri-Cities (between Priest Rapids and the lower Snake River confluence) and Portland (Bonneville to the coast). EPA estimated the potential impact of stormwater in these two reaches to be an increase in the temperature of the Columbia River of 0.0066°C (July) and 0.0045°C (August) from Priest Rapids to the Snake River confluence (Tri-Cities); and 0.0072°C (July) and 0.0088°C (August) from Bonneville to the coast (Portland). In the remainder of the reaches, the estimated temperature increases are significantly less, ranging from 0°C to 0.0003°C. Because the estimated temperature impacts from these sources are minimal and intermittent, EPA has not assigned a WLA to stormwater sources in this TMDL.

If additional data indicate that any of the various sources of stormwater are a significant source of thermal loading, then the States or EPA may access a portion of the reserve capacity or available heat load within the reach to allow for continued discharge from stormwater facilities.

6.5.4 Reserve Allocations

A reserve allocation is a portion of the loading capacity that is reserved for future use. EPA used RBM10, with data from 2011 to 2016, to determine the "reserve" allocation that could be established at each target site. The initial model scenario for the existing NPDES facilities estimated a maximum temperature impact of approximately 0.09°C at the critical location (RM 42). EPA is establishing a 0.01°C reserve allocation, using the remainder of the 0.1°C point source allocation, to be reserved for future use for the following purposes:

- Future growth;
- New point source dischargers of heat;
- Adjustments to the calculated WLAs if, for example, the data that EPA considered during TMDL development are not representative of the existing discharge; and
- All other nonpoint sources on the mainstems that were not considered during TMDL development.

To calculate the reserve allocation, EPA inserted a heat load in the model at the midpoint of each TMDL reach, in addition to the heat loads from all existing NPDES facilities. EPA then ran the model iteratively, increasing the reserve heat load until the maximum cumulative impact equaled 0.1°C. The resulting reserve load for each reach is 4.4×10^9 kcal/day. This loading is similar to the heat load discharged by the largest individual point sources in the study area.

The reserve needs to be managed by Washington and Oregon during implementation, including maintaining a system to track the reserve, determining whether a point source can access the reserve, and establishing a process for granting a portion of the reserve. The reserve allocation also represents an incremental margin of safety, discussed below in Section 6.6.

6.5.5 Tributaries

There are hundreds of tributaries to the mainstems of the Columbia and lower Snake River within the TMDL study area. An assessment of restoration potential in Columbia River tributaries indicates that the estimated average summer impact of riparian shade loss is an average temperature increase of 0.5°C in these tributaries (Fuller et al. 2018). Because there are known impacts to the tributaries, the TMDL assigns load allocations for the tributaries. The TMDL allocates a cumulative temperature increase of 0.1°C in the Columbia and lower Snake Rivers to 23 major tributaries (see listing in ***Table 6-20***) including the point and nonpoint sources within those tributaries.

EPA has not assessed sources within the tributaries and has therefore not divided the 0.1°C allocation between anthropogenic and natural heat loading in the tributaries. However, even without information to distinguish relative heat contributions from background temperature loads, EPA was able to use the RBM10 model to estimate the effect of temperature changes at the mouths of the tributaries on the temperature of the mainstem Columbia and Snake rivers. EPA used the model to evaluate the relationship between tributary and mainstem temperatures; through trial-and-error, model results indicated that a uniform tributary reduction of 0.5°C below current temperatures, at the confluence with the mainstem, results a maximum cumulative temperature change in the mainstem approximately equal to the 0.1°C temperature allocation. Specifically, the maximum cumulative impact on the Columbia River is 0.08°C and occurs in September at River Mile 42. The maximum impact on the Snake River is very small (0.002°C maximum impact), because there are only two small tributaries to the lower Snake River in the study area (Tucannon and Palouse rivers). Model results in ***Table 6-10*** and ***Table 6-11*** show the impacts at each location and time frame. October results are provided for the Columbia River (Bonneville location) where the fall spawning WQC is applicable.

Table 6-18 Estimated impacts of 0.5°C tributary temperature reduction on Columbia River temperature (2011 – 2016)

		Estimated Mean Impact on Columbia River (C)			
Location	**RM**	**July**	**Aug**	**Sept**	**Oct**
Grand Coulee	595	0.01	0.01	0.02	NA
Chief Joseph	546	0.01	0.00	0.02	NA
Wells	515	0.03	0.02	0.02	NA
Rocky Reach	474	0.04	0.03	0.03	NA
Rock Island	453	0.05	0.03	0.03	NA
Wanapum	416	0.05	0.03	0.03	NA
Priest R.	397	0.04	0.03	0.02	NA
McNary	291	0.03	0.02	0.02	NA
John Day	216	0.02	0.02	0.02	NA
Dalles	192	0.03	0.03	0.04	NA
Bonneville	146	0.03	0.04	0.04	0.04
RM 42	42	0.06	0.07	0.08	NA

