Draft Water Quality Management Plan – Willamette Mainstem and Major Tributaries TMDL

Temperature

March 2024

State of Oregon
DEQ Department of Environmental Quality

This document was prepared by:
Brian Creutzburg, Grace Goldrich-Middaugh, Evan Haas, Alex Liverman,, Priscilla Woolverton

Oregon Department of Environmental Quality
Watersheds Section
700 NE Multnomah Street, Suite 600
Portland Oregon, 97232

Contact: Steve Mrazik
Phone: 503-229-5379
www.oregon.gov/deq

Translation or other formats

Español | 한국어 | **繁體中文** | **Русский** | **Tiếng Việt** | العربية

800-452-4011 | TTY: 711 | deqinfo@deq.oregon.gov

Non-discrimination statement

DEQ does not discriminate on the basis of race, color, national origin, disability, age or sex in administration of its programs or activities. Visit DEQ's Civil Rights and Environmental Justice page.

Table of Contents

List of Tables and Figures

1. Introduction

DEQ developed this draft Water Quality Management Plan to guide implementation of the temperature Total Maximum Daily Load developed for the Mainstem of the Willamette River Basin. A WQMP is an element of a TMDL, as described by Oregon Administrative Rule 340-042-0040(4)(l), which provides the framework for management strategies to attain and maintain water quality standards and is designed to work in conjunction with detailed implementation plans prepared by responsible persons, including designated management agencies responsible for TMDL implementation.

This Willamette Mainstem temperature WQMP will be proposed for adoption by Oregon's Environmental Quality Commission, by reference, into rule as OAR 340-042-0090(c)(B). This WQMP is intended to provide comprehensive information for implementation of the temperature TMDL, and will be amended, as needed, upon issuance of any future developed or revised TMDLs within the Willamette Basin. Any subsequently amended or renumbered rules cited in this document are intended to apply.

The Willamette River Basin encompasses twelve subbasins. Except for the Yamhill Subbasin, EPA previously approved temperature TMDLs developed by DEQ for the following eleven subbasins by TMDL:

1. Molalla-Pudding Subbasin TMDL (2008)
2. Willamette Basin TMDL (2006)
    - Clackamas Subbasin
    - Coast Fork Willamette Subbasin
    - Lower Willamette Subbasin
    - McKenzie Subbasin
    - Middle Fork Willamette Subbasin
    - Middle Willamette Subbasin
    - North Santiam Subbasin
    - South Santiam Subbasin
    - Upper Willamette Subbasin
3. Tualatin Subbasin TMDL (2001)

The Willamette Subbasins and Willamette Mainstem and Major Tributaries TMDLs replace the temperature TMDLs above except for the Tualatin Subbasin TMDL, which remains effective for temperature and other approved TMDLs. The Tualatin TMDL did not use the natural conditions criteria to develop TMDL allocations; therefore, it is not required to be replaced under the litigation. The Yamhill subbasin will not be covered by these temperature TMDLs. Therefore, the Subbasins, and Willamette Mainstem and Major Tributaries TMDLs apply to all waters of the state in the following subbasins listed in Table 1:

Table 1: Waterbodies included in Willamette Subbasins TMDL and the Willamette River Mainstem and Major Tributaries TMDLs.

TMDL	Subbasin	Waterbodies Included
Willamette Subbasins	1. Clackamas	All waters of the state in the Clackamas Subbasin except the Clackamas River downstream of River Mill Dam (approximately river miles 0 - 26).
Willamette Subbasins	2. Coast Fork	All waters of the state in the Coast Fork Willamette Subbasin except the Coast Fork Willamette River downstream of Cottage Grove Dam (approximately river miles 0- 30) and the Row River downstream of Dorena Dam (approximately river miles 0 -7.5).
Willamette Subbasins	3. Lower Willamette	All waters of the state in the Lower Willamette Subbasin except the Willamette River and Multnomah Channel.
Willamette Subbasins	4. McKenzie	All waters of the state in the McKenzie Subbasin
Willamette Subbasins	5. Middle Fork	All waters of the state in the Middle Fork Willamette Subbasin except the Middle Fork Willamette River downstream of Dexter Dam (approximately river miles 0 - 17) and Fall Creek downstream of Fall Creek Dam (approximately river miles 0 - 7).
Willamette Subbasins	6. Middle Willamette	All waters of the state in the Middle Willamette Subbasin expect for the Willamette River, Willamette Slough, Mission Lake, and Lambert Slough.
Willamette Subbasins	7. Molalla-Pudding	All waters of the state.
Willamette Subbasins	8. North Santiam	All waters of the state in the North Santiam Subbasin except the North Santiam River downstream of Detroit Dam (approximately river miles 0 - 49), and the Santiam River.
Willamette Subbasins	9. South Santiam	All waters of the state in the South Santiam Subbasin expect for the South Santiam River downstream of Foster Dam (approximately river miles 0 - 38).
Willamette Subbasins	10. Upper Willamette	All waters of the state in the Upper Willamette Subbasin except for the Long Tom River downstream stream of Fern Ridge Dam (approximately river miles 0 - 26), and the Willamette River including the Bonneville Channel, Albany Channel, Curtis Slough, Third Slough, Marshall Slough, Curtis Creek, and Mill Race
Willamette Mainstem and Major Tributaries	11. Willamette Mainstem	Willamette River including all side channels and sloughs from the confluence of the Columbia River to the confluence of Coast Fork of the Willamette and Middle Fork of the Willamette Rivers (approximately river mile 187)
Willamette Mainstem and Major Tributaries	12. Lower Willamette	Multnomah Channel
Willamette Mainstem and Major Tributaries	13. Clackamas	Clackamas River downstream of River Mill Dam/Estacada Lake (approximately river mile 26)
Willamette Mainstem and Major Tributaries	14. Santiam	Santiam River (all 12 miles)

Willamette Mainstem and Major Tributaries	North Santiam	North Santiam River downstream of Detroit Dam (approximately river mile 49)
Willamette Mainstem and Major Tributaries	South Santiam	South Santiam River downstream of Foster Dam (approximately river mile 38)
Willamette Mainstem and Major Tributaries	Upper Willamette	Long Tom River downstream of Fern Ridge Dam (approximately river mile 26)
Willamette Mainstem and Major Tributaries	Middle Fork Willamette	Middle Fork Willamette River downstream of Dexter Dam (approximately river 17)
Willamette Mainstem and Major Tributaries	Middle Fork Willamette	Fall Creek downstream of Fall Creek Dam (approximately river mile 7)
Willamette Mainstem and Major Tributaries	Coast Fork	Coast Fork Willamette River downstream of Cottage Grove Dam (approximately river mile 30)
Willamette Mainstem and Major Tributaries	Coast Fork	Row River downstream of Dorena Dam (approximately river mile 7.5)

The list of waters in Table 1 above is referred to throughout this document as either the "Subbasins" or "Mainstem". Section X of the Willamette Mainstem Temperature TMDL Rule contains a listing of all the Category 5 temperature impairments from the 2022 Integrated Report. The TMDL Technical Support Document contains a complete listing of all the Assessment Units included in this rulemaking.

1.1 Condition assessment and problem description

The first element of the WQMP according to OAR 340-042-0040(l)(A) is an assessment of water quality conditions in the Willamette Mainstem with a problem description. There are assessment units in the Willamette Mainstem listed as impaired (category 5 or 4A) for temperature in Oregon's 2022 Integrated Report, which was approved by the U.S. Environmental Protection Agency on September 1, 2022.

DEQ must develop TMDLs for pollutants causing temperature impairments of waters within the Willamette Mainstem, as required by Section 303(d) of the federal Clean Water Act. These pollutants are solar radiation and heat from various sources and conditions, which contribute to impairments of the temperature criteria established to support aquatic life beneficial uses.

1.2 Goals and objectives

OAR 340-042-0040(4)(l)(B) requires identification of the goals and objectives of the WQMP. The goal of this WQMP is to provide the framework for implementing this temperature TMDL to achieve and maintain the temperature water quality criteria, including narrative criteria, and meet antidegradation requirements in streams within the Willamette Mainstem. The primary objectives of this WQMP are to describe responsibilities for implementing TMDL management strategies and actions necessary to reduce excess pollutant loads to meet all TMDL allocations, and to provide a strategy to evaluate progress towards attaining water quality standards throughout the Willamette Mainstem.

2. Proposed Management Strategies

The following section presents proposed management strategies, by pollutant source and activity, that are designed to meet the load and wasteload allocations required by the Willamette Mainstem temperature TMDL, as required by OAR 340-042-0040(l)(C).

OAR 340-042-0030(6) defines management strategies as "measures to control the addition of pollutants to waters of the state and includes application of pollutant control practices, technologies, processes, siting criteria, operating methods, best management practices or other alternatives."

2.1 Streamside vegetation management strategies

DEQ's water quality analysis and modeling concluded that streamside vegetation planting and management are the strategies necessary to meet water quality standards in the temperature impaired sections of streams in the Willamette Mainstem project area. This is because streamside overstory vegetation reduces solar radiation loads to streams by providing shade. Protecting and restoring streamside overstory vegetation is essential to achieving the TMDL

surrogate measure of effective shade. More information about the physical and ecological factors affecting effective shade can be found in Section X of the draft TMDL Technical Support Document.

The primary streamside vegetation planting and management strategies are summarized as follows:

1. **Vegetation planting and establishment**
   This strategy addresses locations that have little or no shade producing overstory vegetation and are therefore important locations for streamside tree and shrub planting projects. These sites may currently be dominated by invasive species.

2. **Vegetation protection (enhancement, maintenance and growth)**
   This strategy addresses streamside areas that have existing vegetation that needs to be protected from removal to maintain current shade levels. In some cases, protection is needed because effective shade can only be achieved with additional growth. Protecting and maintaining existing vegetation ensures that it can grow and mature, enhances vegetation success and survival, and provides for optimal ecological conditions.

3. **Vegetation thinning and management**
   This strategy addresses streamside areas that might need vegetation density reduction to achieve optimal benefits of shade in the long term. Current site conditions at some riparian areas have been shown to be overly dense with trees or dominated by invasive species that inhibit a healthy streamside community and thinning may be an option to promote development of a healthy mature streamside forest. However, it must be ensured that riparian thinning and management actions will result in limited (i.e., quantity, duration, and spatial extent) stream shade loss. TSD Appendix G presents material describing potential shade and temperature impacts resulting from riparian buffer management and actions to limit these effects.

2.2 Flow management strategies

DEQ's modeling and evaluation of water quality data and research (DEQ 2023a) found that water withdrawals decrease the capacity of streams to assimilate pollutant loads. Because temperature is a flow-related parameter, water withdrawals can result in increased pollutant concentrations and warmer stream temperatures. In waterbodies where temperatures are already known to exceed standards, further withdrawals from the stream will reduce the stream's heat capacity and cause greater fluctuation in daytime and nighttime stream temperatures.

Water conservation is a best management practice that directly links the relationship between water quantity and water quality. Leaving water instream functions as a method to protect water quality from flow-related parameters of concern, such as temperature. Under state law, the first person to file for and obtain a water right on a stream is the last person to be denied water in times of low stream flows. Therefore, restoration of stream flows may require establishing instream water rights. One way this can be accomplished is by donating or purchasing out-of-stream rights and converting these rights to instream uses.

2.3 Hydromodification management strategies

Hydromodification refers to alterations of natural hydrological processes which affect characteristics of a waterbody and impact water quality. Examples of hydromodification in streams include human activities such as modifying stream channel morphologic attributes such as width, depth and course, construction and operation of dams and impoundments for flood control, drinking water, recreation, irrigation, and other uses, as well as activities meant to restore and protect streams. These activities can change the loading, timing, and delivery of nonpoint source pollutants, including temperature (EPA, 2007).

Hydromodification activities that alter channel morphology can impact stream temperature (Galli and Dubose, 1990), e.g., wide, shallow streams allow solar radiation to increase stream temperature compared to narrower and deeper channels (Larson and Larson, 1996). Activities that make streams more prone to erosion and sloughing, such as uncontrolled livestock access, can also result in shallower streams and increased stream temperatures. As streambanks erode and slough, sediments can build on the bottom of the stream, which reduces stream depth. In addition, established riparian vegetation is lost, which reduces stream shade (EPA, 2007). Channelization is another hydromodification activity that impacts channel morphology. Channelization disconnects streams from their floodplains through activities such as urban development or road construction. Streams that have been disconnected from floodplains are not able to slow and store floodwaters during the rainy season or recharge groundwater to support summer flows, which can lead to increased summer stream temperatures (EPA, 2017).

Management of hydromodification activities to prevent stream temperature increases can include BMPs for point and nonpoint source discharges like riparian restoration, livestock fencing, flow augmentation, reservoir operations, and projects including channel modifications. Note that permits are often needed to conduct stream restoration work involving removal and fill activities, and to ensure activities occur during the in-water work period to avoid harming fish. In addition, responsible persons, including DMAs need to conduct site-specific evaluations of streams to determine what specific channel modifications are appropriate to meet the desired future condition. For more information about hydromodification sources and impacts, see EPA's, *National Management Measures to Control Nonpoint Source Pollution from Hydromodification*. See also DEQ's study, *Water Temperature Impacts from In-Channel Ponds in Portland Metro and Northwest Region.*

2.3.1 Large dam owners and reservoir management

There are approximately XX dams located within the Willamette Mainstem temperature TMDL project area that are large enough to require evaluation for dam safety. DEQ compiled this basic list of XX dams from the U.S. Army Corps of Engineers (USACE) National Inventory of Dams (NID) database and a similar database maintained by the Oregon Water Resources Department (OWRD), dam safety program (see Appendix E). The OWRD prescribes dam safety rules that apply to dams 10 feet or higher, or store 9.2 acre-feet or more (OAR 690-020-0000). "Dam" means a hydraulic structure built above the natural ground line that is used to impound water. Dams include all appurtenant structures, and together are sometimes referred to as "the works". Dams include wastewater lagoons and other hydraulic structures that store water, attenuate floods, and divert water into canals. Where possible, DEQ removed reservoirs from this list that were not relevant to the TMDL, such as treatment lagoons or reservoirs not connected to a waterbody.

