Temperature Water Quality Standard Implementation –

A DEQ Internal Management Directive

DEQ
State of Oregon
Department of Environmental Quality

Note to Readers: This document and the information contained within are meant to guide DEQ in its internal procedures for applying the existing water quality standards rules for temperature (OAR 340-041). As such, this Internal Management Directive does not create additional rights or obligations on the part of DEQ, regulated entities or the public.

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Table of Contents

Figures

Tables

Chapter 1 Introduction and Background

Section 1.1 Purpose and Content of this Document

Purpose	The purpose of this document is to provide guidance and a reference for DEQ staff on the meaning, application and implementation of Oregon's temperature standard through the Department's various water quality programs.
Audience	The primary audience of this document is DEQ staff who will apply and implement the temperature standard. However, the information provided should also prove helpful to regulated parties and the public.
Content of this document	This document describes and clarifies the temperature standard rules and their applicability. It also describes procedures and methods for applying the standard in individual NPDES permits, TMDLs and 401 certifications for hydroelectric projects.
Format of this document	The information in this document is organized into chapters, sections (in some chapters) and "maps" or subsections on a particular topic. The document will likely be referred to by staff who have a specific question or task to complete. This format has been used to facilitate finding pertinent information.

Section 1.2 History of the Temperature Standard

History

The first water temperature criteria for Oregon were adopted in 1967 for the Willamette River. In the mid-1970's, the Environmental Quality Commission (Commission, EQC) adopted statewide criteria by basin. Then in 1996, after a 3 year review, the Commission adopted significant revisions to the temperature standard. The Environmental Protection Agency (EPA) reviewed the revisions and consulted with the US Fish and Wildlife Service (USFWS) and the National Marine Fisheries Service (NMFS) for compliance with the Endangered Species Act (ESA). With one exception, EPA approved the revised criteria with conditions in July 1999. EPA rejected the temperature criteria (68 degrees Fahrenheit) for the Lower Willamette River, concluding that it was not protective of salmonids.

As a result of the ESA consultation, the State volunteered to complete several Conservation Measures to better identify where various fish uses occur, participate in an EPA Region 10 project to develop guidance on temperature criteria, and then review Oregon's temperature standards. EPA's Guidance document was finalized in the spring of 2003.

In the spring of 2001, Northwest Environmental Advocates sued EPA and NOAA fisheries on their approval of the revised temperature standard. In spring of 2003, the court ordered EPA to promulgate temperature standards for Oregon, or approve new State standards; primarily because the judge found that the standards were unclear as to where and when they applied.

Adoption of current temperature standards

In December 2003, the EQC adopted revised temperature criteria and detailed beneficial use designations related to fish life stages and species. In March of 2004, EPA approved most, but not all, of the revised criteria and use designations following ESA consultation with USFWS and NMFS.

The temperature criteria that EPA has not yet approved include:

- the narrative criteria for natural lakes, oceans and bays, cool water species and Borax Lake chub,
- several provisions they consider implementation language, and
- the cool water species designations.

This is discussed further in the next chapter on applicability.

Section 1.3 Background on Water Quality Standards

Purpose of a water quality standard

The purpose of water quality standards is to protect beneficial uses of the water and to define the water quality goals for a water body. Standards also serve as the regulatory basis for establishing treatment controls and strategies beyond the required technology-based level of treatment. (40 CFR 130.3)

According to federal regulations:

> States and EPA adopt water quality standards to protect the public health or welfare, enhance the quality of water and serve the purposes of the Clean Water Act (CWA). Serve the purposes of the Act…means that water quality standards should, wherever attainable, provide water quality for the protection and propagation of fish, shellfish and wildlife and for recreation in and on the water and take into consideration their use and value for public water supplies, propagation of fish, shellfish and wildlife, recreation in and on the water and agricultural, industrial and other purposes including navigation. (40 CFR 130.3)

Definition of a water quality standard

A water quality standard, according to federal Clean Water Act regulations, consists of a designated use for a water of the United States and water quality criteria necessary to protect the uses [40 CFR 131.3 (i) and 130.3].

Designated uses

Designated uses are the beneficial uses, such as those listed above, that have been designated for each water body or segment. Designated uses must include existing uses, uses actually attained in the water body at any time since November 28, 1975. However, designated uses may also include uses that are not being attained and, thereby, represent a goal for the water body (40 CFR 131.3). Uses are designated through a public rulemaking process and adoption by the Environmental Quality Commission (EQC).

Because aquatic life uses are most sensitive to temperature, this document focuses on these uses. Oregon has defined several subcategories of fish and aquatic life use depending on the fish species and life stage present and their water quality needs.

Chapter 2 describes how to determine the designated uses for a water body or segment in Oregon.

Criteria

Criteria are constituent concentrations or levels or narrative statements representing the quality of water that supports a particular use. When criteria are met, water quality will generally protect the designated uses. [40 CFR 131.3(b)].

Chapter 3 describes the multiple numeric and narrative criteria that make up Oregon temperature standards.

Anti-degradation policy

The antidegradation policy is another component of water quality standards that applies to all water bodies, regardless of the applicable use or criteria. This policy serves to prevent degradation of waters that are meeting standards by evaluating proposed increases in pollutant loads to determine whether the benefit of the additional pollution outweighs the cost of water quality degradation.

DEQ has a separate Internal Management Directive on the implementation of our Antidegradation Policy.

Section 1.4 Policy Objectives of the New Temperature Standard

Protect beneficial uses

The first and foremost objective of a water quality standard, as required by the Clean Water Act, is to protect the beneficial uses of the waters of the State. In the case of temperature, the most sensitive beneficial use is Oregon's native cold-water aquatic communities. Cold water fish, such as salmon and trout, indicate the presence of these communities. Several temperature criteria have been established to protect various life stages and fish species, depending on their thermal requirements.

Recognize natural variability of stream temperature

Because temperature is variable through time and space in the natural environment, DEQ and the EQC recognize that thermal conditions may not be optimal for cold water fish at all times or in all places. The policy objective in these circumstances is to minimize risk to cold-water aquatic ecosystems from anthropogenic warming. The standard is designed to minimize alteration of the natural thermal regime due to anthropogenic activity. [OAR 340-041-0028(2)]

Chapter 2 Temperature Standard Applicability

Section 2.1 Overview

What this chapter covers

This chapter describes how to determine what criteria are applicable to a given body or segment and when they apply based on the uses designated for the water body/segment.

The criteria are described in Chapter 3.

When a standard is effective for Clean Water Act purposes

After May 30, 2000, a water quality standard newly adopted or revised by a state is not effective for Clean Water Act purposes until it has been approved by EPA. If the newly adopted standard is more protective than the current standard, the state may implement the new standard in NPDES permits prior to EPA approval as a requirement of state law.

EPA approved most of DEQ's new temperature criteria and beneficial use designations in March, 2004. However, the criteria for natural lakes, oceans and bays, cool water species and Borax Lake chub have not yet been approved. The descriptions of these criteria in Chapter 3 include a discussion of effectiveness and whether or not DEQ should implement the criteria prior to EPA approval.

Every water body has a temperature criterion

Every water body in the State has at least one applicable temperature criterion. Many water bodies are subject to multiple criteria, which could include both numeric criteria and narrative criteria. Also, many water bodies will have seasonal criteria that apply during specified times of the year based on a seasonal use, such as spawning.

Section 2.2 Where do the Temperature Criteria Apply?

Overview

This section discusses where the different temperature criteria apply. To determine which temperature criteria apply to a water body or segment, one must know the water body type (i.e. ocean or bay, natural lake, or flowing freshwater) and the designated beneficial use(s) for the water body.
In some cases, beneficial uses are seasonal and the associated criteria apply only during a specified time period. The next section of this chapter discusses how to determine when temperature criteria apply.

Water body type

Water body types include natural lakes, oceans, bays, flowing freshwaters (which includes rivers, streams and in-channel reservoirs) and wetlands.

For the purpose of applying the temperature criteria, any lake that is not a reservoir is considered a natural lake and subject to the narrative criterion for natural lakes. This includes lakes that have been modified or enlarged and are now managed, as long as they were originally a natural lake. Reservoirs are formed by the damming or diversion of rivers. In-channel reservoirs impound part of the flowing water system and, if there is fish passage, migrating fish must pass through the reservoir to complete their journey between spawning grounds and the ocean.

Ocean waters are all oceanic, offshore waters outside of estuaries or bays and within the territorial limits of Oregon [340-041-0002 (41)]. Bays are inlets of the ocean and may contain marine or estuarine water depending on their size and the volume of freshwater entering the bay. Bays are a physical feature, which do not extend upstream of the mouth of a river or stream, even if a portion of the lower river is estuarine. In some bays, it is not obvious where the bay ends and the river begins; the Department will make a have to make a determination on a case by case basis.

Oregon has no unique temperature criteria for wetlands at this time.

Designated beneficial uses for flowing freshwaters

Beneficial uses are designated for each water body in the water quality standards rules (OAR 340-041-0101 to 340-041-0340). These rules along with maps and tables of the beneficial uses may be found on the DEQ website http://www.deq.state.or.us/wq/standards/standards.htm (see page on beneficial uses).

'Fish and aquatic life' is a designated use for all surface water body types. One or more of the following subcategories of fish and aquatic life have been designated for all flowing freshwaters in Oregon:

- Salmon and steelhead spawning,
- Core cold water habitat,
- Salmon and trout rearing and migration,
- Migration corridor,
- Lahontan cutthroat and redband trout,
- Bull trout spawning and juvenile rearing,
- Cool water species, and
- Borax Lake chub.

Reservoirs are part of flowing freshwater systems and the above criteria apply to reservoirs as shown on the use designation maps and tables found on the DEQ website referenced above. Generally, however, reservoirs are not salmon and steelhead spawning habitat. A "stratified waters" rule was adopted by the EQC in 2004, but has not yet been approved by EPA. This rule provides guidance for applying DO, pH and temperature criteria in reservoirs and lakes that stratify. A brief description of the stratified waters rule is provided in Chapter 3 in the section on "Exceptions to Numeric Criteria."

Determining the designated use(s) for a water body

To determine the designated uses for a water body:
1. Determine what basin the water body is in.
2. Look at the basin specific criteria in 340-041-0101 to -0340. The first rule under each basin heading is the rule that designates beneficial uses.
3. Look at the use table(s) and/or figures (maps) referenced in the rule to find the designated uses for a particular water body type or location.
4. If a small tributary is not shown on the map, the applicable year round fish use is the same as the nearest downstream water body that appears on the "Fish Use Designations" map [see OAR 340-041-0028(5)]. Spawning use, however, does not apply to these small streams.

The flow chart in Figure 2-1 illustrates the process of identifying the criteria that apply to a water body based on water body type and designated use.

Table 2-1 and Table 2-2 display where the temperature criteria apply in two formats. Table 2-1 shows which temperature criteria apply to each water body type and beneficial use. Table 2-2 shows which water body types and beneficial uses are subject to each criterion.

Definitions for beneficial uses

"Core cold-water habitat use" means waters that are expected to maintain temperatures within the range generally considered optimal for salmon and steelhead rearing, or that are suitable for bull trout migration, foraging and sub-adult rearing that occurs during the summer. OAR 340-041-0002(13)

"Migration corridor" means those waters that are predominantly used for salmon and steelhead migration during the summer and have little or no anadromous salmonid rearing in the months of July and August. OAR 340-041-0002(35)

"Salmon" means chinook, chum, coho, sockeye and pink salmon.

"Salmon and steelhead spawning use" means waters that are or could be used for salmon and steelhead spawning, egg incubation, and fry emergence. OAR 340-041-0002(50)
"Salmon and trout rearing and migration use" means thermally suitable rearing habitat for salmon, steelhead, rainbow trout, and cutthroat trout. OAR 340-041-0002(51)

"Salmonid or salmonids" means native salmon, trout, mountain whitefish, and char (including bull trout). For purposes of Oregon water quality standards, salmonid does not include brook or brown trout since they are introduced species. OAR 340-041-0002(52)

Section 2.3 When do the Temperature Criteria Apply?

Year round criteria

Most of the temperature criteria apply year round, although during parts of the year they may be superseded by a more stringent seasonal criterion. Table 2-1 and Table 2-2 show the time period to which the various temperature criteria apply. The critical time period for the year round criteria is typically the warmest summer months.

Seasonal criteria

There are several temperature criteria that apply seasonally, or during specific time periods. The most notable of these is the criterion for salmon and steelhead spawning through fry emergence use. The spawning criterion applies to all the full 7-day periods within the dates specified for spawning use on the "Beneficial Use Designations – Fish Uses" tables and the "Salmon and Steelhead Spawning Use Designations" maps referenced in the basin specific criteria (OAR340-041-0101-0340). These tables and maps may be found on DEQ's web site http://www.deq.state.or.us/wq/wqrules/wqrules.htm , or by contacting any DEQ office.

Other seasonal temperature criteria include:

- the narrative bull trout spawning criterion, which applies from Aug 15 to May 15 in specific locations,
- the summer cold water protection criterion, and
- the spawning cold water protection criterion, which applies during the specified salmon and steelhead spawning use dates.

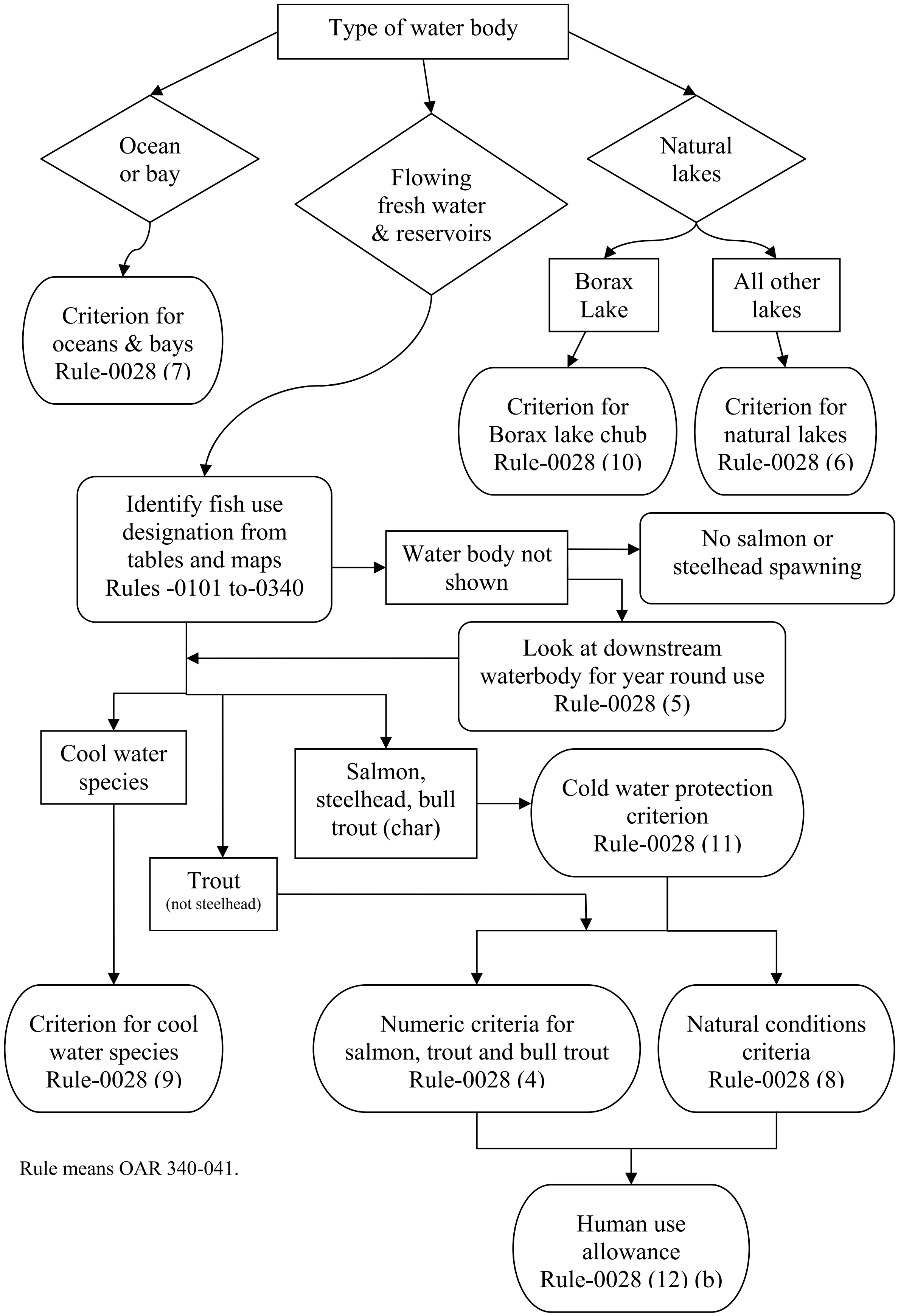
Because the criteria are 7-day averages, they apply to the full 7-day periods that occur within the specified designated use times. When evaluating data where the 7dAM value is reported on the 7th day, the numeric criterion must be met on the 7th day after the beginning of spawning use through the last day of emergence. For example, if spawning begins on September 1st, the first 7-day period of spawning use is September 1st to 7th, and because the 7dAM value is reported on the 7th day, the 13 °C criterion must be met beginning on September 7th. If the last day of spawning use is May 15, the last 7-day period for spawning through emergence use is May 9th to 15$^{th.}$ The 7dAM value would be reported on May 15th and that is the last day 13 °C criterion must be met.

See section 3.2 on the temperature criteria metric for more information on calculating and reporting a rolling 7-day average maximum temperature.

Warm weather, low flow exceptions

The year round criteria must be attained all year, including during the warmest 7-day period of the summer, except for those times that the air temperatures are extremely warm or flow conditions are extremely low as specified in OAR 340-041-0028(12) (c) and (d). (See Chapter 3 for more information on these exceptions.)

Figure 2-1: Flow Chart on Temperature Criteria Applicability



Rule means OAR 340-041.

Table 2-1: Temperature Criteria by Water Body Type and Designated Beneficial Use

Water body Type	Beneficial Use	Applicable Criteria	OAR 340-041-0028	When Criterion Applies
All	All	Air temperature exception	(12)(c)	Summer[1]
All	All	Low flow condition exception	(12)(d)	Year round[2]
All	All salmonid uses[3]	Thermal plume limitations	340-041-0053 (2)(d)	Year round
Flowing freshwater and reservoirs	All salmonid uses	Natural conditions narrative	(8)	Year round
Flowing freshwater and reservoirs	All salmonid uses	Human use allowance	(12)(b)	Year round
Flowing freshwater and reservoirs	Bull trout spawning and juvenile rearing	12.0 °C 7day aver. maximum, Spawning narrative[4], Cold water protection, summer	(4)(f) (4)(f) (11)(a)&(c)	Year round, Aug 15 to May 15 Summer
Flowing freshwater	Salmon & steelhead spawning[5]	13.0 °C 7day aver. maximum, Cold water protection, spawning	(4)(a) (11)(b)	Spawning use dates[6] Spawning use dates
Flowing freshwater and reservoirs	Core cold water habitat	16.0 °C 7day aver. maximum, Cold water protection, summer	(4)(b) (11)(a)&(c)	Year round Summer
Flowing freshwater and reservoirs	Salmon and trout rearing and migration	18.0 °C 7day aver. maximum, Cold water protection, summer	(4)(c) (11)(a)&(c)	Year round Summer
Flowing freshwater and reservoirs	Migration corridor (salmon and steelhead)	20.0 °C 7day aver. maximum, Coldwater refugia narrative, Cold water protection, summer	(4)(d) (4)(d) (11)(a)&(c)	Year round Year round Summer
Flowing freshwater and reservoirs	Migration corridor – Snake and Columbia Rivers only	Seasonal thermal pattern narrative (in addition to above migration corridor criteria)	(4)(d)	Year round

Table 2-1. Temperature Criteria by Water body Type and Designated Beneficial Use (continued)

Water body Type	Beneficial Use	Applicable Criteria	OAR 340-041-0028	When Criterion Applies
Flowing freshwater and reservoirs	Lahontan cutthroat trout or redband trout[7]	20.0 °C 7day aver. maximum, Cold water protection, summer	(4)e) (11)(a)&(c)	Year round Summer
Flowing freshwater and reservoirs	Cool water species[8]	Cool water narrative	(9)	Year round
Unidentified tributaries of flowing freshwater and reservoirs	All uses except spawning	Same use(s) and criteria that apply to nearest downstream water body on the map (except spawning)	(5)	Year round
Natural lakes[8]	Fish and aquatic life	Natural lakes narrative	(6)	Year round
Natural lakes[8]	Borax Lake chub	Borax Lake chub narrative	(10)	Year round
Oceans and bays[8]	Fish and aquatic life	Oceans and bays narrative	(7)	Year round
Reservoirs and managed lakes[8]	Fish and aquatic life	Stratified waters exceptions to temperature, pH or dissolved oxygen	340-041-0061 (15)	When the water body is thermally stratified

NOTES:
[1]Summer means June 1 to September 30.
[2]Year round use means the criterion applies all year except when it is superseded by a more stringent criterion.
[3]Salmonid uses include salmon, steelhead, trout or bull trout (char) uses.
[4]The bull trout spawning narrative applies only below the reservoirs specified in the rule.
[5]The spawning criterion is for salmon & steelhead only; there is no spawning criterion for trout.
[6]Spawning use dates means the dates specified on the "Salmon & Steelhead Spawning Use Designations" maps in OAR 340-041.
[7]Redband trout are the designated use only in specified basins.
[8]These criteria have not been approved by EPA and, therefore, are not yet effective for Clean Water Act purposes.

Table 2-2: Temperature Criteria - Where and When they Apply

Temperature Criterion	WaterbodyType	Beneficial Use	When Criterion Applies	OAR 340-041-0028
13.0 °C 7day aver. maximum	Flowing freshwater	Salmon & steelhead spawning	Spawning use dates[1]	(4)(a)
16.0 °C 7day aver. maximum	Flowing freshwater and reservoirs	Core cold water habitat	Year round[2]	(4)(b)
18.0 °C 7day aver. maximum	Flowing freshwater and reservoirs	Salmon and trout rearing and migration	Year round	(4)(c)
20.0 °C 7day aver. maximum	Flowing freshwater and reservoirs	Migration corridor	Year round	(4)(d)
Coldwater refugia narrative	Flowing freshwater and reservoirs	Migration corridor	Year round	(4)(d)
Seasonal thermal pattern narrative	Flowing freshwater and reservoirs	Migration corridor – Columbia and Snake Rivers only	Year round	(4)(d)
20.0 °C 7day aver. maximum	Flowing freshwater and reservoirs	Lahontan cutthroat or redband trout[3]	Year round	(4)(e)
12.0 °C 7day aver. maximum	Flowing freshwater and reservoirs	Bull trout spawning and juvenile rearing	Year round	(4)(f)
Bull trout spawning narrative	Flowing freshwater and reservoirs	Bull trout spawning and juvenile rearing[4]	Aug 15 to May 15	(4)(f)
Natural lakes narrative[5]	Natural Lakes	Fish and aquatic life	Year round	(6)
Oceans and bays narrative[5]	Oceans and bays	Fish and aquatic life	Year round	(7)
Natural conditions narrative[5]	All	All	Year round	(8)
Cool water species narrative[5]	Flowing freshwater and reservoirs	Cool water species	Year round	(9)

Table 2-2: Temperature Criteria – Where and When they Apply (continued)

Temperature Criterion	Water body Type	Beneficial Use	When Criterion Applies	OAR 340-041-0028
Borax Lake chub narrative[5]	Natural Lakes	Borax Lake chub	Year round	(10)
Cold water protection, summer	Flowing freshwater and reservoirs	All salmon, steelhead and bull trout uses	Summer[6]	(11)(a)&(c)
Cold water protection, spawning	Flowing freshwater and reservoirs	Salmon and steelhead spawning	Spawning use dates	(11)(b)
Human use allowance	All	All	Year round	(12)(b)
Air temperature exception	Flowing freshwater and reservoirs	All	Summer	(12)(c)
Low flow condition exception	Flowing freshwater and reservoirs	All	Year round	(12)(d)
Thermal plume limitations	All	All	Year round	340-041-0053(2)(d)
Stratified waters exceptions to temperature, pH or dissolved oxygen [5]	Reservoirs and managed lakes	Fish and aquatic life	When the water body is thermally stratified	340-041-0061(15)

NOTES:
[1]Spawning use dates means the dates specified on the "Salmon & Steelhead Spawning Use Designations" maps in OAR 340-041. Because there is no criterion for resident trout spawning, dates for this use have not been specified.
[2]Year round use means the criterion applies all year except when it is superseded by a more stringent criterion.
[3]Redband trout are the designated use only in specified basins.
[4]The bull trout spawning narrative applies only below the reservoirs specified in the rule.
[5]These criteria have not been approved by EPA and, therefore, are not yet effective for Clean Water Act purposes.
[6]Summer means June 1 to September 30.

