# CHAPTER 11: MCKENZIE SUBBASIN TMDL

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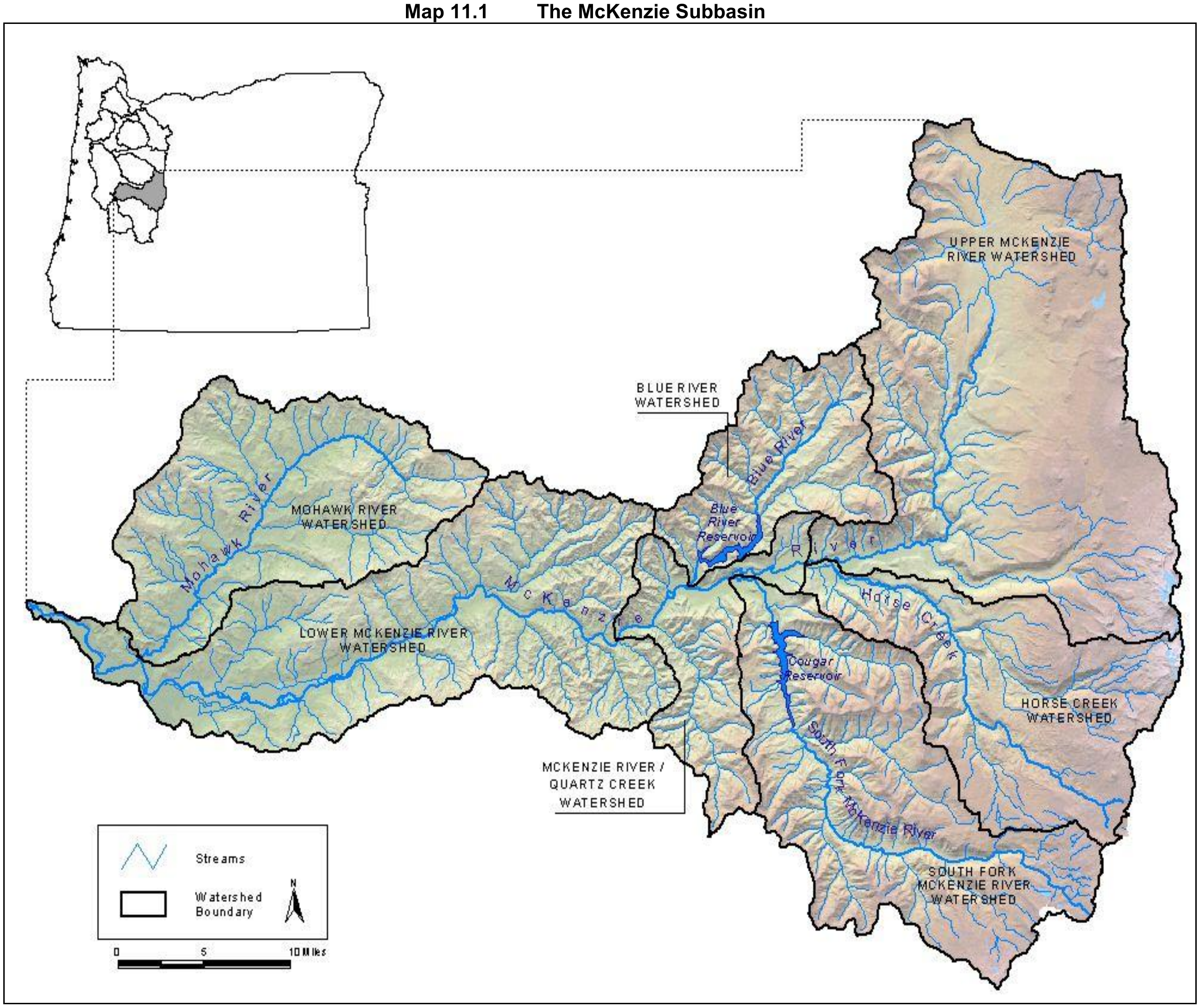
# WATER QUALITY SUMMARY

## Reason for action

The McKenzie Subbasin (Map 11.1) has stream segments listed under section 303(d)[1] of the federal Clean Water Act (CWA) that are exceeding water quality criteria for temperature and dissolved oxygen. Total Maximum Daily Loads (TMDLs) for temperature have been developed based on information for this parameter. Wasteload allocations are developed for individual facilities (point sources) that discharge during the critical period. Load allocations for nonpoint sources are developed for each geomorphic unit and apply to all sectors in the subbasin.

**Map 11.1 The McKenzie Subbasin**




[1] The 303(d) list is a list of stream segments that do not meet water quality criteria.

This chapter only includes TMDLs for rivers and streams in the McKenzie Subbasin. These subbasin rivers and streams are tributary to the McKenzie River. For the McKenzie River downstream of the confluence of South Fork McKenzie River (river mile 60), Blue River downstream of Blue River Reservoir (river mile 1.5), and the South Fork McKenzie River downstream of Cougar Reservoir (river mile 4.5) the temperature analysis is included in the mainstem Willamette River TMDLs, see Chapter 4. All other subbasin TMDLs are included in Chapters 5 – 13.

# Water Quality 303(d) Listed Waterbodies

## OAR 340-042-0040(4)(a)

All current 303(d) listings for the subbasin are presented in Table 11.1. Temperature TMDLs are developed for most subbasin streams in Chapter 11. TMDLs for the McKenzie River downstream of the South Fork McKenzie, lower Blue River and lower South Fork McKenzie are found in Chapter 4.

**Table 11. 1 Name and location of 303(d) listed McKenzie Subbasin waterbodies.**

| Waterbody Name | River Mile | Parameter | Season | TMDL |
|---|---|---|---|---|
| Blue River | 0 to 1.8 | Temperature | Spring, Summer, Fall | Chapter 4 |
| Blue River | 1.8 to 15.5 | Temperature | Summer | Chapter 11 |
| Deer Creek | 0 to 8.3 | Temperature | Summer | Chapter 11 |
| French Pete Creek | 0 to 12.9 | Temperature | Summer | Chapter 11 |
| Horse Creek | 0 to 14.2 | Temperature | Summer | Chapter 11 |
| McKenzie River | 0 to 34.1 | Temperature | Summer | Chapter 4 |
| McKenzie River | 34.1 to 54.5 | Temperature | Summer | Chapter 4 |
| McKenzie River | 54.5 to 83 | Temperature | Summer | Chapter 11 |
| South Fork McKenzie River | 0 to 4.5 | Temperature | Spring, Summer, Fall | Chapter 4 |
| Mill Creek | 0 to 2.7 | Temperature | Summer | Chapter 11 |
| Mohawk | 0 to 25.4 | Temperature | Summer | Chapter 11 |
| Mohawk | 0 to 25.4 | Dissolved Oxygen | Summer | No |
| Shotgun Creek | 0 to 6.6 | Temperature | Summer | Chapter 11 |
| Un-named Tributary to Rebel Creek | 0 to 1.2 | Temperature | Summer | Chapter 11 |

# Water Quality Parameters Addressed

In the McKenzie Subbasin temperature is the only parameter addressed with allocations.

- Bacteria has been addressed through a basin wide assessment of TMDLs developed for subbasins with streams listed as water quality limited for bacteria, specifically the Upper Willamette Subbasin, Middle Willamette Subbasin, and Lower Willamette Subbasin. Planning targets have been identified for urban and agricultural land in the McKenzie Subbasin where no streams have been listed. The appropriate use of planning targets is in water quality management planning. The ubiquitous nature of fecal bacteria suggests that water quality would benefit from implementation of these targeted reductions in the absence of documented violations. In general, targeted reductions for agricultural areas range from 66% to 83%, and reductions for urban areas range from 80% to 94%, relative to current concentrations. The details of this assessment and the planning targets are contained in the Allocation Section of Chapter 2, Willamette Basin Bacteria TMDL.

- Mercury is a parameter of concern throughout the Willamette Basin. A 27% reduction in mercury pollution is needed in the mainstem Willamette to remove fish consumption advisories. Pollutant load allocations are set for each sector but no effluent limits are specified at this time. Sources of mercury in the subbasin will be required to develop mercury reduction plans. Details of the mercury TMDL are included in Chapter 3, the Willamette Basin Mercury TMDL.

## Water Quality Parameters Not Addressed

The Willamette Basin TMDL project began in early 2000 and was designed to address the 1998 303(d) listed waterbodies for parameters that exceeded water quality criteria. In 2002 the 303(d) list was updated. Where data were readily available, new parameter listings were addressed in this TMDL. However, there was not sufficient time to collect the additional data and complete the analysis for some of the newly listed parameters for this TMDL. Certain parameters will be addressed in subsequent TMDL efforts. The parameter that is specifically excluded from this TMDL is:

- Dissolved Oxygen: The dissolved oxygen (DO) listing for Mohawk River will not be addressed in this TMDL. The creek was listed in 2002, which did not allow sufficient time to collect data needed for TMDL analysis. Until a TMDL for dissolved oxygen is developed for this stream, riparian protection and restoration measures developed to address stream temperature concerns in the basin will benefit dissolved oxygen levels.

## Who helped us

Many organizations assisted ODEQ in the development of this TMDL and data from many different sources were considered. ODEQ would like to acknowledge the assistance of the following organizations and agencies.

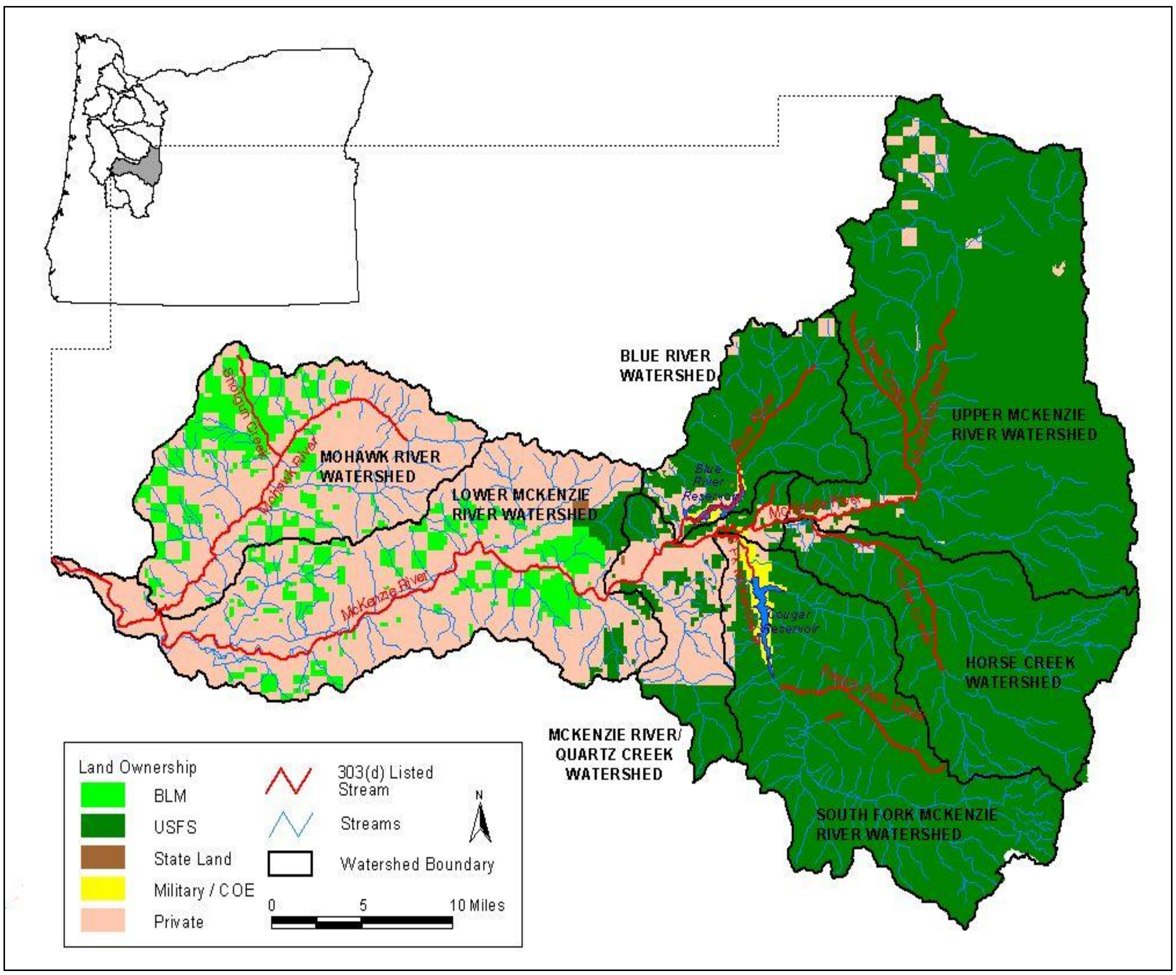
- McKenzie River Watershed Council
- Mohawk Watershed Partnership
- Eugene Water and Electric Board
- Weyerhaeuser Corporation
- U.S. Bureau of Land Management (BLM)
- U.S. Forest Service (USFS)
- U.S. Geological Survey, Oregon District (USGS)
- Oregon Water Resources Department (WRD)
- Oregon Department of Fish and Wildlife (ODFW)

# SUBBASIN OVERVIEW

The McKenzie Subbasin (Hydrologic Unit Code 17090004) is located in the southeast portion of the Willamette Basin with tributaries that flow to the Willamette River at river mile (RM) 171.8. The subbasin's 1,338 square miles (856,466 acres) extend from the Cascade Mountains on the east to the Willamette River. The subbasin includes the following seven watersheds (Map 11.2):

- Blue River Watershed
- Horse Creek Watershed
- Lower McKenzie River Watershed
- McKenzie River / Quartz Creek Watershed
- Mohawk River Watershed
- South Fork McKenzie River Watershed
- Upper McKenzie River Watershed

**Map 11.2 303(d) Listed Streams and Land Ownership in the McKenzie Subbasin**




The subbasin's political jurisdiction includes portions of Lane and Linn counties. The city of Springfield is the largest city in the subbasin, however there are many smaller communities within the McKenzie Subbasin: Thurston, Walterville, Deerhorn, Nimrod, Leaburg, Rainbow, Marcola, Leaburg, Vida, and McKenzie Bridge. The subbasin is owned by numerous private land owners, however the Bureau of Land Management (BLM) owns a small portion of the land downstream of Cougar and Blue River reservoirs, and the United States Forest Service (USFS) primarily owns the land upstream of Cougar Reservoir and Blue River Reservoir, Map 11.2. The land use is primarily forestry. The lower watershed valley floodplain is owned by private landowners, and agricultural, commercial and residential development is dominant.

# Watershed Descriptions

## *Mohawk Watershed*

The Mohawk Watershed drains 165 square miles (106,135 acres) on the west slope of the Cascade Mountain Range and encompasses mostly rural areas of Lane County. Municipalities of Donna, Marcola, Wendling, and Mable are located within the watershed. Forested areas within the uplands of the watershed are owned primarily by industrial timber companies. The Mohawk Watershed Partnership (2000), BLM and Weyerhaeuser Company (1994) have completed Watershed Analyses specific to the Mohawk Watershed. The Lower Mohawk is identified in the McKenzie River Subbasin Assessment (McKenzie Watershed Council, 2001) as a key sub-watershed for aquatic habitat restoration priorities. Rural development and agricultural areas consisting of pasture, hay, and small woodlot operations dominate the lower watershed.

## *Blue River Watershed*

The Blue River Watershed drains a total of 87 square miles (55,851 acres) of land. Most of the area is administered by the U.S. Forest Service; 3% of the watershed is within private ownership. Blue River Dam and Reservoir are on Blue River. Riparian conditions have been degraded due to road related failures, harvest of riparian areas, and yarding logs down channels. Management related debris slides are documented in the Blue River and South Fork McKenzie Watershed Analyses prepared by the Blue River Ranger District. For many streams, this translates to less shade and large woody debris available in this watershed compared to historic times. In some sub-watersheds, riparian areas that were once dominated by conifers are now extensive hardwood stands.

## *South Fork McKenzie Watershed*

The South Fork McKenzie River drains 213 square miles (136,523 acres). Federal ownership is 97% of the land base. The USFS manages 94% of the land, and 3% is managed by USACE. Cougar Dam and Reservoir is on the South Fork McKenzie. Riparian vegetation and channel morphology have been degraded much like Blue River.

## *Upper McKenzie Watershed*

The Upper McKenzie Watershed encompasses 348 square miles (222,728 acres). McKenzie Bridge is the largest municipality in the Upper McKenzie Watershed.

## *Horse Creek Watershed*

The Horse Creek Watershed encompasses 156 square miles (100,357 acres). Horse Creek's headwaters are in the wilderness area. Much of the watershed is managed by the USFS but the lower portion is rural residential.

# MCKENZIE SUBBASIN TEMPERATURE TMDL

The temperature TMDL for the McKenzie Subbasin includes tributaries to the McKenzie River downstream of the confluence of the South Fork McKenzie River, Blue River upstream of Blue River Reservoir, and South Fork McKenzie River upstream of Cougar Reservoir within HUC 17090004. As per Oregon Administrative Rule (OAR) 340-042-0040 required components of a TMDL are listed in Table 11.2.