Dams of all sizes can increase stream temperatures, depending on factors that include dam and stream characteristics, location, and density of dams in a watershed. For these reasons, DEQ expects all dam owners to manage their reservoirs to meet water quality standards, including standards for temperature. For details on reservoir operator implementation requirements, see Section 5.3.5.

2.4 Summary of nonpoint source priority management strategies

Table 2 includes proven strategies (and practices within the strategies) summarized by pollutant source. These strategies and practices are adapted from published sources. DEQ used the categories and terminology from Oregon Watershed Enhancement Board's Oregon Aquatic Habitat Restoration and Enhancement Guide and Oregon Watershed Restoration Inventory Online List of Treatments. Additional strategies included in Table 2 are supported by Oregon Department of Agriculture, the U.S. Department of Agriculture Natural Resources Conservation Service, Oregon State University Extension Service, Oregon Plan for Salmon and Watersheds, and other publicly available published sources. DEQ identified the strategies in Table 2 as appropriate for the conditions and sources within the Mainstem. Therefore, these are considered priority strategies and practices that should receive special focus during TMDL implementation plan development.

DEQ expects that entities identified in Section 5.1 will incorporate strategies and practices listed in Table 2 that are applicable to their jurisdiction in their implementation plans. Implementation plans must include specifics on where and when priority and other strategies and practices will be applied. Implementation plans must also include measurable objectives and milestones for documenting implementation of strategies and practices and gaging their effectiveness. See Section 5.3.2 for location-specific methods for determining where land conditions require restoration, protection and enhancement.

Although not specifically detailed in this WQMP, climate change is another important factor affecting stream temperature. Potential climate change impacts to waterbodies in Oregon may include:

- higher air temperature;
- decreased snowpack leading to less water in reservoirs, streams and groundwater; and
- large-scale wildfires, which can reduce effective shade in streamside areas.

Table 2: Priority temperature management strategies by source

Pollutant	Source or Activity	Management Strategies
Solar Radiation	Insufficient riparian vegetation height, density or width	Streamside tree planting (conifer and hardwood); streamside vegetation planting (shrub or herbaceous cover); streamside vegetation management (invasive thinning, removal or other treatment); voluntary streamside tree retention; streamside invasive plant control; streamside fencing or other livestock streamside exclusion methods; identify and protect cold water refuges

Pollutant	Source or Activity	Management Strategies
		Maintain plants until free to grow; monitor survival rates Develop, update and/or enforce streamside code/ordinance to ensure streamside native vegetation and intact bank conditions are protected or restored following site development; purchase, acquire, designate conservation easements along streamside areas Goal is to increase site effective shade (combination of vegetation height, buffer width and canopy density) through streamside vegetation management strategies using regulatory programs and voluntary activities, including incentive-based projects
	Water withdrawals, flow alteration	Pursue instream water right transfers and leases; water right application reviews; irrigation conservation and management; repair or replace leaking pipes and infrastructure; provide incentives for water conservation; implement water consumption restrictions during the summer months, such as lawn watering
	Channel modification and hydromodification	Conduct whole channel restorations (e.g. enhance channel, wetlands, and floodplain interactions, reduce width to depth channel ratios, bank stabilization, large wood placement, create/connect side channels, etc.); streamside road re-construction/obliteration activities; streamside fencing or other livestock exclusion methods; protect and enhance cold water refuges; develop dam management strategies for temperature; remove in-channel ponds or modify pond structures to reduce temperature increases downstream; and protect areas that don't require restoration actions

2.5 Point source priority management strategies

Point sources may be assigned wasteload allocations and/or other requirements under the TMDL. These point sources are required to have National Pollutant Discharge Elimination System (NPDES) permits for any wastewater discharges. Under federal rules, effluent limits within NPDES permits are required to be consistent with the assumptions and requirements of any available wasteload allocation.

The primary way DEQ addresses numeric wasteload allocations is by including effluent limits in permits (though different mechanisms may be used if they are consistent with the TMDL). There are a number of available pathways that may be used to achieve compliance with these limits and requirements. These include immediate compliance with the limits, the use of compliance schedules, water quality trading, and other pathways allowed under state and federal rules.

3. Timelines for Implementing Strategies

OAR 340-042-0040(l)(D) requires schedules for implementing management strategies including permit revisions, achieving appropriate incremental and measurable water quality targets, implementing control actions and completing measurable milestones. DEQ's water quality permitting program has responsibility for revising permits to comply with TMDLs. Timelines for implementation of management strategies by responsible persons, including DMAs is discussed separately.

3.1 DEQ permit revisions

NPDES permits have five-year terms. Appendix D includes a list of permit holders located within the project area that have NPDES permits, as well as the next expected permit renewal date. DEQ incorporates any required TMDL wasteload allocations into NPDES permits when the permit is renewed.

3.2 Management strategies implemented 2007- 2021 by responsible persons, including DMAs

DEQ uses multiple sources to establish current conditions and track implementation progress in the Willamette Subbasins and Willamette Mainstem project areas.

One of these sources is the Oregon Watershed Enhancement Board's Oregon Watershed Restoration Inventory which is a repository for watershed restoration activities. OWRI contains project level information from watershed councils, landowners and other groups who have implemented restoration projects to improve aquatic habitat and water quality conditions. Additional stream temperature projects in OWRI that have been implemented in the Willamette Basin include riparian fencing, channel modification, voluntary riparian tree retention, dam management and others. The OWRI database reflects 183 total miles of riparian area planted in the Willamette Basin between 2007 and 2021 including 161.6 miles of conifer and hardwood, 13.9 miles of hardwood and 7.4 miles of conifer.

Another source utilized to track implementation progress is the Willamette Basin Year Five Report which summarizes data and information submitted to DEQ by DMAs. DMA reporting during for the 2013-2018 period documented 17.3 total linear miles of streamside trees planted in the Willamette Basin and 0.7 miles planted in the Molalla-Pudding Subbasin from 2016-2021 where a separate Year Five Report was completed. DEQ did not collect total linear miles of streamside trees planted by DMAs in the 2013 Year Five Report. Additionally, DEQ did not collect information from DMAs on linear feet or acres of streamside land acquisitions, which is an important strategy in protecting water quality.

Note that DEQ did not specifically exclude streamside trees planted in the Tualatin Basin, which is not included in the Subbasins and Mainstem TMDLs.

DEQ also utilized effective shade gap modelling to assess current conditions within the project area. Where DEQ completed modeling for this TMDL, effective shade targets were calculated at 25-meter node intervals (Lower Willamette model area) and 200-meter node intervals (Southern Willamette model area) for each waterbody. An effective mean shade was then calculated for DMAs where this modeling occurred, and a shade gap assessment was completed. A shade gap assessment was not completed for all DMAs. For the areas where a shade gap assessment was not completed, effective shade targets are determined through shade curves based on stream site characteristics. The shade gap results for the modeled areas include shade conditions that may have been impacted by streamside planting projects that were completed following the approval of the 2006 Willamette Basin Temperature TMDL.

While DEQ was not able to directly quantify the impact that planting projects documented in OWRI and the DEQ Willamette Basin Year Five Review had on modeled streamside shade gaps, available data demonstrate that the pace and scale of streamside planting will need to increase to meet shade target timelines in Table 3.

3.3 Timeline for implementation of management strategies

This section of the WQMP includes an estimate of the timeline for implementation of management strategies that will be sufficient to support attainment of water quality standards.

For solar radiation, excess pollutant load is identified in radiation units (e.g., langleys/day), whereas effective shade percent is the primary surrogate measure used in this TMDL. DEQ developed timelines to meet water quality standards based on the assumptions that DMAs and other entities will consistently implement the three primary streamside vegetation strategies in Section 2.1 until the streamside vegetation class reaches a mid-seral stage conifer-deciduous mix or equivalent characteristics. For this timeline, DEQ also assumed:

- No measurable existing overstory vegetation is removed, thereby reducing the current shade condition;
- Overstory vegetation grows steadily, consistent with average conifer and deciduous growth curves for this portion of the Willamette Basin; and
- Associated effective shade is produced at a rate commensurate with tree growth without significant disturbance (Means and Helm, 1985).

Significant uncertainty exists in meeting timelines for establishing shade. DEQ completed a shade gap assessment covering approximately XXX stream kilometers of the Willamette Mainstem project area. Available information from this assessment shows that, for areas where DEQ modelled current effective shade gaps, XX stream kilometers have X percent effective shade gap. For this analysis, DEQ assumes that both current effective shade gaps and future implementation rates will be consistent across assessed and non-assessed areas of the Willamette Mainstem.

Estimating timeframes for meeting multiple percent shade targets across the project area is influenced by several factors:

- The project area is large and the percent effective shade targets to be met are developed at a small scale (i.e., 25- and 200-meter increments) or through shade curves.
- A shade gap analysis is unavailable for all streams in the Willamette Basin to gage what percent of streamside areas across the Willamette Mainstem area are not currently meeting effective shade targets.
- DEQ is unable to determine whether the rate of planting that has occurred over the past 16 years would be similar to planting efforts following the adoption of this TMDL.
- DMAs that have a large percentage of private property within their jurisdiction will have challenges in meeting effective shade targets. It will likely take additional time to develop more protective streamside ordinances or regulations, work with landowners, or partner with other organizations to conduct streamside planting and restoration projects in these areas.
- It is unclear how much future planting will be targeted in priority shade gap areas given that some planting projects are more opportunistic in nature.
- The scale of implementation, location, and water quality benefits from future in-stream restoration and flow augmentation projects are unknown.
- The effects of climate change and forest pest impacts on streamside tree species, such as the emerald ash borer, which is now present in Oregon, could result in fewer ash species found in streamside areas.
- The occurrence of natural disturbances, such as wildfires.

DEQ expects responsible persons, including DMAs to consider the timeline projections and interim targets presented below in Table 3 in establishing commitments for streamside planting and protection in TMDL implementation plans. Based on DEQ analysis of the number of stream miles that will need restoration, and the pace of restoration logged in OWRI over the previous years of implementation, restoration will need to occur at an accelerated pace over future years of implementation to meet the targets below. Timelines for attainment of percent cumulative effective shade are generally based on time for trees to grow to heights sufficient to provide effective shade, and in considerations of factors described above. This equates to meeting 10 percent of shade targets across the basin every 10 years beginning in 2030 and meeting all shade targets in 90 years. Meeting shade targets on all waterbodies may not be possible due to factors such as, natural disturbances, the built environment, and private streamside ownership.

Table 3: Projected timelines to meet percent shade targets in the Willamette Subbasins and Willamette Mainstem TMDL in 10-year increments

Assessment Year	Percent Cumulative Shade Targets Met in Willamette Subbasins and Mainstem
2030	10%
2040	20%
2050	30%
2060	40%
2070	50%
2080	60%
2090	70%
2100	80%
2110	90%
2120	100%

4. Attaining Water Quality Standards

Based on the TMDLs analyses, achieving the excess load reductions identified will result in attainment. Each management strategy identified in this WQMP and in responsible persons' implementation plans represents part of a system of measures and practices that collectively reduce pollutant loads and improve water quality.

4.1 How management strategies support attainment of water quality standards

OAR 340-042-0040(l)(E) requires an explanation of how implementing the proposed management strategies will result in attainment of water quality standards.

DEQ identified priority implementation management strategies and specific practices in Table 2 and Section 2.1. DEQ expects these strategies and practices to increase site effective shade and address the excess solar radiation and shade deficits calculated along streams within the Willamette Mainstem (see Section X of the TMDL Rule). DEQ focused on the three vegetation strategies described in Section 2.1 to estimate reasonable timelines for achieving surrogate effective shade targets in Table 3, and by extension solar radiation load reductions to meet temperature water quality standards.

DEQ developed site-specific effective shade targets and effective shade curves to meet temperature load allocations in the TMDL Rule (Section X in the TMDL Rule). Shade curves identify the relationship between stream width, orientation, and effective shade for specific streamside vegetation types. Effective shade curves are applicable to any stream that does not have site specific shade targets. Effective shade curves represent the maximum possible effective shade for a given vegetation type.

Landowners, foresters, restoration professionals and horticulturists have expertise and experience needed to develop site-specific planting prescriptions that will ensure that the best combination of streamside species are planted. These site-specific planting prescriptions will typically contain a higher diversity of shrub and overstory species than the vegetation types used in developing the shade curves. The overall goal is to establish and protect streamside vegetation to meet shade targets established for that site. Maintenance activities, such as removal of invasive species and watering newly established trees and shrubs will be important for trees to become fully established (free to grow).