Table 6-19 Estimated impacts of 0.5°C tributary temperature reduction on Snake River temperature (2011 – 2016)

		Estimated Mean Impact on Snake River (C)		
Location	**RM**	**July**	**Aug**	**Sept**
Lower Granite	107	0.000	0.000	0.000
Little Goose	70	0.001	0.001	0.002
Lower Mon	41	0.001	0.001	0.001
Ice Harbor	6	0.000	0.000	0.000

The tributary load allocations allow for anthropogenic heat contributions in the tributaries but do so without identifying or assessing specific anthropogenic heat sources in the tributaries. EPA recognizes that there are multiple sources of impairment in each tributary, such as riparian shade loss, point sources, flow diversions, and geomorphological changes.

For each of the 23 tributaries, EPA identifies whether the tributary is impaired for temperature and whether a TMDL has been completed in ***Table 6-20***. EPA identifies tributaries as impaired if the tributary is included on Washington or Oregon's current CWA section 303(d) list of impaired waters; or if TMDLs or other pollution control plans are in place, but temperature criteria have not yet been attained. The criteria identified in ***Table 6-20*** are the criteria that apply to the lower portion of the tributary, nearest the mainstems of the Columbia or lower Snake Rivers, during the summer and early fall months. The numeric criteria for 21 of the 23 tributaries are cooler than the numeric criteria for the lower Columbia and lower Snake Rivers (all tributaries except the John Day and Willamette Rivers). That is, the tributaries would cool – rather than heat – the mainstem rivers if the tributary met the applicable water quality criterion. As discussed in Appendix D, EPA ran a model scenario to estimate this potential improvement by capping tributary temperatures at the summer water quality criterion values. The results indicate that the cumulative impact of those tributary improvements would result in a maximum improvement of 0.2°C in the Columbia River at RM 42. As Washington and Oregon continue to develop and implement TMDLs for tributaries, EPA expects modest improvements in mainstem Columbia River temperatures.

Table 6-20 23 major tributaries: temperature impairments and WQC

Tributary Name	Inflow Location (RM)	Temperature Impaired?	TMDL?	Water Quality Criteria (°C)
Columbia River				
Kettle, WA	706	Yes	No	16.0
Colville, WA	699	Yes	No	17.5
Spokane, WA	639	Yes	No	17.5
Okanogan, WA	533	Yes	No	17.5
Methow, WA	524	Yes	No	17.5
Chelan, WA	503	No	N/A	17.5
Entiat, WA	483	Yes	No	17.5
Wenatchee, WA	468	Yes	Yes	17.5
Crab Creek, WA	410	Yes	No	17.5
Yakima, WA	335	Yes	No	17.5
Walla Walla, WA	314	Yes	Yes	17.5
Umatilla, OR	289	Yes	Yes	18.0
John Day, OR	218	Yes	Yes	20.0
Deschutes, OR	204	Yes	No	18.0
Klickitat, WA	180	Yes	No	16.0
Hood, OR	169	Yes	Yes	16.0
Sandy, OR	120	Yes	Yes	18.0
Willamette, OR	102	Yes	Yes	20.0
Lewis, WA	87	Yes	No	17.5
Kalama, WA	73	Yes	No	17.5
Cowlitz, WA	69	Yes	No	17.5
Snake River				
Tucannon, WA	62	Yes	Yes	17.5
Palouse, WA	60	Yes	Yes	17.5

The allocation established for the 23 major tributaries to the Columbia and lower Snake Rivers implement the applicable numeric criteria and incremental temperature allowance provisions for the mainstem rivers. At the same time, a separate cold water refuge provision in Oregon WQS applies to the coldest tributaries to the lower Columbia River. A subset of the major tributaries receiving allocations in ***Table 6-20*** also provide CWR. In addition, a number of smaller tributaries that have *de minimis* impacts to mainstem temperatures are nonetheless important CWRs for fish in the Columbia River and thus contribute to attainment of the designated uses.

6.5.6 Cold Water Refuges

In order to satisfy Oregon's narrative CWR standard and protect all designated uses applicable to the Columbia River, the TMDL identifies temperature targets for the 12 tributary CWRs identified in ***Table 6-21***. As discussed in Section 2.2, the Oregon WQS include a narrative CWR standard for the lower Columbia River that provides supplementary protection to migrating salmon and steelhead in the lower Columbia River. In the draft *Columbia River Cold Water Refuges Plan* (EPA 2019b), EPA identified 12 important CWRs in the lower Columbia River that are accessible to migrating salmon and steelhead (***Table 6-21***). These 12 CWRs have August mean temperatures that are generally at least 2°C cooler than the Columbia River. EPA has provided an initial determination that protection of these 12 CWRs will maintain a sufficient amount of cold water refuge to attain Oregon's WQS (EPA 2019b).

