



**Upper Naches River and Cowiche Creek
Temperature
Total Maximum Daily Load**

Volume 2. Implementation Strategy

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Volume 2. Implementation Strategy

by

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Executive Summary

Introduction

Summer water temperatures of the Naches River and some of its tributaries (Bear Creek; Blowout Creek; Bumping River; Cowiche Creek; Crow Creek; Gold Creek; Little Naches River; Little Rattlesnake Creek; Mathew Creek; Nile Creek; Rattlesnake Creek; and Reynolds Creek) are warmer than Washington State (the state) water quality standards that are set to protect fish. As a result, these waters are included on the state's list of water-quality-impaired waters called the 303(d) list. The Washington State Department of Ecology (Ecology) completes evaluations on waters placed on this list and determines what pollutant load reductions are necessary to bring the waters into compliance with state water quality standards. This total maximum daily load (TMDL) report discusses the temperature loading affecting streams and rivers in the Upper Naches River and Cowiche Creek watersheds (within Water Resource Inventory Area [WRIA] 38). The 303(d) listings in the lower Naches and Tieton River portion of the watershed will be analyzed later as part of a larger project for conventional parameters in the Yakima River watershed.

This document provides targets for reducing heat loading to the Upper Naches River and all the Naches River tributaries except for the Tieton River. Actions that will reduce heat loading in the Naches River watershed and bring streams and rivers into compliance with the state's water quality standards for temperature are identified in the Implementation Strategy section of this document.

This TMDL provides effective shade targets (load allocations) for the riparian zone and temperature limitations (wasteload allocations) for National Pollutant Discharge Elimination System (NPDES)-permitted dischargers. Effective shade targets are based on the results of two different studies conducted by Ecology. One study was conducted in the Wenatchee National Forest (Whiley and Cleland, 2003) and is the basis for water quality targets for the Wenatchee National Forest. The second study was conducted for the Naches River Watershed by Ecology's Environmental Assessment Program (Brock, 2008). The study by Brock (2008) provides targets for water temperature improvements in the watershed that lie outside of the Wenatchee National Forest.

Effective shade was used as a surrogate measure of heat flux to fulfill the requirements of Section 303(d) of the Clean Water Act for a temperature TMDL. Effective shade is defined as the fraction of incoming solar shortwave radiation that is blocked by vegetation and topography from reaching the surface of the stream.

Why do a total maximum daily load (TMDL) in this watershed?

The federal Clean Water Act (CWA) requires that a total maximum daily load (TMDL) be developed for each of the water bodies on the 303(d) list. The 303(d) list is a list of water bodies, which the CWA requires states to prepare, that do not meet state water quality standards. The TMDL study identifies pollution problems in the watershed, and then specifies how much pollution needs to be reduced or eliminated to achieve clean water. Then Ecology, with the assistance of local governments, agencies, and the community develops a plan that describes actions to control the pollution and a monitoring plan to assess the effectiveness of the water quality improvement activities. The water quality improvement report (WQIR) consists of the TMDL study and implementation plan.

Watershed description

This project area is in the Naches River watershed (WRIA 38 - see Figure 1), located in the south-central portion of Washington State. The crest of the Cascade Mountains forms the western boundary of the watershed. Numerous tributaries drain eastward to form the Naches River, which then joins the Yakima River at the city of Yakima. Much of the upper portion of the watershed falls within the Wenatchee National Forest, while the lower portion of the watershed is in private, state, or other land ownership. Annual precipitation in the watershed ranges from as much as 140 inches at the crest of the Cascades to less than 10 inches at the confluence with the Yakima River.

The Naches River Watershed is divided into four distinct sub-basins (Figure 2):

- Upper Naches River, which consists of the mainstem Naches River from the confluence with the Tieton River (River Mile (RM) 17.6) to the headwaters and all major tributaries along this reach.
- Lower Naches River, which includes the mainstem Naches River from RM 17.6 to the confluence with the Yakima (RM 0) and all of the tributaries along this reach.
- Cowiche Creek and all the tributaries along the creek.
- Tieton River and all its tributaries.

This TMDL provides load and wasteload allocations for the upper Naches River and Cowiche Creek sub-basins. Meeting these load and wasteload allocations will result in meeting state water quality standards for temperature throughout the project area.

Original plans for the Naches Basin Temperature TMDL included all four sub-basins. However, the Tieton River and the Lower Naches River Sub-basins were removed from this TMDL and reserved to be addressed in a later project. This change is due to the U.S. Bureau of Reclamation's (USBR's) management of river flows in the Tieton River and Lower Naches River.

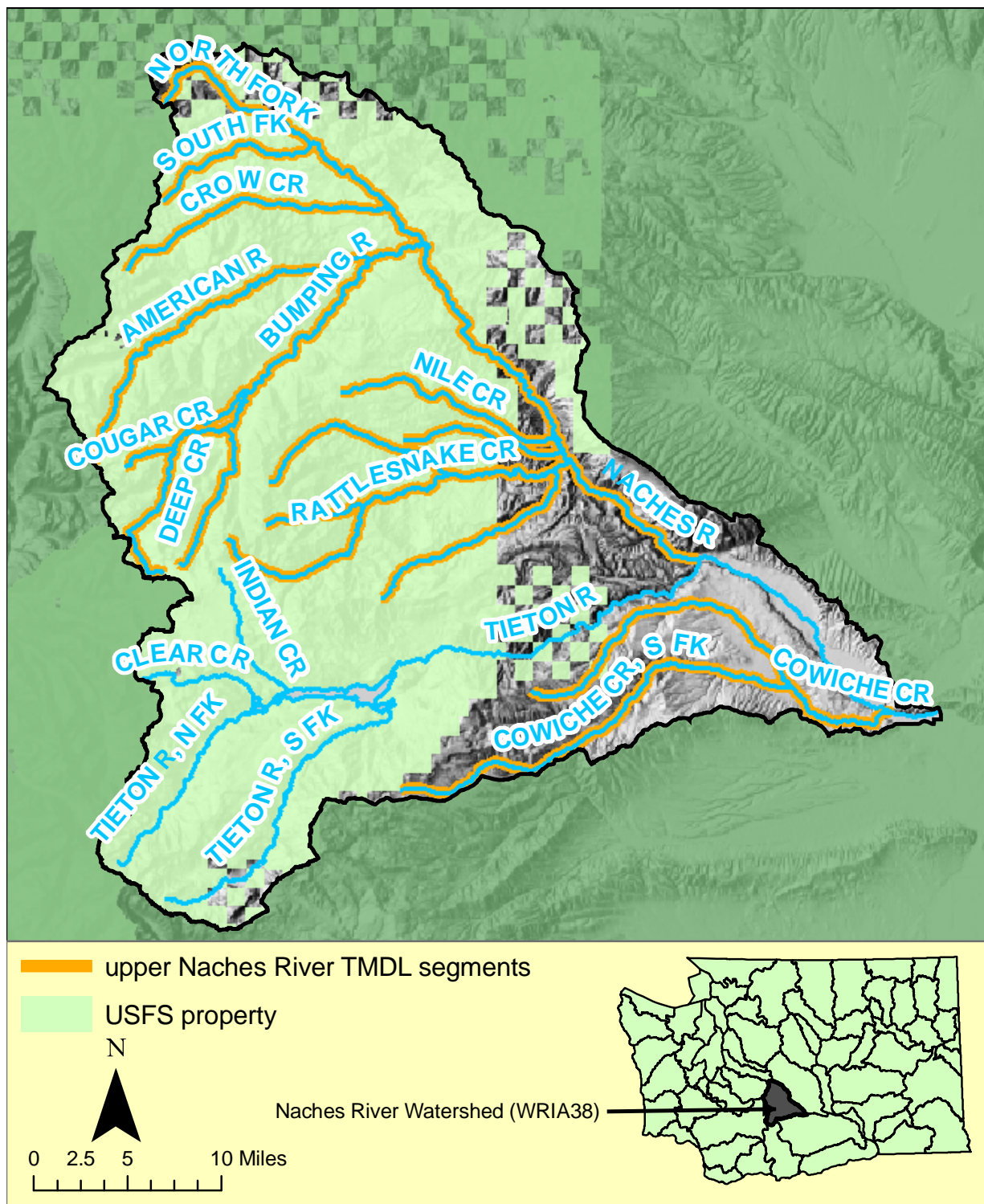


Figure 1: Segments in the Naches River watershed studied for developing a temperature TMDL.

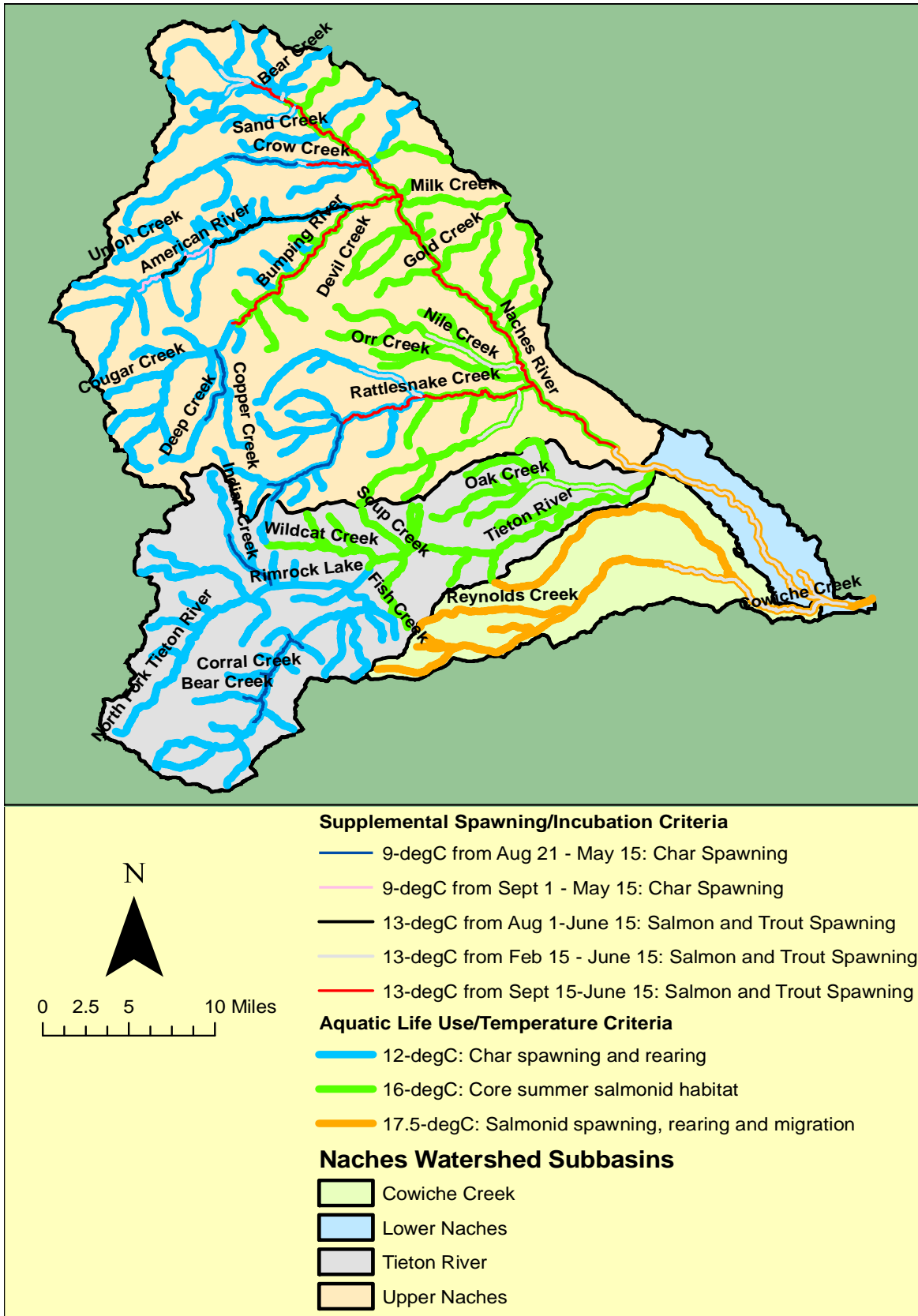


Figure 2: Designated uses and temperature criteria for the Naches River watershed

Stream temperature assessment

Ecology installed numerous continuous temperature data loggers in the Naches River watershed during the dry seasons of 2002 and 2004. In addition, the United States Forest Service (USFS) collected data in the Wenatchee National Forest. In general, the warmest temperatures were found at downstream locations in the Naches River and Cowiche Creek, while cooler temperatures were found in relatively small tributaries or headwater locations.

Stream temperature modeling

Shade from near-stream vegetation cover, channel morphology, and stream hydrology represent the most important factors that influence stream temperature. Stream temperature modeling predicts reductions in water temperature for theoretical conditions. Modeling can be used to estimate what temperatures would be under either natural or alternative conditions by recognizing the effects of changes in riparian vegetation, improvements in riparian microclimate, and reduced channel widths.

Wenatchee National Forest stream modeling

The upper portion of the watershed that lies within the Wenatchee National Forest, above RM 38.8, was modeled in the *Wenatchee National Forest TMDL Water Temperature Total Maximum Daily Load Technical Report* (Whiley and Cleland, 2003). This technical report included:

- Analysis methods using a stream classification system to estimate effective shade levels necessary to meet the water quality standard for surface waters throughout the forest.
- Other analysis methods that examined site potential shade, or the maximum amount of effective shade provided by late-succession vegetation.
- Findings that due to naturally-occurring limitations to vegetative growth, site potential effective shade levels in some portions of the forest are less than what is needed to achieve the numeric temperature standard.

Naches watershed modeling downstream of the Wenatchee National Forest

The Water Quality Study Findings report (Brock, 2008) presents study results for the Naches River from the USFS boundary, RM 38.8 to its confluence with the Tieton River at RM 17.6. Brock's report also presents study information on Cowiche Creek. Study results include:

- Model simulations for the mainstem performed at 7-day average 10-year return period (7Q10) critical flow conditions showing that temperature decreases may be attained with future improvements towards mature riparian vegetation compared with the current conditions.
- Findings that under *critical* conditions, potential temperature reductions should reduce water temperatures to below the threshold for fish lethality, 23°C. However, in some cases, the potential temperature under critical conditions will be greater than the numeric criteria. Potential temperature reductions for *average* conditions with improvements should be much greater.

- Recommendations that a buffer of mature riparian vegetation along the banks of rivers and streams, and improvements in microclimate and channel width, are expected to decrease the average daily maximum temperatures.
- Increasing stream flows will also improve temperatures.