In addition to streamside shading strategies, significant water quality benefits can be achieved through implementation of stream restoration and flow augmentation management strategies.

4.2 Timelines for attaining temperature water quality standards

OAR 340-042-0040(l)(F) requires an estimated timeline for attaining water quality standards through implementation of the TMDL, WQMP and associated TMDL implementation plans. Based on DEQ's source assessment and TMDL analyses (Section 7.2 in the TSD), nonpoint sources contribute nearly all of the excess solar radiation pollutant loading associated with temperature impairments in the Willamette Mainstem TMDL. Therefore, it is critical for nonpoint sources to make timely progress toward reducing anthropogenic pollutant loads to meet the TMDL load allocations.

The TMDL calculates NPS load allocations using a percent effective shade surrogate. Therefore, estimated timelines to meet water quality standards are primarily based on streamside planting activities, although stream channel restoration and increasing instream flows would also improve stream temperature conditions. Based on the timeline to meet effective shade targets shown in Table 3, temperature water quality standards for the Willamette Mainstem will be met by 2120. The wide uncertainty associated with this date stems from unknowns related to current conditions, the potential for natural disturbances and the pace of future restoration activities. Achieving the identified timelines for cumulative effective shade and resulting water quality benefits will require active participation from all responsible persons, including DMAs, within the basin.

5. Implementation Responsibilities and Schedule

5.1 Identification of implementation responsibility

OARs 340-042-0040(4)(I)(G) and 340-042-0080(1) require identification of persons, including Designated Management Agencies, responsible for implementing management strategies and preparing and revising implementation plans.

OAR 340-042-0030(2) defines Designated Management Agency as a federal, state or local governmental agency that has legal authority over a sector or source contributing pollutants and is identified as such by DEQ in a TMDL.

The TMDL rule provides numerous mentions of the term 'responsible person' with associated requirements. OAR 340-042-0025(2) indicates that responsible sources must meet TMDL load allocations through strategies developed in implementation plans. OAR 340-042-0030(9) defines 'reasonable assurance' as a demonstration of TMDL implementation by governments or individuals. OARs 340-042-0040(4)(I)(G) requires identification of persons, including DMAs, responsible for developing and revising implementation plans. OAR 340-042-0040(4)(I)(I) requires a schedule for submittal and revision of implementation plans by responsible persons, including DMAs. OAR 340-042-0080(4) reiterates the requirement for persons, including DMAs, responsible for development, submittal and revision of implementation plans, along with the required elements of those plans. For purposes of this Willamette Mainstem WQMP, for

implementation of the temperature TMDLs, 'responsible person' is defined as any entity responsible for any source of pollution addressed by the TMDL.

Responsible persons including DMAs are organized by DMA type in the following subsections. These persons are responsible for developing or revising implementation plans and implementing management strategies to achieve the TMDL allocations. A complete list of responsible persons including DMAs for the Willamette Mainstem Temperature TMDL is in Appendix A. There are 64 responsible persons including cities, counties, federal and state agencies, and other entities.

Appendix A is not an exhaustive list of every individual that bears responsibility for improving water quality in the Willamette Mainstem. It may be necessary for all people that live, work and recreate in the basin to take steps to reduce pollution and protect or restore water quality to attain standards and designated beneficial uses.

All responsible persons, including DMAs, except those identified in Table 4, are required to develop, submit, implement and revise, as needed, an implementation plan specific to the Willamette Mainstem TMDL. As required in OAR 340-042-0080(4)(a)(A)-(E), implementation plans must include:

- Management strategies that the entity will use to achieve load allocations and reduce pollutant loading;
- Timeline for strategy implementation and a schedule for completing measurable milestones;
- Performance monitoring and a plan for periodic review and revision of implementation plans; and,
- Any other analyses or information specified in the WQMP.

Figure 1 shows which DMAs have the highest percentage of acres in the Mainstem Temperature TMDL that are within 350 feet of a stream centerline. Appendix A contains jurisdictional acres associated with many DMAs, however, that information was not available for all responsible persons or DMAs.

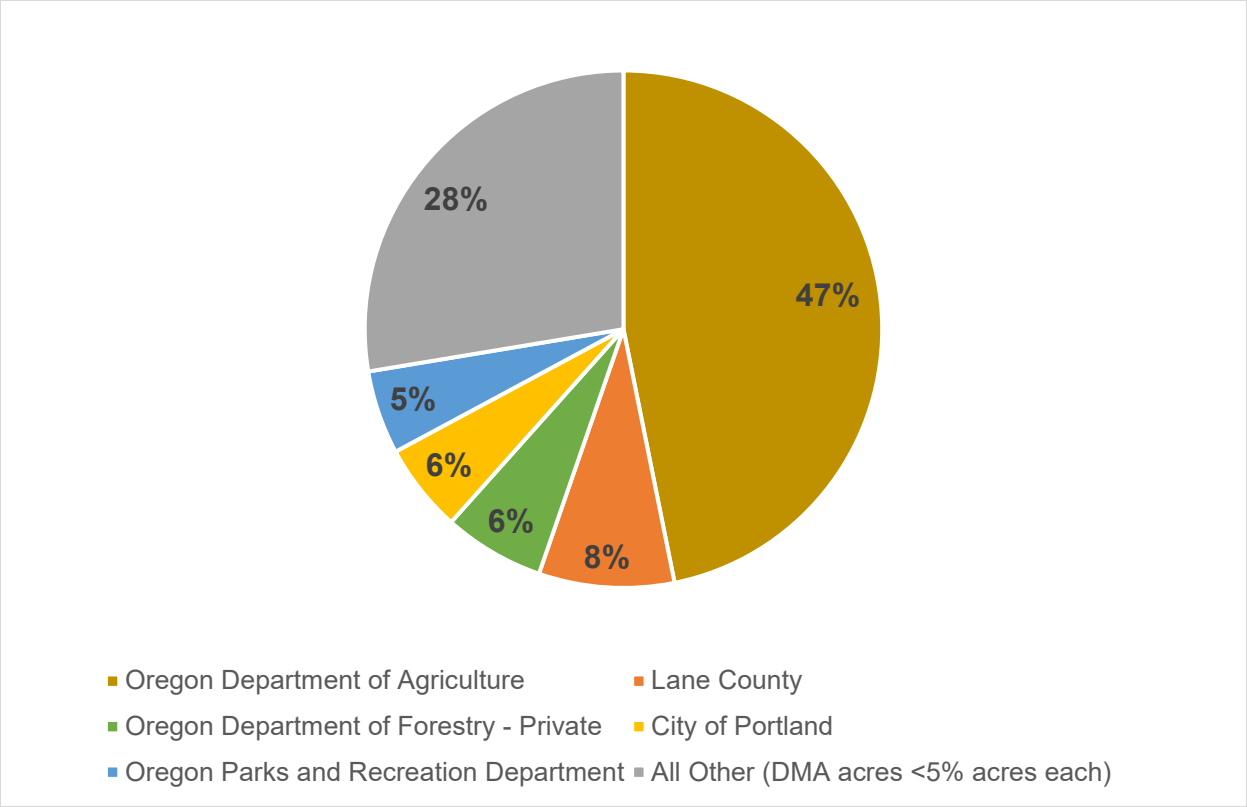


Figure 1: Percent Estimated Acres Owned or Managed by Responsible Persons Including DMAs in Willamette Mainstem TMDL within 350 ft. of stream centerline

5.2 Existing implementation plans

OAR 340-042-0040(l)(H) requires identification of any source or sector-specific implementation plans available at the time of TMDL issuance. Following the issuance of the 2006 Willamette Basin and 2008 Molalla-Pudding TMDLs and WQMPs, DEQ required responsible persons, including DMAs, to develop implementation plans that included specific management strategies and best management practices to meet load allocations for temperature. Reporting requirements for many of these entities included an annual progress report and a comprehensive assessment of activities every five years. For information on each DMA, including which DMAs are existing DMAs, Appendix A. DEQ notes that not all existing DMAs have DEQ-approved TMDL implementation plans. Existing DMAs will need to update their current implementation plans for temperature to ensure any new requirements in this WQMP are met.

In addition, certain statewide rules, programs and management plans for forestry and agriculture are intended, in part, to reduce or control nonpoint sources of pollution. The programs described in OAR 340-042-0080(2)&(3), respectively, represent existing implementation plans for non-federal forest and agricultural lands, and their sufficiency is discussed below.

5.2.1 Oregon Department of Forestry: Adequacy of Forest Practices Act to meet TMDL load allocations

Waterway protection measures were established in 1994 for state and private forest practices in Oregon, as codified in Oregon Revised Statutes 527.610 through 527.992, Oregon's Forest Practices Act (OAR 629-600 through 629-665) and Oregon's Plan for Salmon and Watersheds (Executive Order 99-01). As provided in ORS 527.770, forest operations conducted in accordance with the Forest Practices Act and other voluntary measures are generally considered to be in compliance with water quality standards. However, as provided in OAR 340-042-0080(2), revisions to the Forest Practices Act rules may be required when DEQ determines that these rules are not adequate to implement load allocations in an approved TMDL. Periodic revisions to these rules occurred between the 1990s through 2022, with studies by ODF and DEQ showing that the rules adopted prior to 2022 were not adequate to meet the Oregon temperature criterion for protecting cold water. DEQ determined in this TMDL that the generally applicable Forest Practices Act rules in effect prior to 2022 were not adequate to implement the TMDL load allocations for excess solar radiation loading on small and medium fish-bearing streams to meet the temperature criteria. More information is provided in the TMDL Technical Support Document.

With the publication of the Private Forest Accord Report and subsequent passage of Senate Bill 1501, 1502 and HB 4055, Forest Practices Act rule revisions were adopted by the Board of Forestry in October 2022 and additional amendments are anticipated through 2025. Implementation of these rules, which include increased riparian widths and additional tree retention, may be effective at meeting shade allocations. In addition, as revised rules become effective, implementation of more stringent measures to protect water quality on private forestlands are anticipated to be applied, including in the Willamette Mainstem. These rules are not expected to result in after-the-fact restoration of riparian areas harvested under previous rules. Therefore, effective shade is likely to be deficient for those riparian areas adjacent to small and medium salmon, steelhead and bull trout streams that were harvested prior to implementation of the new rules. The trajectory for providing future riparian shade on these streams is highly variable because it is based on the rules in effect at the time of harvest and the date of replanting. Multiple years will be needed for potential water quality improvements to be realized so that DEQ can evaluate adequacy of the revised rules in meeting the load allocations and surrogate measures required by the Willamette Mainstem temperature TMDL.

For these reasons, ODF is required to develop a TMDL implementation plan to be submitted to DEQ for review and approval.

As agreed, in the 2021 Memorandum of Understanding between DEQ and ODF, DEQ will work with ODF to identify additional regulatory or non-regulatory measures that could be implemented by rule revisions, stewardship agreements, incentive programs or other means to provide reasonable assurance of achieving TMDL solar radiation load allocations. Collaboration on these additional measures will occur during development of ODF's implementation plan.

5.2.2 Oregon Department of Agriculture: Adequacy of agricultural water quality management programs in attaining TMDL load allocations and effective shade surrogate measures

The Oregon Legislature passed the Agricultural Water Quality Management Act in 1993, which directed Oregon Department of Agriculture to adopt rules as necessary and to develop plans to prevent water pollution from agricultural activities (ORS 568.900 to 568.933 and ORS 561.191 and OAR chapter 603, divisions 90 and 95). Subsequently, ODA worked with Local Advisory

Committees and Soil and Water Conservation Districts to develop Agricultural Water Quality Area Rules and Area Plans for 38 watershed-based management areas across the state.

The Willamette Mainstem TMDL includes X ODA Agricultural Water Quality Management Areas that each have an Area Plan (TSD, Section 11). DEQ participates in ODA's Area Plan review process by providing water quality status and trends for each management area, as well as assessments of land conditions, agricultural activities and implementation gaps that likely contribute to water quality impairments. The Area Plans for the X management areas included in this TMDL were reviewed by DEQ within the last three years, however not all reviews resulted in Area Plan revisions.

Willamette Basin streams continue to be identified as impaired on Oregon's Section 303(d) list for temperature in part due to the lack of adequate streamside vegetation in agriculturally influenced streamside areas (Section 9.1.2.1.1). DEQ's assessments of Area Plans identified protecting, maintaining and establishing streamside vegetation as a high priority to achieve TMDL load allocations. However, ODA's Area Plans lack specific measurable goals related to streamside conditions that will achieve TMDL shade measures.

The agricultural Area Rules and Area Plans that regulate and guide streamside management in the Willamette Mainstem TMDL project area do not identify quantitative targets for effective shade based on site specific factors, including stream width or orientation. DEQ also notes the disparity between ODA's implementation of their Area Rules for "site capable vegetation" in streamside areas and the streamside conditions needed to meet effective shade targets in this TMDL. ODA has not demonstrated that voluntary landowner implementation of Area Plans will bridge the gap between current conditions and what is needed to meet TMDL allocations.

DEQ concluded that current Ag WQ program Area Rules combined with implementation of Area Plans' voluntary measures are not adequate in all locations to provide the streamside vegetation requirements and targets that are necessary to meet TMDL effective shade targets, load allocations and temperature water quality standards. Therefore, ODA is required to develop a TMDL implementation plan to be submitted to DEQ for review and approval.

