# Total Maximum Daily Loads for the John Day River Basin

# Technical Support Document Appendix B: Heat Source Model Scenario Report

## Temperature

Date (EQC adoption meeting month and year)

State of Oregon
Department of Environmental Quality

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# 1 Introduction

Once stream temperature models were calibrated (see **TSD Appendix A**), scenarios that represent different sets of conditions were developed by changing one or more the input values. The scenarios were intended to represent “natural” conditions such as potential vegetation, flow and channel morphology. The goal was to combine the various scenario inputs into one background scenario, which estimated the instream temperatures free from anthropogenic influences. The methodologies for developing these scenarios are described in Section 3 below.

The Heat Source model was used to predict hourly stream temperatures, solar radiation fluxes, daily effective shade, and stream temperature responses. The map in **Figure 1-1** provides an overview of where the Heat Source model was used to simulate conditions.

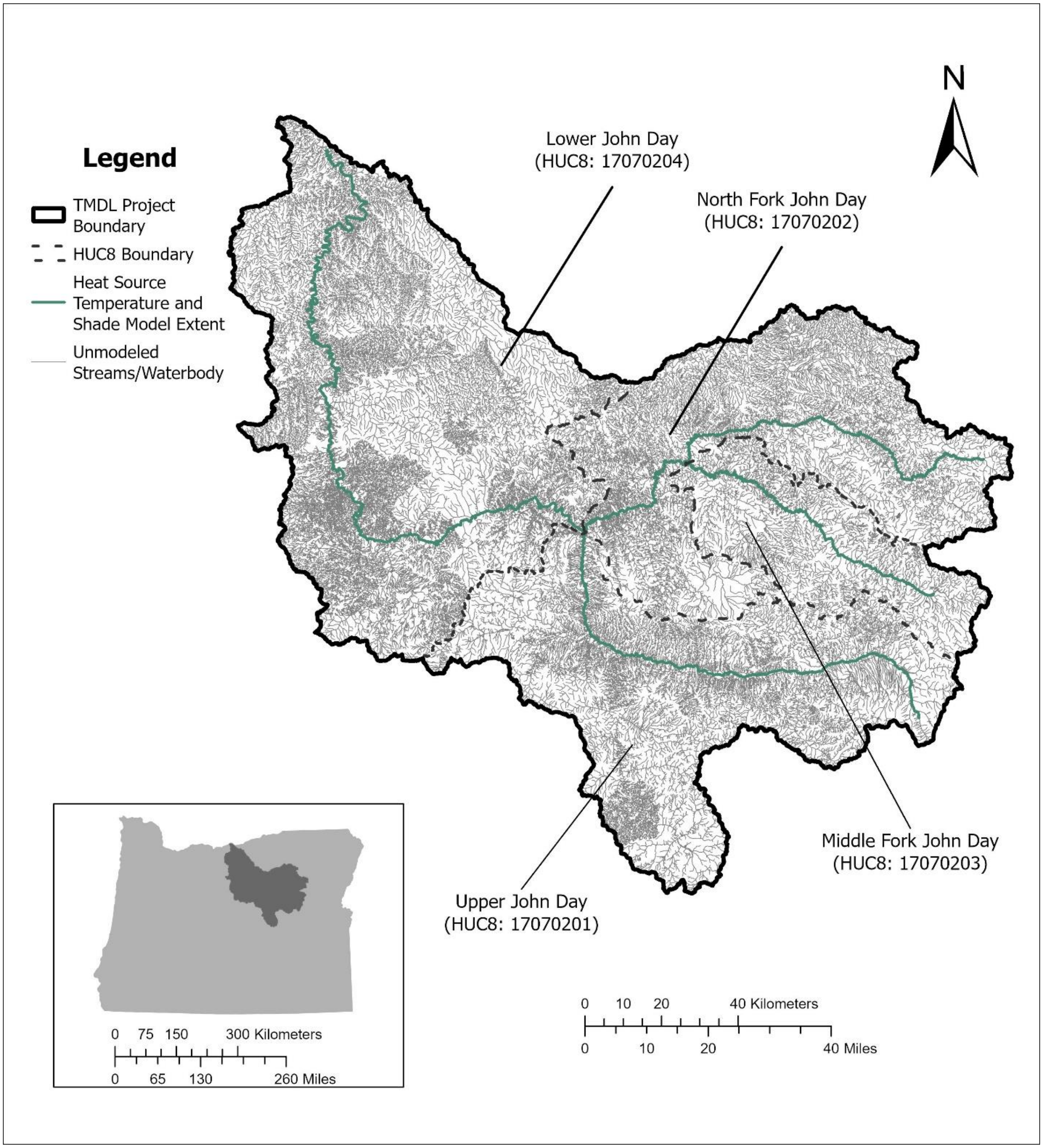


**Figure 1-1: Overview of TMDL project area with model extents.**

# 2 Model analysis and interpretation

This section discusses the calculation metrics that were used when evaluating the scenarios.

### 2.1.1 Significant digits and rounding

The TMDL analysis and interpretation of all model and scenario results accounted for significant digits and rounding. To evaluate human use allowance (HUA) attainment, DEQ calculates and records values to the hundredths (0.01°C). Because DEQ assigns some source sector HUAs to the hundredths, attainment is tracked with equal precision. The TMDL analysis follows the rounding procedures outlined in a DEQ permit-related internal management directive (IMD) on rounding and significant digits (DEQ, 2013b). This IMD says that for "calculated values" (which includes model results), if the digit being dropped is a "5," it is rounded up. For example, if an HUA allocation is set at 0.05°C and the model shows warming equal to 0.054°C, the value is rounded down to 0.05°C and the result is attainment. If the model shows warming equal to 0.055°C, the value is rounded up to 0.06°C and the result is non-attainment.

### 2.1.2 Calculating the 7-Day Average Daily Maximum temperature

For each scenario the 7DADM temperature was calculated using the hourly model output. The 7DADM was calculated using the procedure outlined in DEQ's Temperature IMD (DEQ, 2008). As outlined in this IMD, the 7DADM temperature is calculated by (i) calculating the daily maximum for each day and each location, then (ii) calculating a 7-day rolling average of the daily maximums, the result for which lands on the 7$^{th}$ day and is considered the 7DADM for that day. Following transition to a new fish use designation (such as spawning), the first day that the 7DADM is reported occurs on the 7$^{th}$ day after the new fish use designation begins. For example, if spawning begins October 15, the first 7-day period would be October 15 to 21, with the first 7DADM temperature reported on October 21.

### 2.1.3 Biologically based numeric criteria

The applicable Oregon temperature criteria for the John Day River Basin are defined in DEQ water Quality Standards, Chapter 340 (OAR 340-041-0170, Table 170B) and are summarized below:

- Summarize WQS

These criteria are referenced in rule as the biologically based numeric criteria (or BBNC). The BBNC vary spatially and temporally and are evaluated based on 7DADM temperature.

# 3 Model scenarios

This section describes the model conditions associated with each of the scenarios summarized in **Table 3-1**. The results of these scenarios are found in Section 4 and results are organized by model.

**Table 3-1: Descriptive summary of model scenarios for the John Day River Basin Temperature TMDL.**

| Scenario | Baseline for comparison | Question/ Topic addressed |
|---|---|---|
| Background | Calibration | Effect of anthropogenic sources |
| Restored vegetation A | 2023 Vegetation | Effect of fully restored vegetation |
| Restored vegetation B | Restored vegetation A | Effect of existing infrastructure |
| Restored flow | Calibration | Effect of permitted water withdrawals |
| Consumptive use | Restored flow | Effect of specific rate of water withdrawal (1-10%) |
| Channel morphology | Calibration | Effect of morphological changes (channel widening) |
| Background | Tributary | Effect of tributary temperatures set at their respective TMDL allocations |
| TMDL WLAs | No point source | Effect of each point source discharge at WLA levels |
| Background | HUA Attainment | Effect of point and nonpoint sources set at their respective TMDL allocations |

# 3.1 Current 2023 Condition

The temporal coverage of the calibrated model simulates the mainstem John Day in 2004, and 2002 for the North Fork and the Middle Fork John Day Rivers. In order to have a more up to date understanding of how vegetation and shade influence temperature, DEQ used 2023 canopy height data from Planet Labs to update the TTools data used in the model inputs (Appendix A). Planet labs developed a proprietary model that estimates vegetation structure metrics, canopy height and canopy cover, based on satellite imagery. Information on Planet Labs is discussed in TSD Appendix A

# 3.2 Vegetation scenarios

Restored vegetation, sometimes referred to as system potential vegetation, is an estimate of the mature species composition, height, and density of vegetation that would occur in the absence of human disturbances. System potential vegetation conditions were used in stream temperature modeling scenarios to quantify the impacts of nonpoint source solar radiation loads, and ultimately to develop nonpoint source load allocations for the TMDL.

Appendix [C] describes the methodology used to determine potential vegetation in the John Day River Basin. In brief, the potential vegetation estimates are spatially delineated first on level IV Ecoregion polygons (**Figure 3-1**) and second, on valley form sensu McAllister (2008). In some instances, other differentiating features are applied to increase spatial resolution. The output of this delineation is a list of Ecoregion-physiographic types (hereafter EP Types) that covers all possible EP Types within the landscape. Each EP Type is assigned a vegetation height and shade density attribute, based on basin-specific historic assessments, plant association studies and observations during TMDL monitoring, technical committee review and, for additional vegetation height information, general botanical literature. Every reach within the landscape can be assigned an explicit EP Type after identifying valley form and ecoregion. For each EP Type, a single height and shade density was assigned to each vegetation community. Where stands of shade-producing vegetation are intermittent, each vegetation community within that EP Type was assigned a frequency based on the proportion of the stream length it occupies. For example, reaches within EP Type 8 are potentially 80% conifer forest and 20% willow-shrub-grasses. While preserving the proportion of stream length, the placement of each vegetation community was randomly assigned. The natural potential vegetation estimates and the associated thermal influence are discussed in Section 4.

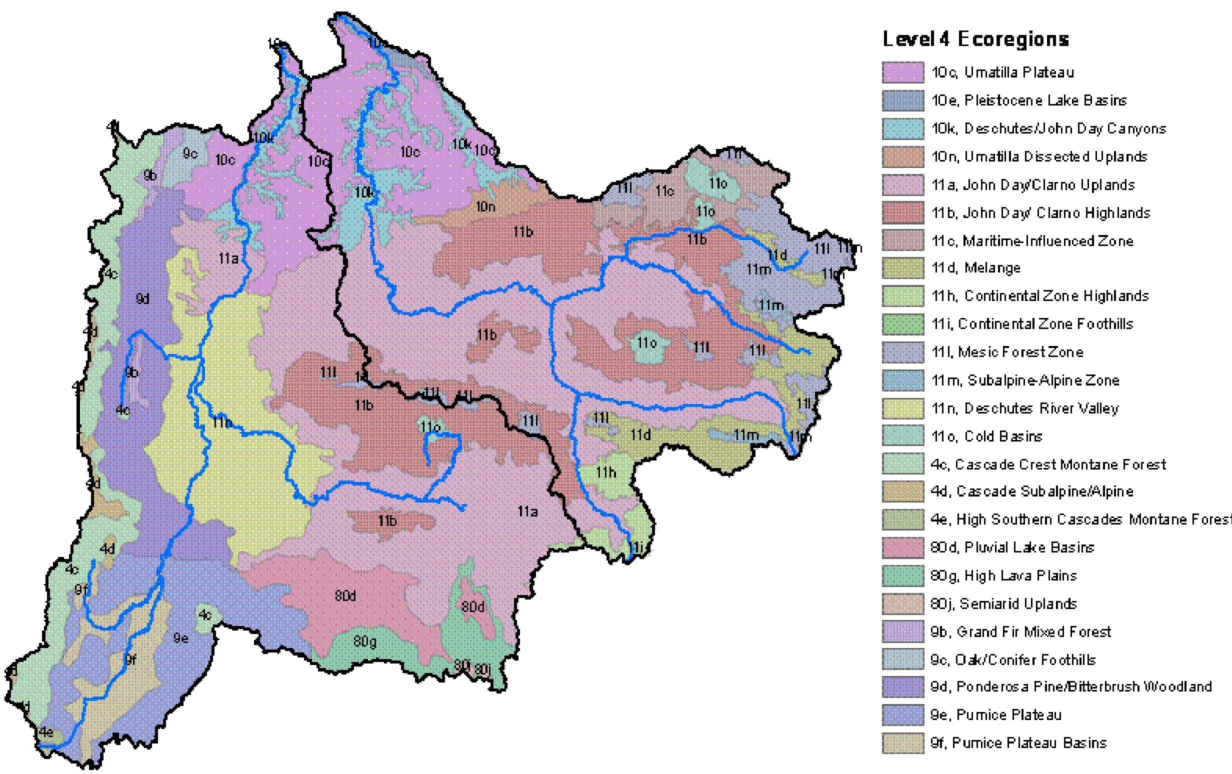


**Figure 3-1: EPA level III and IV Ecoregions in the John Day River and Deschutes River Basins.**

### 3.2.1 Restored Vegetation A (RV A)

In the restored vegetation A (RV-A) scenario transportation corridors (such as roads and highways) and urban, residential, commercial or industrial development (buildings) are removed and replaced with system potential vegetation based on Ecoregion-physiographic (EP) Types (**Figure 3-1**, Appendix C).

This scenario quantifies the impacts of nonpoint source solar radiation loads and is used to develop the HUA.

### 3.2.2 Restored Vegetation B (RV B)

The restored vegetation B (RV-B) scenario does not remove transportation corridors (such as roads and highways) and urban, residential, commercial or industrial development (buildings). All other vegetation is restored to system potential vegetation and uses the same approach in the RV-A scenario.

This scenario quantifies the impacts of nonpoint source solar radiation loads and is used to develop the HUA for solar loading from existing transportation corridors, buildings, and utility infrastructure.

## 3.3 Flow scenarios

Potential flow is the volume of water estimated to be in the modeled reach if there were no human-related influences. In parts of the Basin, flow of water in the John Day River Basin has been altered significantly from historic and natural conditions. **Table 3-2** shows the mean August flow during the model year at four gages in the Basin. The percent exceedance shown in the Table is the percent of other years' mean August flows that exceeded the model years. In other words, the John Day River August flows at John Day were relatively high during 2002 (only 34% of years on record had higher August flows), while the North Fork John Day River August flows at Monument were relatively low (only 27% of years on record had lower August flows). It is important to note that there is relatively little consumptive use in the upper North Fork drainage – progressively less above Monument and much less above the Middle Fork. The difference between 2002 and background temperature and flow profile, above the Middle Fork, should not be interpreted as human-caused flow deficit. Rather, the estimate reflects annual variability and generalized estimation methods.

**Table 3-2: Mean August flow during model year and percent exceedance at gages in the John Day River Basin.**

| USGS Gage | Mean August flow during model year | Percent exceedance flow in August in model year |
|---|---|---|
| John Day River at Blue Mountain Hot Springs (14036860) | 28.2 cfs (2004) | 58% (11 year record) |
| John Day River at John Day (14038530) | 42.1 cfs (2004) | 34% (40 year record) |

| | | |
|---|---|---|
| North Fork John Day River at Monument (14046000) | 81.5 cfs (2002) | 73% (81 year record) |
| Middle Fork John Day River at Ritter (14044000) | 30.4 cfs (2002) | 48% (80 year record) |

Oregon Water Resources Department (OWRD) provided estimates of natural potential flow using the methodology outlined in Determining Surface Water Availability in Oregon (OWRD 2002). OWRD estimates were available monthly along the modeled rivers and for some tributary inflows to the model streams. At these points, OWRD provides estimates of the 50% and 80% exceedances level natural flows meaning that during any natural flow year, there is a 50% and 80% chance, respectively, that the actual flow will exceed the estimated values. The estimated 50th percentile natural flows were used herein to target a median natural flow year.

### 3.3.1 Restored Flow

To simulate natural potential flow to the modeled reaches, DEQ modified tributaries (to model corridors) where OWRD estimated natural inflows. These tributary inputs were modified to reflect the natural flow estimate. After comparing the resulting modeled river (John Day River, North Fork John Day River, and Middle Fork John Day River) flow with the natural flow estimate of OWRD, further flow modifications in the tributaries were necessary. Inflows from the tributaries were modified to create the closest match between the model flows and OWRD estimates during the lowest flow period of the year, generally August. The resulting natural potential flow estimates in the model, and the associated thermal influence, are shown subsequently in this appendix.

In order to provide a better estimate of natural thermal potential, estimates of natural flow inputs to the John Day River from its tributaries were derived as discussed above. For the restored flow scenario, all irrigation return flows derived for calibration (described in **Appendix A**) and points of diversion were eliminated. To supply the flow of water from the tributaries, commensurate with the OWRD estimates of natural flow in the mainstem, appropriate tributaries' current flows were increased according to **Table 3-3** to **Table 3-5**.

**Table 3-3: John Day River inflows from tributaries to simulate restored flows.**

| Inflow | Calibration factor |
|---|---|
| Boundary | Current flow times 1.7 |
| Call Creek | OWRD estimates |
| Deardorff Creek | Current flow times 1.25 |
| Return of side channel (Isham Creek?), Strawberry, Slyfe/Strawberry, Dixie, Indian, Pine, Seep (near Dean and Dissel), Canyon Creek Laycock, Enterprise drain return flow, Beech, Spring (near Birch Cr), Spring, Belshaw & Fields Creeks & Spring | Current flow doubled |
| South Fork John Day River | Current flow times 1.5 |

**Table 3-4: North Fork John Day River inflows from tributaries to simulate restored flows.**

| Inflow | Calibration factor |
|---|---|
| Trail, Middle Fork John Day, Desolation, Camas, Cottonwood, Granite, Big, Potamus, Crane, Ditch, Stony, Mallory, Texas Bar Creeks | Ratio between OWRD estimate and current flow on August 1 |
| Big Wall Creek | Current flow multiplied by 0.8 |
| Meadow Brook | Current flow doubled |
| Trail, Granite, Big | Current or estimate of flow was multiplied by 2 to 6 or flow was added directly during June and parts of July. |

**Table 3-5: Middle Fork John Day River inflows from tributaries to simulate restored flows.**

| Inflow | Calibration factor |
|---|---|
| Granite, Slide, Indian, Big, Camp, Big Boulder, Granit Boulder, Vinegar, Clear Creeks | Ratio between OWRD estimate and current flow on August 1 |
| Bridge, Davis, Vincent, Dead Cow, TIR pool, Deerhorn, Little Boulder, Little Butte, Hunt, Butte, Ruby, Beaver, Ragged, Dry, Dunston, Gibbs, Quartz, Deep, Armstrong, Big, Huckleberry, Cross Hollow, Hansen Canyon, Lick, Flower, Spring (LB), Upper Ritter H.S., Ritter Hot Springs, Long, Spring Complex (LB) Creeks | Current flow doubled |
| Calibration flows | Current flow doubled |

### 3.3.2 Consumptive use

The Consumptive Use scenario evaluates the temperature impacts from withdrawals for consumptive use in the modeled rivers. In this scenario, the inflows representing restored flow conditions are reduced by a specified percentage to simulate water removed for consumptive uses. The simulations showed reduction of natural flows allocated to consumptive use that ranged from 1% to 10%. Additionally, withdrawals from irrigation return flows and other previously removed points of diversion are reintroduced into the model to reflect partial return of withdrawn water to the modeled river. The reintroduced withdrawals from the calibration represented 1% to 10% of their original values.

# 3.4 Tributary temperatures

## 3.4.1 Tributary temperature A

The Tributary Temperature A scenario is used to evaluate the temperature impacts in the John Day River resulting from elevated tributary temperatures that exceed applicable criteria. For this scenario, the tributaries were set to attain the applicable temperature criteria at their mouths. For tributaries that exceed the water quality standard, the maximum temperatures for the tributary were dampened as to not exceed the standard while maintaining the minimum temperature values and proportionally dampening the diel pattern. The temperatures were dampened using **Equation 3-1**. **Figure 3-2** through **Figure 3-10** are visualize this temperature dampening.

**Equation 3-1**

| | | |
|---|---|---|
| $T_{dampened} = T_{min,obs} + \frac{(T_{obs} - T_{min,obs}) \times (T_{WQS} - T_{min,obs})}{T_{max,obs} - T_{min,obs}}$ | | (Equation 3-1) |
| Where, | | - |
| $T_{dampened} =$ | New, dampened temperature. | |
| $T_{min,obs} =$ | Minimum observed tributary temperature for model period. | |
| $T_{max,obs} =$ | Maximum observed tributary temperature for model period. | |
| $T_{WQS} =$ | Water quality standard for tributary. | |
| $T_{obs} =$ | Temperature observation. | |

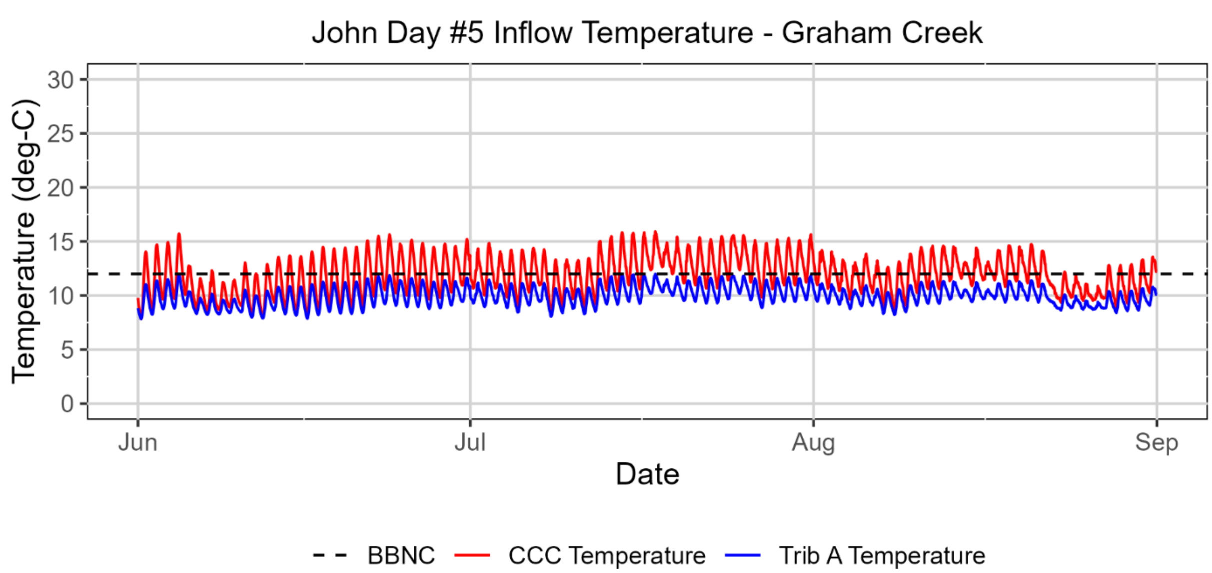


**Figure 3-2: Time series of inflow temperature at Inflow #5 (Graham Creek) of the John Day River model comparing Current Condition Calibration (red) and to the dampened Tributary Temperature A (blue) inputs to meet the BBNC of 12°C.**

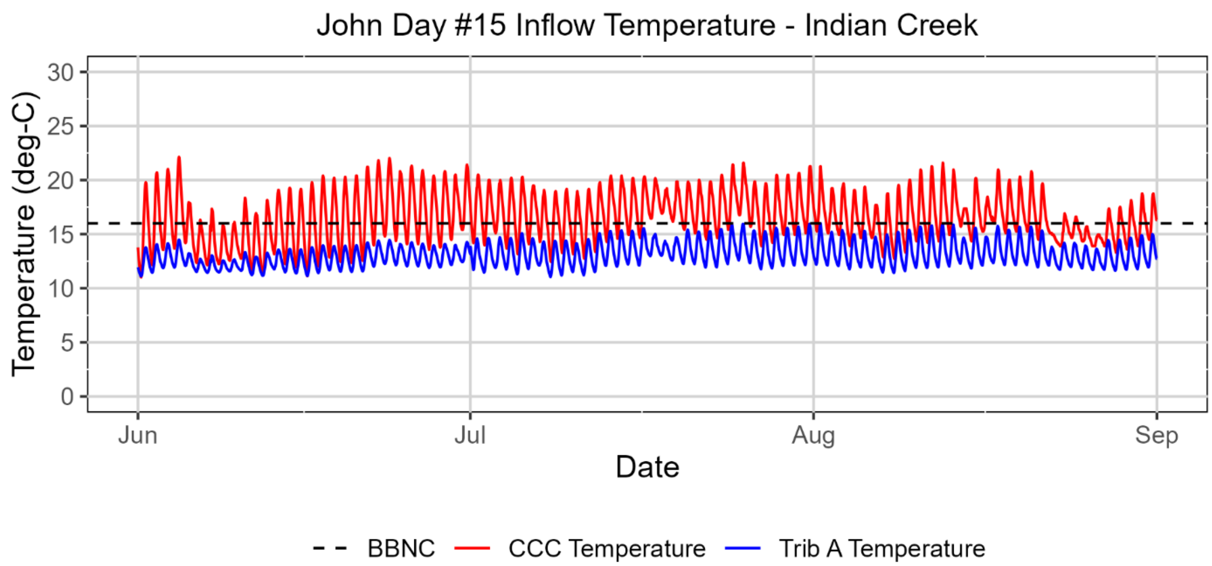


**Figure 3-3: Time series of inflow temperature at Inflow #15 (Indian Creek) of the John Day River model comparing Current Condition Calibration (red) and to the dampened Tributary Temperature A (blue) inputs to meet the BBNC of 16°C.**