**Table 11. 2 McKenzie Subbasin Temperature TMDL Components.**

| | |
|---|---|
| **Waterbodies**<br>**OAR 340-042-0040(4)(a)** | Perennial and/or fish bearing, as identified in OAR 340-041- 0340; Figures 340A & 340B, streams in the McKenzie Subbasin, HUCs 170900401, 170900402, 170900403, 170900404, 170900405, 170900406, and 170900407. |
| **Pollutant Identification**<br>**OAR 340-042-0040(4 )(b)** | <u>*Pollutants:*</u> Human caused temperature increases from (1) solar radiation loading and (2) warm water discharge to surface waters |
| **Beneficial Uses**<br>**OAR 340-042-0040(4)(c)** | Salmonid fish spawning and rearing, anadromous fish passage, resident fish and aquatic life are the most sensitive beneficial uses in the McKenzie Subbasin. |
| **Target Criteria Identification**<br>**OAR 340-042-0040(4)(c)**<br>***CWA §303(d)(1)***<br><br>**OAR 340-041-0028(4)(f)**<br>**OAR 340-041-0028(4)(a)**<br>**OAR 340-041-0028(4)(b)**<br>**OAR 340-041-0028(4)(c)**<br>***OAR* 340-041-0028(8)**<br>**OAR 340-041-0028(12)(b)(B)** | OAR 340-041-0028 provides numeric and narrative temperature criteria. Maps and tables provided in OAR 340-041-0101 to 0340 specify where and when the criteria apply.<br><br>12.0°C during times and at locations of bull trout spawning and juvenile rearing use.<br>13.0°C during times and at locations of salmon and steelhead spawning.<br>16.0°C during times and at locations of core cold water habitat identification.<br>18.0°C during times and at locations of salmon and trout rearing and migration.<br>Natural Conditions Criteria: Where the department determines that the natural thermal potential temperature of all or a portion of a water body exceeds the biologically-based criteria in section 4 the natural thermal potential temperatures supersede the biologically-based criteria and are deemed the applicable criteria for that water body. Maps and tables provided in OAR 340-041-0101 to 0340 specify where and when the criteria apply.<br><br>Following a temperature TMDL or other cumulative effects analysis, waste load and load allocations will restrict all NPDES point sources and nonpoint sources to a cumulative increase of no greater than 0.3 degrees Celsius (0.5Fahrenheit) above the applicable criteria after complete mixing in the water body, and at the point of maximum impact. |
| **Existing Sources**<br>**OAR 340-042-0040(4)(f)**<br>***CWA §303(d)(1)*** | Nonpoint source solar loading due to a lack of riparian vegetation from forestry, agriculture, rural residential, and urban activities.<br><br>Point source discharge of warm water to surface water. |
| **Seasonal Variation**<br>**OAR 340-042-0040(4)(j)**<br>***CWA §303(d)(1)*** | Peak temperatures typically occur in mid-July through mid-August and often exceed the salmon and trout rearing and migration criterion. Temperatures are much cooler late summer through late spring but occasionally exceed the spawning criterion. |
| **TMDL**<br>**Loading Capacity and Allocations**<br>**OAR 340-042-0040(4)(d)**<br>**OAR 340-042-0040(4)(e)**<br>**OAR 340-042-0040(4)(g)**<br>**OAR 340-042-0040(4)(h)**<br>***40 CFR 130.2(f)***<br>***40 CFR 130.2(g)***<br>***40 CFR 130.2(h)*** | <u>*Loading Capacity:*</u> OAR 340-041-0028 (12)(b)(B) states that no more than a 0.3°C increase in stream temperature above the applicable biological criteria or the natural condition criteria as a result of human activities is allowable. This condition is achieved when the cumulative effect of all point and nonpoint sources results in no greater than a 0.3 °C (0.5 °F) increase at the point of maximum impact. Loading capacity is the heat load that corresponds to the applicable numeric criteria plus the small increase in temperature of 0.3°C provided with the human use allowance.<br><br><u>*Excess Load*</u>: The difference between the actual pollutant load and the loading capacity of the waterbody. In these temperature TMDLs excess load is the difference between heat loads that meet applicable temperature criteria plus the human use allowance and current heat loads from background, nonpoint source and point source loads.<br><br><u>*Wasteload Allocations (NPDES Point Sources)*</u>: Allowable heat load based on achieving no greater than a 0.3°C temperature increase at the point of maximum impact. This is achieved by limiting stream temperature increases from individual point sources to 0.075ºC. This may also be expressed as a limitation of 0.3ºC increase in 25% of the 7Q10 stream flow. Where multiple point sources discharge to a single receiving stream the accumulated heat increase for point sources is limited to 0.2˚C.<br><br><u>*Load Allocations (Nonpoint Sources)*</u>: Background solar radiation loading based on system potential vegetation near the stream. An additional heat load equal to 0.05°C temperature increase at the point of maximum impact is available but is not explicitly allocated to individual sources.<br>• Mohawk River background solar radiation loading based on system potential vegetation is $6.10 \times 10^8$ kcal/day.<br>• McKenzie River (RM 54.4 to 81.3) upstream of the confluence with South Fork McKenzie River background solar radiation loading based on system potential vegetation is $9.62 \times 10^8$ kcal/day. |
| **Surrogate Measures**<br>**OAR 340-042-0040(5)(b)**<br>***40 CFR 130.2(i)*** | <u>*Translates Nonpoint Source Load Allocations*</u><br>Effective shade targets translate riparian vegetation objectives into the nonpoint source solar radiation loading capacity. These targets are based on vegetation communities appropriate for each geomorphic unit in the subbasin. |

| | |
|---|---|
| **Margins of Safety**<br>**OAR 340-042-0040(4)(i)**<br>***CWA §303(d)(1)*** | <u>*Margins of Safety*</u> are demonstrated in critical condition assumptions for point source load calculations and are inherent in the methodology for determining nonpoint source loads**.** |
| **Reserve Capacity**<br>**OAR 340-042-0040(4)(k)** | Allocation for increases in pollutant loads for future growth from new or expanded sources. Reserve capacity will be a percentage of the 0.3˚C human use allowance (HUA). The HUA will be divided among various sources. When point sources are present reserve capacity will be 0.05˚C, 17% of the HUA. Where there are no point sources in a subbasin, or less than the allowed 0.2˚C is used by point source discharges, the remainder is allocated to reserve capacity. |
| **Water Quality Management Plan**<br>**OAR 340-042-0040(4)(l)** | The Water Quality Management Plan (WQMP) provides the framework of management strategies to attain and maintain water quality standards. The WQMP is designed to complement the detailed plans and analyses provided in specific implementation plans. See Chapter 14. |
| **Standards Attainment & Reasonable Assurance**<br>**OAR 340-042-0040(4)(l)(e) & (j)** | Implementation of pollutant load reductions and limitations in the point source and non point source sectors will result in water quality standards attainment. Standards Attainment and Reasonable Assurance are addressed in the WQMP, Chapter 14. |

# Waterbodies Listed for Temperature
## OAR 340-042-0040(4)(a)

The McKenzie Subbasin has nine stream segments addressed in this TMDL that are on the 303(d) list for exceeding the water temperature criteria during the summer season, July through September: Blue River upstream of Blue River Reservoir, Deer Creek, French Pete Creek, Horse Creek, upper McKenzie River, Mill Creek, Mohawk River, Shotgun Creek, and an unnamed tributary to Rebel Creek (Table 11.3 and Map 11.3). The McKenzie River downstream of the confluence of the South Fork McKenzie River, Blue River downstream of Blue River Reservoir, and the South Fork McKenzie River downstream of Cougar are also listed for exceeding the temperature criteria. These segments are included in the mainstem TMDL which is discussed in Chapter 4 of this document.

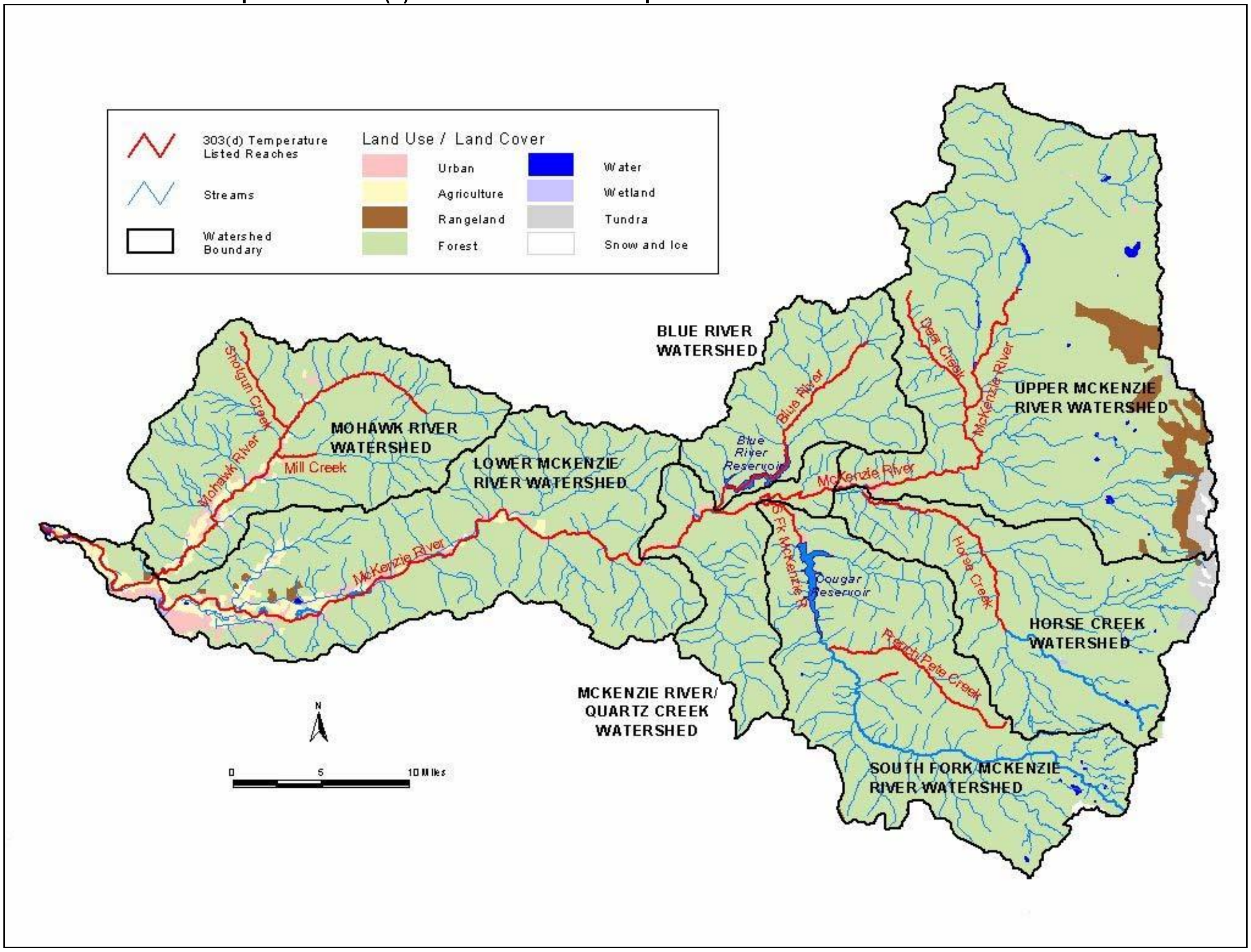
Stream segments were included on the 303(d) list of impaired waters based on the water quality standards in place at the time of evaluation. New temperature standards were adopted by the Environmental Quality Commission in December 2003 and approved by USEPA in March 2004. The new temperature criterion for salmon and trout rearing and migration is 18.0°C (64.4°F). A review of the temperature data for the streams listed in the McKenzie Subbasin indicates that these streams exceed the recently adopted numeric criterion.

**Table 11. 3 McKenzie Subbasin 303(d) Temperature Listed Segments.**

| Waterbody Name | Listed River Mile | Parameter | Criteria | Season |
|---|---|---|---|---|
| Blue River | 1.8 to 15.5 | Temperature | Rearing: 17.8 ºC | Summer |
| Deer Creek | 0 to 8.3 | Temperature | Rearing: 17.8 ºC | Summer |
| French Pete Creek | 0 to 12.9 | Temperature | Bull trout 10°CºC | Summer |
| Horse Creek | 0 to 14.2 | Temperature | Bull trout 10°CºC | Summer |
| McKenzie River | 54.4 to 83 | Temperature | Rearing: 17.8 ºC | Summer |
| Mill Creek | 0 to 2.7 | Temperature | Rearing: 17.8 ºC | Summer |
| Mohawk River | 0 to 25.4 | Temperature | Rearing: 17.8 ºC | Summer |
| Shotgun Creek | 0 to 6.6 | Temperature | Rearing: 17.8 ºC | Summer |
| Unnamed Tributary to Rebel Creek | 0 to 1.2 | Temperature | Rearing: 17.8 ºC | Summer |

French Pete Creek exceeded the 10 degree criterion for bull trout at the time of the 2002 update of the 303(d) list. French Pete Creek discharges into the South Fork McKenzie which is now designated as core cold water habitat. The bull trout designation for these waters has been replaced with the core cold water habitat use. Using the current designated beneficial use, the data review for 2004 shows the stream attaining the 16 degree criterion, and therefore, meeting water quality standards. Consequently, a TMDL is not required for this stream although load allocations to protect waters further downstream will still apply. French Pete Cr. will be removed from the 303(d) based on attainment of the new criterion

**Map 11.3 303(d) Listed Streams for Temperature in the McKenzie Subbasin.**




# Pollutant Identification

## OAR 340-042-0040(4)(b)

ODEQ must establish a TMDL for any waterbody designated on the 303(d) list as exceeding water quality criteria. Although temperature criteria are designed to protect beneficial uses from excessive water temperature, the pollutant of concern is heat energy. Water temperature change is an expression of heat energy exchange per unit of volume:

$$\Delta Temperature \propto \frac{\Delta Heat\ Energy}{Volume}$$

Stream temperatures are affected by natural and human caused sources of heating. Disturbance processes such as wildfire, flood, and insect infestation influence the presence, height and density of riparian vegetation which in turn determines the amount of solar radiation reaching the stream. Such processes are recognized and incorporated as a natural condition in the TMDL. This temperature TMDL does address stream heating caused by human activities that affect characteristics of riparian vegetation in addition to point sources that discharge heat directly into surface waters in the McKenzie Subbasin.

# Beneficial Use Identification

## OAR 340-042-0040(4)(c)

Numeric and narrative water quality criteria are applied to protect the most sensitive beneficial uses. The most sensitive beneficial uses to temperature in the McKenzie Subbasin are:

- Resident fish and aquatic life
- Salmonid spawning, rearing and migration
- Anadromous fish passage

At a minimum, beneficial uses are considered attainable wherever feasible or wherever attained historically.

### *Salmonid Stream Temperature Requirements*

This temperature TMDL is focused on the protection of cold water salmonids, specifically steelhead and salmon. In general, there are three levels of thermally induced fish mortality. If stream temperatures become greater than 32 °C (>90°F), fish die almost instantly due to denaturing of critical enzyme systems in their bodies (Hogan, 1970). This level is termed *instantaneous lethal limit.* The second level is termed *incipient lethal limit* and can cause fish mortality in hours to days when temperatures are in the 21°C to 25°C (70°F to 77°F) range. The time period to death depends on the acclimation and life-stage of the fish. The cause of death is from the breakdown of physiological regulation, such as respiration and circulation, which are vital to fish health (Heath and Hughes, 1973). The third level is the most common and widespread cause of thermally induced fish mortality, termed *indirect or sub-lethal limit* and can occur weeks to months after the onset of elevated stream temperatures of 17.8°C to 23°C (64°F to 74°F). The cause of death is from interactive effects such as: decreased or lack of metabolic energy for feeding, growth, and reproductive behavior; increased exposure to pathogens (viruses, bacteria and fungus); decreased food supply because the macroinvertebrate populations are also impaired by high stream temperature; and increased competition from warm water tolerant species. Table 11.4 summarizes the modes of cold water fish mortality.

**Table 11. 4 Thermally Induced Cold Water Fish Mortality Modes (Brett, 1952; Bell, 1986, Hokanson et al., 1977)**

| Modes of Thermally Induced Fish Mortality | Temperature Range | Time to Death |
|---|---|---|
| *Instantaneous Lethal Limit* – Denaturing of bodily enzyme systems | > 32°C (> 90°F) | Instantaneous |
| *Incipient Lethal Limit* – Breakdown of physiological regulation of vital bodily processes, namely: respiration and circulation | 21°C - 25°C (70°F - 77°F) | Hours to Days |
| *Sub-Lethal Limit* – Conditions that cause decreased or lack of metabolic energy for feeding, growth or reproductive behavior, encourage increased exposure to pathogens, decreased food supply and increased competition from warm water tolerant species | 17.8°C - 23°C (64°F - 74°F) | Weeks to Months |

# Target Criteria Identification

## OAR 340-041-0028(4)(c), OAR 340-041-0028(4)(d),OAR 340-041-0028(9) CWA 303(d)(1)

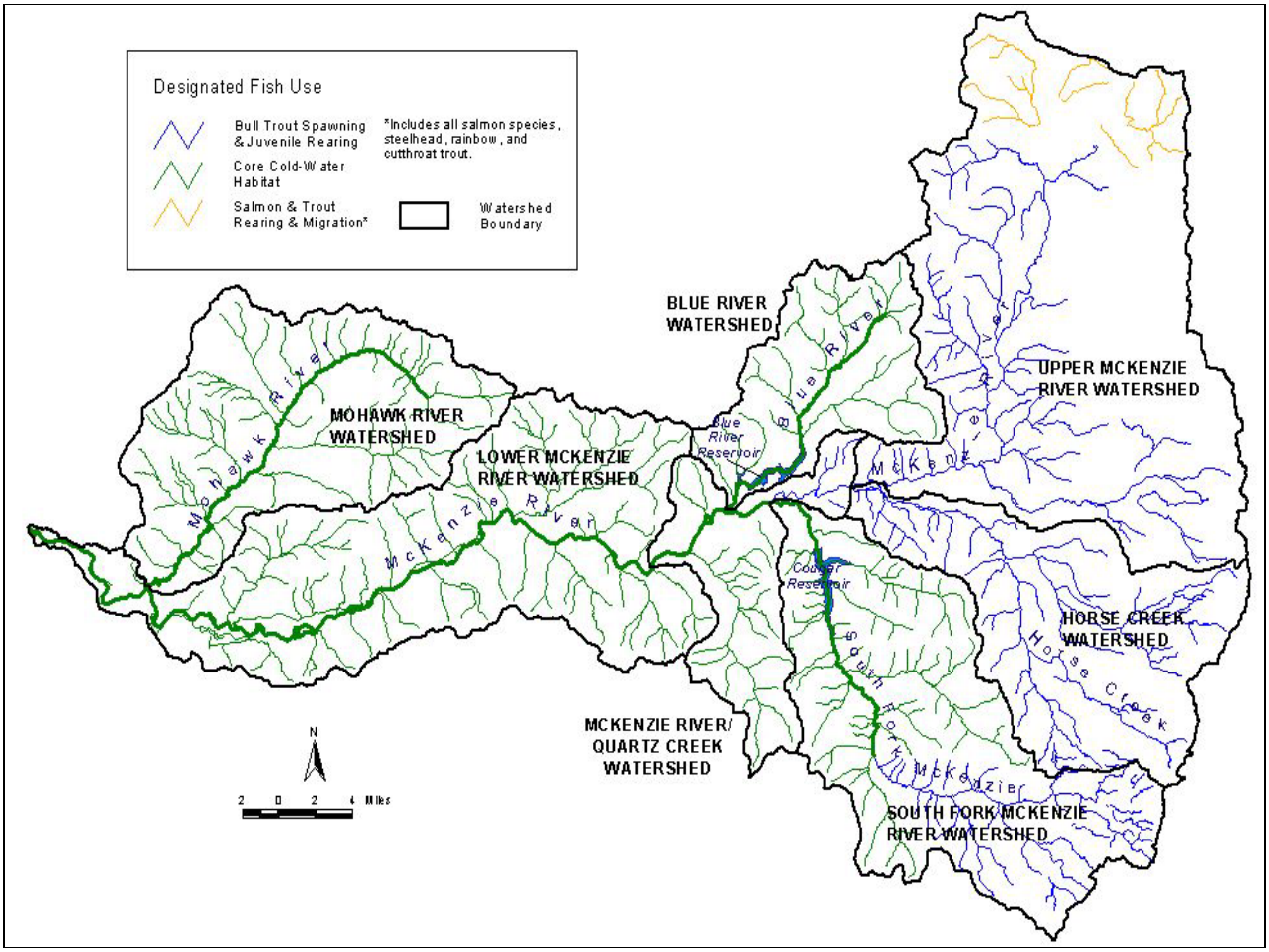
Oregon's water quality criteria for temperature are designed to protect beneficial uses, such as cold-water salmon and trout species, based on specific salmonid life stages. The temperature criteria include both narrative and numeric criteria. Table 11.5 lists the temperature criteria that are applicable to the McKenzie Subbasin. Maps 11.4 and 11.5 illustrate designated subbasin fish use and salmonid spawning use. The maps indicate where salmonid spawning through fry emergence criterion, core cold water habitat criterion, salmonid rearing and migration criterion, and bull trout spawning and rearing criterion apply. For subbasin waters where fisheries uses are not identified, the applicable criteria are the same as the nearest downstream waterbody that is identified in fish use maps. Willamette Basin fish use and spawning use maps are available for electronic download on ODEQs website at:
http://www.deq.state.or.us/wq/standards/FishUseMapsFinal/FFigure340A_Willamette.pdf and
http://www.deq.state.or.us/wq/standards/FishUseMapsFinal/FFigure340B_Willamette.pdf