Section 2.4 What Happens When a Temperature Criterion Is Exceeded?

303(d) List

If a water body or segment exceeds the numeric temperature criteria, the data meets DEQ's data quality requirements, and all other requirements or conditions of the 303 assessment methodology have been met, the water body is classified as "water quality limited and in need of a TMDL" and added to the 303(d) list of impaired waters.

The exception to this is if DEQ has information demonstrating that the parameter of concern is a "natural condition" of the water body [See OAR 340-041-0028 (8)]. See also section 3.7 of this document.

When the TMDL is completed the water body is "de-listed," or removed from the 303(d) list, but it is tracked in the water quality assessment database until DEQ has data showing standards are being attained.

TMDLs

DEQ develops total maximum daily loads (TMDLs) for stream reaches designated as water quality limited. The TMDL analysis determines whether the temperature exceedences are due to natural conditions or human activities, what sources are causing or contributing to the exceedence, how much the total heat load to the stream must be reduced to meet the criteria, and how much heat load will be allocated to each contributing source. Typically, DEQ develops temperature TMDLs for a subbasin. The implementation of the temperature standard through TMDLs is discussed further in Chapter 5.

Discharging without a permit

In Oregon, it is illegal to discharge pollution to waters of the State without a permit and an un-permitted discharge is subject to enforcement. There are limited exceptions to this, such as low capacity fish hatcheries and storm water not addressed by the federal Phase II storm water rules.

Discharging under an NPDES permit

If a source has an NPDES permit to discharge wastewater and the source is meeting its permit requirements for temperature, DEQ will not enforce against them even if the temperature criteria are exceeded. However, the permit may be revised if the source is causing or contributing to the exceedence. This may be done as part of a TMDL, or it may be done prior to the development of a TMDL.

Section 2.5 Questions & Answers on Criteria Applicability

Man made waterways

What temperature criteria apply to a ditch or other man made conveyance: with fish, with no fish use? Does it matter whether it is an "unidentified tributary" or not?

Canals and ditches are waters of the state in Oregon if they have a connection with a natural water body. This means they are subject to water quality standards according to the uses designations shown on the maps and tables referred to in the OAR 340-041 basin rules.

There is a need to review and refine the beneficial use designations for these types of water bodies. The Department did not have time to do this work when we adopted fish use subcategories in 2003. For example, some man-made conveyances or irrigation or drainage ditches may be screened and not contain cold water fish and the Department may want to revise the maps to reflect this.

Winter, no spawning

What temperature criterion applies in the winter if the water body is not designated for spawning? How much would a source be allowed to increase the temperature in this situation? May they warm it up to the criterion (i.e. 18 °C)? How does this protect resident trout spawning and other cold water biota in winter?

If the water body is not designated for salmon or steelhead spawning or bull trout spawning, the temperature criteria that apply in the winter are the numeric criteria for the year round uses (i.e. rearing, migration or core cold water habitat). If the water body exceeds the applicable year round numeric criterion, the human use allowance applies and the source is limited to a 0.3 °C increase above the criterion.

If a non-spawning water body is below the numeric criterion in the winter, the cold water protection criteria do not apply. Oregon rules do, however, contain a narrative biological criterion, a policy to not allow the discharge of wastes that will impair uses, and an antidegradation policy that could be utilized to prevent significant thermal impacts that may impair uses in the winter.

Reservoirs, not stratified

How does the standard apply to reservoirs? What about reservoirs that the stratified waters rule doesn't apply to, reservoirs that don't thermally stratify (i.e. behind J.C. Boyle dam)?

Reservoirs are considered part of the flowing water river systems. However, reservoirs are not typically salmonid spawning habitat. The "stratified waters" rule applies to reservoirs that stratify. For those that do not stratify, the questions may be similar, however. Is there a significant portion of the reservoir that protects the use such that migrating fish can pass through unimpaired and resident species can persist? If not, we should consider what can be done to improve conditions in the reservoir or whether the use is unattainable and needs to be removed as the designated use for the reservoir portion of the water body.

See Sections 2.2 and 3.5 for additional information on application of the temperature standard to reservoirs.

Chapter 3 The Temperature Criteria

Section 3.1 Overview

Introduction

The temperature standard rules include numeric and narrative criteria, which will be described in this chapter. The complete rule language may be found at OAR 340-041-0028 and is provided in Appendix A of this document. Specific rules or rule sections are provided in this chapter. In addition, there are criteria for thermal plumes from point source discharges in the mixing zones rules, which may be found at OAR 340-041-0053(2) (d).

Numeric and narrative criteria

Temperature is a fundamental natural characteristic of water bodies that profoundly influences the composition of native aquatic communities. Water temperature is determined by natural factors, some of which may be outside human control, and it is also influenced by human activity in ways that are biologically significant. Water temperature is highly variable in the natural environment through both time and space at multiple scales. In Oregon, it is common for natural stream temperatures to exceed those considered optimal for cold water biota in some locations and/or for some period of time, presenting some risk of sub-lethal effects, but it is much less common for natural water temperatures to exceed lethal conditions.

The combination of the above factors means that a traditional numeric threshold type of standard has limited ecological relevance and will likely be either under- or over-protective or unattainable in any given location. This has led Oregon to adopt temperature standards that have both numeric and narrative components, both of which are described in detail in this chapter.

For more information on the thermal requirements of cold water fishes or stream temperature variability, see DEQ's temperature web page at http://www.deq.state.or.us/wq/standards/WQStdsTemp.htm.

What this chapter covers

Section 3.2: The temperature criteria metric and how to calculate the 7day average maximum (7dAM) temperature.
Sections 3.3–3.5: The numeric criteria and exceptions
Sections 3.6–3.16: The narrative criteria.
Section 3.17: The thermal plume requirements for point sources contained in the mixing zone rules (OAR 340-041-0053).

Section 3.2 The Temperature Criteria Metric

Temperature criteria metric

The metric for the numeric criteria is the 7-day average of the daily maximum stream temperature, or the "7-day average maximum" (7dAM). While the narrative criteria do not specify, the same metric will be generally be used.

The maximum 7dAM is the 7dAM for the warmest 7 consecutive days (week) of the year. This is the same as the maximum weekly maximum temperature (MWMT) used in some literature to refer to the maximum temperatures that occur during the warmest week of the year.

The only criterion that specifies a different metric is the cold water protection narrative for spawning, which allows a limited increase above the 60-day average maximum stream temperature during the spawning season.

How to calculate and report the 7dAM stream temperature

The 7dAM (7-day average maximum) stream temperature is calculated by averaging the daily maximum instream water temperatures for 7 consecutive days. Because the criteria apply to every 7 day period, it is referred to as the rolling 7dAM. For the second 7-day period, the first day is dropped and another day is added to the end date. For example, one 7-day period is August 4 to 10, the next 7-day period is August 5 to 11, and so on. An example of how to calculate the 7dAM temperature and how this relates to other temperature metrics is shown in Table 3-1 below.

The average daily maximum temperature value for each 7-day period will be reported on the 7^{th} day as shown below. This means that the average of the daily maximum temperatures for the first 7 days of the spawning period will be reported on the 7^{th} day after spawning use begins. Therefore, that 7^{th} day of spawning is the first day that the 7dAM value must meet 13 °C.

Table 3-1: Sample Daily and 7-day Average Maximum Stream Temperatures

(Imnaha River u/s of Gumboot Creek, 2000)

Date	Daily Minimum T	Daily Mean T	**Daily Maximum Temperature**	Diel Flux (daily max - daily min)
Aug 4	13.5	15.9	18.3	4.8
Aug 5	12.3	15.4	18.4	6.1
Aug 6	11.4	14.6	17.8	6.4
Aug 7	11.5	14.8	18.1	6.6
Aug 8	11.1	14.6	18.1	7.0
Aug 9	11.5	14.8	18.1	6.6
Aug 10	12.7	15.6	18.6	5.9
7dAM, reported on 8/10	12.0	15.1	**18.2**	6.2

Monitoring methods

Continuous temperature recorders should be used to monitor compliance with the temperature criteria. These recorders are typically set to record temperature at least once per hour in order to capture the daily maximum temperature as well as the diel fluctuation (the change in temperature that occurs over the 24 hour day; daily maximum minus daily minimum). The recorders should be placed such that they are measuring a well mixed portion of the river. Monitoring methods and quality assurance/quality control protocols may be found in a document titled "ODEQ Procedural Guidance for Water Temperature" (September 1996), which may be obtained from the DEQ laboratory.

Instantaneous measurements that exceed the numeric criteria indicate an exceedence of the standard because that measurement will be equal to or less than the daily maximum temperature. It is much more difficult to use instantaneous measurements to demonstrate compliance, however, because it is unknown and unlikely that instantaneous measurements represent the daily maximum temperatures or the warmest 7-day period.

Section 3.3 Biologically Based Numeric Criteria

Purpose

The purpose of the biologically based numeric criteria is to establish or maintain stream temperatures that fully protect cold water fishes according to the scientific literature. These numeric criteria identify temperatures above which impacts to salmonids begin to occur. Documents summarizing the literature and providing the basis for these criteria are available from DEQ.

Rule Language

OAR 340-041-0028(4) Biologically Based Numeric Criteria. Unless superseded by the natural conditions criteria described in section (8) of this rule, or by subsequently adopted site-specific criteria approved by EPA, the temperature criteria for State waters supporting salmonid fishes are as follows:

(a) The seven-day-average maximum temperature of a stream identified as having salmon and steelhead spawning use on subbasin maps and tables set out in OAR 340-041-0101 to 340-041-0340: Tables 101B, and 121B, and Figures 130B, 151B, 160B, 170B, 220B, 230B, 271B, 286B, 300B, 310B, 320B, and 340B, may not exceed 13.0 degrees Celsius (55.4 degrees Fahrenheit) at the times indicated on these maps and tables;

(b) The seven-day-average maximum temperature of a stream identified as having core cold water habitat use on subbasin maps set out in OAR 340-041-101 to 340-041-340: Figures 130A, 151A, 160A, 170A, 220A, 230A, 271A, 286A, 300A, 310A, 320A, and 340A, may not exceed 16.0 degrees Celsius (60.8 degrees Fahrenheit);

(c) The seven-day-average maximum temperature of a stream identified as having salmon and trout rearing and migration use on subbasin maps set out at OAR 340-041-0101 to 340-041-0340: Figures 130A, 151A, 160A, 170A, 220A, 230A, 271A, 286A, 300A, 310A, 320A, and 340A, may not exceed 18.0 degrees Celsius (64.4 degrees Fahrenheit);

(d) The seven-day-average maximum temperature of a stream identified as having a migration corridor use on subbasin maps and tables OAR 340-041-0101 to 340-041-0340: Tables 101B, and 121B, and Figures 151A, 170A, and 340A, may not exceed 20.0 degrees Celsius (68.0 degrees Fahrenheit)…;

(e) The seven-day-average maximum temperature of a stream identified as having Lahontan cutthroat trout or redband trout use on subbasin maps and tables set out in OAR 340-041-0101 to 340-041-0340: Tables 120B, 140B, 190B, and 250B, and Figures 180A, 201A, and 260A may not exceed 20.0 degrees Celsius (68.0 degrees Fahrenheit);

(f) The seven-day-average maximum temperature of a stream identified as having bull trout spawning and juvenile rearing use on subbasin maps set out at OAR 340-041-0101 to 340-041-0340: Figures 130B, 151B, 160B, 170B, 180A, 201A, 260A, 310B, and 340B, may not exceed 12.0 degrees Celsius (53.6 degrees Fahrenheit)….

Table of Numeric Criteria

Table 3-2 shows the biologically based numeric temperature criteria by designated beneficial use for flowing fresh waters. Oceans and bays and natural lakes have narrative temperature criteria described in Section 3.13 and Section 3.14 of this chapter. Please note that additional narrative criteria (Table 2-2 and Section 3.5 through Section 3.16) may also apply to the uses below. Please also note that a discussion of where and when these numeric criteria apply is provided in Chapter 2.

Table 3-2: Numeric Temperature Criteria, °C

Beneficial Use	Numeric Criterion
Salmon & steelhead spawning	13.0
Core coldwater habitat	16.0
Salmon & trout rearing & migration	18.0
Migration corridor (salmon & steelhead)	20.0
Lahontan cutthroat or redband trout	20.0
Bull trout spawning & juvenile rearing	12.0

Effectiveness

All of the numeric criteria shown here have been approved by EPA and are effective in Oregon for Clean Water Act purposes.

Application

The numeric criteria apply where ever the use is designated unless they are superseded by one of the narrative criteria, such as the natural conditions criterion, or by a site-specific criterion. See Chapter 2 for discussion of where and when the criteria apply.

Changes from 1996 criteria

There is no temperature criterion for spawning for trout species other than steelhead (anadromous rainbow trout).

Salmon and trout rearing habitats have been divided into 3 sub-categories with 3 different numeric criteria:

- "core cold water habitat," which represent colder rearing habitats,
- "salmon & trout rearing and migration," which represent habitats that may get slightly warmer, and
- "Lahontan cutthroat trout or redband trout," which are habitats that contain only one or both of these 2 more tolerant trout species.

The numeric criterion for bull trout juvenile rearing is slightly higher than it was under the former rule.

Section 3.4 Exceptions to the Numeric Criteria

Warm Air Temperature Exception

Rule language: "OAR 340-401-0028(12) (c) Air Temperature Exclusion. A water body that only exceeds the criteria set out in this rule when the exceedence is attributed to daily maximum air temperatures that exceed the 90th percentile value of annual maximum seven-day average maximum air temperatures calculated using at least 10 years of air temperature data, will not be listed on the section 303(d) list of impaired waters and sources will not be considered in violation of this rule."

Many locations in Oregon do not have 10 years of air temperature data available and it is preferable to have an even longer record, i.e. 30 years. In this case, staff should utilize data from the nearest temperature recording station to the site, or perhaps multiple nearby stations, to evaluate whether or not this exception applies for a specified site and time.

This exception applies only to those days of the year when the 7dAM air temperature exceeds the 90th percentile values. For example, the weather station nearest lower Cool Water Creek is 10 miles away. The 90th percentile of the 7dAM air temperature (calculated using data over the last 30 years) for that weather station is 95°F. If Cool Water Creek exceeds the temperature criteria only on those days when the 7dAM air temperature is 95°F or higher, it is not considered in violation of the standard and would not be listed as impaired. If Cool Water Creek exceeds the temperature criteria when the 7dAM air temperature is 94°F, it does exceed the standard and would be listed given the listing criteria and data quality requirements are met.

This provision has been approved by EPA and is effective for CWA purposes in Oregon.

Low Stream Flow Exception

Rule language: OAR 340-041-0028(12) (d) Low Flow Conditions. An exceedence of the biologically-based numeric criteria in section (4) of this rule, or an exceedence of the natural conditions criteria in section (8) of this rule will not be considered a permit violation during stream flows that are less than the 7Q10 low flow condition of that water body.

The 7Q10 low flow is calculated by determining the lowest 7-day streamflow period during the year for each year, and determining the 10-year re-occurrence interval, which is the 10th percentile of the distribution over a long term record. The 7Q10 low flow can also be calculated for particular months or seasons.

EPA did not act on this provision; they interpret that it is not part of the standard, but rather enforcement discretion. It is common practice, however, for both States and EPA to use the 7Q10 low flow when determining dilution and setting permit limits. EPA's *Technical Support Document for Water Quality Based Toxics Control* (1991) recognizes and discusses the 7Q10 low flow as an appropriate design flow for developing both permit limits and wasteload allocations.

A tool for calculating 7Q10 low flows, "DFLOW," may be found at http://deq05/wq/wqpermits/PCTools_Databases.htm or http://www.epa.gov/waterscience/models/dflow/

The Stratified Waters Rule

In May, 2004, the EQC adopted a rule on the implementation of temperature, pH and dissolved oxygen criteria in reservoirs or managed lakes that thermally stratify [OAR 340-041-0061(15)]. The rule provides that the temperature criteria do not need to be met in all parts of a reservoir, but rather in a sufficient portion of the water body to protect the use. Typically, it would be most difficult to meet the temperature criterion at the surface of a reservoir whereas deeper waters could be quite cold.

"Managed lakes" refers to lakes in which the hydrology is managed by controlling the rate or timing of in flow or outflow [OAR 340-041-0002(32)].

This provision has not yet been approved by EPA and, therefore, is not yet effective in Oregon for Clean Water Act purposes.

Section 3.5 Narrative Criteria Overview

What is a narrative criterion?

A narrative criterion is a statement, rather than a concentration or level, of the water quality needed to protect a beneficial use. Narrative criteria are appropriate when numeric criteria can not be established or to supplement numeric criteria. (40CFR 131.11)

The purpose of the narrative criteria

The purpose of the narrative criteria within the temperature standard is to supplement the numeric criteria and result in standards that are more ecologically relevant and more practical and equitable to implement than strictly numeric criteria would be.

In the case of the natural condition criterion, that criterion supersedes and applies instead of the numeric criteria if the natural condition is greater (warmer) than the numeric criteria.

The human use allowance, cold water protection criteria and the thermal plume limitations apply in addition to the numeric criteria.

See the Introduction to Chapter 3 for more discussion on why the temperature standard includes both numeric and narrative criteria.

Table of narrative criteria

Table 2-2 in Chapter 2 above shows the narrative criteria and the water body types or beneficial uses to which they apply. Each of these criteria is described in the following pages.

Section 3.6 Natural Conditions Criterion

Purpose

The "Natural Conditions" narrative criterion is included in the temperature standard to recognize that many Oregon waters would exceed the numeric criteria under natural conditions, according to stream temperature modeling. Where the stream temperature is expected to exceed the numeric criteria under natural conditions, the natural conditions are presumed to be protective of the local native aquatic species, including salmonids. In these cases, the natural condition becomes the criteria for that water body or stream reach and supersedes the numeric criteria.

Rule language

OAR 340-041-0028 (8) Natural Conditions Criteria. Where the department determines that the natural thermal potential of all or a portion of a water body exceeds the biologically-based criteria in section (4) of this rule, the natural thermal potential temperatures supersede the biologically-based criteria, and are deemed to be the applicable temperature criteria for that water body.

Definitions

OAR 340-041-0002(38). "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, and diseased vegetation are considered natural conditions.

OAR 340-041-0002(39). "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.

Metric

Natural thermal potential is estimated using the 7-day average of the daily maximum temperature (7dAM), the same metric used for the numeric criteria.

Application

In order to conclude that "natural conditions" inherently protect the local native biological community even though the numeric criteria are exceeded, DEQ must develop a credible estimate of stream temperatures that have not been measurably altered by human activity.

Natural thermal potential (NTP) represents the best we are able to estimate natural thermal conditions given the current physiographic setting. NTP will most often be determined through stream temperature modeling done during TMDL development for a subbasin. There may be situations, however, where there is sufficient information about a watershed or stream reach to demonstrate that it is currently in natural condition and modeling is not necessary.

Once the natural condition criterion is determined to be applicable, the "human use allowance" is calculated based on the natural thermal potential temperature of the stream rather than the numeric criteria.

In upper stream reaches where the natural condition is below the numeric criterion, natural condition may still be used as the reference temperature for the human use allowance (HUA) in a TMDL and load allocations. This would be done where DEQ determines that the upstream heat load causes or contributes to an exceedence of the natural condition criterion downstream.

See Section 3.10 on the Human Use Allowance below, and Chapters 4 on implementing the temperature standard in TMDLs for additional information.

Season

In some cases, a TMDL may be developed for only one season, generally summer, and natural thermal potential will be estimated only for summer. In this case, the numeric spawning criterion is applied for the spawning period even though the natural condition criterion applies in the summer TMDL period. See Chapter 5 for further information.

Estimating natural thermal potential (NTP)

Natural thermal potential (NTP) is estimated using the methods, models and data available at the time of the analysis. In many cases it is very difficult or impossible to include in a modeling exercise all the possible indirect ways human activity on the landscape may have altered stream temperature. In some cases, a stream may be so heavily influenced by processes that are difficult to model, such as hyporheic exchange, that the Department recognizes the model results are only partially informative and must rely on other methods to inform the evaluation as well. In these cases, paired watershed studies, scientifically logical assumptions and best professional judgment may need to be used to fill knowledge gaps.

DEQ must use the scientifically sound models, methods and data available to us to develop a credible best estimate of natural potential. Over time, the models and data inputs will likely continue to improve and we may revise our estimates of natural thermal potential. This process may require using an adaptive management type of approach.

For further information on estimating natural thermal potential see Chapter 5 of this document, "Developing Total Maximum Daily Loads for Temperature."

Another related reference is EPA Region 10's Natural Conditions Work Group report, *Principles to Consider When Reviewing and using Natural Condition Provisions* (2005).

Determining that a stream is currently in natural condition

For some streams that exceed the numeric criteria, sufficient information may be available to conclude that the stream is in a natural thermal condition and that the stream should not be listed as impaired, or if it already has been listed as impaired, that it is not in need of a TMDL and should be de-listed.

One type of evidence for making this determination would be that the stream is in a wilderness area or a road less area and has had no human management or impact for a long period of time.

Another set of evidence that could be considered is the condition of the riparian vegetation, streamflow and channel morphology. If the watershed has had some minimal management or development but a party can show that neither the riparian vegetation, streamflow, nor channel morphology have been altered, DEQ may conclude that the stream is in a natural condition. This determination would be further supported by data from a similar nearby stream, or 'reference site" that is undisturbed and displays similar temperatures and thermal patterns.

These will be case by case determinations made by DEQ staff, but the information to make the evaluation will most likely need to be provided by another party, such as a state or federal land management agency. The public would have an opportunity to comment on any such determinations during the public review of the proposed 303(d) list.

Tracking water bodies

The TMDL documents and Water Quality Assessment [303(d) list] documents will record what stream reaches are subject to the natural condition criterion rather than the numeric criterion.

Section 3.7 Cold Water Protection Criterion – Summer

Purpose

The purpose of the summer cold water protection criterion is to limit human warming of streams that currently stay cold throughout the summer and contain salmon, steelhead or bull trout. Protecting a range of cold water habitats is important for temperature sensitive fish and other cold water biota. In addition, because added heat is transported downstream, limiting the warming of upper cold water reaches will, under some conditions, reduce the amount of habitat downstream that exceeds the criteria. This provision is intended to prevent or minimize degradation of high quality streams.