Three of the 12 CWR tributaries (Sandy, Wind, and Hood Rivers) drain watersheds where temperature TMDLs have been established. For these three tributaries, the temperature TMDL targets (WQS + 0.3°C) are identified as 7-day averages of the daily maximum temperature. The CWR temperature targets established in this TMDL supplement these existing TMDL temperature targets by designating areas of cold water available for migrating salmon and steelhead, and thereby ensuring that sufficient CWR are available to protect the applicable designated uses. As described in EPA's draft CWR plan, the effectiveness of a CWR depends on water temperature relative to the mainstem, size (volume and flow), and accessibility of the area to migrating salmon and steelhead.

Table 6-21 Temperature targets for 12 CWR in the lower Columbia River

Tributary Name	RM	Tributary Temperature Maximum Target[18]	TMDL	TMDL Target (°C)	Water Quality Standard (C)
		August Mean °C 5-Year Average		7-Day Average of the Daily Maximum	7-Day Average of the Daily Maximum
Cowlitz River	65.2	16.0	No	-	17.5
Lewis River	84.4	16.6	No	-	17.5
Sandy River	117.1	18.8	Yes	18.3	18
Tanner Creek	140.9	11.7	No	-	16
Eagle Creek	142.7	15.1	No	-	18
Herman Creek	147.5	12.0	No	-	18
Wind River	151.1	14.5	Yes	16.3	16
Little White Salmon River	158.7	13.3	No	-	16
White Salmon River	164.9	15.7	No	-	16
Hood River	165.7	15.5	Yes	16.3	16
Klickitat River	176.8	16.4	No	-	16
Deschutes River	200.8	19.2	No	-	18

6.6 MARGIN OF SAFETY

The margin of safety (MOS) is the portion of the TMDL equation that accounts for a lack of knowledge concerning the relationship between LAs and WLAs and water quality. [CWA § 303(d)(1)(C) and 40 CFR 130.7(c)(1)]. For example, knowledge may be incomplete regarding the exact nature and magnitude of temperature loads from various sources. The MOS is intended to account for such uncertainties in a manner that is conservative from the standpoint of environmental protection. In general, the MOS can be achieved through two approaches: (1) implicitly using conservative model assumptions to develop allocations, or (2) explicitly specifying a portion of the TMDL load capacity as the MOS (EPA 1992).

The Columbia and lower Snake Rivers TMDL applies an implicit MOS in derivation of the temperature allocations using conservative assumptions. The principal set of conservative assumptions is:

- EPA is establishing the current conditions benchmark for each 30-day analysis period (July, August, September, and October) that is used to evaluate impairments and exceedance magnitude using DM statistics in all locations, even though criteria are expressed as both DM and 7-DADM depending on the location. EPA is also using the mean of the monthly maxima recorded for the 2011 – 2016 period to establish the current conditions benchmark. In other words, exceedances at a given location are the mean of the six highest daily maximum temperature recorded in that month over the period 2011 – 2016.
- EPA used the RBM10 temperature model to conservatively estimate the dams' impacts on river temperature by comparing *daily average* river temperatures with and without the presence of dams (the model does not simulate *daily maximum* river temperatures). The diel variation in any river is impacted by river width and flow, seasons, and other factors, but is typically greater in a free-flowing river than when dams are present, particularly during the summer months. The impact of the dams on the daily average temperature is greater than the impact on the daily maximum temperature and is therefore a more conservative indicator of dam impact.
- The point source evaluation assumes discharges at maximum or design flow, maximum effluent temperature, and evaluates the 90^{th} percentile impact on river temperatures. By definition, actual discharges from NPDES facilities rarely reach design flows. The point source allocation also includes a reserve allowance that serves as an initial margin of safety until such growth is realized.
- The TMDL assessment focuses on six recent years of data and modeling (2011 – 2016), and this period, compared to the historic record, is characterized by relatively high air temperature and river temperature.

In addition to the above, the extensive development and refinement of the water quality model (RBM10) contributes to its utility in establishing this TMDL. The following are some of the model attributes, explained further in Appendix D, that demonstrate the robust science behind the modeling:

- The technical methodology of the RBM10 model used in EPA's work has been through two peer-review processes. EPA first shared a draft of its 2001 report for review by national experts as well as regional stakeholders' consultants. Later, the developer of the model documented the model methodology in a peer-reviewed paper published by Water Resources Research (Yearsley 2009).

- Since 2009, other organizations have applied the model to rivers in the U.S. and abroad, including published studies by researchers at U.S. Geological Survey, University of Washington, University of California Los Angeles, and Wageningen University (Netherlands). The most recent application was published in 2016.
- EPA Region 10 documented its 2019 update of the RBM10 model in a detailed report. A draft of this report was shared with the three action agencies that operate the Columbia/Snake River mainstem dams (USACE, Bureau of Reclamation, and Bonneville Power Administration). The federal agencies each sent EPA technical comments on the model and report. EPA responded to the comments and conducted a webinar on the model issues with the agencies. In a second round of review on a revised draft report, the document was shared with the same federal agencies and additional stakeholder organizations, and EPA received comments from the States of Oregon and Washington, Chelan and Grant County PUDs, and the pulp and paper industry.