**Table 11. 5 Oregon's Biologically Based Temperature Criteria.**

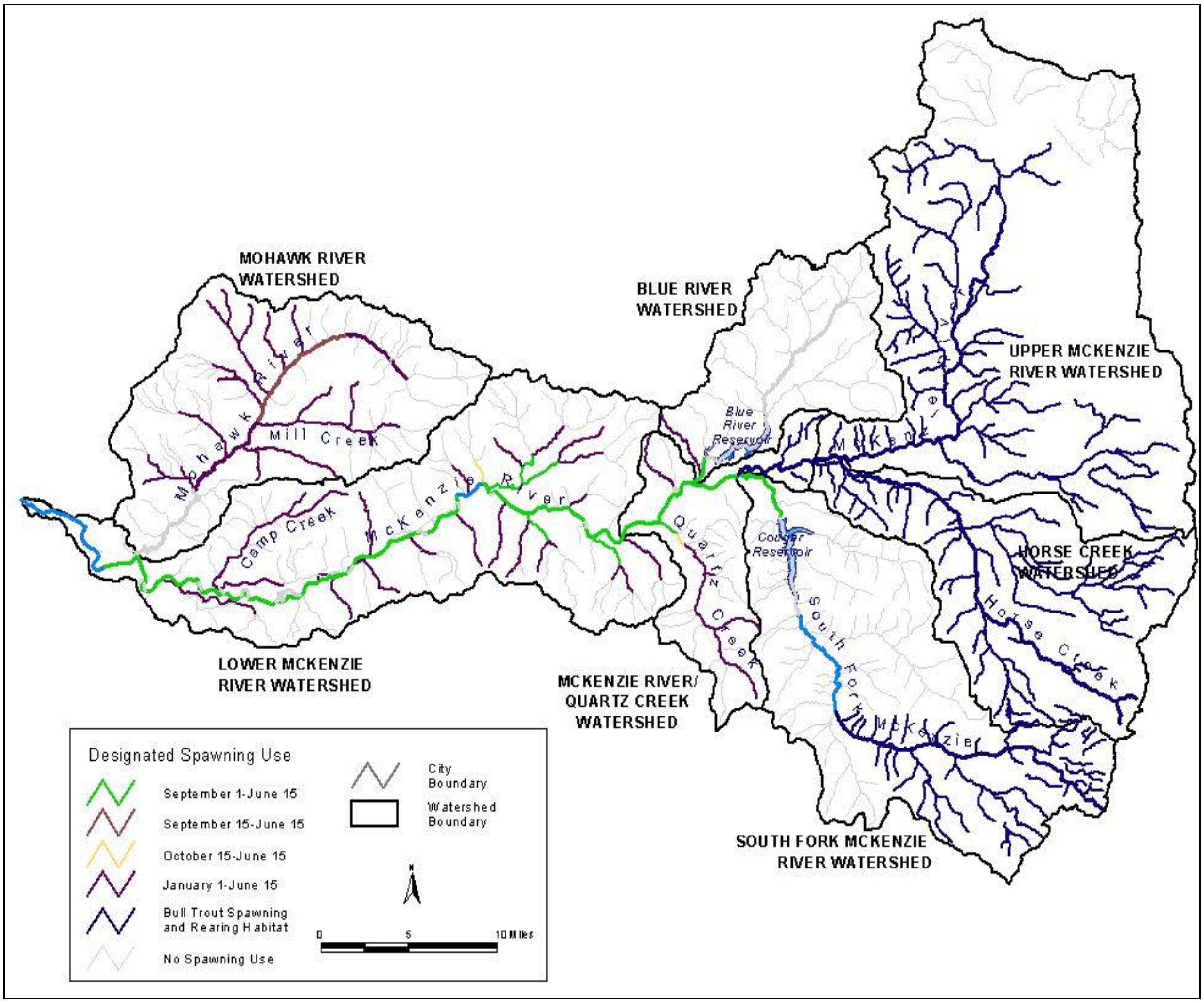
| Beneficial Use | Temperature Criteria |
|---|---|
| Bull Trout Spawning and Juvenile Rearing | ∗12.0°C (53.6°F) |
| Salmon and Steelhead Spawning | ∗13.0°C (55.4°F) |
| Core Cold Water Habitat Identification | *16.0°C (60.8°F) |
| Salmon and Trout Rearing and Migration | ∗18.0 °C (64.4 °F) |

∗ Stream temperature is calculated using the average of seven consecutive daily maximum temperatures on a rolling basis (7-day calculation).

**Map 11.4 McKenzie Subbasin Designated Fish Use Distribution of Anadromous Salmonids**



**Map 11.5 McKenzie Subbasin Designated Spawning Use Distribution of Anadromous Salmonids**




The narrative criteria that apply to the McKenzie Subbasin describe the conditions under which biological numeric criteria may be superseded. The criteria acknowledge that in some instances the biologically based numeric criteria may not be achieved because the natural thermal potential of the stream temperature is warmer than the biologically based numeric criteria. A stream that is free from anthropogenic influence is considered to be at natural thermal potential. When it exceeds the appropriate biologically based criterion, the natural thermal potential becomes the natural condition numeric temperature criterion for that specific stream or stream segment. This often occurs in low elevation streams in the basin during summer months.

Following a temperature TMDL or other cumulative effects analysis, waste load and load allocations will restrict all NPDES point sources and nonpoint sources to a cumulative increase of no greater than 0.3 degrees Celsius (0.5Fahrenheit) above the applicable criteria after complete mixing in the water body, and at the point of maximum impact.

A more extensive analysis of water temperature related to aquatic life and supporting documentation for the temperature standard can be found in the *1992-1994 Water Quality Standards Review Final Issue Papers* (ODEQ, 1995) and in *EPA Region 10 Guidance for Pacific Northwest State and Tribal Temperature Water Quality Standards* (USEPA, 2003).

# Existing Heat Sources

## OAR 340-042-0040(4)(f),CWA §303(d)(1)

Sources of heat pollution include nonpoint sources and point sources. Nonpoint sources are generally more diffuse in nature and cannot be traced back to a particular location. These sources are defined below in terms of land use. Dams and reservoir operations are also included as nonpoint sources of pollution although their effects on water quality are generally more identifiable than dispersed land use activities. Point sources are individual facilities that discharge a pollutant from a defined conveyance (e.g. an outfall pipe) and are regulated by permit.

### *Nonpoint Sources of Heat*

*Land use activities*. Riparian vegetation, stream morphology, hydrology (including groundwater interactions), climate, and geographic location influence stream temperature. While climate and geographic location are outside of human control, riparian condition, channel morphology and hydrology are affected by land use activities. Disturbance or removal of vegetation near a stream reduces stream surface shading because of decreased vegetation height, width and density. This results in greater amount of solar radiation reaching the stream surface.

Riparian vegetation also influences channel morphology. Vegetation supports stream banks during erosive, high flow events and slows floodwaters and promotes sediment deposition when floodwaters overtop the banks. Loss or disturbance of riparian vegetation may precede lateral stream bank erosion and channel widening. This decreases the effectiveness of remaining vegetation to shade the stream and increases the stream surface area exposed to heat exchange processes, particularly solar radiation.

*Dam and Reservoir operations*. Dams and reservoir operations affect stream temperature through the modification of flow regimes and through the delivery of heat stored within the system. Flow augmentation during the low flow periods of the year may be beneficial to stream segments below the dam as higher flows increase stream volume and therefore the loading capacity of the segment. Also, higher volumes correspond to greater stream velocities and shorter travel times through stream reaches exposed to solar radiation. However, operations that divert flows from natural channels during low flow periods may substantially diminish the loading capacity of the stream while also increasing solar loading to the stream because of lower velocities and greater travel times through exposed reaches.

The release of water from reservoirs may also increase downstream temperatures as the heat held by the impounded water is also released. The timing, duration and magnitude of such impacts are dependent upon reservoir characteristics such as surface area, depth, and whether water is released from the bottom of the reservoir or may be selectively withdrawn from various depths.

There are two principal reservoirs in the McKenzie Subbasin, Blue River Reservoir, on the Blue River, and Cougar Reservoir on the South Fork McKenzie River. A discussion of the impact of these reservoirs on the McKenzie River is discussed in Chapter 4.

### *Point Sources of Heat*

Point source discharges play a role in stream heating in the streams of the McKenzie Subbasin. There are four individual NPDES permitted sources in the McKenzie Subbasin, Map 11.6 and Table 11.6. Two of the four individual NPDES point sources are ODFW hatcheries: Leaburg Hatchery discharges to Trout Creek year round at river mile (RM) 1.0 and McKenzie River Hatchery discharges year round to Cogswell Creek at RM 1.0. The third individual NPDES facility is Eugene Water and Electric Board's (EWEB) Carmen-Smith facility that discharges year round to the McKenzie River at RM 82.0. Weyerhaeuser industrial wastewater discharges year round to McKenzie Ditch at RM 1.0. There are also 15 general NPDES permits, consisting of 10 stormwater permits for facilities located within the subbasin. General NPDES permits are located in the lower, valley bottom portion of the McKenzie Subbasin. Stormwater sources are not considered to have reasonable potential to contribute to exceedances of numeric temperature criteria.

**Map 11.6 McKenzie Subbasin NPDES Permit Locations. April, 2003.**

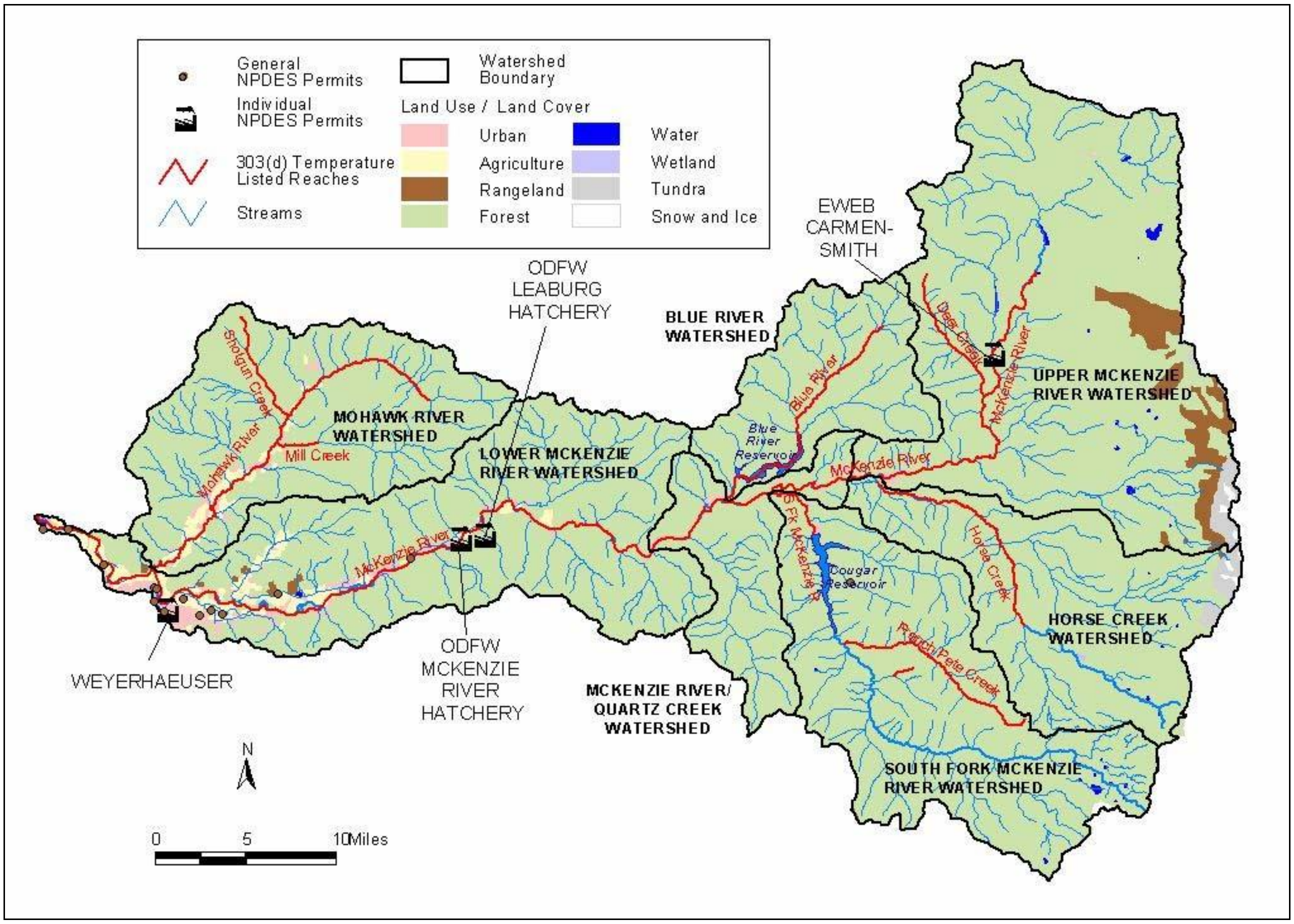



**Table 11. 6 Individual NPDES facilities in the McKenzie Subbasin, which do not discharge to the mainstem McKenzie River downstream of the confluence of South Fork McKenzie River, Blue River downstream of Blue River Reservoir, and South Fork McKenzie River downstream of Cougar Reservoir. April, 2003.**

| Facility Name | Permit Type | Permit Description | Receiving Stream | River Mile | Type of Discharge | Season of Discharge |
|---|---|---|---|---|---|---|
| EWEB CARMEN-SMITH | NPDES-IW-O | Industrial Wastewater; NPDES non-process wastewater NEC | McKenzie River | 82.0 | Waste Water | Year Round |
| ODFW - LEABURG HATCHERY | NPDES-IW-O | Industrial Wastewater; NPDES non-process wastewater NEC | Trout Creek | 1.0 | Waste Water | Year Round |
| ODFW - MCKENZIE RIVER HATCHERY | NPDES-IW-O | Industrial Wastewater; NPDES non-process wastewater NEC | Cogswell Creek | 1.0 | Waste Water | Year Round |
| WEYERHAEUSER | NPDES-IW-A | Industrial Wastewater; NPDES major pulp, paper, fiber pulping industry | McKenzie Ditch | 1.0 | Waste Water | Year Round |

NEC = Not Elsewhere Classified

## Temperature TMDL Approach Summary

During the fall of 2000, ODEQ coordinated and led a temperature data collection field exercise for the US Forest Service (Willamette National Forest) and Bureau of Land Management (BLM) Salem District. The purpose of this field exercise was to train federal management field staff in temperature TMDL field collection methods such as in-stream temperature thermometer placement, riparian vegetation characterization, channel characterization, and flow monitoring. In early June 2000, USFS and BLM placed temperature thermisters in-stream at various locations in the McKenzie Subbasin. These thermisters were removed from the stream before stream flow conditions became hazardous, in late August 2000. During the last week of July, 2000, USFS and BLM staff conducted field sampling exercises to record instantaneous flow, characterize the stream channel, take an audit of in-stream temperatures, and to characterize the riparian vegetation. Digital photos and a Geographical Positioning System (GPS) were used to record the latitude and longitude of each temperature monitoring location. USGS real-time flow gage information was also recorded when available, specifically for Heat Source hydrology development. Aerial photos and Thermal Infrared Radiometry (TIR) and visible video imagery for Mohawk River, Upper McKenzie, Deer Creek, and Horse Creek were provided by the US Forest Service and BLM. Data from these images was used for modeling and analysis.

McKenzie Subbasin stream temperature TMDLs were developed at the watershed scale. . These TMDLs include all surface waters that affect the temperatures of 303(d) listed water bodies because stream temperature is affected by heat loads from upstream as well as local sources. Point and nonpoint sources of heat may not cause an increase in temperature of more than the human use allowance (0.3˚C) when fully mixed with a stream and at the point of maximum impact. For the purposes of Willamette Basin TMDLs, the human use allowance has been divided among various sources using a framework established by DEQ with input from the Willamette TMDL Council. The framework allocates to point sources heat loads that yield a cumulative increase in stream temperature of no more than 0.2˚C. The framework allocates nonpoint sources an increase in temperatures of 0.05˚C and a heat load equivalent to 0.05˚C is held as reserve capacity. Where less than the 0.2˚C cumulative increase in temperature is actually used by point source discharges, the remainder is allocated to reserve capacity. The actual allocation of heat within the human use allowance is not specified in the water quality standards and this framework is used simply as guidance for implementation of the TMDL.

*Point Source Approach.* Allocations or permit limits are developed for individual point source discharges that ensure the combined increase in temperature for all discharges does not exceed 0.2˚C at the point of maximum impact. Wasteload allocations for individual point sources are generally based on a quarter of the human use allowance and yield less than a 0.08ºC increase in temperature at the point of maximum impact. Individual waste load allocations may be greater than 0.08ºC based on an analysis of site specific needs provided the overall point source allocation is within the established human use allowance framework. The specific methods and equations used to develop wasteload allocations are contained in the Allocation section of this chapter, below.

*Nonpoint Source Approach.* Removal or disturbance of riparian vegetation is the primary nonpoint source activity with respect to stream temperatures in the subbasin. The temperature model Heat Source was used to calculate load allocations. Surrogate measures are used to represent nonpoint source heat loads. While heat from solar radiation in excess of natural background rates is considered the pollutant, the surrogate measure is effective shade. Effective shade targets, through the use of shade curves can be translated into site-specific load allocations such as langleys per day. Both shade curves and system potential vegetation objectives were developed for the fifteen geomorphic units in the McKenzie Subbasin.