Management recommendations

For the improvement of water temperatures in the Upper Naches River and Cowiche sub-basins, the following management activities are necessary for compliance with water quality standards throughout the watershed:

- For lands in the Wenatchee National Forest, manage riparian areas to achieve site potential effective shade as described in the *Wenatchee National Forest Water Temperature TMDL Technical Report*.
- Load allocations included in this TMDL for non-federal forestlands, in accordance with Section M-2 of the Forests and Fish Report. Consistent with the Forests and Fish agreement, implementation of the load allocations established in this TMDL for private and state forestlands will be accomplished via implementation of the revised forest practices regulations.
- For areas that are not managed by the USFS or managed in accordance with the state forest practices rules, such as private non-forest areas, programs to increase riparian vegetation should be developed. For example, landowners can install riparian buffers or conservation easements sponsored under the U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) Conservation Reserve Enhancement Program (CREP).
- Future projects that have the potential to increase groundwater or surface water inflows to streams in the watershed. Instream flows and water withdrawals are managed through regulatory avenues separate from TMDLs. However, the amount of instream flow can affect stream temperature: increases in flow generally result in decreases in maximum water temperatures.
- Management activities that would reduce the loading of sediment to the surface waters from upland and channel erosion are also recommended.
- Management activities that reduce upland and channel erosion and avoid sedimentation of fine materials in the stream substrate. Hyporheic exchange flows and groundwater discharges are important to maintaining the current temperature regime and reducing maximum daily instream temperatures. Factors that influence hyporheic exchange flow include the vertical hydraulic gradient between surface and subsurface waters as well as the hydraulic conductivity of the streambed sediments. Activities that reduce the hydraulic conductivity of streambed sediments could result in increased stream temperatures.
- Management activities that increase the amount of large woody debris (LWD) in the Naches River and Cowiche Creek systems, which will have multiple benefits. For instance, adding LWD will assist in pool-forming processes, and help reduce flow velocities that wash out spawning gravels and contribute to channel downcutting. Increased sinuosity will also help dissipate flow energy, promoting the entry of water into the hyporheic zone.

- Incorporating wasteload allocations (Table 1) into NPDES permits for discharges within the watershed.

Table 1: Wasteload allocations for NPDES permitted dischargers

Water body Name	Parameter of Concern	Time Period Restrictions	Permittee Name and ID	Permit Type	Wasteload Allocation
Cowiche Creek	Temperature	July-August	Cowiche Regional Wastewater Treatment Plant	WWTP	17.5 C
Cowiche Creek	Temperature	July-August	Strand Apples Inc Marley Bldg	Fresh Fruit Packer	23.2 C
Cowiche Creek	Temperature	July-August	Strand Apples Inc Main Plant	Fresh Fruit Packer	17.8 C
Cowiche Creek	Temperature	July-August	Cowiche Growers Inc	Fresh Fruit Packer	17.8 C
Cowiche Creek	Temperature	July-August	Ackley Fruit Company LLC	Fresh Fruit Packer	18.1 C
Cowiche Creek	Temperature	July-August	Strand Apples Forney Warehouse	Fresh Fruit Packer	17.8 C
Cowiche Creek	Temperature	July-August	Lloyd Garretson, Co.	Fresh Fruit Packer	18.4 C

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Introduction

Background

The Naches River Watershed (WRIA 38) is divided into four distinct sub-basins. For the purposes of this total maximum daily load (TMDL) these sub-basins are:

- Upper Naches River, which consists of the mainstem Naches River from the confluence with the Tieton River (River Mile RM 17.6) to the headwaters and all major tributaries along this reach.
- Lower Naches River, which includes the mainstem Naches River from RM 17.6 to the confluence with the Yakima (RM 0) and all of the tributaries along this reach.
- Cowiche Creek and all the tributaries along the creek.
- Tieton River and all its tributaries (Figure 2).

This TMDL water quality improvement report (WQIR) presents load and wasteload allocations for the upper Naches River and Cowiche Creek sub-basins. Ecology developed a temperature TMDL technical report for the Wenatchee National Forest that established load allocations for shade in USFS designated lands in WRIA 38 (Whiley and Cleland, 2003). The load allocations developed for USFS lands are incorporated into this report.

Original plans for the Naches Basin Temperature TMDL included all four sub-basins. The Tieton River and the Lower Naches River Sub-basins were removed from this TMDL and reserved to be addressed in a later project due to the Bureau of Reclamation's (USBR) management of river flows in the Tieton River and Lower Naches River.

The Naches River Watershed (WRIA 38) is part of the greater Yakima River watershed. The Naches River flows east from the Cascades to the city of Yakima, where it converges with the Yakima River. The Naches River has four major tributaries: Bumping, American, Tieton, and Little Naches Rivers. There are two reservoirs located within the watershed: Rimrock Lake (approximately 198,000 acre-feet) which is located on the Tieton River, and Bumping Lake (approximately 33,700 acre-feet) which is located on the Bumping River.

The climate of the watershed ranges from cool and moist in the mountains to warm and dry in the valleys. Most of the precipitation falls during November to January. Annual precipitation in the mountains ranges from 80 to 140 inches at the Cascade crest to less than 10 inches in the eastern part of the watershed. Average summertime temperatures range from 55°F in the mountains to 82°F in the valleys. These conditions are formed by predominately westerly winds coming over the Cascade crest and the rain-shadow effect in the valleys below.

The vegetation of the watershed is a complex blend of forest, shrub steppe, and grasslands. The forests are located in the mountainous areas where precipitation is greater, and along the riparian edges of streams and rivers. Ponderosa pine, along with Douglas, Grand and Noble firs form the majority of complex heterogeneous forests at the higher elevations (Haring, 2001). White oak,

cottonwood, birch, and alder are found along the riparian zones in the valleys (Haring, 2001). Most of the land in the lower reaches is populated with fragile shrub and grassland that is highly susceptible to erosion when disturbed.

The Naches River watershed is an important spawning, rearing and migration area for Spring Chinook salmon (*Oncorhynchus tshawytscha*), steelhead trout (*Oncorhynchus mykiss*), and bull trout (*Salvelinus confluentus*). Steelhead and bull trout in the watershed are listed as threatened under the Endangered Species Act. Pacific lamprey, kokanee salmon, cutthroat trout, resident rainbow trout, mountain whitefish and other species of fish also inhabit streams in the watershed (YSFWPB, 2004).

Land ownership in WRIA 38 is predominantly public. The USFS owns and manages the majority of land in the watershed. The Washington State Department of Natural Resources (DNR) and Washington State Department of Fish and Wildlife own and manage the next largest proportion of public lands. The private lands of the upper watershed consist of small recreational cabins and small resorts. The valleys of the mainstem Naches River and Cowiche Creek are predominantly irrigated agricultural croplands. The major crops raised in the watershed are apples, pears, and cherries. There are four municipalities located within the lower Naches Watershed: Naches, Tieton, Cowiche, and Yakima.

USBR manages the Yakima reservoir system, which includes the reservoirs located within the Naches River watershed, using a management policy termed “flip-flop.” In practice, flip-flop consists of releasing virtually all water needed by the Wapato Irrigation Project and the Sunnyside Valley Irrigation District from the upper Yakima reservoirs until September. During this time, releases from Rimrock and Bumping reservoirs are minimized. In early September, the release pattern reverses and the majority of the flow is provided from Rimrock and Bumping reservoirs and the upper Yakima releases are curtailed (Yakima Sub-basin Fish and Wildlife Planning Board, 2004).

The purpose of the flip-flop operation is to encourage Chinook salmon to spawn at lower river stages in the upper Yakima River and its tributaries. This ensures that the flows required to keep the redds watered and protected during the incubation period (November through March) are minimized. It is also consistent with the “normative” flow concept for the upper Yakima arm of the watershed (USBR, 2004). Based on historical records, flip-flop actually occurred earlier than normal in 2004 with release of storage flows from the Naches reservoir system increasing in late August to early September.

Goals and Objectives

Project goals

The long-term goal of the *Upper Naches River and Cowiche Creek Temperature TMDL* is to meet water quality standards for temperatures throughout the project area. This goal will be accomplished by meeting several short-term goals. Riparian health needs to be restored throughout the watershed. This can be accomplished by reducing pollutant loading from point sources and nonpoint sources. Point sources must meet the wasteload allocations provided by this TMDL. Nonpoint sources must increase shade to meet the load allocations in this TMDL. Restoring riparian shade and allowing the riparian zone to revert to a more natural condition will protect streams from temperature impacts.

It is the primary goal of this TMDL to meet water quality standards by establishing load and wasteload allocations for temperature to achieve compliance on a daily basis, regardless of the season. The TMDL will also provide a margin of safety.

TMDL Analysis

Ecology installed numerous continuous temperature data loggers in the Naches River watershed during the dry seasons of 2002 and 2004. In addition, the USFS collected data in the Wenatchee National Forest. In general, the warmest temperatures were found at downstream locations in the Naches River and Cowiche Creek, while cooler temperatures were found in relatively small tributaries or headwater locations.

Stream temperature modeling

Shade from near-stream vegetation cover, channel morphology, and stream hydrology are the most important factors that influence stream temperature. Stream temperature modeling predicts reductions in water temperature for theoretical conditions. Modeling can be used to estimate what temperatures would be under either natural or alternative conditions by recognizing the effects of changes in riparian vegetation, improvements in riparian microclimate, and reduced channel widths.

Wenatchee National Forest stream modeling

The upper portion of the watershed, primarily in the Wenatchee National Forest, above RM 38.8, was modeled in the *Wenatchee National Forest TMDL Technical Report* (Whiley and Cleland, 2003).

- Analysis methods used a stream classification system to estimate the effective shade levels necessary to meet the water quality standard for surface waters throughout the forest.
- Other analysis methods examined site potential shade, or the maximum amount of effective shade provided by late-succession vegetation.

- Due to naturally-occurring limitations to vegetative growth, site potential effective shade levels in some portions of the forest are predicted to be less than what is needed to achieve the numeric temperature standard.

Naches watershed modeling downstream of the Wenatchee National Forest

The remaining portion of the Naches River watershed being addressed by this TMDL was studied and the results presented in the Water Quality Study Findings report (Brock 2008).

- Model simulations for the mainstem performed at seven-day average ten-year return period (7Q10) critical flow conditions show that temperature decreases may be attained with future improvements towards a mature riparian vegetation compared with the current conditions.
- Under *critical* conditions, potential temperature reductions should reduce water temperatures to below the threshold for fish lethality, 23°C. However, in some cases, the potential temperature under critical conditions will be greater than the numeric criteria. Potential temperature reductions for *average* conditions, with improvements, should be much greater.
- A buffer of mature riparian vegetation along the banks of rivers and streams, and improvements in microclimate and channel width are expected to decrease the average daily maximum temperatures.
- Increasing stream flows will also improve temperatures.

Loading capacity

The loading capacity provides a reference for calculating the amount of pollutant reduction needed to bring water into compliance with standards. EPA's current regulation defines loading capacity as "the greatest amount of loading that a can receive without violating water quality standards" (40 CFR § 130.2(f)). Loading capacities in the upper Naches River are solar radiation heat loads based on potential land cover (primarily vegetation) and channel width.

Upper Naches River USFS managed lands

In the *Wenatchee National Forest Water Temperature TMDL Technical Report*, identification of loading capacity targets utilized the landscape stratification system developed specifically for that TMDL analysis. The loading capacities reflected the range of variation in geologic setting and associated physical processes that occurred across the Wenatchee National Forest. Channel classes were based on three attributes, which included:

- Subsection Mapping Units (SMU) that reflect the geologic setting.
- Watershed size.
- Channel morphology.

Existing data collected by the USFS was used in a heat budget analysis to determine loading capacity targets. More information regarding the analysis and the loading capacity targets by

landscape stratification are available in the *Wenatchee National Forest Water Temperature TMDL Technical Report* (Whiley and Cleland, 2003).

Cowiche Creek

Cowiche Creek was not modeled with QUAL2Kw to determine the temperature reductions required or the loading capacity for solar radiation. Therefore, loading capacities in Cowiche Creek are solar radiation heat loads based on shade curves generated for varying channel width and aspect at system potential vegetation.

Upper Naches River non-USFS managed lands

The lowest seven-day average flow with a two-year recurrence interval (7Q2) was selected to represent a typical climatic year. The lowest seven-day average flow with a ten-year recurrence interval (7Q10) was selected to represent a reasonable worst-case condition for the July-August period.

Air temperature values for the 7Q2 condition were assumed to be represented by the average of the hottest week of August 2005, which was the median condition from the historical record at Yakima Airport. The air temperature values for the 7Q10 condition were the average of the hottest week of 2004, which was the 90th percentile condition from Yakima. The corresponding median and 90th percentile air temperature conditions for the near-stream conditions near the Naches River at RM 38.8 were calculated from measurements taken at the WSDOT Saw Mill Flats weather station during August 2005 and August 2004, respectively. The median and 90th percentile air temperatures for the near-stream conditions near the Naches River at RM 17.6 were calculated from measurements taken at the Old River Road Remote Automated Weather Station (RAWS). Critical and average air temperatures for the remainder of the upper Naches River were calculated using a linear regression equation based on elevation.

The following scenarios for effective shade were evaluated for the 7Q2 and 7Q10 flow and climate conditions:

- The effective shade produced by the current riparian vegetation condition.
- Effective shade from average mature riparian vegetation that would naturally occur in the upper Naches River.
- Effective shade from maximum mature riparian vegetation that would naturally occur in the upper Naches River.

The system potential vegetation scenarios account for the presence of Highway 410. The sensitivity analysis of Highway 410's impact on maximum temperatures in the upper Naches River indicates that replacement of the highway with mature riparian vegetation would only result in an overall temperature reduction of 0.01°C. This is likely because the Naches is a wide river, with only about 50 feet between the road and the river to grow vegetation. Additional critical scenarios were evaluated to test the sensitivity of predicted water temperatures to changes in riparian microclimate, decreases in channel width, and reduction of tributary temperatures:

- **Microclimate.** Increases in vegetation height, density, and riparian zone width are expected to result in decreases in air temperature. In order to evaluate the effect of this potential change in microclimate on water temperature, the daily maximum air temperature was reduced by 2°C for reaches modeled with deciduous or conifer trees based on the summary of literature presented by Bartholow (2000).
- **Channel width.** Channel banks are expected to stabilize and become more resistant to erosion as the riparian vegetation along the stream matures. The sensitivity of predicted stream temperatures to reduction of channel width was tested by predicting stream temperatures that would occur if channel width were reduced by 5, 10 and 25%.
- **Reduced tributary temperatures.** A scenario was evaluated with the assumption that all tributaries flowing into the upper Naches River meet the applicable WQ criterion (16°C) during the critical period. This scenario also assumed that the water quality criterion of 16°C was met at the model headwater boundary (RM 38.8).