5.2.3 U.S. Bureau of Land Management: Adequacy of streamside management strategies in attaining TMDL load allocations and effective shade surrogate measures

Streamside vegetation on BLM managed lands in the Willamette Mainstem are currently managed based on BLM's Northwestern and Coastal Oregon Resources Management Plan (BLM, 2016).

Table 5 provides a summary of the riparian buffer distance for different types of waterbodies. BLM calls these areas riparian reserves. The reserve distance is defined based on the site-potential tree height. The site-potential tree height is the average maximum height of the tallest dominant trees (200 years or older) for a given site class. BLM states that site-potential tree heights generally range from 140 feet to 240 feet, depending on site productivity. Within the riparian reserve clearcut harvesting is prohibited. Some tree removal or thinning activities are allowed based on certain circumstances such as to protect public safety, or to keep roads and other infrastructure clear of debris. Tree removal for yarding corridors, skid trails, road construction, stream crossings and road maintenance or improvement are allowed where there is no operationally feasible and economically viable alternative. On fish bearing streams and

perennial streams, between 0 and 120 feet slope distance there is no thinning except for treatments related to sudden oak death or for individual tree cutting or tipping that achieve restoration or habitat enhancement objectives. On intermittent, non-fish bearing streams, the same management strategy is applied but only from 0 to 50 feet.

Table 4: Summary of BLM riparian reserve buffer distance for different waterbody features

Feature	Riparian Reserve Distance measured as slope distance
Fish-bearing streams and perennial streams	One site-potential tree height distance from the ordinary high water line or from the outer edge of the channel migration zone for low-gradient alluvial shifting channels, whichever is greatest, on each side of the stream
Intermittent, non fish-bearing streams	Class I and II subwatersheds: One site-potential tree height distance from the ordinary high water line on each side of the stream
	Class II subwatersheds: 50 feet from the ordinary high water line on each side of a stream
Unstable areas that are above or adjacent to stream channels and are likely to deliver material such as sediment and logs to the stream if the unstable area fails	The extent of the unstable area; where there is stable area between such unstable areas and a stream, and the unstable area has the potential to deliver material such as sediment and logs to the stream, extend the Riparian Reserve from the stream to include the intervening stable area as well as the unstable area
Lakes, natural ponds and reservoirs > 1 acres, and wetland > 1 acres	100 feet extending from the ordinary high water line
Natural ponds < 1 acres, wetlands < 1 acres (including seeps and springs), and constructed water impoundments (e.g. canal ditches and pump chances) of any size	25 feet extending from the ordinary high water line

DEQ's finds that BLM's streamside vegetation management strategies on fish-bearing streams, perennial streams and intermittent, non-fish bearing streams in Class III subwatersheds are adequate and will likely lead to achievement of the TMDL load allocation and effective shade targets. Riparian reserves located on intermittent, non-fish bearing streams in Class I and Class II subwatersheds may not be adequate to achieve the load allocation or effective shade targets. At these locations thinning is authorized between 50 and 120 feet slope distance. The thinning must maintain at least 30 percent canopy cover and 60 trees per acre expressed as an average. Thinning at these levels within 120 feet slope distance from the stream may reduce effective shade and contribute to stream warming. The amount of effective shade reduction and temperature response will depend on the thinning intensity and spacing of thinning treatments (Roon et al 2021).

For these reasons, BLM is required to develop a TMDL implementation plan to be submitted to DEQ for review and approval.

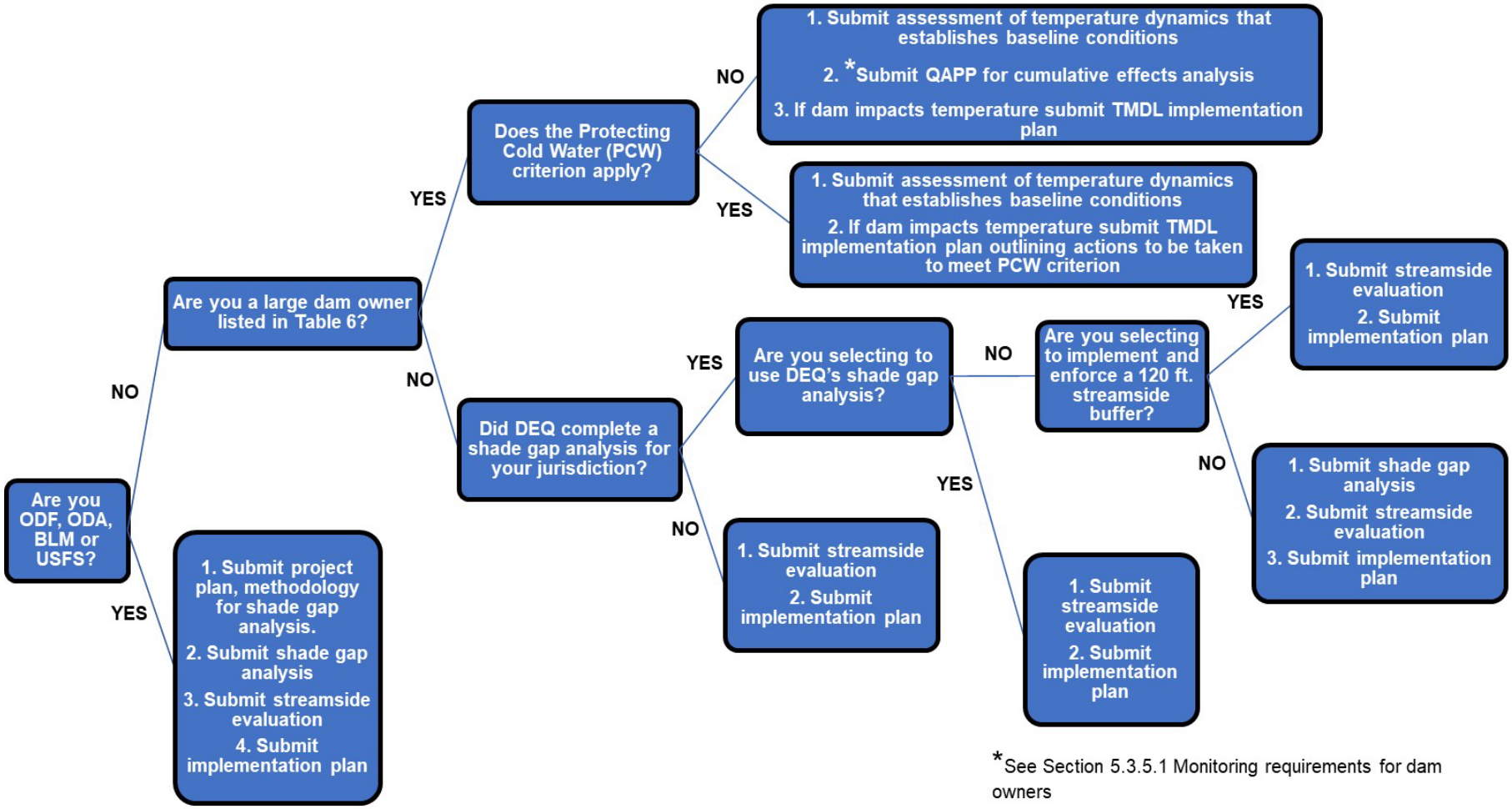
5.3 Implementation plan requirements

Appendix A lists the responsible persons including DMAs that are required to submit an implementation plan. As required in OAR 340-042-0080(4)(a)(A)-(E), implementation plans must include:

- Management strategies that the entity will use to achieve load allocations and reduce pollutant loading;
- Timeline for strategy implementation and a schedule for completing measurable milestones;
- Performance monitoring and a plan for periodic review and revision of implementation plans; and,
- Any other analyses or information specified in the WQMP.

The following subsections provide detail on each component required by this WQMP that must be included in implementation plans. Some implementation plan requirements vary depending on the responsible person or DMA. Figure 3 is provided to help responsible persons and DMAs determine the information and analyses they are responsible for submitting to DEQ. DEQ will work with each entity required to develop a TMDL implementation plan to ensure that all required elements are included with sufficient detail for their plan to be approved on the schedule required in Section 5.3.6.

Figure 2: Decision support tree to help identify information and analyses requirements for different responsible persons and DMAs.



5.3.1 Management strategies

Responsible persons including DMAs in Appendix A that are required to develop a TMDL implementation plan must include applicable priority management strategies from Table 2. Other practices and actions appropriate for activities and landscape conditions specific to the entities' pollutant sources or source sectors should also be included. Implementation plans must identify all streamside areas or streamside activities within a responsible person's or DMA's jurisdiction or responsibility.

5.3.2 Streamside evaluation

Responsible persons including DMAs that are required to submit an implementation plan must complete a streamside evaluation. The streamside evaluation will use a review of current conditions to support implementation measurable objectives and milestones. The streamside evaluation must be included in the TMDL implementation plan. Entities that have a DEQ shade gap analysis, and entities that must complete a shade gap analysis (see Section 5.3.4), must account for the shade gap analysis results in their streamside evaluation. The streamside evaluation must also include, and take into account the following data and information:

a. Quantify the streamside area in acres that needs enhancement (e.g., areas that do not currently meet shade targets, are comprised of non-native vegetation, need additional planting)
b. Quantify the streamside area in acres that may not need action beyond protection.
c. Quantify the streamside area in acres where physical constraints exist (e.g., buildings) that preclude implementation of vegetation management strategies that provide stream shade.
d. Quantify the streamside area in acres where jurisdictional constraints (e.g., private ownership) limit implementation of vegetation management strategies that provide stream shade.
e. Opportunities that may exist to address constraints to implementing vegetation management strategies that provide stream shade.
f. Any areas within your jurisdiction where there is the potential to implement best management practices such as in-stream restoration, flow augmentation projects, experimental temperature management techniques, as well as enhancing and protecting cold water refuges.
g. An evaluation of the data from (a-f) to prioritize implementation.

DEQ acknowledges that factors such as climate change and local geology, geography, soils, climate, legacy impacts, wildfires and floods may hinder achieving the target effective shade. Where natural disturbances have occurred, DEQ expects responsible persons, including DMAs to assess these areas for streamside restoration following an event.

The streamside evaluation must be completed according to the timeline assigned in Table 7. The streamside evaluation will be utilized during the five-year review (see Section 5.3.8.2) to help assess progress in meeting implementation timelines, milestones, and measurable goals in subsequent five-year implementation cycles.

5.3.3 120-foot slope streamside buffer as an alternative to a streamside shade gap analysis

The responsible persons and DMAs that are required to complete a shade gap analysis and those that choose not to use DEQ's shade assessment (where available) for their streamside evaluation (Section 5.3.4) may instead choose to establish and protect overstory, woody vegetation within a 120-foot slope width buffer zone from the stream bank. The buffer zone must be established through development of enforceable ordinances or regulations. The literature review presented in TSD Appendix I indicates that potential stream shade loss associated with a 120-foot buffer will not cause stream temperature increases for most waterbodies. For this option, responsible persons, including DMAs, must ensure that any activity occurring within this 120-foot slope buffer would result in limited stream shade reduction and ensure that stream shade targets are still achieved at that location following management actions. Entities that choose this option must also complete a streamside evaluation (Sec. 5.3.2).

5.3.4 Streamside shade gap analysis requirements

DEQ conducted a vegetation height and shade gaps analysis within approximately 350 feet of modeled waterbodies in the Lower Willamette (partial analysis completed) and Southern Willamette Mainstem, as detailed in Tables XX and XX in the TMDL Rule. This analysis calculates the gap between current effective shade (i.e., assessed) versus the target effective shade. Where DEQ calculated a shade gap analysis, DEQ averaged the percent shade gap across all waterbodies within a DMA's jurisdiction. DEQ will provide the site-specific shade results upon request. Where DEQ was unable to conduct a shade gap analysis, shade curves were developed (Figures XX in the TMDL Rule) to allow users to find target percent effective shade values for streams based on several stream characteristics. Unlike the shade gap analysis, shade curves do not calculate current effective shade.

5.3.4.1 Streamside shade gap analysis methods for responsible persons and DMAs

If DEQ has provided a shade gap analysis for a jurisdiction, then DMAs must either use DEQ's analysis to inform their streamside evaluation (Sec. 5.3.2), or location specific methods to assess the current effective shade within their jurisdiction and whether effective shade allocations along Willamette Mainstem assessment units are met. These methods are described below.

1. Measure current effective shade at the stream surface using monitoring equipment, such as the Solar Pathfinder™, or using a hemispherical camera system and imagery analysis software.
    - Determine vegetation type, canopy density, stream width and stream orientation.
    - Compare current effective shade results to either target effective shade from DEQ's shade gap analysis, or to the target percent effective shade values derived from the shade curves in the TMDL to assess the percent effective shade gap.
    - Entities choosing to use this methodology must submit their assessment strategy to DEQ for approval. Assessments should conform to guidelines outlined in OWEB's Water Quality Monitoring Technical Guidebook (OWEB, 2000)
2. Conduct modeling using the Heat Source model (as used in this TMDL).
3. Another method approved by DEQ through the TMDL implementation plan approval process

A project plan which includes a description of the assessment methodology must be submitted to DEQ for review and approval according to the timeline assigned in Table 7. Method documentation for Solar Pathfinder™ can be accessed at

https://www.solarpathfinder.com/pdf/pathfinder-manual.pdf and in OWEB's Addendum to Water Quality Monitoring Technical Guide Book, Ch. 14: https://www.oregon.gov/oweb/Documents/Stream-Shade-Canopy-Cover-WQ-Monitoring-Guidebook-addendum-ch14.pdf .