## Temperature TMDL Analytical Methods Overview

Load capacity is the assimilative capacity of each stream when anthropogenic sources of heat warm the stream no more than 0.3ºC above its natural thermal potential. Natural thermal potential is realized when point sources discharges of heat are eliminated and vegetation near the stream is undisturbed by management activities. Small additional heat load allocations can be made once these conditions are identified. Wasteload allocations for individual point sources are based on a change in river temperature at the point of maximum impact. These allocations are expressed in energy units such as kilocalories per day. Load allocations for nonpoint sources for Mohawk River and McKenzie River upstream of the confluence with South Fork McKenzie River are based on kilocalories (k/cal)per day, and the surrogate measure of percent effective shade.

Development of stream temperature TMDLs requires the identification of load capacity for each impaired stream. This often demands extensive data collection to support the development of detailed and complex models that are in turn used to simulate system responses to changes in pollutant loads. However, in many stream systems in the McKenzie Subbasin the primary sources of anthropogenic heat are land use activities that affect riparian and near-stream vegetation. Identification of load capacity in these systems first requires determination of stream shade conditions when these disturbances of vegetation are eliminated. This drives the need to determine system potential vegetation and its shade producing characteristics.

System potential vegetation is vegetation that can grow and reproduce at a near-stream site given climate, elevation, soil properties, plant community requirements and hydrologic processes. System potential vegetation is an estimate of the riparian condition where land use activities that cause stream warming are minimized. It is not intended to be an estimate of pre-settlement conditions, but is an important element in the determination of the natural thermal potential of a stream. In the absence of significant point sources of heat or stream flow modification, system potential vegetation is the basis for identification of natural thermal potential temperatures. These natural thermal potential temperatures serve as the natural conditions temperature criterion in many low elevation streams throughout the Willamette Basin.

The Oregon Administrative Rule for temperature has defined both natural conditions and natural thermal potential.

- OAR 340-041-0002(38) states:
  *"Natural conditions" means conditions or circumstances affecting the physical, chemical, or biological integrity of a water of the State that are not influenced by past or present anthropogenic activities. Disturbances from wildfire, floods, earthquakes, volcanic or geothermal activity, wind, insect infestation, diseased vegetation are considered natural conditions.*

- OAR 340-041-0002(39) states:
  "*Natural Thermal Potential" means the determination of the thermal profile of a water body using best available methods of analysis and the best available information on the site potential riparian vegetation, stream geomorphology, stream flows and other measures to reflect natural conditions.*

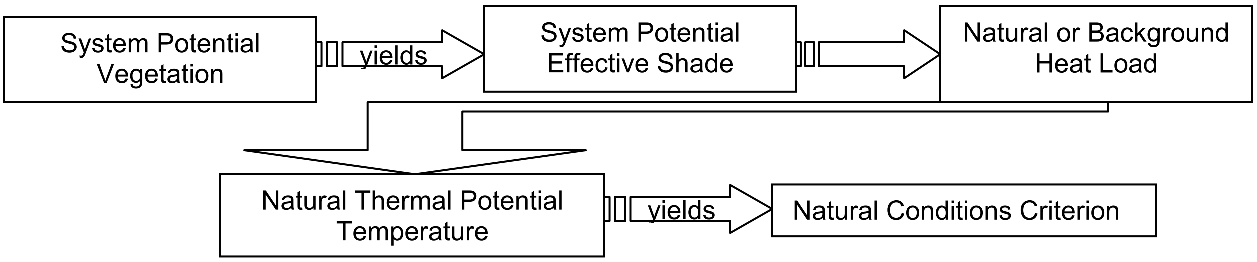
McKenzie Subbasin temperature TMDLs are based on the identification of system potential vegetation for each impaired waterbody and the calculation of the amount of shade provided by that vegetation to the stream. System potential vegetation in this analysis does allow for some level of natural disturbance such as fire and this is reflected as smaller tree heights and lower canopy densities in the calculation of shade levels. Put another way, mature vegetation was not used to simulate target conditions throughout the subbasin.

Effective shade is the percent of daily solar radiation that is blocked by vegetation and topography. System potential vegetation characteristics are used to estimate effective shade for each riparian community. These estimated effective shade values are often referred to as system potential effective shade when in the absence of human disturbance.

Solar radiation is a function of regional and local characteristics and is a factor in determining water temperature in the absence of significant point source influences. Regional factors such as latitude and topography determine potential solar radiation loading whereas local factors such as stream aspect, stream width and streamside vegetation characteristics determine actual solar radiation loading to the stream. Streamside vegetation characteristics that determine effective shade include vegetation height, canopy density, overhang, setback or distance from the edge of the stream, and the width of the riparian buffer. Mature, well-stocked riparian stands generally provide more effective shade to a stream than sparsely stocked riparian stands or stands of early successional plant communities. For more information on system potential vegetation refer to Appendix C, "Potential Near-Stream Land Cover for Willamette Basin".

Effective shade is a surrogate measure used for development of temperature load allocations. The use of effective shade targets alone will not support calculation of natural thermal potential stream temperatures. Extensive modeling is required to describe heat and water movement through the stream system and support the estimation of stream temperatures. Stream temperature estimation at system potential vegetation is calculated using the Heat Source Model. The Heat Source Model version 6.5 was used to calculate stream temperatures and effective shade at system potential vegetation in the Mohawk River and McKenzie River, RM 54.4 to 81.3. A description of the Heat Source model, model calibration statistics, and overview of the analytical analysis are described in Appendix C. An overview of Heat Source is also found on-line: http://www.heatsource.info/ Effective shade targets will allow for the calculation of the amount of solar loading reaching the stream and perhaps most importantly shade targets translate nonpoint source load allocations into site specific vegetation targets for land owners and managers.

The diagram below illustrates this process:



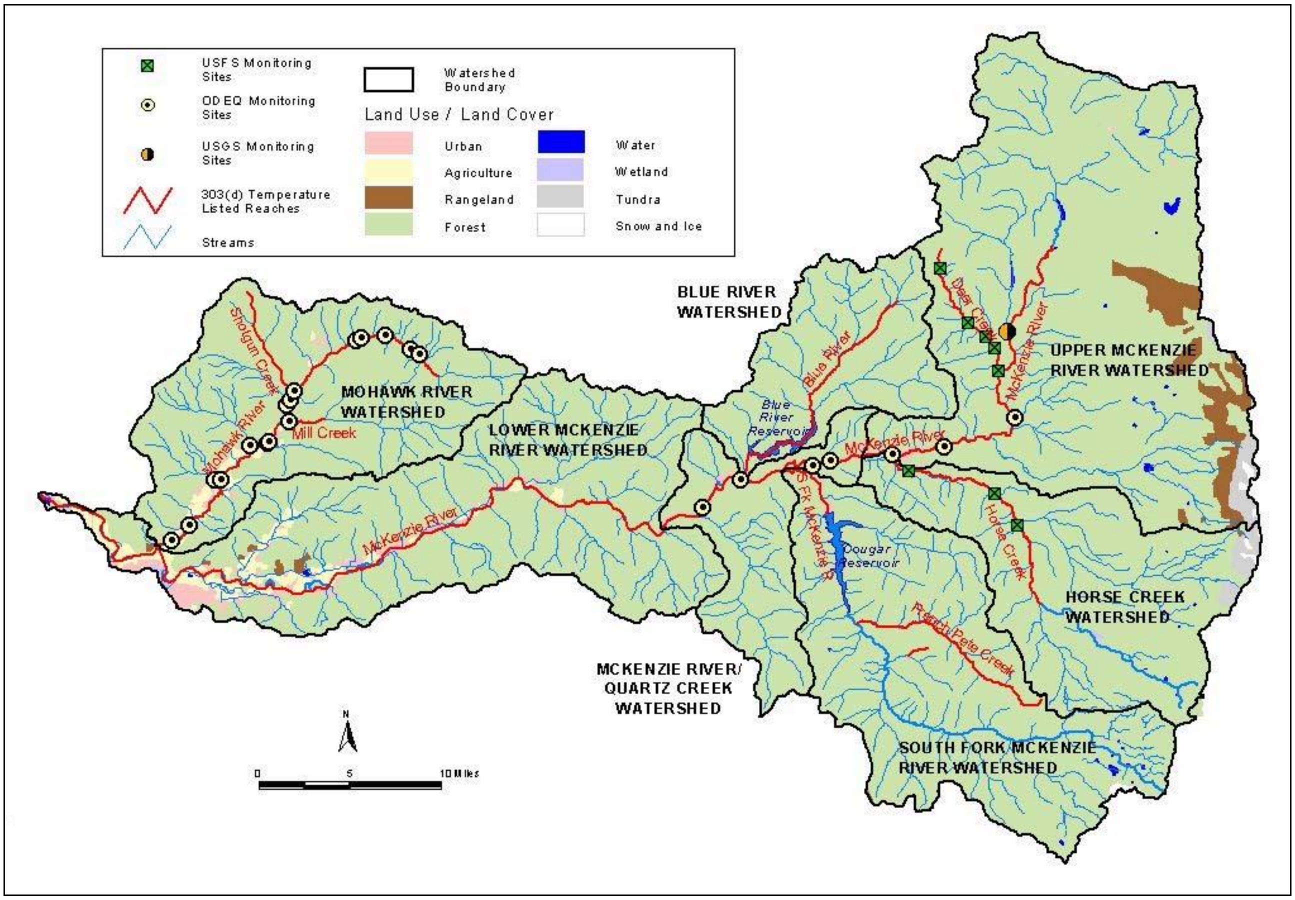

Stream temperature analysis discussed in this chapter is limited to stream systems in the McKenzie Subbasin. The water quality restoration strategies identified are applicable to all streams in the subbasin. Application of these strategies contributes to the basin-scale effort to restore and protect cooler water temperatures in other Willamette River tributaries. This broad scale application to all tributaries is an important element in the protection of coldwater aquatic life in the Willamette Basin. Although these streams are not likely to individually affect temperatures in the Willamette River, collectively they provide important localized sources of cool water and temporary thermal refugia for resident or migrating coldwater fish.

## Seasonal Variation

### OAR 340-042-0040(4)(j), CWA 303(d)(1)

In June 2001, ODEQ and USFS placed temperature thermisters in-stream at various locations throughout the McKenzie Subbasin, Map 11.7.

**Map 11.7 Temperature Monitoring Locations in the McKenzie Subbasin**




Streams in the McKenzie Subbasin exceed biologically based rearing criteria starting in late spring and through late summer. Maximum temperatures typically occurred in late July and early August. Long-term temperature recorders deployed by ODEQ, USFS, and USGS indicate that summer stream temperatures exceed the 18.0ºC (64.4ºF) migration and rearing, 16.0ºC (60.8ºF) core cold water habitat, and 12.0ºC (53.6ºF) bull trout criteria. Temperatures in McKenzie River tributary streams were commonly above the criterion during summer months. Temperatures in Horse Creek ranged from 14.0°C (57.2°F) above Castle Creek to 10.0 °C (50.0°F) below Spring Creek during summer. Temperatures in Deer Creek ranged from 20.0°C (68.0°F) near the mouth to 12.0 °C (53.6 °F) above Country Creek during summer. The Mohawk River summer temperatures ranged from 26.0 °C (78.8 °F) at RM 3.1 to 15 °C (59.0 °F) at RM 22.8.

The longitudinal profile of the seven day moving maximum for Horse Creek, Deer Creek, and Mohawk River are shown in Figure 11.1. Thermisters were removed from the stream before stream flow conditions became hazardous, in late August 2001. In early August, ODEQ staff conducted field sampling exercises to record instantaneous flow, characterize the stream channel, take an audit of in-stream temperatures, and to characterize the riparian vegetation. Digital photos and a Geographical Positioning System (GPS) determined latitude and longitude were recorded at each temperature monitoring location. USGS real-time flow gage information was also recorded when available, specifically for Heat Source hydrology development.

**Figure 11.1 7-Day Moving maximum Temperature Profiles for Horse Creek, Deer Creek, and Mohawk River.**

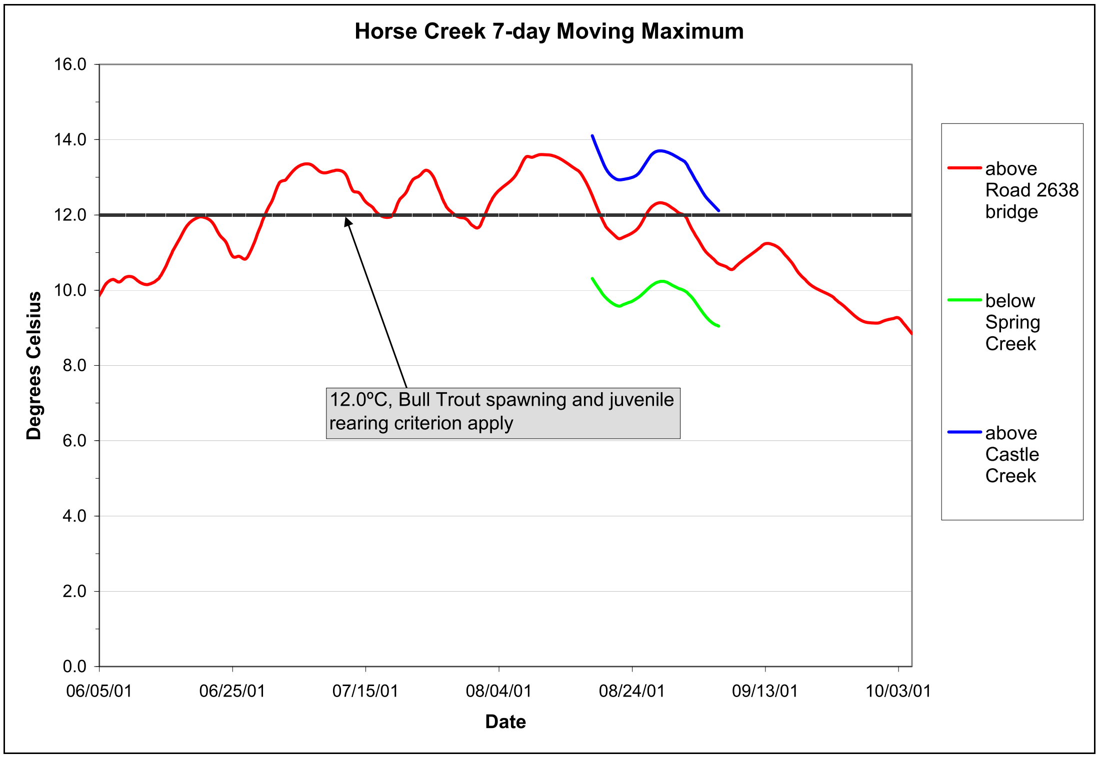
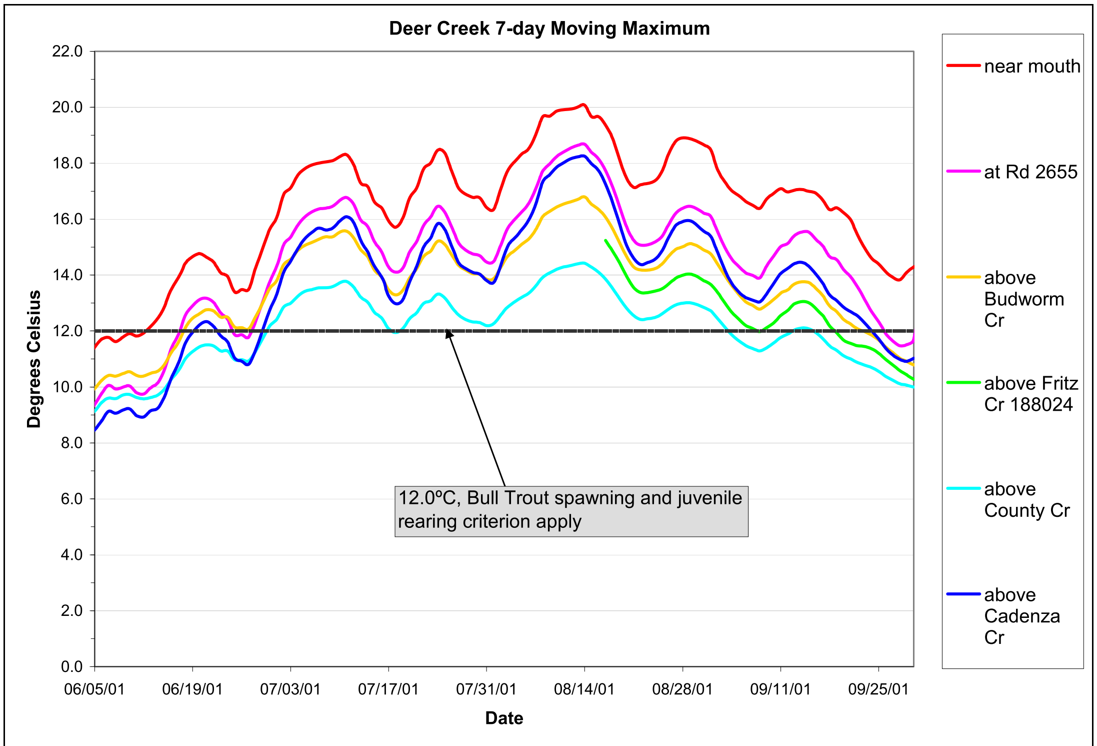
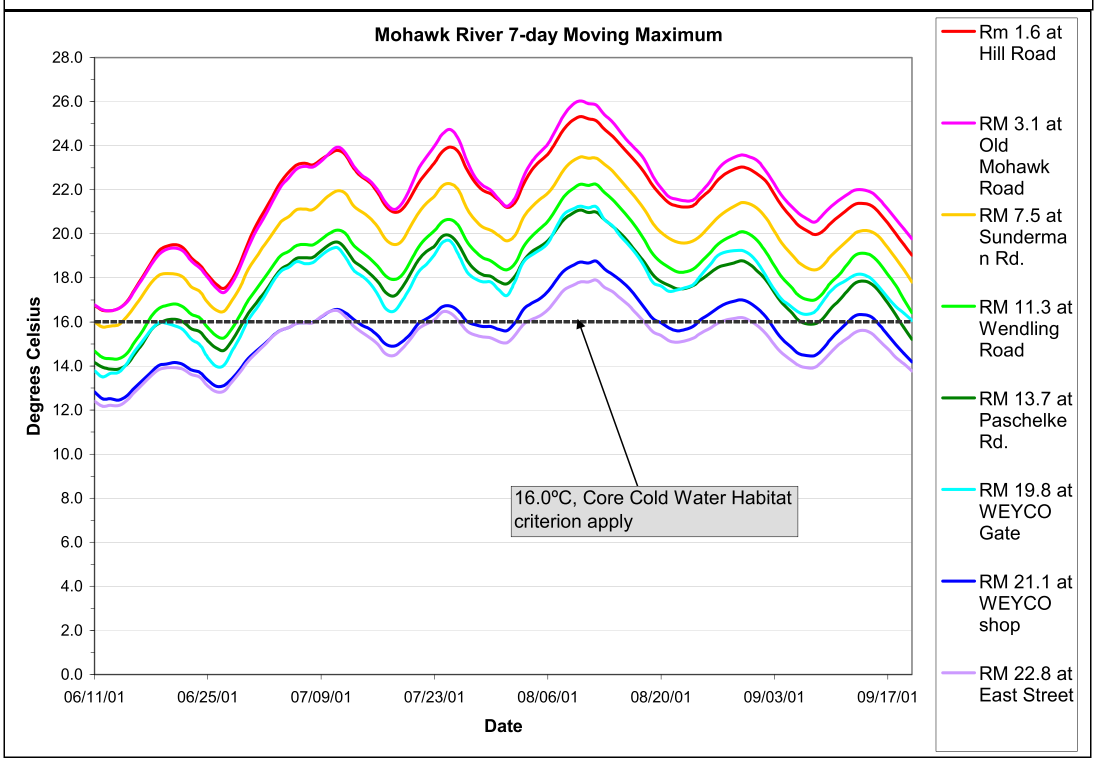



**Figure 11.1 cont.**


Deer Creek 7-day Moving Maximum
Degrees Celsius
22.0
20.0
18.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
06/05/01
06/19/01
07/03/01
07/17/01
07/31/01
08/14/01
08/28/01
09/11/01
09/25/01
Date
12.0ºC, Bull Trout spawning and juvenile rearing criterion apply
near mouth
at Rd 2655
above Budworm Cr
above Fritz Cr 188024
above County Cr
above Cadenza Cr


Mohawk River 7-day Moving Maximum
Degrees Celsius
28.0
26.0
24.0
22.0
20.0
18.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
06/11/01
06/25/01
07/09/01
07/23/01
08/06/01
08/20/01
09/03/01
09/17/01
Date
16.0ºC, Core Cold Water Habitat criterion apply
Rm 1.6 at Hill Road
RM 3.1 at Old Mohawk Road
RM 7.5 at Sunderman Rd.
RM 11.3 at Wendling Road
RM 13.7 at Paschelke Rd.
RM 19.8 at WEYCO Gate
RM 21.1 at WEYCO shop
RM 22.8 at East Street

# Loading Capacity

## OAR 340-042-0040(4)(d), 40 CFR 130.2 (f)

The loading capacity is the total amount of a pollutant that a water body can assimilate without exceeding a water quality criterion or impairing a beneficial use. This is the pollutant load that may be divided among all point and nonpoint sources as allocations.