The results of the model runs for the critical 7Q2 and 7Q10 conditions are presented in Figures 3 and 4. The current condition in the Naches River watershed is expected to result in daily maximum water temperatures that are greater than 16°C in all of the evaluated reaches. Portions of the evaluated streams could be greater than the threshold for lethality of a 7-DADMax temperature at or below 22°C and a 1-day maximum temperature at or below 23°C under current riparian conditions. The “lethality” limit or “threshold for lethality” in Figures 3 and 4 is referring to the following excerpt from WAC173-201A-200(1)(c)(vii)(A) and an Ecology study (Hicks, 2002) that evaluates lethal temperatures for coldwater fish:

For evaluating the effects of discrete human actions, a 7-day average of the daily maximum temperatures greater than 22°C or a 1-day maximum greater than 23°C should be considered lethal to cold water fish species such as salmonids. Barriers to migration should be assumed to exist anytime daily maximum water temperatures are greater than 22°C and the adjacent downstream water temperatures are 3°C or more cooler.

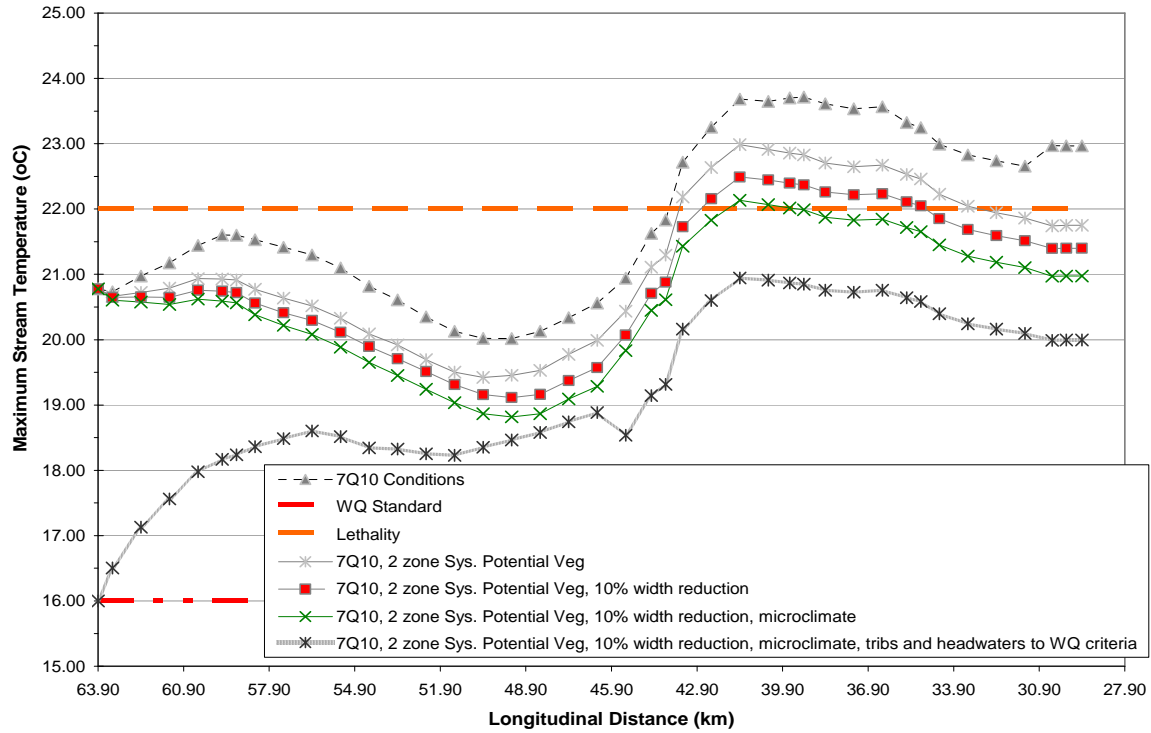


Figure 3: 7Q10 model scenarios for the upper Naches River.

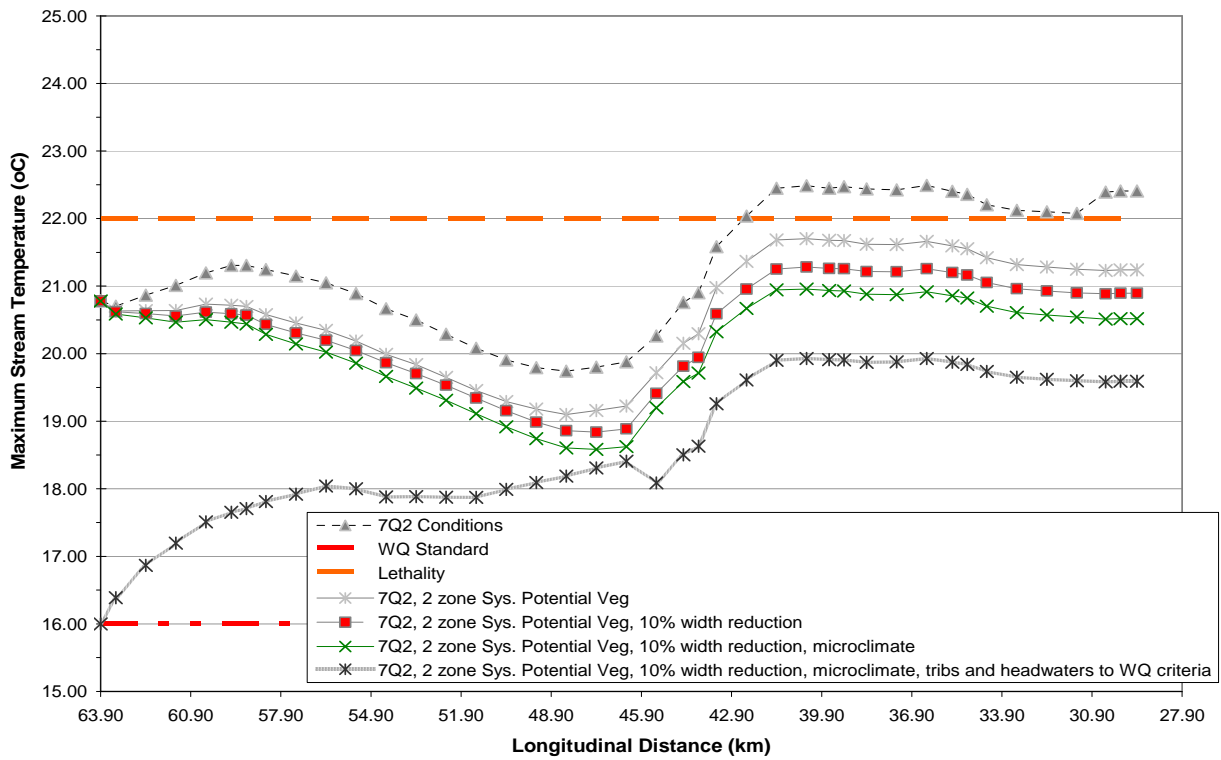


Figure 4: 7Q2 model scenarios for the upper Naches River.

Reductions in water temperature are predicted for hypothetical conditions with mature riparian vegetation, improvements in riparian microclimate, and reduction of channel width. Current temperatures in some sections of the upper Naches River are above the 23°C lethal limit for salmonids during the summer months. Potential reduced maximum temperatures under critical conditions are predicted to be greater than the 16°C numeric standard in the upper mainstem Naches River, but below the lethal limit of 23°C for salmonids. Further reductions are likely if all tributaries and channel complexity are restored (WAC 173-201A-200).

The best estimate of potential summertime stream temperature reductions for the upper Naches River (RM 38.8 to RM 17.6) is 2.7°C. This estimate is based on implementation of system potential vegetation, microclimate reductions, 10% reduction in channel width and restoration of the headwaters and tributaries to the water quality numeric criteria of 16°C. Most of the system is predicted to achieve temperatures in the range of 18-23 degrees-C during the hottest portions of the summer (Table 2).

Table 2: Summary of predicted daily water temperatures (°C) during critical conditions in the upper Naches River

Scenario	Upper Naches River	
	Tave (average daily average of all reaches)	Tmax (average daily maximum of all reaches)
7Q2		
Current condition	18.06	21.35
Average System Potential Vegetation	17.90	21.03
Maximum System Potential Vegetation	17.82	20.87
2 zone Maximum System Potential Vegetation	17.72	20.67
2 zone Maximum System Potential Vegetation, 10% width reduction	17.69	20.41
2 zone Maximum System Potential Vegetation, 10% width reduction, Microclimate reductions	17.53	20.16
2 zone Maximum System Potential Vegetation, 10% width reduction, Microclimate reductions, tributary and headwaters to WQ numeric criteria	16.16	18.64
7Q10		
Current condition	18.41	21.93
Average System Potential Vegetation	18.24	21.59
Maximum System Potential Vegetation	18.14	21.39
2 zone Maximum System Potential Vegetation	18.07	21.24
2 zone Maximum System Potential Vegetation, 5% width reduction	18.04	21.09
2 zone Maximum System Potential Vegetation, 10% width reduction	18.00	20.93
2 zone Maximum System Potential Vegetation, 25% width reduction	17.90	20.44
2 zone Maximum System Potential Vegetation, 10% width reduction, Microclimate reductions	17.81	20.64
2 zone Maximum System Potential Vegetation, 10% width reduction, Microclimate reductions, tributary and headwaters to WQ numeric criteria	16.46	19.20

It is important for stream water quality throughout the year to promote a robust, diverse riparian condition because "...the degree of shading of streams is a function of the structure and composition of riparian vegetation. Dense, low, overhanging canopies greatly reduce light intensity at the water's surface, but high, relatively open canopies allow greater amounts of light to reach the stream. Deciduous riparian vegetation shades streams during summer, but modifies light conditions only slightly after leaf fall, whereas evergreen riparian zones shade stream channels continuously (Montgomery, 1996)."

Water Quality Study results

The QUAL2Kw model simulations indicated that:

1. A buffer of mature riparian vegetation along the banks of the rivers is expected to decrease the average daily maximum temperatures slightly. At 7Q10 flow conditions, a 0.7°C reduction is expected for the upper Naches River.
2. A 10% reduction of the channel width would result in an expected reduction of 1°C. A 25% reduction in channel width may result in a 1.5°C reduction of the average maximum temperatures.
3. The changes in microclimate conditions associated with mature riparian vegetation could further lower the daily average maximum water temperature by about 0.5°C.
4. With all management scenarios in place and the assumption that the headwaters and the tributaries comply with the water quality criterion, the overall decrease in the average maximum temperature for the simulated critical condition is 2.7°C.

The load allocations are expected to result in water temperatures that are equivalent to the temperatures that would occur under natural conditions. Therefore, the load allocations are expected to result in water temperatures that meet the water quality standard.

Establishment of mature riparian vegetation is expected to have a secondary benefit of reducing channel widths and improving microclimate conditions to address those influences on the loading capacity. An adaptive management strategy is recommended to address other influences on stream temperature such as sediment loading, groundwater inflows, and hyporheic exchange.

Load and Wasteload Allocations

This TMDL establishes load allocations for nonpoint sources, as well as wasteload allocations for point sources. Compliance with these allocations will allow the waters of the upper Naches watershed to conform to state water quality standards and achieve the goals of this TMDL.

Load allocations

The *system potential temperature* is an approximation of the temperature that would occur under natural conditions during specified conditions of air temperature and streamflow. The system potential temperature is estimated using analytical methods and computer simulations proven effective in modeling and predicting stream temperatures in Washington. The system potential temperature is based on our best estimates of the *mature riparian vegetation, natural channel shape, and riparian microclimate*.

A system potential temperature is estimated for both an *average* year (50th percentiles of climate and low streamflows) and a *critical condition* year (upper 90th percentile air temperature and low flows that occur only once every ten years). The system potential temperature does not, however, replace the numeric criteria nor invalidate the need to meet the numeric criteria at other times of the year and at other less extreme low flows and warm climatic conditions.

At certain locations and times, the system potential temperature is greater than the numeric criterion assigned to the water body. In these cases, the loading capacity and load allocations in this TMDL should be established such that human activities/sources do not increase water temperatures more than an additional 0.3°C. In all waters where the system potential temperature is higher than the assigned criterion, maximum riparian shade and best channel and flow conditions possible are needed.

Upper Naches River

For the upper Naches River (RM 38.8 to RM 17.6), predicted system potential water temperatures would not meet numeric water quality standards during the hottest period of the year on the upper Naches River. Hence, there is a widespread need to achieve maximum protection from direct solar radiation. The load allocations for the upper Naches River from the USFS boundary (RM 38.8) to the confluence with the Tieton (RM 17.6) are the effective shade that would occur from system potential mature riparian vegetation and a 10% reduction in channel width. *System potential mature riparian vegetation* is defined as *that vegetation which can grow and reproduce on a site, given climate, elevation, soil properties, plant biology and hydrologic processes*. Figure 5 illustrates the deficit in effective shade (difference between existing shade and effective shade from system potential vegetation) in the Upper Naches Watershed.