5.3.4.2 Shade gap analysis requirements for ODF, ODA, BLM and USFS

Together, the ODF, ODA, and BLM either manage or regulate 54 percent of the land area within 350 feet of streams within the Willamette Mainstem project area (Figure 1). Increasing shade on streams within the extensive areas within their jurisdictions is important to achieving the surrogate shade measures of this TMDL. Therefore, ODF, ODA, and BLM must complete a streamside evaluation (section 5.3.2) as well as a shade assessment for streamside areas within their jurisdiction. The assessment must use location-specific methods as given in Section 5.3.4.1 for determining whether effective shade allocations along the temperature impaired Willamette Mainstem assessment units are met. A shade assessment is not needed for those areas where DEQ has completed a shade gap analysis, or for areas where DEQ has determined the management strategies are sufficient (see Sections 5.2.1 and 5.2.4). A project plan which includes a description of the assessment methodology must be submitted to DEQ for review and approval according to the timeline assigned in Table 7.

5.3.5 Cold Water Refuge Requirements

> Responsible persons, including DMAs who have jurisdiction along the lower 50 river miles of the Willamette River must include actions in their TMDL implementation plans to identify, enhance and protect cold water refuges. This reach extends from the mouth of the Willamette River at the confluence with the Columbia River to the confluence of the Willamette River and Chehalem Creek in the area of the Newberg pool. This reach of the river has been designated as a migration corridor in OAR 340-041-0028(4)(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, 300A, and 340A, may not exceed 20.0 degrees Celsius (68.0 degrees Fahrenheit). In addition, these water bodies must have cold water refugia that are sufficiently distributed so as to allow salmon and steelhead migration without significant adverse effects from higher water temperatures elsewhere in the water body. Finally, the seasonal thermal pattern in Columbia and Snake Rivers must reflect the natural seasonal thermal pattern.*

According to OAR 340-041-0002(10) "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 flow of the water body.

DEQ expects DMAs with jurisdiction along these lower 50 river miles of the Willamette River to reference DEQ's *Lower Willamette River Cold-Water Refuge Narrative Criterion Interpretation Study,* or other cold water refuge studies, as a resource for protecting cold water refuges that have already been identified. This study identified a total of 48 cold water refuge locations within the migration corridor.

DMAs along this reach may protect existing refuges by:

1. maintaining or enhancing vegetation for shade
2. protecting the watersheds of cold tributaries
3. protecting channel features that create cold water flows from physical alteration

4. protecting sources of groundwater inflows
5. removing or prohibiting barriers to fish access in areas of cold water

Potential cold-water refuges may also be restored by improving access or enhancing characteristics that form cold-water refuge where they have been altered by human activity.

DMAs not along this 50 river mile reach should also consider including best management practices in their implementation plans that support identifying, enhancing and protecting cold water refuges, which are important to fish seeking escape from warm stream temperatures, in other waterbodies within the Willamette Basin.

5.3.6 TMDL implementation plan requirements for dam owners

Given the large number of dams across the Willamette Basin, DEQ is not focusing implementation requirements on dams owned and operated by individuals or businesses. Additionally, DEQ is not requiring reservoir management plans for dams that are operated to manage seasonal flow to sustain ecological benefits associated with wetlands and marshes. These individual, business, and ecological entities comprise only about 1.2% of the reservoir storage capacity in the Willamette Basin. DEQ encourages partnerships between DMAs and individual dam operators within their jurisdictions to evaluate ways in which these dams could be managed to reduce temperature impacts.

In nearly all cases, large dam owners that are a public utility, or a local, state, or federal government agency, are required to monitor and potentially develop TMDL implementation plans that include reservoir-specific management strategies to mitigate temperature increases that happen between the inflow and outlet of the dam. DMAs must identify specific measurable objectives with milestones and associated implementation timelines for implementing these strategies. The requirements in sections 5.3.2 and 5.3.4 also apply to those areas where dam owners have jurisdiction over the management of streamside vegetation. See Table 6 below for a list of dams and dam owners that are responsible for developing a monitoring plan and may be required to develop a TMDL implementation plan. See Appendix E for the entire list of dams in the Willamette Mainstem project area.

INSERT TABLE 6

5.3.6.1 Monitoring requirements for dam owners

The nature of dam and reservoirs is to alter solar radiation flux and seasonally increase surface temperatures compared to free-flowing stream segments. Increased temperatures may lead to violations of water quality temperature standards and impact aquatic life. Water released from the hypolimnion of stratified reservoirs may cool downstream reaches during the summer leading to attainment of water quality standards. In the fall, a reservoir may become isothermal and contribute to stream warming downstream of the reservoir.

Section XXX of the TMDL rule identifies a temperature surrogate measure target for dam and reservoir operations. Attainment of this target requires assessment of temperatures up and downstream of the dam and reservoir.

Dam owners in Table 6 will collect temperature data and potentially assess temperature dynamics associated with their dam and reservoir operations using a mechanistic model, empirical model, and/or analysis of continuous temperature data collected upstream, downstream, and in the reservoir. The assessment shall include:

(1) Collection of continuous temperature data to characterize reservoir inflow and outflow temperatures;
(2) Reservoir temperature profiles to characterize timing and extent of thermal stratification, and
(3) Collection of reservoir water level fluctuations and outflow rates

All data collected from items 1-3 will be submitted to DEQ or available in an online publicly accessible database. These data will establish baseline conditions for use in adaptive management and will inform evaluations of site-specific approaches to reduce temperature impacts. DEQ recommends dam owners develop a mechanistic or empirical model allowing prediction or comparison of inflow temperature to outflow temperatures. This will provide invaluable information on effective management strategies to reduce temperature. Responsible persons, including DMAs may also be required to submit a TMDL implementation plan that includes specific measurable objectives with milestones and an associated implementation timeline for implementing best management practices that address any altered temperature regimes observed downstream from reservoirs.

The “protecting cold water” criterion in OAR 340-041-0028(11) applies to waters of the state that have summer seven-day-average maximum ambient temperatures that are colder than the biologically based criteria. With some exceptions, these waters may not be warmed cumulatively by anthropogenic point and nonpoint sources by more than 0.3 degrees Celsius (0.5 degrees Fahrenheit) above the colder water ambient temperature. Reservoir operators on reaches where protecting cold water apply must meet the cold water criterion. Additional information on protecting cold water is found in the TMDL Rule (Section XXX).

For reservoirs on reaches where DEQ has determined that protecting cold water does not apply, operators are required either to ensure that discharges meet the temperature target surrogate measure (TMDL Rule Section XXX) or complete a DEQ approved cumulative effects analysis to demonstrate that releases of temperatures that exceed the biologically based numeric criteria during some periods would not contribute to cumulative warming above water quality standards at downstream locations. Reservoir operators who choose to complete a cumulative effects analysis to demonstrate that their releases would not contribute to cumulative warming above water quality standards will be required to submit a QAPP to DEQ for review and approval that outlines which dataset and cumulative effects approach will be used to assess impacts of their releases.

If DEQ determines sufficient data is available to demonstrate that stream temperature does not increase from upstream of dam to downstream of dam, then the reservoir operator may not be required to develop a TMDL implementation plan for dam management.

5.3.7 Timeline and schedule

Each implementation plan must include a commitment to enact specific management strategies on a reasonable timeline, including a schedule for meeting measurable milestones to demonstrate progress. To meet the intent of this requirement and be useful for the requirement to track and report progress, entities should develop management strategies using the SMART elements: Specific, Measurable, Achievable, Relevant, Time-bound (Doran, 1981).

Timelines and milestone schedules should be informed by the Streamside Evaluation, as described in Section 5.3.2 above, and should consider all relevant factors of an entity's specific situation. The due dates and timelines for specific information and analyses discussed in Sections 5.3.2 and 5.3.4 are shown in Table 7 below. DMA timelines in TMDL implementation plans that differ from timelines stated below must be approved by DEQ.

Table 5: Due dates for implementation plans, information and analyses.

Requirement	Due Date / Timeframe
TMDL implementation plan (Appendix A)	18 months after EQC adoption of Willamette Mainstem TMDL
Streamside Evaluation (Sec. 5.3.2)	18 months after EQC adoption of Willamette Mainstem TMDL
Project plan and description of the assessment methodology to be used to complete a shade gap analysis (Sec. 5.3.4)	18 months after EQC adoption of Willamette Mainstem TMDL
Streamside shade gap analysis (Sec. 5.3.4) and updated streamside evaluation **OR** **120 ft. streamside buffer that establishes and protects overstory, woody vegetation (sec. 5.3.3)**	Four years after implementation plan submission deadline
Reservoir operators named in Table 6 (Sec. 5.3.5)	Submit a Quality Assurance Project Plan for temperature monitoring for each reservoir 18 months after EQC adoption of Willamette Mainstem TMDL. Following the temperature assessment, the DMA will consult with DEQ on a timeframe for submitting a cumulative effects analysis, or TMDL implementation plan as needed.

5.3.8 Reporting of performance monitoring and plan review and revision

5.3.8.1 Reporting on performance monitoring

Each implementation plan must include a commitment to prepare annual reports on performance monitoring and a date by which they will be submitted to DEQ. These reports must include implementation tracking for each of the identified management strategies, progress toward timelines and measurable milestones specified in the implementation plan, and evaluation of the effectiveness of the strategies.

DMAs should track and report implementation actions including the number, type and location of projects, best management practices, education activities, or other actions taken to improve or protect water quality. Most DMAs will track implementation actions they are directly responsible for completing, and some may need to track and report on actions that they implement through their support of other land managers, e.g., private landowners.

Oregon Watershed Restoration Inventory Reporting Requirement

Projects designed to control thermal pollution that use practices listed in OWEB's OWRI Online List of Treatments must be reported once by DMAs to the OWRI database (OWEB 2023, OWEB 2023a) upon project completion. DEQ utilizes OWRI's database to track statewide and other watershed-scale size implementation activities for various reporting requirements. Responsible persons, including DMAs must also include BMP implementation activities in annual reports to DEQ to document progress and track actions over time.

Documenting restoration activities in other publicly accessible databases is allowable when approved by DEQ.

Adaptive Management

Implementation plans must include a commitment to use adaptive management to evaluate the effectiveness of implementation activities in improving streamside conditions including stream shade. Annual reports must summarize the status and results of these evaluations on the relevant time scale. At a minimum, reports in year five must summarize implementation and effectiveness over the preceding four years.

5.3.9 Implementation plan review and revision

Implementation plans must be reviewed by each responsible person and DMA, revised to incorporate lessons learned, and approved by DEQ every five years. At a minimum, plans must be revised to reflect updated timelines for the continuation of implementation activities for the next five years. DEQ will use implementation and effectiveness evaluations from annual reports for this review. If implementation plan revisions are needed to correct deficiencies or otherwise ensure the plan is effective following the year five review, DEQ will identify a date for submission of the revised plan for DEQ approval.

5.3.10 Public involvement

As required in OAR 340-042-0040(I)(L), implementation plans prepared by designated management agencies must include a plan to involve the public in implementation of

management strategies. Public engagement and education must be included to meet this requirement.

5.3.11 Maintenance of strategies over time

As required in OAR 340-042-0040(I)(M), implementation plans prepared by responsible persons, including designated management agencies, should include discussion of planned efforts to maintain management strategies over time.

5.3.12 Implementation costs and funding

As required in OAR 340-042-0040(I)(N), this section provides a general discussion of costs and funding for implementing management strategies. Implementation of management strategies to reduce or prevent pollution into waters of the state may incur financial capital or operating costs. These costs vary in relation to pollutant sources and loading, proximity to waterways and type or extent of preventative controls already in place. Certain management practices, such as preventative infrastructure maintenance, may result in long-term cost savings to responsible persons, including DMAs, or landowners.

OAR 340-042-0040(I)(N) also indicates that sector-specific or source-specific implementation plans may provide more detailed analyses of costs and funding for specific management strategies in the plan. DEQ requires each DMA to provide a fiscal analysis of the resources needed to develop, execute and maintain the programs and projects described in implementation plans to the extent that these costs can be accounted for or estimated. DEQ recommends that all responsible persons prepare the following level of economic analysis:

- Staff salaries, supplies, volunteer coordination and regulatory fees
- Installation, operation and maintenance of management measures
- Monitoring, data analysis and plan revisions
- Public education and outreach efforts
- Ordinance development (if needed to implement a management strategy)

This analysis should be in five-year increments to estimate costs, demonstrate sufficient funding is available to begin implementation and identify potential future funding sources to sustain management strategy implementation.

There are multiple sources of local, state and federal funds available for implementation of pollutant management strategies and control practices. Table 8 provides a partial list of financial incentives, technical assistance programs, grant funding and low interest loans for public entities and with principal forgiveness available in Oregon that may be used to support implementation of assessment, pollution controls and watershed restoration actions or land condition improvements that improve water quality in the Willamette Basin. Soil and water conservation districts and watershed councils are additional resources that may support responsible persons and DMAs in implementation of pollutant management strategies and control practices through the programs listed in Table 8.