Rule Language

OAR 340-041-0028 (11)
(a) Except as described in subsection (c) of this rule, waters of the State that have summer seven-day-average maximum **ambient** temperatures that are colder than the biologically based criteria in section (4) of this rule, may not be warmed by more than 0.3 degrees Celsius (0.5 degrees Fahrenheit) above the colder water ambient temperature. This provision applies to all sources taken together at the point of maximum impact where salmon, steelhead or bull trout are present….
(c) The cold water protection narrative criteria in subsection (a) does not apply if:

> (A) There are no threatened or endangered salmonids currently inhabiting the water body;
> (B) The water body has not been designated as critical habitat; and
> (C) The colder water is not necessary to ensure that downstream temperatures achieve and maintain compliance with the applicable temperature criteria.

Policy

New sources and activities, cumulatively, may not warm the temperature of high quality cold water reaches (those that stay below the numeric criteria all summer) by more than 0.3 °C above the current ambient summer maximum temperature, with the exceptions shown in the rule language above and described below.

Definitions

For the purpose of implementing this criterion:
The "summer seven-day average maximum" temperature means the 7dAM temperature for the warmest 7-day period during the summer, or the maximum seven day average maximum for the water body or reach.

"Summer" means June 1 to September 30. [OAR 340-041-0002 (61)]

"Ambient stream temperature" means the instream temperature measured at a specified time and place.

New sources and activities means new or increased loads after the adoption of this criterion (December, 2003).

Point of maximum impact means the location(s) on a water body, or on a downstream water body, at which the greatest increase in temperature caused by human sources/activities occurs.

Human sources or activities may directly or indirectly affect stream temperature. They include point source discharges, streamside vegetation removal, channel morphology alteration, streamflow alteration, stream impoundment and more.

Application

This rule applies to waters:

- That currently remain colder than the biologically based numeric criteria in section (4) throughout the summer (the maximum 7dAM during the summer is less than or equal to the applicable numeric criterion),
- Where salmon, steelhead or bull trout are present, and
- Not designated for salmon and steelhead spawning use. For spawning waters, the numeric spawning criterion and the cold water protection criterion for spawning apply [OAR 340-041-028 (11) (b)]. See next section.

Single source

As of the effective date of this rule (December 2003), if a single new source or activity increases the temperature of the stream more than 0.3 °C above the upstream ambient stream temperature or above the ambient temperature prior to the activity, the criterion is exceeded.

If a single source requests a new or increased load prior to DEQ's ability to do a cumulative impact analysis, that source will be limited to an increase of 0.3 °C with 25% of the 7Q10 low flow for dilution or at the edge of their RMZ, whichever is more restrictive. This approach is consistent with the application of the human use allowance prior to a cumulative effects analysis. If a cumulative impacts analysis is completed and all sources and activities are considered, 100% of the 7Q10 flow may be used to calculate the allowed total cumulative increase.

Cumulative impacts

As of the effective date of this rule (December, 2003), if multiple new sources and activities together cause the temperature of the stream to increase more than 0.3 °C above the upstream ambient temperature or above the ambient stream temperature prior to the activity, the criterion is exceeded.

Exceptions

This provision applies unless all three following circumstances are true :

1. No federally listed T&E salmon, trout, steelhead or bull trout species currently inhabit the water body(ies) affected by the discharge or activity,
2. The water body(ies) affected by the discharge/activity is(are) not federally designated "critical habitat" for a cold water aquatic species under the Endangered Species Act (ESA), and
3. The cold water is not necessary to ensure that downstream reaches achieve and maintain compliance with the temperature criteria.

Federal critical habitat information should be available from the US Fish and Wildlife Service (http://pacific.fws.gov/) and the National Marine Fisheries Service (http://www.nwr.noaa.gov/) ESA websites.

One way to determine that the 3rd requirement above is met is to show that the stream reach that was warmed by human activity has returned to the expected or monitored pre-activity temperature upstream of any reach that exceeds the criteria. For example, in the illustration shown in Figure 3-1, p. 37, the relationship between the difference in temperature from site 1 to site 6 (T_6-T_1) and the difference in temperature from site 5 to site 6 (T_6-T_5) should be the same after the activity as they were prior to the activity. This could occur due to nighttime cooling if the travel time allows the water to go through a full diel cycle, hyporheic influences that cool the water, groundwater inflow that mixes with the stream to cool it, or a combination of the above that make the heat load from the activity undetectable or un-measurable by the time the water reaches site 6.

A second way to determine whether this provision is met is to do a reach model to determine how far downstream the thermal increase caused by the new discharge/activities will continue to affect stream temperature. If the point along the stream at which the temperature affect of the activity is no longer detected is upstream of where the temperature criteria are exceeded, this requirement is met. Likewise, if the effect of the activity extends downstream to stream miles that do exceed the criteria, but the exceedence would occur without the impact of the activities in question and are not exacerbated by it, then this requirement is also met. If however, the model determines that additional stream miles will exceed the criteria due to the new activities, this requirement is not met and the increase is limited to 0.3 °C.

Measurement methods

The temperature metric monitored and compared to the numeric criteria is the 7-day average of the daily maximum stream temperature. Likewise, a 0.3 °C increase refers to a 7-day average increase above the numeric criteria.

The best monitoring method for determining compliance will depend on the site specific circumstances. The monitoring options include:

- temperature monitoring above and below the activity and before and after the activity if possible (see Figure 3-1, p. 37);
- a paired watershed study;
- temperature modeling of the area of concern.

See the document ODEQ Procedural Guidance for Water Temperature, 18 September 1996 on temperature monitoring methods for additional information. This document is available from DEQ.

Factors that determine monitoring method

Some of the factors that may help determine the most appropriate monitoring method include:

- whether there are one or multiple new human activities potentially affecting the temperature of the cold water reach;
- whether the activity is on or upstream of the stream reach containing salmon, steelhead or bull trout;
- how far above the fish bearing stream the activity will occur; and
- whether the activity will be ongoing or recurring (i.e. a new road, development or grazing allotment), versus a one time or infrequent activity (logging).

Application Issues

When monitoring is done to determine whether a nonpoint source activity has caused an increase in stream temperature greater than that allowed by the cold water protection criterion, the activity has already occurred. In this situation, the impact has already occurred or is ongoing. Monitoring information on the thermal impacts of nonpoint source activity is used to develop management practices rather than to regulate each individual activity. Management practices should be designed to prevent impacts from occurring in other similar situations or to discontinue ongoing impacts, such as repeated vegetation removal, in order to allow recovery of the stream and meet the limited temperature increase allowed by the criterion.

For a point source discharge, data and analysis demonstrating the ability of the source to comply with the criterion is required prior to receiving a permit.

Example – Application to permitted point source

An existing fish hatchery, small municipal discharge, or other NPDES permitted facility discharges into a small stream named Freezing Creek. Temperature data from Freezing Creek just above the discharge shows that the maximum 7dAM water temperature during the summer season is 14 °C. The use is core cold water habitat and there are listed salmon that rear here. Therefore, the numeric criterion is 16 °C and the cold water protection narrative applies. The facility increases the temperature of the stream 1 °C to 15 °C below the discharge after mixing. Renewal of the permit at the existing thermal load is allowed. If the facility wants to expand and increase their thermal load, however, the additional load may not increase the temperature of Freezing Creek below the discharge to more than 15.3 °C.

If a new fish hatchery or other permitted discharge wishes to locate on Freezing Creek, the source may not increase the existing ambient temperature prior to its new discharge, which is 14 °C in this example, by more than 0.3 °C after mixing.

Example – Monitoring a non point source activity

In the illustration below (Figure 3-1), Bear Creek and Deer Creek stay below the applicable criteria all summer and are thus subject to the cold water protection narrative criterion. If Bear Creek is fish bearing and the shaded square represents a logging site, monitoring should be done at sites #1 and 2 prior to, during and following logging. Monitoring should be done during the critical warm period (i.e. July to September) prior to logging and during the same time period the summer after logging. If the temperature increase between sites 1 and 2 following logging is 0.3 °C greater than the temperature increase between sites 1 and 2 prior to logging, the summer cold water protection criterion has not been met. If pre-logging data is not available, or to eliminated the effects if interannual climate variation, the difference in temperature between sites 1 and 2 may also be compared to the difference in temperature between sites 5 and 3 to determine whether the logging activity is causing more than the allowed increase.

If Bear Creek is not a fish bearing stream, but Deer Creek is, the monitoring should be conducted at sites #3 and 4 to determine compliance with the criterion. If an additional logging site or human activity that could potentially warm the stream occurs on Deer Creek, the upstream monitoring site should be placed above both the activity and the non fish-bearing tributary (site #5). Depending on the distance between the sites and the stream characteristics, it is possible that the only way to determine the impact of the activities is with a local reach model or paired watershed monitoring approach.

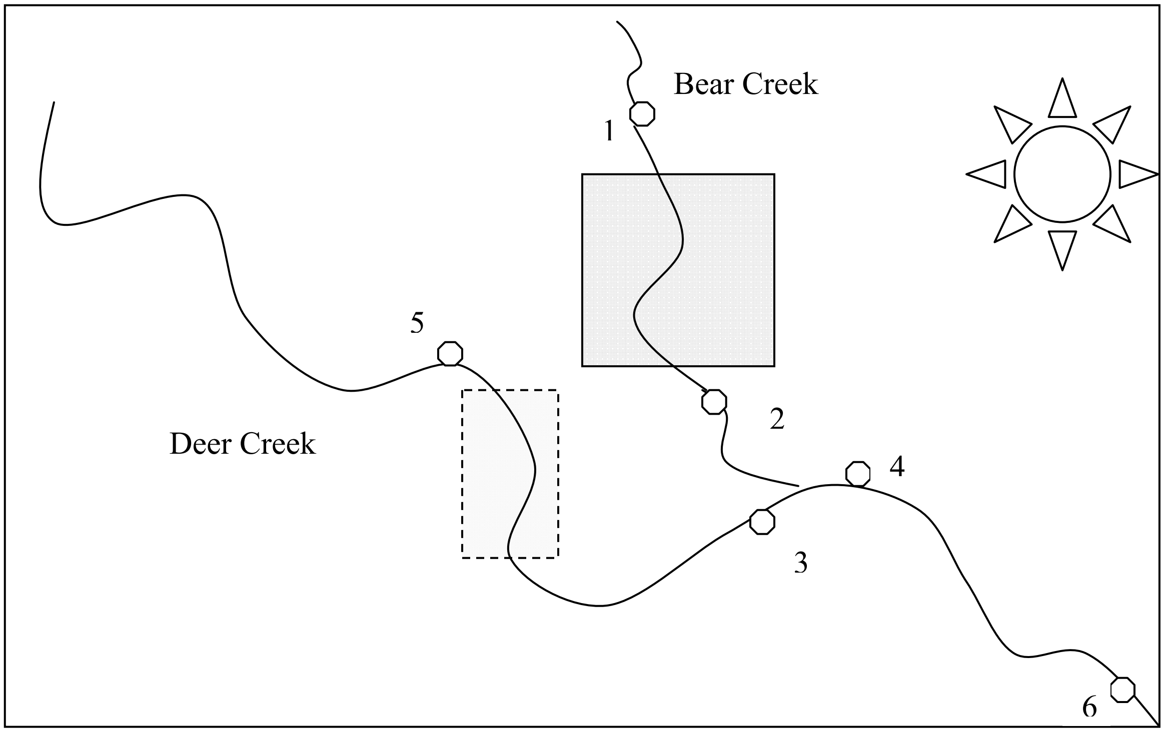


Figure 3-1: Example of Monitoring for Summer Cold Water Protection Criterion

Section 3.8 Cold Water Protection Criterion - Spawning

Purpose

The cold water protection criterion for spawning limits the amount of warming allowed from a point source during the spawning to emergence period when the temperature of the river is below 13 °C. The numeric spawning criterion (13 °C as a 7dAM) also applies throughout the spawning through fry emergence period.

The purpose of the spawning cold water protection provision is to protect egg survival and the proper timing of egg development and hatch and fry emergence from the stream gravels. Water temperature warmed during the incubation period can cause reduced egg survival and can alter the timing of incubation and fry emergence from the gravels. If fry emerge early, stream flows, food availability or other conditions may not be conducive to the survival of the young fish.

Rule Language

OAR 340-041-0028(11) (b) A point source that discharges into or above salmon & steelhead spawning waters that are colder than the spawning criterion, may not cause the water temperature in the spawning reach where the physical habitat for spawning exists during the time spawning through emergence use occurs, to increase more than the following amounts after complete mixing of the effluent with the river:

> (A) If the rolling 60-day average maximum ambient water temperature, between the dates of spawning use as designated under subsection (4) (a) of this rule, is 10 to 12.8 °Celsius, the allowable increase is 0.5 °C above the 60 day average; or
>
> (B) If the rolling 60 day average maximum ambient water temperature, between the dates of spawning use as designated under subsection (4) (a) of the rule, is less than 10 degrees Celsius, the allowable increase is 1.0 °C above the 60 day average, unless the source provides analysis showing that a greater increase will not significantly impact the survival of salmon or steelhead eggs or the timing of salmon or steelhead fry emergence from the gravels in downstream spawning reaches.

Definitions

"Salmon and steelhead spawning use" means waters that are or could be used for salmon and steelhead spawning, egg incubation and fry emergence" from the gravels. OAR 340-41-0002(50)

The 60-day average maximum water temperature

The 60-day average maximum water temperature is the average of the daily maximum temperatures for 60 consecutive days. To calculate a 60-day average maximum water temperature one needs daily maximum water temperature data for 60 consecutive days and averages them to find one average maximum value for that 60-day period.

The rolling 60-day average maximum means that the average maximum temperature is calculated for each consecutive 60-day period. To calculate the rolling 60-day average maximum, one needs temperature data for the entire spawning period.

The phrase "…between the dates of spawning use" means that the entire 60-day averaging period must fall between the beginning and ending dates for spawning use. If spawning begins October 15th, the 1st 60-day averaging period would be October 15 to December 14. If emergence ends May 15, the last 60-day averaging period would be March 16 to May 15.

See Section 5.5 for more information on how to calculate the 60 day average maximum water temperature.

Application

This provision applies to spawning habitat when the 60-day average maximum river temperature is colder than the numeric spawning criterion (13 °C).

This provision applies only to point sources and it applies to each point source. There is no requirement under this provision to look at the cumulative impacts of multiple point sources.

This provision must be met at the location of the physical spawning habitat outside any applicable mixing zone. If the receiving water is designated for spawning use but there is a question as to whether the area immediately downstream of the discharge is actually physical spawning habitat, the permit writer should consult an ODFW biologist to determine where the nearest downstream spawning habitat is located. That location is where this provision must be met, not at the edge of the mixing zone. This does not mean that redds have to be present in any give year for this criterion to apply, just that the habitat characteristics are suitable for spawning.

This provision applies during the spawning use time specified on the fish use designation maps. (See the beneficial uses section under each basin in the water quality standards rules [OAR 340-041-0101 to 0340] for a description of the spawning use locations and times.)

The allowable increase under this provision is calculated assuming mixing with 100% of the streamflow.

The allowable increase is an increase above the 60-day average of the daily maximum temperature, not the 7-day average maximum. In the case of the 1.0 °C allowed increase, it should be met on the coldest 60-day period during the spawning season. In the case of the 0.5 °C increase, it should be met on the coldest 60-day period with a 60-day average of 10° or higher.

The allowed increase is an increase above the upstream ambient stream temperature when that ambient 60-day average maximum temperature is less than the 13.0 °C spawning criterion.

If the spawning use period overlaps with the summer (defined as June 1 to Sept 30), the spawning provision [-00280(11) (b)] applies during the defined spawning use period for point sources. The numeric spawning criterion of 13.0 °C as a 7dAM and the human use allowance limiting increases to 0.3 °C above the numeric criteria apply as well. It is very unlikely that river temperatures will be below 13 °C as a 7dAM during the summer period.

Application to point source heat load limits

To apply this provision in a permit effluent limit, two possible approaches are described below:

1. Apply one heat load limit throughout the spawning season based on whichever of the following scenarios allows the smallest heat load to ensure the criteria are met throughout the season:
   - Determine the 60-day average maximum temperature for the coldest 60-day period within the spawning season; calculate a heat load limit based on the allowed warming above that value.
   - Determine the 7-day average maximum temperature for the beginning and end of the spawning season. If that value is 13.0 °C or higher, calculate a heat load limit based on the allowed 0.3 degree increase above 13.0 °C (see discussion of the human use allowance below).

2. Apply permit limits that vary through the spawning season, for example a monthly limit, based on whichever of the following scenarios allows the smallest heat load to ensure the criteria are met for the worst case conditions that occur during that month:
   - Determine the coldest rolling 60-day average maximum that includes the month and calculate the source's allowed increase over that value.
   - Determine the 7-day average maximum temperature for the months at the beginning and end of the spawning season. If the 7-day average maximum for any 7-day period during the month exceeds 13.0 °C or higher, calculate a heat load limit based on the allowed 0.3 degree increase above 13.0 °C.

See Section 5.5 for more information on applying this criterion in permits.

Section 3.9 The Human Use Allowance

Purpose

The purpose of the human use allowance provision of the temperature standard is to allow some human use of the State's waters and/or some human activity on the landscape that will not cause a biologically significant increase in water body temperature. Many Oregon streams would not be able to meet the numeric criteria, which were established to provide high quality fish habitat, even under natural conditions. The criterion that applies in these cases is the "natural conditions" narrative found at OAR 340-041-0028(8). Without the human use allowance, there would be no thermal assimilative capacity in these streams; the standard would require eliminating all human influence. While an objective of the standard is to minimize the impact from human activity, a 0.3 degree increase would not impair uses and prevents the need to prohibit any activity that could have even a very minor or "de minimis" affect on stream temperature.

This provision, together with the cold water protection provision, provides a more equitable way to distribute the available thermal assimilative capacity in a basin. Without these provisions, upstream sources would be allowed to use any available assimilative capacity and warm streams up to the criteria, leaving no thermal loading capacity for downstream sources.

Rule language

OAR 340-041-0028(12) (b) Human Use Allowance. Insignificant additions of heat are authorized in waters that exceed the applicable temperature criteria as follows:

(A) Prior to the completion of a temperature TMDL or other cumulative effects analysis, no single NPDES point source that discharges into a temperature water quality limited water may cause the temperature of the water body to increase more than 0.3 degrees Celsius (0.5 Fahrenheit) above the applicable criteria after mixing with either 25% of the stream flow, or the temperature mixing zone, whichever is more restrictive; or

(B) 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 (0.5 Fahrenheit) above the applicable criteria after complete mixing in the water body, and at the point of maximum impact.

(C) Point sources must be in compliance with the additional mixing zone requirements set out in OAR 340-041-0053(2) (d).

(D) A point source in compliance with the temperature conditions of its NPDES permit is deemed in compliance with the applicable criteria.

Definitions

"NPDES point source" means a source that discharges pollutants into the State's waters and is, therefore, required to have a permit from DEQ. NPDES stands for National Pollutant Discharge Elimination System.

7Q10 low flow means the lowest 7-day streamflow period during the year with a 10-year recurrence interval, which is the 10^{th} percentile of the distribution of annual 7-day low flows over a long term record. The 7Q10 low flow can also be calculated for particular months or seasons.

Application prior to a TMDL or cumulative effects analysis

Prior to the development of a TMDL or other cumulative effects analysis, the human use allowance is applied on a per source basis for permitted point sources.

In waters that exceed the numeric criteria or estimated natural thermal potential, no single point source is allowed to increase the stream temperature more than 0.3 °C above the applicable criteria assuming mixing with 25% of the receiving stream's 7Q10 low flow. The source must meet this criterion at all flows at or above the 7Q10 low flow.

To calculate the allowed heat load for a point source discharge, the reference temperature used as the basis for the allowed increase is the numeric criterion or natural thermal potential, whichever applies. A thermal balance equation is used to calculate the allowed effluent heat load such that upon mixing with 25% of the streamflow (or at the edge of the mixing zone, whichever is more restrictive), the discharge will not increase the reference temperature by more than 0.3 °C. This is more conservative than allowing a source to increase the temperature by 0.3 °C above the existing upstream temperature because the human use allowance applies where the existing river temperature is higher than the numeric or natural condition criteria (the reference temperature). The cooler the reference temperature, which represents the stream temperature, the less heat may be added by mixing with warm effluent to stay within the 0.3 °C allowed increase.

For more discussion and an example of how to calculate a permit effluent limit using the pre-TMDL human use allowance provision, see Chapter 6, "Implementing the Temperature Standard in NPDES Permits."

Application following a TMDL or cumulative effects analysis

Following the development of a TMDL or other cumulative effects analysis, the human use allowance rule limits the cumulative increase in stream temperature allowed from all sources, point sources and nonpoint sources. All human sources and activities together may not increase the temperature of the river more than 0.3 °C above either the numeric criteria or natural thermal potential. In this case 100% of the streamflow is use to calculate the allowed increase, rather than the 25% streamflow used in the 'per source' provision described above. This provision must be met when the streamflow is at or above the 7Q10 level. Also, it must be met at the "point of maximum impact," the point along the stream or a downstream water body, where all human sources of warming cumulatively have the greatest impact on stream temperature.

The allocation of the total allowed load among various point and nonpoint sources is determined through the TMDL process. See Chapter 4, *Developing TMDLs for Temperature,* for further discussion.

Section 3.10 Narrative Criteria for Salmon and Steelhead Migration Corridors

Purpose

There are two narrative statements included in the migration corridor criteria in addition to the numeric criterion. The purpose of the first narrative is to ensure that sufficient colder water refugia are protected in the otherwise warmer waters of migration corridors. As the temperature of the river increases, the role of colder water refugia becomes more important in enabling fish to migrate though the water body without impairment.

The purpose of the second narrative requirement is to protect or restore natural seasonal thermal patterns in the Columbia and Snake Rivers. Because these rivers are regulated with multiple main stem dams, they are susceptible to shifts in seasonal thermal patterns that may impact the fish uses even if the summer maximum criterion is not exceeded. Large reservoirs tend to keep the downstream river temperature warm later in the fall and cool later in the spring than would occur naturally.

Rule Language

OAR 340-041-0028 (4) (d).…(Numeric criterion)…In addition, these water bodies [referring to migration corridors] must have coldwater refugia that are sufficiently distributed so as to allow salmon and steelhead migration without significant adverse effects from higher water temperatures elsewhere in the water body. Finally, the seasonal thermal pattern in Columbia and Snake Rivers must reflect the natural seasonal thermal pattern;

Definitions

"Cold Water Refugia" means those portions of a water body where, or times during the day when, the water temperature is at least 2 degrees Celsius colder than the daily maximum temperature of the adjacent well-mixed low of the water body. OAR 340-041-0002(10)

"Migration corridor" means those waters that are predominantly used for salmon and steelhead migration during the summer and have little or no anadromous salmonid rearing in the months of July and August. These uses are designated on the following subbasin maps set out at OAR 340-041-0101 to 340-041-0340: Tables 101B and 121B, and Figures 151A, 170A and 340A.

Migration corridors

Migration corridors are generally lower main stem reaches that are expected to get relatively warm in the summer. In all but the warmest months, however, low to moderate temperatures are needed to protect migrating adult or juvenile fish.

Water bodies currently designated as migration corridors include:

- Columbia River, mouth to WA border,
- Snake River, WA border to ID border,
- Willamette River, mouth to RM 50,
- John Day River, mouth to the North Fork John Day,
- Catherine Creek, mouth to Little Creek, and Little Creek (Grande Ronde basin), and
- Small lower segments of the Coos River, Coalbank slough, Catching slough and Coquille River (South Coast basin).

Application of the coldwater refugia narrative

The cold water refugia narrative applies only to water bodies designated as migration corridors. Migration corridors are often too large and low in the system to be kept cool by vegetative shade and groundwater inflow, although these factors can be important to maintaining refugia in these systems. Refugia may be located where there are deep pools, vegetative or topographic shade, the inflow of cold groundwater or tributaries, hyporheic exchange or a combination of these factors. Fish will move into refugia if the temperature of the stream flow becomes too warm.