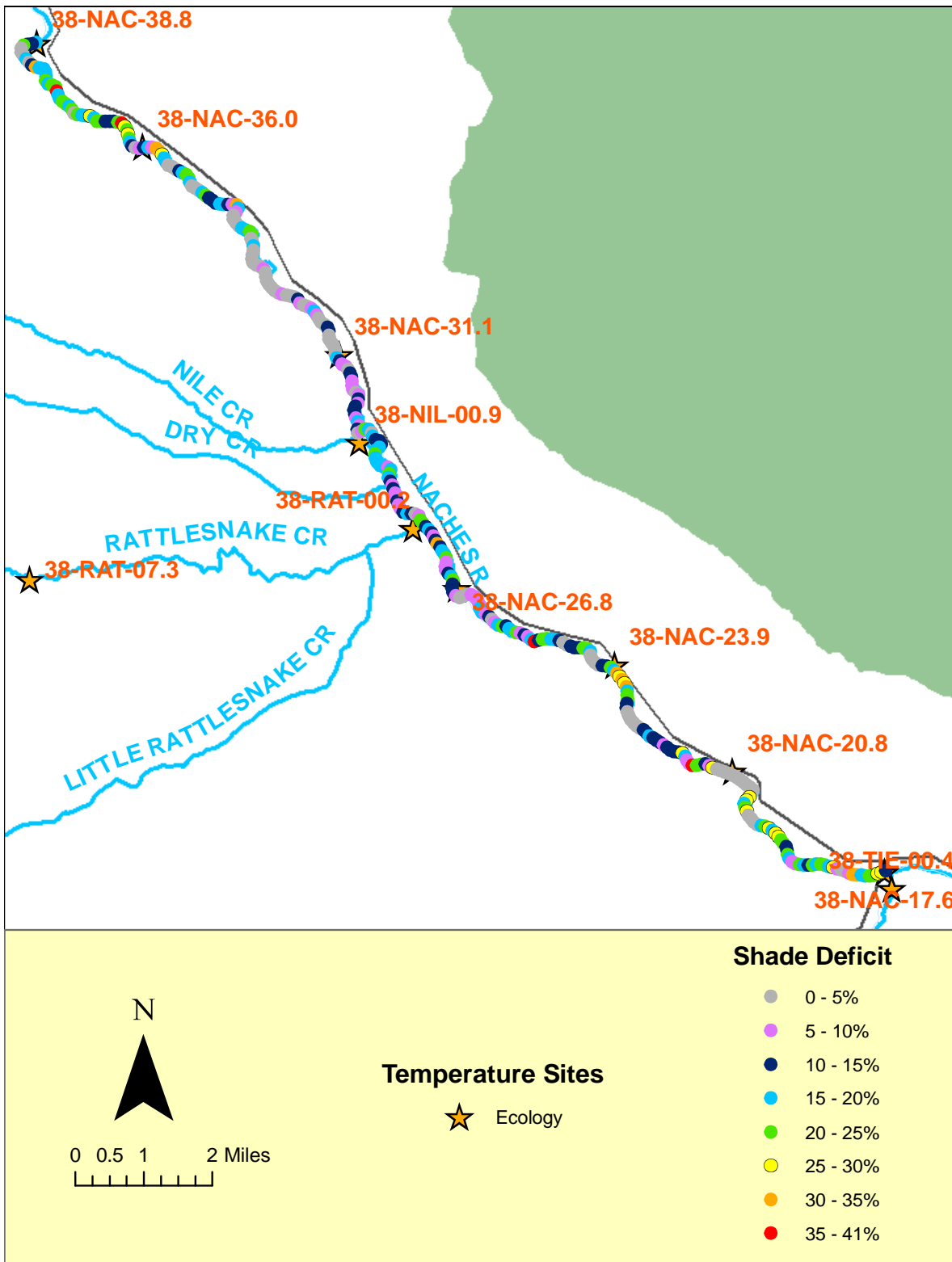


Figure 5: Shade deficit between current conditions and system potential vegetation and channel conditions for the upper Naches River (RM 38.8 to RM 17.6).

Upper Naches River tributaries and Cowiche Creek

For the Cowiche Creek system and all tributaries flowing into the upper Naches River, the load allocations for shade are represented in Figure 6 based on the estimated relationship between shade, channel width, and stream aspect at the assumed maximum riparian vegetation. Figure 6 shows that the importance of shade decreases as the width of the channel increases.

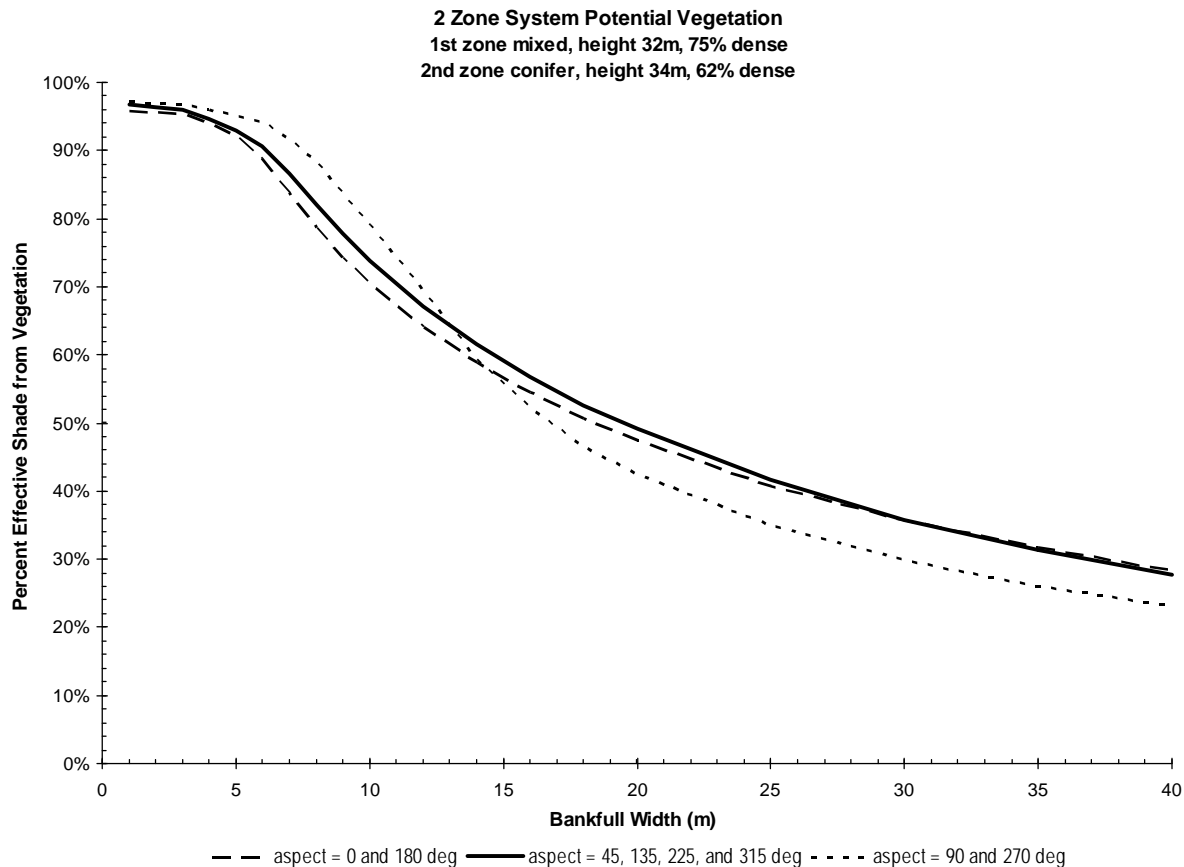


Figure 6: Load allocations for effective shade for various bankfull width and aspect of the un-simulated Cowiche Creek system and tributaries to the upper Naches River.

Surface waters on Wenatchee National Forest lands

The *Wenatchee National Forest Water Temperature TMDL Technical Report* developed load allocations based on a channel classification system developed for surface waters within the Wenatchee National Forest. Table 3, in conjunction with Figure 7, outlines the TMDL load allocations, or the effective shade levels required to meet the temperature standard, and the load allocation, or the effective shade level provided by site potential vegetation. Direct application of Table 3 to the listed and impaired streams is provided in Table 4.

Table 3: Wenatchee National Forest Water Temperature TMDL Technical Report load allocations by channel class.

Classification	Flow (cfs)	W:D (wetted)	TMDL Allocation Effective Shade (%)	Load Allocation (System Potential) Effective Shade (%)		
				Group a	Group b	Group c
M242Cp Naches Mountains						
Cp-1A	1	10	70	48	61	70
Cp-1B	1	15	70	48	61	70
Cp-2B	2	15	70	47	61	69
Cp-2C	2	15	70	47	61	69
Cp-3B	4	20	60	46	58	67
Cp-3C	4	30	65	46	58	67
Cp-4C	8	35	60	43	55	63
Cp-5C	16	40	55	39	51	58
Cp-6C	32	45	50	33	44	51

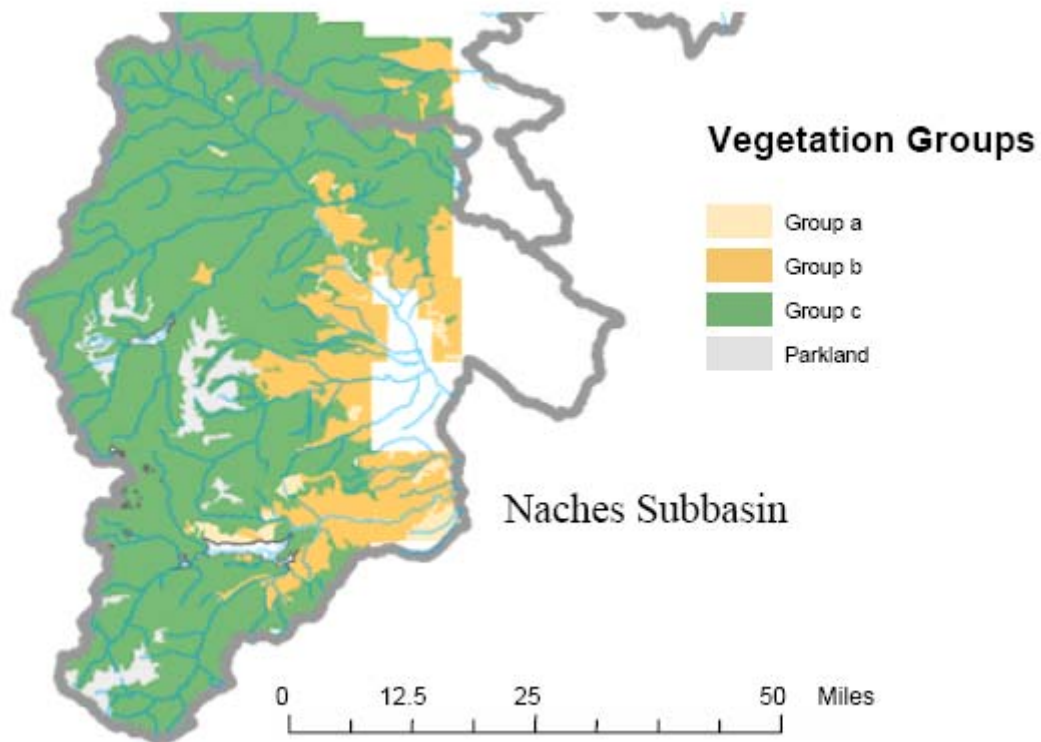


Figure 7: Wenatchee National Forest vegetation groups for the Naches River sub-basin.

Table 4: Allocations (as percent effective shade) developed in the Wenatchee National Forest Water Temperature TMDL Technical Report.

Stream Name	1996 Waterbody ID	Township, Range, Section	Stream Classification	TMDL Allocation Effective Shade (%)	Load Allocation Effective Shade (%)
American River	WA-38-1060	17N,13E,12	Cp-5Cc	55	58
Bear Creek	WA-38-1088	19N,13E,32	Cp-2Bc	70	69*
NF Nile Ck. (Benton)	WA-38-2110	16N,15E,03	Cp-1Ab	70	61*
Bumping River	WA-38-1070	17N,13E,12	Cp-5Cc	55	58
Crow Creek	WA-38-1081	18N,14E,30	Cp-4Cc	60	63
Gold Creek	WA-38-1041	17N,14E,36	Cb-2Aa	70	47*
Mathew Creek	WA-38-1086	18N,13E,10	Cp-2Bc	70	69*
Rattlesnake Creek	WA-38-1035	15N,14E,10	Cp-5Cb	55	51*
Little Rattlesnake Ck.		15N, 14E, 25	Cp-3Cb	65	58*
Little Naches River		17N, 14E, 4	Cp-6Cc	50	51
Little Naches River		18N, 14E, 30	Cp-5Cc	55	58
Little Naches River		18N, 13E, 14	Cp-5Cc	55	58
Little Naches River		18N, 13E, 9	Cp-4Cc	60	63
Little Naches River		18N, 13E, 5	Cp-4Cc	60	63
Sand Creek		18N, 13E, 14	Cp-2Bc	70	69*
Bumping River		17N, 14E, 4	Cp-6Cc	50	51
Bumping River		16N, 11E, 36	Cp-4Cc	60	63
Quartz Creek		18N, 14E, 30	Cp-3Cc	65	67

*- TMDL allocation defaults to the load allocation (site potential vegetation).

Wasteload allocations

The water quality standards (WAC 173-201A) restrict the amount of warming that point sources can cause when temperatures are warmer than water quality criteria. At times and locations where the assigned numeric criteria cannot be attained, even under estimated natural conditions, the state standards hold human warming to a cumulative allowance for additional warming of 0.3°C above the natural conditions estimated for those locations and times.

Maximum effluent temperatures should also be no greater than 33°C to avoid creating areas in the mixing zone that would cause instantaneous lethality to fish and other aquatic life (WAC 173-201A-200(1)(c)(vii)(D)).

The load allocations for nonpoint sources are considered sufficient to attain water quality standards by resulting in water temperatures that are equivalent to natural conditions. Therefore, water quality standards allow an increase over natural conditions for point sources for the establishment of wasteload allocations. However, point sources must still be regulated to meet the incremental warming restrictions established in the standards to protect cool water periods.

Maximum temperatures (T_{NPDES}) for the NPDES effluent point source discharges into Cowiche Creek, including the Cowiche Regional Waste Water Treatment Plant (WWTP) and six fruit

packing facilities, were calculated from the following mass balance equation (Ecology, 2007), in recognition that the system potential upstream temperature is greater than 17.5°C.

Salmonid spawning, rearing and migration:

$$T_{NPDES} = [17.5\text{ °C}-0.3\text{°C}] + [\text{chronic dilution factor}] * 0.3\text{ °C}$$

Cowiche regional WWTP

The Cowiche WWTP discharges water to North Fork Cowiche Creek about 2 miles upstream of the confluence with the mainstem Cowiche Creek. Table 5 presents the maximum effluent temperature allowable for the reported dilution factor for the Cowiche WWTP Permit No. WA-005239-6.

The Cowiche Creek system was not modeled to determine the system potential conditions. Therefore, it is likely that the system potential temperature upstream from the NPDES discharger is greater than the water quality criteria of 17.5°C and will vary depending on the river flow and weather conditions. The wasteload allocation expressed in the permit limit must ensure that the discharge does not exceed the water quality standards under all but the most critical conditions (7Q10 flows).

Table 5: Wasteload allocation for the Cowiche Regional Publicly Owned Treatment Works.

NPDES Facility	Chronic dilution factor	Water quality standard for temperature (degrees C)	Allowable increase in temperature at the mixing zone boundary (degrees C)	T _{NPDES} = Maximum allowable effluent temperature WLA (degrees C)
Cowiche WWTP	1.0	17.5	0.3	17.5

Discharge monitoring report (DMR) data from Cowiche WWTP for the period November 2002-June 2007 shows that maximum discharge temperatures in June, July, August and September range between 14.2 °C (57.6°F) and 21.2°C (70.2°F). Based on the TMDL technical analysis, the wasteload allocation is set to 17.5°C.