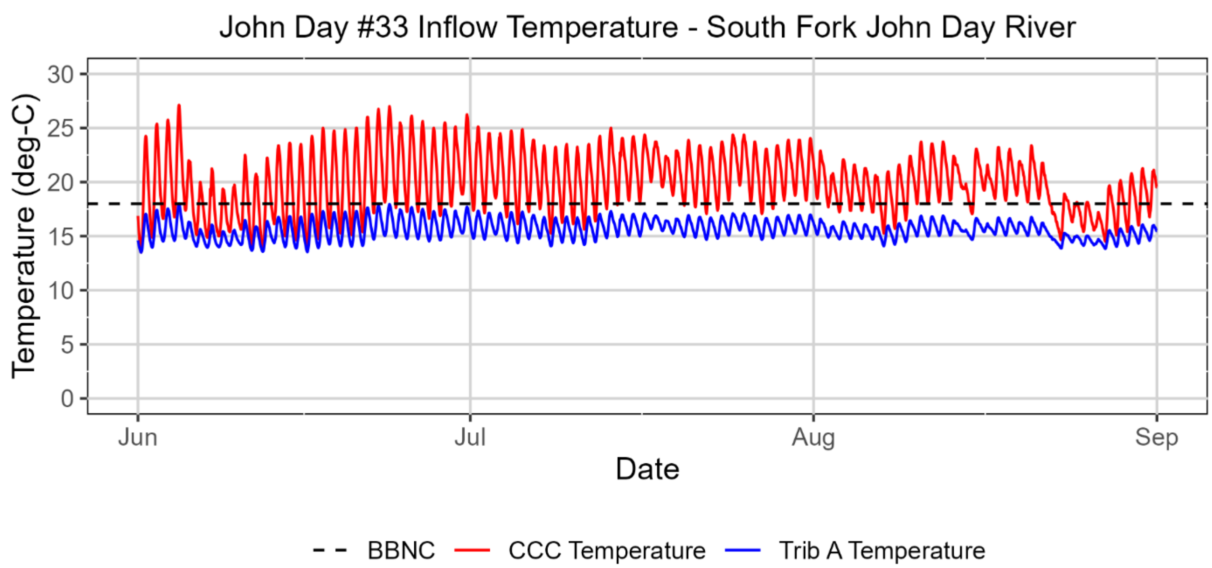


**Figure 3-4: Time series of inflow temperature at Inflow #33 (South Fork John Day River) of the John Day River model comparing Current Condition Calibration (red) and to the dampened Tributary Temperature A (blue) inputs to meet the BBNC of 18°C**

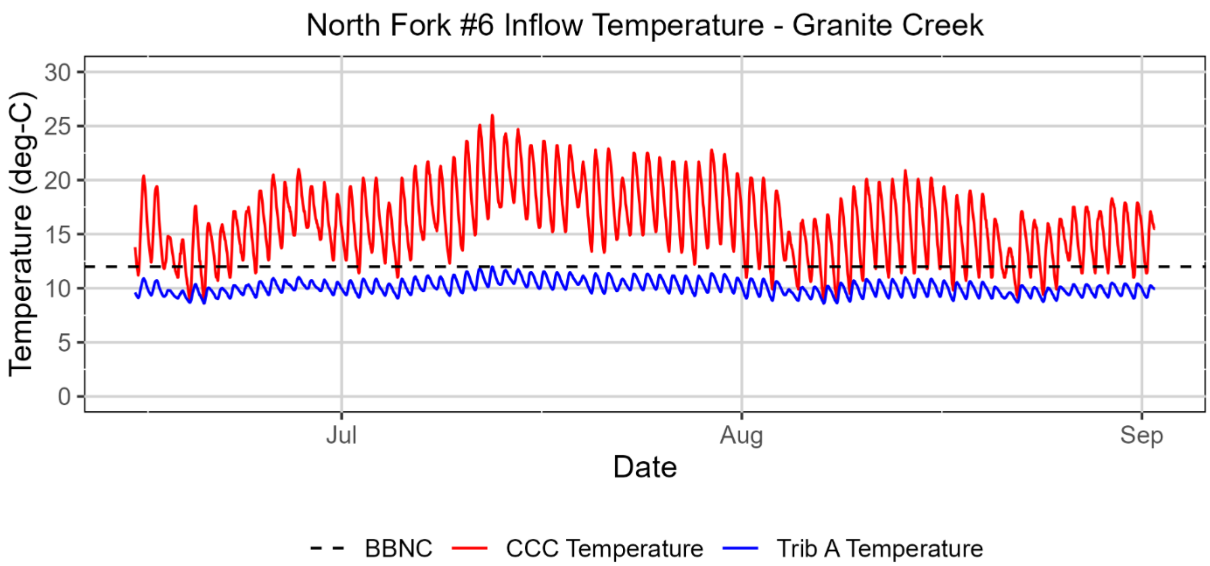


**Figure 3-5: Time series of inflow temperature at Inflow #6 (Granite Creek) of the North Fork John Day River model comparing Current Condition Calibration (red) and to the dampened Tributary Temperature A (blue) inputs to meet the BBNC of 12°C.**

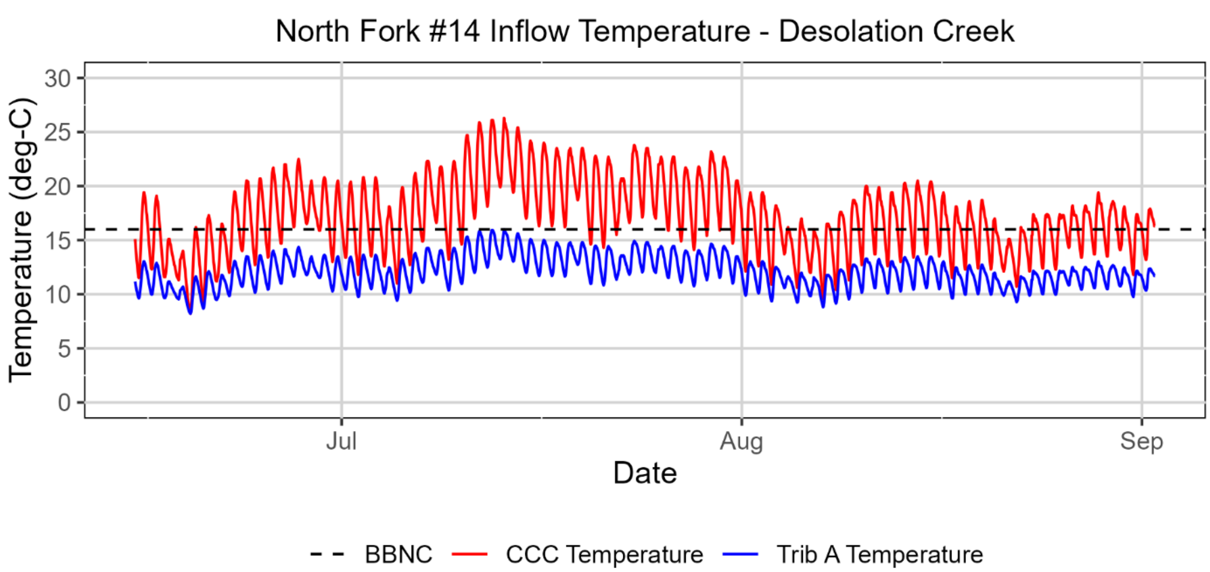


**Figure 3-6: Time series of inflow temperature at Inflow #14 (Desolation Creek) of the North Fork John Day River model comparing Current Condition Calibration (red) and to the dampened Tributary Temperature A (blue) inputs to meet the BBNC of 16°C.**

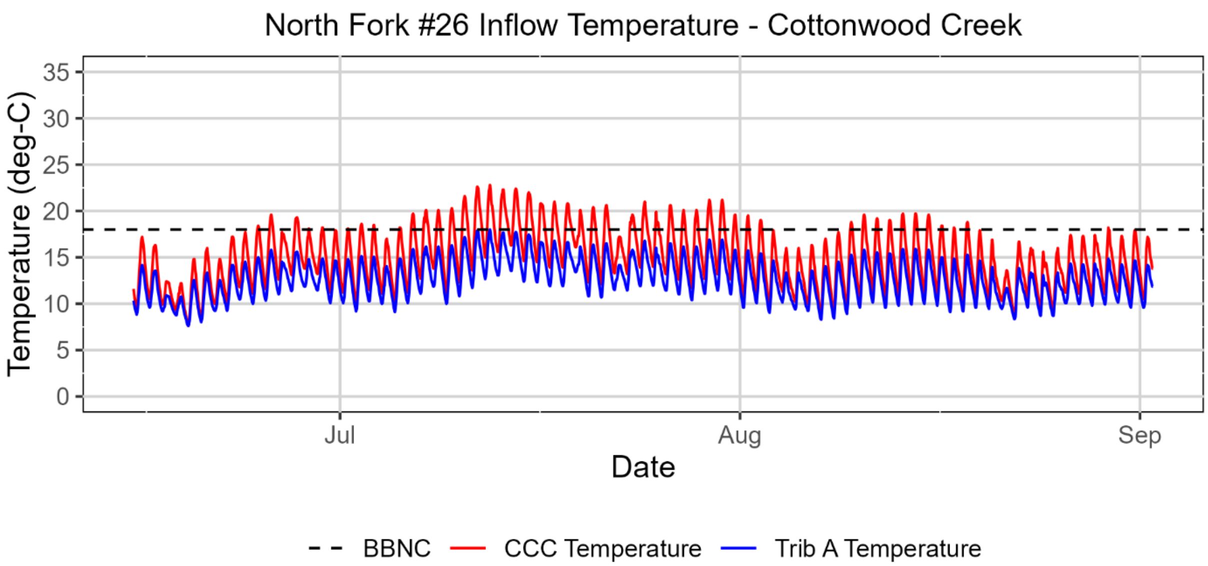


**Figure 3-7: Time series of inflow temperature at Inflow #26 (Cottonwood Creek) of the North Fork John Day River model comparing Current Condition Calibration (red) and to the dampened Tributary Temperature A (blue) inputs to meet the BBNC of 18°C.**

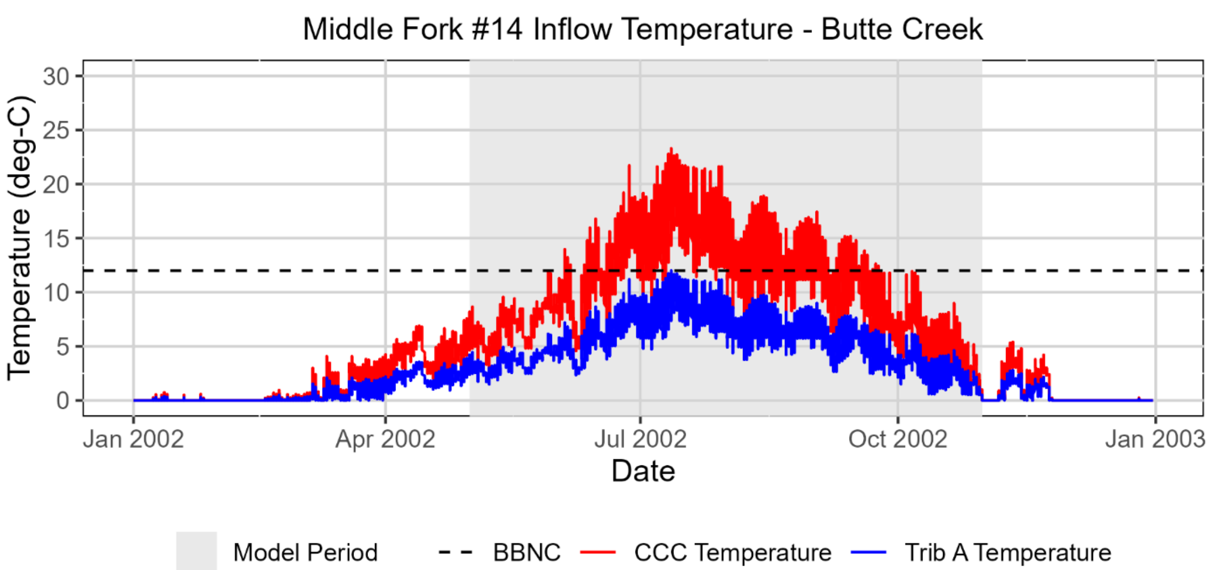


**Figure 3-8: Time series of inflow temperature at Inflow #14 (Butte Creek) of the Middle Fork John Day River model comparing Current Condition Calibration (red) and to the dampened Tributary Temperature A (blue) inputs to meet the BBNC of 12°C. The shaded gray area indicates the model period (May 1, 2002 - October 31, 2002).**

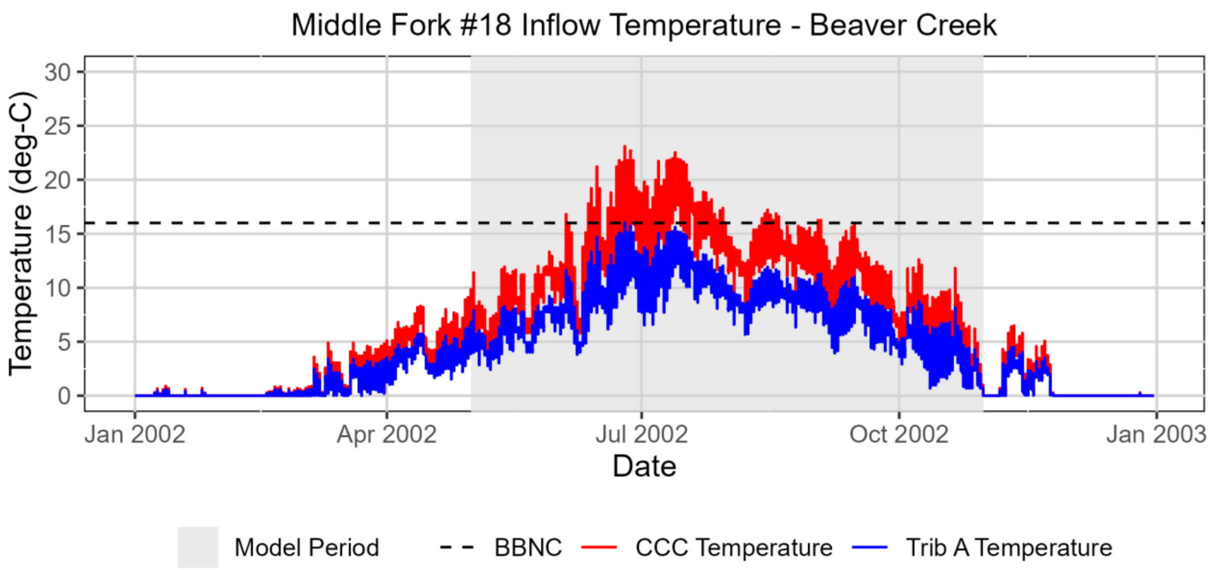


**Figure 3-9: Time series of inflow temperature at Inflow #18 (Beaver Creek) of the Middle Fork John Day River model comparing Current Condition Calibration (red) and to the dampened Tributary Temperature A (blue) inputs to meet the BBNC of 16°C. The shaded gray area indicates the model period (May 1, 2002 - October 31, 2002).**

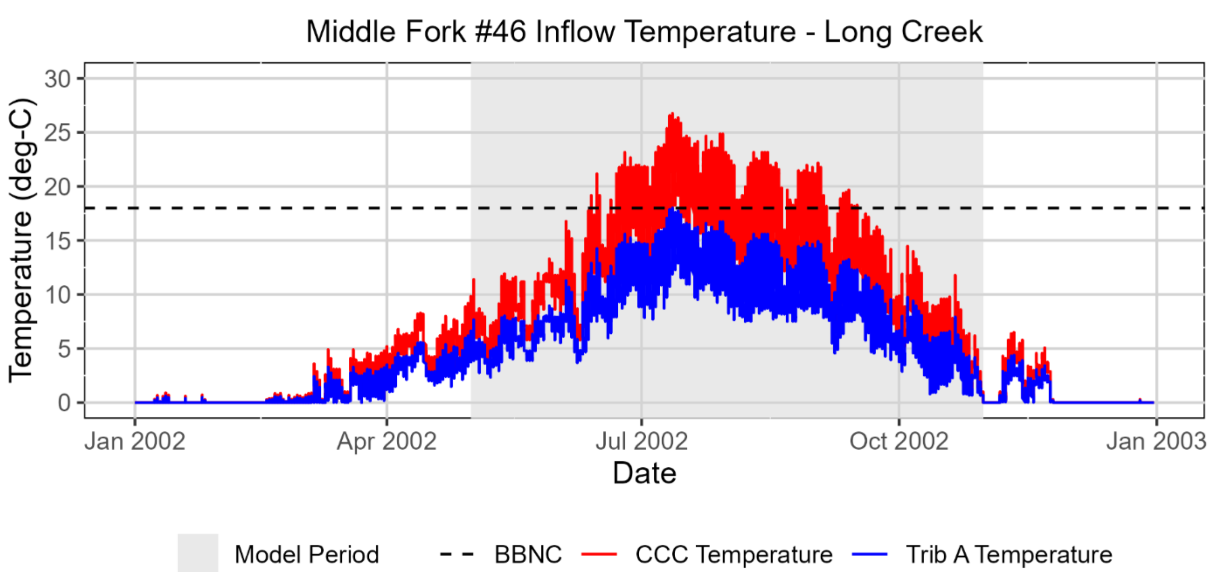


**Figure 3-10: Time series of inflow temperature at Inflow #46 (Long Creek) of the Middle Fork John Day River model comparing Current Condition Calibration (red) and to the dampened Tributary Temperature A (blue) inputs to meet the BBNC of 18°C. The shaded gray area indicates the model period (May 1, 2002 - October 31, 2002).**

### 3.4.2 Tributary temperature B

The Tributary B scenario is the same as the calibration, except tributary temperatures were increased by the assigned TMDL HUA allocations at their mouths. The Tributary A scenario is used to evaluate the John Day River temperature response to tributary temperatures set at their respective TMDL HUA allocations. Each tributary was assigned a temperature increase of 0.30°C to include all HUA source categories as well as the reserve capacity.

## 3.5 Channel morphology

The morphology of the streams and rivers in the John Day River Basin has been altered significantly from historic and natural conditions. As channels and uplands are modified through land use, instream and bedload sediment loads generally increase, which generally results in widening the downstream channel. Through restoration, though channel widths will not always decrease, we generally expect potential decreases of 25-50% (Anderson et al. 2004, Beechie et al. 2007, Castro & Jackson 2001, Grande Ronde Model Watershed 2002, Hey, R. 2006, Li et al. 1994, McDowell, P. 2000, ODSL 2005, River Design Group 2007, Rosgen 1996, Smith & Smith 1984, USBLM 1998, USFS 1995, USFS 2007). Alternatively, one example of channel widening via restoration is found in the USFS restoration of nine miles of upper-middle part of the North Fork of the John Day, where channel and vegetation restoration through and area of dredge mine tailings resulted in a slight widening of the channel. There are other areas in the John Day River Basin, including the Granite Creek watershed, where in-channel dredging occurred and similar results might be expected, where tailing piles have artificially narrowed channels. This underscores the difficulty in pre-determining channel potential. As described in the temperature TMDL, the surrogate for channel morphology is narrative rather than quantitative.

Several attempts were made to estimate the potential morphological conditions. First, several morphological parameters were measured in undisturbed reference reaches. Of the possible parameter pairings, the strongest correlations were identified, such as drainage area and channel width. When the regression equations were extrapolated to model corridors, the results were unrealistic in lower regions, which are associated with fewer representative reference reaches. Then, the potential morphology parameters were estimated from the literature. The literature values were estimated for small watersheds up to 900 sq. km, which may or may not well represent the lower John Day mainstem (10,000 – 22,000 sq. km). There is still no clear source of information from which to estimate potential morphology in the Basin, particularly as drainage area increases.

Due to the uncertainty in estimating historic or natural channel morphological traits, a series of channel width reduction scenarios were simulated for each model. The bankfull widths were reduced by 10-50% every 50 m, while cross sectional areas were preserved (**Figure 3-11**). Assuming a trapezoidal shape, the resulting bottom widths and angle of the bank (“z” as defined in Appendix A) were calculated and input to the scenario. As the bankfull widths were reduced, some wetted areas were converted to land. Those areas were assigned a vegetation type from the nearest downstream neighbor. The range of natural morphological scenarios produced a range of potential instream temperatures, which showed the impact morphology can have on rivers in the Basin.

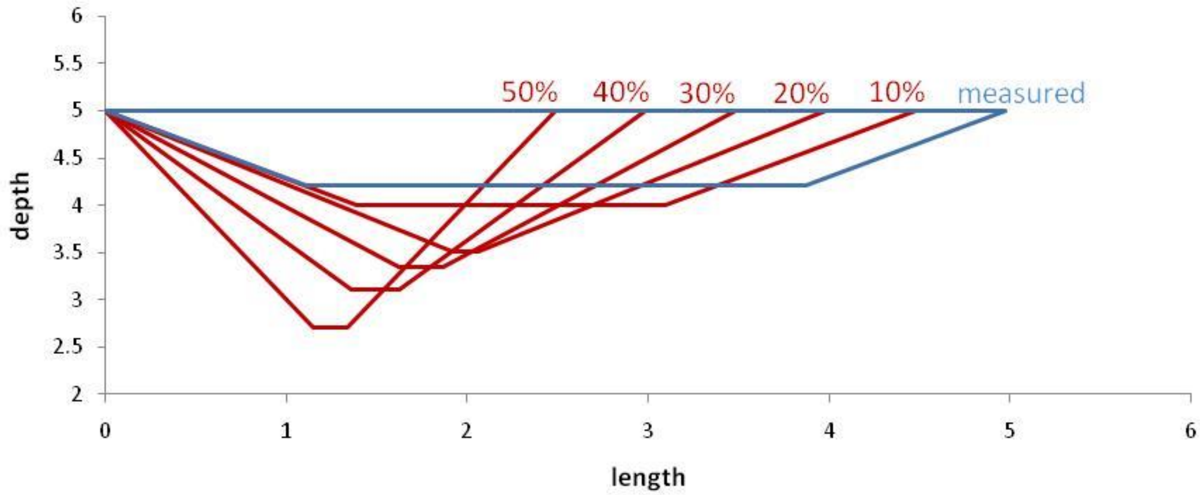


**Figure 3-11: Example of bankfull width reductions and resulting channel shapes.**

These scenarios represent a range of potential morphological conditions that bound the probable natural condition. The model results were therefore one representation of the natural morphological condition, but it should be realized that further understanding of Basin morphologic potential is needed for robust quantitative estimations. In the interim, the Department considers that a 30% reduction is a reasonable estimate, being within that which would be derived from comparison to existing natural conditions, restoration targets and general literature values. However, as described in Section 9 of the John Day River Basin Temperature TMDL, this is not a prescriptive target for this TMDL. The 30% bankfull width reduction scenario was used as an average example when only one representation was needed, such as inputting values to another model. The range of morphological changes and the associated thermal influence are discussed in Section 4 of this appendix.

# 3.6 Wasteload allocations

This scenario is identical to the background scenario; except that point source discharges are included in the model and reflect the TMDL waste load allocations. The WLA scenario evaluates the thermal impact of all point source dischargers set at the WLA discharge.

The allocation approach for point sources in Oregon was to use the current maximum thermal loads at critical 7Q10 low flow conditions as the starting point to calculate HUA assignments and waste load allocations. The model was then used to determine if this amount of warming provided capacity for other source categories and reserve capacity. The HUA assigned to each facility at the point of discharge is therefore based on the temperature increase above the applicable criteria using the maximum effluent discharge at 7Q10 river flows, assuming 100% mix.

## 3.7 No point sources

This scenario is identical to the calibration scenario.

## 3.8 Background

The background scenario results from combining the restored vegetation, restored flow, and restored morphology inputs into one scenario. The range of potential morphological conditions was simulated (0% to 50%). In a more natural state, other parameters are expected to change in a river, such as increased hyporheic exchange and reduced incoming temperatures from tributaries. The large number of tributaries, the variability in the derivation of their current temperature profiles, the lack of information about their potential temperature profiles, and the sensitivity of the model to inflows culminated in a large uncertainty around estimating natural tributary temperatures. Therefore, no estimates of potential tributary temperatures were made.

## 3.9 HUA attainment

In the HUA attainment scenario, DEQ examined how restored conditions and TMDL allocations combine to meet the HUA requirement. This scenario integrates the background scenario with the tributary temperature B scenario and WLA scenario, to reflect their assigned allocations, as described in Section 3.4 and Section 3.6.

# 4 Model scenario results and comparisons

When comparing the hourly results from two model scenarios to determine the temperature change, the following steps were taken:

1. Calculate the 7DADM or daily maximum temperatures for scenario 1 at every model output location for every day of the model period.
2. Calculate the 7DADM or daily maximum temperatures for scenario 2 at every model output location for every day of the model period.
3. For allocation scenarios, the HUA is defined as the maximum allowable increase above the applicable biologically-based numeric criteria (BBNC). Thus, to determine the maximum temperature change in relation to HUAs, only days when the BBNC was exceeded were considered and thus days when 7DADM or daily maximum river temperatures did not exceed the BBNC were excluded. Note that the BBNC varied spatially and temporally and this was accounted for in the assessment.
4. Compute the difference between the 7DADM or daily maximum temperatures of scenario 1 and scenario 2 only for days that exceed the BBNC.

5. Round the differences to two decimals Celsius, based on the adopted rounding procedure discussed in Section 2.1.1.

The 7DADM is the preferred temperature metric for comparing two scenarios. If the model period or available data were less than 7 days, the daily maximum temperature metric was used instead. It was assumed that the daily maximum temperatures approximate 7DADM results.

# 4.1 John Day River

**Table 4-1** summarizes the 7DADM stream temperatures predicted at the mouth and at the POMI of the John Day River for all model scenarios.