Taken together, these assumptions and refinements provide support that the implicit MOS is adequate and appropriately conservative.

6.7 WATER QUALITY CRITERIA ATTAINMENT AND EXCESS TEMPERATURE

TMDLs are generally designed to identify a path for attainment of WQS in an impaired waterbody. The CWA instructs that a TMDL "be established at a level necessary to implement applicable water quality standards." This TMDL assigns wasteload allocations and load allocations consistent with meeting the identified loading capacity under WA and OR WQS (0.3°C above the WQC) when waters are not meeting the otherwise applicable numeric criteria.

As explained earlier in the TMDL, EPA used the RBM10 model to estimate the Columbia and lower Snake River temperatures that would occur if point and nonpoint source impacts within the TMDL study area were removed. EPA's estimate of the Columbia and lower Snake River temperature conditions without the 15 dams and point sources are presented in ***Figure 6-5*** through ***Figure 6-7*** for two locations: Bonneville Dam and Ice Harbor Dam. As discussed further in this section and in Section 2.4, these figures do not represent the "natural" river temperatures because the impacts of numerous sources remain imbedded in the temperature predictions, both within the TMDL area (e.g., climate change) and outside of the TMDL area (e.g., loadings from sources located upstream of the TMDL boundary in Idaho and Canada). EPA has been unable to isolate those imbedded impacts in quantifiable terms and thus did not attempt to exclude them through adjustments to the TMDL in order to characterize the "natural" state of the rivers.

Figure 6-5 through ***Figure 6-7*** illustrate daily average temperature ranges that occur in the modeled scenario throughout the modeling period. In ***Figure 6-5***, for example, the daily average temperatures at Bonneville Dam during August range from about 16.5°C to 22°C during the 47-year simulation. The daily average temperatures represented in these figures will always be lower than the daily maximums that occur during the same time period; therefore, the daily maximum range is equivalent to or warmer than 16.5°C to 22°C. ***Figure 6-5*** also illustrates that when point and nonpoint sources are removed from the model simulation, Washington's 20°C daily maximum WQC at the Bonneville Dam tailrace will sometimes be met (shown graphically by points below the 20°C line) and sometimes not be met (as represented by point above that line). As discussed in Section 4.3 and Appendix G, the river temperatures have increased during the 47 years included in the model simulation, and the probability of exceedance has likewise increased over that time period. ***Figure 6-6*** illustrates the decadal warming for the free-flowing Columbia River at Bonneville.

Cold water release operations at Dworshak Dam began in the 1990s. In order to illustrate the effect of the cold-water releases on temperatures in the mainstems, EPA plotted the estimated lower Snake River free-flowing temperatures without point and nonpoint sources, but with the Dworshak Dam cold-water releases for a reduced time period (1995 – 2016) at Ice Harbor Dam. Similar to the Columbia River plot, the model projects that the lower Snake River temperature at this location nonetheless would exceed the 20°C standard at times (***Figure 6-7***).