Fruit packing facilities

Five fruit packing facilities discharge to the North Fork Cowiche Creek between the Cowiche WWTP and the confluence with the mainstem Cowiche Creek. One fruit packing facility, Lloyd Garretson Co., discharges to Cowiche Creek near the mouth. Table 6 presents the maximum effluent temperature allowable for the dilution factor for each facility. The dilution factor for each facility was calculated as the ratio between the 7Q10 flow at the mouth of the North Fork Cowiche Creek (0.26-cfs) or the mouth of Cowiche Creek (0.5-cfs) and the maximum DMR reported effluent flow between January 2000 and June 2007.

Each facility is held to the water quality standard of 17.5°C plus 0.3°C at the edge of their mixing zone. This conservative calculation should ensure that cumulatively the facilities do not cause an increase of more than 0.3°C above the water body's system potential temperature.

Table 6: Wasteload allocations for fruit packing facilities that discharge to the North Fork Cowiche Creek.

NPDES Facility	Permit Number	Monitoring Point	Chronic dilution factor	Water quality standard for temperature (°C)	Allowable increase in temperature at the mixing zone boundary (°C)	T _{NPDES} = Maximum allowable effluent temperature WLA (°C)
Strand Apples Inc Marley Bldg	WAG435036C	1	20	17.5	0.3	23.2
Strand Apples Inc Main Plant	WAG435044C	3	2	17.5	0.3	17.8
Cowiche Growers Inc	WAG435046C	5	2	17.5	0.3	17.8
Ackley Fruit Company LLC	WAG435070C	1	3	17.5	0.3	18.1
Strand Apples Forney Warehouse	WAG435283A	1	2	17.5	0.3	17.8
Lloyd Garretson, Co.	WAG435210C	1	4	17.5	0.3	18.4

Allocation for future growth

EPA guidance suggests considering anticipated *future growth* when allocating loadings for point sources. However, the North Fork Cowiche Creek is an effluent-dominated stream and the current NPDES permit for the Cowiche WWTP does not allow for a mixing zone for the plant. Based on the TMDL technical analysis, the wasteload allocation was set to 17.5°C. Hence, future plant expansions will have to continue to adhere to the 17.5°C effluent temperature limit.

Additionally, there is no reserve loading for future expansions of existing dischargers or new dischargers.

Seasonal variation

Clean Water Act (CWA) Section 303(d)(1) requires that TMDLs “be established at the level necessary to implement the applicable water quality standards with seasonal variations”. The current regulation also states that determination of “TMDLs shall take into account critical conditions for streamflow, loading, and water quality parameters” [40 CFR 130.7(c)(1)]. Finally, Section 303(d)(1)(D) suggests consideration of normal conditions, flows, and dissipative capacity.

Existing conditions for stream temperatures in the Naches River watershed reflect seasonal variation. Cooler temperatures occur in the winter, while warmer temperatures are observed in the summer. Figure 8 summarizes the highest seven-day average maximum water temperatures in 2004. The highest temperatures typically occur from mid-July through mid-August. This time frame is used as the critical period for development of the TMDL.

Seasonal estimates for streamflow, solar flux, and climatic variables for the TMDL are taken into account to develop critical conditions for the TMDL model. The critical period for evaluation of

solar flux and effective shade was assumed to be July 31 because it is the mid-point of the period when water temperatures are typically at their seasonal peak.

Critical streamflows for the TMDL were evaluated as the lowest 7-day average flows with a two-year recurrence interval (7Q2) and ten-year recurrence interval (7Q10) for the months of July and August. The 7Q2 streamflow was assumed to represent conditions that would occur during a typical climatic year and the 7Q10 streamflow was assumed to represent a reasonable worst-case climatic year.

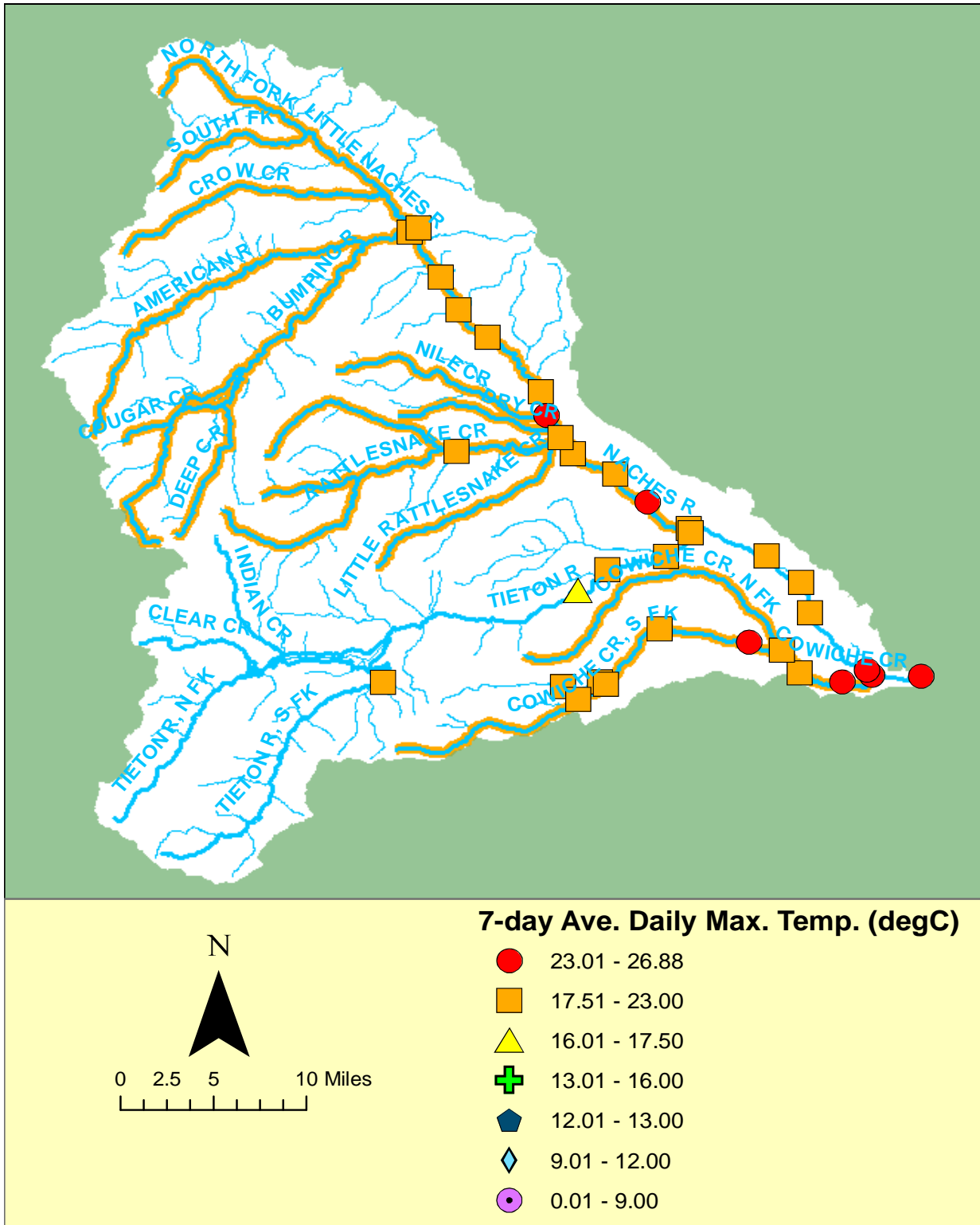


Figure 8: Highest 7-day average daily maximum temperatures observed in the Naches River watershed during the summer 2004 field season.

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Margin of Safety

The margin of safety accounts for uncertainty about pollutant loading and water-body response. In this TMDL, the margin of safety is addressed by using critical climatic conditions in the modeling analysis. The margin of safety in this TMDL is implicit because of the following:

- To estimate a reasonable worst-case condition for water temperatures in the upper Naches River watershed, Ecology used the 90th percentile of the highest 7-day-averages of daily maximum air temperatures for each year of record at the Yakima airport. Typical conditions were represented by the median of the highest seven-day-averages of daily maximum air temperatures for each year of record.
- The lowest seven-day average flows during July-August with recurrence intervals of ten years (7Q10) were used to evaluate reasonable worst-case conditions. Typical conditions were evaluated using the lowest seven-day average flows during July-August with recurrence intervals of two years (7Q2).
- Model uncertainty for prediction of maximum daily water temperature was assessed by estimating the root-mean-square error (RMSE) of model predictions compared with observed temperatures during model validation. The average RMSE for model calibration and confirmation was 0.6°C.
- The load allocations are set to the effective shade provided by fully mature riparian shade, which are the maximum values achievable in the upper Naches River watershed (RM 38.8 to RM 17.6).

The margin of safety is also explicit because:

- Cloud cover data collected at the airport was used for all model scenarios run for the upper Naches River segments. In addition, a cloud cover of 0% was used for the critical condition model runs.
- The wasteload allocations for the point sources were developed using the maximum reported DMR facility flows and 7Q10 streamflows to calculate the dilution factors.

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Reasonable Assurance

Past and ongoing activities by the North Yakima Conservation District (NYCD), city of Cowiche, Washington Department of Fish and Wildlife, NRCS, Ecology, Yakama Nation Fisheries Program, and landowners support the goals of this TMDL.

The ultimate goal of this TMDL is to meet the state water quality standards for stream temperature throughout the Naches River watershed. Maintaining the TMDL goals will be required once compliance is achieved. Ecology offers reasonable assurance that the TMDL goals will be met due to the following:

- Education, outreach, technical and financial assistance, permit administration, and enforcement will all be used to ensure the success of this TMDL.
- There is considerable interest and local involvement in resolving the water quality problems in the upper Naches River watershed. Many organizations and agencies are already engaged in stream restoration and source correction actions that will help resolve the temperature problem.
- A wide variety of current and ongoing restoration actions are identified in the Implementation Strategy. These actions fully support the goals of this TMDL and should significantly reduce water temperatures in the upper Naches River watershed.
- While Ecology is authorized under Chapter 90.48 RCW to impose strict requirements or issue enforcement actions to achieve compliance with state water quality standards, it is the goal of all participants in the Naches River TMDL process to achieve clean water through cooperative efforts.

The elements listed above provide reasonable assurance that the goals of the upper Naches River watershed nonpoint source TMDL will be met by 2089.

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Implementation Strategy

Introduction

The goal of a TMDL is to ensure that an impaired water body attains water quality standards within the shortest, reasonable time. This implementation strategy provides a list of activities that should be undertaken to restore and maintain water quality. It describes the roles and authorities of cleanup partners and the programs or other means through which they will address these water quality issues. Cleanup partners are those organizations with jurisdiction, authority, resources, or direct responsibility for implementing restoration activities.

After EPA approves the *Upper Naches River and Cowiche Creek Temperature TMDL*, Ecology will collaborate with interested and responsible parties to implement improvements in the watershed necessary to restore water quality. Ecology and other entities will provide technical assistance and seek more funding for these actions, and for any new actions identified as the body of data grows over time.

In general, the activities identified in the TMDL analysis to protect and restore water quality in the upper Naches River and Cowiche Creek watersheds include restoring system potential riparian conditions along all water bodies, reducing sediment input, and increasing stream flow levels. This plan is based on existing law, regulation, and the voluntary action of property owners with lands adjacent to streams. Implementation of this TMDL relies on continuing the many existing voluntary efforts to reduce stream temperature and protect riparian areas throughout the watershed. Ecology also encourages more nonpoint source pollution prevention actions in the watershed. Ecology will initiate formal enforcement actions or control the use of state and federal assistance when determined necessary to achieve implementation consistent with the water quality targets established in this TMDL.

Load allocations are based on a combination of system potential mature riparian vegetation, effective shade, and channel width, and are assigned to the upper Naches River and tributaries, Cowiche Creek, and waters within the Wenatchee National Forest lands. Ecology will work with other state and federal agencies to coordinate actions that may affect water quality. These agencies include, but are not limited to the U.S. Forest Service (USFS); National Resource Conservation Service; local conservation districts; Washington Department of Transportation; Washington Department of Natural Resources (DNR); and Yakima County. Of these agencies, DNR, USFS and Yakima County have the most influence on activities that potentially affect riparian conditions. The expectation is that DNR-regulated state and private forests and the USFS-run Wenatchee National Forest will be managed to restore and maintain system potential riparian shade along all streams in the watershed.

Other lands within the watershed are subject to Yakima County's Shoreline Management Plan and Critical Areas Ordinances, which provide riparian protection through limitations on development techniques and shoreline encroachment.

The seven contributing NPDES permitted point sources (the Cowiche Regional Wastewater Treatment Plant and six fruit packing facilities) are assigned WLAs, which will be incorporated as effluent limitations in their NPDES permits. As necessary, Ecology will assign schedules for these dischargers to achieve compliance with the temperature targets.

Certain challenges in the watershed may limit potential improvements in some areas. For example, long stretches of state highway 410 are located immediately adjacent to the Naches River. There is currently no room for riparian vegetation between the highway and the river in much of these stretches. Streamside vegetation is needed to provide filtration of pollutants potentially carried by rainfall runoff from the highway and to provide riparian shade. Future opportunities to improve riparian conditions along this highway may occur when maintenance is conducted.

Physical and socio-economic issues, such as locations of human habitation, existing development, roads, and railroads, will be considered during development of implementation actions. Restoring and maintaining system potential riparian vegetation is the highest priority because of its importance for mitigating increases of stream temperature and providing streamside habitat.

The implementation strategy described below identifies and details what needs to be done to improve and maintain water quality. It also briefly explains the roles and authorities of cleanup partners (those organizations with jurisdiction, authority, or direct responsibility for cleanup), along with the programs or other means through which they will address these water quality issues.

What needs to be done

Water temperature targets are set by the TMDL for the upper Naches River and its tributaries. The principal focus of implementation must be to continue restoration of riparian vegetation that provides shade and other mitigations that help maintain the cool water necessary to support the characteristic uses (such as cold water fishery) designated for this basin. This TMDL provides riparian shade targets because these are more meaningful for guiding management decisions to control the pollutant *heat* (from solar radiation). The water quality analysis determined that maximum possible shade along all portions of the upper Naches River, its tributaries, and Cowiche Creek is required to meet water quality standards.

Nonpoint sources reach their reduction targets, called load allocations, through implementation of a variety of projects. Completion of these projects often begins because of increased awareness of water quality problems as an outcome of TMDL development and its associated outreach and education conducted by Ecology and local partners. Education and outreach are important steps toward completing many nonpoint source reduction projects. Nonpoint source projects can be categorized, and locally prioritized, within three different general types of project:

1. Reduce pollutant loading from nonpoint sources by implementation of best management practices (BMPs).

2. Maintain a watershed's ability to keep water healthy by protection of existing ecological functions such as riparian zones, wetlands and floodplains.
3. Increase a watershed's ability to keep water healthy by restoration of ecological functions such as riparian zones, wetlands and floodplains.