**Table 4-2** daily maximum stream temperatures predicted at the mouth of John Day River for all model scenarios.

**Table 4-1: Summary of maximum 7DADM stream temperature at the mouth and at the POMI of the John Day River for all model scenarios over the entire model period.**

| Temperature Metric | Scenario | Stream Temperature (°C) | Location |
|---|---|---|---|
| 7DADM | Current Conditions | 27.87 | Outlet |
| 7DADM | Restored Vegetation A | 28.21 | Outlet |
| 7DADM | Restored Vegetation B | 28.21 | Outlet |
| 7DADM | Topography | 28.23 | Outlet |
| 7DADM | Restored Flow | 28.16 | Outlet |
| 7DADM | 1% Consumptive Use | 28.17 | Outlet |
| 7DADM | Tributary Temperature A | 28.20 | Outlet |
| 7DADM | Tributary Temperature B | 28.23 | Outlet |
| 7DADM | Channel Morphology | 28.19 | Outlet |
| 7DADM | Wasteload allocation | 28.23 | Outlet |
| 7DADM | Attainment | 28.14 | Outlet |
| 7DADM | Background | 28.13 | Outlet |

**Table 4-2: Summary of daily maximum stream temperature at the mouth and at the POMI of the John Day River for all model scenarios over the entire model period**

| Temperature Metric | Scenario | Stream Temperature (°C) | Location |
|---|---|---|---|
| Daily maximum | Calibration | 29.42 | Outlet |
| Daily maximum | Restored Vegetation A | 29.40 | Outlet |
| Daily maximum | Restored Vegetation B | 29.40 | Outlet |
| Daily maximum | Topography | 29.43 | Outlet |
| Daily maximum | Restored Flow | 29.19 | Outlet |
| Daily maximum | 1% Consumptive Use | 29.19 | Outlet |
| Daily maximum | Tributary Temperature A | 29.39 | Outlet |
| Daily maximum | Tributary Temperature B | 29.42 | Outlet |
| Daily maximum | Channel Morphology | 29.09 | Outlet |

| Temperature Metric | Scenario | Stream Temperature (°C) | Location |
|---|---|---|---|
| Daily maximum | Wasteload allocation | 29.42 | Outlet |
| Daily maximum | Attainment | 29.16 | Outlet |
| Daily maximum | Background | 29.15 | Outlet |

### 4.1.1 Vegetation scenarios

This section summarizes the temperature impacts of restored vegetation.

The potential natural vegetation within the riparian corridor was assigned according to the method described in Section 3.2. As described in Section 3.2, restored vegetation was assigned based on EP Types, based on vally form and ecoregion. EP type reach breaks were established for the modeled rivers. Breaks were located at each ecoregion boundary, and further delineated by the valley form determination based on 10-m DEM assessment, and other criteria, as described in Appendix [C]. Figure 4-1 and **Error! Reference source not found.** describe the system potential vegetation model inputs by reach. The John Day River had an additional consideration below river km 282 (North Fork John Day River confluence), which contains upslope areas that are naturally incapable of supporting trees or other shade producing vegetation, due to soil type, water table depth, instability, etc.. Outside of a 50 m buffer around the main water channel, these areas are not predicted to support near-stream vegetation. Model inputs outside of the 50 m buffer retained their existing vegetation coverage (barren steep rocky slopes, bedrock outcrops, etc.) in the restored vegetation scenario (Appendix A), unless they were clearly anthropogenically influenced (i.e., roads, buildings, rail, dams, etc.), in which case, they were assigned the nearest neighbor's land cover. Inside the 50 m riparian buffer, the potential vegetation communities were assigned potential land cover as described in Section 3.2.


**Figure 4-1: John Day River reach classification for potential vegetation.**

**Table 4-3: John Day River reach classification for potential vegetation by Ecoregion-Physiographic (EP) Type (based on ecoregion and valley subtype).**

| Reach ID* | Upper Node | Lower Node | Model Node Range (m from mouth) | Level 4 Ecoregion | Valley Subtype | Ecoregion-Physiographic (EP) Type | Land Cover Height in meters (stream length in %) | Land Cover Density (%) |
|---|---|---|---|---|---|---|---|---|
| 1 | model boundary | bottom of Ecoregion 11l | 437000 - 433750 | 11l | C | 57 | 29.3 (100) | 80 |
| 2 | top of Ecoregion 11d | conifer forest lower edge | 433700 - 430050 | 11d | C | 49 | 28.8 (100) | 85 |
| 3 | conifer forest lower edge | Deardorff Creek | 430000 - 424800 | 11a | D | 8 | 27.4 (80) | 85 |
| | | | | | | | 2.5 (20) | 85 |
| 4 | Deardorff Creek | Prairie City | 424750 - 409600 | 11a | A | 43.5 | 27.4 (80) | 85 |
| | | | | | | | 2.5 (20) | 85 |
| 5 | Prairie City | top of Picture Gorge | 409550 - 316550 | 11a | A | 43.5 | 27.4 (80) | 85 |
| | | | | | | | 2.5 (20) | 85 |
| 6** | top of Picture Gorge | North Fork | 316500 - 282250 | 11a | D | 8 | 21 (40) | 85 |
| | | | | | | | 2.5 (60) | 85 |
| 7** | North Fork | Service Creek | 282200 - 238200 | 11a | D | 8 | 21 (40) | 85 |
| | | | | | | | 2.5 (60) | 85 |
| 8** | Service Creek | bottom of Ecoregion 11a | 238150 - 135350 | 11a | D | 8 | 16.3 (25) | 85 |
| | | | | | | | 2.5 (75) | 85 |
| 9** | top of Ecoregion 10k | bottom of Ecoregion 10k | 135300 - 17000 | 10k | D | 2 | 10.8 (50) | 90 |
| | | | | | | | 2.5 (50) | 90 |
| 10** | top of Ecoregion 10e | Tumwater Falls | 16950 - 0 | 10e | D | 41 | 8.4 (50) | 90 |
| | | | | | | | 1.5 (50) | 90 |

Note:
*Reach IDs correspond with those in Figure XXX.
**Outside the 50 m riparian buffer was left at “existing” vegetation values.

**Table 4-4** summarizes the daily maximum stream temperature change between the Current Condition Calibration and Restored Vegetation A scenarios for the John Day River. It shows the daily maximum temperature difference at the most downstream node (the outlet) is equal to 0.06°C. In addition, the greatest daily maximum temperature difference between the two scenarios (POMI) is equal to 8.40°C and occurs at stream model km 410.

**Figure 4-2** shows the change in the daily maximum stream temperatures between the Current Condition Calibration and Restored Vegetation A model scenarios for the John Day River over the entire model period.

**Table 4-4: Summary of maximum 7DADM stream temperature change between Current Condition Calibration and Restored Vegetation A model scenarios for the John Day River over the entire model period.**

| Model KM | Maximum change in Stream Temperature (°C) | Location |
|---|---|---|
| 0 | 0.06 | outlet |
| 410 | 8.40 | POMI |

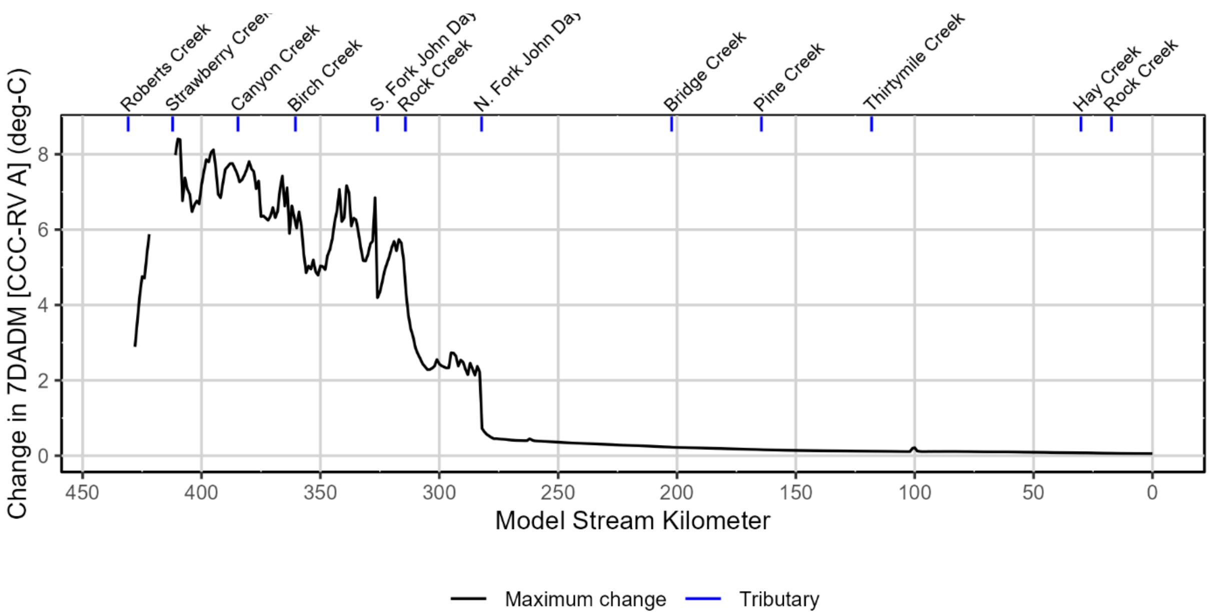


**Figure 4-2: Change in maximum 7DADM stream temperatures between the Current Conditions Calibration (CCC) and Restored Vegetation A (RV A) model scenarios for the John Day River over the entire model period.**

**Table 4-5** summarizes the daily maximum stream temperature change between the Current Condition Calibration and Restored Vegetation B scenarios for the John Day River. It shows the daily maximum temperature difference at the most downstream node (the outlet) is equal to 0.06°C. In addition, the greatest daily maximum temperature difference between the two scenarios (POMI) is equal to 8.24°C and occurs at stream model km 410.

**Figure 4-3** shows the change in the daily maximum stream temperatures between the Current Condition Calibration and Restored Vegetation B model scenarios for the John Day River over the entire model period.

**Table 4-5: Summary of maximum 7DADM stream temperature change between Current Condition Calibration and Restored Vegetation B scenarios for the John Day River over the entire model period.**

| Temperature Metric | Model KM | Scenario | Stream Temperature (°C) | Location |
|---|---|---|---|---|
| 7DADM | 0 | Change | 0.06 | outlet |
| 7DADM | 410 | Change | 8.24 | POMI |

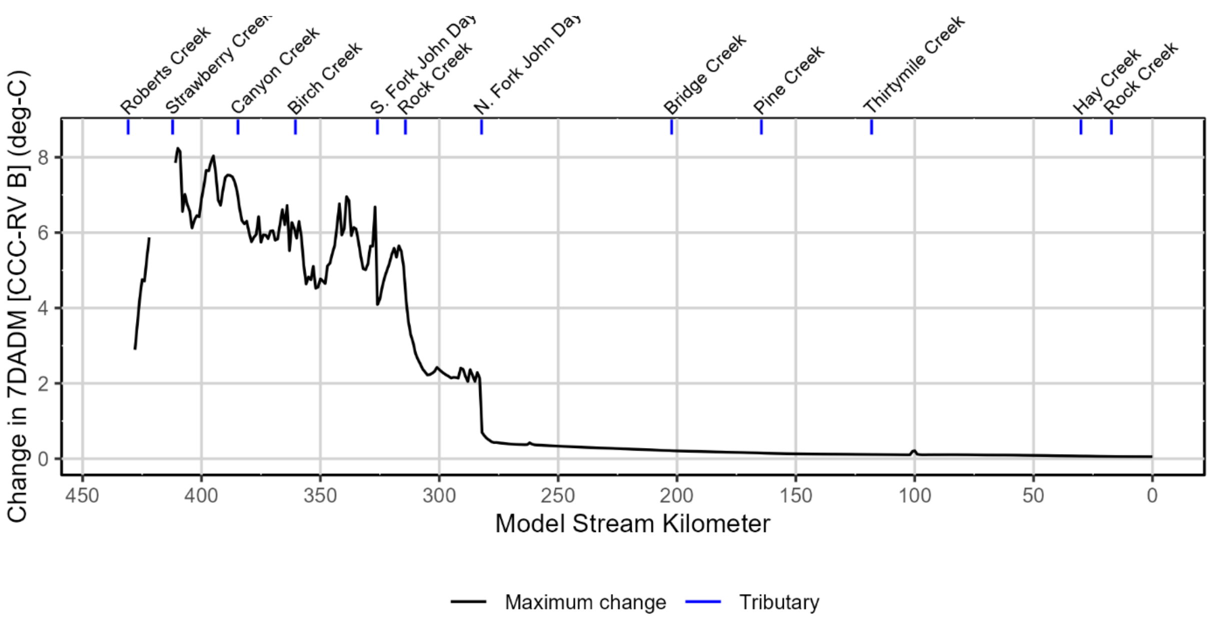


**Figure 4-3: Change in maximum 7DADM stream temperatures between the Current Conditions Calibration (CCC) and Restored Vegetation B (RV B) model scenarios for the John Day River over the entire model period.**

**Table 4-6** summarizes the daily maximum stream temperature change between the Restored Vegetation B and Restored Vegetation A scenarios for the John Day River in order to understand the impact of transportation corridors (such as roads and highways) and urban, residential, commercial or industrial development (buildings). It shows the daily maximum temperature difference at the most downstream node (the outlet) is equal to 0.00°C. In addition, the greatest daily maximum temperature difference between the two scenarios (POMI) is equal to 2.09°C and occurs at stream model km 379.

**Figure 4-4** shows the change in the daily maximum stream temperatures between the Restored Vegetation B and restored Vegetation A model scenarios for the John Day River over the entire model period.

**Table 4-6: Summary of maximum 7DADM stream temperature change between Restored Vegetation A and Restored Vegetation B scenarios for the John Day River over the entire model period.**

| Temperature Metric | Model KM | Scenario | Stream Temperature (°C) | Location |
|---|---|---|---|---|
| 7DADM | 0 | Change | 0.00 | outlet |
| 7DADM | 379 | Change | 2.09 | POMI |

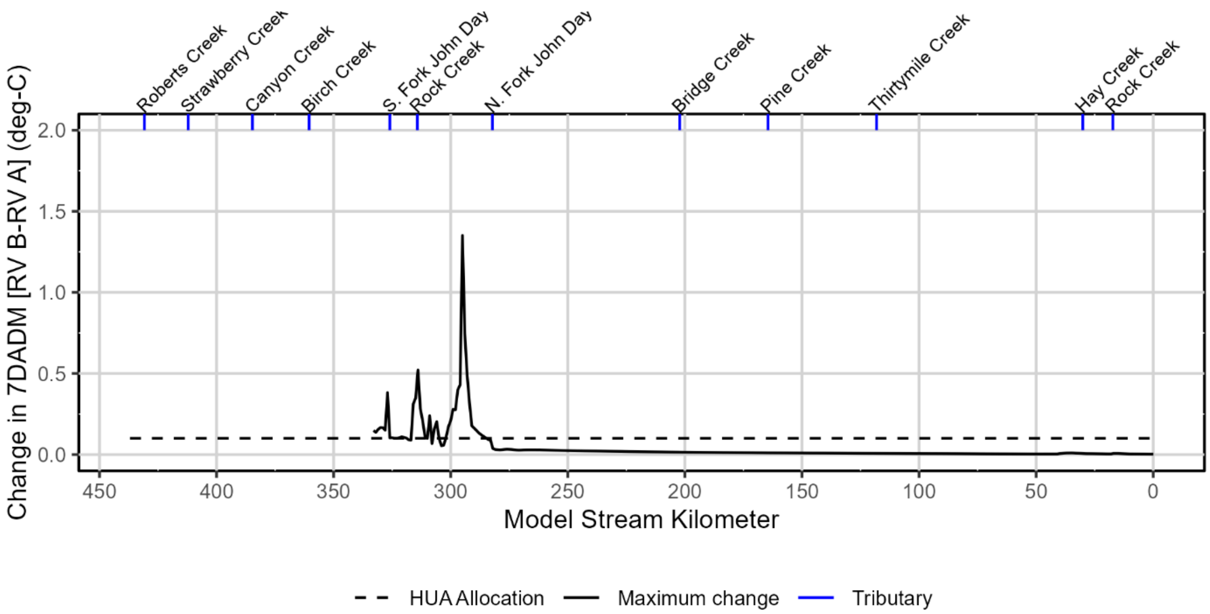


**Figure 4-4: Change in maximum 7DADM stream temperatures between the Restored Vegetation B (VEG B) and Restored Vegetation A (VEG A) model scenarios for the John Day River over the entire model period.**

**Table 4-7** summarizes the mean effective shade for the Calibration, Current 2023 Condition, Restored Vegetation A, and Topographic Shade scenarios for the John Day River. The difference in mean effective shade between the Restored Vegetation A and Current 2023 Condition scenarios is equal to 11.21 percentage points.

**Figure 4-5** and **Figure 4-6** compare effective shade predictions from the Restored Vegetation A and Current 2023 Condition scenarios for the John Day River. **Figure 4-7** compares effective shade predictions from the Current 2023 Condition and Topographic Shade scenarios for the John Day River.

**Table 4-7: Summary of mean effective shade for the Calibration, Current Condition, Restored Vegetation and Topographic Shade scenarios for the John Day River.**

| Scenario | Mean effective shade (%) |
|---|---|
| Calibration | 7.38 |

| Scenario | Mean effective shade (%) |
|---|---|
| Current 2023 Conditions | 8.43 |
| Restored Vegetation | 19.64 |
| Shade Gap (Restored – Current 2023) | 11.21 |
| Topographic Shade | 4.60 |

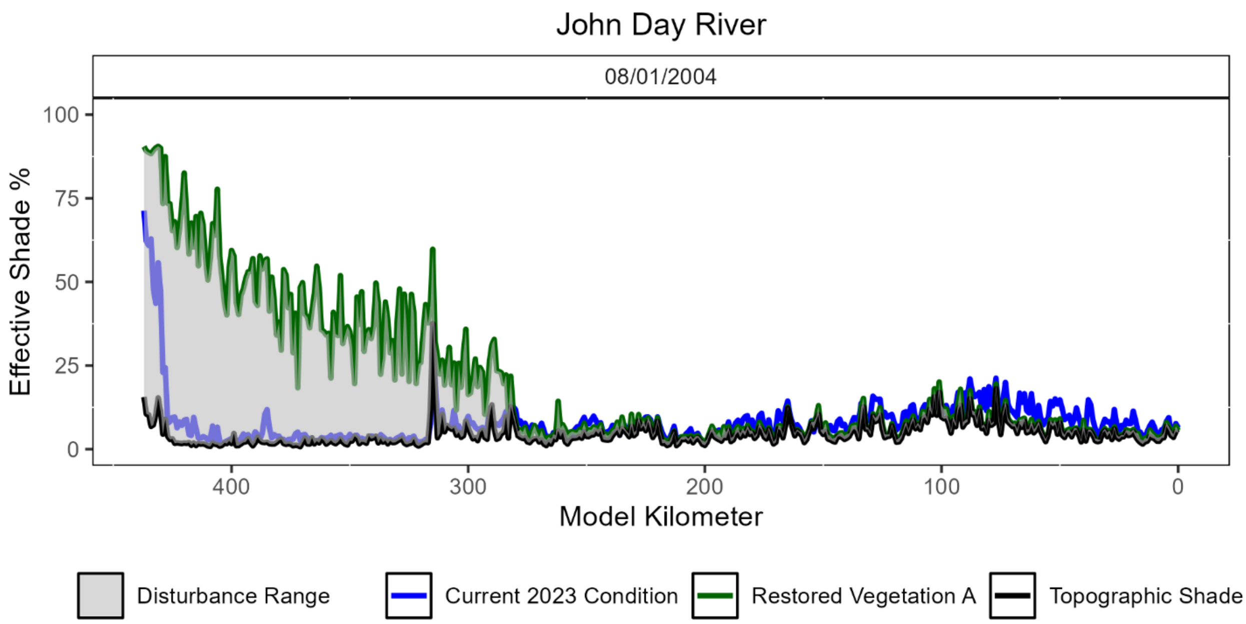


**Figure 4-5: Comparison of effective shade from the Current 2023 Condition, Restored Vegetation A, and Topographic Shade scenarios for the John Day River.**

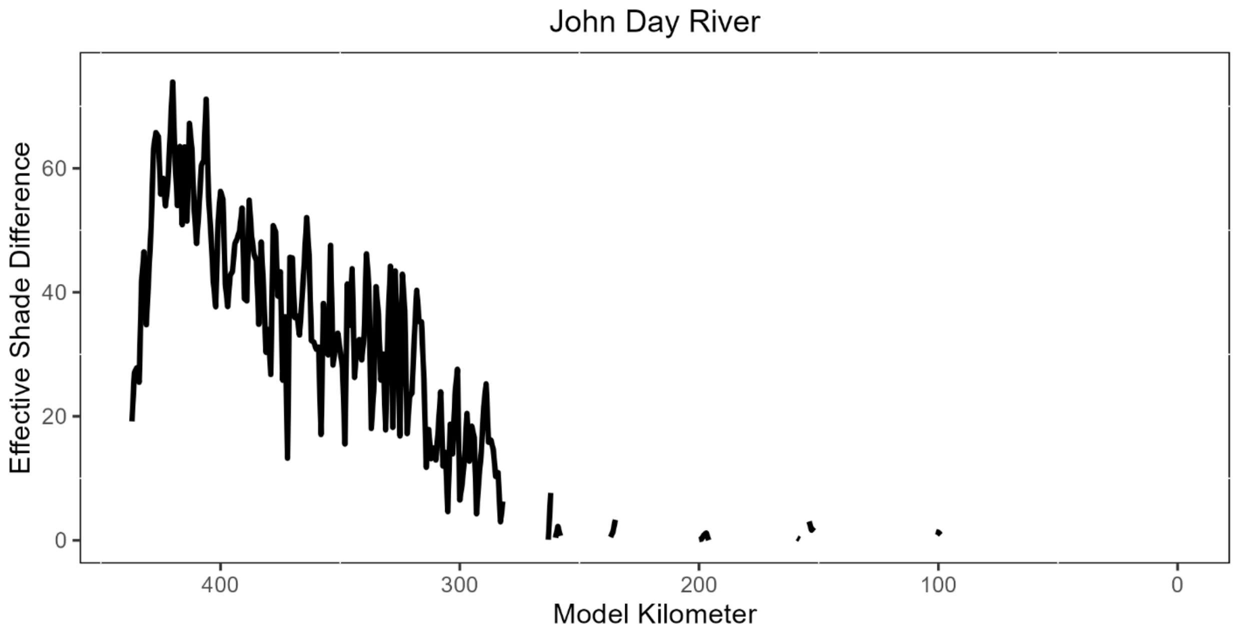


**Figure 4-6: Percentage point difference between effective shade from the Restored Vegetation A and Current 2023 Condition scenarios for the John Day River. Missing values indicate that the shade difference is negative due to instances of higher effective shade in the Current 2023 Condition scenario versus the Restored Vegetation scenario.**

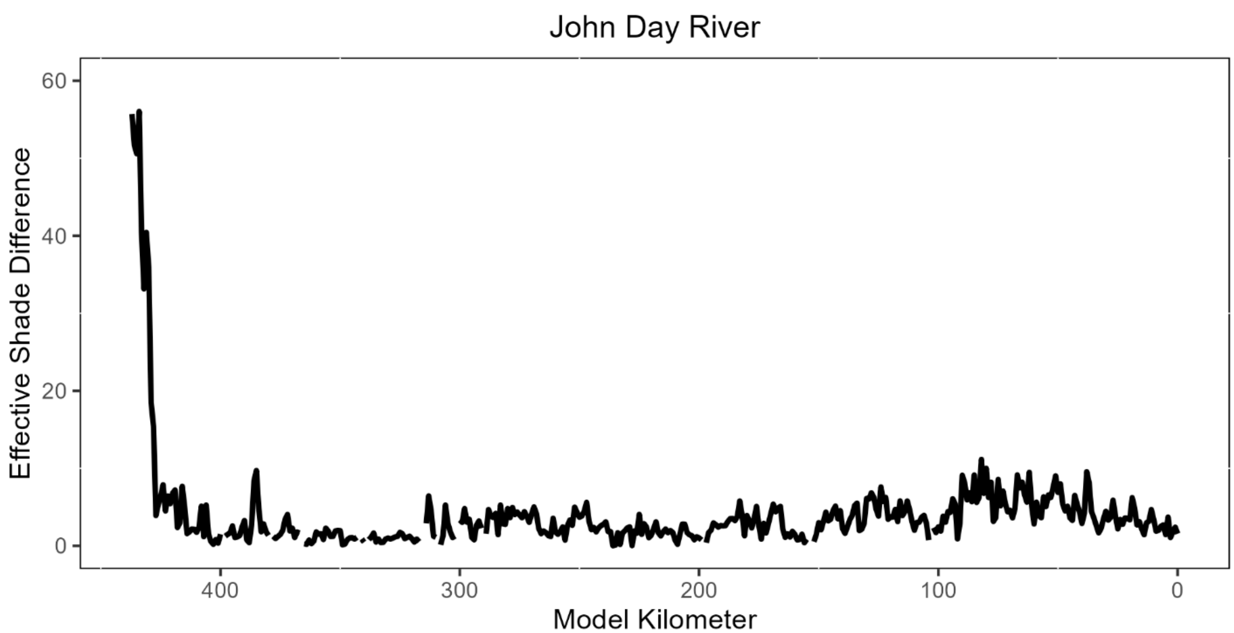


**Figure 4-7: Percentage point difference between effective shade from the Current 2023 Condition and Topographic Shade scenarios for the John Day River. Missing values indicate that the shade difference is negative due to instances of higher effective shade in the Topographic Shade scenario versus the Current 2023 Condition scenario.**

### 4.1.2 Flow scenarios

This section summarizes the effects of stream flow on temperature.

**Table 4-8** summarizes the daily maximum stream temperature change between the Current Condition Calibration and Restored Flow scenarios for the John Day River. This comparison evaluates the temperature impacts from flow deviations from natural conditions. It shows the daily maximum temperature difference at the most downstream node (the outlet) is equal to 0.28°C. In addition, the greatest daily maximum temperature difference between the two scenarios (POMI) is equal to 6.26°C and occurs at stream model km 290.

**Figure 4-8** shows the change in the daily maximum stream temperatures between the Current Condition Calibration and Restored Flow model scenarios for the John Day River over the entire model period.