Migration corridors should be surveyed for existing and potential cold water refugia. Existing refugia should be protected by maintaining or enhancing vegetative shade, protecting cold water inputs from groundwater or tributaries and protecting pools from filling (i.e. due to sediment deposits) or other physical alterations. Potential refugia should be restored by enhancing these characteristics where they have been previously altered by human activity. Implementation of this narrative will most likely occur during the development of and following a TMDL. Implementation that pertains to nonpoint source activities will likely be assigned to Designated Management Agencies.

Point source thermal discharges should not be placed in a location that will degrade or destroy cold water refugia. DEQ can implement this provision for point sources through our NPDES permits.

How to determine whether cold water refugia are sufficiently distributed

At this time, determining whether cold water refugia are sufficiently distributed to allow salmon and steelhead migration without impairment must be based on best professional judgment. There is no objective analytical method available to determine this. In addition, the answer to this question will vary from river to river, depending on other factors. The role of refugia and their ability to ameliorate the impacts of exposure to warmer temperatures during parts of the day is not well understood.

Methods to identify existing and potential cold water refugia include longitudinal temperature data, such as can be collected using FLIR technology and studies of historical channel morphology to identify or estimate how many pools were present prior to human alteration. Another may be to look at a nearby streams or reaches that have not been altered to better understand how much refugia to expect and where the refugia may be located.

EPA has funded the development of a guide for addressing cold water refugia, which is expected to be completed in 2008.

Application of the seasonal thermal pattern narrative

The natural seasonal thermal pattern (NSTP) narrative criterion applies specifically to the main stem Columbia and Snake Rivers. These are highly managed rivers due to the multiple large dams. The criterion requires that the Snake and Columbia rivers be managed such that seasonal changes in water temperature reflect the natural seasonal temperature pattern. This means that fall cooling and spring warming of river temperatures should not be significantly delayed as a result of the management of the dams and reservoir releases. Fall cooling is important to protect the migration of adult salmon upstream and spawning. Many northwest rivers cool quite rapidly in the fall. In addition, winter temperatures should drop below the spawning criterion to protect the survival of incubating eggs and the appropriate timing of development, hatch and emergence.

The natural seasonal thermal pattern of these rivers may be estimated by modeling, by monitoring upstream reaches unaffected by the reservoir, or by comparison to similar nearby rivers or large tributaries.

See Chapter 7, *Hydroelectric Project 401 Certifications,* for further discussion on the implementation of the NTSP criterion.

Section 3.11 Bull Trout Spawning Narrative Criterion

Purpose

The purpose of this narrative criterion is to ensure that bull trout spawning waters that occur below reservoirs are not significantly warmed by reservoir releases during the spawning and egg incubation period.

Rule Language

OAR 340-401-0028 (4) (f) …(Numeric criterion)...From August 15 through May 15, in bull trout spawning waters below Clear Creek and Mehlhorn reservoirs on Upper Clear Creek (Pine Subbasin), below Laurance lake on the Middle Fork Hood River, and below Carmen reservoir on the Upper McKenzie River, there may be no more than a 0.3 degrees Celsius (0.5 Fahrenheit) increase between the water temperature immediately upstream of the reservoir and the water temperature immediately downstream of the spillway when the ambient seven-day-average maximum stream temperature is 9.0 degrees Celsius (48 degrees Fahrenheit) or greater, and no more than a 1.0 degree Celsius (1.8 degrees Fahrenheit) increase when the seven-day-average stream temperature is less than 9.0 degrees Celsius.

Policy

This narrative criterion limits the human warming allowed in specified bull trout spawning waters. Bull trout are a federally listed T&E species.

There is no numeric criterion set specifically to protect bull trout spawning, thought the 12° criterion for streams having bull trout spawning and juvenile rearing use applies year round. It is expected that where the 12.0 °C criterion for bull trout juvenile rearing, or natural thermal potential, is met during the warmest week of the year, the condition of the stream is such that the natural thermal regime and appropriate spawning and incubation temperatures are protected as well. Where bull trout spawning occurs below reservoirs, however, this assumption may not hold. Reservoirs tend to delay fall cooling and may keep the water temperature too warm for the spawning period and part of the incubation period. Therefore, this narrative was included to protect bull trout spawning and incubation waters that occur below reservoirs.

Application

This narrative applies only in the locations specified in the rule language above from August 15 to May 15 of each year. These are the only locations where bull trout spawning occurs below reservoirs. These streams and the reservoirs are subject to other temperature criteria as well. The bull trout spawning narrative criterion is added to, not a substitute for, other applicable temperature criteria.

Monitoring

To determine compliance with this criterion, the upstream measurement should be taken in a well mixed portion of the river(s) immediately upstream of the influence of the reservoir, where the stream is still free flowing. If groundwater input into the reservoir is significant, this should be accounted for as well. The downstream measurement should be taken in the stream channel at the nearest point downstream of the spillway where the spillway discharge is mixed with the streamflow, or just below the spillway if the flow from the spillway is the entire flow of the stream (i.e. there is no other instream flow to mix with).

The unit of measurement is the 7-day average maximum temperature.

Section 3.12 The Cool Water Species Criterion

Purpose

The purpose of this narrative criterion is to protect cool water fishes and other cool water aquatic biota from impairment associated with anthropogenic warming of their habitat.

Rule Language

OAR 340-041-0028(9) Cool Water Species.
(a) No increase in temperature is allowed that would reasonably be expected to impair cool water species.
(b) See OAR 340-41-0185 for a basin specific criterion for the Klamath River.

OAR 340-041-0185 (2) Temperature. From June 1 to September 30, no NPDES point source that discharges to the portion of the Klamath River designated for cool water species may cause the temperature of the water body to increase more than 0.3 °C above the natural background after mixing with 25% of the stream flow. Natural background for the Klamath River means the temperature of the Klamath River at the outflow from Upper Klamath Lake plus any natural warming or cooling that occurs downstream. This criterion supersedes OAR 340-041-0028(9) (a) during the specified time period for NPDES permitted point sources.

Effectiveness

This rule has not yet been approved by EPA and, therefore, is not effective for all Clean Water Act purposes. However, because the standard is more protective for streams that were previously designated for cool water use (no salmonid use); which include the lower Owyhee and Malheur Rivers, the Klamath River from Klamath Lake to Keno dam, and the Lost River (Klamath basin); the new criterion is effective for NPDES permitting on these streams.

DEQ should not implement this criterion for reaches that were formerly designated for salmonid uses. In these reaches, the new standard is less stringent and therefore not effective until both the criterion and the new cool water use designations have been approved by EPA.

Definitions

“Cool-Water Aquatic Life” means aquatic organisms that are physiologically restricted to cool waters, including but not limited to native sturgeon, Pacific lamprey, suckers, chub, sculpins, and certain species of cyprinids (minnows).

Basins that contain cool water species

The following basins contain water bodies or water body segments designated for cool water species use:

- Goose and Summer Lakes Basin (Table 140B)
- Klamath Basin (Figure 180A)
- Malheur Lake Basin (Table 190B)
- Malheur River Basin (Figure 201A)
- Owyhee Basin (Table 250B)
- Willamette Basin (Figure 340A)

(OAR 340-041-140, -180, -190, -201, -250 and -340)

Policy

This criterion limits anthropogenic warming of streams that would reasonably be expected to impair cool water species.

A site specific criterion was adopted for the Klamath River because it is expected to be easier to implement and this reach has a couple of point sources that require NPDES permits. Also, Klamath Lake may be used to set the natural background temperature for this reach.

How to determine whether an increase will impair cool water species

The Department must determine whether a proposed temperature increase would reasonably be expected to impair cool water species. The Department may take a step wise approach to this analysis. First, it is reasonable to conclude that if a source can meet the redband trout criterion of 20 °C plus the human use allowance, their increase will not impair cool water species, which have more tolerance of warm temperatures than trout.

If a source can not meet the redband trout criterion, the Department will determine what cool water species are present and develop a reference temperature based on the thermal tolerance information available for those species or closely related species. The source would then be limited to a 0.3 °C increase above that reference temperature.

The Department will base its evaluations on the best available information and professional judgment. The Department will consult biologists from ODFW, other agencies or academic institutions, if available. Pertinent information would include, the species present and their thermal requirements, physical characteristics of the water body, current ambient temperatures and the magnitude, duration and frequency of the proposed temperature increase.

Section 3.13 Oceans and Bays Criterion

Purpose

The purpose of this narrative criterion is to prevent anthropogenic warming of ocean and bay waters that would harm fish, shellfish and other aquatic life.

Rule Language

OAR 340-401-0028 (7) Oceans and Bays. Except for the Columbia River above river mile 7, ocean and bay waters may not be warmed by more than 0.3 degrees Celsius (0.5 degrees Fahrenheit) above the natural condition unless a greater increase would not reasonably be expected to adversely affect fish or other aquatic life. Absent a discharge or human modification that would reasonably be expected to increase temperature, DEQ will presume that the ambient temperature of the ocean or a bay is the same as its natural thermal condition.

Effectiveness

This criterion has not yet been approved by EPA and is therefore not effective for Clean Water Act purposes. However, this standard is essentially the same as the previously approved criterion for marine and estuarine waters, and therefore, should be used for NPDES permitting purposes as a requirement of state law.

The former criterion [OAR 340-041-basin (b)(D)] said: "Marine and estuarine waters: No significant increase above natural background temperature shall be allowed, and water temperatures shall not be altered to a degree which creates or can reasonably be expected to create an adverse effect on fish or other aquatic life."

Definitions

"Oceans Waters" means all oceanic, offshore waters outside of estuaries or bays and within the territorial limits of Oregon. OAR 340-041-0002 (41)

"Ambient stream temperature" means the stream temperature measured at a specific time and place. The selected location for measuring stream temperature must be representative of the stream in the vicinity of the point being measured. OAR 340-041-0002 (2)

Policy

This criterion limits anthropogenic warming of natural ambient ocean and bay temperatures to 0.3 °C outside an assigned mixing zone unless the source can demonstrate that additional warming would not reasonably be expected to adversely affect fish or other aquatic life. This criterion specifies a total allowable warming from all anthropogenic sources in total, point and nonpoint source, not an increase for each source independently.

Current ambient ocean and bay temperatures will be presumed to be at or near natural background condition unless there have been human activities or discharges that would reasonably be expected to have altered the temperatures of the ocean or bay waters outside an assigned mixing zone.

Application

This criterion applies to ocean waters and bays, not to estuarine portions of rivers and streams. It is determined by the physical feature, not the salinity of the water. For the Columbia River, however, the rule specifically states that this criterion does apply below river mile *7 (Is there a landmark for where RM7 is located?).* In other cases where it is not easy to discern where the bay ends and the river begins, DEQ must use best professional judgment until these boundaries are delineated.

How to determine a greater increase could be allowed

In order for the Department to allow an increase greater than 0.3 °C, a source(s) would need to demonstrate to our satisfaction that the greater increase would not "reasonably be expected to adversely affect fish or other aquatic life." It is not the DEQ's responsibility to prove that there would be an adverse affect. The Department will base its determination on the best available information and professional judgment. The Department will consult biologists or other experts on the ocean waters or bay in question from ODFW, other agencies or academic institutions if available.

Pertinent information would include current ambient temperatures, the species present and their thermal requirements, physical characteristics of the water body (i.e. currents, tides, river inflows, etc.), whether the bay has been altered or impacted by human activity in the past, and the magnitude, duration and frequency of the proposed temperature increase.

Section 3.14 Natural Lakes Criterion

Purpose

The purpose of this criterion is to prevent anthropogenic warming of natural lakes that would harm fish and aquatic life or other beneficial uses.

Rule Language

OAR 340-041-0028 (6) Natural Lakes. Natural lakes may not be warmed by more than 0.3 degrees Celsius (0.5 degrees Fahrenheit) above the natural condition unless a greater increase would not reasonably be expected to adversely affect fish or other aquatic life. Absent a discharge or human modification that would reasonably be expected to increase temperature, DEQ will presume that the ambient temperature of a natural lake is the same as its natural thermal condition.

Effectiveness

This criterion has not yet been approved by EPA and is therefore not yet the effective standard for Clean Water Act purposes. However, because this criterion is the same as or more stringent than the formerly approved criterion, DEQ should begin using the criterion for NPDES permitting immediately.

The former criterion for lakes [OAR 340-041-basin (b) (A) (ix)] said: "…unless specifically allowed under a Department-approved surface water temperature management plan…no measurable surface water temperature increase resulting from anthropogenic activities is allowed… in natural lakes." 'Measurable' was defined as 0.25°F.

Definitions

"Ambient stream temperature" means the stream temperature measured at a specific time and place. The selected location for measuring stream temperature must be representative of the stream in the vicinity of the point being measured. OAR 340-041-0002 (2)

Policy

This criterion limits anthropogenic warming of natural lake temperatures to 0.3 °C outside an assigned mixing zone, unless the source can demonstrate that additional warming would not reasonably be expected to adversely affect fish or other aquatic life. This criterion specifies a total allowable warming of lake waters from all anthropogenic sources, point and nonpoint, not an increase for each source independently.

Current ambient lake temperatures will be presumed to be at or near natural background condition unless there have been human activities or discharges that would reasonably be expected to have altered the lake's temperature outside an assigned mixing zone. If thermal impacts have occurred, the Department must estimate the natural lake temperature and what loading would be allowed to ensure the lake is not increased more than 0.3 °C above that natural reference temperature.

Application

This criterion applies to lakes, not to reservoirs. For the purpose of applying this criterion, if a natural lake has been modified and is somehow managed lake, it is still a lake, not a reservoir, and this criterion applies. The numeric criteria in 340-041-0028(4) do not apply to lakes, but they do apply to reservoirs. Reservoirs were originally flowing waters, and are still part of the flowing water system through which migrating fish must pass.

This criterion means that in no location within the lake outside the assigned mixing zone may the lake be warmed by more than 0.3° from human activity. In other words the 0.3° increase may not extend past a spatially designated mixing zone. It is not calculated based on a heat load being completely mixed with the full lake volume.

How to determine a greater increase could be allowed

In order for the Department to allow an increase greater than 0.3 °C, the source would need to demonstrate to the Department's satisfaction that the greater increase would not "reasonably be expected to adversely affect fish or other aquatic life." It is not DEQ's responsibility to prove that there would be an adverse affect. The Department will base its determination on the best available information and professional judgment. The Department will consult a biologist or other expert(s) on the lake in question from other agencies or academic institutions if available.

Pertinent information would include the current ambient lake temperature, the resident species of the lake and their thermal requirements, lake characteristics (i.e. size, productivity, stratification, etc.) whether the lake has been altered or impacted by human activity in the past, and the magnitude, duration and frequency of the proposed temperature increase.

Section 3.15 Borax Lake Chub Criterion

Purpose

The Borax Lake chub is the only native warm water species in Oregon. Its habitat is associated with warm water springs and lakes in the arid south central part of the State. The purpose of this criterion is to ensure that the Borax Lake chub, a federally listed endangered species, is protected from human caused alteration of its thermal environment.

Rule Language

OAR 340-041-0028(10) Borax Lake Chub. State waters in the Malheur Lake Basin supporting the Borax Lake chub may not be cooled more than 0.3 degrees Celsius (0.5 degrees Fahrenheit) below the natural condition.

Effectiveness

This rule has not yet been approved by EPA and therefore is not effective as a federal water quality standard. DEQ should not implement this standard prior to EPA action. The waters this criterion applies to were formerly designated for trout use. Therefore, the new standard is less stringent than the former standard and should not be implemented until both the new use designation and the new criterion are approved by EPA.

Policy

Waters where Borax Lake chub is the designated fish use may not be cooled by more than 0.3 °C from the natural lake temperature. This is a total allowed cooling from all human activity and sources. The prior rule had no criterion for Borax Lake chub.

Application

This criterion applies to waters associated with Borax Lake and Lower Borax Lake, including lake outflows, in the Alvord Subbasin of the Malheur Lake Basin in south central Oregon.

Section 3.16 Thermal Plume Requirements for Point Sources

Purpose

The purpose of the temperature requirements for thermal plumes is to protect salmonids from acute or short term impacts close to a point of discharge (for example, within the permitted mixing zone). Because the temperature criteria must be met after mixing with the receiving water, the temperature of the effluent itself could be quite a bit warmer than the numeric criteria and could create a relatively warm plume for a short distance downstream of the discharge. The temperature requirements for thermal plumes are intended to prevent short term lethality, thermal shock, migration blockage, and/or impacts to spawning and incubation.

Rule Language

OAR 340-041-0053(2) (d) Temperature Thermal Plume Limitations. Temperature mixing zones and effluent limits authorized under 340-041-0028(12) (b) will be established to prevent or minimize the following effects to salmonids inside the mixing zone:

(A) Impairment of an active salmonid spawning area where spawning redds are located or likely to be located. This adverse effect is prevented or minimized by limiting potential fish exposure to temperatures of 13 degrees Celsius (55.4 Fahrenheit) or more for salmon and steelhead, and 9 degrees Celsius (48 degrees Fahrenheit) or more for bull trout;

(B) Acute impairment or instantaneous lethality is prevented or minimized by limiting potential fish exposure to temperatures of 32.0 degrees Celsius (89.6 degrees Fahrenheit) or more to less than 2 seconds;

(C) Thermal shock caused by a sudden increase in water temperature is prevented or minimized by limiting potential fish exposure to temperatures of 25.0 degrees Celsius (77.0 degrees Fahrenheit) or more to less than 5 percent of the cross section of 100 percent of the 7Q10 low flow of the water body; the Department may develop additional exposure timing restrictions to prevent thermal shock; and

(D) Unless the ambient temperature is 21.0 degrees or greater, migration blockage is prevented or minimized by limiting potential fish exposure to temperatures of 21.0 degrees Celsius (69.8 degrees Fahrenheit) or more to less than 25 percent of the cross section of 100 percent of the 7Q10 low flow of the water body.

Definitions

"Salmonids" means native salmon, trout, mountain whitefish, and char (including bull trout). For purposes of Oregon water quality standards, salmonid does not include brook or brown trout since they are introduced species.

"7Q10 low flow" means the seven-day average low flow that recurs once in 10 years, statistically, based on a long term flow record.

Application

The thermal plume requirement for spawning applies where the actual spawning habitat is located, whether it is within the mixing zone or downstream. The objective is to limit fish, eggs and aelvin exposure to temperatures warmer than 13 °C.

All the other thermal plume requirements apply at the edge of the zone of initial dilution or immediately upon entry into the receiving water and until the thermal plume is completely mixed with the receiving water.

These requirements may affect the heat load a point source is allowed to discharge and, therefore, their effluent temperature limit. They may also affect where the discharge may be located or how it is dispersed into the water body, for example whether a diffuser is required.

The thermal plume requirements for thermal shock and migration blockage apply to all salmonid (cold water) fish use sub-categories, not just migration corridors.

For more information on how to calculate temperature effluent limits to meet these requirements, see Chapter 6 on NPDES permits.

Chapter 4 Developing Total Maximum Daily Loads for Temperature

Section 4.1 Overview

What is a TMDL?

TMDL stands for total maximum daily load, an expression of the total amount of a pollutant, in this case heat, that can enter a water body without causing the water body to exceed the temperature standard. The TMDL must take into account the natural background level and then determine the additional loading capacity (or assimilative capacity) available to allocate to point and nonpoint anthropogenic sources. Often a portion of the total load is reserved for future growth and development or as a margin of safety. A wasteload allocation is then assigned to each point source and a load allocation is assigned to groups of nonpoint sources, background, margin of safety and/or reserve for future growth and development.

When a temperature TMDL is required

A temperature TMDL is required for streams listed on the 303(d) list as water quality limited for temperature and in need of a TMDL. Streams are listed as water quality limited if they are found to violate the temperature standard based on the minimum data quality requirements during DEQ's biennial water quality assessment.

What this chapter covers

This document does not describe step by step how to do a temperature TMDL, but rather refers the reader to the TMDL documents for detailed information. This chapter does provide general discussion, however, of some of the primary issues DEQ staff must address in developing a TMDL and some of the policy decisions the agency has made regarding implementation of the temperature standard via TMDLs; including:

- scoping the spatial and temporal scale of the TMDL,
- identifying useful analytical methods,
- estimating natural thermal potential,
- addressing model assumptions and limitations (e.g. boundary conditions, model error, natural condition inputs, etc.)
- determining the cumulative human use allowance and the point(s) of maximum impact (POMI), and
- allocating heat loads among point and nonpoint sources, margin of safety and reserve capacity for future growth.

Completed TMDLs based on the 2003 temperature standards

The following TMDLs, based on the temperature standards adopted in 2003, have been completed by DEQ and approved by EPA:

1. Walla Walla Sub-Basin TMDL, approved by EPA September, 2005
2. Sandy River Sub-Basin TMDL, approved by EPA April, 2005
3. Willamette Basin TMDL, approved by EPA September, 2006.
4. Umpqua Basin TMDL, approved by EPA April, 2007.
5. Willow Creek Sub-Basin TMDL, approved by EPA February, 2007.

Additional temperature TMDLs are under development or have been submitted to EPA.

TMDL documents are available on the internet at www.deq.state.or.us/wq.

Section 4.2 Determining the Appropriate TMDL Targets

The numeric temperature criteria or natural thermal potential

An important early step in developing a temperature TMDL is determining the applicable numeric criteria for the streams included. Where the current ambient temperature is higher than the numeric criteria (i.e. water quality limited), the TMDL will target either the applicable numeric criteria or the natural condition temperature if natural condition is warmer than the numeric criteria.

The human use allowance

The TMDL must also determine the heat load allowed by the post-TMDL cumulative human use allowance narrative criterion. This heat load is calculated or modeled based on an allowed increase above the applicable numeric criteria or natural thermal potential.

Targets for reaches not water quality limited

There will likely be reaches or tributaries within a TMDL sub-basin/basin that currently meet the numeric temperature criteria (i.e. high quality water). If anthropogenic loading in these reaches contributes to an exceedence of the criteria downstream, or if that load affects the cumulative anthropogenic increase at the point of maximum impact, allocations will be given to the contributing source(s). In this case, the temperature target will be lower than would otherwise be required to meet the temperature standard at the site of the discharge in order to reduce the anthropogenic warming that is contributing to the downstream exceedence.

In addition, high quality reaches are subject to the narrative cold water protection criteria, which limit anthropogenic increases above the current ambient temperature. Generally, this is a near field or local consideration and is not included in the TMDL, which is focused on the water quality limited reaches. Therefore, this would be evaluated during permit, 401 certification or water quality management plan (for nonpoint sources) development.

Are the designated uses and criteria appropriate?

When TMDL work begins for a sub-basin, information is gathered and local expertise is consulted to help with the process. It is possible that at this time, site specific information will be collected that indicates that the use designations for one or more reaches within the basin are not existing uses and/or are not consistent with the designation methods used during the last rule revision. If this is the case, DEQ should decide whether to revise the use designation and the applicable criteria prior to the TMDL, or whether the change wouldn't affect the TMDL and can wait for a future triennial review update.

Conversely, it is possible that DEQ would find, in the course of data gathering and analysis during TMDL development, that a use occurs where it is not currently designated. In this case, DEQ will need to decide whether an "existing" use is present and should be designated, and whether the TMDL will incorporate the new use and its related water quality criteria as targets.

Section 4.3 Scoping a TMDL – Spatial & Temporal Coverage

Determining the appropriate spatial scale

Temperature TMDLs have most often been done at the third (basin), fourth (sub-basin) or fifth (watershed) field HUC scale. Because there are usually multiple temperature-limited reaches in a sub-basin and because multiple sources may influence the point of maximum impact, it is more efficient to assess TMDLs at the basin/sub-basin scale rather than reach by reach. In addition, basin scale TMDLs may save time and resources for communities and other interested parties who would otherwise need to be involved in multiple TMDL development processes within a basin.