The loading capacity provides a reference for calculating the amount of pollutant reduction needed to bring water into compliance with water quality standards. USEPA's current regulation defines loading capacity as "*the greatest amount of loading that a water can receive without violating water quality standards*" (40 CFR § 130.2(f)). Oregon's temperature criteria states that a surface water temperature increase of no more than 0.3°C (0.54ºF) above the applicable criterion is allowed from all anthropogenic sources at the point of maximum impact.

The loading capacity is dependent on the available assimilative capacity of the receiving water. For water bodies whose natural thermal potential temperatures are at or above the temperature criterion for a given period, there is no available assimilative capacity beyond the 0.3°C (0.54ºF) human use allocation. The loading capacity is essentially consumed by non-anthropogenic sources. When natural thermal potential temperatures are less than biological based numeric criteria, the load capacity may be somewhat greater than the human use allowance provided additional heat loads do not prevent attainment of water quality standards in downstream waters.

### *Critical Condition*

The critical condition for stream temperature and heat loading is the seasonal period of maximum stream temperatures and lowest stream flows. Maximum stream temperatures are a function of the meteorological inputs (solar radiation) and low stream flows that usually occur during the summer period. For many point sources the most critical condition for complying with the human use allowance occurs during the period of low stream flow and when the greatest difference between effluent and river temperatures occur, usually in late summer to early fall.

# Allocations

## 40 CFR 130.2(g), 40 CFR 130.2(h)

Loading capacity is allocated among point sources as wasteload allocations and to nonpoint sources as load allocations. Load allocations to anthropogenic sources are only available where surface water temperatures throughout a given stream meet the applicable water quality criteria plus the human use allowance. The general principle for allocation in the McKenzie Subbasin is to target natural background heat inputs from nonpoint sources and to limit point source loads to small allocations within the human use allowance.

# Wasteload Allocations

## OAR 340-042-0040(4)(g)

A wasteload allocation (WLA) is the amount of pollutant that a point source can contribute to the stream without violating water quality criteria. Waste load allocations for temperature are expressed as heat load limits assigned to individual point sources of treated industrial and domestic waste. Waste load allocations are provided for all NPDES facilities that have reasonable potential to warm the receiving stream when the applicable criteria are exceeded. The WLAs in this chapter are for point sources to waterbodies other than the McKenzie River downstream of the confluence of South Fork McKenzie River, Blue River downstream of Blue River Reservoir, and the South Fork McKenzie River downstream of Cougar Reservoir. Point sources that discharge directly to the McKenzie River have been considered as part of the Willamette TMDL detailed in Chapter 4.

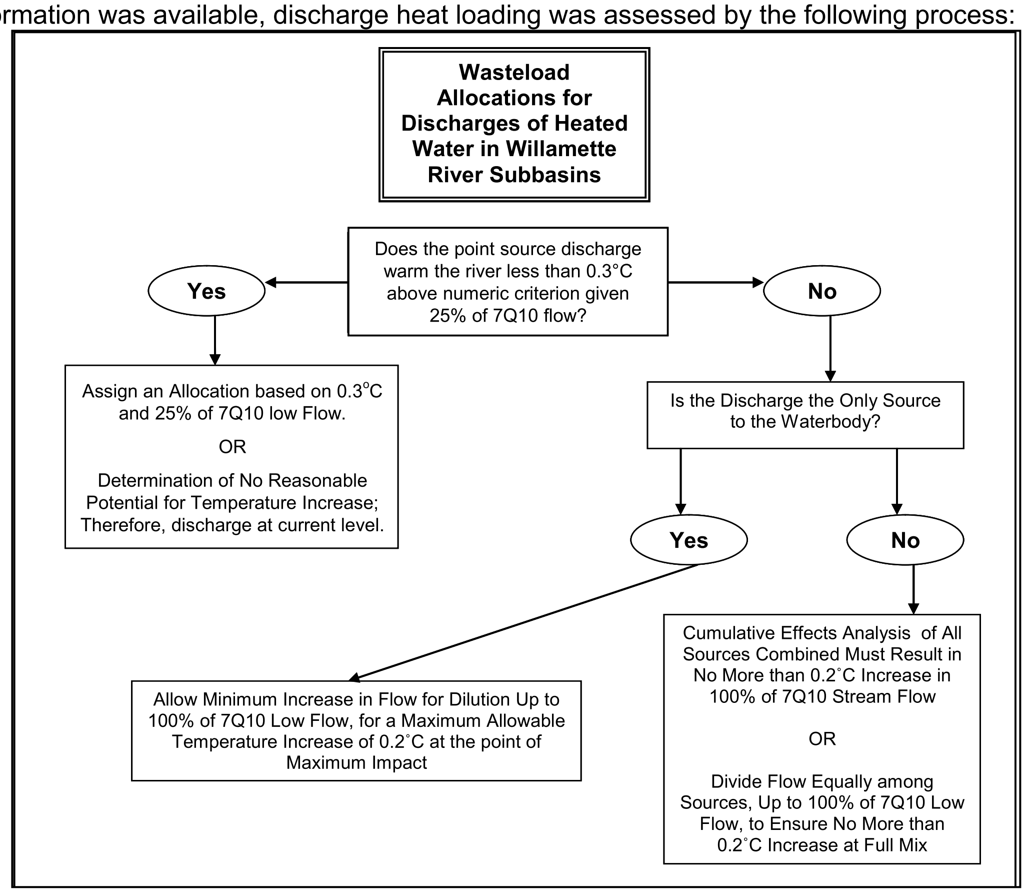
### *Waste Load Allocations in Small Streams*

Discharges were screened to determine which would likely receive a wasteload allocation based on the type of discharge, and the volume and temperature of effluent. General permits that are unlikely to discharge significant volumes of warm water during critical periods (e.g., stormwater permits) are not expected to have a reasonable potential to increase instream temperatures. General permits that discharge heated effluent (e.g., boiler blowdown, log ponds) were considered as potential sources. For discharges with insufficient information (absence of stream flow data) to screen for effects or develop a wasteload allocation (WLA), a WLA will be calculated at the time of permit renewal by the method described below.

Oregon's temperature standard [OAR 340-041-0028(12)] allows an insignificant increase in temperature from all point and nonpoint sources combined as a Human Use Allowance (HUA = 0.3˚C). Prior to development of a TMDL, the standard allows the assumption that a 0.3˚C increase in ¼ of the receiving stream flow or the volume of the temperature mixing zone (whichever is more restrictive) will not cause an impairment.

The waste load allocation scheme below assumes an allowable change in temperature above criteria of 0.3˚C within 25% of the 7Q10 low flow (a calculation of the seven-day, consecutive low flow with a ten year return frequency). This is the initial step in the development of a waste load allocation on smaller streams or when information is insufficient to allow a greater proportion of receiving water flow for mixing. The resultant temperature increase in fully mixed receiving water would be limited to 0.08˚C. More than the minimum flow allowance (25% of 7Q10 low flow) may be allocated to an individual source when analysis demonstrates standards attainment. The resulting temperature increase in this scenario depends on the proportion of low flow allocated, but should not exceed the point source sector allocation of 0.2°C over the entire waterbody. Moreover, each discharge is also required to ensure the local effects of discharge will not cause impairment to health of fish by meeting thermal plume requirements adopted under OAR 340-41-0053(2)(d).

Where information was available, discharge heat loading was assessed by the following process:



The pre-TMDL limits in the flow chart above refer to currently permitted discharge limits for existing point sources. Wasteload allocations are expressed in terms of heat load (kilocalories per day). These heat loads are calculated from estimates of river flow, effluent flow, effluent temperature, and either the appropriate biologically based criterion or the natural thermal potential at the point of discharge. Heat load is calculated with **Equation 1** (below). Where in-stream and effluent flow information is sufficient, allocations, and effluent limits may be developed based on flow rates for time periods other than monthly or an entire season (e.g., daily loads). The $Q_{ZOD}$ term may vary depending upon the situation for the discharger as explained in the decision tree above, but will usually be ¼ of the 7Q10 low flow on either a monthly or a yearly basis dependent on data availability.

**Equation 1**:

$$H_{PS} = Q_{ZOD} + Q_{PS} \cdot \frac{1 \cdot ft^3}{1 \cdot sec} \cdot \frac{1 \cdot m^3}{35.31 \cdot ft^3} \cdot \frac{1000 \cdot kg}{1 \cdot m^3} \cdot \frac{86400 \cdot sec}{1 \cdot day} \cdot \Delta T_{ZOD} \cdot c = \frac{Kcal}{day}$$

where:

- $H_{PS}$: Heat from point source effluent received by river (kcal/day)
- $Q_{ZOD}$: River flow volume allowed for mixing- ¼ of 7Q10 low flow statistic (cfs)
- $Q_{PS}$: Point source effluent discharge (cfs)
- $\Delta T_{ZOD}$: Change in river temperature at point of discharge - 0.3$^{o}$C allowable ($^{o}$C)
- c: Specific heat of water (1 Kcal / 1kg 1ºC)

Estimates of effluent temperature were calculated using mass loading equations (**Equation 2**) taking into account river flow and temperature, and effluent flow and temperature. Allocations are usually calculated to ensure an increase in temperature of no more than 0.3°C (0.54°F) in one-quarter of the volume of the receiving stream. When this volume is fully mixed with the receiving stream, this increase in temperature would be limited to 0.08°C. Where more than the minimal flow volume is allocated, either to allow more heat load to an individual discharger on a stream, or to calculate the cumulative effects of multiple discharges, the allocation is no more than 0.2°C (0.36°F) increase given the entire flow of the river receiving the cumulative discharges. If new or more comprehensive information (e.g. flow data, temperature data, mixing zone characteristics) is available at the time permits are renewed, permit limits will reflect revised wasteload allocations as calculated using **Equation 1** above and the best information available.

**Equation 2**:

$$T_{WLA} = \frac{[(Q_{PS} + Q_{ZOD}) \cdot (T_R + \Delta T_{ZOD})] - (Q_{ZOD} \cdot T_R)}{Q_{PS}}$$

where:

- $T_R$: Temperature Criterion or Upstream potential river temperature ($^{o}$C)
- $T_{WLA}$: Maximum allowable point source effluent temperature ($^{o}$ C)
- $\Delta T_{ZOD}$: Change in river temperature at point of discharge - 0.3$^{o}$C allowable ($^{o}$C)
- $Q_{ZOD}$: River flow volume allowed for mixing- ¼ of 7Q10 low flow statistic (cfs)
- $Q_{PS}$: Point source effluent discharge flow volume (cfs)

Two major discharges with a likelihood of increasing heat load to the streams in the McKenzie Subbasin are two fish hatcheries operated by Oregon Department of Fish and Wildlife (ODFW). The Leaburg and McKenzie River hatcheries each divert large volumes of water from the McKenzie River and then discharge that water back to Trout Creek and Cogswell Creek, respectively, after some period of retention in fish impoundments. It is uncertain whether these facilities increase the temperature of water during this process. Current general permits for these facilities require characterization of effluent to determine the effects of hatchery operations on receiving waters. Wasteload allocations and permit limits will be determined for these facilities if necessary by the methods described above during the next permit renewal.

**Table 11. 7 NPDES permitted discharges potentially requiring permit limits to ensure water quality standards.**

| Common Name | Permit Type | Permit Description | File Number | Receiving Stream | River Mile | Season of Discharge | Effluent Temp. (˚C) | Effluent Temp. (˚F) | Effluent Flow (cfs) |
|---|---|---|---|---|---|---|---|---|---|
| ODFW – Leaburg | GEN03 | Industrial Wastewater, 300, NPDES fish hatcheries | 64490 | Trout Creek | 1.0 | Year Around | 4.4 -12.8 [a] | 40-55 [a] | 60 |
| ODFW – McKenzie | GEN03 | Industrial Wastewater, 300, NPDES fish hatcheries | 64500 | Cogswell Creek | 1.0 | Year Around | 4.4 -12.8 [a] | 40-55 [a] | 40 |

a= Effluent temperatures are being characterized as requirement of current general permit

# Load Allocations

## OAR 340-042-0040(h)

Load Allocations are portions of the loading capacity divided among natural, current anthropogenic, and future anthropogenic nonpoint pollutant sources. Load allocations (i.e. distributions of the loading capacity) are provided in Table 9.7 for Crabtree and Thomas creeks.

In this TMDL, load allocations are allowed 0.05˚C of the human use allowance (0.3˚C). This heat allowance is in addition to the load that streams would receive when they are at system potential and would allow activities that might increase the loading (such as riparian management activities) or for human disturbance that may not easily be addressed (e.g. presence of a road near a stream that would limit shading). The 0.05°C increase in temperature above criteria (1/6$^{th}$ of the HUA) is dedicated to nonpoint sources but is not allocated to individual sources at this time.

The current loading from nonpoint sources is much greater than that which would exist under natural thermal potential. This requires nonpoint sources to reduce thermal inputs to reach natural thermal potential conditions through allocation of a surrogate measure, effective shade. The principal means of achieving this condition is through protection and restoration of riparian vegetation. Additional measures may also be taken to improve summer temperatures. For example, water conservation measures that improve summer stream flows will benefit stream temperatures through an increase in load capacity. Stream restoration efforts that result in narrower stream channel widths will improve the effectiveness of existing vegetation to shade the stream surface.

Nonpoint source allocations were assigned natural background loads and are implemented as shade curves for upland forests and each geomorphic unit. This allocation also applies to tributaries of temperature listed waterbodies. Shade curves illustrate the relationship between each potential vegetation cover type, channel width and the resulting effective shade level.

**Solar Radiation Heal Load Calculation Diagram**

Total Solar Radiation Heat Load from <u>All Nonpoint Sources,</u>

$$H_{\text{Total NPS}} = H_{\text{SP NPS}} + H_{\text{Anthro NPS}} = \Phi_{\text{Total Solar}} \cdot A$$

Solar Radiation Heat Load from <u>Background Nonpoint Sources (*System Potential*),</u>

$$H_{\text{SP NPS}} = \Phi_{\text{SP Solar}} \cdot A$$

Solar Radiation Heat Load from <u>Anthropogenic Nonpoint Sources,</u>

$$H_{\text{Anthro NPS}} = H_{\text{Total NPS}} - H_{\text{SP NPS}}$$

*Note: All solar radiation loads are the clear sky received loads that account for Julian time, elevation, atmospheric attenuation and scattering, stream aspect, topographic shading, near stream vegetation stream surface reflection, water column absorption and stream bed absorption.*

where,

$H_{\text{Total NPS}}$: Total Nonpoint Source Heat Load (kcal/day)
$H_{\text{SP NPS}}$: Background Nonpoint Source Heat Load based on *System Potential* (kcal/day)
$H_{\text{Anthro NPS}}$: Anthropogenic Nonpoint Source Heat Load (kcal/day)
$\Phi_{\text{Total Solar}}$: Total Daily Solar Radiation Load (ly/day)
$\Phi_{\text{SP Solar}}$: Background Daily Solar Radiation Load based on *System Potential* (ly/day)

$\Phi_{Anthro\ Solar}$: Anthropogenic Daily Solar Radiation Load (ly/day)
A: Stream Surface Area - calculated at each 100 foot stream segment node ($cm^2$)

System Potential vegetation characteristics were developed to include the effects of natural disturbance on riparian vegetation distribution and attributes within each geomorphic unit. The term "geomorphic unit" refers to quaternary geologic units shown as polygons that were differentiated on the basis of stratigraphic, topographic, pedogenic, and hydrogeologic properties (O'Connor et al, 2001). In other words, surface deposits of unconsolidated material above bed rock shaped by processes of erosion, sediment transport and deposition.

- Flood
- Wind Throw
- Fire
- Insect Infestation

System potential vegetation includes the random distribution of conifer, mix conifer-hardwood, and hardwood species in each geomorphic unit. This random distribution of attributes within each geomorphic unit is intended to include the effects of natural disturbance in the system potential riparian vegetation condition. Some geomorphic units may also incorporate prairie. The proportions of forest, savanna and prairie to be used in each geomorphic unit were developed following rules detailed in Table 1 and on page 14 of the Potential Near-Stream Land Cover document included in Appendix C. As an example, in the quaternary alluvium unit (Qalc) which is unconsolidated silt, sand, and gravel of the Willamette River and major Cascade Range tributaries the vegetation distribution includes 80% forest, 17% savanna and 3% prairie. Forest land includes a mix of conifer (4%), hardwood (3%) and mixed (93%) forests, which determine the shade characteristics of the near-stream plant community.