**Table 4-8: Summary of maximum 7DADM stream temperature change between Current Condition Calibration and Natural Flow model scenarios for the John Day River over the entire model period.**

| Temperature Metric | Model KM | Scenario | Stream Temperature (°C) | Location |
|---|---|---|---|---|
| 7DADM | 0 | Change | 0.28 | outlet |
| 7DADM | 290 | Change | 6.26 | POMI |

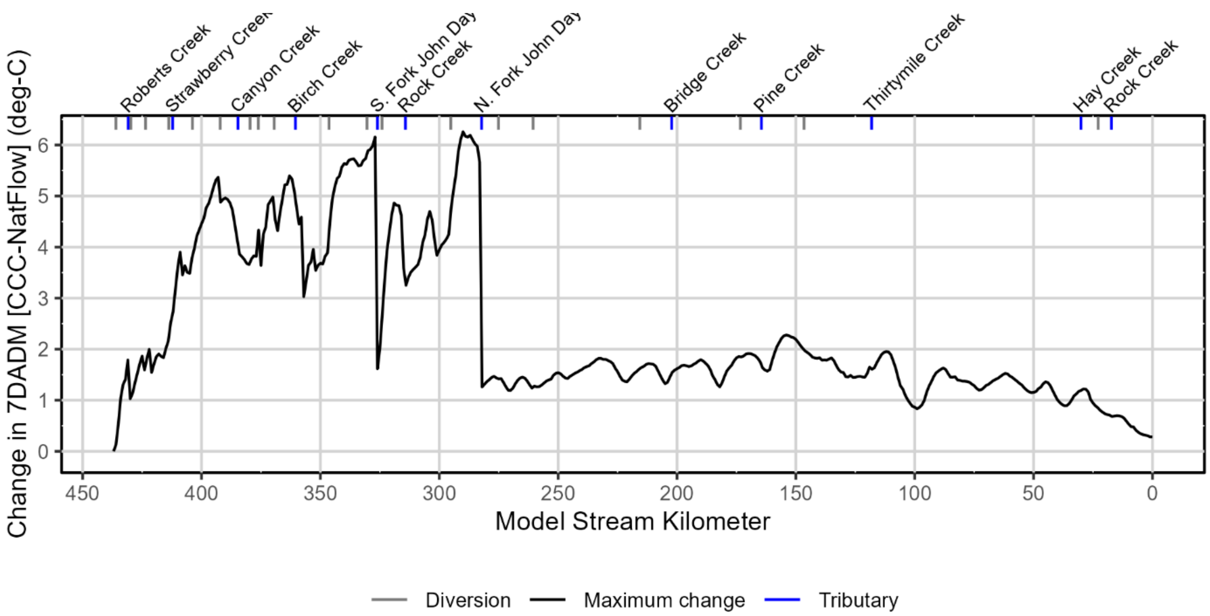


**Figure 4-8: Change in maximum 7DADM stream temperatures between the Current Conditions Calibration (CCC) and Natural Flow (NatFlow) scenarios for the John Day River over the entire model period.**

**Table 4-9** summarizes the daily maximum stream temperature change between the 1% Consumptive Use and Restored Flow scenarios for the John Day River. This comparison evaluates the effect of water withdrawals (1% of consumptive use) on temperature. It shows the daily maximum temperature difference at the most downstream node (the outlet) is equal to 0.00°C. In addition, the greatest daily maximum temperature difference between the two scenarios (POMI) is equal to 0.10°C and occurs at stream model km 327.

**Figure 4-9** shows the change in the daily maximum stream temperatures between the 1% Consumptive Use and Restored Flow model scenarios for the John Day River over the entire model period.

**Table 4-9: Summary of maximum 7DADM stream temperature change between 1% Consumptive Use and Natural Flow model scenarios for the John Day River over the entire model period.**

| Temperature Metric | Model KM | Scenario | Stream Temperature (°C) | Location |
|---|---|---|---|---|
| 7DADM | 0 | Change | 0.00 | outlet |
| 7DADM | 327 | Change | 0.10 | POMI |

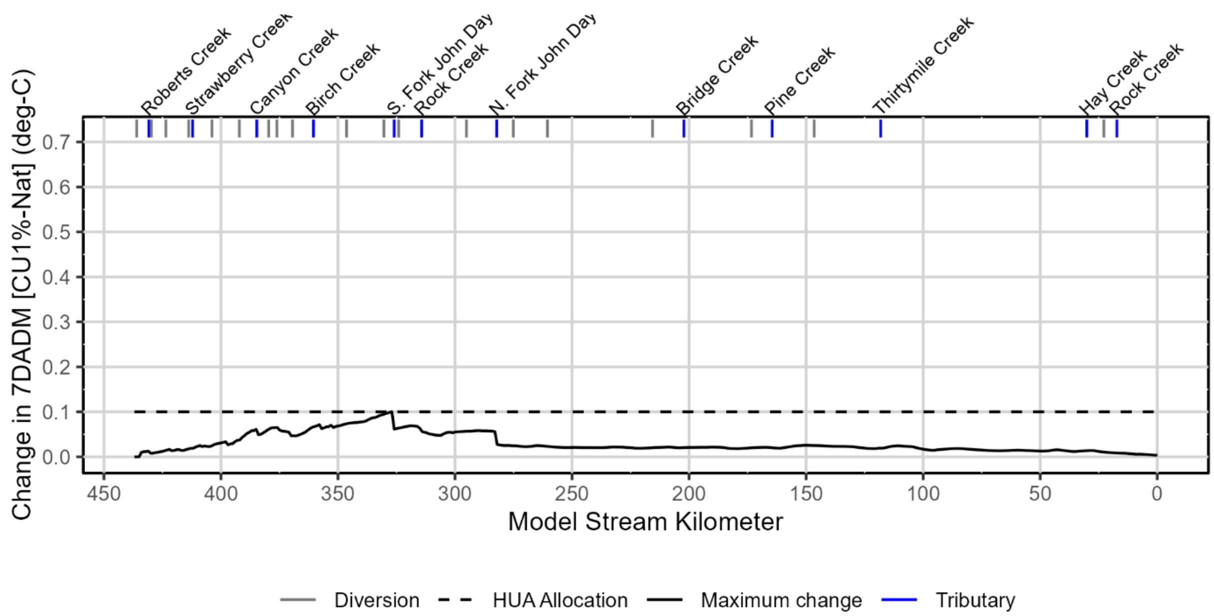


**Figure 4-9: Change in maximum 7DADM stream temperatures between the 1% Consumptive Use (CU1%) and Restored Flow (Nat) scenarios for the John Day River over the entire model period.**

### 4.1.3 Tributary temperatures

This section summarizes the temperature impacts of tributary temperatures. Tributary Temperature A scenario examines exceedances of the water quality standards at the tributaries.

**Table 4-10** summarizes the daily maximum stream temperature change between the Current Condition Calibration and Tributary Temperature A scenarios for the John Day River. It shows the daily maximum temperature difference at the most downstream node (the outlet) is equal to 0.43°C. In addition, the greatest daily maximum temperature difference between the two scenarios (POMI) is equal to 7.80°C and occurs at stream model km 282.

**Figure 4-10** shows the change in the daily maximum stream temperatures between the Current Condition Calibration and Tributary Temperature A model scenarios for the John Day River over the entire model period.

**Table 4-10: Summary of maximum 7DADM stream temperature change between Current Condition Calibration and Tributary Temperature A model scenarios for the John Day River over the entire model period.**

| Temperature Metric | Model KM | Scenario | Stream Temperature (°C) | Location |
|---|---|---|---|---|
| 7DADM | 0 | Change | 0.43 | outlet |
| 7DADM | 282 | Change | 7.80 | POMI |

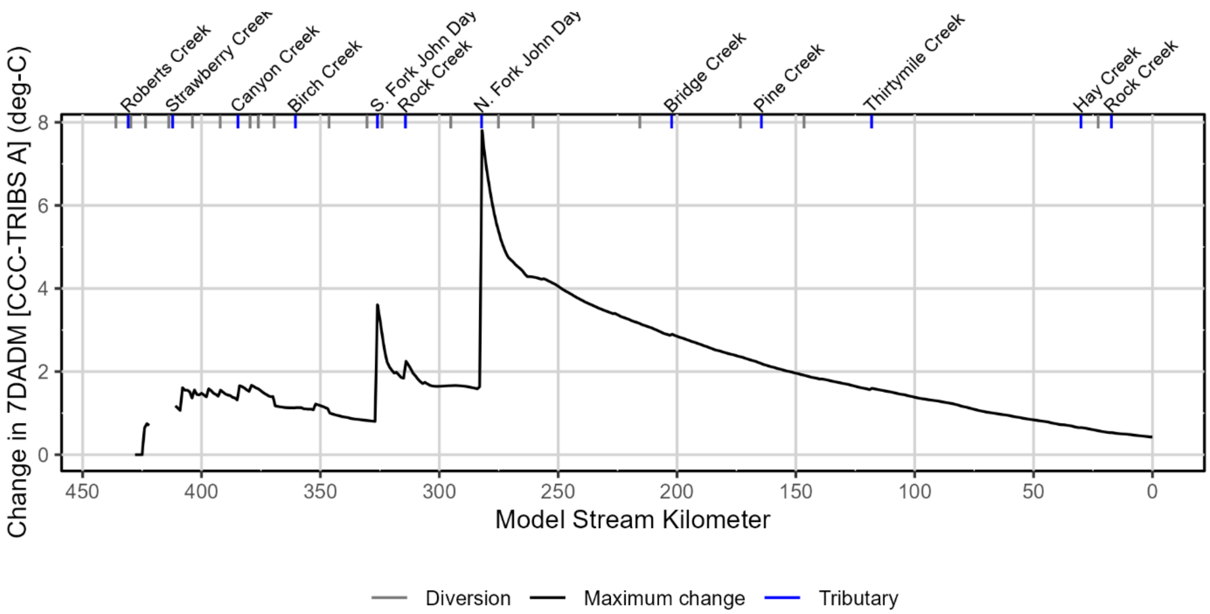


**Figure 4-10: Change in maximum 7DADM stream temperatures between the Current Conditions Calibration (CCC) and Tributary Temperature A model scenarios for the John Day River over the entire model period.**

Tributary Temperature B scenario examines the temperature impacts of restored tributary temperatures. In this scenario, tributary temperatures are increased by 0.30°C to show inclusion of the reserve capacity.

**Table 4-11** summarizes the daily maximum stream temperature change between the Current Condition Calibration and Tributary Temperature B scenarios for the John Day River. It shows the daily maximum temperature difference at the most downstream node (the outlet) is equal to

0.02°C. In addition, the greatest daily maximum temperature difference between the two scenarios (POMI) is equal to 0.26°C and occurs at stream model km 282.

**Figure 4-11** shows the change in the daily maximum stream temperatures between the Current Condition Calibration and Tributary Temperature B model scenarios for the John Day River over the entire model period.

**Table 4-11: Summary of maximum 7DADM stream temperature change between Current Condition Calibration and Tributary Temperature B (HUA = 0.30) model scenarios for the John Day River over the entire model period.**

| Temperature Metric | Model KM | Scenario | Stream Temperature (°C) | Location |
|---|---|---|---|---|
| 7DADM | 0 | Change | 0.02 | outlet |
| 7DADM | 282 | Change | 0.26 | POMI |

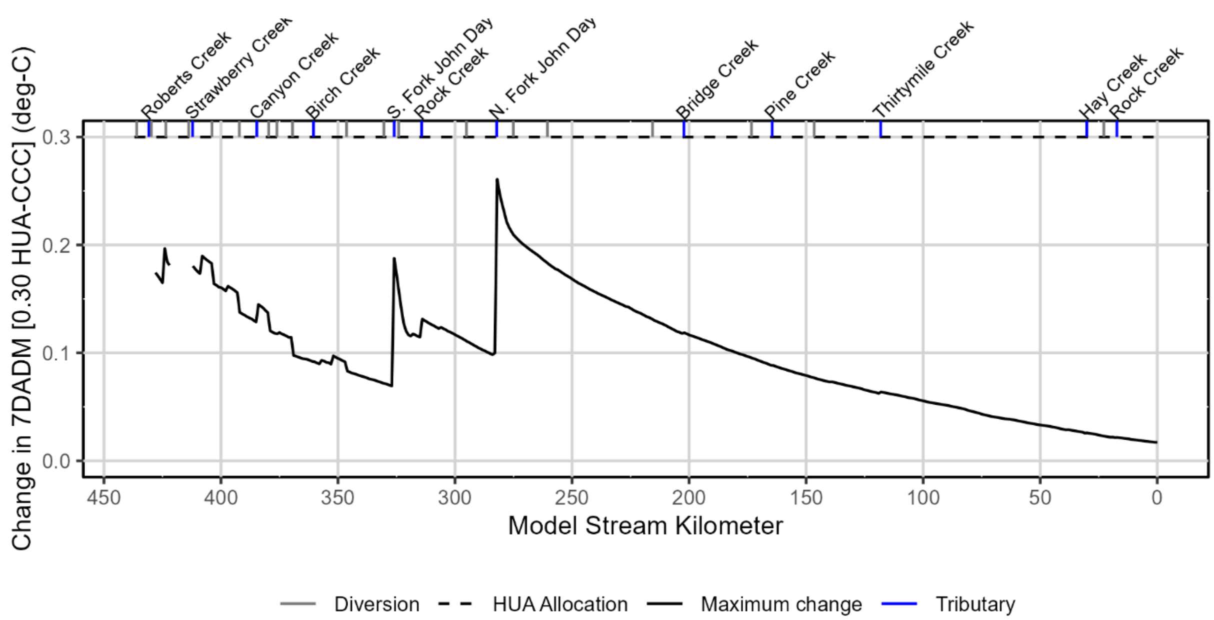


**Figure 4-11: Change in maximum 7DADM stream temperatures between the Current Conditions Calibration (CCC) and Tributary Temperature B (HUA = 0.30°C; 0.30 HUA) model scenarios for the John Day River over the entire model period.**

## 4.1.4 Channel morphology

**Table 4-12** summarizes the daily maximum stream temperature change between the Current Condition Calibration and 30% of Channel Morphology scenarios for the John Day River. It shows the daily maximum temperature difference at the most downstream node (the outlet) is equal to 0.63°C. In addition, the greatest daily maximum temperature difference between the two scenarios (POMI) is equal to 6.83°C and occurs at stream model km 393.

**Figure 4-12** shows the change in the daily maximum stream temperatures between the Current Condition Calibration and 30% of Channel Morphology model scenarios for the John Day River over the entire model period.

**Table 4-12: Summary of maximum 7DADM stream temperature change between Current Condition Calibration and 30% of Channel Morphology model scenarios for the John Day River over the entire model period.**

| Temperature Metric | Model KM | Scenario | Stream Temperature (°C) | Location |
|---|---|---|---|---|
| 7DADM | 0 | Change | 0.63 | outlet |
| 7DADM | 393 | Change | 6.83 | POMI |

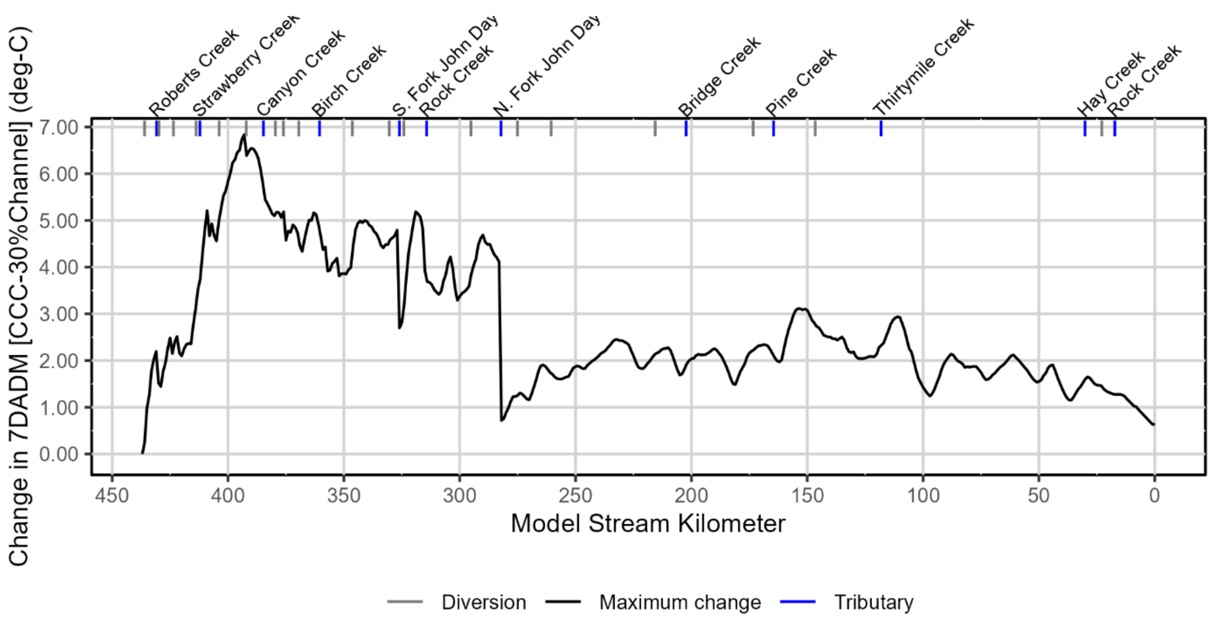


**Figure 4-12: Change in maximum 7DADM stream temperatures between the Current Conditions Calibration (CCC) and 30% Channel Morphology (30%Channel) scenarios for the John Day River over the entire model period.**

## 4.1.5 Wasteload allocations

This section summarizes the temperature impacts of point sources discharging at their wasteload allocations. The impact of the wasteload allocations was determined by comparing the Wasteload Allocation scenario to the No Point Source scenario.

The No Point Source scenario for the John Day River model is equivalent to the Calibrated Current Conditions (CCC) scenario, which includes zero discharges from the three individually permitted point sources along the river.

The Wasteload Allocation scenario was conducted by modifying point source discharges to reflect proposed or existing TMDL wasteload allocations. In the model, effluent temperatures were calculated using equations described in the John Day River Basin TSD (Section XXX

Wasteload allocation equation), and effluent flows were based on the NPDES-permitted average design flow.

**Table 4-13** summarizes the 7DADM stream temperature changes between the Wasteload Allocations and No Point Sources scenarios for the John Day River. The results show that at the most downstream node (the outlet) the wasteload allocations have no impact on 7DADM temperatures (0°C warming). At the POMI, the 7DADM temperature difference is 0.1°C.

**Figure 4-13** displays the change in maximum 7DADM stream temperatures between the Wasteload Allocations and No Point Sources scenarios over the entire John Day River model period. The greatest temperature change occurred at the Mt. Vernon STP (model km 370), where the 7DADM stream temperature was approximately 0.1°C warmer in the Wasteload Allocations scenario than in the No Point Sources scenario.

**Table 4-13: Summary of maximum 7DADM stream temperature change between Wasteload Allocations and No Point Sources model scenarios for the John Day River over the entire model period.**

| Temperature Metric | Model KM | Scenario | Stream Temperature (°C) | Location |
|---|---|---|---|---|
| 7DADM | 0 | Change | 0.00 | outlet |
| 7DADM | 370 | Change | 0.10 | POMI |

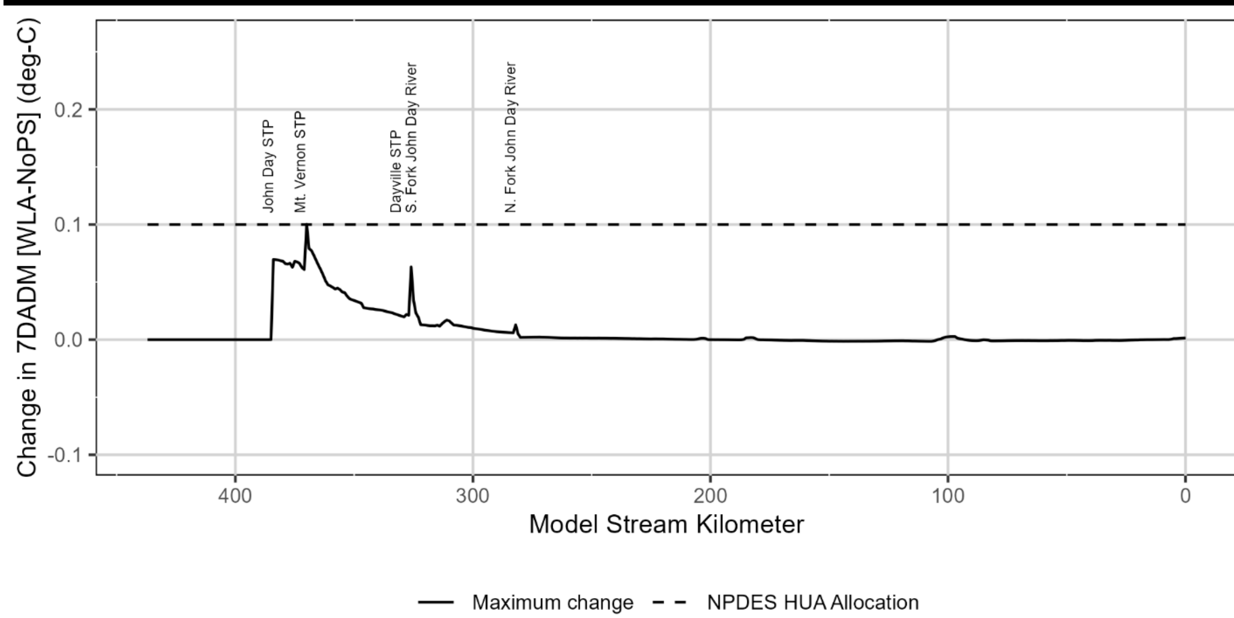


**Figure 4-13: Change in maximum 7DADM stream temperatures between the Wasteload Allocations and No Point Sources scenarios for the John Day River over the entire model period.**

## 4.1.6 Background

This scenario summarizes the temperature impacts of background conditions.

**Table 4-14** summarizes the daily maximum stream temperature change between the Current Condition Calibration and Background scenarios for the John Day River. The Background scenario shown here uses the 30% Channel Morphology to represent morphology. It shows the daily maximum temperature difference at the most downstream node (the outlet) is equal to 1.00°C. In addition, the greatest daily maximum temperature difference between the two scenarios (POMI) is equal to 13.52°C and occurs at stream model km 327.

**Figure 4-14** shows the change in the daily maximum stream temperatures between the Current Condition Calibration and Background model scenarios for the John Day River over the entire model period.

**Table 4-14: Summary of maximum 7DADM stream temperature change between Current Conditions Calibration and Background model scenarios for the John Day River over the entire model period.**

| Temperature Metric | Model KM | Scenario | Stream Temperature (°C) | Location |
|---|---|---|---|---|
| 7DADM | 0 | Change | 1.00 | outlet |
| 7DADM | 327 | Change | 13.52 | POMI |

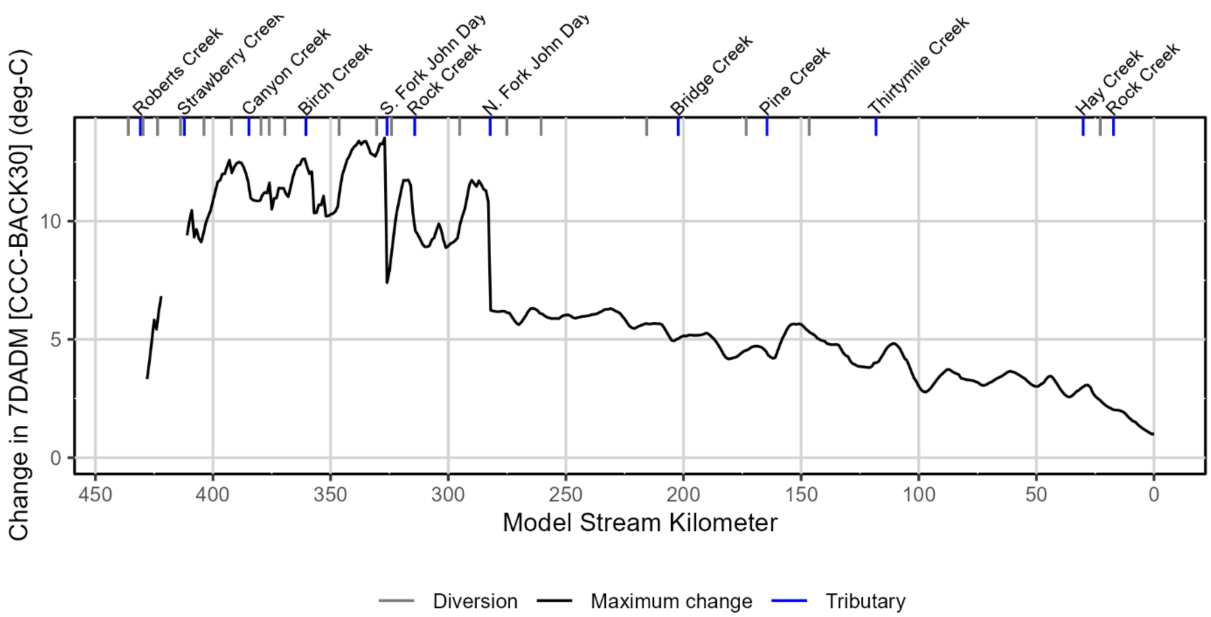


**Figure 4-14: Change in maximum 7DADM stream temperatures between the Current Conditions Calibration and Background model scenarios for the John Day River over the entire model period.**

**Table 4-15** summarizes the daily maximum stream temperature change between the Background scenario and the BBNC for the John Day River. It shows the daily maximum temperature difference at the most downstream node (the outlet) is equal to 7.65°C. In addition, the greatest daily maximum temperature difference between the two scenarios (POMI) is equal to 7.65°C and occurs at stream model km 27.

**Figure 4-15** shows the change in the daily maximum stream temperatures between the Background model scenario and the BBNC for the John Day River over the entire model period.