Table 6: Partial list of funding programs available in the Willamette Mainstem

Program	General Description	Contact
Clean Water State Revolving Fund	Loan program for below-market rate loans for planning, design, and construction of various water pollution control activities.	DEQ
Conservation Reserve Enhancement Program (CREP)	Provides annual rent to landowners who enroll agricultural lands along streams. Also cost-shares conservation practices such as riparian tree planting, livestock watering facilities, and riparian fencing.	NRCS
Conservation Reserve Program (CRP)	Competitive CRP provides annual rent to landowners who enroll highly erodible lands. Continuous CRP provides annual rent to landowners who enroll agricultural lands along seasonal or perennial streams. Also cost-shares conservation practices such as riparian plantings.	NRCS
Conservation Stewardship Program (CSP)	Provides cost-share and incentive payments to landowners who have attained a certain level of stewardship and are willing to implement additional conservation practices.	NRCS
Emergency Watershed Protection Program (EWP)	Available through the USDA-Natural Resources Conservation Service. Provides federal funds for emergency protection measures to safeguard lives and property from floods and the products of erosion created by natural disasters that cause a sudden impairment to a watershed.	NRCS
Emergency Forest Restoration Program (EFRP)	Available through the USDA-Natural Resources Conservation Service. Helps owners of non-industrial private forests restore forest health damaged by natural disasters.	USDA
Oregon 319 Nonpoint Source Implementation Grants	Fund projects that reduce nonpoint source pollution, improve watershed functions and protect the quality of surface and groundwater, including restoration and education projects.	DEQ
Environmental Quality Incentives Program (EQIP)	Cost-shares water quality and wildlife habitat improvement activities, including conservation tillage, nutrient and manure management, fish habitat improvements, and riparian plantings.	NRCS
Agriculture Water Quality Support Grant	Provides capacity to support voluntary agricultural water quality work in small watersheds and to meet the goals of the Agricultural Water Quality Management Area Plans and the SIA initiative.	ODA
Agricultural Conservation Easement Program (ACEP)	Provides financial and technical assistance to help conserve agricultural lands and wetlands and their related benefits.	NRCS
Federal Reforestation Tax Credit	Provides federal tax credit as incentive to plant trees.	Internal Revenue Service
Grassland Reserve Program (GRP)	Provides incentives to landowners to protect and restore pastureland, rangeland, and certain other grasslands.	NRCS

Program	General Description	Contact
Landowner Incentive Program (LIP)	Provides funds to enhance existing incentive programs for fish and wildlife habitat improvements.	U.S. Fish and Wildlife Service
Oregon Watershed Enhancement Board (OWEB)	Provides grants for a variety of restoration, assessment, monitoring, and education projects, as well as watershed council staff support. 25 percent local match requirement on all grants.	OWEB
Oregon Watershed Enhancement Board Small Grant Program	Provides grants up to $10,000 for priority watershed enhancement projects identified by local focus group.	OWEB
Partners for Wildlife Program	Provides financial and technical assistance to private and non-federal landowners to restore and improve wetlands, riparian areas, and upland habitats in partnership with the U.S. Fish and Wildlife Service and other cooperating groups.	U.S. Fish and Wildlife Service
Public Law 566 Watershed Program	Program available to state agencies and other eligible organizations for planning and implementing watershed improvement and management projects. Projects should reduce erosion, siltation, and flooding; provide for agricultural water management; or improve fish and wildlife resources.	NRCS
Resource Conservation & Development (RC & D) Grants	Provides assistance to organizations within RC & D areas in accessing and managing grants.	Resource Conservation and Development
ODF Small Forestland Investment in Stream Habitat (SFISH) Grants	Provides funding for Small Forestland Owners (SFO's) to improve road conditions and stream crossings as part of forest operations.	ODF
State Forestation Tax Credit	Provides for reforestation of under-productive forestland not covered under the Oregon Forest Practices Act. Situations include brush and pasture conversions, fire damage areas, and insect and disease areas.	ODF
Forest Stewardship Program	Provides cost share dollars through USFS funds to family forest landowners to have management plans developed.	ODF
Western Bark Beetle Mitigation	ODF administers a cost share program for forest management practices pertaining to bark beetle mitigation for forest health and is funded through the USFS.	ODF
State Tax Credit for Fish Habitat Improvements	Provides tax credit for part of the costs of voluntary fish habitat improvements and required fish screening devices.	ODFW
Wetlands Reserve Program (WRP)	Provides cost-sharing to landowners who restore wetlands on agricultural lands.	NRCS
Wildlife Habitat Tax Deferral Program	Maintains farm or forestry deferral for landowners who develop a wildlife management plan with the approval of the Oregon Department of Fish and Wildlife.	ODFW
Funding Resources for Watershed Protection and Restoration	EPA's Funding Resources for Watershed Protection and Restoration (EPA, 2023) contains links to multiple funding sources	Various

5.4 Schedule for implementation plan submittal

OAR 340-042-0040(4)(l)(I) specifies that the WQMP contain a schedule for submittal of implementation plans. As stated in OAR 340-042-0080(4)(a), entities identified in the WQMP with responsibility for developing implementation plans are required to prepare and submit an implementation plan for DEQ approval according to the schedule in the WQMP.

Within 18 months of EQC adoption of the Willamette Basin mainstem TMDL , persons, including DMAs, responsible for developing implementation plans must submit implementation plans to DEQ for review and approval. OAR 340-012-0055(2)(e) identifies failure to timely submit or implement a TMDL implementation plan, as required by DEQ order or rule, as a Class II violation. OAR 340-012-0053(1) identifies failure to report by the reporting deadline, as required by DEQ order or rule, as a Class I violation.

Should a sector or sector-wide DMA fail to submit an approvable TMDL implementation plan or fail to timely implement, DEQ may pursue enforcement under OAR 340-012-0055(e) or identify individual sources (landowners/operators) as persons responsible for developing and implementing TMDL implementation plans to address the load allocations relevant for the sector. DEQ may revise the WQMP or issue individual orders to identify additional responsible persons and notify them of the required schedule for submitting source-specific implementation plans.

Following the issuance of this TMDL and WQMP, DEQ may determine that nonpoint source implementation plans are not necessary for certain entities identified in the WQMP based on available information or new information provided by those entities. For these entities, DEQ will provide a written determination for why a plan is not required. This determination could be based on a variety of factors, such as inaccurate identification within the geographic scope of the TMDLs, or documentation that an entity is not a source of pollution or does not discharge pollutants to a waterbody within the geographic scope of a TMDL.

Once approved, DEQ expects implementation plans to be fully implemented according to the timelines and schedules for achieving measurable milestones specified within the plans. Implementation plans must be reviewed and revised as appropriate for DEQ approval every five years and submitted on the date specified in DEQ’s approval letter for an implementation plan.

6. Monitoring and Evaluation of Progress

OAR 340-042-0040(4)(l)(K) requires that the WQMP include a plan to monitor and evaluate progress toward achieving the TMDL allocations and associated water quality standards for the impairments addressed in the TMDL. Additional objectives of monitoring efforts are to assess progress towards reducing excess pollutant loads and to better understand variability associated with environmental or anthropogenic factors. This section summarizes DEQ’s

approach, including the required elements of identification of monitoring responsibilities and the plan and schedule for reviewing monitoring information to make TMDL revisions, as appropriate.

There are two fundamental components to DEQ's approach to monitoring and evaluating TMDL progress:

1. Tracking the implementation and effectiveness of activities committed to by responsible persons in DEQ-approved implementation plans, and
2. Periodically monitoring the physical, chemical and biological parameters necessary to assess water quality status and trends for the impairments that constitute the basis for this TMDL.

All responsible persons, including DMAs are responsible for tracking the implementation and effectiveness of their actions and meeting milestones where established. Progress in implementing streamside actions prioritized through the streamside evaluation, as well as other restoration efforts to improve stream temperature (e.g. channel morphology and stream flow restoration, protection and enhancement of cold water refuges, etc.) will form the basis against which implementation progress will be assessed. Although DEQ encourages responsible persons including DMAs to conduct physical, chemical or biological monitoring to better evaluate how implementation actions may impact water quality conditions, DEQ is only requiring the DMAs listed under section 6.1 to conduct water column monitoring associated with this TMDL.

With input from partners, DEQ will develop overarching water column sampling and analysis plans to finalize the first iteration of the Willamette Basin Temperature Monitoring Strategy after the issuance of the Willamette Mainstem Temperature TMDL and WQMP. DEQ will continue to work with partners to implement the sampling and analysis and periodically refine the strategy as needed.

6.1 Persons responsible for water quality monitoring

Section 5.1 identifies responsible persons, including Designated Management Agencies that are responsible for developing TMDL implementation plans and implementing the management strategies described on the timelines committed to in approved plans. Section 5.3 details the content required in implementation plans and annual reports, as well as the schedules for their submittal.

DEQ is requiring ODA, ODF, BLM, and USFS to undertake monitoring actions in areas within their jurisdiction or ownership to help determine the status of instream water quality and landscape conditions associated with water quality. These four agencies have jurisdiction over approximately 54% of streamside areas in the Willamette Mainstem TMDL. For this reason, DEQ considers it appropriate for these large agencies to collaborate with DEQ on the Monitoring Strategy. DEQ encourages and invites other DMAs to collaborate with DEQ on collecting water quality data, especially DMAs that have been collecting temperature data as part of TMDL implementation or other related programs.

This effort will be iterative, beginning with review of existing data and monitoring locations, then adjusted as needed to improve understanding of current water quality status and develop a temperature trend monitoring network. DEQ expects to refine this monitoring strategy over time and modify as necessary.

The objectives for monitoring and assessment will be described in DMA implementation plans and will include, but are not limited to:

1. Provide information necessary to determine locations for applying management strategies or to assess the effectiveness of those strategies.
2. Refine information on source-specific or sector-specific pollutant loading.
3. Provide information necessary to demonstrate progress towards meeting load allocations.
4. Provide information used to identify roles and participate in collaborative effort among responsible persons to characterize water quality status and trends.
5. Provide information integral to an adaptive management approach to inform and adjust management strategies over time.

Environmental media and water column monitoring activities conducted by ODA, ODF, BLM, USFS, or other DMAs to meet TMDL objectives, data collection and management must be performed in adherence to Quality Control procedures and Quality Assurance protocols established by DEQ, U.S. EPA or other appropriate organizations. This requirement will be met through developing or adapting Quality Assurance Project Plans or project-specific Sampling and Analysis Plans, and submitting to DEQ for review and approval based on a schedule determined by DEQ once development of the Monitoring Strategy has been initiated. ODA, ODF, BLM, USFS or other DMAs can also agree to participate in a collaborative monitoring plan under an umbrella QAPP. DEQ staff will coordinate QAPP development with ODA, ODF, BLM, and USFS upon request in advance of submission. Resources for developing quality assurance project plans and sampling and analysis plans are available on DEQ's water quality monitoring website (DEQ, 2023).

At a minimum, ODA, ODF, BLM, and USFS must acknowledge in their implementation plans their responsibility in collaborating with DEQ to develop the Willamette Basin Temperature Monitoring Strategy. DEQ encourages these agencies to begin evaluating their existing temperature monitoring networks, if any, and explore opportunities to establish future long-term monitoring sites. Data collected by DMAs participating in the monitoring strategy must be in a format accessible to DEQ.

6.2 Plan and schedule for reviewing monitoring information and revising the TMDL

DEQ recognizes that it will take time before management practices identified in a WQMP are fully implemented and effective in reducing and controlling pollution. DEQ also recognizes that despite best efforts, natural events beyond the control of humans may interfere with or delay attainment of the TMDL. Such events include, but are not limited to, floods, fire, insect infestations and drought. In addition, DEQ recognizes that technology and practices for controlling nonpoint source pollution will continue to develop and improve over time. DEQ will use adaptive management to refine implementation as technology, and knowledge about these approaches progress.

Adaptive management is a process that acknowledges and incorporates improved technologies and practices over time to refine implementation. A conceptual representation of the TMDL adaptive management process is presented in Figure 4.