A total of 52 river miles in the McKenzie Subbasin addressed in this TDML were analyzed and simulated during the critical period. The Mohawk River and McKenzie River were modeled using HeatSource on August 9th, 2001and September 3rd, 1999, respectively. The Mohawk River was modeled on the date of warmest stream temperatures recorded by in-stream monitors. The McKenzie River was modeled on the date that the TIR flight was conducted by the Willamette National Forest—McKenzie River Ranger District. The McKenzie River from river mile 54-81 was modeled using Heat Source, while the lower portion of the river was modeled using CEQUALW2 as part of the mainstem Willamette River modeling effort (see Chapter 4). The stream temperatures that result from system potential riparian conditions for the Mohawk River, Figure 11.2, and McKenzie River, Figure 11.3, are presented. These graphs represent the maximum daily stream temperatures observed longitudinally downstream. A decrease in the maximum observed daily maximum stream temperatures are observed for the Mohawk River when system potential riparian vegetation is applied. The stream temperatures that result from system potential riparian vegetation are the allocated condition.

**Figure 11.2 Mohawk River distribution of maximum daily stream temperatures at current conditions and system potential vegetation.**

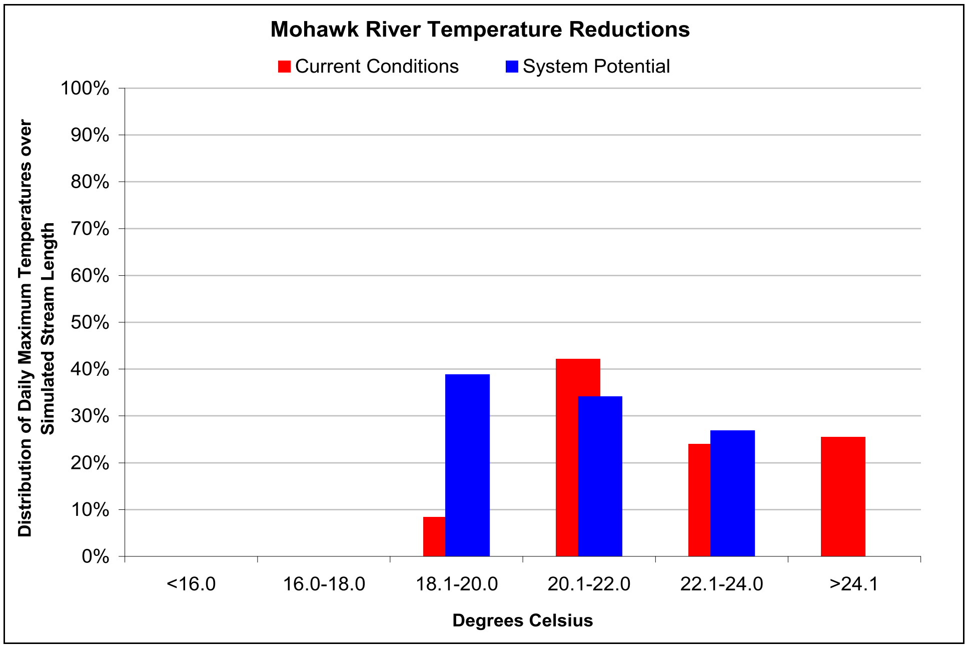
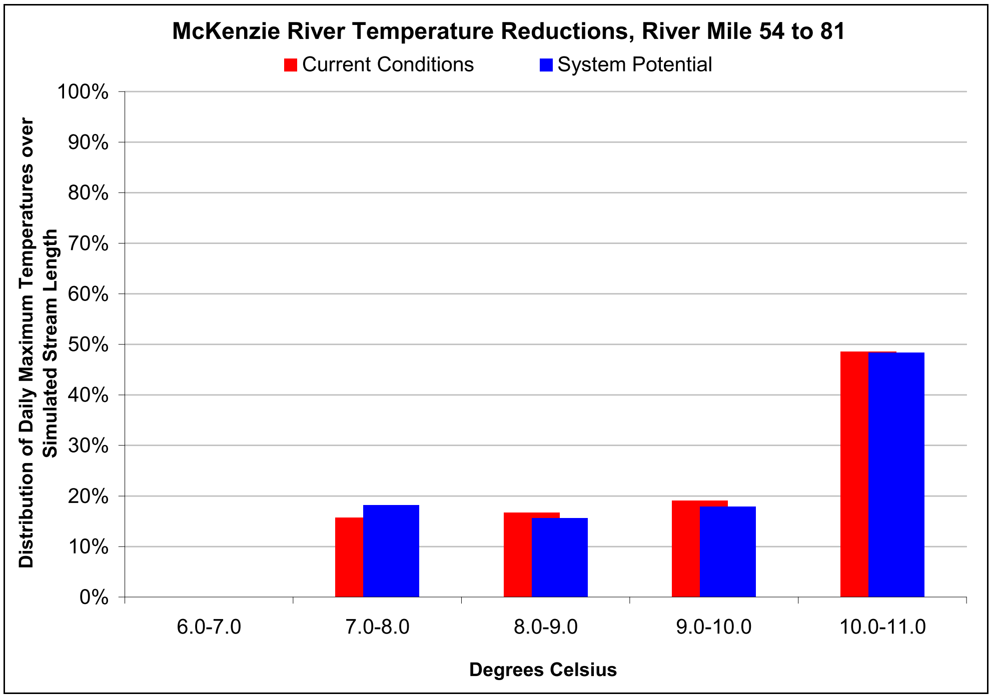

Mohawk River Temperature Reductions
Current Conditions
System Potential
Distribution of Daily Maximum Temperatures over Simulated Stream Length
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
<16.0
16.0-18.0
18.1-20.0
20.1-22.0
22.1-24.0
>24.1
Degrees Celsius

**Figure 11.3 McKenzie River distribution of maximum daily stream temperatures at current conditions and system potential vegetation, river mile 54 to 81.**




The percent effective shade calculated for current conditions versus system potential vegetation conditions for Mohawk River and McKenzie River (RM 54.4 to 81.3) averaged over a 1 km (0.6 miles) distance are shown in Figures 11.4 and 11.5. Typically system potential vegetation provides greater percent effective shade values to the river, however for both rivers under the currently simulated system potential vegetation conditions each river has a lower percent effective shade calculated value than at current conditions in specific reaches of the river. This decrease in effective shade under system potential conditions is due in part to the simulated natural disturbance scenario developed to characterize system potential vegetation as described in Appendix C. For example, the system potential condition at RM 24 in the Mohawk River may have accounted for a disturbance in the riparian community when in fact under current conditions RM 24 may not have a disturbed riparian community.

**Figure 11.4 Mohawk River Longitudinal Percent Effective Shade Profile of Current Conditions versus System Potential Vegetation, averaged over a 1 km distance.**

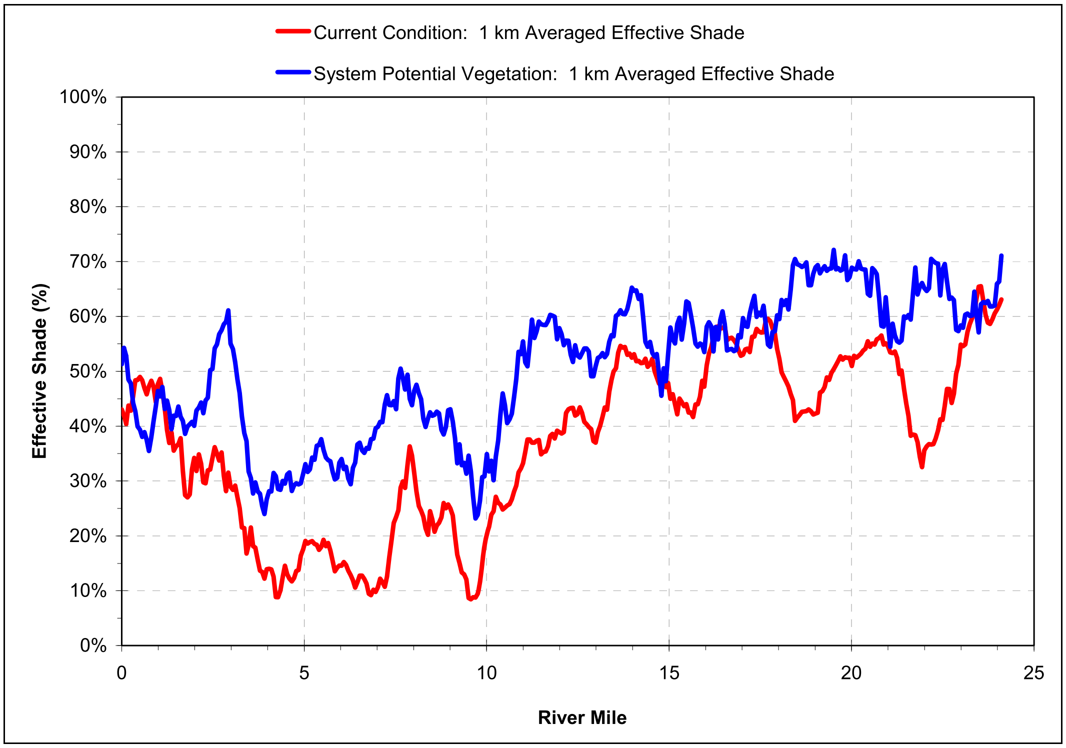
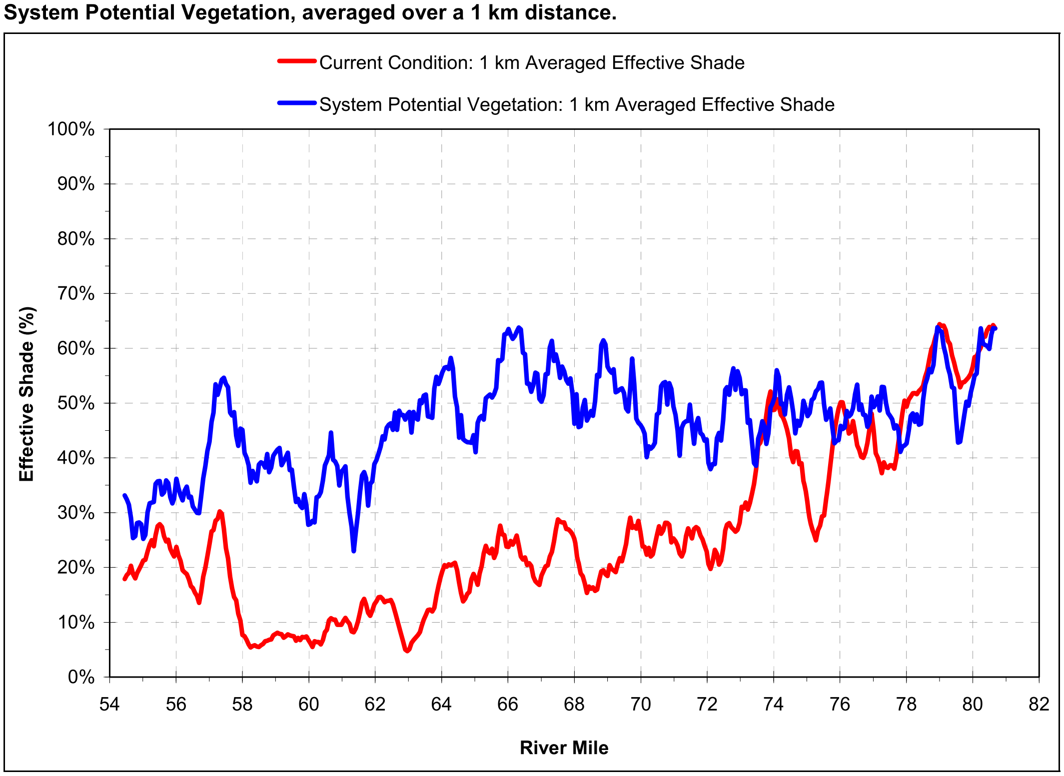



**Figure 11.5 McKenzie River, RM 54.4 to 81.3, Longitudinal Percent Effective Shade Profile of Current Conditions versus System Potential Vegetation, averaged over a 1 km distance.**



It is expected that effective shade values would increase if stream channel widths decreased and riparian vegetation increased. Decreasing channel widths would increase the effectiveness of the system potential vegetation to shade the stream and in effect decrease in-stream temperatures, and also decrease the width-to-depth ratio of the stream. On average simulated system potential conditions yield about a 10% increase in effective shade over current condition shade levels in the Mohawk River and McKenzie River (RM 54.4 to 81.3).

A summary of the solar radiation loads for Mohawk River and McKenzie River (RM 54.4 to 81.3) at current and system potential conditions is shown in Table 11.8. The difference between current and system potential conditions is the calculated anthropogenic load for nonpoint sources. This table does not represent all listed waterbodies in the subbasin but only those where resources and priority allow for load calculation. Modeling of Mohawk River with system potential riparian vegetation indicates that $6.10 \times 10^8$ kcal/day heat load is attributed to system potential condition and $1.59 \times 10^8$ kcal/day is due to anthropogenic sources. Modeling of the McKenzie River (RM 54.4 to 81.3) with system potential riparian vegetation indicates that $9.62 \times 10^8$ kcal/day heat load is attributed to system potential condition and $8.14 \times 10^8$ kcal/day is due to anthropogenic sources.

**Table 11. 8 Mohawk River and McKenzie River (RM 54.4 to 81.3) Solar Radiation Load Summary.**

| **Stream** | **Current Condition** ($10^8$ kcal/d) $H_{Total\ NPS}$ | **System Potential Condition** ($10^8$ kcal/d) $H_{SP\ NPS}$ | **Anthropogenic** $H_{Anthro\ NPS}$ ($10^8$ kcal/d) |
|---|---|---|---|
| Mohawk River | 7.69 | 6.10 | 1.59 |
| McKenzie River (RM 54.4 to 81.3) | 17.76 | 9.62 | 8.14 |
| **Totals** | 25.45 | 15.72 | 9.73 |

The point of maximum impact for anthropogenic sources of heat is defined as the point in the stream where the maximum change in temperature between natural thermal potential temperature and current temperatures are observed.

In the Mohawk River and the McKenzie River (RM 54.4 to 81.3) this is where the differences between system potential vegetation and current vegetation conditions most affect stream temperatures. In the Mohawk River, the point of maximum impact occurs at river mile 18.5, downstream of Shotgun Creek. The change between current condition stream temperatures and system potential vegetation temperatures at the point of maximum impact is 3.1°C (5.6°F). At the mouth of the Mohawk River, the maximum current condition temperature is 24.7°C (76.5°F), and system potential vegetation simulations suggest this temperature would decrease to 22.8°C (73.0°F). The point of maximum impact for McKenzie River (RM 54.4 to 81.3) occurs at river mile 62.5, downstream of the confluence with the South Fork McKenzie River. The change between current condition and system potential vegetation stream temperatures is 0.4°C (0.7°F). At the mouth of the river the current condition temperature is 10.9°C (51.6°F), simulations state that this temperature would decrease under system potential vegetation to 10.5°C (50.9°F).

In addition to system potential vegetation other methods may decrease stream temperatures and increase effective shade, such as:

- Restoring stream channel morphology
- Increasing stream channel complexity
- Restoring floodplain processes
- Restoring natural stream flow
- Decreasing tributary stream temperatures

# Excess Load

## OAR 340-042-0040(4)(e)

The excess load is the difference between the actual pollutant load and the loading capacity of a water body. Load allocations for nonpoint sources are based on system potential vegetation. Riparian information provided by the ODEQ, USFS, and BLM indicates that there is inadequate shade throughout the McKenzie Subbasin. ODEQ data also suggest shade levels are less than system potential in the Mohawk River and the McKenzie River. Excess heat loading occurs wherever inadequate shade levels are widespread.

# Surrogate Measures

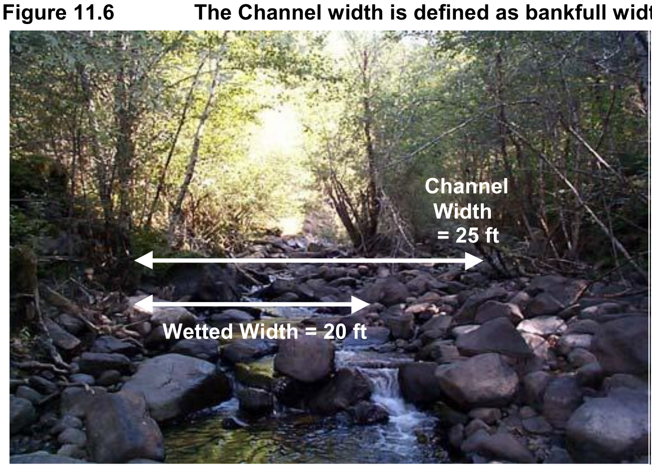
## OAR 340-042-0040(5)(b) ,40 CFR 130.2(i)

The McKenzie Subbasin Temperature TMDL incorporates measures other than "daily loads" in allocating heat to nonpoint sources. These measures are termed surrogate measures. The applied surrogate measure in this temperature TMDL is percent effective shade expressed as a shade curve. Shade curves have been developed for each geomorphic unit in the Willamette Valley and upland forest area of the Cascade and Coast Ranges in the Willamette Basin. Shade curves determine the nonpoint source load allocation. They were developed using trigonometric equations estimating the shade underneath tree canopies.

Percent effective shade is perhaps the most straightforward stream parameter to monitor and calculate. It is easily translated into quantifiable water quality management and recovery objectives. Percent effective shade is defined as the percentage of direct beam solar radiation attenuated and scattered before reaching the ground or stream surface, commonly measured with a Solar Pathfinder.

Shade curves represent general relationships between the percent effective shade reaching the stream surface, solar radiation loading of the stream, system potential vegetation, stream aspect from north, and the width of the channel. The channel width, Figure 11.6, is the distance from the edge of right bank vegetation to the edge of left bank vegetation.

**Figure 11.6 The Channel width is defined as bankfull width.**




System potential vegetation has been developed for each geomorphic unit in the Willamette Basin. It is defined as the riparian vegetation which can grow and reproduce on a site given the plant biology, site elevation, soil characteristics, and local climate. However, it does not include considerations for resource management, human use, and other human disturbances. A natural disturbance regime has been incorporated into the riparian composition for each geomorphic region that includes provisions for fire, disease, wind-throw, and other natural occurrences. Each shade curve translates the amount of percent effective shade that each geomorphic unit tree composition provides to the stream based on the streams channel width (bankfull width) and stream aspect from north. Each geomorphic unit is composed of a percentage of forest, savannah, and prairie and reflects the tree species composition that will grow and reproduce in each geomorphic unit. For a detailed description of the system potential vegetation development and of the riparian tree species composition for each geomorphic unit, see Appendix C. A shade curve has been developed for each geomorphic and upland forest unit in the McKenzie Subbasin, Map 11.8 to 11.10 and Figure 11.7. Watershed geomorphic maps that represent more than one geomorphic unit are shown for the Mohawk River Watershed and Lower McKenzie River Watershed. The other four watersheds in the subbasin are to apply the upland forest geomorphic class to all areas in the watershed: Blue River Watershed, Upper McKenzie River Watershed, Horse Creek Watershed, and South Fork McKenzie River Watershed.