**Table 4-15: Summary of maximum 7DADM stream temperature change between the Background model scenario and BBNC for the John Day River over the entire model period.**

| Temperature Metric | Model KM | Scenario | Stream Temperature (°C) | Location |
|---|---|---|---|---|
| 7DADM | 0 | Change | 7.53 | outlet |
| 7DADM | 27 | Change | 7.65 | POMI |

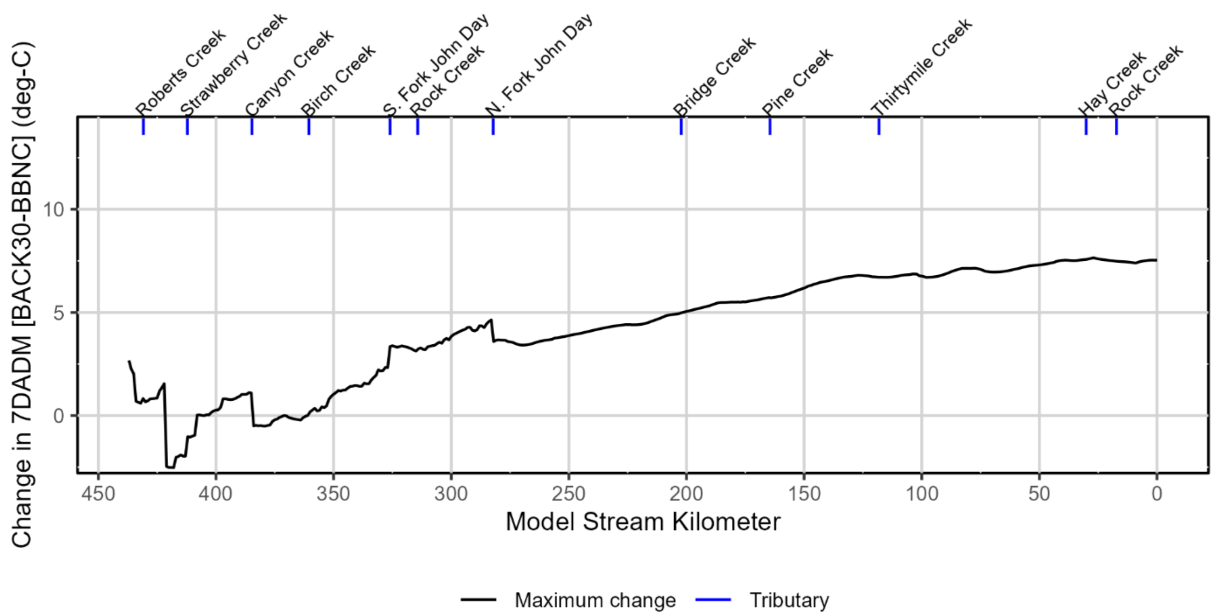


**Figure 4-15: Change in maximum 7DADM stream temperatures between the Background model scenario and the BBNC for the John Day River over the entire model period.**

## 4.1.7 HUA Attainment scenario

**Table 4-16** summarizes the HUA attainment scenario model set up.

**Table 4-16: HUA Attainment model scenario set up for John Day River.**

| Model input variable | Attainment scenario setup description |
|---|---|
| Riparian landcover | Set to system potential vegetation conditions. |
| Tributary temperatures | Hourly tributary temperatures were increased by the assigned allocations on each tributary; hourly temperatures were increased by 0.25°C which is the total proposed HUA minus the reserve capacity. |
| Tributary flow | Equivalent to tributary flows used in 1% consumptive use model scenario. |
| Boundary condition temperature | Equivalent to boundary condition temperatures used in 1% consumptive use model scenario. |
| Boundary condition flow | Equivalent to boundary condition flows used in 10% consumptive use model scenario. |

| Model input variable | Attainment scenario setup description |
|---|---|
| Withdrawals | Equivalent to withdrawals used in current conditions model calibration. |
| NPDES point sources | There are no NPDES point source discharges within the model extent, though there is an allocation assigned to point sources. |
| Nonpoint source dam and reservoir operations | There are no dam or reservoir operations within the model extent. |
| Solar loading from existing infrastructure | Solar loading from existing infrastructure was modeled |

**Table 4-17** summarizes the daily maximum stream temperature change between the Attainment and Background scenarios for the John Day River. It shows the daily maximum temperature difference at the most downstream node (the outlet) is equal to 0.01°C. In addition, the greatest daily maximum temperature difference between the two scenarios (POMI) is equal to 0.19°C and occurs at stream model km 326.

**Figure 4-16** shows the change in the daily maximum stream temperatures between the Attainment and Background model scenarios for the John Day River over the entire model period.

**Table 4-17: Summary of maximum 7DADM stream temperature change between the Attainment and Background model scenarios for the John Day River over the entire model period.**

| Temperature Metric | Model KM | Scenario | Stream Temperature (°C) | Location |
|---|---|---|---|---|
| 7DADM | 0 | Change | 0.01 | outlet |
| 7DADM | 326 | Change | 0.19 | POMI |

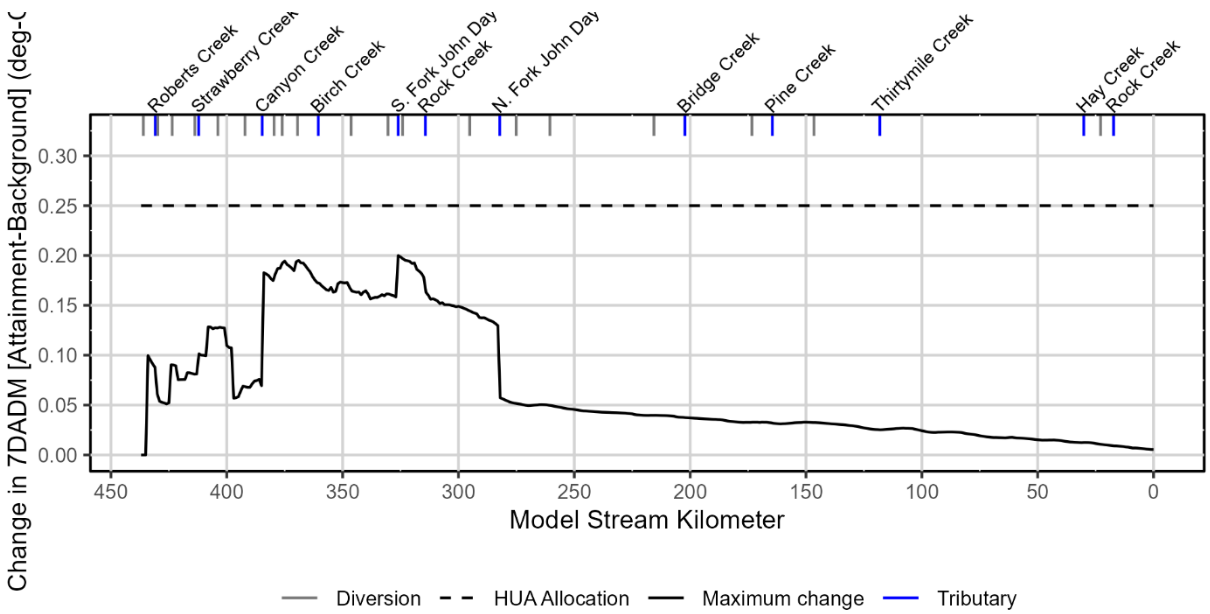


**Figure 4-16: Change in maximum 7DADM stream temperatures between the Attainment and Background model scenarios for the John Day River over the entire model period.**

# 4.2 North Fork John Day River

**Table 4-18** summarizes the 7DADM stream temperatures predicted at the mouth and at the POMI of the North Fork John Day River for all model scenarios.

**Table 4-19** daily maximum stream temperatures predicted at the mouth of the North Fork John Day River for all model scenarios.

**Table 4-18: Summary of maximum 7DADM stream temperature at the mouth of the North Fork John Day River for all model scenarios over the entire model period.**

| Temperature Metric | Scenario | Stream Temperature (°C) | Location |
|---|---|---|---|
| 7DADM | Current Conditions | 27.42 | Outlet |
| 7DADM | Restored Vegetation A | 27.07 | Outlet |
| 7DADM | Restored Vegetation B | 27.09 | Outlet |
| 7DADM | Restored Flow | 26.65 | Outlet |
| 7DADM | 1% Consumptive Use | 26.75 | Outlet |
| 7DADM | Tributary Temperature A | 26.92 | Outlet |
| 7DADM | Tributary Temperature B | 27.44 | Outlet |
| 7DADM | Channel Morphology | 26.31 | Outlet |
| 7DADM | Attainment | 26.58 | Outlet |
| 7DADM | Background | 26.41 | Outlet |

**Table 4-19:Summary of daily maximum stream temperature at the mouth of the North Fork John Day River for all model scenarios over the entire model period.**

| Temperature Metric | Scenario | Stream Temperature (°C) | Location |
|---|---|---|---|
| Daily Maximum | Current Conditions | 28.46 | Outlet |
| Daily Maximum | Restored Vegetation A | 28.12 | Outlet |
| Daily Maximum | Restored Vegetation B | 28.13 | Outlet |
| Daily Maximum | Restored Flow | 27.57 | Outlet |
| Daily Maximum | 1% Consumptive Use | 27.69 | Outlet |
| Daily Maximum | Tributary Temperature A | 27.98 | Outlet |
| Daily Maximum | Tributary Temperature B | 28.48 | Outlet |
| Daily Maximum | Channel Morphology | 27.21 | Outlet |
| Daily Maximum | Attainment | 27.55 | Outlet |
| Daily Maximum | Background | 27.40 | Outlet |

## 4.2.1 Vegetation scenarios

**Table 4-20** summarizes the daily maximum stream temperature change between the Current Condition Calibration and Restored Vegetation A scenarios for the North Fork John Day River. It shows the daily maximum temperature difference at the most downstream node (the outlet) is equal to 0.43°C. In addition, the greatest daily maximum temperature difference between the two scenarios (POMI) is equal to 7.68°C and occurs at stream model km 152.2.

**Figure 4-17** shows the change in the daily maximum stream temperatures between the Current Condition Calibration and Restored Vegetation A model scenarios for the North Fork John Day River over the entire model period.

**Table 4-20: Summary of maximum 7DADM stream temperature change between Current Condition Calibration and Restored Vegetation A model scenarios for the North Fork John Day River over the entire model period.**

| Temperature Metric | Model KM | Scenario | Stream Temperature (°C) | Location |
|---|---|---|---|---|
| 7DADM | 0 | Change | 0.43 | outlet |
| 7DADM | 152.2 | Change | 7.68 | POMI |

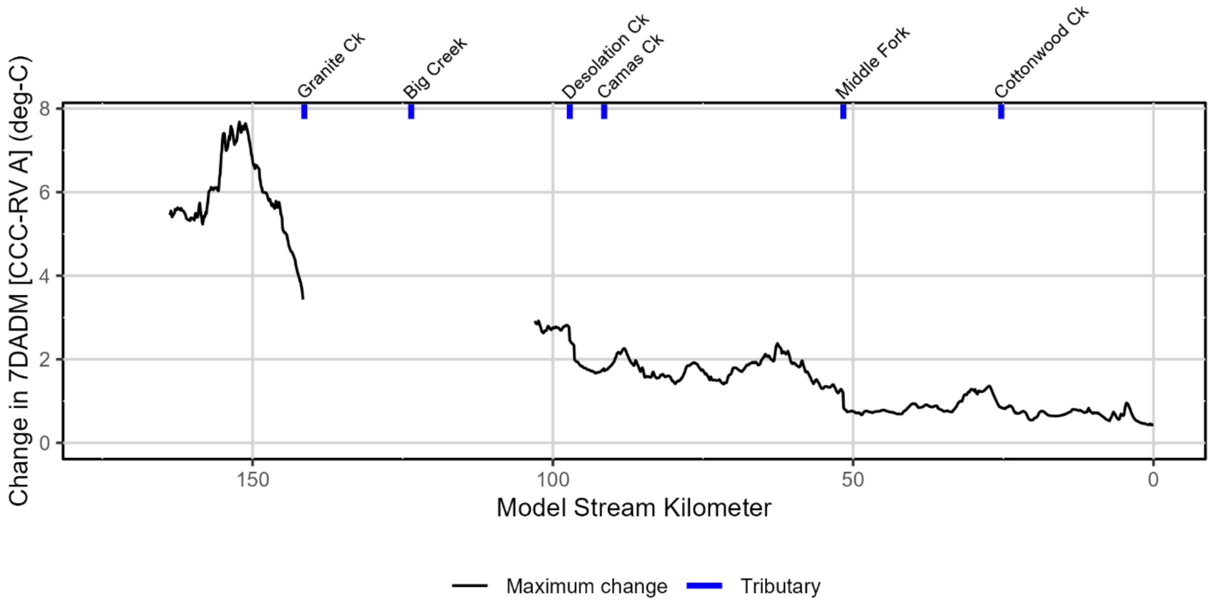


**Figure 4-17: Change in maximum 7DADM stream temperatures between the Current Conditions Calibration and Restored Vegetation A (RV A) model scenarios for the North Fork John Day River over the entire model period.**

**Table 4-21** summarizes the daily maximum stream temperature change between the Current Condition Calibration and Restored Vegetation B scenarios for the North Fork John Day River. It shows the daily maximum temperature difference at the most downstream node (the outlet) is equal to 0.42°C. In addition, the greatest daily maximum temperature difference between the two scenarios (POMI) is equal to 7.68°C and occurs at stream model km 410.

**Figure 4-18**shows the change in the daily maximum stream temperatures between the Current Condition Calibration and Restored Vegetation B model scenarios for the North Fork John Day River over the entire model period.

**Table 4-21: Summary of maximum 7DADM stream temperature change between Current Condition Calibration and Restored Vegetation B model scenarios for the North Fork John Day River over the entire model period.**

| Temperature Metric | Model KM | Scenario | Stream Temperature (°C) | Location |
|---|---|---|---|---|
| 7DADM | 0 | Change | 0.42 | outlet |
| 7DADM | 152.2 | Change | 7.68 | POMI |

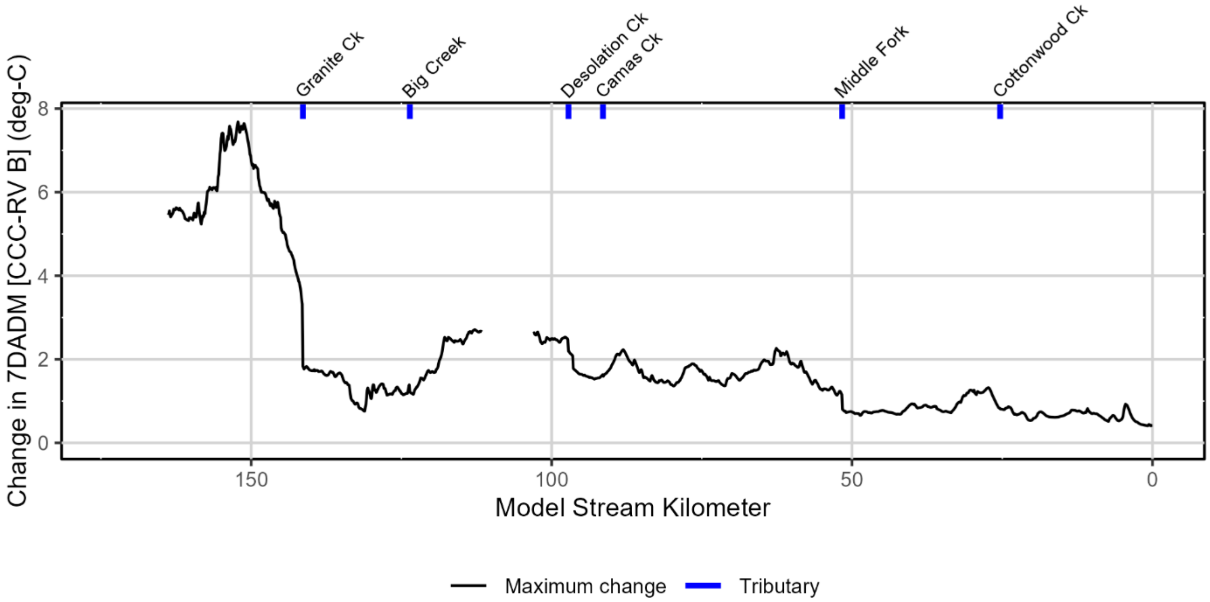


**Figure 4-18: Change in maximum 7DADM stream temperatures between the Current Conditions Calibration and Restored Vegetation A (RV B) model scenarios for the North Fork John Day River over the entire model period.**

**Table 4-22** summarizes the daily maximum stream temperature change between the Restored Vegetation B and Restored Vegetation A scenarios for the North Fork John Day River in order to understand the impact of transportation corridors (such as roads and highways) and urban, residential, commercial or industrial development (buildings). It shows the daily maximum temperature difference at the most downstream node (the outlet) is equal to 0.03°C. In addition, the greatest daily maximum temperature difference between the two scenarios (POMI) is equal to 0.29°C and occurs at stream model km 97.5.

**Figure 4-19** shows the change in the daily maximum stream temperatures between the Restored Vegetation B and restored Vegetation A model scenarios for the North Fork John Day River over the entire model period.

**Table 4-22: Summary of maximum 7DADM stream temperature change Restored Vegetation B and Restored Vegetation A model scenarios for the North Fork John Day River over the entire model period.**

| Temperature Metric | Model KM | Scenario | Stream Temperature (°C) | Location |
|---|---|---|---|---|
| 7DADM | 0 | Change | 0.03 | outlet |
| 7DADM | 97.5 | Change | 0.29 | POMI |

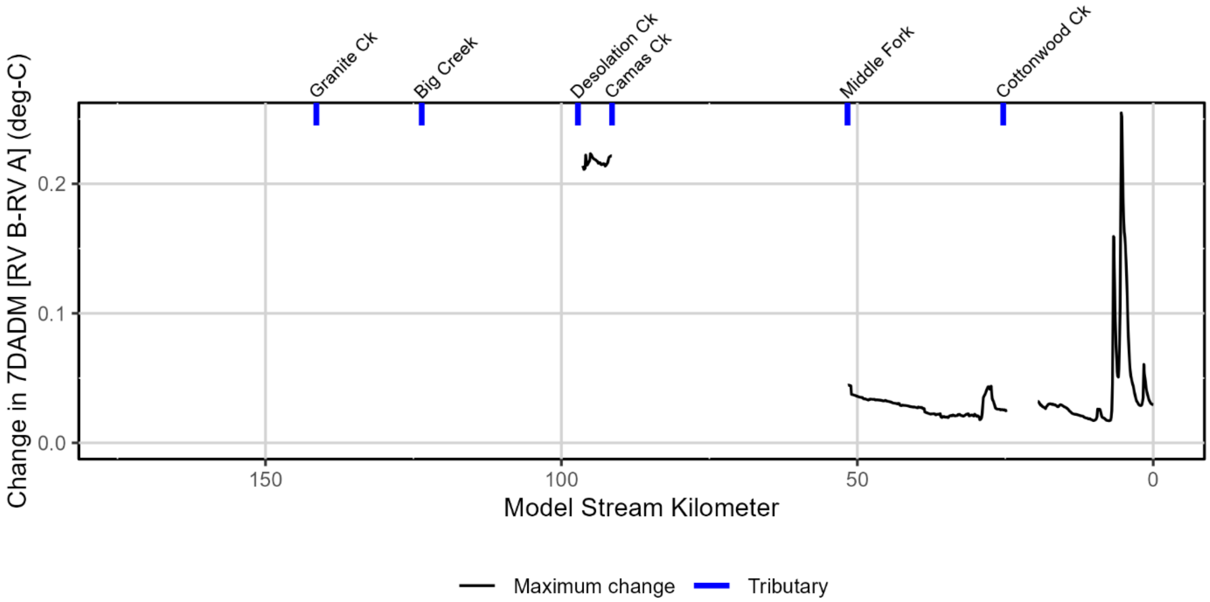


**Figure 4-19: Change in maximum 7DADM stream temperatures between the Restored Vegetation B (RV B) and Restored Vegetation A (RV A) model scenarios for the North Fork John Day River over the entire model period.**

**Table 4-23** summarizes the mean effective shade for the Calibration, Current 2023 Condition, Restored Vegetation A, and Topographic Shade scenarios for the North Fork John Day River. The difference in mean effective shade between the Restored Vegetation A and Current 2023 Condition scenarios is equal to 19.69 percentage points.

**Figure 4-20** and **Figure 4-21** compare effective shade predictions from the Restored Vegetation A and Current 2023 Condition scenarios for the North Fork John Day River. **Figure 4-22** compares effective shade predictions from the Current 2023 Condition and Topographic Shade scenarios for the North Fork John Day River.

**Table 4-23: Summary of mean effective shade for the Current Condition, Restored Vegetation A and Topographic Shade scenarios for the North Fork John Day River.**

| Scenario | Mean effective shade (%) |
|---|---|
| Calibration | 24.17 |
| Current 2023 Condition | 19.57 |
| Restored Vegetation | 39.27 |
| Shade Gap (Restored – Current 2023) | 19.69 |
| Topographic Shade | 11.35 |

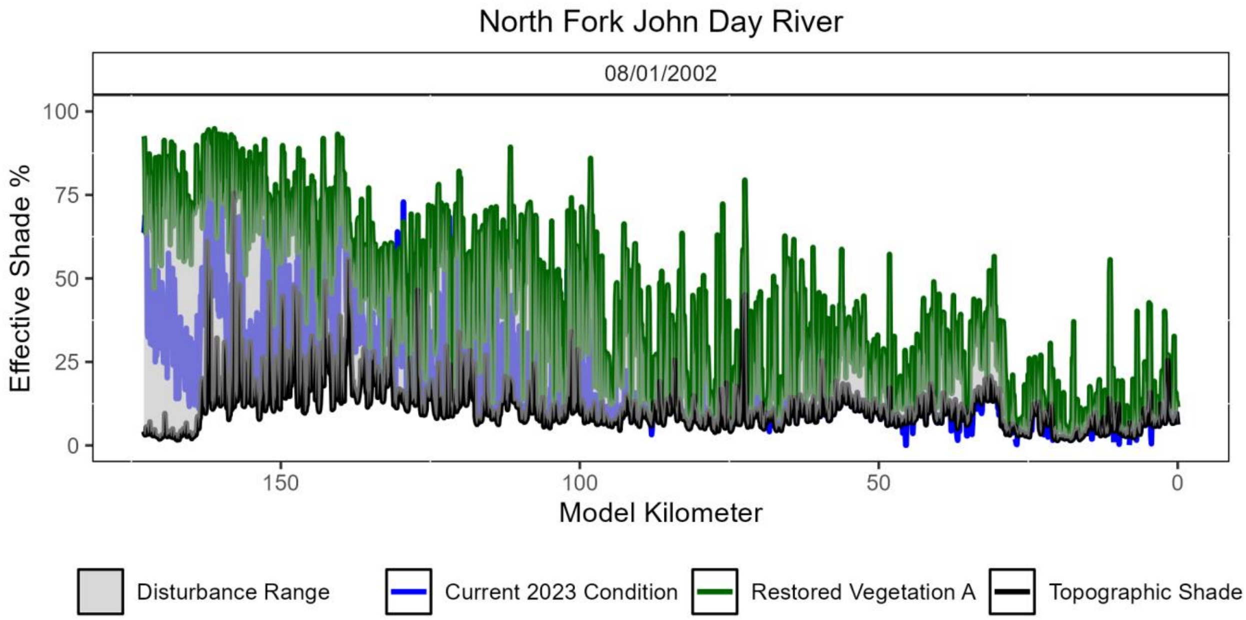


**Figure 4-20: Comparison of effective shade from the Current Condition, Restored Vegetation, and Topographic Shade scenarios for the North Fork John Day River.**

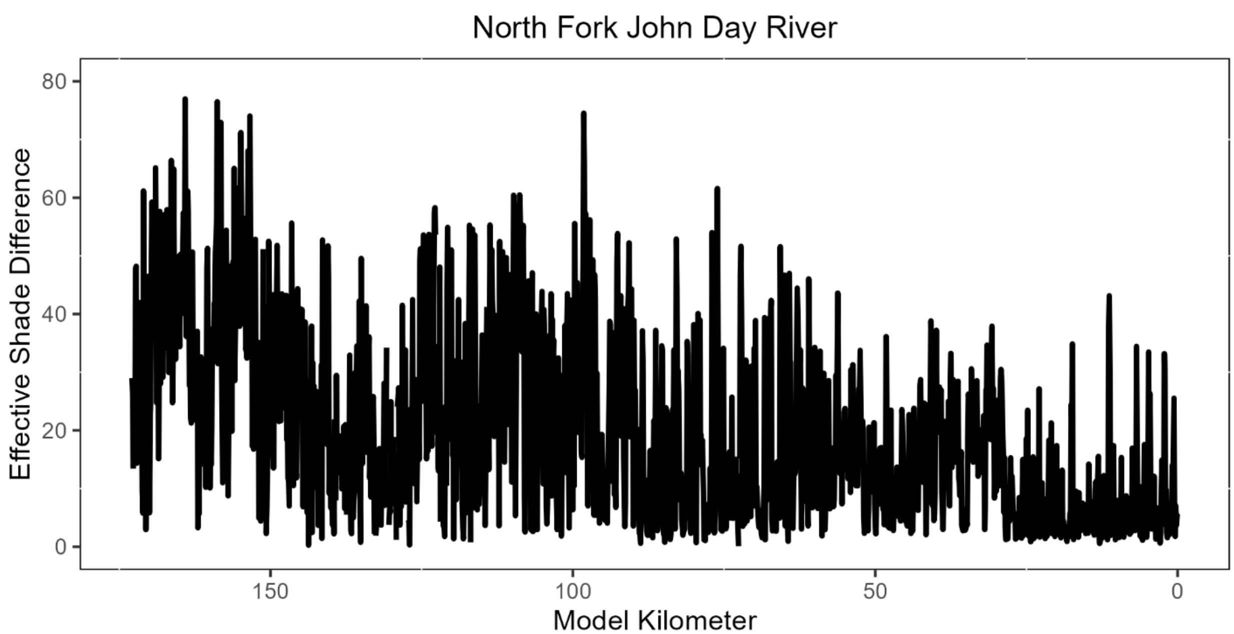


**Figure 4-21: Percentage point difference between effective shade from the Restored Vegetation A and Current 2023 Condition scenarios for the North Fork John Day River.**

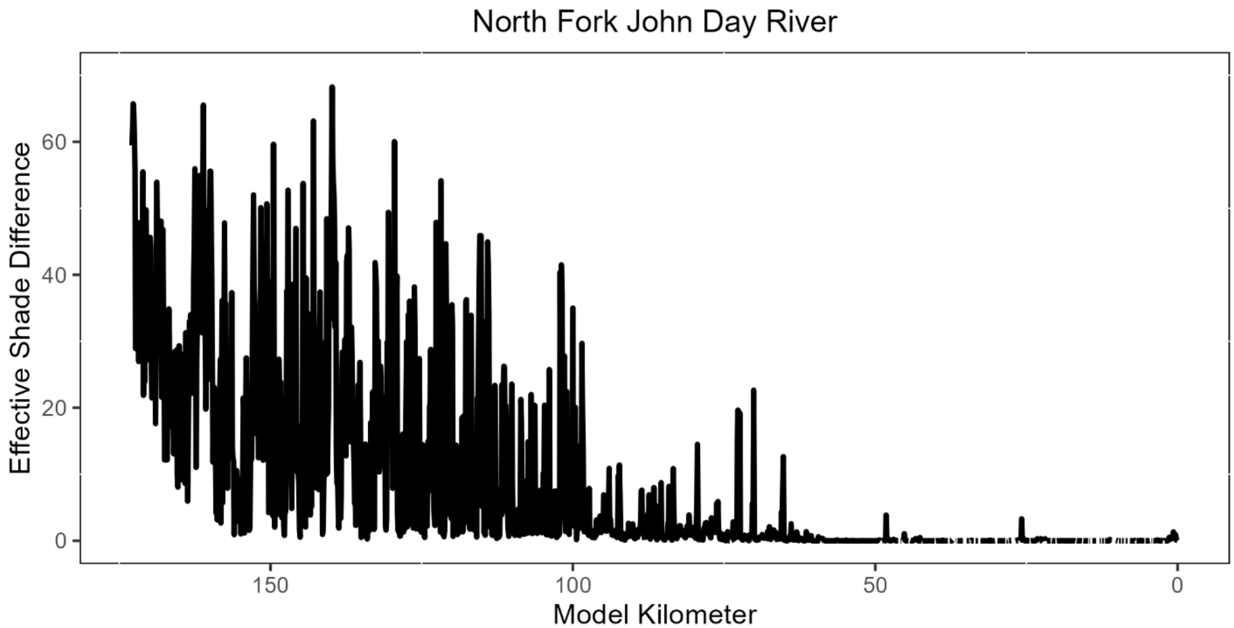


**Figure 4-22: Percentage point difference between effective shade from the Current Condition and Topographic Shade scenarios for the North Fork John Day River.**

## 4.2.2 Flow scenarios

**Table 4-24** summarizes the daily maximum stream temperature change between the Current Condition Calibration and Restored Flow scenarios for the North Fork John Day River. This comparison evaluates the temperature impacts from flow deviations from natural conditions. It shows the daily maximum temperature difference at the most downstream node (the outlet) is equal to 1.61°C. In addition, the greatest daily maximum temperature difference between the two scenarios (POMI) is equal to 2.34°C and occurs at stream model km 132.7.