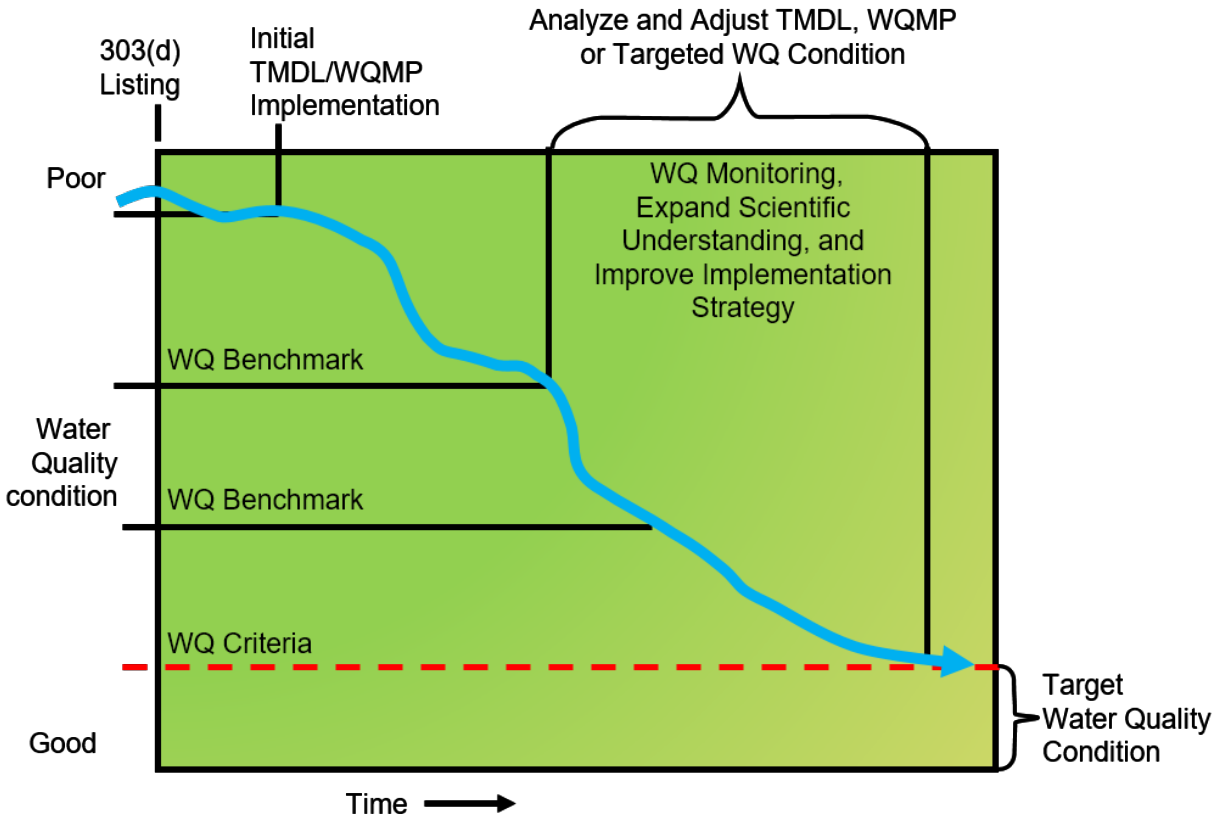


Figure 3: Conceptual representation of adaptive management

DEQ considers entities complying with DEQ-approved TMDL implementation plans to be in compliance with their respective requirements contained in the TMDLs. The annual reports and Year Five Reviews submitted to DEQ by each of the responsible persons, including DMAs, in the Willamette Basin will be evaluated individually and collectively. DEQ will use this information to determine whether management actions are supporting progress towards TMDL objectives, or if changes in management actions and/or TMDLs are needed.

DEQ will review annual reports, participate with responsible persons, including DMAs, in review of monitoring information, and participate in implementing the Willamette Basin Monitoring Strategy.

Every five years, DEQ will collectively evaluate annual reports and all available monitoring data and information to assess progress on meeting the goals of the TMDLs and WQMP.

- DEQ will require responsible persons including DMAs to revise their implementation plans to address deficiencies where DEQ determines that implementation plans or effectiveness of management strategies are inadequate.
- DEQ and partners will revise sampling and analysis plans or other aspects of the Monitoring Strategy where progress toward meeting Monitoring Strategy objectives is not being made.
- DEQ will consider TMDL revisions if DEQ's evaluation of water monitoring data and supporting information indicate that the TMDL load allocations for a given pollutant-impairment are insufficient to meet state numeric criteria or narrative criteria, or insufficient to protect the designated beneficial uses.

- DEQ will follow all public participation requirements, including convening a local technical or rulemaking advisory committee to provide input on TMDL revisions per OAR 340-042-0040(7).

7. Reasonable Assurance of Implementation

OAR 340-042-0030(9) defines Reasonable Assurance as "a demonstration that a TMDL will be implemented by federal, state or local governments or individuals through regulatory or voluntary actions including management strategies or other controls." OAR 340-042-0040(4)(l)(J) requires a description of reasonable assurance that management strategies and sector-specific or source-specific implementation plans will be carried out through regulatory or voluntary actions. As a factor in consideration of allocation distribution among sources, OAR 340-042-0040(6)(g) states that "to establish reasonable assurance that the TMDL's load allocations will be achieved requires determination that practices capable of reducing the specified pollutant load: (1) exist; (2) are technically feasible at a level required to meet allocations; and (3) have a high likelihood of implementation." This three-point test is consistent with EPA past practice on determining reasonable assurance in the Chesapeake Bay TMDL (EPA, 2010) and supports federal antidegradation rules and Oregon's antidegradation policy (OAR 340-041-0004).

The Clean Water Act section 303(d) requires that a TMDL be "established at a level necessary to implement the applicable water quality standard." Federal regulations define a TMDL as "the sum of the individual wasteload allocations for point sources and load allocations for nonpoint sources and natural background" [40 CFR 130.2(i)]. For TMDL approval, EPA guidance documents and memos on the TMDL process requires determinations that allocations are appropriate to implement water quality standards and reasonable assurance that nonpoint source controls will achieve load reductions, when WLAs are based on an assumption that nonpoint source load reductions will occur (EPA, 1991, 2002 and 2012).

Although TMDL implementation is anticipated to improve rather than lower water quality, federal antidegradation rules at 40 CFR 131.12(a)(2), require states to "assure that there shall be achieved the highest statutory and regulatory requirements for all new and existing point sources and cost-effective and reasonable best management practices for nonpoint source control," when allowing any lowering of water quality.

When a TMDL is developed for waters impaired by point sources only, the existence of the NPDES regulatory program and the issuance of NPDES permits provide the reasonable assurance that the wasteload allocations in the TMDL will be achieved. That is because federal regulations implementing the Clean Water Act require that water quality-based effluent limits in permits be consistent with "the assumptions and requirements of any available wasteload allocation" in an approved TMDL [40 CFR 122.44(d)(1)(vii)(B)].

Where a TMDL is developed for waters impaired by both point and nonpoint sources, it is the state's best professional judgment as to the three-point test in OAR 340-042-0040(6)(g) on reasonable assurance that the TMDL's load allocations will be achieved.

Where there is a demonstration that nonpoint source load reductions can and will be achieved; a determination that reasonable assurance exists and allocation of greater loads to point sources is appropriate. Without a demonstration of reasonable assurance that relied-upon nonpoint source reductions will occur, reductions to point sources wasteload allocations are needed.

The Willamette Basin TMDLs were developed to address both point and nonpoint sources with load reduction allocations proportional to estimated source contributions and in consideration of opportunities for effective measures to reduce those contributions. There are several elements that combine to provide the reasonable assurance to meet federal and state requirements, including for antidegradation. Education, outreach, technical and financial assistance, permit administration, permit enforcement, responsible person's implementation and DEQ enforcement of TMDL implementation plans will all be used to ensure that the goals of this TMDL are met.

7.1 Accountability framework

Reasonable assurance that needed load reductions will be achieved for nonpoint sources and antidegradation requirements and narrative water quality criteria will be met is based primarily on an accountability framework incorporated into the WQMP, together with the implementation plans of persons responsible for implementation. This approach is similar to the accountability framework adopted by EPA for the Chesapeake Bay TMDL, which was adopted in 2010 (EPA, 2010). Figure 5 presents the accountability framework elements, which are intended to work in concert to demonstrate reasonable assurance of implementation.

Figure 4: Representation of the reasonable assurance accountability framework led by DEQ

Pollutant reduction strategies are identified in Section 2 and more specific strategies, practices and actions will be detailed in each required implementation plan, to be submitted per the timelines in Section 5.4. These strategies and actions are comprehensively implemented through a variety of regulatory and non-regulatory programs. Many of these are existing strategies and actions that are already being implemented within the watershed and demonstrate reduced pollutant loading. These strategies are technically feasible at an appropriate scale to meet the allocations. A high likelihood of implementation is demonstrated because DEQ reviews the individual implementation plans and proposed actions for adequacy and establishes a monitoring and reporting system to track implementation and respond to any inadequacies. In Oregon, forestry and agricultural related nonpoint source best management strategies are actualized through implementation of state Forest Practices Act and agricultural Water Quality Management Area Plans and Rules. In Sections 5.2.1 and 5.2.2 DEQ determined that ODF and ODA must also develop and implement TMDL implementation plans that describe strategies specific to the Willamette River Mainstem. This adds to the accountability for implementation of cost-effective and reasonable best management and further assures that antidegradation requirements and narrative criteria will be met.

Approximately responsible persons, including Designated Management Agencies in Appendix A are responsible for implementation of pollutant reduction strategies. General timelines, milestones and measurable objectives are identified in Sections 3 and 4.2, respectively. More

specific timelines, milestones and measurable objectives will be specified in each required implementation plan. These elements support timely action by both DEQ and persons/agencies responsible for implementation so that enforcement and adaptive management actions can be triggered and evaluation of attainment of TMDL goals occurs.

DEQ periodically reviews reporting by persons and agencies responsible for implementing pollutant reduction strategies to track the management strategies being implemented and evaluate achievements against established timelines and milestones.

Following up on reviews to track progress of implementation plans, DEQ will take appropriate action if the DMAs or responsible persons fail to develop or effectively implement their implementation plan or fulfill milestones. DEQ's actions can include enforcement or engagement in voluntary initiatives. DEQ uses both, as appropriate within the process, to achieve optimal pollutant reductions. In some cases, DEQ will also take enforcement actions where necessary based on authorities listed in Section 8 or raise the issue to the Environmental Quality Commission as provided in OAR 340-042-0080.

DEQ tracks water quality status and trends concurrently with implementation of management strategies. DEQ relies on a system of interconnected evaluations, which include DMAs meeting measurable objectives, effectiveness demonstration of pollutant management strategies, accountability of implementation, periodically assessing progress on Oregon's Nonpoint Source Program Five-Year Plan Goals (approved by EPA), discharge monitoring and instream monitoring. DEQ also periodically evaluates water quality data collected through ambient and specific monitoring programs, including monitoring plans developed specifically for the Willamette Basin, as presented in Section 6. The *Assessment and Monitoring Strategy to Support Implementation of Mercury Total Maximum Daily Loads for the Willamette Basin* is one such plan, which was developed in partnership with EPA. DEQ regularly prepares Status and Trends reports and conducts water quality assessments on status of all waterways in Oregon every two years, as required by the Clean Water Act for submittal to EPA for approval as DEQ's Integrated Report. Together, these data and evaluations allow refinement of focus on specific geographic areas or discharges and appropriate implementation of adaptive management actions to attain, over time, the objectives of the TMDL.

7.2 Reasonable assurance conclusions

DEQ's implementation approach is multi-faceted and requires many targeted management practices across the entire basin to reduce anthropogenic pollutants, regardless of source origination.

The management strategies and practices that must be employed to reduce excess solar radiation loading are spatially distributed and involve multiple responsible persons. Also, highly variable lag times are anticipated following the establishment of shade-producing vegetation to decrease solar radiation reaching streams. For these reasons, there is some uncertainty about the pace of achieving the needed reductions necessary in the Willamette Mainstem to attain water quality criteria. DEQ's WQMP addresses this uncertainty by including an extensive monitoring, reporting, and adaptive component that is designed to match the accountability framework used by EPA in its Chesapeake Bay TMDL (2010).

The rationale described in this document stems from robust evaluations, implements an accountability framework and provides opportunities for adaptive management to maximize pollutant reductions. In addition, DMAs and other groups have been continuing to implement on-the-ground actions since the establishment of the 2006 Willamette Basin Temperature TMDL. Together this approach provides reasonable assurance to meet state and federal requirements, including for antidegradation, and attain the goals of the TMDL.

8. Legal Authorities

As required in Oregon Administrative Rule 340-042-0040(4)(l)(O), this section cites legal authorities relating to implementation of management strategies.

Clean Water Act, Section 303(d)

The DEQ is the Oregon state agency responsible for implementing the Clean Water Act in Oregon. Section 303(d) of the 1972 Federal Clean Water Act as amended requires states to develop a list of rivers, streams and lakes that cannot meet water quality standards without application of additional pollution controls beyond the existing requirements on industrial sources and sewage treatment plants. These waters are referred to as “water quality limited.” Water quality limited waterbodies must be identified by the EPA or by a state agency which has this authority. In Oregon, the responsibility to delegate water quality limited waterbodies rests with DEQ and DEQ’s list of water quality limited waters is updated every two years. The list is referred to as the 303(d) list. Section 303 of the Clean Water Act further requires that TMDLs be developed for all waters on the 303(d) list. The Oregon Environmental Quality Commission granted DEQ authority to implement TMDLs through OAR 340-042, with special provisions for agricultural lands and nonfederal forestland as governed by the Agriculture Water Quality Management Act and the Forest Practices Act, respectively. The EPA has the authority under the Clean Water Act to approve or disapprove TMDLs that states submit. When a TMDL is officially submitted by a state to EPA, EPA has 30 days to take action on the TMDL. In the case where EPA disapproves a TMDL, EPA must issue a TMDL within 30 days. A TMDL defines the amount of pollution that can be present in the waterbody without causing water quality standards to be violated. A WQMP is developed to describe a strategy for reducing water pollution to the level of the load allocations and waste load allocations prescribed in the TMDL, which is designed to restore the water quality and result in compliance with the water quality standards. In this way, the designated beneficial uses of the water will be protected for all users.

Endangered Species Act, Section 6

Section 6 of the 1973 federal Endangered Species Act, as amended, encourages states to develop and maintain conservation programs for federally listed threatened and endangered species. In addition, Section 4(d) of the ESA requires the National Marine Fisheries Service to list the activities that could result in a “take” of species they are charged with protecting. With regard to this TMDL, NMFS’ protected species are salmonid fish. NMFS also described certain precautions that, if followed, would preclude prosecution for take even if a listed species were harmed inadvertently. Such a provision is called a limit on the take prohibition. The intent is to provide local governments and other entities greater certainty regarding their liability for take.