Several major land-use groups will continue to implement BMPs to reduce water temperatures in upper Naches River waterways. These groups include the timber industry; irrigated agriculture; ranchers; state, county, and municipal governments; and homeowners with waterfront property.

Actions that can help cool water temperature fall into six major categories:

1. Protection and restoration of riparian vegetation.
2. Restore stream channel and riparian function.
3. Increasing summer stream flows.
4. Allowing streams access to floodplains.
5. Control effluent temperature impacts from NPDES facilities.
6. Public education about the importance of healthy riparian areas.

Discussion of each of these action categories follows.

Protect and restore riparian vegetation

A mature stand of native riparian vegetation helps prevent sunlight from reaching the stream, thereby reducing the heating from solar radiation. Shade produced by mature riparian vegetation is key to keeping a stream cool. Additionally, riparian vegetation can help stabilize the streambank, filter sediment, enhance groundwater flow, and provide a microclimate effect, all of which has benefits water quality and stream habitat.

To promote healthy riparian areas and let streamside vegetation (ideally trees) grow to maturity, suitable riparian areas must be protected from harm. Some actions that accomplish this goal are fencing livestock away from riparian areas and providing buffers for vegetation between recreational camping areas and streams.

Damaged riparian areas should also be protected to prevent further damage and allow vegetation to re-grow. The most effective method to protect a riparian area is fencing.

Livestock managers should continue to implement appropriate BMPs for grazing and pasture operations. These practices will help reduce livestock contact with water bodies, which will in turn allow riparian areas to revegetate and increase riparian shade. The NRCS Field Office Technical Guide provides specifications for fencing and other practices that will protect water quality from the effects of livestock.

Homeowners that have waterfront property should protect existing streamside vegetation and should consider planting native plants to enhance their riparian areas and resist streambank erosion.

The owners of the largest tracts of public forested land in the upper Naches River watershed are the USFS and DNR. The largest private timber owner is the Plum Creek Timber Company.

Much timber acreage is also held in small tracts by numerous private landowners. All of these groups are participating in activities that will reduce water temperatures in the upper Naches River watershed. The private and state landowners are implementing improvements required by the state forest practices rules, and the USFS must comply with the load allocations established in this TMDL.

Restore stream channel and riparian function

Several hydrologic features of streams and rivers are associated with cooler water. These features include increased sinuosity (where appropriate); minimal width-to-depth ratio; stable streambanks; use of side channels; and instream elements such as large woody debris and boulders.

Reduce width-to-depth ratio

Excessively wide, shallow streams heat much more quickly in the summer sun when vegetation is not present. The increased width-to-depth ratios are often the result of excessive sediment input to the stream. To reduce the width-to-depth ratio (make stream deeper and more narrow), sediment input to the stream must be reduced as well. Sediment input to a stream or river generally comes from two sources: bank erosion or overland flows of sediment-laden runoff.

Bank stabilization is an effective method of slowing or stopping streambank erosion. Healthy, thriving riparian vegetation can help hold a bank in place. In addition, installation of bank structures, such as whole-tree revetments, can redirect stream flow and reduce erosion. Bank stabilization with mature riparian vegetation is preferable to constructed means of bank protection.

Many of the actions to protect, restore, and replant the riparian areas will help bank erosion.

Attention should be paid to upland sediment sources as well. Erosion of poorly maintained forest roads, for instance, can contribute large volumes of sediment to small, sensitive tributaries. Increased road maintenance and proper closure of unnecessary roads can help eliminate this problem. In addition, working with agricultural irrigators to help reduce field erosion can also reduce sediment input to streams.

The state forest practices rules require that private timber companies regularly maintain existing roads. The timber companies must also create a list of which roads should be improved in order to avoid erosion that could impair waterways. This list must be prioritized in order of which roads could cause the most pollution. Over time, the timber companies must complete all improvements on the list. These actions should reduce the sediment input from logging roads.

Restore stream channel

Stream channels that have more sinuosity and connected side channels have greater stability and connection to the hyporheic zone, which results in cooler streams. This is because the added sinuosity increases stream length, decreases stream slope, and allows a stream to dissipate energy

during high flows. Increased sinuosity also gives the stream more water to recharge the hyporheic zone.

Adding sinuosity or reconnecting side channels is generally achieved one of two ways: naturally or by human engineering.

Natural stream shaping can be achieved by adding instream structures such as large woody debris (LWD) or boulders. These structures intercept and redirect the stream, which can change erosional and depositional aspects of the stream. Over time, this can add sinuosity.

Frequently, stream shaping and side channel connections are created by engineering designs, and executed by careful construction with heavy equipment. This type of work is often done in conjunction with the placement of stream structures (LWD, boulders, or other) and riparian plantings.

The USFS– Naches Ranger District and the Yakima Tributary Access and Habitat Program (YTAHP) have installed numerous new stream structures in the upper Naches watershed.

Increase summer stream flows

Higher stream flows result from a larger volume of water in the stream. A larger volume of water retains its (cool) temperature longer and heats more slowly in the summer sun than a smaller volume. Therefore, one useful tool to keeping summer water temperatures cooler is to keep more water in the stream. Several actions can accomplish this goal:

- Dedicate water that would otherwise be diverted from the stream into a water trust. This allows the landowner with legal water rights to protect his water rights while helping to improve water quality by leaving water in the stream.
- Ensure that water removed from the stream for irrigation is applied to crops in the most efficient manner possible. More efficient irrigation (such as sprinklers or drip lines) can satisfy all irrigation needs while using much less water.
- Ensure that no water is illegally withdrawn from area waterways. Only holders of legal water rights are allowed to withdraw water from streams and rivers.
- Use restoration and land-use practices that increase and protect natural storage of water in smaller order drainages. These practices include restoration of beaver populations and protection of forests from catastrophic fire to increase natural water storage in the watershed and reduce erosion.

Allow streams to access floodplains

Flooding of a river or stream's floodplain during spring snowmelt recharges the adjacent hyporheic zone. This in turn promotes the consistent entry of cool water into the stream during the dry season. Stream hydrologists recommend that streams be allowed to access their floodplains at least every two years for maximum stream health.

Control effluent temperature impacts from NPDES facilities

The seven NPDES facilities (Cowiche Regional Wastewater Treatment Plant and six fruit packers) have permits to discharge treated effluent into project area waterways. As these permits are renewed in the future, they may be modified as necessary to reduce impacts from effluents on receiving water temperatures.

The Cowiche Regional WWTP discharges to the North Fork Cowiche Creek, creating an effluent-dominated stream. The Cowiche Creek watershed has been identified as important aquatic habitat for salmon and steelhead, but has also been identified as being flow-limited for these and other species. Recent water acquisition projects for Cowiche Creek have resulted in increased stream flows for this river system through acquisition of water rights at significant costs. The Cowiche Regional WWTP has limited capacity to cool its effluent other than expensive methods (such as a chiller or cooling tower) that would result in minimal if any improvement to the overall system potential of the watershed. Given the rural, agricultural location of the facility, the most reasonable and feasible option for treatment may be to get the effluent out of the stream during the critical period and land apply on nearby agricultural crops. However, this would be in direct conflict with the goals of the water acquisition projects to increase flow in Cowiche Creek.

Given the importance of the instream flow in Cowiche Creek, the Cowiche Regional WWTP may meet the criteria for an extended mixing zone (this will be evaluated with the next NPDES permit reissuance). Extended mixing zones may, in some cases, be granted to a discharger by Ecology in accordance with WAC 173-201A-400(12 & 13). Two cases cited in the WAC are relevant here:

- (b) Where altering the size configuration (of the mixing zone) is expected to result in greater protection to existing and characteristic uses, and
- (c) Where the volume of water in the effluent is providing a greater benefit to the existing or characteristic uses of the water body due to flow augmentation than the benefit of removing the discharge, if such removal is the remaining feasible option.

The design criteria of the WWTP specifies an average maximum flow for the month of 0.44 million gallons per day (0.68 cubic feet per second). However, flow in North Fork Cowiche Creek during the critical summertime low-flow period commonly approaches zero. As noted above, the water volume of this effluent has important benefits for fish and other aquatic life, even though it may at times exceed the temperature standard of 17.5°C. A possible configuration of the mixing zone would be to extend it down to the confluence of Cowiche Creek with the Naches River. Gauging records for the Naches River near its confluence with Cowiche Creek show a 7Q10 low flow of 206 cfs. This scenario could provide a chronic dilution factor of 50. The decision to establish an extended mixing zone will be evaluated with the next NPDES permit reissuance, and will consider the potential costs and benefits to aquatic uses were this discharge to be removed from the river (via a switch to land application, etc). Ecology will also consider whether a modified mixing zone should be allowed at other times of the year when the discharge may not be advantageous to aquatic life.

Educate people about the importance of healthy riparian areas

Public education is a critical element of any successful water quality improvement plan. Several groups are currently engaged in outreach and education regarding the importance of healthy riparian areas and prevention of streambank erosion.

Local agricultural advisory groups (NYCD, NRCS, and others) will continue to promote outreach and education regarding water quality and riparian restoration, and continue to offer technical assistance to irrigators, ranchers and other rural residents.

Yakima County, the city of Cowiche, and Ecology will work together to develop public-education programs to promote riparian restoration.

The USFS – Naches Ranger District has a long and successful history of public outreach, especially concerning stream and riparian protection, and they will continue these efforts.

Enforce state forest practices regulations

The state's forest practices regulations will be relied upon to bring waters on private and state forestlands into compliance with the load allocations established in this TMDL.

The effectiveness of the Forests and Fish program is being assessed through a formal adaptive management program. The success of this TMDL will be assessed using monitoring data from streams in the watershed.

DNR is encouraged to condition forest practices to prohibit any further reduction of stream shade. DNR should not waive or modify any shade requirements for timber harvesting activities on state and private lands.

New forest practices rules for roads also apply. These include new road construction standards, as well as new standards and a schedule for upgrading existing roads. Under the new rules, roads must provide for better control of road-related sediments, provide better streambank stability protection, and meet current BMPs. DNR is also responsible for oversight of these activities.

SEPA/Planning standard language

TMDLs must be considered during State Environmental Policy Act (SEPA) and other local land use planning reviews. If the land-use action under review is known to potentially impact temperature as addressed by this TMDL, then the project may have a significant adverse environmental impact. SEPA lead agencies and reviewers are required to look at potentially significant environmental impacts and alternatives and to document that the necessary environmental analyses have been made. Land use planners and project managers should consider findings and actions in this TMDL to help prevent new land uses from violating water quality standards.

Ecology recently published a focus sheet on how TMDLs play a role in SEPA impact analysis, threshold determinations, and mitigation (www.ecy.wa.gov/biblio/0806008.html). Additionally, the TMDL should be considered in the issuance of land use permits by local authorities.

Who needs to participate?

There are numerous opportunities to coordinate actions to reduce stream temperature with other planning efforts. This should help to achieve water quality improvements more efficiently and effectively. Ecology will continue to work closely with these groups to improve water quality in the watershed.

County and city governments

Local regulatory programs involving land-use planning and permitting are expected to help reduce water temperatures in the upper Naches watershed. Shorelines of streams with mean annual flows greater than 20 cubic feet per second (cfs) are protected under the Shoreline Management Act. (Larger rivers greater than 200 cfs east of the Cascade crest are defined as shorelines of statewide significance.) The county and cities develop and manage plans for streams protected by the Shoreline Management Act. In addition, land management practices next to streams are limited by Yakima County through their critical areas ordinances. These ordinances prescribe buffer widths for streams or wetlands. Yakima County protects these buffer requirements while permitting certain activities. Yakima County must periodically update their Shoreline Management Plans and critical areas ordinances.

Yakama Nation

The Confederated Tribes of the Yakama Nation (Yakama Nation) have a hand in restoration of fish habitat throughout their historic fishing grounds, which includes the Naches River watershed.

The Yakama Nation expressed interest in the upper Naches watershed TMDLs, as they are concerned with salmon and steelhead production in the Naches River watershed. The Yakama Nation is also a partner in the Yakima Tributary Access and Habitat Program (YTAHP), which continues to restore riparian areas in the upper Naches and Cowlitz watersheds.

Natural Resources Conservation Service (NRCS)

The USDA NRCS offers technical and financial assistance to landowners for water-quality related projects through a variety of programs. One program seeks the input of a local work group to help NRCS establish priority conservation practices for Environmental Quality Improvement Program (EQIP) funding. For more information on the funding available through NRCS and other USDA programs, please see the Funding section in this report. Ecology expects that when state and federal funding is provided to landowners for projects that potentially affect riparian areas and stream flow, those projects will be designed to (re)establish the system potential riparian conditions necessary to restore water quality.

USDA - Forest Service

The USFS participated in and contributed to the development of the Wenatchee National Forest Temperature Technical Assessment, which provides load allocations for waters on national forest lands. The USFS will complete the work required to achieve compliance with those load allocations, which are part of this TMDL.

North Yakima Conservation District

Conservation districts have authority under Chapter 89.08 RCW to develop farm plans that protect water quality. Conservation districts also provide information, education, and technical assistance to residents on a voluntary basis.

The North Yakima Conservation District (NYCD) has been active in installing riparian buffers along watershed streams. The NYCD also provides technical and financial assistance for:

- Irrigation efficiency projects.
- Fish passage barrier removal.
- Fish screen design and installation.
- Metering of pumps for surface and shallow groundwater withdrawals.
- Sediment reduction.
- Livestock influenced water quality improvement projects.
- Stream restoration projects.
- Irrigation efficiency projects.
- Irrigation diversion screens and metering.
- Upland sediment reduction projects.
- Livestock best management practice (BMP) projects to improve water quality.

In addition, the NYCD participates in educational programs. The NYCD also applied for and received a grant to expand their riparian buffer program to urban areas in the watershed.

The NYCD offers a variety of technical and financial-assistance programs to private landowners to address water quality and quantity issues within the Naches River watershed. The NYCD previously collected temperature data in the Cowiche Creek watershed. This data was entered into Ecology's Environmental Information Management System (EIM).

The NYCD is an active participant in the promotion and installation of the USDA Farm Service Agency's Conservation Reserve Enhancement Program (CREP), which enhances riparian buffers. The NYCD provided technical and cost-share assistance funding in the past and continues to pursue grant funding for future programmatic needs.

The NYCD is also a partner in YTAHP, which continues to restore riparian areas in the upper Naches and Cowiche watersheds.