**Figure 4-23** shows the change in the daily maximum stream temperatures between the Current Condition Calibration and Restored Flow model scenarios for the North Fork John Day River over the entire model period.

**Table 4-24: Summary of maximum 7DADM stream temperature change between Current Conditions and Restored Flow model scenarios for the North Fork John Day River over the entire model period.**

| Temperature Metric | Model KM | Scenario | Stream Temperature (°C) | Location |
|---|---|---|---|---|
| 7DADM | 0 | Change | 1.61 | outlet |
| 7DADM | 132.7 | Change | 2.34 | POMI |

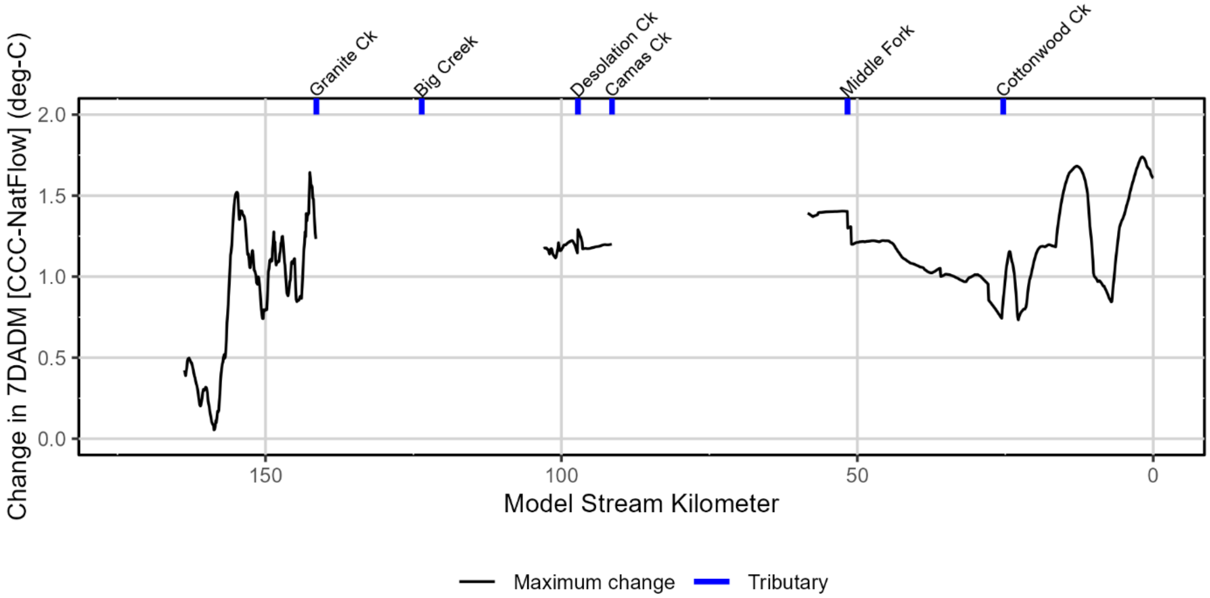


**Figure 4-23: Change in maximum 7DADM stream temperatures between the Current Conditions and Restored Flow model scenarios for the North Fork John Day River over the entire model period.**

**Table 4-25** summarizes the daily maximum stream temperature change between the 1% Consumptive Use and Restored Flow scenarios for the North Fork John Day River. This comparison evaluates the effect of water withdrawals (1% of consumptive use) on temperature. It shows the daily maximum temperature difference at the most downstream node (the outlet) is equal to 0.33°C. In addition, the greatest daily maximum temperature difference between the two scenarios (POMI) is equal to 1.14°C and occurs at stream model km 154.8.

**Figure 4-24** shows the change in the daily maximum stream temperatures between the 1% Consumptive Use and Restored Flow model scenarios for the North Fork John Day River over the entire model period.

**Table 4-25: Summary of maximum 7DADM stream temperature change between Consumptive use (1%) and Restored Flow model scenarios for the North Fork John Day River over the entire model period.**

| Temperature Metric | Model KM | Scenario | Stream Temperature (°C) | Location |
|---|---|---|---|---|
| 7DADM | 0 | Change | 0.33 | outlet |
| 7DADM | 154.8 | Change | 1.14 | POMI |

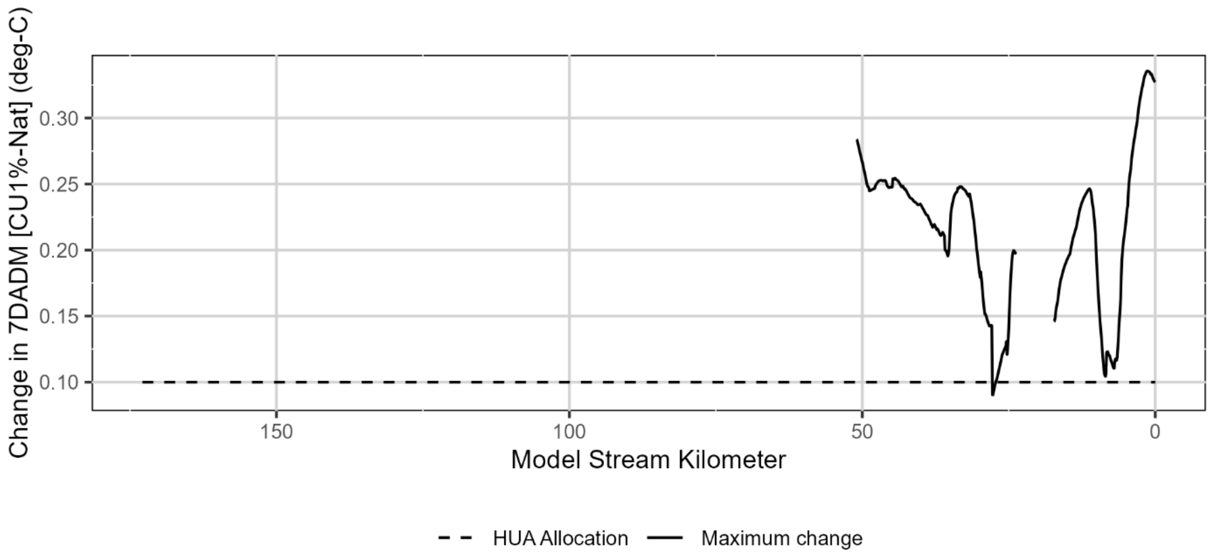


**Figure 4-24: Change in maximum 7DADM stream temperatures between the Consumptive Use (1%) and Restored Flow model (Nat) scenarios for the North Fork John Day River over the entire model period.**

### 4.2.3 Tributary temperatures

This section summarizes the temperature impacts of tributary temperatures. Tributary Temperature A scenario examines exceedances of the water quality standards at the tributaries.

**Table 4-26** summarizes the daily maximum stream temperature change between the Current Condition Calibration and Tributary Temperature A scenarios for the North Fork John Day River. It shows the daily maximum temperature difference at the most downstream node (the outlet) is equal to 1.73C. In addition, the greatest daily maximum temperature difference between the two scenarios (POMI) is equal to 5.65°C and occurs at stream model km 51.

**Figure 4-25** shows the change in the daily maximum stream temperatures between the Current Condition Calibration and Tributary Temperature A model scenarios for the John Day River over the entire model period.

**Table 4-26: Summary of maximum 7DADM stream temperature change between Current Condition Calibration and Tributary Temperature A model scenarios for the John Day River over the entire model period.**

| Temperature Metric | Model KM | Scenario | Stream Temperature (°C) | Location |
|---|---|---|---|---|
| 7DADM | 0 | Change | 1.73 | outlet |
| 7DADM | 51 | Change | 5.65 | POMI |

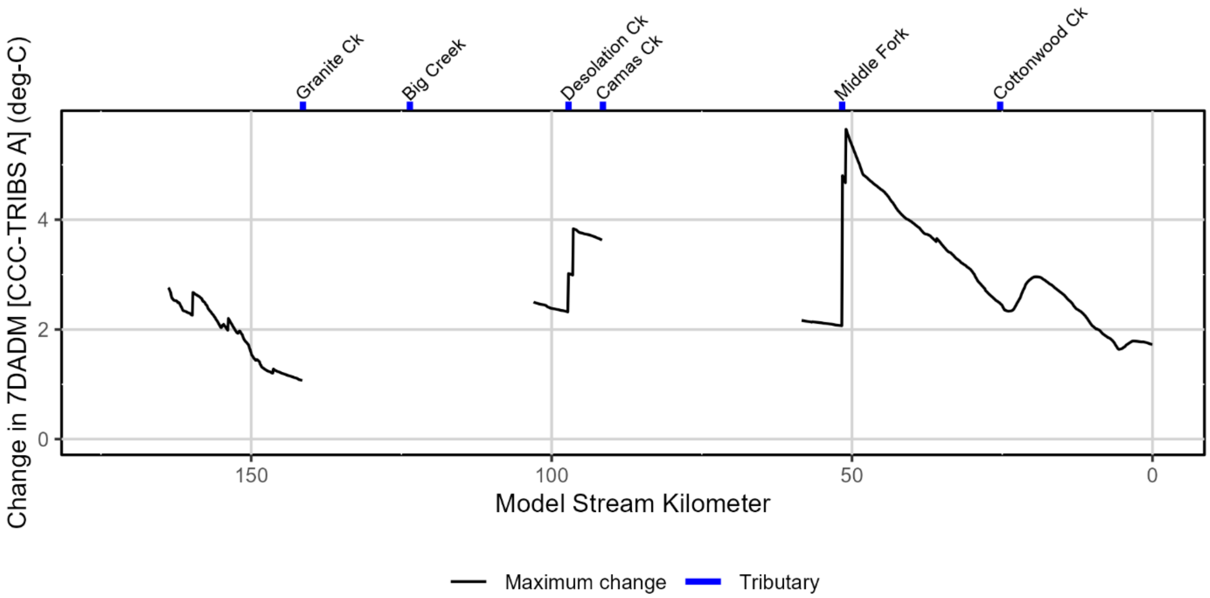


**Figure 4-25: Change in maximum 7DADM stream temperatures between the Current Conditions Calibration (CCC) and Tributary Temperature A model scenarios for the John Day River over the entire model period.**

Tributary Temperature B scenario examines the temperature impacts of restored tributary temperatures. In this scenario, tributary temperatures are increased by 0.30°C to show inclusion of the reserve capacity.

**Table 4-27** summarizes the daily maximum stream temperature change between the Current Condition Calibration and Tributary Temperature B scenarios for the North Fork John Day River. It shows the daily maximum temperature difference at the most downstream node (the outlet) is equal to 0.13°C. In addition, the greatest daily maximum temperature difference between the two scenarios (POMI) is equal to 0.21°C and occurs at stream model km 51.

**Figure 4-26** shows the change in the daily maximum stream temperatures between the Current Condition Calibration and Tributary Temperature B model scenarios for the North Fork John Day River over the entire model period.

**Table 4-27: Summary of maximum 7DADM stream temperature change between the Tributary Temperature B (HUA=0.30) and Current Condition Calibration model scenarios for the North Fork John Day River over the entire model period.**

| Temperature Metric | Model KM | Scenario | Stream Temperature (°C) | Location |
|---|---|---|---|---|
| 7DADM | 0 | Change | 0.13 | outlet |
| 7DADM | 51 | Change | 0.21 | POMI |

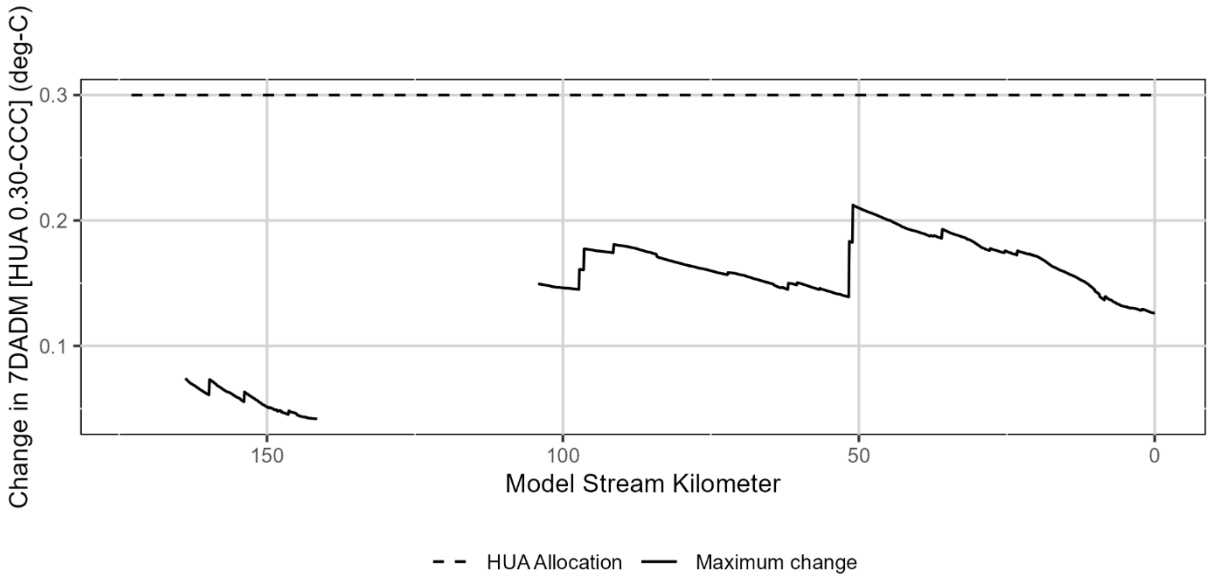


**Figure 4-26: Change in maximum 7DADM stream temperatures between the Tributary Temperature B (HUA=0.30) model scenario and the Current Conditions Calibration for the North Fork John Day River over the entire model period.**

## 4.2.4 Channel Morphology

**Table 4-28** summarizes the daily maximum stream temperature change between the Current Condition Calibration and 30% of Channel Morphology scenarios for the North Fork John Day River. It shows the daily maximum temperature difference at the most downstream node (the outlet) is equal to 1.71°C. In addition, the greatest daily maximum temperature difference between the two scenarios (POMI) is equal to 2.81°C and occurs at stream model km 72.3.

**Figure 4-27** shows the change in the daily maximum stream temperatures between the Current Condition Calibration and 30% of Channel Morphology model scenarios for the North Fork John Day River over the entire model period.

**Table 4-28: Summary of maximum 7DADM stream temperature change between Current Condition Calibration and Channel Morphology (30%) model scenarios for the North Fork John Day River over the entire model period.**

| Temperature Metric | Model KM | Scenario | Stream Temperature (°C) | Location |
|---|---|---|---|---|
| 7DADM | 0 | Change | 1.71 | outlet |
| 7DADM | 72.3 | Change | 2.81 | POMI |

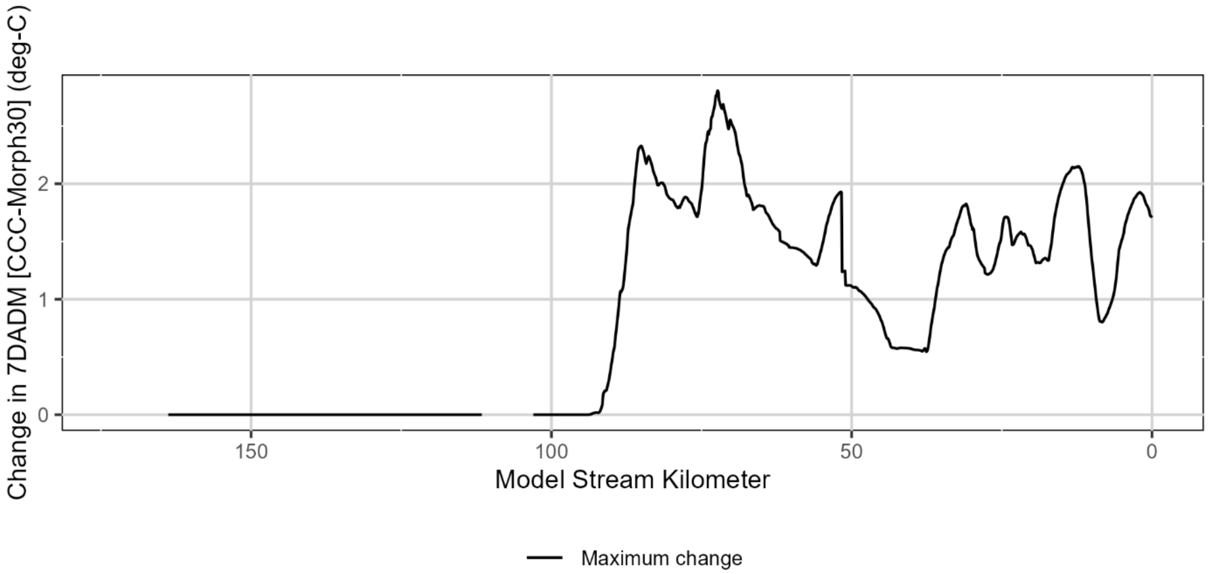


**Figure 4-27: Change in maximum 7DADM stream temperatures between the Current Conditions Calibration and Channel Morphology (30%) model scenarios for the North Fork John Day River over the entire model period.**

## 4.2.5 Background

This scenario summarizes the temperature impacts of background conditions.

**Table 4-29** summarizes the daily maximum stream temperature change between the Current Condition Calibration and Background scenarios for the North Fork John Day River. The Background scenario shown here uses the 30% Channel Morphology to represent morphology. It shows the daily maximum temperature difference at the most downstream node (the outlet) is equal to 4.20°C. In addition, the greatest daily maximum temperature difference between the two scenarios (POMI) is equal to 6.11°C and occurs at stream model km 164.5.

**Figure 4-28** shows the change in the daily maximum stream temperatures between the Current Condition Calibration and Background model scenarios for the North Fork John Day River over the entire model period.

**Table 4-29: Summary of maximum 7DADM stream temperature change between Current Condition Calibration and Background (30%) model scenarios for the North Fork John Day River over the entire model period.**

| Temperature Metric | Model KM | Scenario | Stream Temperature (°C) | Location |
|---|---|---|---|---|
| 7DADM | 0 | Change | 4.20 | outlet |
| 7DADM | 164.5 | Change | 6.11 | POMI |

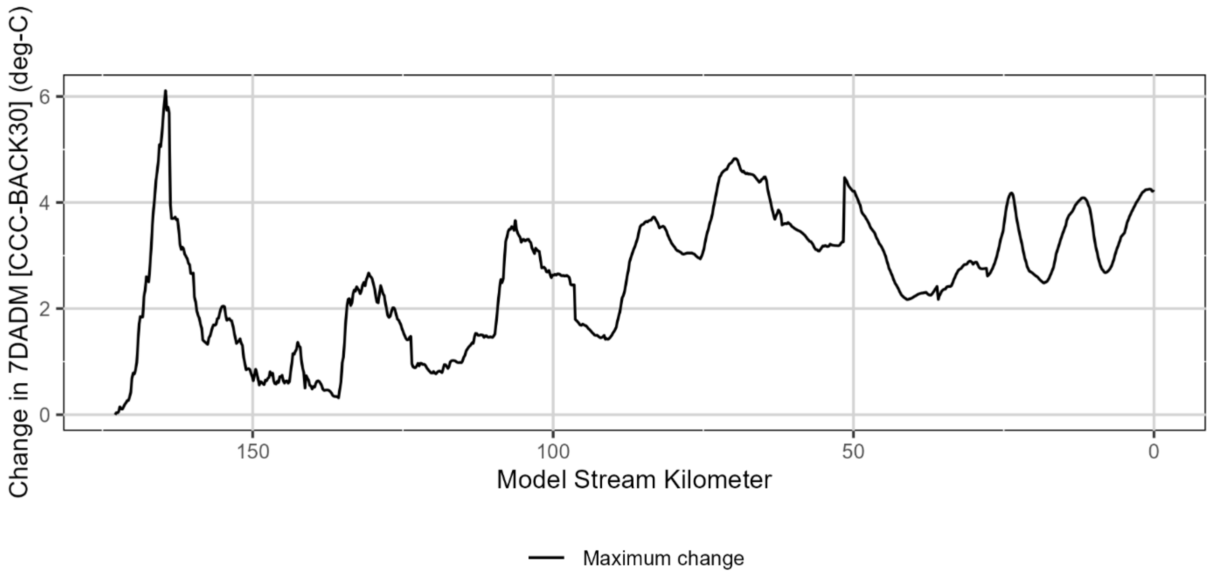


**Figure 4-28: Change in maximum 7DADM stream temperatures between the Current Conditions Calibration and Background (30%) model scenarios for the North Fork John Day River over the entire model period.**

**Table 4-30** summarizes the daily maximum stream temperature change between the Background scenario and the BBNC for the North Fork John Day River. It shows the daily maximum temperature difference at the most downstream node (the outlet) is equal to 7.04°C. In addition, the greatest daily maximum temperature difference between the two scenarios (POMI) is equal to 12.89°C and occurs at stream model km 152.3.

**Figure 4-29** shows the change in the daily maximum stream temperatures between the Background model scenario and the BBNC for the North Fork John Day River over the entire model period.

**Table 4-30: Summary of maximum 7DADM stream temperature change between the Background (30%) model scenario and the BBNC for the North Fork John Day River over the entire model period.**

| Temperature Metric | Model KM | Scenario | Stream Temperature (°C) | Location |
|---|---|---|---|---|
| 7DADM | 0 | Change | 7.04 | outlet |
| 7DADM | 152.3 | Change | 12.89 | POMI |

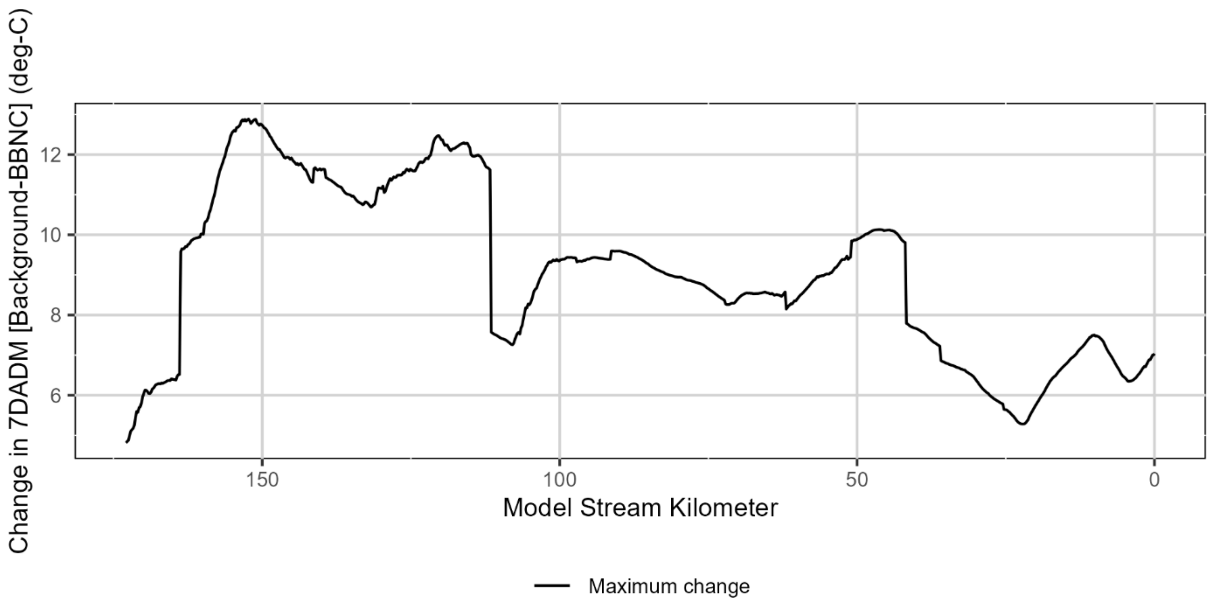


**Figure 4-29: Change in maximum 7DADM stream temperatures between Background (30%) model scenario and the BBNC for the North Fork John Day River over the entire model period.**

### 4.2.6 HUA Attainment

**Table 4-31** summarizes the HUA attainment scenario model set up.

**Table 4-31: HUA Attainment model scenario set up for the North Fork John Day River.**

| Model input variable | Attainment scenario setup description |
|---|---|
| Riparian landcover | Set to system potential vegetation conditions. |
| Tributary temperatures | Hourly tributary temperatures were increased by the assigned allocations on each tributary; hourly temperatures were increased by 0.30°C which is the total proposed HUA including the reserve capacity. |
| Tributary flow | Equivalent to tributary flows used in 1% consumptive use model scenario. |
| Boundary condition temperature | Equivalent to boundary condition temperatures used in 1% consumptive use model scenario. |
| Boundary condition flow | Equivalent to boundary condition flows used in 1% consumptive use model scenario. |
| Withdrawals | Equivalent to withdrawals used in 1% consumptive use model scenario. |
| NPDES point sources | There are no NPDES point source discharges within the model extent, the allocation assigned to point sources is 0.00°C. |
| Nonpoint source dam and reservoir operations | There are no dam or reservoir operations within the model extent, though there is an allocation assigned to this source of 0.00°C. |

| | |
|---|---|
| Solar loading from existing infrastructure | Solar loading from existing infrastructure was modeled |

**Table 4-32** summarizes the daily maximum stream temperature change between the Attainment and Background scenarios for the North Fork John Day River. It shows the daily maximum temperature difference at the most downstream node (the outlet) is equal to 0.91°C. In addition, the greatest daily maximum temperature difference between the two scenarios (POMI) is equal to 2.85°C and occurs at stream model km 51.5.