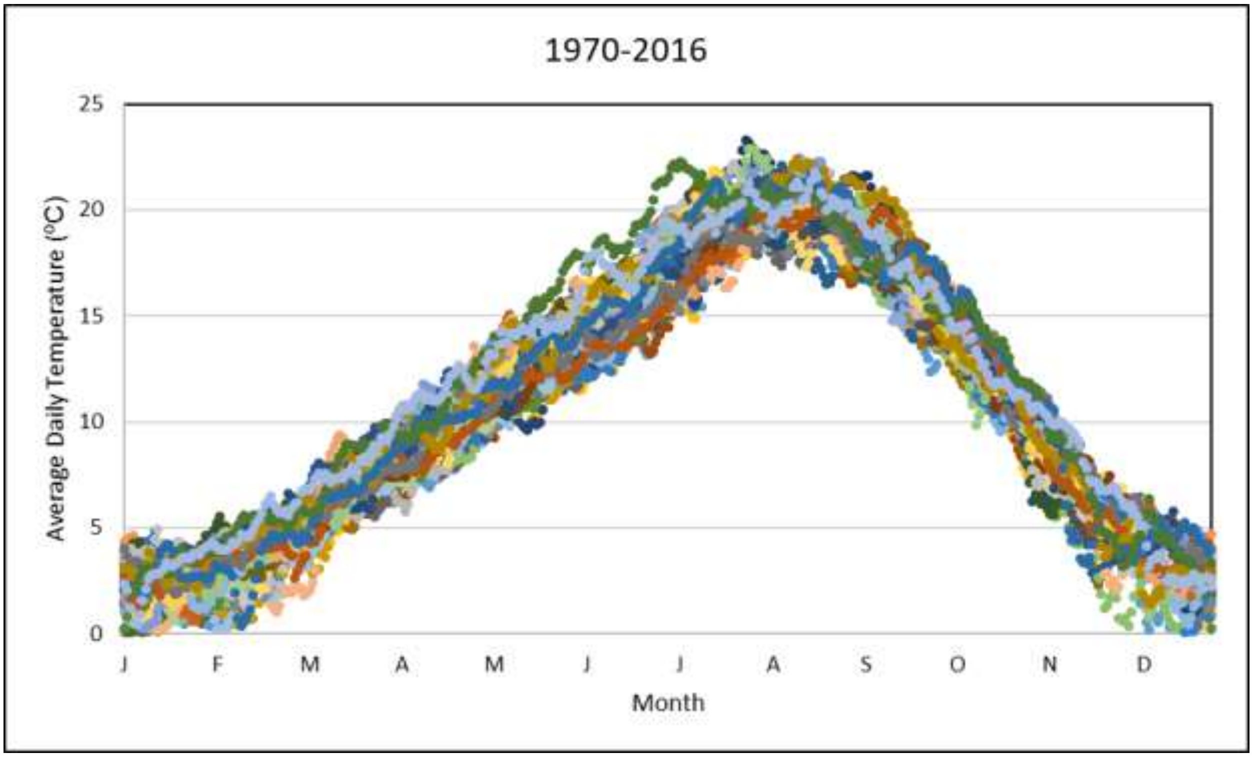

Figure 6-5 RBM10 simulation of free-flowing river temperatures at Bonneville Dam on the Columbia River (all years: 1970 – 2016)

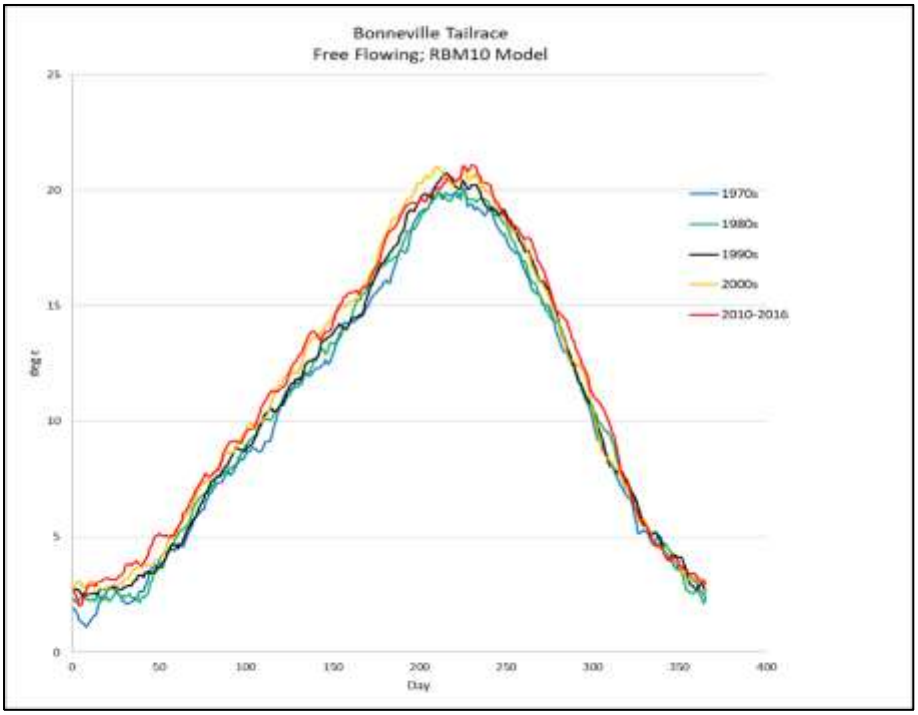

Figure 6-6 Decadal average temperatures from 47-year RBM10 simulation of free-flowing river at Bonneville Dam