NMFS published their rule in response to Section 4(d) in July of 2000 (see 65 FR 42421, July 10, 2000). The NMFS 4(d) rule lists 12 criteria that will be used to determine whether a local program incorporates sufficient precautionary measures to adequately conserve fish. The rule provides for local jurisdictions to submit development ordinances for review by NMFS under one, several or all of the criteria. The criteria for the Municipal, Residential, Commercial and Industrial Development and Redevelopment limit are listed below:

1. Avoid inappropriate areas such as unstable slopes, wetlands, and areas of high habitat value;
2. Prevent stormwater discharge impacts on water quality;
3. Protect riparian areas;
4. Avoid stream crossings – whether by roads, utilities, or other linear development;
5. Protect historic stream meander patterns;
6. Protect wetlands, wetland buffers, and wetland function;
7. Preserve the ability of permanent and intermittent streams to pass peak flows (hydrologic capacity);
8. Stress landscaping with native vegetation;
9. Prevent erosion and sediment run-off during and after construction;
10. Ensure water supply demand can be met without affecting salmon needs;
11. Provide mechanisms for monitoring, enforcing, funding and implementing; and
12. Comply with all other state and federal environmental laws and permits.

Oregon Revised Statute Chapter 468B

DEQ is authorized by law to prevent and abate water pollution within the State of Oregon. Particularly relevant provisions of this chapter include:

ORS 468B.020 Prevention of pollution

(A) Pollution of any of the waters of the state is declared to be not a reasonable or natural use of such waters and to be contrary to the public policy of the State or Oregon, as set forth in ORS 468B.015.

(B) In order to carry out the public policy set forth in ORS 468B.015, the Department of Environmental Quality shall take such action as is necessary for the prevention of new pollution and the abatement of existing pollution by:

a) Fostering and encouraging the cooperation of the people, industry, cities and counties, in order to prevent, control and reduce pollution of the waters of the state; and

b) Requiring the use of all available and reasonable methods necessary to achieve the purposes of ORS 468B.015 and to conform to the standards of water quality and purity established under ORS 468B.048.

ORS 468B.110 provides DEQ and the EQC with authority to take actions necessary to achieve and maintain water quality standards, including issuing TMDLs and establishing wasteload allocations and load allocations.

NPDES and WPCF Permits

DEQ administers two different types of wastewater permits in implementing Oregon Revised Statute (ORS) 468B.050. These are: the NPDES permits for waste discharge into waters of the United States; and Water Pollution Control Facilities permits for waste disposal on land. The NPDES permit is also a federal permit and is required under the Clean Water Act. The WPCF permit is a state program.

401 Water Quality Certification

Section 401 of the CWA requires that any applicant for a federal license or permit to conduct any activity that may result in a discharge to waters of the state must provide the licensing or permitting agency a certificate from DEQ that the activity complies with water quality requirements and standards. These include certifications for hydroelectric projects and for 'dredge and fill' projects. The legal citations are: 33 U.S.C. 1341; ORS 468B.035 – 468B.047; and OAR 340-048-0005 – 340-048-0040.

USACE Dam Operation and Management

In association with other federal statues, including House Document No. 531 Volume V, the River and Harbor Act, the Flood Control Act, and the Water Resources Development Act, the USACE is charged with operating its projects in compliance with the federal Clean Water Act, and in accordance with all federal, State, interstate and local requirements, administrative authority, and process and sanctions respecting the control and abatement of water quality pollution as per Title 1 Section 313 (33 U.S.C. 1323).

Oregon Forest Practices Act

The Oregon Department of Forestry is the designated management agency for regulating land management actions on non-federal forestry lands that impact water quality (ORS 527.610 to 527.992, and OAR 629 Divisions 600 through 665). The Board of Forestry has adopted water protection rules, including but not limited to OAR Chapter 629, Divisions 625, 630, and 635-660, which describe best management practices for forest operations. The Oregon Environmental Quality Commission, Board of Forestry, DEQ, and ODF have agreed that these pollution control measures will primarily be relied upon to result in achievement of state water quality standards. Statutes and rules also include provisions for adaptive management that provide for revisions to FPA practices where necessary to meet water quality standards. These provisions are described in ORS 527.710, ORS 527.765, OAR 629-035-0100, and OAR 340-042-0080.

Agricultural Water Quality Management Act

The Oregon Department of Agriculture is responsible for the prevention and control of water pollution from agricultural activities as directed and authorized through the Agricultural Water Quality Management Act, adopted by the Oregon legislature in 1993 (ORS 568.900 to ORS 568.933). It is the lead state agency for regulating agriculture for water quality (ORS 561.191). The Agricultural Water Quality Management Plan Act directs the ODA to work with local communities to develop water quality management plans for specific watersheds that have been identified as violating water quality standards and have agriculture water pollution contributions. The agriculture water quality management plans are expected to identify problems in the watershed that need to be addressed and outline ways to correct the problems. Water Quality

area rules for areas within the Willamette Basin include OAR 603-095-2100 to 1160, OAR 603-095-2300 to 2360, OAR 603-095-2600 to 2660, and OAR 603-095-3700 to 3760.

Local Ordinances

Local governments are expected to describe in their implementation plans their specific legal authorities to carry out the management strategies necessary to meet the TMDL allocations. If new or modified local codes or ordinances are required to implement the plan, the DMA will identify code development as a management strategy. Legal authority to enforce the provisions of a city's NPDES permit would be a specific example of legal authority to carry out specific management strategies.

9. References

DEQ. 2014. Willamette Basin Five Year Review. https://www.oregon.gov/deq/wq/tmdls/Pages/TMDLs-Implementation.aspx

DEQ. 2022. Water Quality Status and Trends. https://www.oregon.gov/deq/wq/programs/Pages/wqstatustrends.aspx

DEQ. 2022. EPA approved Integrated Report. https://www.oregon.gov/deq/wq/Pages/WQ-Assessment.aspx

DEQ. 2018. Oregon Nonpoint Source Pollution Program 2017 Annual Report. Oregon Department of Environmental Quality. July 2018.

DEQ. 2023c. Volunteer Monitoring Resources webpage. https://www.oregon.gov/deq/wq/Pages/WQ-Monitoring-Resources.aspx. Accessed January 20, 2023.

DEQ. 2023d. Water Temperature Impacts from In-Channel Ponds in Portland Metro and Northwest Region.

Doran, George T. 1981. There's a S.M.A.R.T. way to write management's goals and objectives. Management Review. 70. Pages 35-36. https://community.mis.temple.edu/mis0855002fall2015/files/2015/10/S.M.A.R.T-Way-Management-Review.pdf. Accessed January 20, 2023.

EPA. 1991. Guidance for Water Quality-based Decisions: The TMDL Process. EPA/440/4-91-001. Washington, D.C.

EPA. 2002. Guidelines for Reviewing TMDLs under Existing Regulations issued in 1992. May 20, 2002.

EPA. 2007. National Management Measures to Control Nonpoint Source Pollution from Hydromodification. EPA 841-B-07-002. National Management Measures to Control Nonpoint Source Pollution from Hydromodification (epa.gov)

EPA. 2008. Handbook for Developing Watershed Plans to Restore and Protect Our Waters. US Environmental Protection Agency. https://nepis.epa.gov/Exe/ZyPDF.cgi/P1002U9R.PDF?Dockey=P1002U9R.PDF.

EPA. 2010. Chesapeake Bay TMDL. December 29, 2010. https://www.epa.gov/chesapeake-bay-tmdl/chesapeake-bay-tmdl-document.

EPA. 2012. Supplemental Information for Reviewing Reasonable Assurance in TMDLs. Office of Wetlands, Oceans and Watersheds. February 15, 2012.

EPA. 2017. Causal Analysis/Diagnosis Decision Information System (CADDIS): *Vol. 2: Sources, Stressors, and Responses - Temperature*. https://www.epa.gov/caddis-vol2/temperature

EPA. 2023. Funding Resources for Watershed Protection and Restoration webpage. https://www.epa.gov/nps/funding-resources-watershed-protection-and-restoration. Accessed January 20, 2023.

EPA and DSL. 2020. Stream Function Assessment Methodology. US Environmental Protection Agency and Oregon Department of State Lands. https://www.oregon.gov/dsl/WW/Pages/SFAM.aspx.

Galli J., and R. Dubose. 1990. Thermal Impacts Associated with Urbanization and Stormwater Management Best Management Practices. Metropolitan Washington Council of Governments, Department of Environmental Programs, Washington DC.

Larson, L.L., and S.L. Larson. 1996. Riparian Shade and Stream Temperature: A Perspective. Rangelands, 18(4):149-152.

NRCS. 2009. Stream Visual Assessment Protocol Version 2. National Biology Handbook. Subpart B – Conservation Planning. Part 614. US Department of Agriculture – Natural Resources Conservation Service. December 2009. https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs144p2_042678.pdf.

Oregon Plan for Salmon and Watersheds. 1999. Oregon Aquatic Habitat Restoration and Enhancement Guide. Restoration_Enhancement_Guide.pdf (oregon.gov)

OWEB. 2004. Riparian Assessment Framework – The Oregon Plan for Salmon and Watersheds. Oregon Watershed Enhancement Board. https://digital.osl.state.or.us/islandora/object/osl:16642/datastream/OBJ/view.

OWEB. 2023. Oregon Watershed Restoration Inventory. https://www.oregon.gov/oweb/data-reporting/Pages/owri.aspx. Accessed March 15, 2023.

OWEB. 2023a. Oregon Watershed Restoration Inventory Online. https://apps.wrd.state.or.us/apps/oweb/owrio/default.aspx. Accessed March 15, 2023.

BLM (U.S. Department of the Interior, Bureau of Land Management). 2016. *Northwestern & Coastal Oregon record of decision and resource management plan.*

USFS and BLM (U.S. Department of Agriculture, Forest Service; U.S. Department of the Interior, Bureau of Land Management). 1994. *Record of decision for amendments to Forest Service and Bureau of Land Management planning documents within the range of the northern spotted owl*.

Roon D.A., Dunham J.B., Groom J.D. 2021. Shade, light, and stream temperature responses to riparian thinning in second-growth redwood forests of northern California. *PLoS ONE* 16(2):e0246822

Appendix A: Proposed list of responsible persons including designated management agencies

No.	Designated Management Agencies/Responsible Persons	DMA Type	Acres Within Project Area
1	Albany & Eastern Railroad	Railroad	10.2
2	Benton County	County	71.7
3	Bonneville Power Administration	Special District	21.2
4	Central Oregon & Pacific Railroad	Railroad	19.6
5	City of Albany	City	104.2
6	City of Canby	City	0.3
7	City of Corvallis	City	192.1
8	City of Cottage Grove	City	307.5
9	City of Creswell	City	9.5
10	City of Dundee	City	19.7
11	City of Eugene	City	600.6
12	City of Gates	City	82
13	City of Gladstone	City	137
14	City of Happy Valley	City	66.2
15	City of Harrisburg	City	31.1
16	City of Independence	City	101.3
17	City of Jefferson	City	44.1
18	City of Keizer	City	87.4
19	City of Lake Oswego	City	33.4
20	City of Lebanon	City	54.1
21	City of Lyons	City	29.8
22	City of McMinnville	City	3.1
23	City of Mill City	City	119
24	City of Millersburg	City	22.7
25	City of Milwaukie	City	52.5
26	City of Monroe	City	63.6
27	City of Newberg	City	6.5
28	City of Oregon City	City	159.6
29	City of Portland	City	1651.5
30	City of Salem	City	667.4
31	City of Springfield	City	158.9
32	City of St. Helens	City	2.1
33	City of Stayton	City	209.7
34	City of Sweet Home	City	151.5
35	City of Waterloo	City	6.5
36	City of West Linn	City	338.2

37	City of Wilsonville	City	143.8
38	Clackamas County	County	419.1
39	Columbia County	County	89.8
40	Lane County	County	2519.4
41	Linn County	County	906.5
42	Marion County	County	315.9
43	Multnomah County	County	2.5
44	Oregon Department of Agriculture	State	13939.8
45	Oregon Department of Aviation	State	5
46	Oregon Department of Fish and Wildlife	State	237.1
47	Oregon Department of Forestry - Private	State	1877.2
48	Oregon Department of Forestry - Public	State	62.9
49	Oregon Department of Geology and Mineral Industries	State	106.1
50	Oregon Department of State Lands	State	87.8
51	Oregon Department of Transportation	State	760.6
52	Oregon Pacific Railroad	Railroad	0.3
53	Oregon Parks and Recreation Department	State	1557.5
54	Polk County	County	73.4
55	Port of Portland	Special District	1.7
56	Portland & Western Railroad	Railroad	22.1
58	U.S. Army Corps of Engineers	Federal	128.4
59	U.S. Bureau of Land Management	Federal	256.1
60	U.S. Department of Agriculture	Federal	0.7
61	U.S. Fish and Wildlife Service	Federal	36.2
63	Union Pacific Railroad	Railroad	48.2
64	Yamhill County	County	46

INSERT Appendix B: Acres of jurisdiction, by HUC, within 350 ft of stream centerline for each DMA

INSERT Appendix C: Graphs showing designated management agency jurisdiction by subbasin and within 350 feet of a stream

INSERT Appendix D: NPDES Permit Issuance Dates

INSERT Appendix E: List of Large Reservoirs in the Willamette Mainstem TMDL Project Area