The relative areas of the geomorphic classifications of the McKenzie Subbasin are presented in Table 11.9. Despite the relatively fine scale of the geomorphic classifications, the differences among the various shade curves are subtle in some cases.

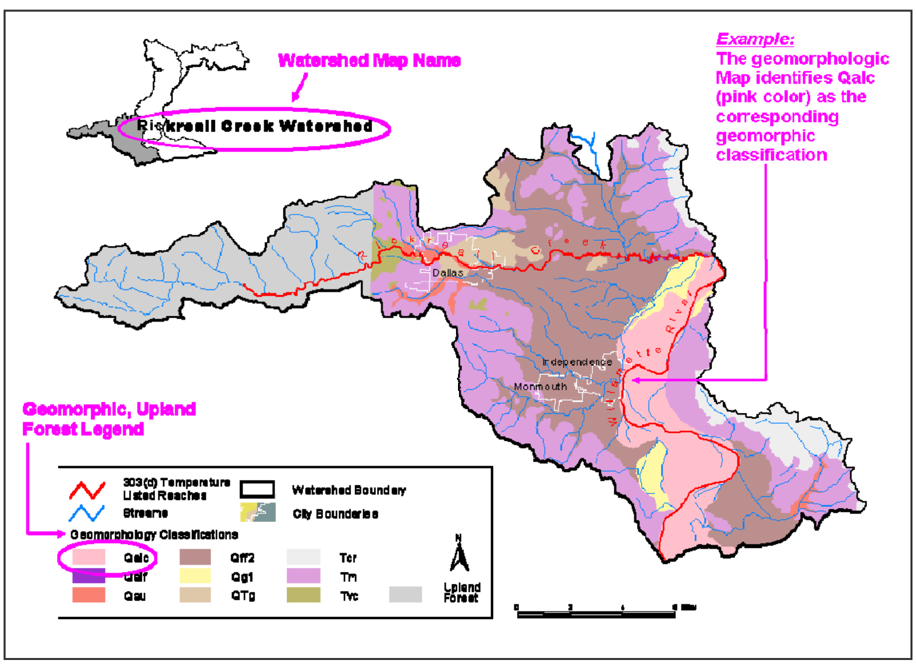
**Table 11. 9 Area of Geomorphic Units in the McKenzie Subbasin. Values are ranked in order of increasing area size.**

| Geomorphic Class | Acres | Square Miles | Relative Area (%) |
|---|---|---|---|
| Quaternary Landslide deposits (Qls) | 214 | 0.3 | 0.0 |
| Quaternary terrace gravels (QTg) | 853 | 1.3 | 0.1 |
| Pre-Flood Quaternary sand/gravel (Qg2) | 1,348 | 2.1 | 0.2 |
| Post Flood Quaternary sand/gravel (Qg1) | 4,199 | 6.6 | 0.5 |
| Undifferentiated Quaternary Alluvium (Qau) | 5,340 | 8.3 | 0.6 |
| Quaternary alluvium floodplain deposits (Qalc) | 10,910 | 17.0 | 1.3 |
| Western Cascades tertiary volcanics (Tvw) | 84,437 | 131.9 | 9.9 |
| Upland Forests (Uf) | 749,169 | 1,170.6 | 87.5 |
| **Grand Total** | **856,470** | **1,338.2** | **100** |

## How to Use a Shade Curve:

1. Determine the applicable geomorphic or upland forest unit that applies to the stream reach you are applying a Shade Curve to.

*Example*: You are located in the Rickreall Creek watershed, in the city of Independence along the west bank of the Willamette River. By using the appropriate map, below, you identify the geomorphic unit on your property to be Qalc (Quaternary alluvium floodplain deposits).



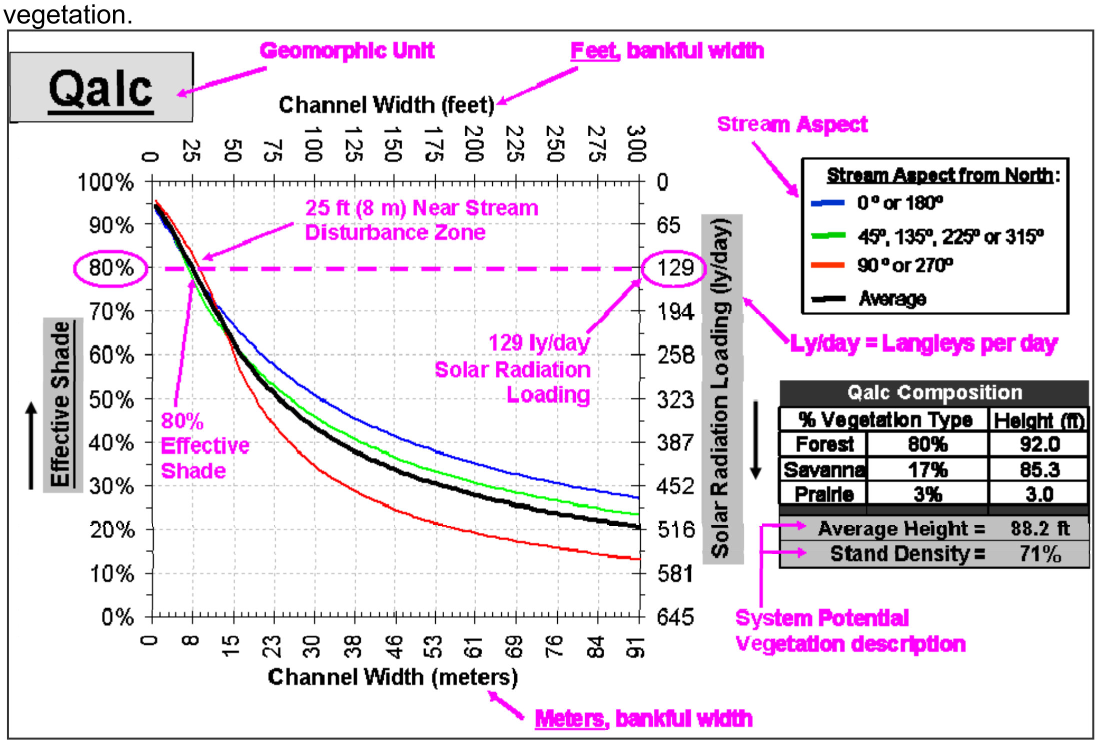
2. Determine the stream aspect from north.

*Example*: Based on your location on a tributary to the west bank of the Willamette River in Independence, standing in-stream mid-channel, facing north you determine the river's aspect as 0º or 180º from north (this means the river reach runs south to north).

3. Determine the channel width of the stream reach.

*Example*: At your location you measure the channel width using a tape measure or lasar range finder, you determine the stream width is 25 feet.

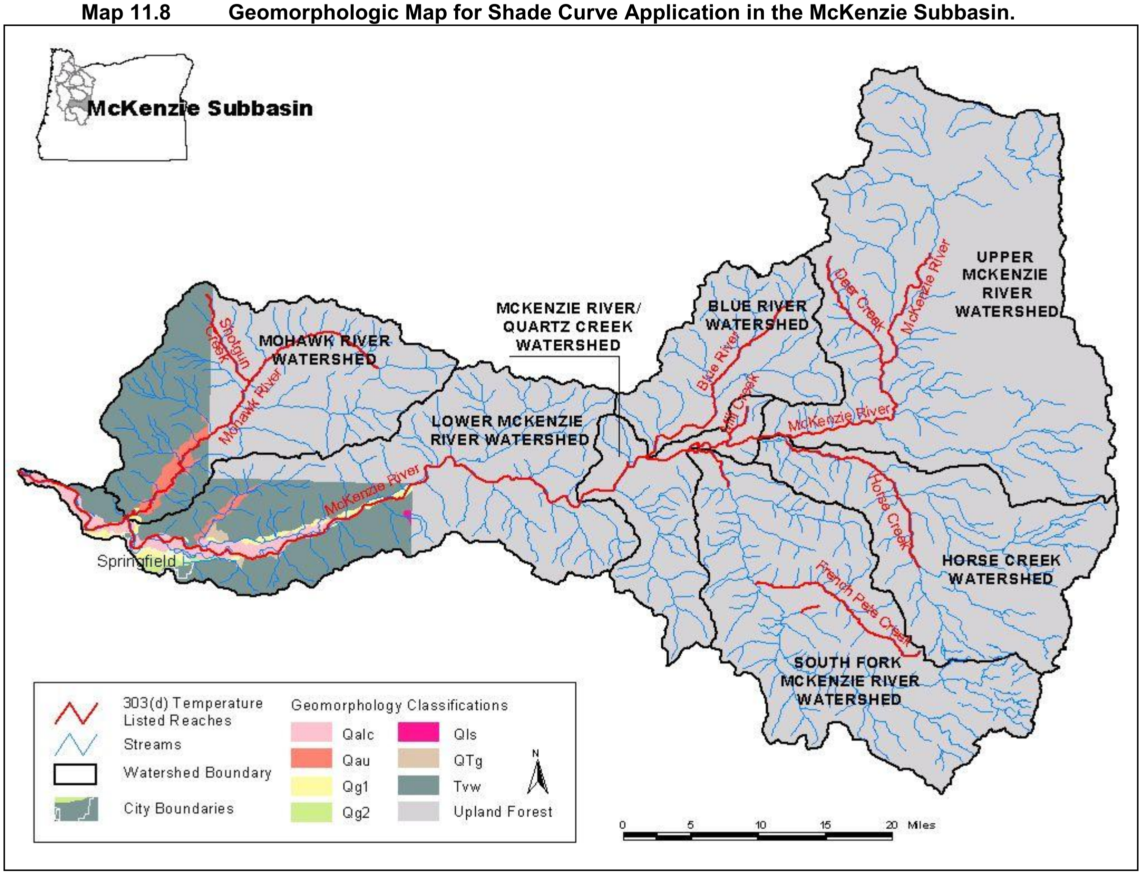
4. Using the appropriate geomorphic or upland forest Shade Curve, using the appropriate stream aspect line and channel width (x-axis), read the y-axis to determine the percent effective shade and solar radiation loading. This is the loading capacity of the stream reach at system potential vegetation.



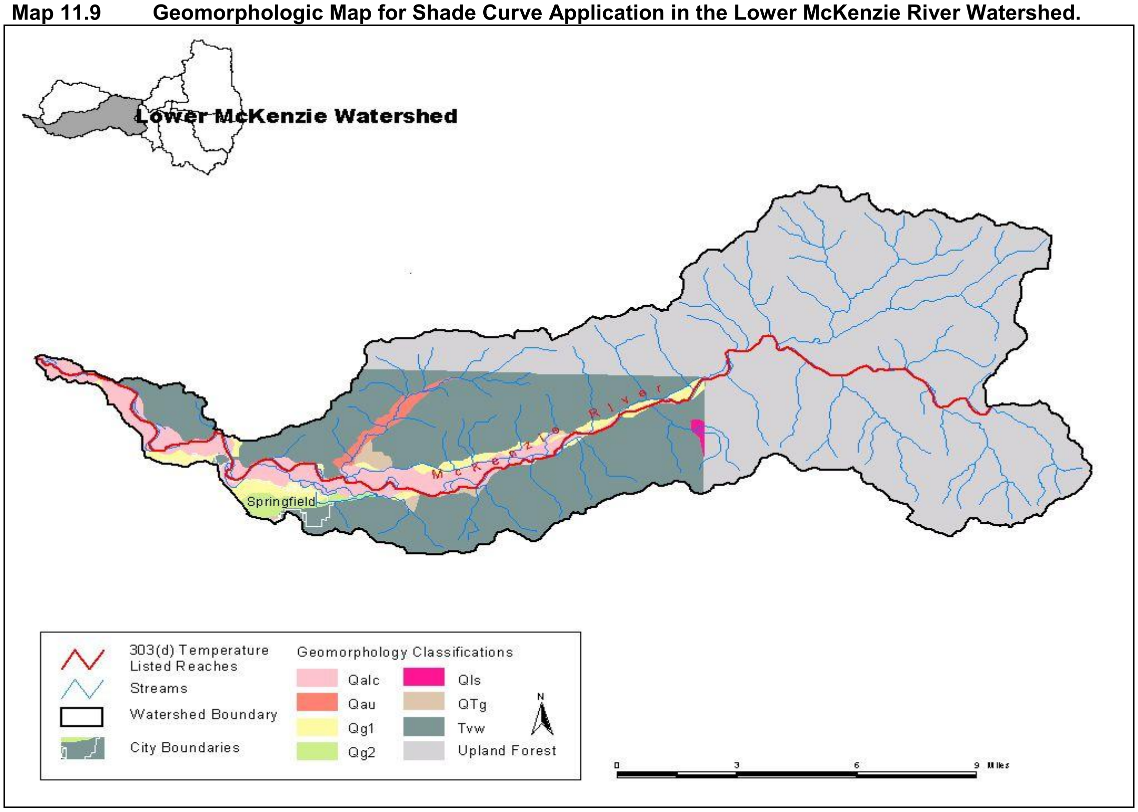

*Example*: A tributary to the Willamette River on the west bank near Independence with a stream aspect from north of 0º or 180º (blue line) and a channel width of 25 feet: using the blue line to determine the loading capacity from the x-axis identify the 25 feet (8 m) mark and read the y-axis, the solar radiation loading would be 129 Langleys/day with 80% effective shade when system potential vegetation is applied to the left and right bank of the stream reach. System potential vegetation identifies the riparian average height, 88.2 feet (26.9 m), and stand density (tree canopy density), 71 %, that would be established in the riparian area. If it is difficult to determine the streams aspect from north, the average stream aspect from north, black line, can be used to determine the solar radiation loading and effective shade.

*Conclusion*: A land owner or manager living on the west side of the Willamette River near the city of Independence, measures the channel width of the tributary stream as 25 feet (8 m), with a stream aspect from north of 0º or 180º. By using the geomorphic map for shade curve development that is specific to the areas watershed, provided by ODEQ, in this case Rickreall Creek Watershed geomorphic map. The land owner identifies their location and the corresponding geomorphic unit as Qalc in this example. The land owner then uses the Qalc shade curve to identify what the effective shade and solar radiation loading reaching the stream would be when the land owner establishes a riparian area corresponding to the system potential vegetation description. This is considered the nonpoint source load allocation.

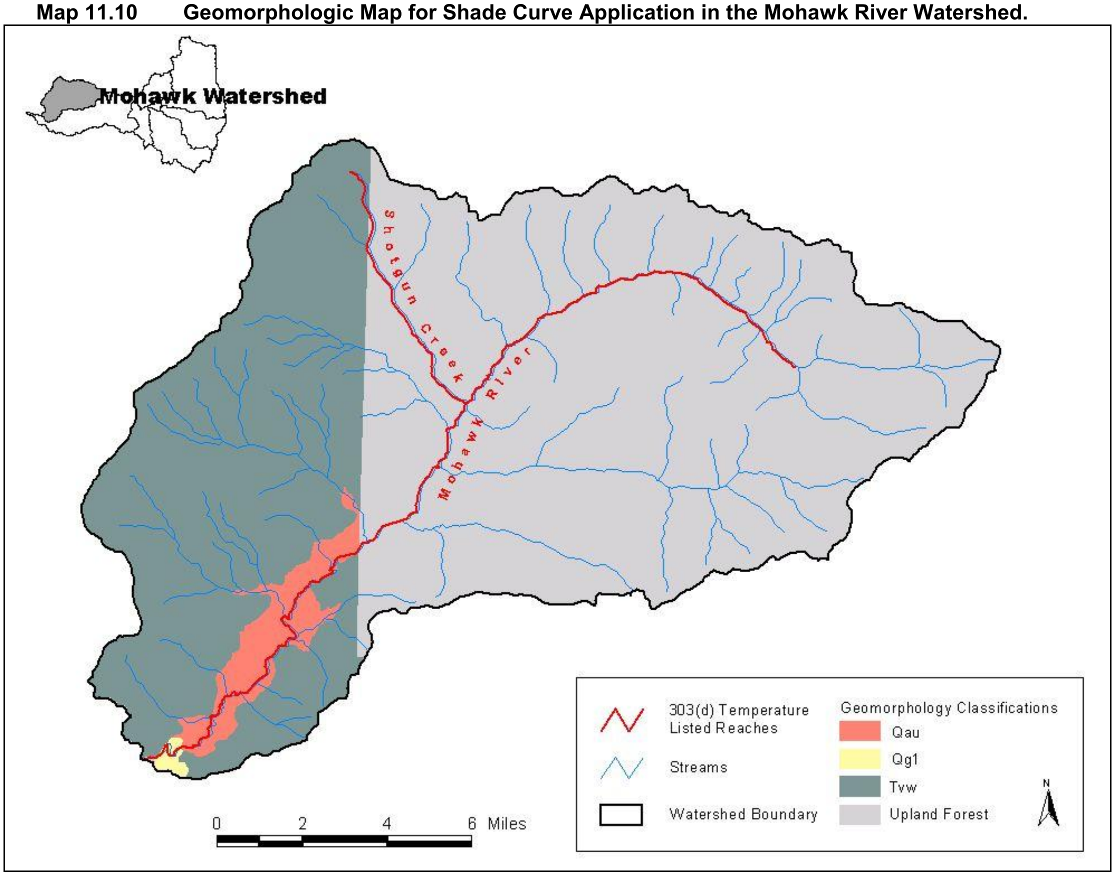
**Map 11.8 Geomorphologic Map for Shade Curve Application in the McKenzie Subbasin.**