Identifying which reaches to model

Although the TMDL may include an entire sub-basin or basin, a detailed analysis of loading capacity is not done for all the river miles and tributaries in the basin. In determining which reaches and tributaries require detailed analysis or modeling, consider whether the reach or tributary:

1. has point sources discharges, dams or major flow modifications,
2. has the capacity to significantly affect the temperature or flow of the water quality limited reach, or
3. 3. contains important fish habitat, or is considered cold water refugia within the basin.

Is the stream currently in natural condition?

It is possible that a stream reach listed as water quality limited is currently at its natural thermal potential and that this can be determined without modeling. This may be possible if the sub-basin or watershed is relatively small and there is no anthropogenic activity currently impacting the thermal regime of the water body. It is unlikely that this situation would negate the need for a TMDL at a sub-basin scale, but it may be that some reaches within the basin do not need to be included for this reason. In this case, the load from those streams would be accepted as a boundary condition or natural background load to the streams they flow into.

Subject to Department approval, natural condition assessments may be submitted to DEQ as TMDL input. Such assessments should include a thorough description of existing conditions related to stream heat transfer and a complete description of past and present human activity in the watershed that could feasibly result in stream heating. Assessments should evaluate stream shade, flow, channel conditions and point source discharges.

Determining

TMDLs should be based on the critical condition or worst case scenario – the

the temporal scope of the TMDL

situation in which the standard is most likely to be exceeded or the waste load allocations would be difficult to achieve. The summer maximum critical condition is when stream temperatures are warmest and most likely to reach temperatures that cause adverse effects to fish and aquatic life. This is the time period when insolation is greatest and stream flows are low. Human activity that increases exposure of the stream to solar radiation (nonpoint sources) will have the greatest warming affect on the stream. To date, most streams are listed as water quality impaired during the summer warm period and this is when the most temperature data is available. In Oregon, the maximum weekly maximum stream temperature is most likely to occur in late July or August.

For streams affected by point source discharges, the critical condition could occur in the late summer or fall. Stream temperatures may not be as warm as they are in mid-summer, but the stream flows available for dilution may be at their lowest. Meeting the 0.3 °C human use allowance may be most difficult for point sources when stream temperatures are close to the numeric criteria and the streamflow available for dilution is low (i.e. T=18 or 16 °C and streamflow = 7Q10). The beginning of the fall spawning period, when flows are still low and the numeric criterion drops to 13°, may present another critical condition for point sources.

For streams affected by dams, the critical condition may be in the fall or early winter. Dam releases may keep summer flows higher and summer daily maximum temperatures lower than the natural condition. But often reservoirs retain heat longer and dam releases prevent river temperatures from dropping as quickly in the fall as they would under natural conditions. This can keep stream temperatures warmer than needed for upstream migration, spawning or egg development.

Section 4.4 Scoping the TMDL – Analytical Methods

Temperature modeling

Most temperature TMDLs use modeling to determine natural versus anthropogenic heating, whether the stream can meet the numeric temperature criteria and if not, the natural thermal potential (NTP) of the stream. If the NTP is warmer than the numeric criteria, NTP replaces the biologically based numeric criteria as the target for the TMDL. The modeling also helps DEQ to determine how much load reduction is necessary to meet the cumulative human use allowance. (See the Human Use Allowance section below for more information.)

Alternative to modeling – mass balance analysis

Modeling may not be necessary in a sub-basin where a mass balance analysis of thermal loading and stream temperature data under worst case conditions shows that a reduction in point source heat load will allow the numeric temperature criteria to be attained and the source(s) is(are) willing to make the needed reduction. This scenario is most probably rare.

In another scenario, there may be sub-basins that can not stay below the numeric criteria, have only one or 2 point sources or a dam, but are predominantly affected by nonpoint sources. In this case, if it can be shown that the point source or dam can meet a temperature increase limit of 0.1° (a share of the human use allowance) for example, and the nonpoint sources were treated as described below, modeling may not be necessary.

Alternatives to modeling – nonpoint source only streams

It is possible that a TMDL for a sub-basin with no point sources or dams would not require modeling. A temperature model estimates the instream temperatures that would result given stream and riparian area improvements, such as increasing shade, re-establishing natural streamflow and/or reducing channel width. Alternatively, without stream temperature modeling, the TMDL could provide surrogate targets for shade and other stream characteristics based on the same data and assumptions that would be used as temperature model inputs. Developing and calibrating a model to quantify the resultant instream temperature is costly and not necessary in order to know what actions must occur to meet the standard. Also, it is simply not practical to model every major stream in Oregon. This method may be implemented through generalized or site-specific shade modeling or calculation.

Section 4.5 Natural Thermal Potential

Definition

OAR 340-041-0002(39) "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.

Relation to "natural conditions"

Natural condition is the condition of the water body absent any anthropogenic influence. Natural thermal potential is our best estimate of what the stream temperature would be under natural conditions, knowing there are limitations to our ability to determine what the absolute natural condition would be absent any present or past human activity that could affect stream temperature.

Estimating NTP

In estimating natural thermal potential, DEQ will use a scientifically defensible method and the best available data. In many cases, modeling is the best method to estimate NTP. See the section below for more information on modeling. DEQ simulates hydraulics, heat, shade and temperature using a stream temperature model, calibrates the model to the sub-basin with recent data, and then estimates natural thermal potential using best available information on natural stream conditions. One common output of this analysis is a longitudinal profile of summer maximum stream temperatures (late afternoon during warmest weeks of summer). As discussed in the section on TMDL scoping, other time periods may also be analyzed if needed.

DEQ calibrates the model using recent data from the sub-basin and then runs one or more scenarios to estimate NTP. The inputs for modeling NTP are based on the best available data to estimate natural stream and riparian conditions, which may include vegetative and topographic shade, channel morphology, streamflow, and cold water inflows (such as tributaries or groundwater). Natural conditions are estimated based on existing areas of minimal disturbance, historic documents and photos, research, comparable watersheds, best professional judgment and available literature and data. Given there is limited or no historical data in some locations or for some parameters, there is uncertainty associated with some of these inputs, for example, channel morphology.

Addressing uncertainty

There will always be uncertainties in our best estimate of natural thermal potential stemming either from the constraints of the model or uncertainties in the data inputs to the model meant to characterize natural conditions. The TMDL document should discuss the sources of uncertainty and which we suspect could be significant factors. For example, a river may have the physiographic setting, channel morphology and substrate that we suspect would have resulted in significant hyporheic cooling prior to human modification. Even if we can not currently quantify the thermal affect of the hyporheic flows, we should recognize that our NTP estimate would likely be high if hyporheic flows were a significant factor that we could not account for.

Estimates of NTP may rely on application of conservative estimates of controlling factors in determining a margin of safety for the estimates. Using estimates that underestimate mitigating conditions generally result in a more conservative or protective estimate. These elements are commonly included in TMDL allocation schemes as implicit margins of safety.

One way to determine whether the uncertainty of an input variable is significant to the outcome of the model is to do a sensitivity analysis. A sensitivity analysis allows the modeler to evaluate how much the variability in a natural condition input (e.g. lower width to depth ratios or greater cold groundwater inflow during summer base flows) may affect the estimated NTP and document a range of natural thermal potential profiles if that is useful. Then the Department would have to decide which NTP within that range to use as a basis for allocating the human use allowance and for determining wasteload allocations. In Oregon's Willow Creek temperature TMDL, a range of temperatures and shade levels (and associated heat loads) were specified in an area of uncertain NTP vegetation characteristics.

Section 4.6 Modeling Considerations

What model to use

Staff developing the TMDL and providing technical assistance should discuss the model options and best fit for the sub-basin and parameters in question. In choosing a model, staff must determine whether the precision of the model allows us to answer the critical questions for the specific application.

The following models have recently been used by DEQ in developing temperature TMDLs. Others may be appropriate in particular circumstances or may be developed or improved in the future.

"Heat Source" (www.deq.state.or.us/wq/TMDLs/WQAnalTools.htm) is the model most commonly used by DEQ at this time. The model provides one-dimensional output for up to one year. However, due to slow run times, it is best used when simulations are needed for a time span of a few weeks or less. High resolution input data is required.

"CE-QUAL-W2" (http://www.ce.pdx.edu/w2/) has some advantages over Heat Source, but is more resource intensive. This model is two-dimensional and can simulate stream temperatures over time. It can also model other parameters such as dissolved oxygen and bacteria. (The user's manual is Cole, T.M. and S. Wells, 2000. CE-QUAL-W2: A Two-Dimensional, Laterally Averaged, Hydrodynamic and Water Quality Model, Version 3.) Because this model runs faster than Heat Source, it is more useful for multi-month or year simulations. However, because of stability issues, it is practical only for large rivers and not useful for small or high gradient streams.

"QUAL2K" (http://www.epa.gov/ATHENS/wwqtsc/html/qual2k.html) is a water quality model commonly used to model pH and dissolved oxygen in addition to temperature.

Which reaches to model

Only a small portion of the total stream miles in a sub-basin are modeled. To determine which reaches to model, consider the following:

- Feasibility of modeling (adequate flow, data and staff resources).
- Whether natural thermal potential temperature estimates are needed.
- The scale and distribution of the 303d listings. For example, if NTP is the applicable criterion on the main stem, it may be inferred that the natural conditions criterion applies on perennial tributaries as well. If there are no point sources on a tributary, shade curves could be used to determine load allocations, rather than modeling, saving considerable resources.
- Continuity - where feasible, model reaches should connect, reflecting the continuity of downstream heat and mass transfer.

- Reaches that represent the most and least anthropogenic heating. A total anthropogenic heat load can be determined for a river only if the simulation begins in relatively natural headwaters and ends at the river's mouth. In addition, the accuracy of the NTP determination in warm reaches relies on anchoring the model to relatively natural headwaters. Encompassing a wide range of elevations and stream temperatures along a single modeled artery is key to fully addressing the question of whether NTP exceeds the biologically-based numeric criteria at a variety of scales. This is one of the reasons for working at a subbasin or larger order scale.

Boundary conditions

For un-modeled tributaries to a modeled reach for which data is available, the current ambient temperature at the tributary mouth may be used as a boundary condition, particularly if that temperature is colder than the applicable numeric criterion. For tributaries for which data is not available, the modeler may estimate temperature from a nearby tributary of similar size and drainage area, or use the temperature criterion as the boundary condition.

Credible sources of data for estimating natural condition

In some cases there may be no credible source of data for model inputs if the stream has been altered for a long time and no historic data is available. This may be a common situation. For example, a dam that has been in place and has altered flow regimes for a long period of time may have altered the channel morphology and even substrate of the stream. If there is no credible way to reconstruct the pre-dam conditions, NTP may need to be estimated using current channel and substrate information. (See also the previous discussion on addressing uncertainty in estimating NTP.)

Identifying model limitations

Capturing and understanding variation across a complex landscape is a common challenge. Identifying specific limitations increases analytical credibility and focuses future monitoring and analytical advancements. Discussion of these limitations is included in documents that describe the models used to develop a TMDL or characterize natural thermal potential.

The precision of temperature models varies depending on the model and site-specific characteristics. In some situations a resolution of better than ±1.0 °C is achievable and in other situations, lower resolution is more likely. In addition to model resolution limitations, precision is lost in assessing model inputs such as natural channel geometry, hydraulics and stream shading. In modeling natural conditions, the capability to simulate changes in sinuosity and hyporheic exchange are currently minimal, due either to model limitations or practical issues regarding data collection.

Attempts at simulating historical conditions cannot be validated and are likely inadequate on multiple counts. Modeling applications should consider the degree of divergence between the hypothetical simulation conditions and the calibrated model condition.

Characterizing model error and uncertainty

Model error is quantified by comparing the calculated values for the calibration period to observed values for the same time period. Performance statistics should accompany TMDLs that include modeling. Common statistics are mean error, mean absolute error and root mean square error. A water quality model can accurately calculate heat load impacts that are less than the RMS error and ME of the model.

One source of uncertainty in a model comes into play when the model is calibrated under one set of conditions and then scenarios are run for conditions outside of the range of conditions used for the calibration and/or validation.

Another source of uncertainty when estimating natural condition is our inability to know what all the stream, riparian and floodplain characteristics were historically, or what they would be today absent any human impact or development. In this case we may only be able to identify expected or possible sources of error but we would not be able to quantify that error. A sensitivity analysis with the model could be used to identify how much the uncertainty in a particular attribute would affect the simulated temperature.

When modeling the impact of a heat load on stream temperature, the calibrated model is usually run with the heat load removed. It is then rerun with the heat load added back. The difference between temperatures calculated by the model for the two simulations is the impact of the heat load on temperature (the ΔT impact). When modeling is performed in this manner, most of the error associated with the model calibration cancels out. Therefore, models can accurately calculate ΔT impacts that are much smaller than calibration error of the model.

For example, the wasteload allocation for a point source may be designed to limit the impact of the discharge for a given flow to 0.1 °C using a model with an root mean squared (RMS) error of 0.5 °C, as follows:

Q_R=	10,000	River flow rate u/s from discharge, cfs
T_R=	20.0	River temperature upstream from discharge, °C
Q_E=	100	Effluent flow rate, cfs
ΔT=	0.10	Allowable temperature increase, °C
D_F=	101	Dilution Factor
T_E=	30.1	Allowable effluent temperature, °C

As shown, for the given flow rates and river temperature, an effluent temperature of 30.1 °C would result in a ΔT of 0.10 °C.

Since the river temperature upstream from the discharge is calculated using a model with an RMS error of 0.5 °C, it could range from 19.5 to 20.5 °C. If the river temperature were 19.5 °C, the ΔT impact of the discharge would be 0.105 °C, while if the river temperature were 20.5 °C, the impact would be 0.095 °C. Therefore, the ΔT impact of the effluent would be 0.10 ± 0.005 °C, which equates to an accuracy of ± 5%.

Section 4.7 The Cumulative Human Use Allowance

Cumulative human use allowance – post TMDL

The human use allowance is the temperature increase above the numeric criterion or natural thermal potential that is allowed due to anthropogenic activity. Following a TMDL, the human use allowance is the cumulative heat load that would cause a 0.3 °C increase in temperature above the NTP from all anthropogenic sources (point and nonpoint) combined at the point of maximum impact after mixing with 100% of the streamflow.

The human use allowance provides a margin of thermal load for discharges and other human activity along the stream that DEQ believes are biologically insignificant and in some cases, not measurable. The human use allowance provides for quantitative assessment and allowance of limited heat inputs, while minimizing ecological impacts. Without the human use allowance, the natural condition criterion would provide no assimilative capacity for any human heat sources or warming activities along a stream.

Cumulative effects analysis

Unless the human sources of heat load to a stream are very limited and discreet, a cumulative effects analysis will most likely require modeling. Through modeling, DEQ can determine the heat budget longitudinally (heat contributions and losses from the water as it travels downstream) along the river and the total heat load due to anthropogenic versus natural sources. Then DEQ can use the model to determine which sources contribute heat to the point of maximum impact and how much each source will need to reduce its load in order to meet the 0.3 °C increase limit.

Point of maximum impact (POMI)

The point of maximum impact is the location along a stream where the cumulative heat load from all human sources and activities results in the greatest increase in the temperature of the river above the estimated natural thermal potential. A typical temperature model output is a longitudinal profile (by river mile) of daily maximum stream temperature under current conditions and under natural thermal potential conditions. When comparing these longitudinal profiles, the point at which the difference between the 2 lines is greatest is the point of maximum impact. If the TMDL covers a large area, there may be more than one POMI as the effect of some sources dissipates or is diluted and the effect of others sources is added. The cumulative human use allowance allows no more than a 0.3 °C increase in the temperature of the river above the NTP at any point longitudinally along the river's course.

Section 4.8 Allocating the Loading Capacity (Cumulative Human Use Allowance) Among Multiple Sources

Allocating among sources

During TMDL development, DEQ must decide how to allocate the cumulative human use allowance between point sources, nonpoint sources, margin of safety and reserve capacity for future growth. In doing this DEQ must be able to show that the TMDL will meet the criterion (a 0.3 °C increase above NTP from all sources combined at the point of maximum impact) and that we must have some reasonable assurance that the load and wasteload allocations can be met. DEQ works with the sources and other interested parties in the basin throughout the TMDL development and load allocation process.

Loads assigned to nonpoint sources and background are called Load Allocations and loads assigned to point sources are call Wasteload Allocations.

In most cases, it is unlikely that nonpoint sources will be able to meet a load allocation of zero. If it is possible that a zero load allocation could eventually be met, it would likely take a very long time. In most sub-basins, there will continue to be some amount of disturbance from development and land management practices even if all land owners tried to apply best management practices.

DEQ is developing a separate document to provide internal guidance on how to allocate the total load among sources under a temperature TMDL. In addition, individual TMDL documents describe how this was done in each TMDL.

Allocating the nonpoint source load

There are numerous nonpoint sources of activity that may affect temperature and may receive a load allocation, including agricultural activity, forestry, irrigation return flows, hydrologic modifications, urban development and roads or railroads located adjacent to a stream. In the case of nonpoint sources, the load allocation is typically given to a designated management agency (DMA), which could be a state agency, such as the Oregon Departments of Forestry, Agriculture or Transportation, or a city, county or special district. The DMA is responsible for developing a water quality management plan describing how the land managers as a group will comply with their load allocation.

Section 4.9 How Load and Wasteload Allocations May be Expressed

Load allocations and surrogate measures

While a TMDL and its associated load allocations may be expressed as a total heat load, surrogate measures are typically provided for nonpoint source loads to translate the heat load value into a measurable target that relates more directly to land management practices.

Surrogate measures used in temperature TMDLs to date have included:
1. effective shade targets (often in turn translated into riparian vegetation targets),
2. channel widths, and
3. minimum flows (i.e. 401 certification flows for hydro projects).

Wasteload allocations

Wasteload allocations (WLAs) for point sources are quantitative so that they can be put into permits as thermal load limits. They will most often be expressed as an excess thermal load (ETL), explained further below. They will often be expressed as a formula used to calculate the allowed heat load based on variables that fluctuate, such as streamflow and upstream NTP temperature. Sometimes a spreadsheet or look up table is also provided in the TMDL document to show what the discharge temperature and flow volume must be under various conditions in order to meet the WLA.

Although an estimated NTP is often used as the TMDL target when WLAs and permit limits are calculated, the dilution available to the sources must be based on current stream flows and sources must be able to meet the criteria at a 7Q10 low flow condition.

Excess thermal load (ETL)

For a temperature TMDL, the wasteload allocation assigned to a point source will typically be expressed as an excess thermal load (ETL) in kilocalories per day (Kcal/day). The excess thermal load (ETL) allows the source a limited temperature increase (calculated and specified in the TMDL and their wasteload) above the applicable criteria for a given receiving water flow condition. The ETL may be expressed using one of the two equations shown here.

1. $ETL = \Delta T_{PS} \cdot (Q_E + Q_R) \cdot C_F$
2. $ETL = Q_E \cdot (T_E - T_C) \cdot C_F$

Where:

ETL = the excess thermal load in kilocalories per day (Kcal/day)
ΔT_{PS} = The maximum temperature increase not to be exceeded by the individual source, calculated and assigned in the TMDL.
Q_E = the point source effluent flow (CMS)
Q_R = the 7Q10 river flow (CMS)
T_E = the point source effluent temperature (°C) as a 7dAM
T_C = the applicable temperature criterion (°C); the biologically based numeric criteria or the NTP, whichever applies
C_F = a conversion factor for SI units and heat capacity = 86, 400,000 kcals/day ▪°C ▪ m^3

As an alternative, the wasteload allocation may be expressed as an allowed temperature increase (ΔT_{PS}) above the criterion. This is sometimes referred to as the "delta T," and is calculated using the following formula:

$$\Delta T_{PS} = \left(\frac{Q_E}{Q_E + Q_R} \right) \cdot (T_E - T_C)$$

Note: If using US customary units for flow (cfs), the conversion factor (C_F) to calculate thermal load in kcal/day is 2,446,665 kcal-s / °C-ft-day.

Example WLA expressed as an excess thermal load (ETL)

Due to rounding, ΔT_{PS} and ETL results may vary slightly.

Point Source	Receiving Stream	River Mile	T_E	Q_E	7Q10 low river flow	T_C	ΔT_{PS}	ETL (kcals/day)
Oregon Acme Inc	Clear River	10.5	30 °C	0.20 cms	14.0 cms	Core Cold 16.0 °C	0.197 °C	241.9 million
Oregon Acme Inc	Clear River	10.5	30 °C	0.30 cms	18.0 cms	Core Cold 16.0 °C	0.230 °C	362.9 million
Oregon Acme Inc	Clear River	10.5	27 °C	0.29 cms	20.0 cms	Spawning 13.0 °C	0.200 °C	350.8 million

Alternative ways to express or display a WLA

In some cases, the WLA may be presented as a table showing maximum allowed effluent temperatures or allowed temperature increases for various receiving water flow scenarios.

For smaller point sources, the WLA may be expressed as a single ΔT_{PS} and maximum effluent temperature limit ($T_{E, max}$) for the low flow receiving water condition (the 7Q10 or lowest 7-day average flow with a return period of 10 years). This would allow simpler reporting requirements.

A thermal load expressed using the formula below is an alternative that may be useful in limited circumstances. If this formula is used, the WLA must also include a maximum effluent temperature ($T_{E, max}$). If a permit contains only a ($Q_E \times T_E$) load limit, it may be possible for the source to exceed the temperature increase allocated to them in the TMDL (their portion of the human use allowance HUA, ΔT_{PS}) without exceeding their ($Q_E \times T_E$) limit. Adding a maximum effluent temperature ($T_{E, max}$), to the permit prevents this problem. The maximum effluent temperature limit would not need to be put into a permit if the facility has no reasonable potential to exceed that limit.

$$TL = \left(Q_E \times T_E\right) \times C_F$$

Where:
$T_E \leq T_{E, max}$
TL= the thermal load of the discharge (kcal/day).
Q_E = effluent flow (cms).
T_E = effluent temperature (°C)
$T_{E, max}$ = the maximum effluent temperature not to be exceeded (^oC)
C_F = 86,400,000 kilocalories-s / day-^oC-m^3

Section 4.10 Additional TMDL Implementation Questions

Temperature criteria that may not be addressed in the TMDL

TMDLs do not address the cold water protection criterion. If a source discharges to a water body to which the cold water protection provision applies, the permit writer must evaluate whether the thermal load for that source must be limited more than would be required by their wasteload allocation.

TMDLs also do not address thermal plume impacts, which are local or "near field" effects. Again, the permit writer must evaluate whether the thermal load limit for a source must be further restricted in order to meet the thermal plume limitations.

What to do when current temperatures are cooler than NTP?

In some cases, current summer stream temperatures are colder than the natural thermal potential due to flow augmentation from reservoirs. How should the TMDL address this situation?

If the current temperature is colder than the applicable biologically based numeric criterion, the cold water protection narrative criterion applies to streams with salmon, steelhead or bull trout, with some exceptions. If the current temperature is colder than the NTP but warmer than the numeric criterion, NTP is the applicable criterion. The natural condition criterion supersedes the numeric criteria when the natural condition is warmer than the numeric criteria.