Ecology expects that when state and federal funding is provided to landowners for projects that potentially affect the condition of riparian areas and stream flow in the upper Naches Watershed,

those projects will be designed to (re)establish system potential riparian conditions and enhance critical season stream flow, respectively. These improvements are critical for restoring water quality in this watershed.

Washington State Department of Ecology (Ecology)

EPA delegated authority to Ecology under the federal Clean Water Act to:

- Establish water quality standards.
- Administer the NPDES wastewater permitting program.

Ecology also has independent state authority to enforce water quality regulations under Chapter 90.48 RCW.

In cooperation with conservation districts and other local organizations, Ecology will pursue implementation of BMPs for agricultural and other land uses. Ecology provides technical and financial assistance to people interested in installing BMPs. Ecology has a competitive grant and loan process for local governments and non-profit organizations. Grant money can be used to plan and install BMPs, and loans can be used to purchase direct-seed equipment or improve wastewater treatment facilities. The agency's Environmental Assessment Program conducts effectiveness monitoring to determine if water quality is improving. Ecology is authorized under Chapter 90.48 RCW to initiate enforcement actions if voluntary compliance with state water quality standards is unsuccessful. However, it is the goal of all participants in the *Upper Naches River and Cowiche Creek Temperature TMDL* process to achieve clean water through voluntary control actions.

Washington State Department of Fish and Wildlife

The Washington State Department of Fish and Wildlife (WDFW) is actively involved with habitat improvement, hatchery production, technical assistance, and assessments in the watershed. Habitat improvement activities include dam removal and passage projects, identifying areas in need of fish screens and installing them, and assisting with Habitat Conservation Plans. WDFW's hatchery production activities include releasing trout and steelhead, evaluating hatchery fish success, and performing habitat surveys.

WDFW is also a partner in YTAHP, which continues to restore riparian areas in the upper Naches and Cowiche watersheds.

WDFW provides technical assistance on habitat improvement projects from project identification and design through the permit process. WDFW also gives technical assistance to regional planning efforts. WDFW has an extensive assessment role in the watershed, including spawning surveys, monitoring species distribution, measuring stream flows, conducting instream flow studies, and monitoring stream temperature. WDFW staff also work to obtain funding for habitat-improvement projects, and offers financial assistance to landowners for similar projects. WDFW will need to ensure that permits issued for habitat projects do not affect water quality. In addition, as WDFW acquires new land they should promote the same BMPs necessary for healthy riparian corridors.

Washington State Department of Natural Resources (DNR)

DNR has primary administrative and enforcement responsibilities for the Forest Practices Act (Ch. 76.09 RCW) and state forest practices rules. DNR is encouraged to condition forest practices to prohibit any further reduction of stream shade. DNR should not waive or modify any shade requirements for timber harvesting activities on state and private lands in the project area.

DNR is also responsible for oversight of activities on forest roads. New forest practices rules include standards for new road construction and upgrading and maintaining existing roads. Under the new rules, roads must provide for better control of road-related sediments, provide better streambank stability protection, and meet current BMPs.

Washington State University Extension (WSU)

WSU Cooperative Extension offers educational opportunities on a wide range of topics about water quality. Many of the educational materials offered by WSU Extension are located on the internet at <http://wawater.wsu.edu/>. WSU Extension has an ongoing commitment to develop educational publications on emerging issues. Notices about these publications and funding opportunities are also posted on the above web site.

Washington Water Trust (WWT)

WWT is a private, nonprofit organization whose mission is to restore instream flows to benefit water quality, fisheries, and recreation in Washington's rivers and streams. WWT cooperates with landowners, tribes and local organizations to obtain existing water rights from people willing to sell, lease, or donate their water right. The group's focus is on small streams with endangered or threatened fish stocks. WWT believes that focusing their efforts on smaller streams will result in significant environmental benefits. For more information visit: www.thewatertrust.org.

Table 7 lists entities that may take actions to reduce water temperature. The information listed in the table may change as personnel and available funding are better defined during the development of the implementation plan (WQIP). (See Appendix A for a glossary and list of acronyms.)

Table 7: Organization of TMDL cleanup partners and their contributions.

Group	Actions
Agricultural producers	<ul style="list-style-type: none">• Apply BMPS to reduce erosion.• Protect riparian areas and replant with native vegetation where possible
Area colleges and universities, such as Yakima Valley Community College and Central Washington University	<ul style="list-style-type: none">• Conduct research.• Provide education on water quality and BMPs.• Provide internships.
Cooperative Monitoring and Evaluation Committee (CMER)	<ul style="list-style-type: none">• Monitoring of Forests and Fish rules in support of adaptive management
Cowiche Regional WWTP	<ul style="list-style-type: none">• Monitor and maintain NPDES permit limits.
Washington Dept of Natural Resources (DNR)	<ul style="list-style-type: none">• Administration and enforcement of Forests and Fish Rules

Group	Actions
Washington Dept of Ecology	<ul style="list-style-type: none"> • Continue to fund agricultural BMP implementation: • Continue providing technical assistance, financial assistance, and educational opportunities. • Evaluate whether interim and final targets are being met. If targets are not met, work with Water Quality Subcommittee on Adaptive Management Strategy. • Perform effectiveness monitoring. • Review progress of TMDL implementation with the TMDL advisory group. • Use enforcement authority when necessary.
Fruit packers	<ul style="list-style-type: none"> • Monitor and maintain NPDES permit limits.
Homeowners with waterfront property	<ul style="list-style-type: none"> • Install, maintain, and/or enhance riparian buffers. • Minimize impermeable surfaces. • Reduce unnecessary irrigation. • Avoid actions that will cause stream bank destabilization or erosion, or will otherwise add sediment to area waterways or decrease shading of the riparian area
Irrigators and Irrigation Entities (Districts and Companies)	<ul style="list-style-type: none"> • Continue irrigation efficiency efforts. • Implement BMPs to conserve water and provide in stream flow
Natural Resources Conservation Service (NRCS)	<ul style="list-style-type: none"> • Continue educational efforts to area residents, especially streamside landowners. • Continue to fund BMP implementation and offer technical assistance.
North Yakima Conservation District (NYCD)	<ul style="list-style-type: none"> • Continue to fund BMP implementation and offer technical assistance • Continue irrigation efficiency programs. • Continue providing education to agricultural producers, streamside landowners and others in the watershed. • Continue to monitor water quality of the watershed's surface water (as funding is available). • Continue to seek funding for BMP implementation. • Continue to monitor water quality of the watershed's surface waters
NYCD, NRCS	<ul style="list-style-type: none"> • Extend outreach efforts and technical assistance to all agricultural producers (irrigators, livestock managers, others) in the watershed
Private and state timber owners	<ul style="list-style-type: none"> • Implement forest management practices that lead to achieving the load allocations of this TMDL as required by forest practices rules.
Ranchers	<ul style="list-style-type: none"> • Maintain vegetation in riparian pastures. • Prevent streambank erosion. • Implement livestock management BMPs to prevent damage to riparian areas
Washington State University Cooperative Extension	<ul style="list-style-type: none"> • Continue educational efforts to area residents, especially streamside landowners. •
Yakima County	<ul style="list-style-type: none"> • Administration of Critical Area Ordinances and Shoreline Master Programs
Yakima County, City of Cowiche and WSDOT	<ul style="list-style-type: none"> • Implement stormwater BMPs.
Yakima Tributary Access and Habitat Program (YTAHP)	<ul style="list-style-type: none"> • Continue riparian restoration efforts

What is the schedule for achieving water quality standards?

The goal of this TMDL is to reduce water temperature mainly by increasing system potential shade and reducing stream width. Similar shade increase is required on federal, state, and private lands. Trees will need many years to grow and produce the shade required by this TMDL. Therefore, the water temperature standard should be met 80 years after the completion of the water quality implementation plan, or 2091. All implementation actions required to achieve shade targets must be installed by 2021.

Monitoring progress

Assessing progress in meeting the goals of this water quality improvement report requires

- Monitoring the rate of implementation.
- Ensuring that it continues on schedule.
- Conducting water quality monitoring at key locations in the upper Naches River and Cowiche Creek watersheds.

Ecology conducts effectiveness monitoring. However, because of the time involved in getting riparian planting projects underway and achieving some height of the vegetation for effective shading, Ecology does not expect to schedule effectiveness monitoring in the near future. Ecology will begin monitor the pace of implementation when this TMDL is approved by EPA.

Entities with enforcement authority are responsible for following up on any enforcement actions. Stormwater permittees and point source permittees are responsible for meeting the requirements of their permits. Those conducting restoration projects or installing BMPs are responsible for monitoring plant survival rates and maintenance of improvements, structures and fencing.

Monitoring and assessment are considered critical to generating understanding and support for improving creek health among landowners living in each creek watershed. The plan may consider a variety of monitoring approaches and assessment methods, because some provide better feedback and will generate more interest among the public. River and creek health can be defined in a variety of ways, and could include measurements of:

- Stream width-to-depth ratios taken and compared to the data presented in the water quality study findings (Brock 2008).
- Vegetation height and survival rates, which can be assessed in newly established riparian areas.
- Sediment on the stream bottom (bed load and/or embeddedness), which can be taken before and after projects.
- Riparian photo points, which can be established and aerial photos can be taken. Ecology recommends photo points because they show changes over time.

- Stream temperature, which can also be used to show progress. However, unless there has been a considerable change in stream flow or stream restoration work, lower temperatures may be difficult to detect.
- Biological indicators, such as an increase in the number of steelhead and bull trout in a given stream reach. This could also be a redd count.

Adaptive management

Natural systems are complex and dynamic. The way a system will respond to human management activities is often unknown and can only be described as probabilities or possibilities. Adaptive management involves testing, monitoring, evaluating applied strategies, and incorporating new knowledge into management approaches that are based on scientific findings. In the case of TMDLs, Ecology uses adaptive management to assess whether the actions identified as necessary to solve the identified pollution problems are the correct ones and whether they are working. As we implement these actions, the system will respond and will also change. Adaptive management allows us to fine-tune our actions to make them more effective, and to try new strategies if we have evidence that a new approach could help us to achieve compliance.

Implementation targets will be set to achieve compliance with the load allocations in this TMDL. Partners will work together to monitor progress towards these goals, evaluate successes, obstacles, and changing needs, and make adjustments to the implementation strategy as needed.

Ecology will use adaptive management when visual assessment of implementation shows that the TMDL is not being implemented, or when water monitoring data show that the TMDL targets are not being met or implementation activities are not producing the desired result. A feedback loop (Figure 9) consisting of the following steps will be implemented:

- Step 1. The activities in the water quality implementation plan are put into practice.
- Step 2. Programs and BMPs are evaluated for technical adequacy of design and installation.
- Step 3. The effectiveness of the activities is evaluated by assessing new monitoring data and comparing it to the data used to set the TMDL targets.
 - Step 3a. If the goals and objectives are achieved, the implementation efforts are adequate as designed, installed, and maintained. Project success and accomplishments should be publicized and reported to continue project implementation and increase public support.
 - Step 3b. If not, then BMPs and the implementation plan will be modified or new actions identified. The new or modified activities are then applied as in Step 1.

It is ultimately Ecology’s responsibility to assure that implementation is being actively pursued and water standards are achieved.

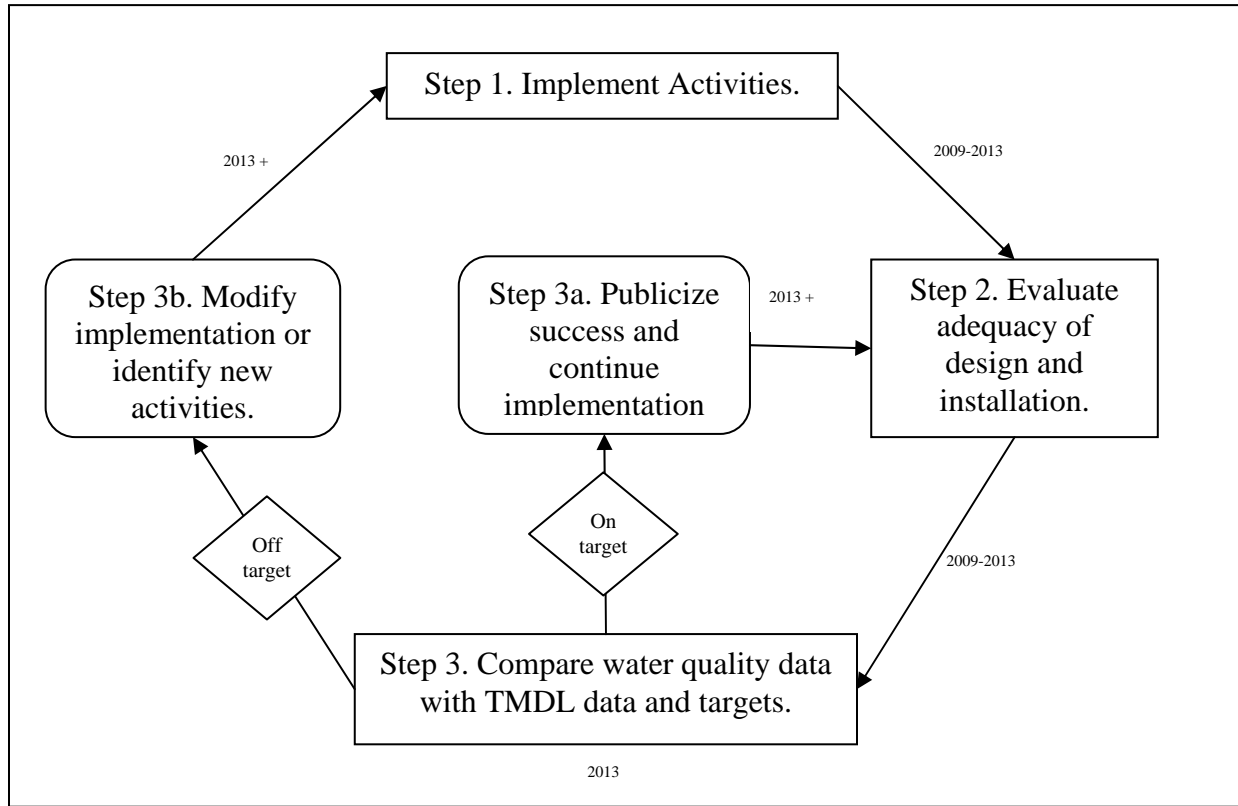


Figure 9. Feedback loop for determining need for adaptive management.

Potential funding sources

Numerous funding sources are available to support BMP implementation for this water quality improvement plan. Table 8 below is a partial list; stakeholders are recommended to seek other sources as well.