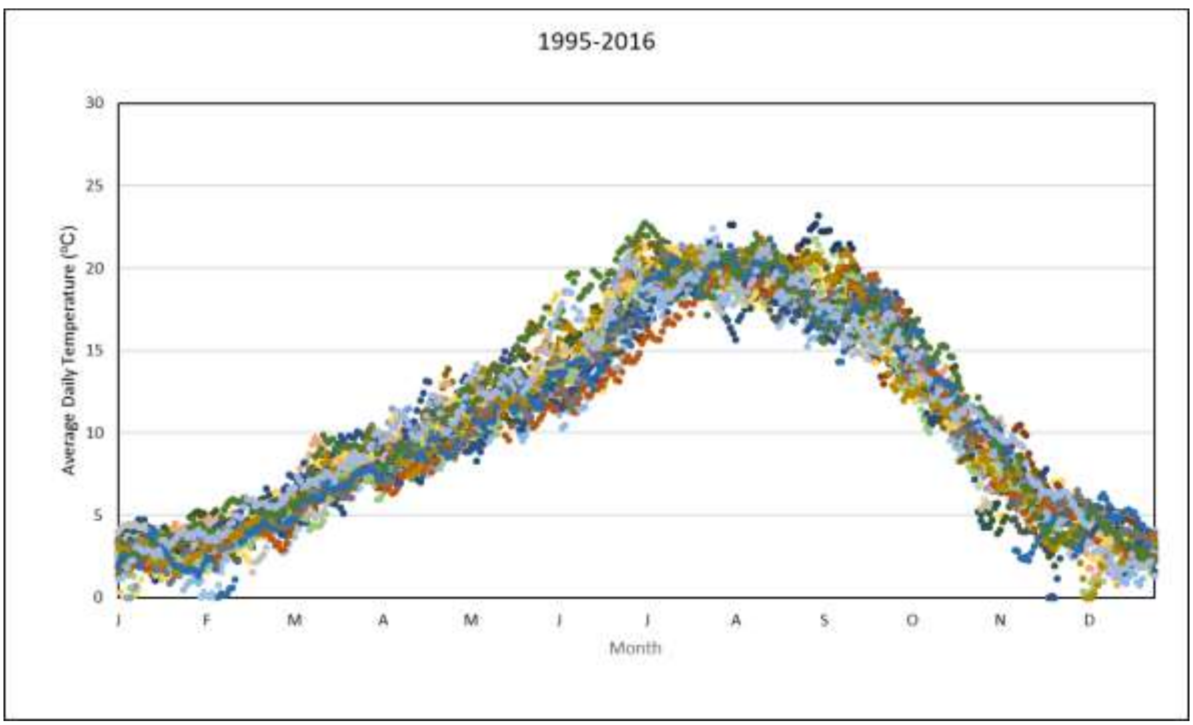

Figure 6-7 RBM10 simulation of free-flowing river temperatures at Ice Harbor Dam on the Snake River (1995 – 2016)

For the purposes of this TMDL, EPA uses the term "excess temperatures" to refer to temperatures above the loading capacity (criteria + 0.3°C) that may be reasonably predicted to occur even with the achievement of the allocations in the TMDL. Viewed as a whole, these figures illustrate the estimated excess temperatures reasonably predicted to recur at two locations in the Columbia and lower Snake Rivers from July – October. The loading capacity at these locations is 20.3°C, and these figures illustrate that EPA expects temperatures to exceed the loading capacity.

The estimated range of temperatures in the Columbia and lower Snake Rivers are presented in ***Table 6-22***. EPA calculated the range of daily average temperatures – presented as the minimum daily average and the maximum daily average – using the RBM10 model free flowing scenario, which simulate the temperatures that would occur in the absence of point sources and dams in the Columbia and lower Snake Rivers. Information presented in this table indicates that the following impairments may continue to exist, even if LAs and WLAs are implemented:

- In July, August, and September, when the applicable numeric standard at these locations is 20°C, the estimated highest daily average temperatures are above 20°C at each location, which means that the DM or 7-DADM are also above 20°C. The estimated lowest daily averages are approximately 7°C to 10°C cooler. This range of daily maximum temperatures indicates that, on any given day in that month, the standard may be attained but attainment cannot reasonably be expected to occur every day of that month.
- In October, when the applicable numeric standard at these locations is 13°C, the estimated highest daily average temperatures are greater than 13°C, which means that the 7-DADM are also above 13°C. The estimated lowest daily averages are approximately 10°C cooler. This 10°C range of DM temperatures indicates that, on any given day of the month, the standard may be attained but attainment cannot reasonably be expected to occur every day of that month.

Table 6-22 Minimum and maximum daily average temperatures in RBM10 simulations of free-flowing Columbia and Snake Rivers (1970-2016)