However, when stream temperatures are higher than the numeric criteria, DEQ may assign a wasteload allocation based on the current upstream ambient T rather than NTP if current ambient T is lower than NTP. DEQ may limit the warming of waters colder than NTP in order to meet criteria downstream, protect the colder water habitat and/or reserve some assimilative capacity for future growth

DEQ does not have to give all the available assimilative capacity to sources in a TMDL. DEQ may limit warming in order to address far field effects or we may decide it is bad policy to give all the available assimilative capacity away if that would allow one source a very large heat load (i.e. a 0.3 °C increase above NTP when current ambient temperature is cooler). Cold water habitat is a valuable public resource. DEQ may want to hold the assimilative capacity as margin of safety, reserve for future growth or to simply to protect the cold water resource and beneficial uses.

In addition, antidegradation policies would apply to any proposed new or increased heat loading. DEQ would not typically give a source a WLA greater than their current heat load if the source discharges to a stream that exceeds the numeric criteria. DEQ's antidegradation policy requires sources to operate within their current permitted load until such time as the source does an antidegradation review and the Department or Commission approves a load increase.

It is also possible, depending on the particular situation, that restoring a more natural thermal regime would involve managing dam releases to allow increased summer temperatures in order to provide cool fall temperatures needed for the onset of spawning.

TMDLs completed prior to the new standard

A TMDL based on a standard that has been revised is still in effect until the TMDL is revised or revoked by the Department or disapproved by EPA. However, if a standard has been revised since the TMDL was completed, sources must also meet the new criterion. Therefore, if a water quality based effluent limit based on the new criterion is more stringent than the wasteload allocation; the permit limit must be based on the new criterion [40 CFR 122.44(d)]. Otherwise, the permit limit will be based on the wasteload allocation under the approved TMDL until the TMDL is revised under the new standard and a new wasteload allocation is assigned to the source.

An exception to this may be possible in certain circumstances if the previous TMDL is considered to remain an appropriate cumulative effects analysis for the purposes of the human use allowance [OAR 340-041-0028 (12) (b)].

Also, anti-backsliding provisions may apply to a proposed increase in the effluent load limit, even if the increase would meet a revised less stringent criterion. There is an exception to the prohibition on backsliding policy, however, if a TMDL is done and a new WLA is assigned in accordance with CWA Section 303(d) (4).

Chapter 5 Implementing the Temperature Standard in NPDES Permits – Reasonable Potential Analysis

Section 5.1 Overview

NPDES permits

A primary means for implementing water quality standards under the Clean Water Act is through National Pollutant Discharge Elimination System (NPDES) permits. Any point source that wants to discharge waste to Oregon waters must first obtain an NPDES permit from DEQ. These permits prescribe what treatment or control technologies or processes must be employed prior to discharge.

Permit limits for pollutants

NPDES permits also set limits, if needed, for the levels of pollutants that may be contained in the effluent when it is discharged to a receiving water. A permit limit is required if there is a “reasonable potential” that the discharge, even after meeting the required technology based controls, may cause or contribute to an exceedence of a water quality standard.

When a temperature limit should be included in the permit

A temperature limit will be included in an NPDES permit if there is a “reasonable potential” that the discharge will cause or contribute to an exceedence of the temperature standards (340-401-0028) or the thermal plume requirements in the mixing zone rules (340-041-053), or if the source has been given a wasteload allocation under a temperature TMDL. The permit limit may be written as a thermal load (e.g. kilocalories, BTUs) or a maximum effluent temperature.

Reasonable potential analysis (RPA)

This refers to the analysis done to determine whether there is a reasonable potential for a discharge to cause or contribute to the exceedence of the temperature standard. The method for conducting this analysis for temperature is described in Section 5.1 below.

Units

In calculating the potential of a source to exceed the temperature standard, or in setting effluent limits, 7dAM effluent temperature (T_E) data should be used if it is available. If the source does not have 7dAM effluent temperature data, the single maximum daily temperature may used instead. In order for the grab sample data to represent the daily maximum effluent temperature, the samples should be collected in the mid to late afternoon during the critical warm season.

For the equations in this chapter, if using U.S. customary units for flow (Cubit feet per second, cfs), the conversion factor to calculate a thermal load in kilocalories per day is 2,446,665 kcal-s / °C-ft-day.

What this chapter covers

Section 5.2. Tools available for permit writers.

How to determine whether a permit limit is required (reasonable potential analysis) for sources with no wasteload allocation (WLA):

> Section 5.3 - to meet the human use allowance (i.e. for streams that are water quality limited for temperature),
> Section 5.4 - for streams that meet the numeric temperature criteria,
> Section 5.5 - to meet the cold water protection criteria, and
> Section 5.6 - to meet the thermal plume limitations.

Section 5.7. Permitting discharges to oceans & bays.

Section 5.8. Permitting discharges to cool water streams (streams designated for cool water species use).

Section 5.2 Tools Available for Permit Writers

DEQ Intranet – Permit Writer's Corner

There are several tools available to permit writers on DEQ's intranet at the following link: http://deq05/wq/wqpermits/PCTools_Databases.htm

The tools include:

- DFLOW – to calculate 7-day low flows and other flow statistics.
- A Thermal Effluent Limits Spreadsheet, written by Steve Schnurbusch, DEQ Western Region.
- Permit wizards.
- Examples of permit evaluations for application of the temperature standard or a TMDL wasteload allocation.
- Other useful resources.

DEQ uses the USGS methodology for calculating streamflow statistics, which is a log 3 Pearson method. This is also the method used in DFLOW.

Water quality trading

Water quality trading may be a useful tool in some circumstances. Please see DEQ's Water Quality Trading IMD for information on DEQ's policies on water quality trading as an option for implementing water quality standards or wasteload allocations. The Trading IMD may be found at http://www.deq.state.or.us/wq/pubs/imds/wqtrading.pdf .

What to do when sufficient data is not available

When there is not sufficient data available to do the analysis and calculations as described in this chapter, the permit writer has the following options:

1. The permit writer can require the applicant to collect the necessary data, which will then be used to evaluate whether a permit limit is needed after one or two years. If the reasonable potential analysis shows that a permit limit is needed, the permit would be re-opened and modified to incorporate the limit.

2. If limited data is available, that data together with reasonable assumptions can be used to set permit limits that will ensure that the discharge will meet the criteria under "worst case" conditions. If and when additional data becomes available, the permit writer may re-open and modify the permit, or modify it upon subsequent renewal. An example may be a facility that has only grab sample effluent temperature data, not continuous data. In this case, the reasonable potential analysis and permit limit calculations could be based on the highest single daily maximum effluent temperature until additional data is collected, and then revised when there is sufficient data to calculate a

rolling 7dAM.

3. The permit may contain an interim limit to ensure the standards are not violated before sufficient data is collected to perform a reasonable potential analysis. For example, DEQ may propose an interim effluent temperature limit of 18.3 °C to ensure that the source will not increase the temperature more than 0.3 °C above the numeric criterion of 18 °C. Again, a re-opener clause should be included in the permit to allow the Department to adjust the permit limits during the term of the permit.

Where a permittee is required to collect data to evaluate reasonable potential and the need for a permit limit, they will typically be required to report that data with their monthly discharge monitoring reports (DMRs). The permittee may be required to collect effluent temperature and flow data and may also be required to collect stream temperature and flow data in some cases.

Section 5.3 Determining Whether a Permit Limit is Needed to Meet the Human Use Allowance

Temperature Limited Streams

pre-TMDL

The human use allowance narrative criterion applies if a stream is water quality limited. Additionally, the human use allowance applies if 1) temperature data show that the ambient temperature upstream of the source exceeds the numeric criteria or 2) the source contributes to a downstream listing for temperature impairment.

The permit writer may use the following mass balance formula to determine the temperature increase in the receiving water that will result from a point source discharge. If there is a reasonable potential for the source to cause an increase of more than 0.3 °C above the criteria on a weekly average basis, see Section 5.2 for information on how to calculate an effluent limit.

$$\Delta T_{MZ} = \frac{T_E - T_C}{D}$$

Where:
T_E = Effluent Temperature (°C), 7dAM
D = Dilution = $(Q_E + Q_R) / Q_E$

- Where Q_E = effluent flow = weekly average dry weather design flow (ADWDF). If not known, approximate by using 1.5 x monthly ADWDF.
- And where Q_R = receiving water flow = 25% of 7Q10 flow or the assigned mixing zone, whichever is more restrictive.

T_C = Temperature Criteria (°C)
ΔT_{MZ} = Temperature increase at edge of the regulatory mixing zone (°C). Should be ≤ 0.3 °C.

Note that for point sources that discharge into large rivers, the temperature mixing zone may be more limiting (provide less dilution) than 25% of the 7Q10 low flow of the river. Conversely, a medium to large point source discharging to a small stream may be limited by the 25% of low flow for mixing.

Example RPA-temperature limited stream, pre-TMDL, domestic facility, summer period

Given: A mid-size domestic treatment plant discharges year round and DEQ needs to determine whether a temperature limit is needed. According to fish use designation maps, salmon & trout rearing and migration is the year round use and salmon and steelhead spawning is designated from October 15th through May 15th. According to the 303d list, the receiving stream is water quality limited for temperature during the summer.

The permit writer must determine whether the human use allowance of the temperature standard will be met during the summer discharge period. A method for doing this analysis is shown here.

The following conditions exist for the summer period:

- Ambient stream temperature (7-day average maximum), T_R = 20 °C
- Temperature criterion, T_C =18 °C 7dAM
- Effluent temperature, T_E = 23 °C, 7dAM
- Effluent monthly ave. dry weather design flow (ADWDF) = 0.5 mgd
- Critical low flow (7Q10), Q_R = 34 cfs
- Allowable increase = 0.3 °C
- Dilution calculated from temperature mixing zone study = 10

Solution: The first step is to determine which mixing scenario is limiting, dilution from the mixing zone, or from 25% of the critical flow (7Q10). To calculate the dilution (D) available from 25% of the critical low flow:

1. Multiply monthly ADWDF by 1.5 to estimate weekly (mgd).
2. Multiply weekly ADWDF (mgd) by 1.547 to convert to cfs.
3. Q_E = 0.5 mgd (1.5)(1.547cfs/mgd) = 1.16 cfs
4. Q_R = 25% of 7Q10 = 0.25 x 34 cfs = 8.5 cfs
5. D= $(Q_E + Q_R)/Q_E$ = (1.16 + 8.5)/1.16 = 8.33

This dilution is less than the dilution from the mixing zone study and, therefore, will be used for the RPA analysis.

The second step is to determine whether the source causes more than a 0.3 °C increase above the temperature criterion in the receiving water.

$\Delta T = (T_E - T_C)/D$

ΔT = (23 – 18)/8.33 = 0.60 °C

Since 0.6 °C exceeds the allowable increase of 0.3 °C, there is a reasonable potential the source will exceed the human use allowance during the summer and a summer temperature limit is needed in the permit

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Example

For the 13° spawning criterion, the worst case condition may be the fall

RPA-temperature limited stream, pre-TMDL, domestic facility, spawning period

"shoulder season." The example below assumes this is the case. Spawning may begin any time from mid August to October for salmon, depending on the species. For steelhead and resident trout, spawning may not begin until January. In that case, the variables for calculating reasonable potential should be adjusted to be appropriate for winter conditions (i.e. wet weather design flow, winter time low river flows, etc.).

Given: A mid-size domestic treatment plant discharges year round and DEQ needs to determine whether a temperature limit is needed to ensure compliance with the temperature standard. According to the spawning use maps, salmon and steelhead spawning is designated for the receiving stream from October 15th through May 15th. According to the 303d list, the receiving stream is water quality limited for temperature during the spawning period.

The permit writer must determine whether the human use allowance will be met during the spawning period. A method for doing this analysis is shown here.

The following conditions exist for the spawning period:

- Temperature criterion for spawning through emergence, T_C =13 °C
- Effluent temperature, T_E = 16.1 °C, 7dAM
- Effluent monthly ave dry weather design flow (ADWDF) = 5 mgd
- Critical low flow (7Q10) for fall, Q_R = 128 cfs
- Allowable increase = 0.3 °C
- Dilution calculated from Temperature Mixing Zone Study = 5

Solution: The first step is to determine which mixing scenario is limiting, the temperature mixing zone, or 25% of the critical flow. To calculate the dilution (D) available from 25% of the critical low flow:

1. Multiply monthly ADWDF (mgd) by 1.5 to estimate weekly ADWDF (mgd).
2. Multiply weekly ADWDF (mgd) by 1.547 to convert to cfs.
3. Q_E = (5 mgd) (1.5) (1.547) = 11.6 cfs
4. Q_R = 25% of 7Q10 = 0.25 x 128 cfs = 32 cfs
5. D= $(Q_E + Q_R)/Q_E$ = (11.6 + 32)/11.6 = 3.8

This dilution (3.8) is less than the dilution from the mixing zone study (5) and, therefore, will be used for the RPA analysis.

The second step is to determine whether the source causes more than a 0.3 °C increase above the temperature criterion in the receiving water.

$$\Delta T = (T_E - T_C)/D$$
$$\Delta T = (16 - 13)/3.8 = 0.8\ °C$$

Since 0.8 °C exceeds the allowable increase of 0.3 °C, there is reasonable potential that the source will exceed the human use allowance during the winter spawning period and a temperature limit will be needed for the winter discharge period.

Determining effluent flow

When performing temperature RPA for domestic WWTPs, weekly effluent flow values should be used. Weekly values can be approximated by multiplying the monthly average dry weather design flow (ADWDF) by 1.5. A domestic facility may develop a plant specific ratio to use in place of the default if they have sufficient data.

When performing a temperature RPA for industrial facilities, the only difference from the domestic facility examples above, is the effluent design flow, Q_E. The effluent design flow used to determine dilution for the chronic mixing zone model should be used in place of the ADWDF in the temperature RPA formulas above. The effluent design flow for industrial facilities does not need to be converted to a weekly average value because the effluent flow from industrial process is typically consistent over time. See DEQ's Regulatory Mixing Zone IMD (Final December 2007, Effective July 1, 2008) for additional information on determining industrial effluent flow values.

Section 5.4 Determining Whether a Permit Limit is Needed for Streams that Meet the Numeric Temperature Criteria

RPA for streams that meet the numeric criteria

For streams that meet the biologically based numeric criteria year-round (i.e. during the warmest 7-day period of the year), the human use allowance does not apply. The cold water protection criterion may apply; see Chapters 2 and 3 to determine whether the cold water protection criterion applies. If the CWP criterion does apply, see the following section (5.5) for how to determine whether a permit limit is needed to meet the CWP criterion.

If the cold water protection criterion does not apply, the stream must meet the numeric criteria for the designated uses at the edge of an assigned mixing zone. To determine the reasonable potential to exceed the criteria at the edge of the mixing zone, the permit writer can use a thermal balance equation as shown in the example below.

Note: If the temperature of the river happens to be just 0.1 to 0.2° below the numeric criterion, the source will be allowed a 0.3° increase rather than just the 0.1 or 0.2° increase up to the numeric criterion. For example, if the criterion is 18 °C and the maximum 7dAM ambient river temperature is 17.8, the facility will still be allowed a 0.3° human use allowance increase, which means the facility would have to meet 18.1 °C at the edge of the MZ. The human use allowance provides a 0.3 °C increase if the river is at or above the criterion, and the cold water protection criterion allows a 0.3 °C increase if the ambient T is below the criterion. If CWP does not apply and the ambient temperature is 17.7 or less, the source is also allowed an increase of 0.3° or more, up to the numeric criterion. The standard was not intended to be more stringent for streams just 0.1 or 0.2° below the criterion than it is in every other situation.

In addition, best control technologies and practices should be applied to minimize anthropogenic warming and implement the policy of the Commission:

> (OAR) 340-041-0028(2) Policy. It is the policy of the Commission to protect aquatic ecosystems from adverse warming and cooling caused by anthropogenic activities. The Commission intends to minimize the risk to cold-water aquatic ecosystems from anthropogenic warming, to encourage the restoration and protection of critical aquatic habitat, and to control extremes in temperature fluctuations due to anthropogenic activities. The Commission recognizes that some of the State's waters will, in their natural condition, not provide optimal thermal conditions at all places and at all times that salmonid use occurs. Therefore, it is especially important to minimize additional warming due to

anthropogenic source.

In addition, if a new or increased heat load is proposed, antidegradation policy requirements apply. The antidegradation policy may limit a heat load increase from a permitted source even if that increased load would not cause a violation of the water quality criteria. For more information see OAR 340-041-0004 and DEQ's "Antidegradation Policy Implementation IMD (2001).

Example RPA-streams meeting the numeric criteria

Is the maximum temperature of the effluent greater than the applicable numeric criterion for the location of the discharge? If no, there is no reasonable potential for the source to cause an exceedence of the numeric criteria.

If yes, use the following thermal balance analysis to determine whether there is a reasonable potential for the discharge to cause an exceedence of the criterion:

$$T_{RMZ} = (T_E - T_R) / D$$

Where:
T_{RMZ} = the temperature of the river at the edge of the regulatory mixing zone
D = Dilution provided by the assigned regulatory mixing zone
T_E = 7dAM or max daily effluent temperature, and
T_R = 7dAM stream temperature in °C for the warmest 7-day period

If T_{RMZ} is greater than T_C, where T_C is the applicable numeric temperature criterion, then there is a potential to exceed the standard and a permit limit is required.

If T_R is greater than (T_C - 0.3 °C), but less than T_C, there is reasonable potential to exceed if $T_{MZ} \geq T_C + 0.3$ °C. See section above for explanation.

Does the cold water protection criterion apply downstream?

If the cold water protection (CWP) criterion applies downstream of a source, a far-field analysis is required to determine whether the source will cause an exceedence of the CWP criterion at the point where salmon, steelhead or bull trout are present (for summer) or where spawning habitat occurs (for the spawning season). See Section 5.5 below for additional information. Whether this analysis can be done using the cold water protection protocol provided below, or whether modeling is needed depends in part on the distance between the source and the use, the likelihood of heat loss from the stream and the available dilution (i.e. inflow from tributaries or groundwater).

Section 5.5 Determining Whether a Permit Limit is Needed to Meet the Cold Water Protection Criteria

RPA for the summer cold water protection criterion

If the summer cold water protection criterion applies (see Section 3.2), the permit writer should conduct a thermal balance analysis to determine whether there is a reasonable potential for the source to increase the temperature of the receiving water by more than 0.3 °C. To do this, use a mass balance equation where:

- Dilution (D) is determined using 100% of the 7Q10 flow for mixing,
- Q_E = maximum weekly average dry weather design flow,
- T_E = maximum daily (or 7dAM) effluent temperature, and
- T_R = maximum 7dAM stream temperature.

Note: If only the monthly average dry weather design flow is known for Q_E, multiply that value by 1.5 to estimate weekly average design flow, as shown in the example of RPA for the human use allowance above.

For example: If the summer maximum 7dAM of the receiving stream upstream from the discharge is 17 °C and the criterion for the stream is 18 °C and none of the exceptions apply, then the cold water protection criterion applies. If the 7d average maximum daily temperature of the effluent is 24, and dilution is 20:

$$\Delta T = (T_E - T_R)/D$$
$$\Delta T = (24 - 17)/20 = 0.35$$

Because $\Delta T > 0.3$, there is reasonable potential that this source will exceed the cold water protection criterion and needs a heat load or temperature limit in the permit.

If there are multiple point sources discharging in proximity, the permit writer must determine how much temperature increase each source could have so that the cumulative increase is not more than 0.3 °C. If there are 2 dischargers, for example, this could be done by giving each source an increase of 0.15 °C or by giving each source on increase of 0.3 °C with 50% of the 7Q10 low flow for mixing. Another option is to calculate the total allowed load and then determine how to equitably divide that load among the local sources according to need or agreement between them.

RPA for the

If the ‘spawning to emergence’ cold water protection criterion applies (see

spawning to emergence period - cold water protection criterion

Section 3.2), the permit writer should conduct a mass balance analysis to determine whether there is a reasonable potential for the source to increase the temperature of the receiving water by more than the allowed amount.

If the data required for the analysis below is not available, the permit writer may use conservative assumptions to determine whether there is any reasonable potential that the source would exceed the cold water protection limits. If the source can meet the cold water protection criterion under the conservative scenario and is satisfied with any resulting restrictions, there would be no need to collect data for further analysis. If additional data is needed, see Section 3.3 for more information on how to require data collection in the permit and revise the permit if needed following analysis of the data.

To determine whether there is a reasonable potential that a source will exceed this criterion the permit writer should consider both of the following possible worst case condition scenarios:

<u>Scenario 1 - the coldest winter period:</u>
1. Calculate the 60-day average maximum water temperature of the receiving stream just upstream of the discharge for the coldest 60-day period of the spawning to emergence period. (See below for information on how to calculate a 60-day rolling average of the daily maximum temperature.) If that value is less than 10 °C, the source may increase the river temperature 1.0 °C after mixing with 100% of the average flow (60Q2) for that same 60-day period. (See below for information on how to calculate a 60Q2.)
2. Determine whether there is a reasonable potential for the source to increase the river temperature by more than 1.0 °C using a mass balance equation where:

- Dilution (D) is determined using a Q_R = 100% of the 60Q2 flow or the average flow for the 60-day period,
- Q_E = monthly average wet weather design flow,
- T_E = monthly average effluent temperature for that same coldest 60 day period, and
- T_R = the lowest 60-day average maximum stream temperature for the winter period.

For example: If T_R is 7 °C, T_E is 20 °C, and dilution is 20:

$$\Delta T = (T_E - T_R)/D$$

$$\Delta T = (20 - 7)/20 = 0.65$$

Because $\Delta T < 1.0$, there is no reasonable potential that this source will exceed the spawning to emergence cold water protection criterion and a permit limit is not needed.

<u>Scenario 2 - the “shoulder” periods:</u>

1. Calculate the 60-day average maximum water temperature of the receiving stream just upstream of the discharge for the first and last 60 days of the spawning to emergence period. (See below for information on how to calculate a 60-day rolling average of the daily maximum temperature.) If that value is 10 °C to 12.8 °C, the source may increase the river temperature 0.5 °C after mixing with 100% of the average flow (60Q2) for that same 60-day period. If the value is less than 10 °C, the source may increase the river temperature 1.0 °C after mixing with 100% of the average flow (60Q2) for that same 60-day period. (See below for information on how to calculate a 60Q2.)
2. Determine whether there is a reasonable potential for the source to increase the river temperature by more than the allowed amount using a mass balance equation where:

- Dilution (D) is determined using a Q_R = 100% of the 60Q2 flow or the average flow for the 60-day period,
- Q_E = monthly average design flow (use dry or wet depending on when the shoulder season is and which would be most appropriate for the time period),
- T_E = monthly average effluent temperature for that same 60 day period, and
- T_R = the 60-day average maximum stream temperature for the 60 day period of the shoulder season being analyzed.

For example: If T_R is 11 °C, T_E is 20 °C, and dilution is 20:

$$\Delta T = (T_E - T_R)/D$$

$$\Delta T = (20 - 11)/20 = 0.45$$

Because $\Delta T < 0.5$, there is no reasonable potential that this source will exceed the spawning to emergence cold water protection criterion and a permit limit is not needed.

Please remember that the spawning criterion of 13 °C as a 7dAM and the human use allowance of no more than 0.3 above that criterion still apply as well throughout the spawning to emergence period.

How to calculate the 60-day rolling average daily maximum temperature (T_R)

The first step is to identify the appropriate spawning period for the receiving water. A common spawning season begins on October 15 and ends on May 15. Next, if maximum daily stream temperature for the spawning season is available, it is then possible to calculate the rolling 60-day average of the daily maximum temperatures as shown in the table below. In this example, the first 60-day average value would be for October 15 through December 13 and the last 60-day average value would be from March 17 through May 15.