Table 8: Partial list of potential funding sources for the *Upper Naches River and Cowiche Creek Temperature TMDL*

Sponsoring Entity	Funding Source	Uses to be Made of Funds
Northwest Power and Conservation Council	Bonneville Power Administration	Restoration of anadromous fish habitat, which can include improvement of irrigation systems, riparian restoration, and even purchase of riparian properties at-risk for development
Department of Ecology, Shorelands program	Coastal Zone Protection Fund	Some funding is available through a program that taps into penalty monies collected by Ecology's water quality program.

Sponsoring Entity	Funding Source	Uses to be Made of Funds
Department of Ecology, Water Quality Program	Centennial Clean Water Fund, Section 319, and State Revolving Fund http://www.ecy.wa.gov/programs/wq/funding/	Facilities and water pollution control-related activities; implementation, design, acquisition, construction, and improvement of water pollution control. Priorities include implementing water cleanup plans; keeping pollution out of streams and aquifers; modernizing aging wastewater treatment facilities; reclaiming and reusing wastewater.
Natural Resources Conservation Service (NRCS)	Emergency Watershed Protection http://www.nrcs.usda.gov/programs/ewp/index.html	NRCS purchases land vulnerable to flooding to ease flooding impacts.
NRCS	Environmental Quality Incentive Program http://www.nrcs.usda.gov/programs/eqip/	Voluntary conservation program for farmers and ranchers that promotes agricultural production and environmental quality as compatible national goals; includes cost-share funds for farm BMPs.
NRCS	Federal Conservation Reserve Enhancement Program http://www.snohomishcd.org/crep.htm	Conservation easements; cost-share for implementing agricultural/riparian BMPs.
NRCS	Wetland Reserve Program http://www.wa.nrcs.usda.gov/programs/wrp/wrp.html	Landowners may receive incentives to enhance wetlands in exchange for retiring marginal agricultural land.
Office of Interagency Committee, Salmon Recovery Board	Salmon Recovery Funding Board http://www.iac.wa.gov/srfb/grants.asp	Provides grants for habitat restoration, land acquisition and habitat assessment.

Summary of public involvement methods

1. Public meeting to announce the launch of the Naches River Watershed Temperature TMDL.
2. Technical advisory committee (TAG) established (primary correspondence via email at TAG request).
3. Participation at the Nile Valley Community days.
4. Comment periods for Study Plan and TMDL submittal.
5. Meetings with individual permit holders will be held prior to reissuance of their NPDES permits.
 - Cowiche WWTP
 - Fruit Packers

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Appendices

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Appendix A. Glossary, acronyms, and abbreviations

1-DMax or 1-day maximum temperature: The highest water temperature reached on any given day. This measure can be obtained using calibrated maximum and minimum thermometers or continuous monitoring probes having sampling intervals of 30 minutes or less.

7-DADMax or 7-day average of the daily maximum temperatures: The arithmetic average of seven consecutive measures of daily maximum temperatures. The 7-DADMax for any individual day is calculated by averaging that day's daily maximum temperature with the daily maximum temperatures of the three days prior and the three days after that date.

7Q2 flow: A typical low-flow condition. The 7Q2 is a statistical estimate of the lowest 7-day average flow that can be expected to occur once every other year on average. The 7Q2 flow is commonly used to represent the average low-flow condition in a water body and is typically calculated from long-term flow data collected in each watershed. For temperature TMDL work, the 7Q2 is usually calculated for the months of July and August as these typically represent the critical months for temperature in our state.

7Q10 flow: A critical low-flow condition. The 7Q10 is a statistical estimate of the lowest 7-day average flow that can be expected to occur once every 10 years on average. The 7Q10 flow is commonly used to represent the critical flow condition in a water body and is typically calculated from long-term flow data collected in each watershed. For temperature TMDL work, the 7Q10 is usually calculated for the months of July and August as these typically represent the critical months for temperature in our state.

90th percentile: A statistical number obtained from a distribution of a data set, above which 10 percent of the data exists and below which 90 percent of the data exists.

303(d) list: Section 303(d) of the federal Clean Water Act requires Washington State periodically to prepare a list of all surface waters in the state for which beneficial uses of the water – such as for drinking, recreation, aquatic habitat, and industrial use – are impaired by pollutants. These are water quality-limited water bodies (ocean waters, estuaries, lakes, and streams) that fall short of state surface water quality standards and are not expected to improve within the next two years.

Angular canopy density (ACD): The percentage of time that a given point on a stream will be shaded from direct beam solar radiation between 10 a.m. to 2 p.m. local solar time. For example, if a point on a stream is always shaded from 10 a.m. to 2 p.m. in August, then August ACD at that point is 100 percent. If that point is never shaded between 10 a.m. to 2 p.m., then ACD at that point is zero. Average ACD of a stream reach is estimated by sampling it over the width and length of the reach. Typical values of the ACD for old-growth stands in western Oregon have been reported to range from 80 to 90 percent.

Bankfull stage: Formally defined as the stream level that “corresponds to the discharge at which channel maintenance is most effective, that is, the discharge at which moving sediment,

forming or removing bars, forming or changing bends and meanders, and generally doing work that results in the average morphologic characteristics of channels” (Dunne and Leopold, 1978).

Best management practices (BMPs): Physical, structural, or operational practices that, when used singularly or in combination, prevent or reduce pollutant discharges.

Char: Char (genus *Salvelinus*) are distinguished from trout and salmon by the absence of teeth in the roof of the mouth, presence of light colored spots on a dark background, absence of spots on the dorsal fin, small scales, and differences in the structure of their skeleton. (Trout and salmon have dark spots on a lighter background.)

Clean Water Act: A federal act passed in 1972 that contains provisions to restore and maintain the quality of the nation’s waters. Section 303(d) of the Clean Water Act establishes the TMDL program.

Critical condition: When the physical, chemical, and biological characteristics of the receiving water environment interact with the effluent to produce the greatest potential adverse impact on aquatic biota and existing or designated water uses. For steady-state discharges to riverine systems, the critical condition may be assumed to be equal to the 7Q10 (see definition) flow event unless determined otherwise by the department.

Designated uses: Those uses specified in Chapter 173-201A WAC (Water Quality Standards for Surface Waters of the State of Washington) for each water body or segment, regardless of whether or not the uses are currently attained.

Effective shade: The fraction of incoming solar shortwave radiation that is blocked from reaching the surface of a stream or other defined area.

Existing uses: Those uses actually attained in fresh and marine waters on or after November 28, 1975, whether or not they are designated uses. Introduced species that are not native to Washington, and put-and-take fisheries comprised of non-self-replicating introduced native species, do not need to receive full support as an existing use.

Extraordinary primary contact: Waters providing extraordinary protection against waterborne disease or that serve as tributaries to extraordinary quality shellfish harvesting areas.

Hyporheic: The area beneath and adjacent to a stream where surface water and groundwater intermix.

Load allocation: The portion of a receiving waters loading capacity attributed to one or more of its existing or future sources of nonpoint pollution or to natural background sources.

Loading capacity: The greatest amount of a substance that a water body can receive and still meet water quality standards.

Margin of safety: Required component of TMDLs that accounts for uncertainty about the relationship between pollutant loads and quality of the receiving water body.

National Pollutant Discharge Elimination System (NPDES): National program for issuing and revising permits, as well as imposing and enforcing pretreatment requirements, under the Clean Water Act. The NPDES permit program regulates discharges from wastewater treatment plants, large factories, and other facilities that use, process, and discharge water back into lakes, streams, rivers, bays, and oceans.

Nonpoint source: Pollution that enters any waters of the state from any dispersed land-based or water-based activities, including but not limited to, atmospheric deposition; surface water runoff from agricultural lands; urban areas; or forest lands; subsurface or underground sources; or discharges from boats or marine vessels not otherwise regulated under the National Pollutant Discharge Elimination System Program. Generally, any unconfined and diffuse source of contamination. Legally, any source of water pollution that does not meet the legal definition of “point source” in section 502(14) of the Clean Water Act.

Point source: Sources of pollution that discharge at a specific location from pipes, outfalls, and conveyance channels to a surface water. Examples of point source discharges include municipal wastewater treatment plants, municipal stormwater systems, industrial waste treatment facilities, and construction sites that clear more than five acres of land.

Pollution: Such contamination, or other alteration of the physical, chemical, or biological properties, of any waters of the state. This includes change in temperature, taste, color, turbidity, or odor of the waters. It also includes discharge of any liquid, gaseous, solid, radioactive, or other substance into any waters of the state. This definition assumes that these changes will, or are likely to, create a nuisance or render such waters harmful, detrimental, or injurious to (1) public health, safety, or welfare, or (2) domestic, commercial, industrial, agricultural, recreational, or other legitimate beneficial uses, or (3) livestock, wild animals, birds, fish, or other aquatic life.

Primary contact recreation: Activities where a person would have direct contact with water to the point of complete submergence including, but not limited to, skin diving, swimming, and water skiing.

Riparian: Relating to the banks along a natural course of water.

Salmonid: Any fish that belong to the family *Salmonidae*. Basically, any species of salmon, trout, or char. www.fws.gov/le/ImpExp/FactSheetSalmonids.htm

Surface waters of the state: Lakes, rivers, ponds, streams, inland waters, salt waters, wetlands and all other surface waters and water courses within the jurisdiction of Washington State.

Surrogate measures: To provide more meaningful and measurable pollutant loading targets, EPA regulations [40 CFR 130.2(i)] allow other appropriate measures, or surrogate measures in a TMDL. The Report of the Federal Advisory Committee on the Total Maximum Daily Load (TMDL) Program (EPA, 1998) includes the following guidance on the use of surrogate measures for TMDL development:

When the impairment is tied to a pollutant for which a numeric criterion is not possible, or where the impairment is identified but cannot be attributed to a single traditional “pollutant,”

the state should try to identify another (surrogate) environmental indicator that can be used to develop a quantified TMDL, using numeric analytical techniques where they are available, and best professional judgment (BPJ) where they are not.

System potential: The design condition used for TMDL analysis.

System potential channel morphology: The more stable configuration that would occur with less human disturbance.

System potential mature riparian vegetation: Vegetation, which can grow and reproduce on a site, given climate, elevation, soil properties, plant biology, and hydrologic processes.

System potential riparian microclimate: The best estimate of air temperature reductions that are expected under mature riparian vegetation. System potential riparian microclimate can also include expected changes to wind speed and relative humidity.

System potential temperature: An approximation of the temperatures that would occur under natural conditions. System potential is our best understanding of natural conditions that can be supported by available analytical methods. The simulation of the system potential condition uses best estimates of *mature riparian vegetation, system potential channel morphology, and system potential riparian microclimate* that would occur absent any human alteration.

Total maximum daily load (TMDL): A distribution of a substance in a water body designed to protect it from exceeding water quality standards. A TMDL is equal to the sum of all of the following: (1) individual wasteload allocations for point sources, (2) the load allocations for nonpoint sources, (3) the contribution of natural sources, and (4) a Margin of Safety to allow for uncertainty in the wasteload determination. A reserve for future growth is also generally provided.

Wasteload allocation: The portion of a receiving waters loading capacity allocated to existing or future point sources of pollution. Wasteload allocations constitute one type of water quality-based effluent limitation.

Watershed: A drainage area or basin in which all land and water areas drain or flow toward a central collector such as a stream, river, or lake at a lower elevation.

Acronyms and Abbreviations

Following are acronyms and abbreviations used frequently in this report.

BMPs	Best management practices
cfs	Cubic feet per second
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
NPDES	National Pollutant Discharge Elimination System
RAWS	Remote Automated Weather Stations
RM	River mile
TIR	Thermal infrared radiation

TMDL	Total maximum daily load (water cleanup plan)
USFS	United States Forest Service
USGS	United States Geological Survey
WDFW	Washington Department of Fish and Wildlife
WRIA	Water Resources Inventory Area
WWTP	Wastewater treatment plant

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Appendix B. Record of public participation

Introduction

Ecology held a public meeting in May 2004, in Nile, WA, to introduce the study and process for developing this TMDL. A Technical Advisory Group was formed and a mailing list of other interested stakeholders was maintained. Periodic updates were sent to interested residents and organizations.

Summary of comments and responses

Ten individuals/organizations requested copies of the report. No comments were received during the public comment period.

List of public meetings

1. Public meeting to announce the launch of the Naches River Watershed Temperature TMDL.
2. Technical advisory committee (TAG) established (primary correspondence via email at TAG request).
3. Participation at the Nile Valley Community days.
4. Comment periods for Study Plan and TMDL submittal.
5. Meetings with individual permit holders will be held prior to reissuance of their NPDES permits.
 - Cowiche WWTP
 - Fruit Packers

Outreach and announcements

A 30-day public comment period for this report was held from October 20 through November 19, 2010.

The following advertisements were placed in the Yakima Herald on October 20 and November 3, 2010 (attached below).



Comments requested on the Upper Naches River and Cowiche Creek Temperature Water Quality Improvement Report (TMDL)

Summer water temperatures of the upper Naches River and some of its tributaries (Bear Creek; Blowout Creek; Bumping River; Cowiche Creek; Crow Creek; Gold Creek; Little Naches River; Little Rattlesnake Creek; Mathew Creek; Nile Creek; Rattlesnake Creek; and Reynolds Creek) are warmer than Washington State water quality standards that are set to protect fish. In 2004, the Department of Ecology (Ecology) collected data in response to listings on the 303(d) list. Ecology determined that stream temperatures need to be reduced in the watershed and made recommendations to accomplish the necessary thermal reductions.

Ecology developed a water quality improvement report to clean up unhealthy waters in the Upper Naches River and Cowiche Creek watersheds. The report identifies some potential sources of thermal pollution including lack of riparian shade and seven NPDES permit holders.

Your comments are encouraged during the 30-day public comment period from October 20 to November 19, 2010.

Following the public comment period, Ecology will submit the water quality improvement report to EPA for approval. This approved plan will guide subsequent cleanup activities.

For more information, please call Jonathan Merz at 509-454-7207, or e-mail jome461@ecy.wa.gov.

Public comment period October 20 – November 19, 2010

The Plan is available for review at:

- <http://www.ecy.wa.gov/biblio/1010068.html>
- Department of Ecology
15 W. Yakima Avenue, Suite 200
Yakima, WA 98902-3401
- Call (509)454-7207 for print copy

Please send written comments by **November 19, 2010** to Jonathan Merz, Department of Ecology, 15 W. Yakima Avenue, Suite 200, Yakima, WA 98902-3401, or email at jome461@ecy.wa.gov.

Appendix C. Response to public comments

No comments were received during the 30-day public comment period.