Location	RM	July		August		September		October	
		Min	Max	Min	Max	Min	Max	Min	Max
Columbia River									
Canadian Border	735	10.8	20.7	13.4	20.9	11.9	20.2	8.6	17.1
Grand Coulee	595	11.6	21.7	14.2	21.8	12.2	21.3	8.0	16.8
Chief Joseph	546	12.0	21.9	14.6	21.9	12.5	21.1	7.6	16.6
Wells	515	12.4	22.0	15.1	22.1	12.6	21.5	7.4	16.7
Rocky Reach	474	12.6	22.2	15.5	22.1	12.9	21.4	7.3	16.6
Rock Island	453	12.8	22.2	15.5	22.1	12.8	21.4	7.1	16.5
Wanapum	416	12.9	22.4	15.8	22.1	12.8	21.7	7.0	16.7
Priest Rapids	397	13.1	22.6	15.7	22.1	12.7	21.6	7.5	16.6
Hanford Reach	326	13.6	23.2	16.2	22.6	12.5	21.9	7.1	16.8
Snake Confluence	322	14.1	22.6	16.3	22.2	12.6	22.1	7.3	16.9
McNary	291	14.3	23.0	16.3	22.4	12.3	22.2	7.0	16.8
John Day	216	14.2	23.2	16.4	22.6	12.2	22.0	6.4	17.0
Dalles	192	14.7	23.2	16.2	22.5	12.3	21.8	6.4	17.4
Bonneville	146	14.5	23.2	16.5	22.7	12.4	21.6	7.1	17.4
Snake River									
Anatone	168	14.5	24.5	17.8	24.8	15.0	23.5	9.0	19.6
Clearwater Confl.	138	13.8	23.1	15.0	24.6	12.6	22.9	7.1	18.9
Lower Granite	107	14.0	22.9	15.3	24.6	12.3	22.9	6.5	18.8
Little Goose	70	14.3	23.1	15.0	24.7	11.9	23.1	5.6	18.7
Lower Monumental	41	14.3	23.1	14.9	24.9	11.6	23.1	5.2	18.6
Ice Harbor	6	14.5	22.9	15.2	24.9	11.3	23.1	4.6	18.4

There are numerous sources of warming that contribute to excess temperature in this TMDL. As discussed throughout this chapter, the TMDL identifies and assigns load reductions to point and nonpoint sources within the TMDL area. At the same time, the following sources have not been assigned allocations in this TMDL.

- As discussed in Section 4.3, climate change effects are estimated to have caused instream temperature increases of 1.5°C ± 0.5 in the TMDL area. These effects increase the temperature of the Columbia and Snake Rivers both within and outside of the TMDL area.
- Sources of thermal impairment within the Columbia River basin but outside the TMDL area in Canada and Idaho have not been quantified by EPA or other government agencies because models or other tools that may help quantify area-wide temperature effects currently do not exist. Sources outside the TMDL area are similar to sources within the TMDL area.

As explained above, even if the temperature reductions identified in this TMDL were to occur, EPA cannot reasonably predict that the numeric criteria will be met at all times and all places.

This TMDL restricts the identified point and nonpoint sources to increases in temperature that can be allocated under WA and OR WQS (0.3°C), which is consistent with the WQS. As previously and more fully discussed in Section 1.1, Washington and Oregon may consider changes to applicable designated uses to promote the States' ability to comply with established WQS.

7.0 REASONABLE ASSURANCE

CWA section 303(d) requires that a TMDL be "established at a level necessary to implement the applicable water quality standard." According to 40 C.F.R. §130.2(i), "[i]f best management practices or other nonpoint source pollution controls make more stringent load allocations practicable, then wasteload allocations can be made less stringent." Providing reasonable assurance that nonpoint source control measures will achieve expected load reductions increases the probability that the pollution reduction levels specified in the TMDL will be achieved, and therefore, that applicable standards will be attained.

In a state-issued TMDL, the state documents reasonable assurance in the TMDL (or an implementation plan) through a description of how the load allocations will be met. The TMDL or the implementation plan generally describes both the potential actions for achieving the load allocations and the state's authorities and mechanisms for implementing nonpoint source pollution reductions. A state's implementation plan for nonpoint sources provides reasonable assurance that more stringent WLAs are not necessary in order to implement the applicable water quality standard.

By contrast, this federal TMDL is being issued by EPA, which lacks authority to implement nonpoint source controls or otherwise assure reductions in nonpoint source pollution. Nonpoint sources typically implement their load allocations through a wide variety of programs (which may be regulatory, non-regulatory, or incentive-based, depending on the state or tribal program) and voluntary actions. Implementation of this TMDL depends on development of implementation plans by Washington and Oregon, as well as river temperature reduction efforts by other federal agencies. EPA expects the States to work within their authorities to implement activities to reduce nonpoint source heat loading. EPA recommends that the States, in developing their implementation plans, consider continued development, revision, and implementation of tributary TMDLs, including protection of CWRs; funding mechanisms to address traditional nonpoint sources of heat; voluntary conservation programs; a collaborative monitoring and tracking program; and other activities designed to reduce water temperature.

The States also promote land and forestry stewardship incentive programs that provide funding for restoration and conservation projects. The States' nonpoint source management programs award project funds to third parties to support program implementation. State soil conservation districts work with both private and public landowners to protect soil and water resources, with an emphasis on nonpoint source control measures. Implementation of these projects has a positive impact on reducing heat loading in the Columbia River basin.