**Figure 4-30** shows the change in the daily maximum stream temperatures between the Attainment and Background model scenarios for the North Fork John Day River over the entire model period.

**Table 4-32: Summary of maximum 7DADN stream temperature change between the HUA Attainment and Background scenarios for the North Fork John Day River over the entire model period.**

| Temperature Metric | Model KM | Scenario | Stream Temperature (°C) | Location |
|---|---|---|---|---|
| 7DADM | 0 | Change | 0.91 | outlet |
| 7DADM | 51.5 | Change | 2.85 | POMI |

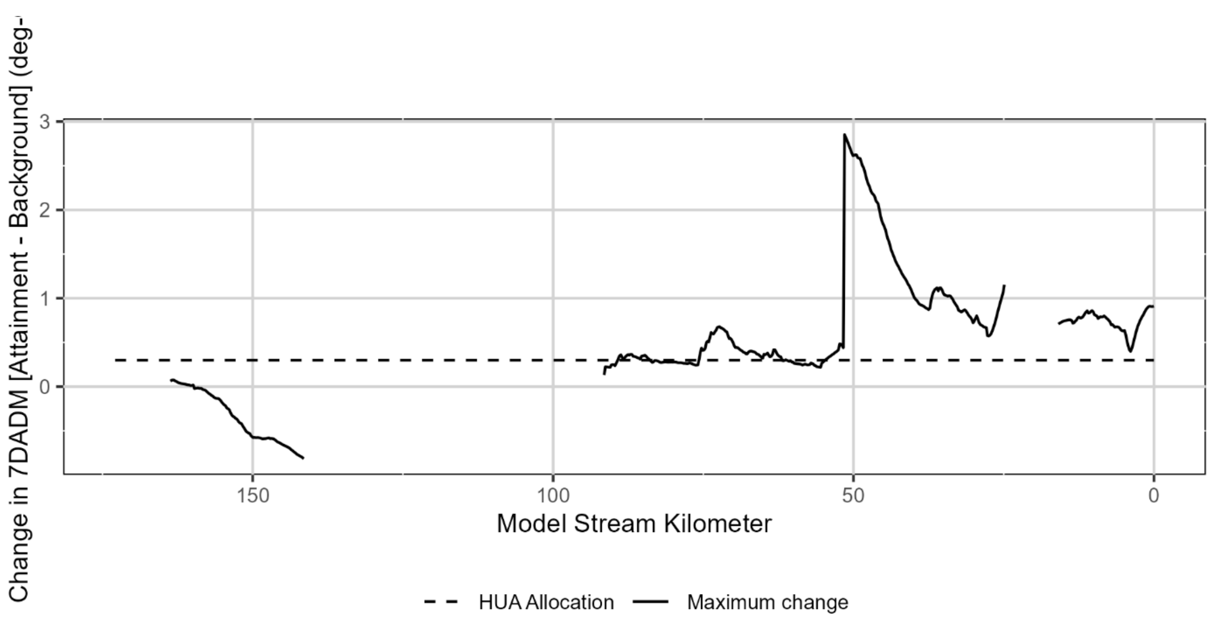


**Figure 4-30: Change in maximum 7DADM stream temperatures between the Attainment and Background model scenarios for the John Day River over the entire model period.**

## 4.3 Middle Fork John Day River

**Table 4-33** summarizes the 7DADM stream temperatures predicted at the mouth and at the POMI of the Middle Fork John Day River for all model scenarios.

**Table 4-35** daily maximum stream temperatures predicted at the mouth of the Middle Fork John Day River for all model scenarios.

**Table 4-33: Summary of maximum 7DADM stream temperature at the mouth of the Middle Fork John Day River for all model scenarios over the entire model period.**

| Temperature Metric | Scenario | Stream Temperature (°C) | Location |
|---|---|---|---|
| 7DADM | Calibration | 31.09 | Outlet |
| 7DADM | Restored Vegetation A | 29.30 | Outlet |
| 7DADM | Restored Vegetation B | 29.39 | Outlet |
| 7DADM | Restored Flow | 30.52 | Outlet |
| 7DADM | 1% Consumptive Use | 30.52 | Outlet |
| 7DADM | Tributary Temperature A | | Outlet |
| 7DADM | Tributary Temperature B | 31.09 | Outlet |
| 7DADM | Channel Morphology | 27.80 | Outlet |
| 7DADM | Attainment | 28.45 | Outlet |
| 7DADM | Background | 26.39 | Outlet |

**Table 4-34: Summary of daily maximum stream temperature at the mouth of the Middle Fork John Day River for all model scenarios over the entire model period.**

| Temperature Metric | Scenario | Stream Temperature (°C) | Location |
|---|---|---|---|
| Daily maximum | Calibration | 33.22 | Outlet |
| Daily maximum | Restored Vegetation A | 31.24 | Outlet |
| Daily maximum | Restored Vegetation B | 31.35 | Outlet |
| Daily maximum | Restored Flow | 32.48 | Outlet |
| Daily maximum | 1% Consumptive Use | 32.49 | Outlet |
| Daily maximum | Tributary Temperature A | | Outlet |
| Daily maximum | Tributary Temperature B | 33.22 | Outlet |
| Daily maximum | Channel Morphology | 29.08 | Outlet |
| Daily maximum | Attainment | 30.23 | Outlet |
| Daily maximum | Background | 26.39 | Outlet |

### 4.3.1 Vegetation scenarios

**Table 4-36** summarizes the daily maximum stream temperature change between the Current Condition Calibration and Restored Vegetation A scenarios for the Middle Fork John Day River. It shows the daily maximum temperature difference at the most downstream node (the outlet) is equal to 3.98°C. In addition, the greatest daily maximum temperature difference between the two scenarios (POMI) is equal to 6.62°C and occurs at stream model km 107.95.

**Figure 4-31** shows the change in the daily maximum stream temperatures between the Current Condition Calibration and Restored Vegetation A model scenarios for the Middle Fork John Day River over the entire model period.

**Table 4-35: Summary of maximum 7DADM stream temperature change between Current Condition Calibration and Restored Vegetation A model scenarios for the Middle Fork John Day River over the entire model period.**

| Temperature Metric | Model KM | Scenario | Stream Temperature (°C) | Location |
|---|---|---|---|---|
| 7DADM | 0 | Change | 3.98 | outlet |
| 7DADM | 107.95 | Change | 6.62 | POMI |

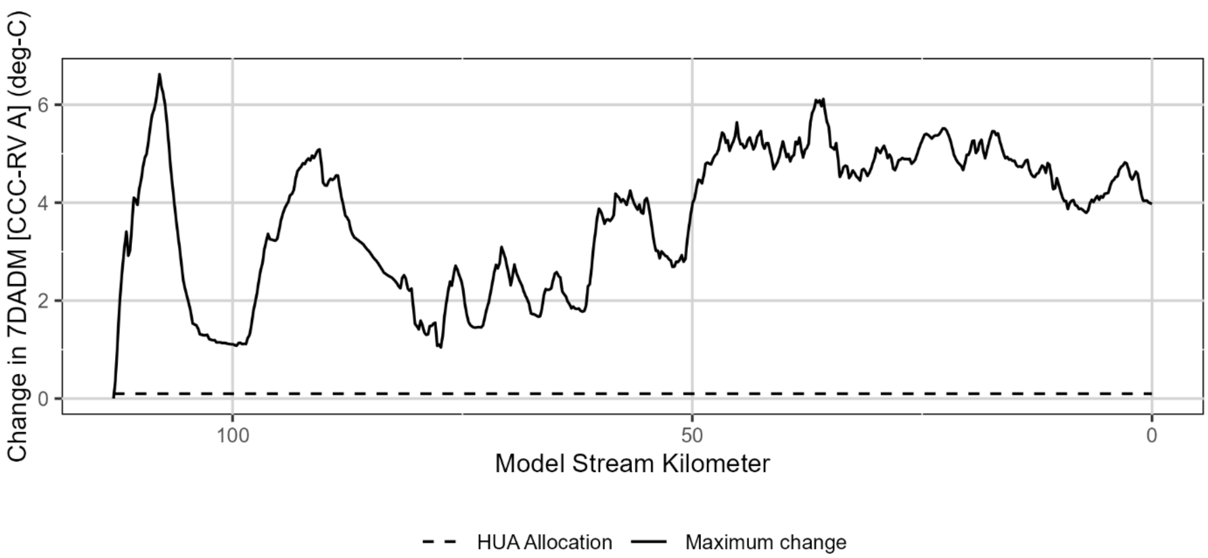


**Figure 4-31: Change in maximum 7DADM stream temperatures between the Current Conditions Calibration and Restored Vegetation A model scenarios for the Middle Fork John Day River over the entire model period.**

**Table 4-36** summarizes the daily maximum stream temperature change between the Current Condition Calibration and Restored Vegetation B scenarios for the Middle Fork John Day River. It shows the daily maximum temperature difference at the most downstream node (the outlet) is equal to 3.86°C. In addition, the greatest daily maximum temperature difference between the two scenarios (POMI) is equal to 6.62°C and occurs at stream model km 107.95.

**Figure 4-32** shows the change in the daily maximum stream temperatures between the Current Condition Calibration and Restored Vegetation B model scenarios for the Middle Fork John Day River over the entire model period.

**Table 4-36: Summary of maximum 7DADM stream temperature change between Current Condition Calibration and Restored Vegetation B model scenarios for the Middle Fork John Day River over the entire model period.**

| Temperature Metric | Model KM | Scenario | Stream Temperature (°C) | Location |
|---|---|---|---|---|
| 7DADM | 0 | Change | 3.86 | outlet |
| 7DADM | 107.95 | Change | 6.62 | POMI |

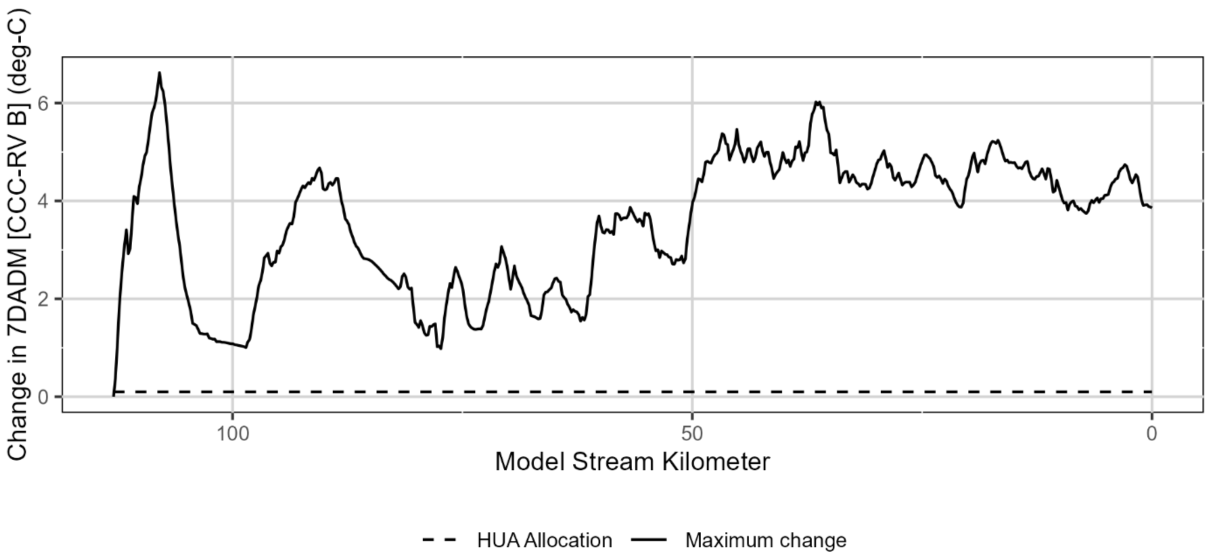


**Figure 4-32: Change in maximum 7DADM stream temperatures between the Current Conditions Calibration and Restored Vegetation B model scenarios for the Middle Fork John Day River over the entire model period.**

**Table 4-37** summarizes the daily maximum stream temperature change between the Restored Vegetation B and Restored Vegetation A scenarios for the Middle Fork John Day River in order to understand the impact of transportation corridors (such as roads and highways) and urban, residential, commercial or industrial development (buildings). It shows the daily maximum temperature difference at the most downstream node (the outlet) is equal to 0.13°C. In addition, the greatest daily maximum temperature difference between the two scenarios (POMI) is equal to 1.23°C and occurs at stream model km 22.75.

**Figure 4-33** shows the change in the daily maximum stream temperatures between the Restored Vegetation B and restored Vegetation A model scenarios for the Middle Fork John Day River over the entire model period.

**Table 4-37: Summary of maximum 7DADM stream temperature change between Vegetation B and Vegetation A model scenarios for the Middle Fork John Day River over the entire model period.**

| Temperature Metric | Model KM | Scenario | Stream Temperature (°C) | Location |
|---|---|---|---|---|
| 7DADM | 0 | Change | 0.13 | outlet |
| 7DADM | 22.75 | Change | 1.23 | POMI |

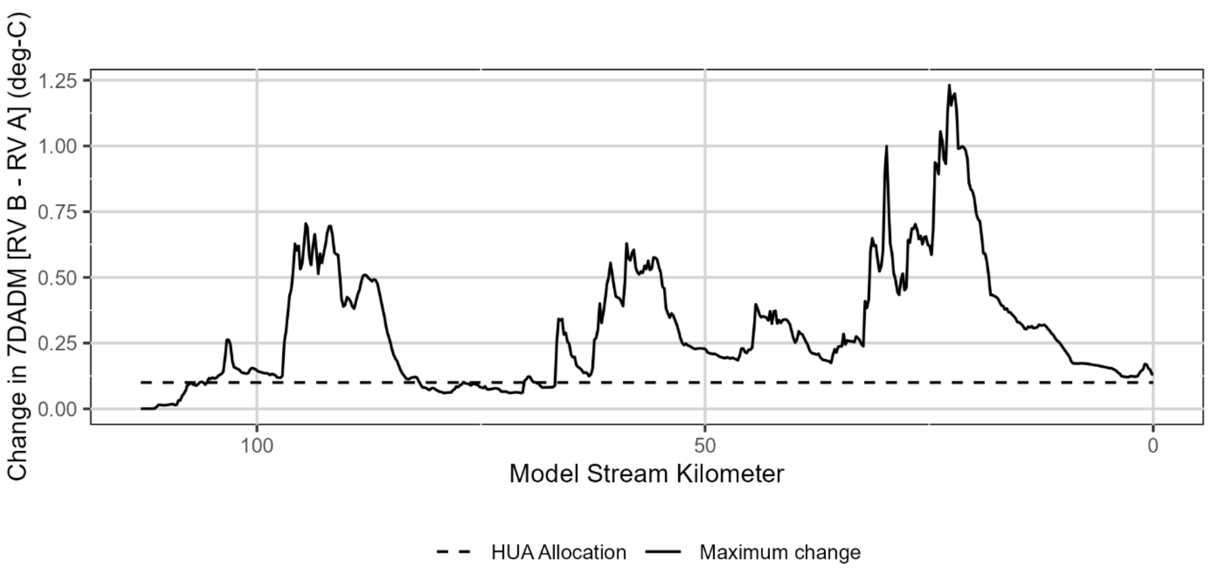


**Figure 4-33: Change in maximum 7DADM stream temperatures between the Restored Vegetation B (RV B) and Restored Vegetation A (RV A) model scenarios for the Middle Fork John Day River over the entire model period.**

**Table 4-38** summarizes the mean effective shade for the Calibration, Current 2023 Condition, Restored Vegetation A, and Topographic Shade scenarios for the Middle Fork John Day River. The difference in mean effective shade between the Restored Vegetation A and Current 2023 Condition scenarios is equal to 26.45 percentage points.

**Figure 4-34** and **Figure 4-35** compare effective shade predictions from the Restored Vegetation A and Current 2023 Condition scenarios for the North Fork John Day River. **Figure 4-36** compare effective shade predictions from the Current 2023 Condition and Topographic Shade scenarios for the North Fork John Day River.

**Table 4-38: Summary of mean effective shade for the Calibration, Current Condition, Restored Vegetation A, and Topographic Shade scenarios for the Middle Fork John Day River.**

| Scenario | Mean effective shade (%) |
|---|---|
| Calibration | 15.48 |
| Current 2023 Condition | 11.52 |
| Restored Vegetation | 37.98 |

| Scenario | Mean effective shade (%) |
|---|---|
| Shade Gap (Restored – Current 2023) | 26.45 |
| Topographic Shade | 6.86 |

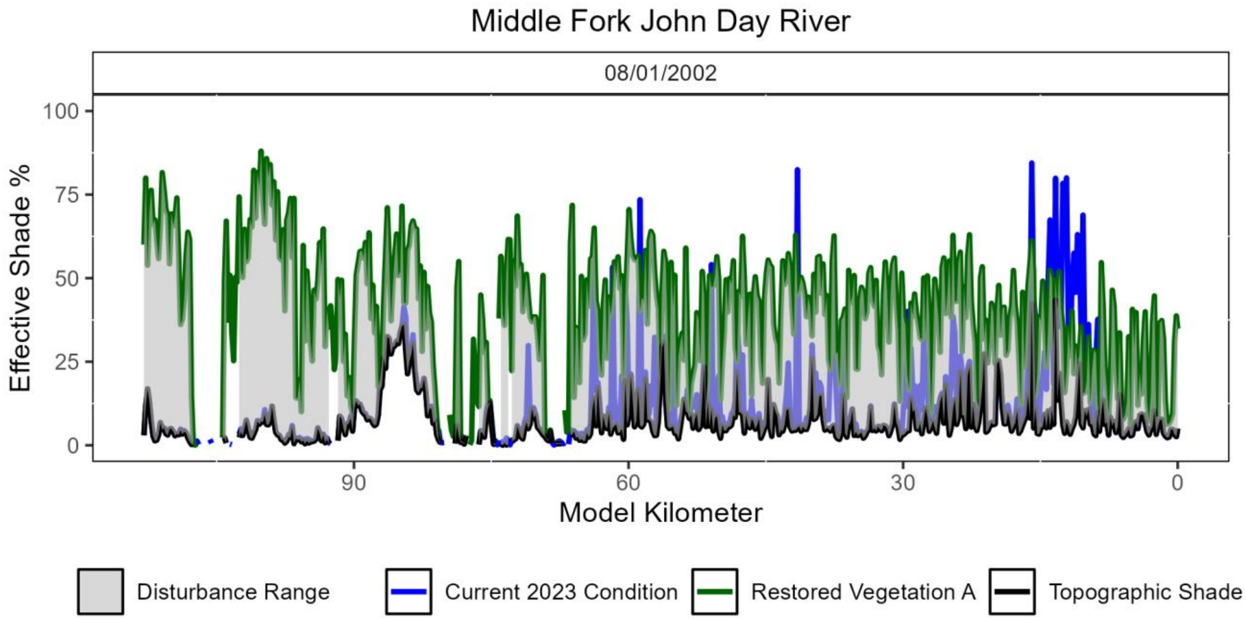


**Figure 4-34: Comparison of effective shade from the Current 2023 Condition, Restored Vegetation A, and Topographic Shade scenarios for the Middle Fork John Day River. Missing values indicate that the shade difference is negative due to instances of higher effective shade in the Current Condition scenario versus the Restored Vegetation scenario.**

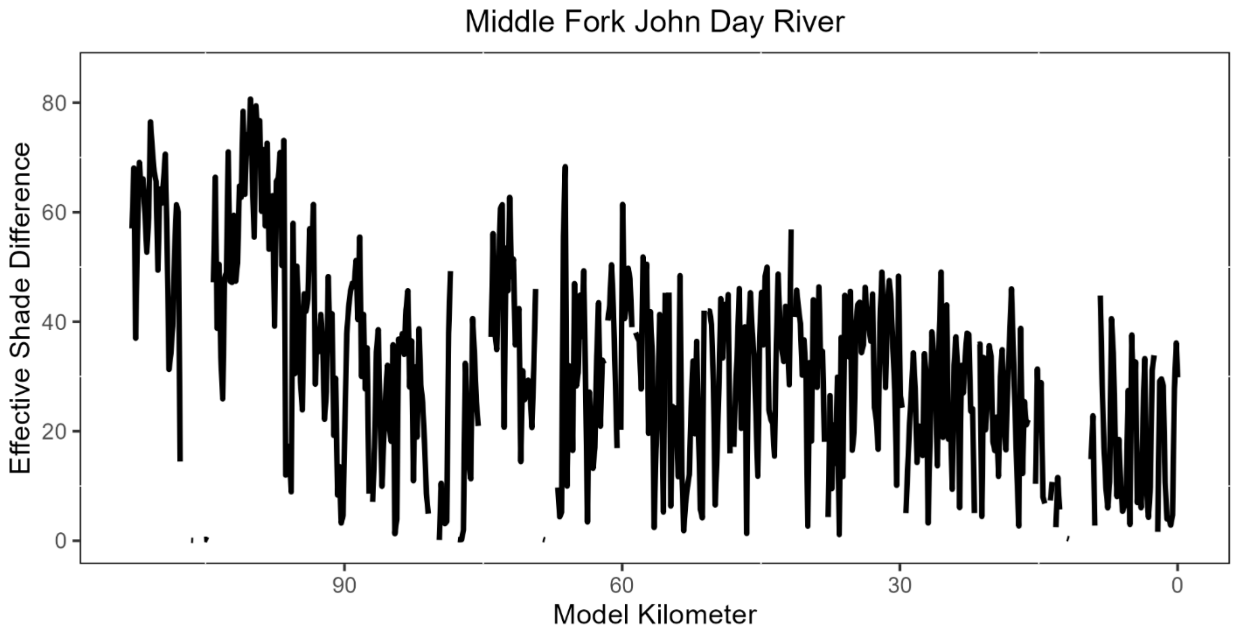


**Figure 4-35: Percentage point difference between effective shade from the Restored Vegetation A and Current 2023 Condition scenarios for the Middle Fork John Day River. Missing values indicate that the shade difference is negative due to instances of higher effective shade in the Current 2023 Condition scenario versus the Restored Vegetation A scenario.**

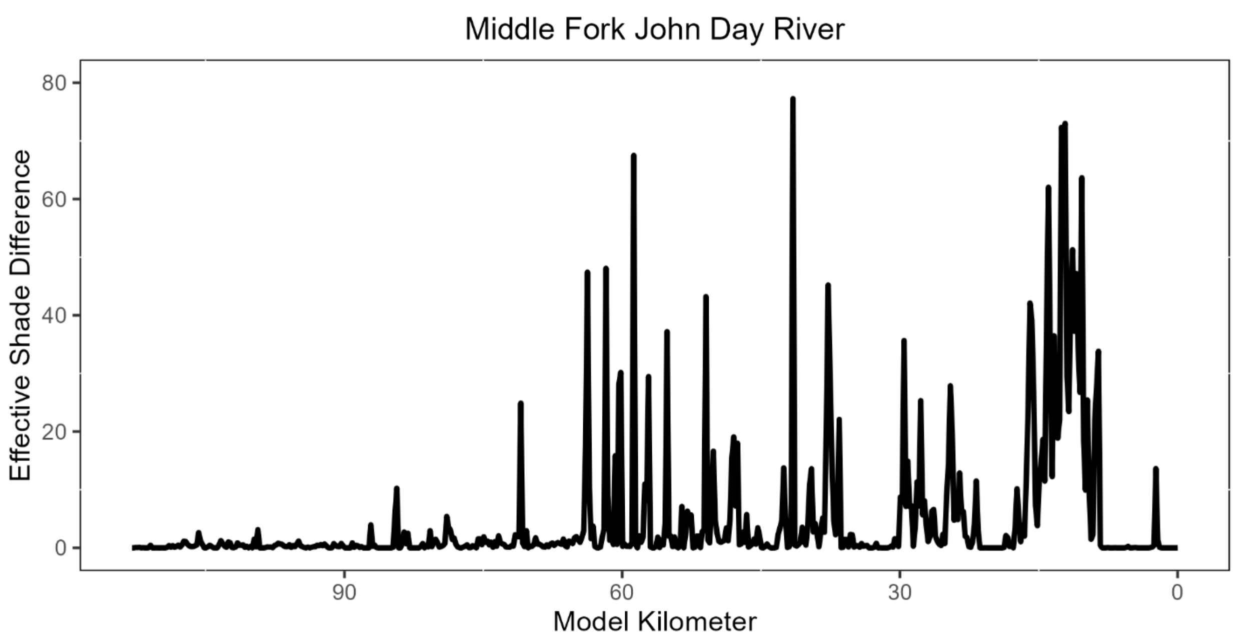


**Figure 4-36: Percentage point difference between effective shade from the Current 2023 Condition and Topographic Shade scenarios for the Middle Fork John Day River. Missing values indicate that the shade difference is negative due to instances of higher effective shade in the Topographic Shade scenario versus the Current 2023 Condition shade scenario.**

### 4.3.2 Flow scenarios

**Table 4-39** summarizes the daily maximum stream temperature change between the Current Condition Calibration and Restored Flow scenarios for the Middle Fork John Day River. This comparison evaluates the temperature impacts from flow deviations from natural conditions. It shows the daily maximum temperature difference at the most downstream node (the outlet) is equal to 2.75°C. In addition, the greatest daily maximum temperature difference between the two scenarios (POMI) is equal to 2.97°C and occurs at stream model km 2.55.