Table 5-1: Example of 60-day Rolling Average Daily Max Temperature Calculation

Date	Day	Daily Max. Temperature	60-day Rolling Average Temp.
Oct 15 (beginning of spawning)	1	T_1	NA
Oct 16	2	T_2	NA
Oct 17	3	T_3	NA
.	.	.	.
.	.	.	.
.	.	.	.
Dec 14	60	T_{60}	$(T_1 + T_2 + \ldots T_{60})/60$ First 60-day average value for spawning season
Dec 15	61	T_{61}	$(T_2 + T_3 + \ldots T_{61})/60$
.	.	.	.
.	.	.	.
March 17	151	T_{151}	.
.	.	.	.
May 15 (end of emergence)	210	T_{210}	$(T_{151} + T_{152} + \ldots T_{210})/60$ Last 60-day average value for spawning season

How to calculate the 60Q2 - the average 60-day low flow for the winter period

The general steps used to determine the wintertime 60Q2 flow, or the lowest 60-day average low flow with a one in two (2)-year recurrence interval are:

- Ensure that flow measurements of the receiving stream are available on a daily or weekly basis for at least five (5) winter seasons
- If these flow measurements are not available, the stream flow will need to be measured or estimated based on nearby stream gauge data.
- Determine the lowest 60-day average flow value for each year
- Calculate the lowest 60-day average flow with a recurrence interval of two years
- EPA has two software programs that can calculate design flow: DFLOW or FLOSTAT. Both programs are available from EPA. The software package WQHYDRO (Aroner) also has the ability to calculate the 60Q2 stream flow value.
- More information on evaluating critical design stream flows can be found on the permit writers' corner under the Stream Information heading on the Tools and Databases menu.

Section 5.6 Determining Whether a Permit Limit is Needed to Meet the Thermal Plume Limitations

Impairment of an active spawning area

1. Do salmon, steelhead or bull trout spawn in the receiving water downstream of the discharge?
2. Is there an active spawning area within the thermal plume?
3. Is the effluent temperature greater than 13 °C or 9 °C if the stream is bull trout spawning habitat?

If the reach downstream of a discharge is designated for spawning use, DEQ staff should work with local biologists to determine where the active spawning habitat actually occurs.

If the source has a defined ZID (zone of initial dilution), the active spawning area is outside the ZID and the temperature of the plume is less than 13 °C at the edge of the ZID (zone of initial dilution); or 9 °C if the stream has bull trout spawning, then there is no reasonable potential to exceed this criterion.

If the answer to questions 1, 2 and 3 are all yes, the permit writer must determine whether there is a reasonable potential for the temperature of the plume to exceed 13 °C when it reaches the salmon or steelhead spawning area; or 9 °C when it reaches the bull trout spawning area.

1. First calculate the temperature with a mass balance calculation after estimating the amount of dilution available upstream of the spawning area. The worst case scenario would occur when the stream temperature above the discharge is relatively high and dilution is low.
2. Then if needed, the amount of heat loss (other than dilution) can be considered if the spawning area is downstream far enough that some heat loss could be expected to occur. This may require a local modeling exercise to determine.

[Option: low level FLIR data could be collected under “worse case conditions” to identify whether the river temperature is above 13 °C when it reaches the active spawning area.]

If the ambient temperature of the river upstream of the discharge is 13° or greater, then the spawning criterion and the human use allowance, rather than this thermal plume limitation, would drive any required permit limits.

Acute impairment or instantaneous lethality

Is the effluent temperature greater than 32 °C? If so, the permit evaluation report should demonstrate that the hot water will be dissipated in a small enough distance that fish drifting with the current through the plume would not be exposed to water 32 °C or greater for longer than 2 seconds, and that fish would not be entrained in water 32 °C or greater for longer than 2 seconds.

One way to conduct this analysis is to determine whether the temperature at the edge of the ZID is below 32 °C and the travel time through the ZID is 2 seconds or less at the 7Q10 low flow condition.

If the permit evaluation can not demonstrate that the acute temperature and time criteria can be met, a permit limit is required to reduce the effluent temperature or increase the dispersal rate.

Thermal shock – ambient river temperature < 23 °C

1. Is the effluent temperature 25° C or greater?
2. Is the ambient upstream temperature of the river less than 23 °C?

If the answer to question 1 is no, there is no reasonable potential for the source to exceed the thermal shock criterion. If the answer to question 1 is yes and the answer to question 2 is no, see the discussion on the next page. If the answers to questions 1 and 2 are both yes, the permit writer must analyze whether the discharge will cause 5% or more of the cross section of the river, when it is at a 7Q10 low flow condition, to exceed 25 °C.

Example 1: If there is a zone of initial dilution (ZID) and analysis shows the ZID is less than 5% of the cross sectional area of the river and the temperature of the plume will be less than 25 °C at the edge of the ZID, then there is no reasonable potential that this criterion will be exceeded. Depending on the river morphology and location of discharge, it may be reasonable to substitute width for cross sectional area in this analysis.

Example 2. Calculate whether the discharge will be reduced to less than 25 °C after mixing with 5% of the streamflow. To determine that it is appropriate to use flow as a surrogate for cross sectional area, some information on channel morphology and discharge location and dispersal is required. If the discharge enters the river in a slow shallow part of the stream, using flow rather than cross sectional area may not be appropriate.

In this example, the dilution available with 5% of the flow of the river is 10:1, the permit writer has determined that 5% of Q is an appropriate surrogate for cross sectional area, the upstream ambient river temperature is 20.5 °C and effluent temperature is 36 °C. The following analysis shows given these conditions and assumptions, there is no reasonable potential for the source to exceed this criterion:

Where:
$D = (Q_E + Q_R)/Q_E$
T_R = upstream ambient river temperature = 20.5 °C
T_E = effluent temperature = 36 °C (daily maximum)

$\Delta T = (T_E - T_R)/D$
$\Delta T = (36 - 20.5)/10 = 1.6$
$T_R + \Delta T = 20.5 + 1.6 = 22.1$
$22.1 < 25$, the criterion is met

Thermal shock – ambient river temperature 23 °C or more

Thermal shock is caused by a sudden increase in temperature. If the ambient river temperature is 23 °C or greater, it is not likely that a temperature just over 25° would cause thermal shock. However, thermal shock could be caused by a greater increase. The permit writer should consult the literature in this case to determine whether the discharge could cause thermal shock in greater than 5% of the cross sectional area of the stream, depending on the effluent temperature.

The following literature will help with the analysis and is available from the DEQ standards section:

Coutant, C.C. 1973. Effects of thermal shock on vulnerability of juvenile salmonids to predation. J. Fish. Res. Bd. Can. 30:965-973.

Tang, J., M.D. Bryant, and E.L. Brannon. 1987. Effect of temperature extremes on the mortality and development rates of coho salmon embryos and alevins. Prog. Fish-Cult. 49(3):167-174.

Wedemeyer, G. 1973. Some physiological aspects of sublethal heat stress in the juvenile steelhead trout (*Salmo gairdneri*) and coho salmon (*Onchorynchus kisutch*). J. Fish. Res. Board Can. 30:831-834.

Migration blockage – pre TMDL

1. Is the ambient temperature of the river less than 21 °C?
2. Is the effluent temperature 21 °C (7dAM) or greater?

If the answer to either question 1 or 2 is no, there is no reasonable potential for the source to create a thermal migration barrier. If the answers to both questions are yes, the permit writer must analyze whether the discharge will cause 25% or more of the cross section of the river, when it is at a 7Q10 low flow condition, to exceed 21 °C.

Example 1: If a source will meet the human use allowance of no more than a 0.3 °C increase above the numeric criteria (13-20 °C) with 25% of the 7Q10 flow for mixing and streamflow is an appropriate surrogate for cross sectional area, then that source would be expected to meet this thermal plume limitation as well. Streamflow may not be an appropriate surrogate for cross sectional area if the discharge enters the stream in a shallow, slow moving portion of the stream rather than a deep or fast moving portion of the stream.

Example 2: Mixing analysis shows that the temperature of 21 °C will be met prior to the edge of an assigned mixing zone. The width of the plume is approximately 51 feet at the edge of the mixing zone. The width of the river in the area of the outfall at a 7Q10 low flow conditions is approximately 935 feet. Therefore, a temperature of 21 °C will be restricted to 5.5% of the width. Because 5.5% is much less than 25%, it is safe to presume that the mixing zone is less than 25% of the cross section of the river as well.

If the permit writer determines that neither streamflow nor width is an adequate surrogate for cross sectional area, then they will need to estimate the cross sectional area of the stream that will exceed 21 °C. If that is greater than 25%, then the permit will need to either reduce the heat load in the discharge, or relocate or re-configure the plume to not cause a migration blockage.

Migration blockage – post TMDL

After a TMDL or cumulative effects analysis is completed, a source may be allowed more than 25% of the 7Q10 flow for mixing. In this case, there is a greater chance that the discharge could exceed the migration blockage criterion. The discharge heat load allocated to a source may need to be further limited to meet this requirement unless the plume can be configured or dispersed in a manner such that it does not cause greater than 25% of the cross sectional area of the stream to exceed 21 °C.

Section 5.7 How to Determine RPA and Permit Limits for Oceans & Bays

Has the water temperature has been modified?

The first step in this evaluation is to determine whether the ocean or bay receiving water has been altered or modified by human activity in a manner that would reasonably be expected to have altered the water temperature. Are there other thermal discharges or have there been geomorphologic or hydrologic alterations that would be expected to affect water temperature?

Estimating natural condition temperature

If there has been an activity that would be expected to have modified the water temperature, the Department must determine how best to estimate the natural temperature of the receiving water. This may be done by monitoring similar nearby waters outside the influence of the human activity, or by back-calculating out the effect of a nearby thermal discharge. Also, a discharge plume or mixing model may be used to determine whether a nearby source is affecting the receiving water at the location of the proposed discharge. That temperature is then used as the reference temperature for calculating the permitted load.

Calculating the permit effluent limit

If the water body is determined to be at natural condition, first a mixing zone must be assigned. Then a mass balance equation is used to determine the heat load that can be added to the water body without increasing the receiving water temperature by more than 0.3 °C at the edge of their assigned mixing zone, given the mixing or dilution provided by that mixing zone.

If natural condition has been estimated, that temperature is used as the reference temperature for calculating the allowed load rather than the current ambient temperature.

Section 5.8 How to Determine RPA and Permit Limits for Cool Water Species

Potential to impair cool water species

The first step the permit writer can use to determine whether there is a potential for the proposed thermal load to impair cool water species is to evaluate whether the source could meet the criterion for redband trout and the human use allowance. In other words, will the discharge cause more than a 0.3 °C increase above 20 °C with 25% of the low streamflow for mixing, using 20 °C and the reference (river) temperature in the calculation? If the discharge can meet the redband trout criterion, the Department can conclude that it will not impair cool water species.

If the discharge can not meet the redband trout criterion, information must be gathered on what cool water species are present and on their thermal tolerances. The water quality standards staff can help with this process. This information is then used to develop a site-specific reference temperature. If the temperature of the discharge is below the reference temperature, the discharge will not impair the cool water species.

Lastly, if the effluent temperature is greater than the reference temperature, the permit writer must calculate, using the same formulas provided in section 5.1, whether there is a potential for the source to increase the river temperature more than 0.3 °C above the reference temperature. If there is a potential for this to occur, an effluent limit must be included in the permit.

Calculating a permit limit

The same process would be used as explained in section 5.3 for calculated a temperature permit limit pre-TMDL. The site specific reference temperature developed based on the local cool water species is used in this calculation in place of the numeric temperature criteria for cold water fish uses.

Chapter 6 Calculating Permit Limits

Section 6.1 Overview

Overview

If there is a reasonable potential for an NPDES point source to cause or contribute to an exceedence of any of the applicable numeric or narrative temperature criteria, the permit writer must apply an effluent limit in the permit to ensure compliance with the temperature standard. In addition, if a source has received a wasteload allocation (WLA) under a TMDL that WLA will be applied in the permit as an effluent limit. This section describes how to calculate effluent limits once the permit writer has determined that a limit is required (See Chapter 5 for information on reasonable potential analysis).

Permit limit options

A temperature permit limit may be written as:
1. A maximum effluent temperature based on a fixed effluent design flow, or
2. A maximum excess thermal load in kilocalories/day.

The advantage of an excess thermal load (ETL) limit over an effluent temperature limit is that the source has the flexibility to alter either the effluent temperature or discharge volume to meet the allowed heat load.

The excess thermal load (ETL) limit is advantageous for sources that may at times discharge effluent at temperatures below the numeric criteria but at high volumes. The way DEQ calculates the excess thermal load limit, as described below, only the heat load that has the potential to increase the temperature of the river above the applicable numeric temperature criterion would apply toward the limit. If a total heat load expressed as ($Q_E \times T_E$) is used for the thermal load limit, a source could exceed its limit even when the effluent temperature is below the applicable temperature criterion and the discharge has no potential to increase the temperature of the river.

Section 6.2 Calculating a Permit Limit to Meet the Human Use Allowance – pre-TMDL

Calculating an effluent temperature limit

The simplest type of temperature permit limit is an effluent temperature limit.

The maximum allowed effluent temperature (as a weekly average of the daily maximum effluent T) is calculated using:

$$T_E = \Delta T\ (D) + T_C$$

where:
Dilution (D)= $(Q_E + Q_R) / Q_E$
Q_R = 25% of the 7Q10 low flow for the receiving water
Q_E = weekly average dry weather design flow; approximated by monthly average dry weather design flow * 1.5
(Convert mgd to cfs by multiplying the mgd by 1.547cfs/mgd)
T_C = the applicable numeric temperature criterion
$\Delta T \leq 0.3$ °C

Example: A source discharges to a stream with salmon and trout rearing and migration use.
T_C = the applicable numeric criterion = 18 °C.
Q_E = 1 mgd = 1.547 cfs.
Q_R = 30 cfs
D = (1.547 + 30)/1.547 = 20.4

$$T_E = \Delta T\ (D) + T_C = 0.3\ (20.4) + 18 = 24.1\ °C$$

The effluent temperature could not exceed 24 °C (7dAM) in order to ensure the source does not increase the temperature of the river by 0.3 °C.

Calculating an excess thermal load limit –

No WLA

The weekly average excess thermal load (ETL) limit in kilocalories per day is calculated using the following formula:

$$ETL = Q_e D \Delta T_{PS} C_F$$

Where:

Q_E = Weekly Average Dry Weather Design Flow in mgd (1.5 × Monthly Average Dry Weather Design Flow, for domestic facilities.)`

D = Dilution = $(Q_E + Q_R)/ Q_E$

Q_R = 7Q10 low flow of receiving stream

ΔT_{PS} = Allowed temperature increase at edge of MZ (0.3 °C)

C_F = Conversion for units and heat capacity:
If Q_E is in cms = 86,400,000 kilocalorie-sec / day-^oC-m^3
If Q_E is in cfs = 2,446,665 kcal-sec/ °C-ft-day.

Note: A spreadsheet available to calculate weekly average excess thermal load limits is located on the permit writers' corner (Tools & Databases section) at: http://deq05/wq/wqpermits/PCTools_Databases.htm.

Applying the excess thermal load limit

No WLA

To determine whether the discharge meets its excess thermal load (ETL) limit, use the formula: $Q_E (T_E - T_C) C_F \leq$ ETL limit, where:

T_C = the numeric temperature criterion and
C_F = a conversion factor to translate the units into kilocalories/day

See also Section 6.7 on permit compliance monitoring and reporting.

Example: Summer Rearing and Migration Period, Domestic facility

Given: A mid-size domestic treatment plant for Small Town USA discharges to Blue River year round. According to the reasonable potential analysis a permit limit is needed to ensure that this source complies with the human use allowance in the temperature standard. No TMDL has been done for Blue River.

We know the following:

- Applicable Temperature Criterion, T_C = 18 °C
- Effluent Temperature, T_E = 23 °C
- Effluent Monthly Average Dry Weather Design Flow, Q_E = 0.5 million gallons per day (mgd)
- Critical low flow, Q_R, 7Q10 = 34 cfs
- Allowable increase = 0.3 °C

Solution: The first step is to determine the limiting mixing scenario. We can calculate 25% of the critical mixing zone by:

Converting Monthly Average Design Flow to a weekly average:

Q_E = 0.5 mgd x 1.5 = 0.75 mgd

Converting to cfs: 0.75 mgd x 1.547 cfs/mgd = 1.16 cfs

25 % of 7Q10 = 0.25 x 34 cfs = 8.5 cfs

$D = (Q_E + Q_R)/Q_E = (1.16 + 8.5)/1.16 = 8.33$

Therefore, limiting D is based on 25% of critical flow = 8.33

The next step is to calculate the excess thermal load (ETL) limit using the formula below and an allowed temperature increase (ΔT) of 0.3 °C. In addition a conversion factor is used to convert for SI units and heat capacity.

$$ETL = Q_E\, D\, \Delta T\, C_F$$
$$= (1.16 \text{ cfs})(8.33)\ (0.3\ °C)\ (2{,}446{,}665 \text{ kilocalorie-sec / day-}^{o}\text{C-ft}^3)$$
$$= 7.09 \text{ million kcal/day (as a weekly average)}$$

A weekly average excess thermal load limit of 7.09 million kcal/day will apply to Small Town USA's discharge under the 7Q10 stream flow condition to ensure compliance with the human use allowance of 0.3 °C above the temperature criterion for Blue River during the summer rearing and migration period.

Example: Spawning Period,

Domestic facility,

No WLA

Given: For Mid Sized City USA, a permit limit is needed to ensure that this source complies with the human use allowance in the temperature standard. No spawning period TMDL has been done for Unnamed River.

We know the following:

- Temperature criteria for spawning, T_C = 13 °C
- Effluent Temperature, T_E = 16.1 °C
- Effluent Monthly Average Dry Weather Design Flow, Q_E = 5.27 million gallons per day (mgd) = 8.15 cfs
- Critical low flow, Q_R, =7Q10 for spawning period = 128 cfs
- Allowable increase = 0.3 °C

Solution: The first step is to determine the limiting mixing scenario. We already know from the temperature Reasonable Potential Analysis for Mid Sized City before, that the limiting dilution, D, (based on 25% of critical flow) = 3.6.

The next step is to estimate Weekly ADWDF from Monthly ADWDF and convert Q_E from mgd to cfs. Q_E = Monthly ADWDF 5.27mgd ×1.5 = Weekly ADWDF 7.9mgd × 1.547 = 12.2 cfs

Next, calculate excess thermal load (ETL) limit using the formula below and using an allowed temperature increase (ΔT_{all}) of 0.3 °C. In addition a conversion factor is used to convert for SI units and heat capacity.

$$ETL = Q_E\ D\ \Delta T\ C_F$$
$$= (12.2 cfs)\ (3.6)\ (0.3\ °C)\ (2{,}446{,}665 \text{ kilocalorie-sec / day-}^{o}\text{C-ft}^3)$$
$$= 32.2 \text{ million Kcals/day (weekly average)}$$

This is the excess thermal load limit that will be applied to Mid Sized City USA's discharge permit to ensure compliance with the human use allowance of 0.3 °C above the spawning criterion for Unnamed River.

Dynamic permits

A dynamic permit may be written to provide a different effluent limit for various seasons, designated use periods, or even by month. In such a case, the 7Q10 of the receiving water for the season or month would be the basis for dilution and the effluent limit rather than the annual 7Q10, which is the lowest 7 day flow for the year that recurs, on average, once every 10 years.

Another type of dynamic permit that may be written is a flow-based permit. The facility will have an effluent limit that it must be able to meet under annual 7Q10 conditions, but when stream flow and, therefore, dilution is higher, higher heat load discharges are allowed as long as the temperature increase that would occur after mixing with 25% of the streamflow or at the edge of the mixing zone, whichever is more restrictive, is still met. The permit may express the effluent limit as a formula or as a table showing the allowed heat loads at various receiving water flow levels.

Industrial facilities

When calculating excess thermal load (ETL) limits for industrial facilities, the only difference from the procedure for a domestic facility example is the effluent design flow, Q_E. The effluent design flow that is used to determine dilution for the chronic mixing zone model should be used in the formulas above to determine the heat load limit. The effluent design flow does not need to be converted from a monthly average to a weekly average value.

Section 6.3 Calculating a Permit Limit to Meet the Numeric Criteria

Effluent temperature limit to meet numeric criteria at edge of the RMZ

Streams that meet the numeric criteria above the point of discharge and are exempt from the cold water protection criterion must meet the biologically based numeric criterion at the edge of the regulatory mixing zone (RMZ) (see also section 5.4). The biologically based numeric criteria are shown on Table 2-1 and may be found in OAR 340-041-0028(4). If the source has a reasonable potential to exceed the numeric temperature criteria, use the following equation to calculate the maximum allowed effluent temperature (as a weekly average of the daily maximum effluent T). This is the effluent temperature that, for a given dilution factor, would increase the river temperature up to, but not exceed, the biologically-based numeric criteria.

T_E = maximum allowed effluent T = $(\Delta T_{PS} \times D) + T_R$
where:
$\Delta T_{PS} = T_C - T_R$
Dilution (D)= dilution provided by mixing zone during 7Q10 low flow conditions
T_C = the applicable numeric temperature criterion
T_R = maximum 7dAM ambient river temperature

Example: A source discharges to a stream with salmon and trout rearing and migration use.

T_C = the applicable numeric criterion = 18 °C.
T_R = 17 °C
D = 10

In this case, the effluent may heat the river from 17 °C to 18 °C, so:

ΔT = 18-17=1.0 °C and
T_E = (1.0) 10 + 17 = 27 °C.

The effluent temperature limit of 27 °C will ensure the source does not cause an exceedence of the 18° criterion at the edge of the mixing zone.

Note: If the river temperature in the example above was greater than 17.7, the calculated allowed ΔT would be less than 0.3 °C. In this case, the permit writer can allow the source up to a 0.3° increase (ΔT=0.3 °C). This makes the allowed increase for sources in this situation consistent with sources that discharge to a river that is cooler (17.7 °C or less) and sources discharging to a river that is warmer (18.0 °C or more). In both of these situations, the source is allowed a 0.3° increase. See Section 5.4 for additional explanation.

Section 6.4 Calculating Permit Limits to Meet the Cold Water Protection Criteria

Summer cold water protection criterion –

Effluent limits

The permit writer must calculate an effluent temperature or thermal load limit that will prevent the source from increasing the maximum 7dAM temperature of the river by more than 0.3 °C using 100% of the flow for mixing. The same options for calculating limits are available as described above for the human use allowance, but in this case:

1. The reference temperature for the allowed increase is the maximum 7dAM ambient stream temperature (T_R), and
2. Dilution (D) is determined using 100% of the 7Q10 low flow for mixing if there is only one source, or a portion of the 7Q10 flow if there are multiple sources, and weekly average dry weather design flow.

If there are multiple point sources discharging in proximity, the permit writer should determine how much temperature increase each source could have to not exceed a cumulative increase of more than 0.3 °C. If there are 2 dischargers, for example, this could be done by giving each source an increase of 0.15 °C or by giving each source an increase of 0.3 °C with 50% of the 7Q10 low flow for mixing. Another approach would be to determine the total heat load allowed for the reach and allocate that load among the sources.

Summer cold water protection criterion –

Example

Given: A mid-sized domestic treatment plant for Our Town discharges to Salmonid River year round. According to the reasonable potential analysis, a permit limit is needed to ensure that this source complies with the cold water protection criterion. Because the Salmonid River meets the numeric criteria all year no TMDL has been done.

We know the following:

- Ambient 7dAM stream temperature, T_R = 17 °C
- Effluent temperature, T_E = 23 °C
- Q_E =Effluent monthly average dry weather design flow = 0.5 mgd = weekly design flow of 0.75 mgd = 1.16 cfs
- Critical low flow, Q_R, = 7Q10 = 20 cfs
- Dilution, D = 18.2
- Allowable increase, ΔT_{PS} = 0.3 °C
- Conversion factor, C_F = 2,446,665 kcal·s/ °C·ft^3·day

TL = Q_E D ΔT_{PS} C_F = (1.16) (18.2) (0.3) (2,446,665)
= 15.5 million Kcals/day

The permit limit is expressed as a rolling 7-day average of the TL.