The Columbia River System Operations (CRSO) agencies (US Army Corps of Engineers, Bureau of Reclamation, and Bonneville Power Administration) are currently finalizing the 2020 Final CRSO EIS and associated NOAA Fisheries Biological Opinion for the federal hydropower system. The Final EIS and Biological Opinion may identify water temperature improvement projects for the Columbia River, similar to those identified in the Water Quality Plan for Total Dissolved Gas and Temperature (USACE 2009) and the Sockeye Salmon Passage Report (NOAA 2016). The federal power agencies continue to review control measures outlined in these plans and implement operational adjustments, as appropriate, with the potential to lower water temperatures.

The Columbia River Basin Federal Caucus provides an ongoing forum for federal agencies in the Columbia River basin to work together on the planning, science, and implementation of actions to address water temperature improvements. Past and ongoing actions have included river operations, structural configurations at specific hydropower projects, and habitat restoration in the tributaries. The 2008 Columbia River Basin Federal Caucus Memorandum of Understanding identifies implementation of Clean Water Act and water temperature actions as a priority focus area for the Caucus. The Columbia River Federal Caucus coordinates with the Columbia River Federal Executives as described in the MOU, including potential coordination on water temperature improvements.

The Northwest Power Act requires the Northwest Power and Conservation Council to implement the Columbia River Basin Fish and Wildlife Program to mitigate the impact of the federal hydropower system. The Fish and Wildlife Program includes fish passage and tributary improvements, both key areas in reducing water temperature. The Fish and Wildlife Program provides an opportunity for State leadership as temperature improvement actions move forward. Members of the Council are appointed by the Governors of Idaho, Montana, Washington, and Oregon. State leadership through the Northwest Power and Conservation Council during implementation planning could provide opportunities to share information and coordinate with federal agencies on proposed actions to mitigate the temperature increases attributable to the federal hydropower system.

States, federal power agencies, Columbia River PUDs, and local organizations have maintained and are likely to increase temperature data collection throughout the Columbia and lower Snake Rivers basins. Federal power agencies have maintained and are likely to continue current fixed monitoring at the tailraces and forebays of the federal dams. Hourly monitored water temperature data collected by the USACE are uploaded, in real time, to the DART website.

Existing CWA section 401 certifications issued by Ecology for the PUDs have included conditions that require completion of an extensive temperature monitoring plan, including an adaptive management approach to attain the numeric water quality criteria. To date, Ecology has included conditions in CWA section 401 certifications for the Priest Rapids Hydroelectric Project, Rocky Reach Dam, and Wells Dam that require the PUDs to conduct temperature monitoring at the forebays and tailraces of the associated dams for the duration of the license. The Federal Energy Regulatory Commission licenses for these three dams include the States' CWA section 401 certification conditions, making them federally enforceable requirements.

Increasing air temperatures and nonattainment of standards at the upstream boundaries of the TMDL study area have been identified as sources of excess heat outside the allocation structure of this TMDL. The estimated impact of climate change on temperature loadings to the Columbia and Snake Rivers may require continued efforts at local, state, national, and international levels to address the causes of and adapt to and mitigate the effects of climate change. Idaho has a provision of its water quality standards intended to protect the standards of downstream waters, including waters of another state or tribe. Habitat restoration and TMDL development efforts in Idaho will help meet Washington's standards at the point the Snake River crosses into Washington.

The regulatory and non-regulatory measures described above and described in more detail in State implementation plans and federal dam operation plans provide adequate reasonable assurance for the temperature wasteload and load allocations in this TMDL.

8.0 TRIBAL CONSULTATION, PUBLIC OUTREACH AND NEXT STEPS

Government-wide and EPA-specific policies call for regular and meaningful consultation with Indian tribal governments when developing policies and regulatory decisions on matters affecting their communities and resources. EPA has offered opportunities for formal government-to-government consultation to 14 Columbia River basin Tribal governments and will conduct consultations and coordination as requested. EPA will work closely with the Washington Department of Ecology and Oregon Department of Environmental Quality as they move forward in the development of their implementation plans, providing support, if needed, in coordination with federal agencies through the Columbia River Federal Caucus, the Columbia River Federal Executives, and other forums that may assist the States.

EPA will provide specific outreach and engagement to point source dischargers, including the Columbia River basin industries and municipalities. EPA will provide outreach to Grant County PUD, Chelan County PUD, and Douglas County PUD who own and operate the five non-federal dams on the Columbia River. EPA will also continue the engagement, coordination, and communication with the Columbia River basin federal agencies to share technical information on the findings of the TMDL and to coordinate related work efforts including the Columbia River Systems Operations Biological Opinion and the Columbia River Systems Operations Review EIS.

Implementation of this TMDL is largely the responsibility of State and Tribal governments; however, EPA does issue federal NPDES permits within the Columbia and Snake River watersheds and therefore has a role incorporating point source wasteload allocations from this TMDL into those federal permits. EPA is committed to remain engaged with all interested stakeholders through the implementation of this TMDL.

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