**Figure 4-37** shows the change in the daily maximum stream temperatures between the Current Condition Calibration and Restored Flow model scenarios for the North Fork John Day River over the entire model period.

**Table 4-39: Summary of maximum 7DADM stream temperature change between Current Condition Calibration and Natural Flow model scenarios for the Middle Fork John Day River over the entire model period.**

| Temperature Metric | Model KM | Scenario | Stream Temperature (°C) | Location |
|---|---|---|---|---|
| 7DADM | 0 | Change | 2.75 | outlet |
| 7DADM | 2.55 | Change | 2.97 | POMI |

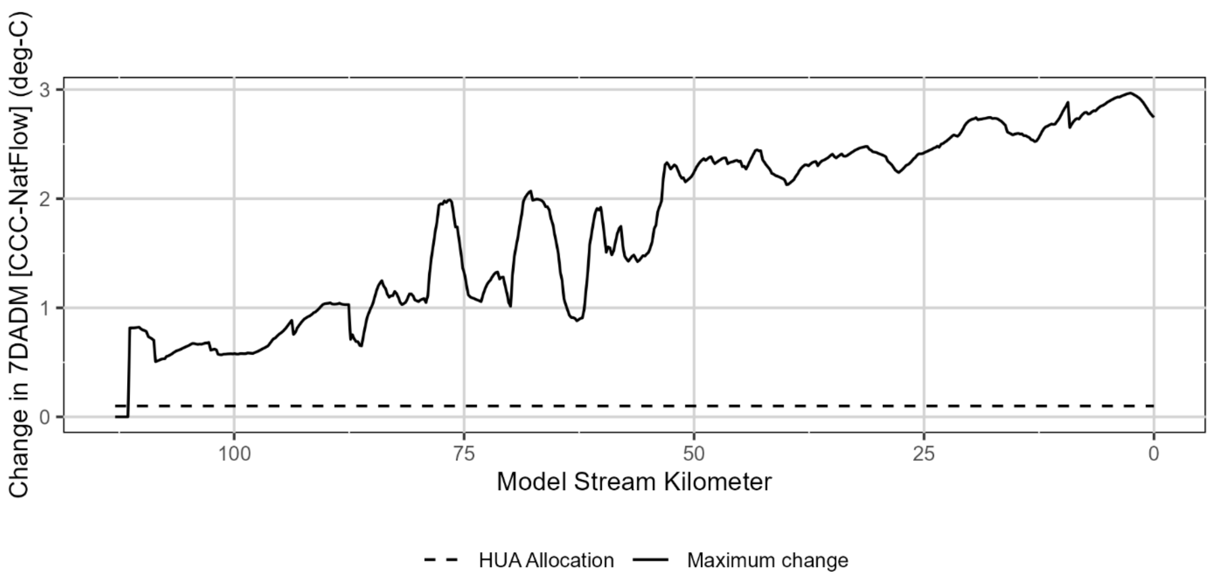


**Figure 4-37: Change in maximum 7DADM stream temperatures between the Current Conditions Calibration and Natural Flow model scenarios for the Middle Fork John Day River over the entire model period.**

**Table 4-40** summarizes the daily maximum stream temperature change between the 1% Consumptive Use and Restored Flow scenarios for the Middle Fork John Day River. This comparison evaluates the effect of water withdrawals (10% of consumptive use) on temperature. It shows the daily maximum temperature difference at the most downstream node (the outlet) is equal to 0.03°C. In addition, the greatest daily maximum temperature difference between the two scenarios (POMI) is equal to 0.04°C and occurs at stream model km 2.55.

**Figure 4-38** shows the change in the daily maximum stream temperatures between the 10% Consumptive Use and Restored Flow model scenarios for the Middle Fork John Day River over the entire model period.

**Table 4-40: Summary of maximum 7DADM stream temperature change between Natural Flow and 10% Consumptive Use model scenarios for the Middle Fork John Day River over the entire model period.**

| Temperature Metric | Model KM | Scenario | Stream Temperature (°C) | Location |
|---|---|---|---|---|
| 7DADM | 0 | Change | 0.03 | outlet |
| 7DADM | 2.55 | Change | 0.04 | POMI |

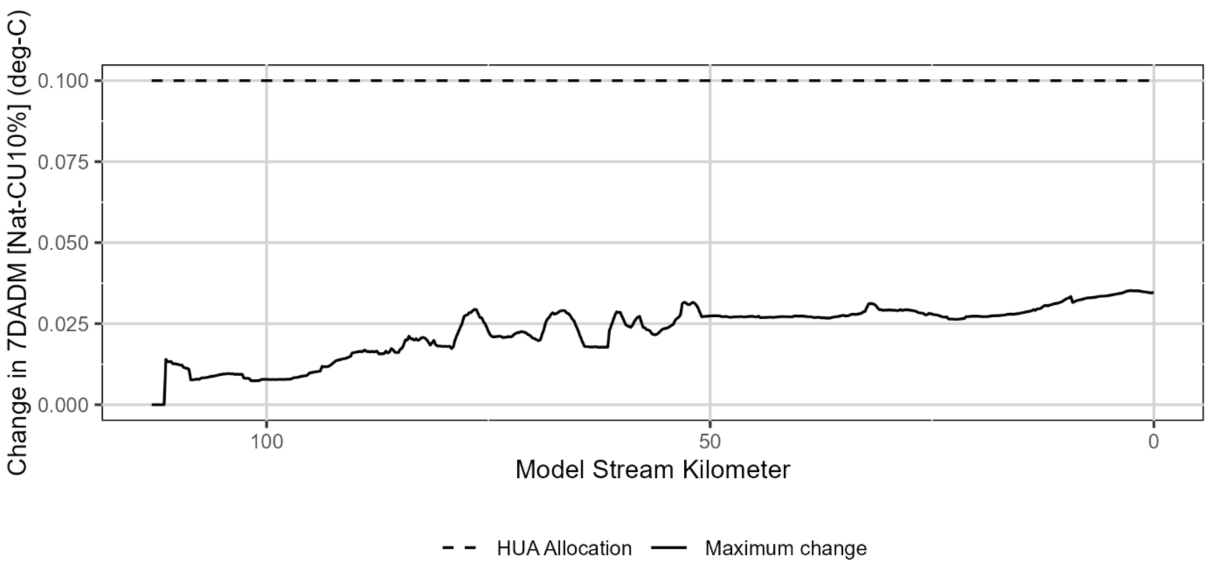


**Figure 4-38: Change in maximum 7DADM stream temperatures between the Restored Flow (Nat) and 10% Consumptive Use (CU10%) model scenarios for the Middle Fork John Day River over the entire model period.**

## 4.3.3 Tributary temperature scenarios

This section summarizes the temperature impacts of tributary temperatures. Tributary Temperature A scenario examines exceedances of the water quality standards at the tributaries.

**Table 4-41** summarizes the daily maximum stream temperature change between the Current Condition Calibration and Tributary Temperature A scenarios for the North Fork John Day River. It shows the daily maximum temperature difference at the most downstream node (the outlet) is equal to X.XX°C. In addition, the greatest daily maximum temperature difference between the two scenarios (POMI) is equal to X.XX°C and occurs at stream model km XXX.

**FIGURE** shows the change in the daily maximum stream temperatures between the Current Condition Calibration and Tributary Temperature A model scenarios for the John Day River over the entire model period.

**Table 4-41: Summary of maximum 7DADM stream temperature change between Current Condition Calibration and Tributary Temperature A model scenarios for the John Day River over the entire model period.**

| Temperature Metric | Model KM | Scenario | Stream Temperature (°C) | Location |
|---|---|---|---|---|
| 7DADM | 0 | Change | | outlet |
| 7DADM | | Change | | POMI |

**[INSERT FIGURE]**

Tributary Temperature B scenario examines the temperature impacts of restored tributary temperatures. In this scenario, tributary temperatures are increased by 0.30°C to show inclusion of the reserve capacity.

**Table 4-42** summarizes the daily maximum stream temperature change between the Current Condition Calibration and Tributary Temperature B scenarios for the Middle Fork John Day River. It shows the daily maximum temperature difference at the most downstream node (the outlet) is equal to 0.10°C. In addition, the greatest daily maximum temperature difference between the two scenarios (POMI) is equal to 0.19°C and occurs at stream model km 87.35.

**Figure 4-39** shows the change in the daily maximum stream temperatures between the Current Condition Calibration and Tributary Temperature B model scenarios for the Middle Fork John Day River over the entire model period.

**Table 4-42: Summary of maximum 7DADM stream temperature change between Tributary Temperature B (HUA=0.30) and Current Conditions Calibration model scenarios for the Middle Fork John Day River over the entire model period.**

| Temperature Metric | Model KM | Scenario | Stream Temperature (°C) | Location |
|---|---|---|---|---|
| 7DADM | 0 | Change | 0.10 | outlet |
| 7DADM | 87.35 | Change | 0.19 | POMI |

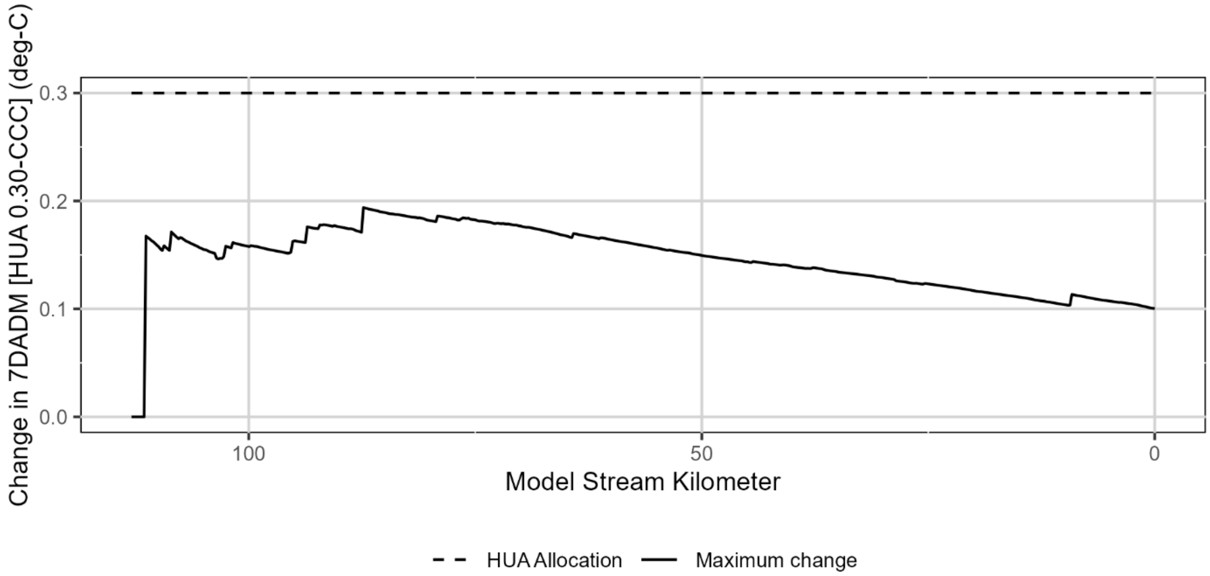


**Figure 4-39: Change in maximum 7DADM stream temperatures between the Tributary Temperature B (HUA=0.30) Current Conditions Calibration model scenarios for the Middle Fork John Day River over the entire model period.**

## 4.3.4 Channel Morphology

**Table 4-43** summarizes the daily maximum stream temperature change between the Current Condition Calibration and 30% of Channel Morphology scenarios for the Middle Fork John Day River. It shows the daily maximum temperature difference at the most downstream node (the outlet) is equal to 3.35°C. In addition, the greatest daily maximum temperature difference between the two scenarios (POMI) is equal to 4.08°C and occurs at stream model km 52.95.

**Figure 4-40** shows the change in the daily maximum stream temperatures between the Current Condition Calibration and 30% of Channel Morphology model scenarios for the Middle Fork John Day River over the entire model period.

**Table 4-43: Summary of maximum 7DADM stream temperature change between the Current Conditions Calibration and Channel Morphology (30%) model scenarios for the Middle Fork John Day River over the entire model period.**

| Temperature Metric | Model KM | Scenario | Stream Temperature (°C) | Location |
|---|---|---|---|---|
| 7DADM | 0 | Change | 3.35 | outlet |
| 7DADM | 52.95 | Change | 4.08 | POMI |

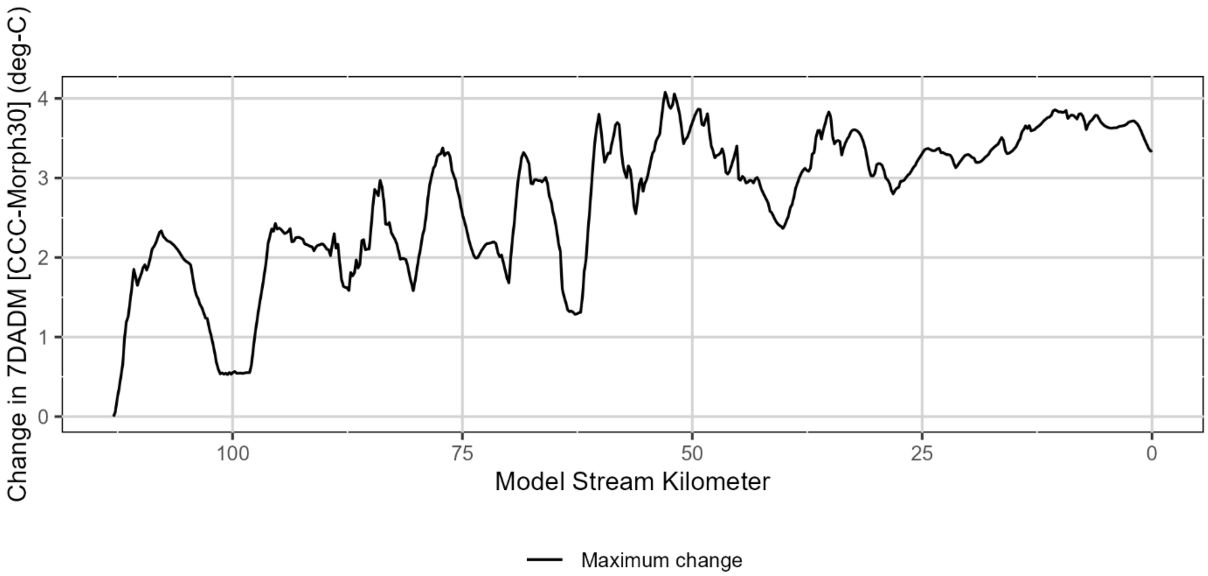


**Figure 4-40: Change in maximum 7DADM stream temperatures between the Current Conditions Calibration and Channel Morphology (30%) model scenarios for the Middle Fork John Day River over the entire model period.**

## 4.3.5 Background

This scenario summarizes the temperature impacts of background conditions.

**Table 4-44** summarizes the daily maximum stream temperature change between the Current Condition Calibration and Background scenarios for the Middle Fork John Day River. The Background scenario shown here uses the 30% Channel Morphology to represent morphology. It shows the daily maximum temperature difference at the most downstream node (the outlet) is equal to 7.11°C. In addition, the greatest daily maximum temperature difference between the two scenarios (POMI) is equal to 8.59°C and occurs at stream model km 23.75.

**Figure 4-41** shows the change in the daily maximum stream temperatures between the Current Condition Calibration and Background model scenarios for the Middle Fork John Day River over the entire model period.

**Table 4-44: Summary of maximum 7DADM stream temperature change between the Current Conditions Calibration and Background (30%) model scenarios for the Middle Fork John Day River over the entire model period.**

| Temperature Metric | Model KM | Scenario | Stream Temperature (°C) | Location |
|---|---|---|---|---|
| 7DADM | 0 | Change | 7.11 | outlet |
| 7DADM | 23.75 | Change | 8.59 | POMI |

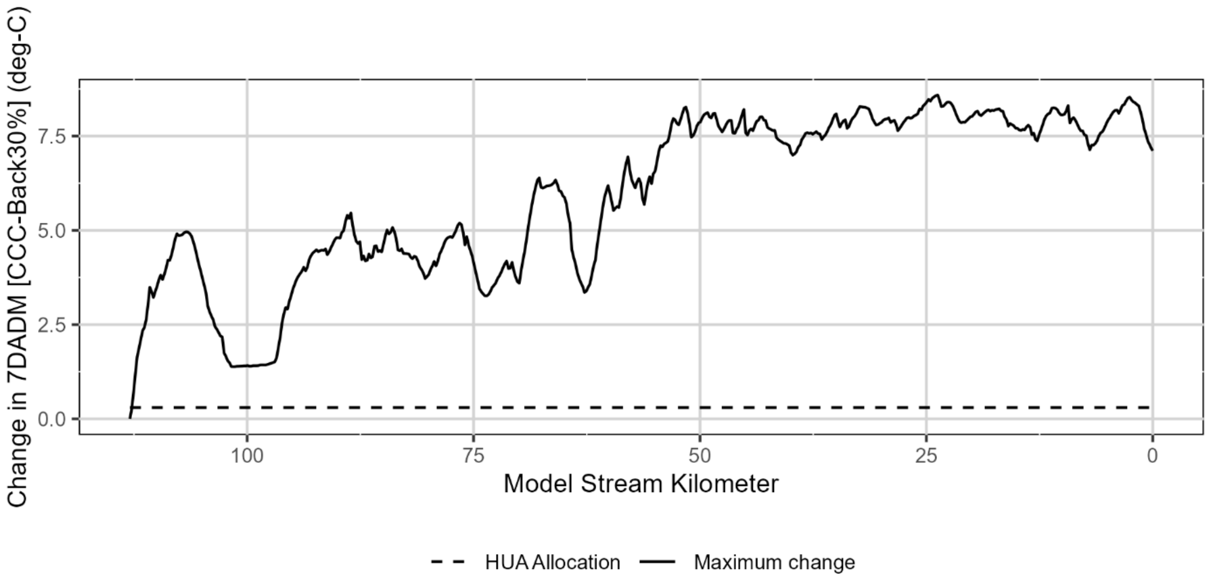


**Figure 4-41: Change in maximum 7DADM stream temperatures between the Current Conditions Calibration and Background (30%) model scenarios for the Middle Fork John Day River over the entire model period.**

**Table 4-45** summarizes the daily maximum stream temperature change between the Background scenario and the BBNC for the Middle Fork John Day River. It shows the daily maximum temperature difference at the most downstream node (the outlet) is equal to 7.25°C. In addition, the greatest daily maximum temperature difference between the two scenarios (POMI) is equal to 14.32°C and occurs at stream model km 112.95.

**Figure 4-42** shows the change in the daily maximum stream temperatures between the Background model scenario and the BBNC for the Middle Fork John Day River over the entire model period.

**Table 4-45: Summary of maximum 7DADM stream temperature change between the Background (30%) model scenario and the BBNC for the North Fork John Day River over the entire model period.**

| Temperature Metric | Model KM | Scenario | Stream Temperature (°C) | Location |
|---|---|---|---|---|
| 7DADM | 0 | Change | 7.25 | outlet |
| 7DADM | 112.95 | Change | 14.32 | POMI |

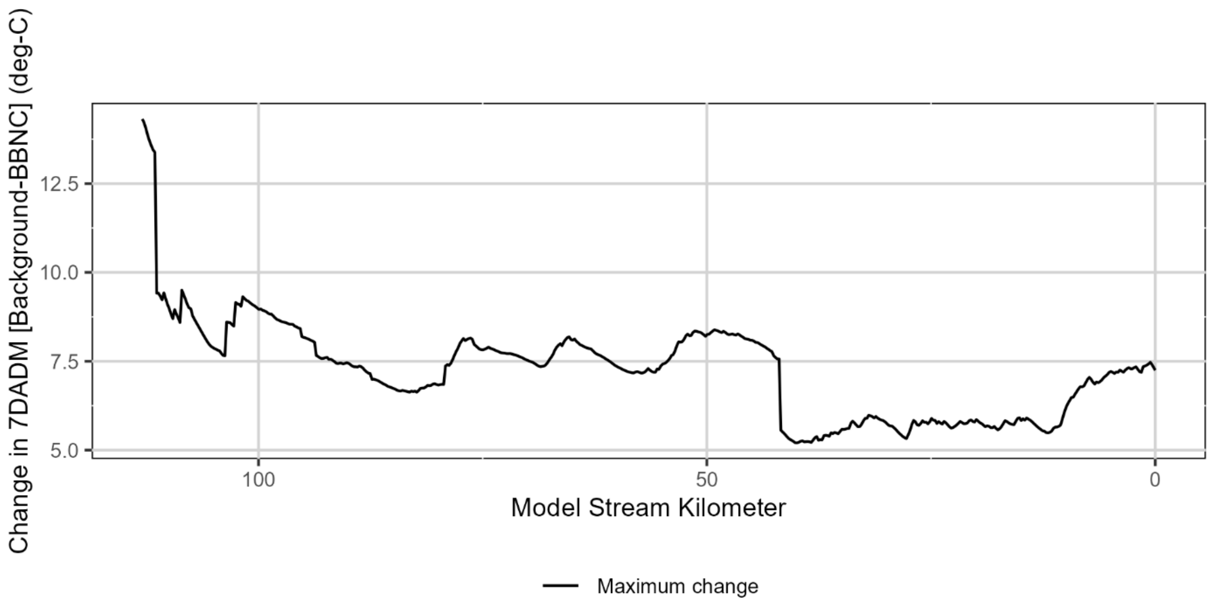


**Figure 4-42: Change in maximum 7DADM stream temperatures between Background (30%) model scenario and the BBNC for the North Fork John Day River over the entire model period.**

### 4.3.6 HUA Attainment

**Table 4-46** summarizes the HUA attainment scenario model set up.

**Table 4-46: HUA Attainment model scenario set up for the Middle Fork John Day River.**

| Model input variable | Attainment scenario setup description |
|---|---|
| Riparian landcover | Set to system potential vegetation conditions. |
| Tributary temperatures | Hourly tributary temperatures were increased by the assigned allocations on each tributary; hourly temperatures were increased by 0.30°C which is the total proposed HUA including the reserve capacity. |
| Tributary flow | Equivalent to tributary flows used in 10% consumptive use model scenario. |
| Boundary condition temperature | Equivalent to boundary condition temperatures used in 10% consumptive use model scenario. |
| Boundary condition flow | Equivalent to boundary condition flows used in 10% consumptive use model scenario. |
| Withdrawals | Equivalent to withdrawals used in 10% consumptive use model scenario. |
| NPDES point sources | There are no NPDES point source discharges within the model extent, the allocation assigned to point sources is 0.00°C. |
| Nonpoint source dam and reservoir operations | There are no dam or reservoir operations within the model extent, though there is an allocation assigned to this source of 0.00°C. |

| Model input variable | Attainment scenario setup description |
|---|---|
| Solar loading from existing infrastructure | Solar loading from existing infrastructure was modeled |

**Table 4-47** summarizes the daily maximum stream temperature change between the Attainment and Background scenarios for the Middle Fork John Day River. It shows the daily maximum temperature difference at the most downstream node (the outlet) is equal to 0.39°C. In addition, the greatest daily maximum temperature difference between the two scenarios (POMI) is equal to 0.40°C and occurs at stream model km 5.15.

**Figure 4-43** shows the change in the daily maximum stream temperatures between the Attainment and Background model scenarios for the Middle Fork John Day River over the entire model period.

**Table 4-47: Summary of maximum 7DADM stream temperature change between the Attainment and Background (0%) model scenarios for the Middle Fork John Day River over the entire model period.**

| Temperature Metric | Model KM | Scenario | Stream Temperature (°C) | Location |
|---|---|---|---|---|
| 7DADM | 0 | Change | 0.39 | outlet |
| 7DADM | 5.15 | Change | 0.40 | POMI |

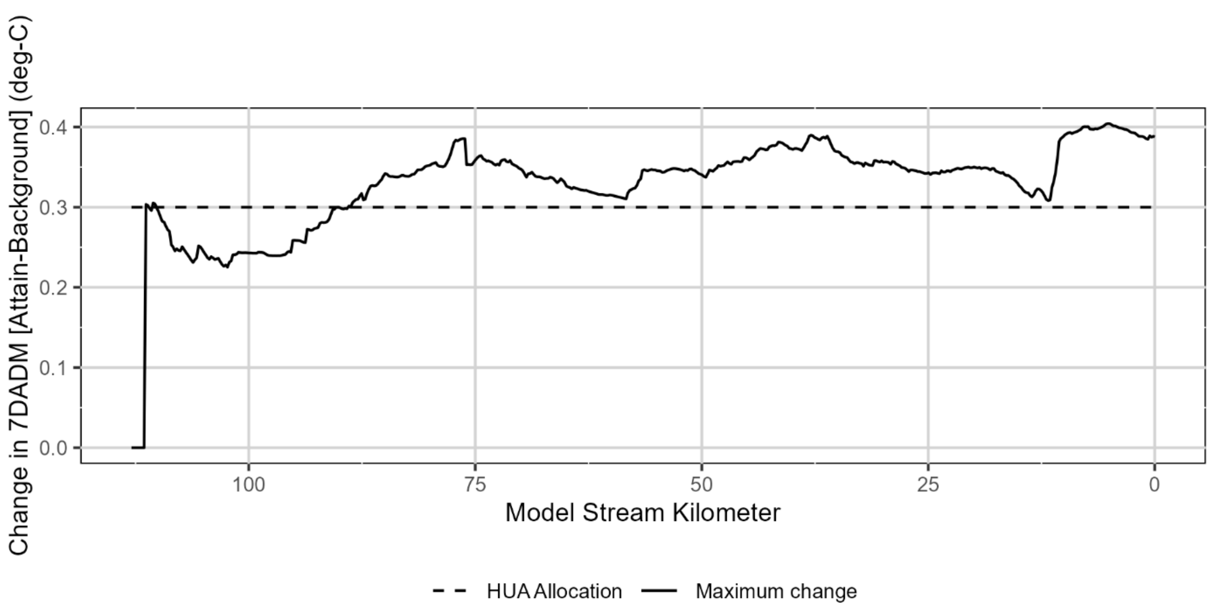


**Figure 4-43: Change in maximum 7DADM stream temperatures between the Attainment and Background (0%) model scenarios for the Middle Fork John Day River over the entire model period.**

# 5 References

[Insert references used]