Spawning to emergence period cold water protection criterion

If the source has a reasonable potential to exceed the 'spawning to emergence' cold water protection criterion, the permit writer must include a permit limit to ensure compliance, with the exception described below.

In this case:

- T_R = 60-day average of the daily maximum stream temperature (Information on how to calculate the 60dAM temperature is provided in an earlier section of this chapter titled "Determining whether a permit limit is needed to meet the cold water protection criteria.")
- T_E = winter average maximum daily effluent temperature
- Q_E =Effluent Monthly Average Dry Weather Design Flow (cms or cfs)
- Q_R = 60Q2 for the winter period (See section 5.1 for information on how to calculate the 60Q2 flow.)
- Allowable increase = 1.0 °C if T_R <10 °C or 0.5 °C if T_R = 10 to 12.8 °C
- C_F if Q_E is in cfs = 2,336,665 kcal·s/ °C·ft^3·day

ETL = Q_E D ΔT C_F
= (7.7 cfs)(27) (1.0 °C) (2,446,665 kcal·s/ °C·ft^3·day)
= 508.7 million Kcals/day

The permit limit should be expressed as a 60-day rolling average of the ETL. Upon request by a source, a permit limit may be expressed as a 7day rolling average of the ETL, but a 7day limit may be more restrictive than a 60 day limit.

If there are multiple point sources discharging in proximity, the permit writer should determine how much temperature increase each source could have to not exceed a cumulative increase of more than 1.0 °C. If there are 2 dischargers, for example, this could be done by giving each source an increase of 0.5 °C or by giving each source an increase of 1.0 °C with 50% of the 60Q2 flow for mixing.

Exception to spawning CWP limit

The cold water protection criterion for spawning waters prohibits an increase of more than 1.0 °C when the 60dAM ambient water temperature is 10 °C or less with the following exception:

> "…unless the source provides analysis showing that a greater increase will not significantly impact the survival of salmon or steelhead eggs or the timing of salmon or steelhead fry emergence from the gravels in the downstream spawning reach." [OAR 340-041-0028 (11)(b)(B)]

This rule clearly states that it is the responsibility of the permitted source to provide the evidence that would enable DEQ to make this finding. DEQ will look for evidence that the survival of eggs will not be significantly reduced and the timing of egg development and hatch and fry emergence from the gravels will not be significantly altered from the normal range for the water body or location.

If a source wishes to pursue this avenue, they should consult with their DEQ permit writer and the water quality standards staff for additional information.

Section 6.5 Calculating a Permit Limit to Meet the Thermal Plume Limitations

Impairment of an active spawning area

Option 1: If the source discharges into an active spawning area, place a limit on the temperature of the discharge so that the plume will be 13 °C or less at the edge of the ZID.

Option 2: Place a limit on the temperature of the discharge so that the plume will be 13 °C or less when it reaches the spawning area. This option would allow a greater heat load from the source if the spawning area is further from the discharge point and there is an opportunity for greater mixing prior to the spawning area.

1. Determine the amount of dilution available for mixing prior to reaching the spawning area (D).
2. Determine the effluent temperature limit using the following mass balance equation:

$$T_E = D\,(13 - T_R) + T_R$$

Where:
T_E = the maximum 7dAM effluent temperature
T_R = the maximum 7dAM upstream river temperature during the spawning period or the month of concern
$\Delta T = 13 - T_R$
D = dilution, mixing prior to reaching spawning area
Q_E = maximum winter design flow of the effluent, and
Q_R is the 7Q10 low flow of the river for the spawning period or the month of concern

Option 3:

1. Determine the practicable measures available to:
   - reduce the effluent temperature,
   - change the location of the plume to avoid the spawning area or allow more mixing, and/or
   - re-configure the discharge to disperse the plume and/or maximize mixing.
2. Identify what the effluent temperature limit and other permit requirements need to be to ensure the measures are utilized.

Note: If the ambient river temperature upstream of the facility is 13° or more, the spawning criterion rather than the thermal plume limitation will determine permit limits.

Acute impairment or instantaneous lethality

1. Determine the size of the ZID and the travel time through the ZID for a fish floating with the current.
2. Depending on the travel time (time of exposure) through the ZID, use the mixing equation shown below to ensure that fish passing through the ZID with the current will be exposed to water 32 °C or greater for less than 2 seconds.

$$T_E = D\,(32\ °C - T_R) + T_R$$

Where:
T_E = maximum daily effluent temperature (°C)
T_R = maximum 7dAM upstream river temperature (based on at least 5 years of data if available)
D = the amount of dilution required to limit exposure to the above times of exposure
Q_E = maximum dry weather design flow of the effluent
Q_R = 7Q10 low flow of the river

Thermal shock

To set an effluent temperature limit that will prevent the temperature of the river from exceeding 25 °C after mixing with 5% of the 7Q10 low flow, use the following equations:

$$T_E = D\,(25 - T_R) + T_R$$

Where:
T_E = maximum daily effluent temperature, °C
T_R = 7dAM upstream river temperature, °C
D = $(Q_E + 0.05\ Q_R) / Q_E$
Q_E = maximum dry weather design flow of the effluent
Q_R = 7Q10 low flow of the river

The assumption using this approach is that meeting 25 °C after mixing with 5% of the low flow equates to meeting 25° in no more than 5% of the cross sectional area of the river. If it is felt that this assumption is not true, the area or width of the ZID or mixing zone and the dilution provided by the ZID or mixing zone may be used instead.

Example 1: If Q_E is 10 cfs, Q_R is 100 cfs, and T_R is 20 °C:

$$D = (Q_E + 0.05\ Q_R) / Q_E = (10 + 0.05*100) / 10 = 1.5$$

$$T_E = [D \times (25 - T_R)] + T_R = [1.5 \times (25-20)] + 20 = 27.5$$

The temperature of the effluent can not exceed 27.5 °C in order to meet the thermal shock criterion.

Migration blockage

Option 1: To set an effluent temperature limit that will prevent the temperature of the river from exceeding 21 °C after mixing with 25% of the 7Q10 low flow, use the following equations:

$$T_E = D\,(21 - T_R) + T_R$$

Where:
T_E = maximum daily effluent temperature (°C)
T_R = 7dAM upstream river temperature
D = $(Q_E + 0.25\, Q_R) / Q_E$
Q_E = maximum dry weather design flow of the effluent
Q_R = 7Q10 low flow of the river

The assumption using this approach is that meeting 21 °C after mixing with 25% of the low flow equates to meeting 21° in no more than 25% of the cross sectional area of the river.

Example: If Q_E is 10 cfs, Q_R is 100 cfs, and T_R is 20 °C:

$$D = (Q_E + 0.25\, Q_R) / Q_E = (10 + 0.25 * 100) / 10 = 3.5$$

$$T_E = [D \times (21 - T_R)] + T_R = [3.5 \times (21-20)] + 20 = 23.5\ °C$$

The temperature of the effluent could not exceed 23.5 °C in order to meet the migration blockage criterion.

Option 2: Mixing analysis shows that the 21 °C criterion will be met prior to the edge of the mixing zone. The width of the plume is approximately 50 feet at the edge of the mixing zone. The width of the river in the area of the outfall at a 7Q10 low flow conditions is approximately 600 feet. Therefore, a temperature of 21 °C will be restricted to 8.3% of the river width. Because 8.3% is much less than 25%, it is safe to presume that the mixing zone is less than 25% of the cross section of the river as well.

Section 6.6 Post TMDL Permit Limits – Putting Temperature Wasteload Allocations into Permits

Section overview

If a temperature TMDL has been completed and a source has been given a wasteload allocation (WLA), the source's permit must include an effluent limit based on their WLA, or a technology-based limit if that is more restrictive than the water quality-based WLA.

This section covers how to establish temperature limits after a temperature Total Maximum Daily Load (TMDL) has been completed; how to translate a Wasteload Allocation (WLA) into a permit effluent limit. This section does not discuss how to determine whether a technology-based limit applies that would be more restrictive. Guidance for this procedure is already available for permit writers.

Post-TMDL temperature limits

WLAs are based on the temperature criteria or natural thermal potential and the cumulative human use allowance, which is determined based on modeling and/or other analyses done during the TMDL development.

Following a TMDL, the heat load of a source may be limited even though it does not have the potential to increase the temperature of the stream above the numeric criteria at the site of the discharge or at the edge of the mixing zone. Rather, the WLA may be based on the source's contribution of heat to the cumulative human use allowance at a downstream point of maximum impact.

Most TMDLs include a WLA for the summer rearing and migration season. Some TMDLs may also include a separate thermal load for the winter spawning season, as there is a different temperature criterion for spawning.

A temperature wasteload allocation will typically be expressed as an Excess Thermal Load (ETL) limit in kilocalories per day (kcal/day). An ETL is the maximum amount of heat energy that a point source can add to the receiving water based on how much the particular source is allowed to increase temperature as calculated in the TMDL. Compliance will be determined by using an equation with a (T_E-T_C) term to indicate that a change in river temperature is what is being measured.

Translating the WLA into a permit limit

Case 1: Continuous effluent temperature monitoring

It should be noted that the application of the excess thermal load allocation in the permit needs to be consistent with the modeling or other method used to develop the WLA. [The permit writer should notify the TMDL development team if he or she finds that the temperature of the receiving water is less than the reference temperature that was used to develop allowable temperature increases in the TMDL.]

There are two methods to translate a temperature WLA into a water quality-based effluent limit, depending on the frequency at which the point source monitors their effluent temperature. The first method is when the source performs continuous monitoring of effluent temperature (for example, at 15-minute intervals). In this case, the permit writer can accurately calculate the 7-day average ETL from the daily maximum effluent temperatures and can directly apply the WLA as a weekly average effluent limit in Schedule A of the permit. Schedule B will then specify that continuous monitoring of effluent temperature is necessary and will provide direction on how to calculate the rolling 7-day average excess thermal load in kcals/day from the previous week's daily maximum temperatures.

Translating the WLA into a permit limit

Case 2: Non-continuous effluent temperature monitoring

When a WLA, which is expressed as a weekly average of the daily maximums, is translated into a permit limit, if continuous effluent temperature data is not available (i.e. effluent temperature is sampled only once or twice a week), there is uncertainty about whether the weekly average effluent heat load calculation is accurate. The sampling protocol may not capture all of the statistical maximum values.

To account for infrequent temperature monitoring, the water quality based effluent limit will be expressed as a daily maximum limit even though the wasteload allocation expressed as a seven-day average. While this may be conservative, especially given the certainty factors (95% or more), a daily maximum limit is more appropriate than a weekly average, given that it will be difficult to have a realistic idea of a weekly average excess thermal load due to the small data set compared with the data set from continuous monitoring.

Putting the WLA into a permit

Case 3: Maximum allowed T increase (Max ΔT)

As an alternative, if the wasteload allocation is expressed as an allowed temperature increase in degrees Celsius (ΔT_{PS}), that allowed increase may be used in the permit and would be expressed as a maximum allowed temperature increase (Max ΔT °C). The maximum allowed increase would come directly from the TMDL document, which would show it as the assigned ΔT_{PS} for the source. Some TMDL documents show the ΔT_{PS} allowed by each source in addition to a wasteload allocation in kilocalories per day. See Section 6.7 for information on how the permittee would demonstrate compliance with this permit limit. This type of limit requires both effluent and river temperature and flow data to demonstrate compliance.

Section 6.7 Permit Compliance Monitoring and Reporting

Demonstrating compliance with an ETL limit

An example of an ETL limit that would be included in Schedule A of an NPDES permit, is:

Excess Thermal Load (from May 16 through October 14):
Shall not exceed a rolling 7-day average of 7.8 million Kcals/day

The monitoring request in Schedule B needs to be written clearly so it is understood how to calculate the ETL for a source on a rolling weekly average basis. There are three steps to include in Schedule B assuming continuous temperature monitoring:

1. Monitor the effluent temperature
2. Calculate the weekly average of the daily maximum effluent temperature
3. Calculate the rolling weekly average ETL with a simple formula.

To make it clear to the permittee how to determine compliance with a weekly average ETL, Schedule B could be written as follows:

Item or Parameter	Minimum Frequency	Type of Sample
Effluent Temperature, Daily Max.	Daily	Continuous
Effluent Temperature, Average of Daily Maximums (May 16 through October 14)	Daily (as a rolling 7-day average)	Calculation
Excess Thermal Load (May 16 through October 14)	Daily (as a rolling 7-day average)	Calculation (see Note 1)

Note 1 for this permit would specify using the following formula to show compliance with the ETL limit:

$$ETL = Q_E \times (T_E - T_C) \times C_F$$

Where:
ETL = the discharged excess thermal load in Kcals/day
Q_E = rolling 7-day average of daily flow in cfs
T_E = rolling 7-day average of daily maximum effluent temperatures
T_C = applicable temperature criterion 7dAM in°C
C_F = 2,446,665 kcal-s/ °C-ft^3-day

The first 7-day period that must comply with the spawning criterion is the first 7 days after the date the spawning use designation begins, reported on the 7th day.

For example, if spawning begins October 15, the first 7-day period would be October 15 to 21, with the 7dAM temperature or WLA reported on October 21.

If a limit is expressed as a 60-day rolling average of the daily thermal load, rather than a 7-day rolling average, each variable in the calculation above would also need to be a 60-day average value. A 60-day limit may be used for the cold water protection for spawning criterion.

Demonstrating compliance with a maximum T increase limit

Some permits may express the temperature limit as a maximum allowed temperature increase, Max. ΔT. An example of a Max. ΔT limit that would be included in Schedule A of an NPDES permit, is:

> Maximum Increase in Temperature to meet the Human Use Allowance (Max. ΔT °C)
> Shall not exceed a rolling 7-day average of 0.08 °C (see Note 1)

Note 1 for this permit would specify that one of the following formulas must be used to show compliance with the permit:

$$\Delta T_{PS} = [(Q_E \times T_{E)} + (Q_R \times T_C\ ) / (Q_E + Q_R)] - T_C$$

or, the simplified formula:

$$\Delta T_{PS} = [Q_E / (Q_E + Q_R)] \times (T_E - T_C)$$

Where:
ΔT_{PS} = calculated temperature increase from the individual source to be compared against limit, e.g. 0.08 °C
Q_R = the 7Q10 river flow in cfs [1]
Q_E = rolling 7-day average of daily flow in cfs [2]
T_E = rolling 7-day average of daily maximum effluent temperatures
T_C = applicable temperature criterion as a 7dAM, °C

[1]Use 25% of the 7Q10 flow to implement the single source human use allowance and 100% of the 7Q10 flow to implement the cumulative human use allowance.

[2] Use weekly design flow (either a site specific flow or the default flow of ADWDF × 1.5). Flow values in MGD must be multiplies by 1.547 to obtain results in cfs.

See also discussion above on compliance with an ETL limit for additional information.

Rationale for weekly average limits

Federal code and court cases specify that effluent limits be expressed in various forms (weekly average, monthly average, and/or daily maximum). DEQ believes that weekly average limits are appropriate for temperature for the following reasons:

1. There is limited added control of point source temperature loadings by establishing monthly average permit limitations when weekly average or daily maximum limits already exist. Examples illustrate that calculated monthly average limits are only slightly lower than weekly average limits.
2. The approach for establishing daily maximum and average monthly limits in EPA's *Technical Support Document for Water Quality-Based Toxics Control* was developed for data that are independent of seasons and is appropriate for toxic pollutants. This method is not appropriate for temperature, however, which is dependent (correlated) on season. We expect to see warmer effluent temperatures in the summer and colder effluent temperatures in the winter. In contrast, one would not expect effluent copper data, for example, to be seasonally-dependent.
3. EPA has not provided guidance for calculating average monthly limits for auto-correlated data, such as temperature.
4. The effort required to determine a specific coefficient of variation for auto-correlated temperature data, and a corresponding average monthly limit is substantial.

Section 6.8 Permit Considerations that May Not be Included in the WLA

Thermal plume limitations

The permit writer must find out whether the WLA assigned to the source incorporated any load limits necessary to meet the thermal plume limitations in the mixing zone rules, OAR 340-041-0053(2)(d). The thermal plume limitations are near field and occur within the mixing zone or thermal plume. If the thermal plume requirements have not been included in the TMDL analysis, then the permit writer must determine whether the source, after implementing their WLA, will have a reasonable potential to exceed the thermal plume requirements. If so, the excess thermal load limit or other permit conditions will need to be adjusted accordingly. This process is described in sections 5.6 and 6.5.

Summer cold water protection criterion

It is likely that the TMDL analysis or modeling for a basin will exclude a number of high quality reaches or tributaries. A TMDL development project can not model every stream in the sub-basin. DEQ may find that multiple point and nonpoint sources are causing the temperature of a high quality reach to increase more than 0.3 °C. In this case, the permit writer must determine whether there is a reasonable potential for the permitted source to cause or contribute to an exceedence of the cold water protection criterion and, if so, should include a permit limit to prevent this. See Sections 5.6 and 6.4 for more information.

Criteria that may not be part of the TMDL

If the TMDL addresses only the summer critical period, the permit writer must still implement the spawning criteria, including the numeric spawning criterion and the spawning period cold water protection narrative. In this case, the permit writer would implement these criteria according to the procedures used when a TMDL/WLA has not been completed.

WLAs assigned under former standard

If a TMDL is still in affect under the former temperature standard, the permit writer must include the WLA in the permit until the existing TMDL is replaced, revised or revoked by the EQC and that revision is approved by EPA. However, if the new standard would require limits more restrictive than the TMDL, then the more restrictive limits based on meeting the current standard must be included in the permit.

Anti-backsliding & Anti-degradation

An exemption to the anti-backsliding rule will be invoked for increased water quality-based thermal load permit limits if a new temperature TMDL is completed and approved by EPA, and a new WLA is assigned to the source in accordance with CWA Section 303(d) (4). [See CWA Section 402(o).]

In addition, before allowing a source an increased thermal load, DEQ must find that either: a) no lowering of water quality is likely, or b) the lowering of water quality has been deemed necessary and important, as described in the "Antidegradation Policy Implementation Internal Management Directive for NPDES Permits and Section 401 Water Quality Certifications" (DEQ, March 2001).

Chapter 7 Hydroelectric Project 401 Certifications

How dams affect temperature patterns, diel flux

Dams result in the storage of water in reservoirs, the diversion of water from natural stream channels and the return of diverted flows to the river channel at various locations. Dams alter water depth, flow velocity and the travel time of water through a river reach. In addition to flow regime modification, changes in water temperatures may occur upstream and downstream of storage dams, downstream of diversion dams (i.e. in the diversion reach), and downstream of any return flow.

The storage of water behind dams can cause both diel and seasonal changes to instream temperatures. The change in temperature of a water body over time is partly a function of the width to depth ratio. Deep water bodies, such as reservoirs, have less heat exchange with the environment than water bodies that are shallow. The deeper water body heats and cools more slowly. Therefore, the water discharged from a dam often has reduced diel variation. Reservoirs also store heat, which may result in a shift in the seasonal temperature profile. Sometimes, reservoirs increase the daily average stream temperature because more solar energy is absorbed by a wide open reservoir than by a narrow, shaded stream. For these reasons, downstream temperatures may be seasonally warmer at some locations than they would be if the reservoirs were not in place. At other times of the year, reservoirs may cause lower downstream temperatures than would occur if the reservoirs were not in place.

Temperature control structures

A Temperature Control Structure (TCS) is any structural device used to selectively withdraw waters from specific depths or layers within a thermally stratified reservoir. As opposed to an outlet structure that can only withdraw reservoir water from a single elevation, a TCS allows water withdrawal from two or more elevations, thus enabling some level of temperature management of both the waters of the reservoir and the reservoir discharge. For example, selective withdrawal allows cold water to be pulled from the bottom of a stratified reservoir to potentially mimic more natural seasonal riverine temperature downstream of the reservoir.

Migration Corridors:

Cold water refugia &

Natural seasonal thermal pattern

The temperature standard includes specific requirements for streams designated as migration corridors. These river reaches must have coldwater refugia that are sufficiently distributed so as to allow salmon and steelhead to migrate through these relatively warm lower rivers without significant adverse effects. In addition, there is a requirement that the seasonal thermal pattern in Columbia and Snake Rivers must reflect the natural seasonal thermal pattern. See Section 3.10 for more information on these criteria.

As an illustration, Figure 7-1 compares the seasonal temperature profiles of two rivers. In these profiles, the rising and falling slopes are very similar, peak widths are similar and timing of onset of temperature increases and decreases are nearly identical between River A and River B. If River A were representative of a natural seasonal thermal pattern, River B would reflect that pattern and would meet the natural seasonal thermal pattern requirements. In Figure 7-2, the seasonal pattern has been shifted below the reservoir, even though the maximum temperature has not increased.

Figure 7-1: Two Temperature Profiles

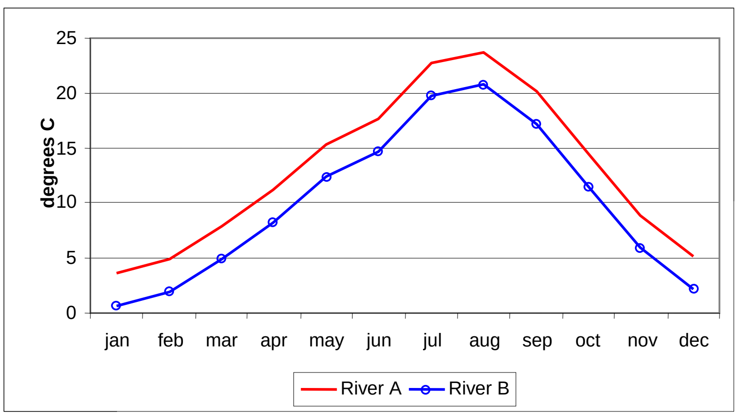
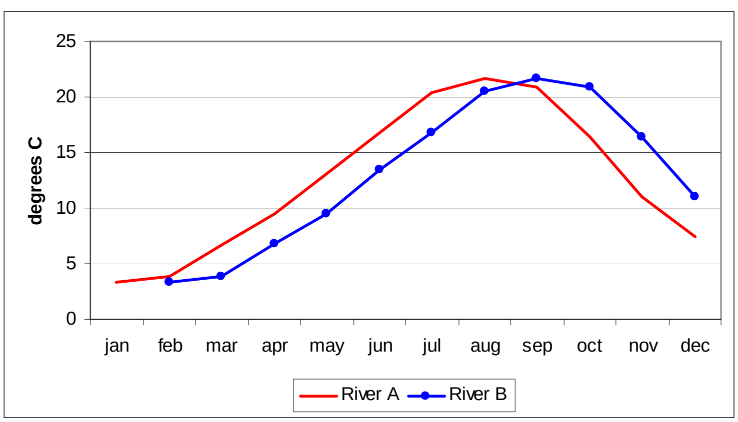


Figure 7-2: Shifted Seasonal Temperature Pattern



Chapter 8 Publications and Contact Information

Publications

Oregon Water Quality Standards, Oregon Administrative Rules Chapter 340, Division 41. Available at: http://www.deq.state.or.us/regulations/rules.htm

EPA Region 10 Guidance for Pacific Northwest State and Tribal Temperature Water Quality Standards, April 2003. Available at: http://yosemite.epa.gov/r10/water.nsf/Water+Quality+Standards/WQS+R10+Docs

Additional documents are available at the DEQ temperature standard webpage http://www.deq.state.or.us/wq/standards/temperature.htm .

DEQ Contacts

If you have questions on Oregon's temperature standard, please contact:

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If you have questions on the application of Oregon's temperature standard in NPDES permits, please contact:

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