**Map 11.9 Geomorphologic Map for Shade Curve Application in the Lower McKenzie River Watershed.**



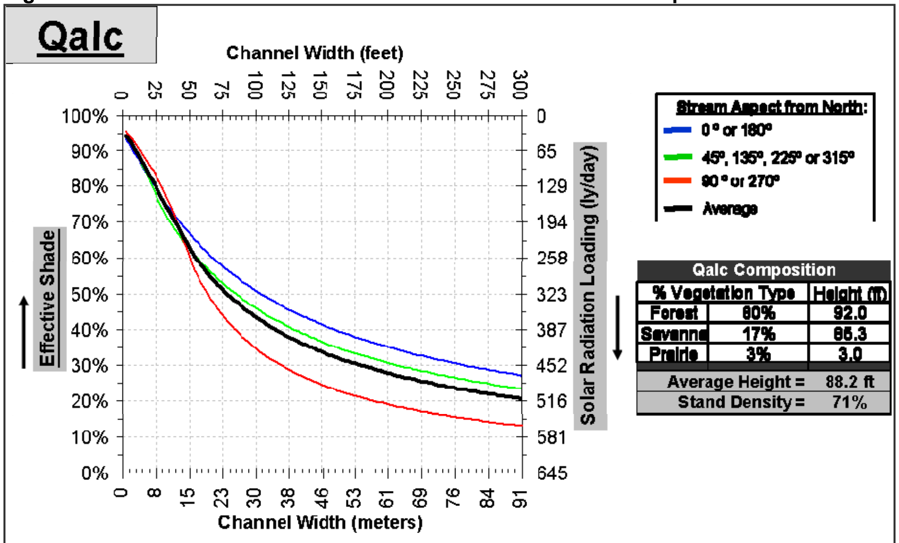
**Map 11.10 Geomorphologic Map for Shade Curve Application in the Mohawk River Watershed.**



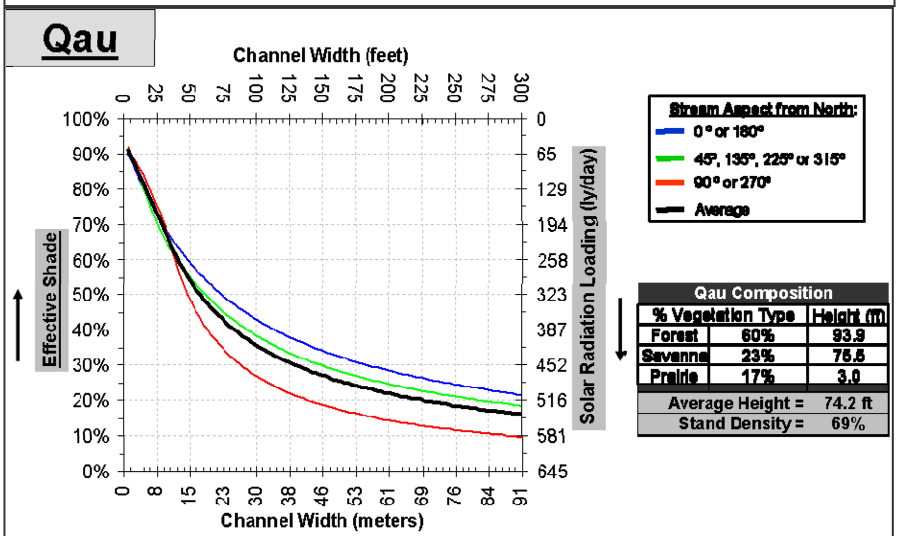

The shade curve method provides no information on existing shade conditions or the expected system potential stream temperature. It does provide quick and accurate estimates of the allocations necessary to eliminate temperature increases resulting from anthropogenic impacts on stream shading. The shade curves presented in Figure 11.7 apply to all water bodies in the McKenzie Subbasin based on the geomorphic and upland forest unit of the reach. The shade curves represented in each figure have been calculated based on the average height for each unit as defined by system potential vegetation. Interpretation and implementation of the shade curves requires the identification of the geomorphic or upland forest unit that applies to the stream reach (Map 11.8 to 11.10), measuring the streams channel width (bankfull width), and then depending on the streams aspect from north reading the shade curves graph to determine the percent effective shade and solar radiation loading that the system potential vegetation composition will provide. For a list of geomorphic class abbreviations for each shade curve please see Table 11.9 titled “Area of Geomorphic Units in the McKenzie Subbasin”, above.

Geomorphic unit code Pre Flood Quaternary Sand/Gravel (Qg2) is represented in the McKenzie Subbasin. The shade curve for Qg2 has not been developed. Historically the geomorphic unit code Qg2 had 90% prairie vegetation along streams that historically became subsurface in the summer and for which water is currently artificially diverted to maintain summer flows, historic vegetation is probably not a good guideline for modeling potential present day stream temperature. Instead, ODEQ will use the nearest adjacent geomorphic code as determined by the geomorphologic maps, Map 11.8 to 11.10.

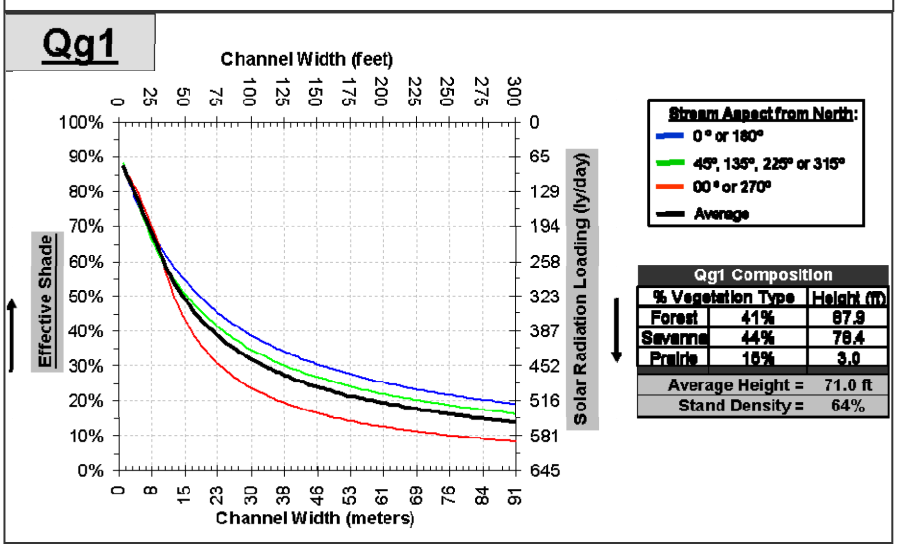
**Figure 11.7 Shade Curves for McKenzie Subbasin Geomorphic Classifications.**




| Qalc Composition | | |
|---|---|---|
| % Vegetation Type | | Height (ft) |
| Forest | 80% | 92.0 |
| Savanna | 17% | 85.3 |
| Prairie | 3% | 3.0 |
| Average Height = | | 88.2 ft |
| Stand Density = | | 71% |

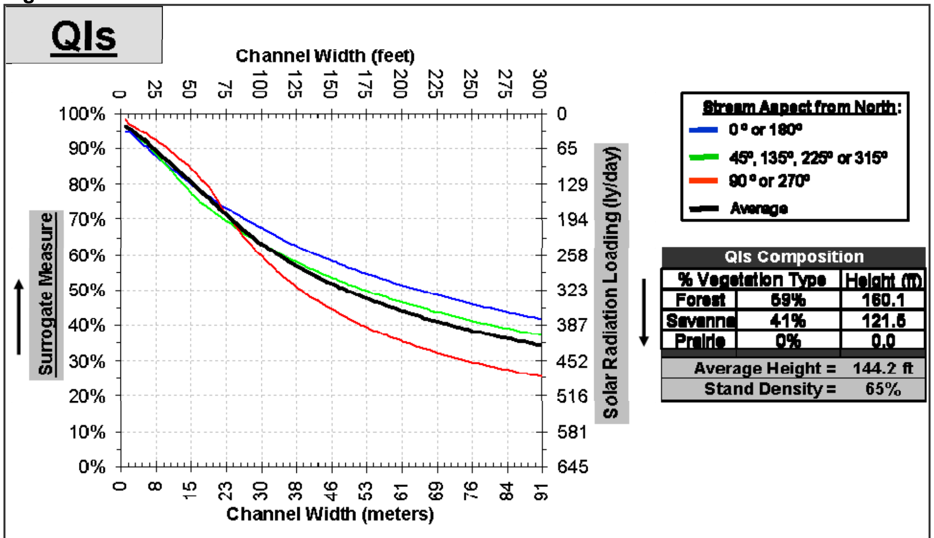



| Qau Composition | | |
|---|---|---|
| % Vegetation Type | | Height (ft) |
| Forest | 60% | 93.9 |
| Savanna | 23% | 75.5 |
| Prairie | 17% | 3.0 |
| Average Height = | | 74.2 ft |
| Stand Density = | | 69% |

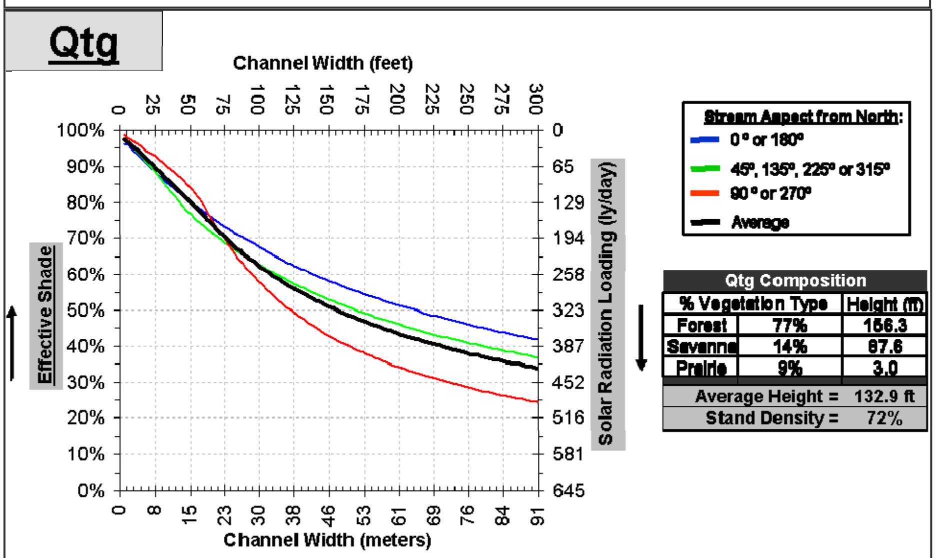



| Qg1 Composition | | |
|---|---|---|
| % Vegetation Type | | Height (ft) |
| Forest | 41% | 87.9 |
| Savanna | 44% | 78.4 |
| Prairie | 15% | 3.0 |
| Average Height = | | 71.0 ft |
| Stand Density = | | 64% |

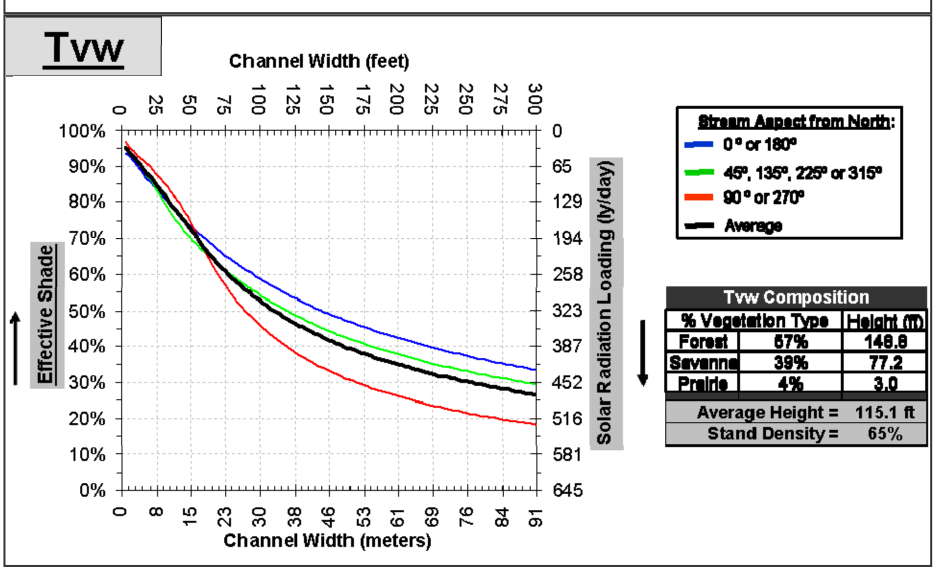
**Figure 11.7 cont'd**




| Qls Composition | | |
|---|---|---|
| % Vegetation Type | | Height (ft) |
| Forest | 59% | 160.1 |
| Savanna | 41% | 121.6 |
| Prairie | 0% | 0.0 |
| Average Height = | | 144.2 ft |
| Stand Density = | | 65% |

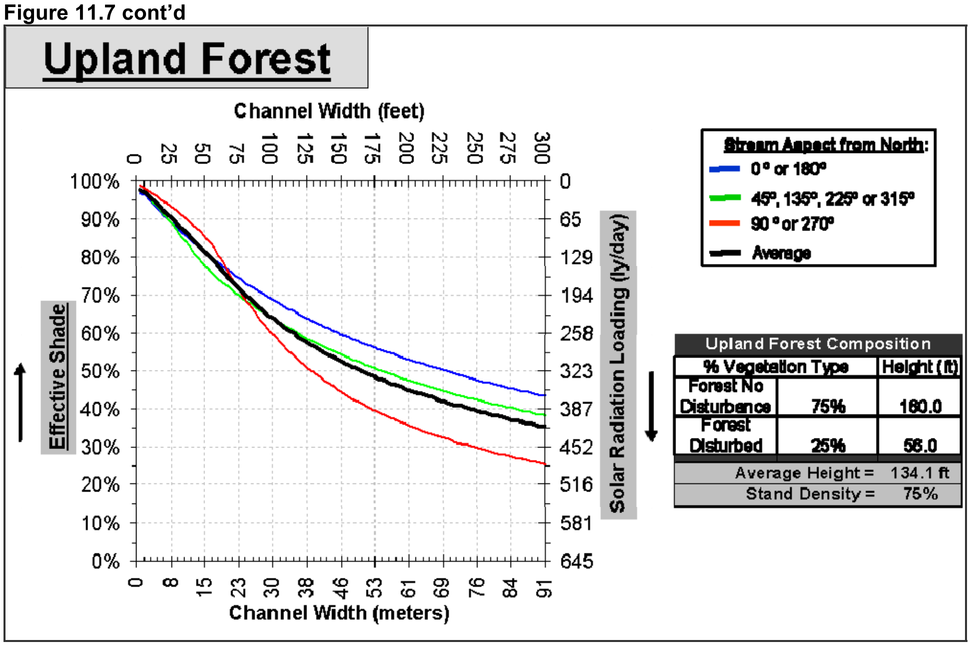



| Qtg Composition | | |
|---|---|---|
| % Vegetation Type | | Height (ft) |
| Forest | 77% | 156.3 |
| Savanna | 14% | 87.6 |
| Prairie | 9% | 3.0 |
| Average Height = | | 132.9 ft |
| Stand Density = | | 72% |




| Tvw Composition | | |
|---|---|---|
| % Vegetation Type | | Height (ft) |
| Forest | 57% | 148.6 |
| Savanna | 39% | 77.2 |
| Prairie | 4% | 3.0 |
| Average Height = | | 115.1 ft |
| Stand Density = | | 65% |

**Figure 11.7 cont'd**




## Margin of Safety

### OAR 340-042-0040(4)(i), CWA 303(d)(1)

A margin of safety is intended to account for uncertainty in available data or in the effect controls will have on loading reductions and water quality. A margin of safety is expressed as unallocated assimilative capacity or conservative analytical assumptions used in establishing the TMDL (e.g., derivation of numeric targets, modeling assumptions or effectiveness of proposed management actions).

The margin of safety may be implicit, as in conservative assumptions used in calculating the Loading Capacity, Wasteload Allocations, and Load Allocations. It may also be explicitly stated as an added, separate quantity in the TMDL calculation. In any case, assumptions should be stated and the basis behind the margin of safety documented. The margin of safety is not meant to compensate for a failure to consider known sources. Table 11.10 presents six approaches for incorporating a margin of safety into TMDLs.

The following factors may be considered in evaluating and deriving an appropriate MOS:

- ✓ *The analysis and techniques used in evaluating the components of the TMDL process and deriving an allocation scheme.*
- ✓ *Characterization and estimates of source loading (e.g., confidence regarding data limitation, analysis limitation or assumptions).*
- ✓ *Analysis of relationships between the source loading and instream impact.*
- ✓ *Prediction of response of receiving waters under various allocation scenarios (e.g., the predictive capability of the analysis, simplifications in the selected techniques).*
- ✓ *The implications of the MOS on the overall load reductions identified in terms of reduction feasibility and implementation time frames.*

A TMDL and associated margin of safety, which results in an overall allocation, represent the best estimate of how standards can be achieved. The selection of the margin of safety should clarify the implications for monitoring and implementation planning in refining the estimate if necessary (adaptive management). The

TMDL process accommodates the ability to track and ultimately refine assumptions within the TMDL implementation-planning component.

**Table 11. 10 Approaches for Incorporating a Margin of Safety into a TMDL**

| *Type of Margin of Safety* | *Available Approaches* |
|---|---|
| ***Explicit*** | 1. Set numeric targets at more conservative levels than analytical results indicate.<br>2. Add a safety factor to pollutant loading estimates.<br>3. Do not allocate a portion of available loading capacity; reserve for margin of safety. |
| ***Implicit*** | 1. Conservative assumptions in derivation of numeric targets.<br>2. Conservative assumptions when developing numeric model applications.<br>3. Conservative assumptions when analyzing prospective feasibility of practices and restoration activities. |

A margin of safety has been incorporated into the temperature assessment methodology. Wasteload allocations are based on critical conditions that are unlikely to occur simultaneously. For example, it is unlikely that maximum effluent flows and maximum effluent temperatures are likely to occur simultaneously however those values were used to calculate point source heat loads. Furthermore, receiving stream values were also based on attainment of biological based criteria during low flow periods defined as the low flow of a ten year cycle.

Calculating a numeric margin of safety for nonpoint source loads is not easily performed with the methodology presented in this document. In fact, the basis for the loading capacities and load allocations is system potential conditions and it is not the purpose of this plan to promote riparian conditions and shade levels that exceed natural conditions.

# Reserve Capacity

## OAR 340-042-0040(4)(k)

Reserve capacity has been allocated for temperature through much of the Willamette Basin. Explicit allocations have generally only been made in conjunction with point source wasteload allocations. Where there are multiple point sources in a waterbody, point sources in combination have been allocated 0.2˚C of the Human Use Allowance. Another 0.05˚C is allocated to nonpoint sources of heat. These latter sources have generally been limited to natural solar radiation levels determined by shade curves for a given area. The final 0.05˚C is allocated to reserve capacity, and will be available for use by point sources or nonpoint sources by application to ODEQ. In total, these allocations may not increase temperature in a water quality limited waterbody by more than 0.3°C (0.54°F) at the point of maximum impact.

In those situations where the point source allocation is less than 0.2˚C or if there are no point sources, the remaining portion of the Human Use Allowance will be set aside as reserve capacity. The nonpoint source allocation will remain at 0.05˚C unless special circumstances exist that require a larger or smaller allocation. More information regarding the use of reserve capacity may be found in Chapter 14, Water Quality Management Plan, Part 2, under Temperature Implementation.

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